Hospital admissions for oral health-related conditions in Western Australia: a ten-year analysis

Esther Kruger-Claassen
BChD (Stellenbosch) MChD (Stellenbosch)

This thesis is presented for the degree of Doctor of Philosophy of The University of Western Australia

School of Anatomy, Physiology and Human Biology

2016
This thesis is dedicated to the memory of my husband, Johann Claassen.
Abstract

The Australian dental health system is facing many challenges. The population is growing fast and ageing rapidly. The public sector is under-resourced, whilst the private sector, currently providing most services, is operating in a free-market system, driven by economy and business. Those that rely on the public sector, or those unable to afford private services, are facing various barriers accessing services. Multiple social and socio-economic determinants also come into play and contribute to a situation where marginalised subgroups within the Australian population suffer from poor oral health. For many, this situation leads to hospital admission to obtain care.

The aims of this research were to examine those hospital admissions (for oral-health related conditions), and determine who gets admitted for what, for how long, at what cost, and to project future scenarios based on the decade worth of baseline data.

Oral health inequalities are clearly reflected in hospital admissions. Hospital admissions are strongly associated with age, Aboriginal status, socio-economic background, insurance status, and geographical area of residence. Admissions for potentially preventable conditions are increasing over time. There are significant differences in the mix of conditions that various subgroups are admitted to hospital for. The high socio-economic background, non-Aboriginal, urban person gets admitted for very different conditions than the poor, Aboriginal, rural person. Projections to the year 2030 indicate increases in hospital admission rates, with major cost and resource implications.

Based on these findings, it becomes clear that a focus purely on strategies that revolve around providing more dental services to more people, and making it more affordable, is unlikely to solve all problems on a population level. It will improve access to primary care, but not address other societal and socio-economic determinants of disease. Recognition that lifestyle choices are severely restricted amongst the most marginalised and disadvantaged groups in the population, can no longer be ignored in attempts to reduce health inequalities.
# Table of contents

Abstract................................................................................................................................. i
Table of Contents...................................................................................................................... ii
List of Tables ............................................................................................................................. viii
List of Figures .......................................................................................................................... x
List of Abbreviations ............................................................................................................... xii
Acknowledgements ............................................................................................................... xiv
Statement of Candidate Contribution .................................................................................. xv
Publications arising from thesis ........................................................................................... xvi

**Chapter One** ....................................................................................................................... 1
  1. Introduction ....................................................................................................................... 2

**Chapter Two** ...................................................................................................................... 8
  2. Literature Review .............................................................................................................. 8
    2.1. The Health System in Australia ................................................................................. 9
    2.1.1. Complexities of the Australian Health System .................................................... 9
    2.1.2. Types of Healthcare ............................................................................................... 13
        2.1.2.1. Primary Care .................................................................................................. 13
        2.1.2.2. Secondary Care ............................................................................................. 14
        2.1.2.3. Hospitals ....................................................................................................... 14
    2.1.3. Funding of the Health System .............................................................................. 14
    2.1.4. Medicare ............................................................................................................... 15
    2.1.5. Private Health Insurance ...................................................................................... 16
    2.2. The Dental Health System in Australia ................................................................. 17
    2.2.1. The Dental Workforce ......................................................................................... 18
    2.2.2. Public Dental Services ......................................................................................... 19
        2.2.2.1. General Oral Health Services for Disadvantaged Adults.......................... 20
        2.2.2.2. Specialist Dental Care for Disadvantaged Adults................................. 21
    2.2.3. Private Dental Care .............................................................................................. 21
    2.2.4. Dental Insurance ................................................................................................. 22
    2.2.5. Expenditure on Dental Health ............................................................................. 22
        2.2.5.1. Individual Private Expenditure ................................................................. 23
        2.2.5.2. Private Health Expenditure ....................................................................... 23
        2.2.5.3. Government Expenditure ......................................................................... 23
        2.2.5.4. State/Territory Government Expenditure .............................................. 23
        2.2.5.5. Department of Veterans Affairs Expenditure ...................................... 24
2.3. Oral Health Services in Western Australia ........................................... 25
  2.3.1. Dental Health Services ............................................................... 26
    2.3.1.1. Public Dental Services ....................................................... 26
    2.3.1.2. Private Dental Services ..................................................... 28
  2.3.2. The Dental Workforce in WA ..................................................... 28
  2.3.3. Challenges Facing the Dental Health System ............................... 29
    2.3.3.1. Workforce Distribution ..................................................... 29
    2.3.3.2. Rural and Remote Services ............................................... 31
    2.3.3.3. Ageing Population ........................................................... 31
    2.3.3.4. Affordability of Services .................................................... 31
    2.3.3.5. Prevention of Disease ....................................................... 32
  2.4. Health and Oral Health .............................................................. 33
  2.4.1. Oral health of Australian Adults ............................................. 34
  2.4.2. Inequalities in Oral Health ..................................................... 36
    2.4.2.1. Age and Gender ............................................................... 36
    2.4.2.2. Socio-Economic Disadvantage ............................................. 39
    2.4.2.3. Indigenous Status ............................................................ 42
    2.4.2.4. Geographical location ....................................................... 46
  2.5. Hospitalisations for Oral Conditions ........................................... 48
    2.5.1. The term “Hospitalisation” ................................................. 48
    2.5.2. Potentially Preventable Hospitalisations .................................. 52
    2.5.3. Conditions leading to Hospitalisation .................................... 53
      2.5.3.1. Removal of Embedded and Impacted Teeth ................................ 54
      2.5.3.2. Dental Caries ................................................................. 58
      2.5.3.3. Diseases of the Pulp and Peri-apical conditions .................. 60
      2.5.3.4. Fractures of the jaws, teeth, nasal bone, palate, lower facial bones ................................................................. 65
      2.5.3.5. Oral and Oropharyngeal Cancers ....................................... 68
      2.5.3.6. Gingivitis and Periodontal Disease .................................... 69
      2.5.3.7. Dentofacial Anomalies ..................................................... 71
  2.6. Conclusion ..................................................................................... 74

Chapter Three .......................................................................................... 73
3. Aims and Hypothesis ........................................................................... 77
  3.1. Aims .............................................................................................. 78
    3.1.1. Older patients ......................................................................... 78
    3.1.2. Aboriginal and Torres Strait Islander patients .......................... 78
    3.1.3. Potentially Preventable hospitalisations .................................. 79
    3.1.4. Socio-Economic Disadvantage ................................................. 79
    3.1.5. Rural and Remote patients ....................................................... 79
    3.1.6. Future Projections ................................................................. 80
  3.2. Hypotheses ..................................................................................... 80
Chapter Four ................................................................. 83
  4. Materials and Methods ......................................................... 83
    4.1. Ethics ........................................................................... 84
    4.2. Study Population ........................................................... 84
    4.3. Hospitalisation Data ......................................................... 86
    4.4. Principal Diagnosis ........................................................... 86
    4.5. Population Rates ............................................................... 88
    4.6. Aboriginality ................................................................. 89
    4.7. Accessibility and Remoteness .............................................. 89
    4.8. Socio-economic Status ....................................................... 90
    4.9. Costs ........................................................................... 91
    4.10. Projections ................................................................. 92
    4.11. Statistical Analysis .......................................................... 93

Chapter Five ................................................................. 94
  5. Hospital admissions of older people for oral health related conditions over ten years: implications for the future ......................................................... 94
    5.1. Abstract ........................................................................ 95
    5.2. Introduction ................................................................... 96
    5.3. Materials and Method ......................................................... 97
    5.4. Results ......................................................................... 101
      5.4.1. Incidence ................................................................. 101
      5.4.2. Cost and Bed-Days ...................................................... 104
      5.4.3. Projections ............................................................... 105
      5.4.4. Conditions ............................................................... 105
    5.5. Discussion ................................................................. 108
    5.6. Conclusion .................................................................. 112

Chapter Six ................................................................. 113
  6. Potentially preventable hospital separations related to oral health: a 10-year analysis .................................................................. 113
    6.1. Abstract ........................................................................ 114
    6.2. Introduction ................................................................... 115
    6.3. Materials and Methods ......................................................... 117
    6.4. Results ......................................................................... 120
      6.4.1. Demographics and Rates ............................................ 120
      6.4.2. Trends Analysis ......................................................... 122
      6.4.3. Mix of Conditions ...................................................... 123
      6.4.4. Costs and Bed-days .................................................. 125
    6.5. Discussion ................................................................. 126
    6.6. Conclusion .................................................................. 131
Chapter Seven .................................................................................................................................................. 132
7. Ten years of hospitalisation for oral health related conditions in Western Australia: an unjust dichotomy .......................................................................................................................... 132
  7.1. Abstract.................................................................................................................................................. 133
  7.2. Introduction........................................................................................................................................ 134
  7.3. Materials and Methods ........................................................................................................................ 135
  7.4. Results................................................................................................................................................ 138
    7.4.1. Demographics ............................................................................................................................ 138
    7.4.2. Age-standardised population rates .............................................................................................. 138
    7.4.3. Costs, insurance status and length of stay ................................................................................. 140
    7.4.4. Mix of conditions by Aboriginality ............................................................................................. 140
    7.4.5. Trends over time .......................................................................................................................... 141
  7.5. Discussion .......................................................................................................................................... 143
  7.6. Conclusion .......................................................................................................................................... 147

Chapter Eight .................................................................................................................................................. 149
8. Fractures of the mandible and maxilla: a ten year analysis................................................................. 149
  8.1. Abstract.............................................................................................................................................. 150
  8.2. Background...................................................................................................................................... 151
  8.3. Methods.......................................................................................................................................... 153
  8.4. Results.............................................................................................................................................. 155
    8.4.1. Demographics ............................................................................................................................ 155
    8.4.2. Costs and bed-............................................................................................................................ 156
    8.4.3. Rates.......................................................................................................................................... 156
    8.4.4. Socio-economic disadvantage .................................................................................................. 159
    8.4.5. Accessibility and Remoteness .................................................................................................... 160
  8.5. Discussion .......................................................................................................................................... 160
  8.6. Conclusion .......................................................................................................................................... 164

Chapter Nine .................................................................................................................................................. 165
9. Socio-economic disadvantage and oral-health related hospital admissions: a ten-year analysis................................................................. 165
  9.1. Abstract.............................................................................................................................................. 166
  9.2. Introduction...................................................................................................................................... 167
  9.3. Methods and Materials...................................................................................................................... 169
  9.4. Results.............................................................................................................................................. 172
    9.4.1. Demographics ............................................................................................................................ 172
    9.4.2. Principal Diagnosis .................................................................................................................... 174
    9.4.3. Trends over time .......................................................................................................................... 174
    9.4.4. Socio-economic status and length-of-stay, cost and insurance status ........................................... 177
    9.4.5. Socio-economic status and principal diagnosis ......................................................................... 177
  9.5. Discussion .......................................................................................................................................... 180
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.7.2. Pulp and peri-apical conditions</td>
<td>249</td>
</tr>
<tr>
<td>12.7.3. Malignancies</td>
<td>249</td>
</tr>
<tr>
<td>12.8. Future projections</td>
<td>250</td>
</tr>
<tr>
<td>12.9. Limitations of the Study</td>
<td>252</td>
</tr>
<tr>
<td>12.10. Future research</td>
<td>254</td>
</tr>
<tr>
<td>12.11. Conclusions</td>
<td>255</td>
</tr>
<tr>
<td>References</td>
<td>258</td>
</tr>
<tr>
<td>Appendices</td>
<td>278</td>
</tr>
</tbody>
</table>

- Ethics Approval A
- International Classification of Diseases (ICD 10 - AM)- Classification numbers B
- Publication: *Hospital admissions of older people for oral health related conditions over ten years: implications for the future* C
- Publication: *Potentially preventable hospital separations related to oral health: a 10-year analysis* D
- Publication: *Ten years of hospitalisation for oral health related conditions in Western Australia: an unjust dichotomy* E
- Publication: *Fractures of the mandible and maxilla: a ten year analysis* F
- Publication: *Socio-economic disadvantage and oral-health related hospital admissions: a ten-year analysis* G
List of Tables

Table 5.1: Hospitalisations of patients older than 65 over ten years in Western Australia.................................................................................................................................................. 102
Table 5.2: DRG costs and length-of-stay over ten years and by age-group......... 104
Table 5.3: Mix of oral health related conditions that patients over the age of 65 years were admitted to hospital for, over a ten-year period in WA.......................... 106
Table 5.4: Mix of oral health related conditions that patients between ages 65 and 74 years were admitted to hospital for, over a ten-year period in WA.............. 107
Table 5.5: Mix of oral health related conditions that patients older than 75 years were admitted to hospital for, over a ten-year period in WA........................................ 107
Table 6.1: Rates of avoidable hospitalisations by age, Aboriginal status, SEIFA and ARIA, over ten years.............................................................................................................. 121
Table 6.2: Mix of conditions, all avoidable oral health related hospitalisations over ten years in Western Australia, by Aboriginal status.................................................. 124
Table 6.3: Mix of conditions, all avoidable oral-health related hospitalisations, over ten years in WA, percentages per age group......................................................... 125
Table 7.1: Hospital admissions for oral health related conditions among adults in Western Australia over a ten-year period................................................................. 139
Table 8.1: Jaw fracture rates by age, gender and Aboriginal status, over ten years, in WA.......................................................................................................................... 157
Table 8.2: Distribution of jaw fractures cases over ten years by area Socio-Economic Index of Disadvantage (SEIFA) quintiles................................................................. 159
Table 8.3: Distribution of jaw fractures cases over ten years by area remoteness index (ARIA) classification......................................................................................... 160
Table 9.1: Variables contributing to the Index of Relative Socio-Economic Disadvantage (IRSD).............................................................................................................. 171
Table 9.2: Characteristics of all adult oral health-related hospital admissions over ten years in WA................................................................. 173

Table 9.3: Hospitalisation rates over ten years by IRSD quintile....................... 175

Table 9.4: Insurance status, length of stay, and cost over ten years by IRSD quintile.................................................................................. 177

Table 9.5: Odds ratios (and 95% confidence intervals) for principal diagnosis at admission, by age group, in relation to socio-economic disadvantage of area of residence.................................................................................. 179

Table 10.1: Remoteness and Accessibility Index of Australia............................ 193

Table 10.2: Oral health-related hospitalisations by different variables and across accessibility and remoteness (ARIA) categories......................................................... 195

Table 11.1. Demographics of baseline ten-year data......................................... 216
List of Figures

Figure 2.1: Map of Australia, indicating individual States and Territory borders ............ 11

Figure 2.2: Health services funding and responsibility ................................................. 13

Figure 2.3: Rate of hospital separations for hospitalisations requiring general anaesthesia for procedures related to dental conditions, by sex and age group, 2011–12 .................................................................................................................. 50

Figure 2.4: Hospital separation rate for hospitalisations requiring general anaesthesia for procedures related to dental conditions, by sex and age group, Aboriginal and Torres Strait Islander peoples, 2011–1 ................................................... 51

Figure 5.1: Rate increase (per 1000) in hospitalisation over ten years, by age group ... 103

Figure 5.2: Projection of hospitalisation rates (per 1000) of people over the age of 65 to the year 2025, using two methods ................................................................. 105

Figure 6.1: Changes in hospitalisation rates (per 1000) over ten years, by age group ... 122

Figure 6.2: Hospitalisation rates (per 1000) over ten years by Aboriginal status ...... 123

Figure 7.1: Conditions leading to oral health related hospital admissions among WA adults, over ten years ........................................................................................................... 141

Figure 7.2: Conditions leading to oral health related hospital admissions among WA adults, over ten years, for Aboriginal patients ................................................................. 142

Figure 7.3: Conditions leading to oral health related hospital admissions among WA adults, over ten years, for non-Aboriginal patients ............................................................ 143

Figure 8.1: Hospitalisation rates (per 1000 population) for jaw fractures in Western Australia over a decade, by age group ............................................................................ 158

Figure 9.1: Rates of hospitalisation over ten years by IRSD quintile ................................ 176

Figure 9.2: Hospitalisation rates by age group and relative socio-economic disadvantage .................................................................................................................. 176
Figure 10.1: Oral health-related hospitalisation rates over time for each ARIA category. 197

Figure 10.2: Oral health-related hospitalisation rates over time for each ARIA category, with the exception of the diagnosis category “Removal of embedded and impacted teeth”. 198

Figure 10.3: Rates of hospitalisations for impacted teeth, caries, disorders of teeth/supporting structures, fractures and malignancies, across ARIA categories. 199

Figure 10.4: Rates of hospitalisations for pulp conditions, jaw diseases, jaw fractures, dentofacial anomalies and gingivitis and periodontitis, across ARIA categories. 200

Figure 11.1: Projections of adult oral-health hospitalisation rates by age group. 217

Figure 11.2: Projected adult oral-health related hospitalisations by area of residence. 217

Figure 11.3: Projected rates of adult hospital admissions for removal of embedded and impacted teeth. 218

Figure 11.4: Projected rates of adult hospital admissions for dental caries. 219

Figure 11.5: Projected rates of adult hospital admissions for other diseases of the teeth and supporting tissues. 220

Figure 11.6: Projected rates of adult hospital admissions for jaw fractures. 221

Figure 11.7: Projected rates of adult hospital admissions for fractures of the teeth, nasal bone, palate, and lower facial bones. 221

Figure 11.8: Projected rates of adult hospital admissions for oral malignant neoplasms. 222

Figure 11.9: Projected rates of adult hospital admissions for pulp and peri-apical conditions. 223

Figure 11.10: Projected rates of other diseases of the jaws. 223

Figure 11.11: Projected increase in direct costs for adult hospital admissions for all oral conditions, lowest and highest estimates. 225
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAR</td>
<td>Age Adjusted Rate</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACCD</td>
<td>Australian Consortium for Classification Development</td>
</tr>
<tr>
<td>ACHR</td>
<td>Australian Centre for Health Research</td>
</tr>
<tr>
<td>AHMAC</td>
<td>Australian Health Ministers’ Advisory Council</td>
</tr>
<tr>
<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
</tr>
<tr>
<td>AMS</td>
<td>Aboriginal Medical Service</td>
</tr>
<tr>
<td>AR-DRG</td>
<td>Australian Refined Diagnosis Related Groups</td>
</tr>
<tr>
<td>ARIA</td>
<td>Accessibility and Remoteness Index of Australia</td>
</tr>
<tr>
<td>BCCA</td>
<td>British Columbia Cancer Agency</td>
</tr>
<tr>
<td>CDC</td>
<td>Centre for Disease Control</td>
</tr>
<tr>
<td>CEHSEU</td>
<td>Clinical epidemiology and health service evaluation unit</td>
</tr>
<tr>
<td>CDDS</td>
<td>Chronic Disease Dental Scheme</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CPDSS</td>
<td>Country Patients Dental Disease Subsidy</td>
</tr>
<tr>
<td>DHS</td>
<td>Dental Health Services</td>
</tr>
<tr>
<td>DRISS</td>
<td>Dental Relocation Infrastructure Support Scheme</td>
</tr>
<tr>
<td>DRG</td>
<td>Diagnostic Related Group</td>
</tr>
<tr>
<td>ED</td>
<td>Emergency Department</td>
</tr>
<tr>
<td>HMDS</td>
<td>Hospital Morbidity Data System</td>
</tr>
<tr>
<td>HSCIC</td>
<td>Health and Social Care Information Centre</td>
</tr>
<tr>
<td>ICD10-AM</td>
<td>International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification</td>
</tr>
<tr>
<td>IRSD</td>
<td>Index of Relative Socio-Economic Disadvantage</td>
</tr>
<tr>
<td>KAMSC</td>
<td>Kimberley Aboriginal Medical Services Council</td>
</tr>
<tr>
<td>MPDSS</td>
<td>Metropolitan Patients Dental Subsidy Scheme</td>
</tr>
<tr>
<td>NACOH</td>
<td>National Advisory Committee on Oral Health</td>
</tr>
<tr>
<td>NDTIS</td>
<td>National Dental Telephone Interview Survey</td>
</tr>
<tr>
<td>NHS</td>
<td>National Health Service</td>
</tr>
<tr>
<td>NICE</td>
<td>National Institute for Health and Care Excellence</td>
</tr>
<tr>
<td>NIDCR</td>
<td>National Institute of Dental and Craniofacial Research</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>NOHS</td>
<td>National Oral Health Survey</td>
</tr>
<tr>
<td>NSW</td>
<td>New South Wales</td>
</tr>
<tr>
<td>NT</td>
<td>Northern Territory</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
</tr>
<tr>
<td>PPH</td>
<td>Potentially Preventable Hospitalisations</td>
</tr>
<tr>
<td>QLD</td>
<td>Queensland</td>
</tr>
<tr>
<td>SA</td>
<td>South Australia</td>
</tr>
<tr>
<td>SEIFA</td>
<td>Socio-Economic Indexes for Areas</td>
</tr>
<tr>
<td>SIGN</td>
<td>Scottish Intercollegiate Guidelines Network</td>
</tr>
<tr>
<td>SLA</td>
<td>Statistical Local Area</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>US</td>
<td>United States</td>
</tr>
<tr>
<td>VIC</td>
<td>Victoria</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
</tbody>
</table>
I need to express my sincere appreciation and gratitude to my supervisors, Winthrop Professor Marc Tennant, and Emeritus Professor John McGeachie. Marc’s expertise and understanding of the work made this task so much more manageable. I appreciate his vast knowledge and experience in the fields of health services research and dental public health, and his expert skills in the management and analysis of enormous datasets. He never was, or is, too busy to assist or answer questions. I greatly benefit from his keen scientific insight every day, and have been for nearly sixteen years.

I am also grateful to Emeritus Professor John McGeachie. The depth and extent of John’s knowledge in the writing of research is unmeasurable. He is also one of the kindest, most supportive and encouraging people I have ever met.

I am thankful for the excellent atmosphere created by Marc and John in which to do research – one simply cannot ask for better supervisors.

I would also like to acknowledge the support of the Epidemiology and GIS Branch of the WA Health Department. My sincere gratitude goes to Dr Jim Codde, who developed the Rates Calculator all those years ago and kindly allowed me to use it for my research. Without this software, my analysis would have been so much more complicated. Thanks also to Peter Somerford, who was instrumental in helping me to obtain the oral health dataset. I would also like to thank Dr Alex Xiao, for assistance with my questions regarding Rates Calculator projection analysis methods.

None of this would have been possible without the love and support of my beautiful sons, Niklas and Daniel. Throughout this process they remained so patient and supportive. Their wonderful sense of humour and our laughs every day keeps reminding me of what truly is important in life.

My late husband, Dr Johann Claassen, to whom this thesis is dedicated, was the person who encouraged and motivated me to start this work in the first place. Although he will never see the end result, he will always remain and be remembered as my biggest source of inspiration.
Statement of Candidate Contribution

I hereby declare that all of the included work in this thesis is entirely my own. This research was conducted under the supervision of Winthrop Professor Marc Tennant and Emeritus Professor John McGeachie. For all the published papers, my contribution was 85%.

Dr Esther Kruger-Claassen
BChD MChD

Winthrop Professor Marc Tennant
School of Anatomy, Physiology and Human Biology

Emeritus Professor John McGeachie
School of Anatomy, Physiology and Human Biology
Publications arising from thesis

Thesis Format
The regulations of The University of Western Australia provide the option for candidates for the Degree of Doctor of Philosophy to present their thesis as a series of papers which have been published in refereed journals, manuscripts that have been submitted for publication but not yet accepted, or manuscripts that could have been submitted.

This thesis comprises of a series of published and submitted papers in peer reviewed journals, with seven of the twelve chapters in the published or submitted paper format:

Kruger E, Tennant M. Hospital admissions of older people for oral health related conditions over ten years: implications for the future. Gerodontology, 2015. doi10.1111/ger.12189 (Appendix C)


Kruger E, Tennant M. Do hospital admission rates reflect poorer oral health of rural and remote dwelling Western Australians? Submitted to Rural and Remote Health Journal.

Kruger E, Tennant M. Projecting adult hospital admissions for oral health related conditions. Submitted to Australian Health Review Journal.
Chapter 1

1. Introduction
1. Introduction

A smile can be an instant indicator of socioeconomic status, employability and self-esteem. It is also a predictor of physical health. Although the mouth is an integral part of the body, the dental health system in Australia operates in complete isolation from the rest of the health system. The Australian health care system is a very fragmented system, with an array of funding programs, and an equal array of public, private and non-government health care providers (Dwyer, 2008). Public sector health services are provided by all levels of government: local, state, territory and the Australian Government (AIHW, 2014a; Dwyer 2008). Private sector health service providers include private hospitals, medical practices and pharmacies (AIHW 2014). Although public hospitals are funded by the state, territory and Australian governments, they are managed by state and territory governments. Private hospitals are owned and operated by the private sector. Medicine and dentistry remain distinct practices that have always been treated differently by the health care system, health insurance funds, public health professionals, policymakers and government leaders. The extent of this divide is reflected in the universal health insurance scheme, Medicare: dental care is not, and has never been, covered by Medicare. As a result of dental care not being properly included in the public health system, more than 85% of dental care is provided in the private system, where market forces set the cost of care (Dudko et al, 2015), and largely determine the locations of private practices (Shiika et al, 2015; Tennant et al, 2013; Tennant and Kruger, 2013; George et al, 2011).
With public services restricted to a safety-net for disadvantaged groups in the population, a visit to the dentist remains an unaffordable luxury for many Australians. Waiting lists in the public sector are long and growing (Dudko et al, 2015), and most public dental clinics are located in cities and large regional centres (George et al, 2011; Tennant and Kruger, 2013). In such circumstances, many people are forced to seek pain relief from general medical practitioners and emergency departments, adding to the pressure on these services (Barnett et al, 2015; Barnett et al, 2016). Access to services is largely dependent on the capacity to pay.

The consequences are costly, and not just in monetary terms. National oral health surveys and statistics emphasise and confirm the divide between those with and without good oral health. Over the last few decades, overall improvements in terms of oral health of the population is evident (mostly due to prevention, introduction of fluoride and changed dental practice techniques), but many marginalised groups within the population carry the burden of very poor oral health (some 25% of the adult Australian population still have untreated dental caries) (Slade et al, 2007). In 2010-11 (the most recent data) there were 60,590 potentially preventable hospital admissions for dental conditions and 129,084 cases of general anaesthesia for dental procedures, mostly for children having extractions (AIHW, 2014a, AIHW, 2014b).

There are growing concerns about the situation, and calls to the Federal Government to address the issue, both from within and outside the health care sector. Over the years, successive Governments have introduced various Schemes and programs, aimed and
targeted at different subgroups within the population, and with varying levels of success.

The first public dental policy in Australia to attract Medicare benefits for dental services was the Chronic Dental Diseases Scheme (CDDS), introduced as part of the Enhanced Primary Care Program in 2007. (The purpose of the Enhanced Primary Care program was to provide Medicare rebates for allied health services, for people who have a chronic medical condition). It was scrapped by the Federal Government in 2013. The CDDS became the most expensive dental initiative in Australian history. Analysis of the scheme indicated that the main driver for its utilisation was increased subsidy and remuneration, rather than improvement of oral health through dental intervention (Lam et al, 2012; Lam et al, 2013).

Previous governments made efforts to address preventive services for children and tackle the long waiting lists for public dental services for adults. The 2015-16 budget announced some changes that directly relate to dental services: The Federal Government has committed $200 million to the states and territories for the delivery of dental services and continued access to the Child Dental Benefits Schedule (Government financial support scheme for basic dental services for children aged between 2 and 17 years) under a 12 month National Partnership Agreement (NPA) for 2015-16. The $200m is to be shared between the NPA ($155m) and a continuation of funding for the Child Dental Benefits Scheme (CDBS) ($45m) to be delivered through the public sector. This funding is promised for the 2015/16 year only. The Government has also announced that, although support for the Dental Relocation Infrastructure Support Scheme (DRISS) will continue, the DRISS will be "redesigned" to ensure that the right practitioner is sent to the right areas to deliver care. (The DRISS was designed to help improve dental workforce distribution and service
delivery in rural and remote areas, by providing relocation and infrastructure grants to encourage and support dentists to relocate to rural and remote area). It was also announced that the Dental Graduate Year Program (that assisted young graduates to experience the practice of dentistry in remote regions of Australia and in the public sector), is to be closed. The same will occur with the Oral Health Therapist Graduate Year Program. It was said that these schemes had little impact on the delivery of services in rural and remote areas.

It is clear that there never will be enough public funding to provide all the dental services, to all who need it, or even to all who demand it. Medicare, even without the inclusion of dental care, is already seen by some as unsustainable in its current form because of an ageing population. The solution to current problems in dental care demand a wide variety of possible strategies. All of these need to fall within the very tight constraints of limited public health resources. One factor that is clear however is that equal access to dental services for all will in all probability never be possible, and a fair system of vertical and horizontal equity might be more realistic. Horizontal equity means the provision of equal health care to those who are the same in a relevant respect (such as having the same 'need'), and vertical equity means treating differently those who are different in relevant respects (such as having different 'need') (Culyer, 2007). The ethos and philosophy of dentistry remains focused on a downstream, patient-centred, curative and rehabilitative approach to oral diseases. Whilst such services are necessary to care for those who have already suffered the consequences of oral diseases, they ultimately do not influence population oral health (Sheiham, 2000; Newton and Bower, 2005; Watt, 2007).
Dental health professionals are expected to engage in oral disease prevention, but their tools limit the approach to chairside activities, and is still based on the common notion that the major dental diseases (dental caries and periodontal disease) are behavioural diseases, and shaped by individual lifestyles. However, lifestyles also have causes and individual behaviours reflect cultural norms, expectations and opportunities that are socio-economically determined and structurally maintained. Importantly, the effects of the societal and socio-economic determinants reach way above their influences as individual attributes, and effective approaches to the prevention and control of oral diseases are aligned with this causal chain (Newton and Bower, 2005; Watt, 2007). A more balanced distribution of efforts and resources along the whole range of intervention points from the downstream curative, to the upstream structural healthy policy approaches is required if appropriate, evidence-based, effective, cost-effective, sustainable, equitable, universal, comprehensive and ethical delivery of health care, including oral health care, is the goal. Following on from these points, a focus purely on strategies that, to a very large extent, simply revolve around providing more dental services to more people, and making it more affordable, is unfortunately not going to solve all problems on a population level.

On a population level, focus on areas of concern should include strategies to prevent disease (at micro- and macro-levels), and ultimately close the gap in oral health disparities. One of the consequences of dental disease might ultimately be hospital admissions for treatment, and these hospital admissions provide a measurable indicator of disease. Strategies cannot be implemented without a sound knowledge- and evidence base regarding the specific problem (If you cannot measure it, you cannot improve it). As far back
as the nineteenth century, Florence Nightingale promoted hospital statistics as essential to improve outcomes of care (Tulchinsky and Varavikova, 2014). This should also apply to hospital statistics regarding oral conditions.

In terms of hospital admissions for dental conditions, very little analysis of dental hospital morbidity data is carried out. Population-level hospitalisation data however, is a valuable epidemiological, informational, planning, budgeting and quality control tool. Hospitalisation data can be an indication of the prevalence of conditions in the community, the functioning of the non-hospital care system or, alternatively, use of the hospital system to respond to changing needs (AIHW 2014a).

In terms of hospital admissions for oral-health related conditions, there is a need to assess “who gets admitted for what” on a population level. Trends over time need to be investigated, especially against the background of a changing demographic profile of the Australian population – the population is growing, and it is ageing rapidly. Questions around the specific conditions leading to hospitalisation; possible differences in admission rates between population subgroups; the costs involved; the associations of hospital admissions with specific demographic variables, such a poverty and rural living; as well as future projections of hospital admissions, need to be investigated.

Answers to these questions provide knowledge and information on which to base the planning and implementation of healthy policies and sound approaches to population oral health. The aims of this thesis are largely based on these questions.
Chapter 2

2. Literature Review
2.1 The health system in Australia

Oral health is an integral part of general health, and to fully comprehend the complexities surrounding the dental health system and delivery of oral health care in Australia, an understanding of the Australian health system is essential. Against many key indicators of population health, Australia performs very well relative to its international peers. Organisation for Economic Co-operation and Development (OECD), as well as Australian Institute for Health and Welfare (AIHW) data, indicate that Australians enjoy one of the longest life expectancies in the world and falling incidences of many major diseases (ACHR, 2007). This reflects the quality of Australia’s broad social policy framework as much as it reflects the quality of its health care system. Health is a function of far more than a nation’s health care system, and Australia’s health system encompasses more than just its hospital sector (ACHR, 2007). In this chapter, the health system in Australia and how it operates will be explained, including funding arrangements and public and private insurance schemes. The dental health system, the oral health workforce and funding and expenditure on dental services will be also described. This will be followed by a focus on oral health and services in WA, inequalities in health and oral health, and lastly, hospitalisations for oral health related conditions, with reference to the international literature.

2.1.1. Complexities of the Australian system

The Commonwealth of Australia was formed on 1 January 1901 when six partly self-governing British colonies united to become states of a nation. (Figure 2.1) The rules of government for this new nation were enshrined in the Australian Constitution which
defined how the Commonwealth government was to operate and what issues it could pass laws on. The Constitution created a 'federal' system of government. Under a federal system, powers are divided between a central government and individual states. In Australia, power was divided between the Commonwealth federal government and the six state governments. Although the six states joined together to form the Commonwealth of Australia, they still each retain the power to make their own laws over matters not controlled by the Commonwealth.

State governments also have their own constitutions, as well as a structure of legislature, executive and judiciary. Territories are areas within Australia's borders that are not claimed by one of the six states. Territories can be administered by the Australian Government, or they can be granted a right of self-government. The six states and the Northern Territory have established one further level of government: Local governments (also known as local councils) handle community needs. Constitutional responsibility for local government lies with the state and territory governments. Consequently, the roles and responsibilities of local government differ from state to state.

The Australian health care system is complex, especially when compared to other countries with similar federal systems (AIHW 2014a, OECD, 2015). Responsibilities are split between federal and state governments, and the result is a very fragmented system that is difficult for patients to navigate (OECD, 2015). Care coordination is
complicated even more by a division of care between “primary care” and “community health” resulting in the possibility of duplication of services, waste and inefficiency, as well as a lack of coordination (Bennett, 2013, OECD, 2015). The complexity is to some extent unavoidable, as a multi-faceted and inclusive approach is necessary to meet the health needs of Australians, which are shaped by a variety of factors, including gender, age, behaviour, residential location, and socioeconomic and cultural background (AIHW, 2014a).

Figure 2.1. Map of Australia, indicating the individual States and Territory borders.
Reflecting the array of funding programs, there is an equal array of public, private and non-government health care providers (Dwyer, 2008). Public sector health services are provided by all levels of government: local, state, territory and the Australian Government (AIHW, 2014a; Dwyer 2008). Private sector health service providers include private hospitals, medical practices and pharmacies (AIHW 2014). Although public hospitals are funded by the state, territory and Australian governments, they are managed by state and territory governments.

Private hospitals are owned and operated by the private sector. The Australian Government and state and territory governments fund and deliver a range of other health services, including population health programs, community health services, health and medical research, Aboriginal and Torres Strait Islander health services, mental health services, and health infrastructure (AIHW 2014).

The complexity of the Australian health system is illustrated in Fig. 2.2, which shows main services, funding responsibilities and providers (AIHW, 2014a).
2.1.2 Types of healthcare

2.1.2.1 Primary health care

Primary health care is the first level of contact individuals, families and communities have with the health care system (Kelleher, 2001). It includes services provided by general
medical and dental practitioners, nurses, Indigenous health workers, pharmacists and other allied health professionals such as physiotherapists, dietitians and chiropractors.

2.1.2.2. Secondary care

The primary health-care system can be considered as the gateway to the wider health system, and individuals are directed from one primary care service to another, and from primary services into secondary and other health services, and back again (AIHW, 2008a). Secondary care is medical care provided by a specialist or facility (Nicholson, 2012).

2.1.2.3. Hospitals

Australia’s hospitals (both public and private) provide a range of services for both non-admitted and admitted patients. Services for non-admitted patients include emergency department services and outpatient clinics. For admitted patients, they include emergency and planned (elective) care, maternity services, medical and surgical services, either provided on a same-day basis, or involving a stay in hospital overnight or longer (AIHW, 2013a).

2.1.3. Funding of the health system

Australia’s health care system is funded and administered by several levels of government (national, state/territory and local) and is supported by private health insurance arrangements. Australia’s national public health insurance scheme, Medicare, is funded
and administered by the Australian Government and consists of three health care components – medical services, prescription pharmaceuticals, and hospital treatment as a public patient (the latter is jointly funded by the Australian and State/Territory governments) (ABS, 2012).

Health is very expensive to provide, with total expenditure on health estimated at $154.6 billion in 2013–14, which equates to 9.8% of GDP. Governments provided $104.8 billion (or 67.8%) of total health expenditure, which represented about 25% of taxation revenue. Funding by individuals was the fastest growing area of non-government sector expenditure over the decade (AIHW 2015a).

2.1.4. Medicare

The Australian Government’s funding contributions include a universal public health insurance scheme, Medicare. Medicare provides cover for primary health care, ambulatory services and inpatient care in public hospitals. It is funded through federal tax revenue and 1.5% levy on taxable income (ABS, 2012). Private healthcare and insurance continues to exist in parallel, and provides complementary ancillary services not covered by Medicare, such as dental, physiotherapy and some equivalent inpatient services also covered by Medicare (Australian Government, 2012a). Medicare benefits are based on a schedule of fees (the Medicare Benefits Schedule, or MBS), which are set by the Australian Government after discussion with the medical profession. Practitioners are not required to adhere to the schedule (except for optometry) and can charge more than the scheduled fee. In these
instances the patient is required to pay the extra amount, often called a ‘gap’ payment (AIHW, 2014a). Through the Pharmaceutical Benefit Scheme (PBS), managed by the Department of Health and administered by Department of Human Services, the Government also subsidises some medicines (Australian Government, 2016).

2.1.5. Private health insurance

Private health insurance is not compulsory. There are two types of private health insurance: hospital policies cover hospital treatment; and general treatment policies cover ancillary treatment (e.g. ambulance services, dental services, prescription glasses, and physiotherapy). Most health funds offer combined policies that provide a packaged cover for both hospital and general treatment services. (Australian Government, 2012a). Part of the cost of being admitted as a private patient is also covered by the Australian Government through the MBS and PBS. Private patients have more control in choosing their treating doctor in hospital and may be able to reduce their waiting time for elective surgery by having treatment in a private hospital (AIHW, 2014a; Law, 2011). A person can choose to be treated as a public patient in a public hospital, even if they have private health insurance. As at 30 June 2015, 56% of Australians had private health cover, and the number of insured persons aged over 65 was 1.85 million, representing 52% of the Australian population aged over 65 (Private Healthcare Australia, 2015).
2.2. The dental health system in Australia

Medicare, the universal healthcare insurance scheme, excludes dental care (Schwarz, 2006). The majority of dental care (80–90%) is delivered through traditional fee-for-service private dental care, with or without the assistance of private insurance (Schwarz 2006; Hopkins 2007). Although some low income households do have private health insurance, most insurance policies are held by middle and high income households in Australia (Hopkins, 2007). Public dental services are funded by the State and Territory governments, and are limited to the provision of school dental services for children and a safety-net service for disadvantaged adults, pensioners, and other defined disadvantaged groups (a number of independent services providing dental care without systematic coordination or linkages to general health services) (Schwarz, 2006; Hopkins, 2007; NACOH, 2004). Restrictions in funding however have resulted in considerable waiting times for services. The accessibility problems associated with public dental services means that many people eligible for public care will instead access private care or receive no care (Hopkins, 2007).

Australia’s first national oral health plan was developed by the National Advisory Committee on Oral Health (NACOH), and endorsed by the Australian Health Minister’s Conference (AHMC) in 2004. (At the time of writing, the second National Oral Health Plan for 2015 to 2024, was still in consultation draft format). The purpose of the original plan was to ‘improve health and well-being across the Australian population by improving oral health status and reducing the burden of disease’ (NACOH, 2004). The plan identified the
following seven areas for action: promoting oral health across the population; children and adolescents; older people; low income and social disadvantaged; people with special needs; Aboriginal and Torres Strait Islander peoples; and workforce development (NACOH, 2004). Australia have water fluoridation programs currently operating. As of March 2012, artificially fluoridated drinking water is provided for 70% or more of the population in all states and territories. In Australia, dental health has improved since water fluoridation began in the 1950s and Australians born after 1970 have, on average, half the level of tooth decay of their parents’ generation.

2.2.1. The Dental Workforce

In 2012, there were about 57 dentists, 4 dental therapists, 5 dental hygienists, 3 oral health therapists and 5 dental prosthetists employed per 100,000 people in Australia. On average, dentists worked 37 hours per week. Dentists working in a clinical practice were younger (43 compared to 51 years) and worked more hours per week than those in non-clinical roles (37 compared to 34 hours). One in three practicing dentists was female (36.5%). Most dentists were employed in Major cities (79% of all employed dentists), while only 0.9% were in Remote/Very remote areas (0.9%). Major cities had the highest rates of dentists and dental hygienists, while Remote/Very remote areas had the lowest rates of all dental practitioners, except dental therapists. The largest group of dentists with specialist qualifications was orthodontists (518 or 39%). The majority of dental specialists were employed in Major cities (89%) (AIHW, 2014b).
2.2.2. Public Dental Services

The Federal Government (Commonwealth) remains responsible for the provision (directly and indirectly) of public dental services, but the responsibility for the delivery of the major programs for children and disadvantaged adults is devolved to the States and Territories (NACOH, 2004). This include the provision of oral health promotion. Increasingly these programs are being integrated into multi-function dental clinics, but the division of resources to these two programs (children and disadvantaged adults) and their interaction shapes the actual level of service delivery to child and adult Australians (Spencer and Harford, 2008).

The Commonwealth is directly involved in oral health services through Veteran’s Affairs programs, the Armed Forces and the Army Reserve Dental Scheme; university training for dentists, dental therapists, dental hygienists and oral health therapists; subsidised drugs prescribed by dentists under the PBS; dental services provided through Community Controlled Aboriginal Medical Services (CCAMS), which are Commonwealth-funded; provision of dental services to public hospital patients through the Australian Health Care Agreement; some specialist oral surgery and oral radiography through Medicare; the Cleft Palate Scheme; and dental services in the Christmas and Cocos Islands (Schwarz, 2006; NACOH, 2004). CCAMS is a primary health care service initiated and operated by local Aboriginal communities to deliver holistic, comprehensive, and culturally appropriate health care to the community which controls it (through a locally elected Board of Management).
2.2.2.1. General oral health services for disadvantaged adults

The States and Territories limit publicly funded dental care for adults to holders of concession cards issued by Centrelink, and most jurisdictions have introduced patient co-payments for these services. (Centrelink is an Australian Government agency responsible for delivering a wide range of services and unemployment benefits to Australians who find themselves on a low income or without an income. Centrelink is responsible for issuing concession cards, which enable people to access cheaper health care services and medicines. There are different types of concession and health care cards. Each card has its own eligibility requirements and concessions.)

There is significant variation between the jurisdictions in the per capita funding of dental care for eligible adults (NACOH, 2004). The capacity of the adult public dental services is extraordinarily limited. The 1,098 dentists in the public sector provide general dental care, in theory, to 4.2 million eligible adults in addition to playing a role in the school dental services. The rate of public sector dentists is 26.8 per 100,000 eligible adults (Spencer and Harford, 2008). This is in contrast to the 62.5 private general dentists per 100,000 population of adults ineligible for public dental care. It is estimated that only about 7% of all Australian adults receive dental care from public dental services in any year (Spencer and Harford, 2008). Research indicates that among concession card holders, about 50% have not made a visit in the last year, and of those who have visited in the last 12 months, only one third visited a public dental service. Of those who visited a public dental service in the last year, most, about two-thirds to three-quarters, visited for an ‘emergency’ or same day dental care. This is a one-off, main problem, ‘palliative’ dental service. Hence, only
about five percent of eligible concession card holder adults are receiving ‘primary’ dental care from the public dental services (Harford et al, 2011.)

2.2.2.2. Specialist dental care for disadvantaged adults

Specialist dental services are more complex services, provided mostly on referral from general dental providers. The States and Territories provide a limited range of specialist dental services for concession card holders. In some States, these services are provided mainly by qualified dental specialists; in others they are provided in dental teaching hospitals as part of training programs for dental specialists (NACOH, 2004).

2.2.3. Private dental care

The overwhelming majority of dental care, approximately 80-90 % is provided through private clinics, with or without the assistance of private health insurance (Hopkins 2007, Schwarz 2006). This system of dental care delivery strongly influences where and how better dental care can be delivered. Some 83% of Australian dentists are in private practice and 84% are general practitioners (Harford et al, 2011). Significant access issues relates to disadvantaged groups who are not eligible for public dental services and have difficulty accessing regular private oral health services due to cost (NACOH, 2004). The socioeconomically disadvantaged are unlikely to have dental insurance to help cover costs, and long waiting times in the public sector is another issue contributing to people not accessing care (Hopkins, 2007).
2.2.4. Dental insurance

In 2010 the National Dental Telephone Interview Survey found that, over half of all people aged 5 and over (53.8%) had some level of dental insurance. Adults aged 45–64 had significantly higher rates of dental insurance, and those aged 65 and over had significantly lower rates of insurance than other age groups. Dentate adults (having some natural teeth) who lived in Major cities were more likely to have dental insurance than those who lived in Inner regional or Outer regional areas (AIHW, 2012a; AIHW 2014a).

Over three-quarters of dentate adults in the highest household income group (76.3%) had some level of dental insurance. Less than one-third of adults in the bottom three household income groups (ranging from 27.3% to 29.8%) had dental insurance (AIHW, 2012a; AIHW 2014a). The majority of adults with insurance reported that their insurance paid some (78.7%) or all (7.8%) of the dental costs of their last visit. Only 9.4% of insured adults paid all their own dental expenses (AIHW, 2012a). Almost one-fifth of insured adults (17.3%) who were required to cover their own dental expenses said it caused a large financial burden (AIHW, 2012a; AIHW 2014a).

2.2.5. Expenditure on dental health

According to the AIHW’s latest report on national expenditure (2013-2014) (AIHW, 2015), the nation’s expenditure on dental services (at constant prices) has increased from $8,595 million in financial year 2011-12, to $8,819 million in financial year 2012-13 and $8,914
million in financial year 2013-14 (AIHW, 2015). The major contributors to dental service expenditure include the following:

- **Individual Private Expenditure**
  
  In the financial year 2013–14, individuals spent an estimated $5,336 million on dental services. (AIHW, 2015a).

- **Private Health Expenditure**
  
  Funding for dental services by private health insurance funds in financial years 2013–14 was $1,547 million, some 12% of the $12,877 million in current health expenditure by private health insurance funds. (AIHW, 2015a).

- **Australian Government Expenditure**
  
  The Australian Government outlay on dental services (excluding the Department of Veterans Affairs expenditure) continued to decline, as it was $503 million in financial years 2013-14, $854 million in FY2012-13 and $984 million in FY2011-12 (AIHW, 2015a).

- **State / Territory Government Expenditure**
  
  Expenditure by State / Territory Governments on dental services was $713 million in FY2013. In the ten years over FY2003-04 to FY2013-14 average annual growth was only 1.6% (AIHW, 2015a).
Department of Veterans Affairs Expenditure

Australian Government Department of Veterans’ Affairs (DVA) funding for dental services provided to eligible veterans and their dependents was $109 million in financial years 2013-14 (AIHW, 2015a).

From a public policy perspective it is interesting to note that the AIHW has suggested that there is some overestimation of health expenditure in the dental area. Its argument is that expenditure on orthodontics is included in dental expenditure, but the principal purpose of some of this expenditure is cosmetic and health is a secondary purpose. Thus the AIHW has suggested that some of it should probably not be part of health expenditure (AIHW 2015).
2.3. Oral health services in Western Australia (WA)

Western Australia is geographically the largest of Australia’s six states, with a total land mass of 2,529,875 square kilometres, and the second largest country subdivision in the world. It occupies the entire western third of Australia, but is home to only 11% of the total Australian population (2.6 million people), most of whom (92%) live in the southwest corner of the state (ABS, 2015). The capital city, Perth, is home to 1.7 million people, and is geographically the most isolated city in the world. Most of the state is very sparsely populated, and population density is only 0.95/km$^2$ (ABS, 2015).

The Indigenous population of the State is 3.6%. Twenty-five per cent of the population is under the age of 19 years, and 12% of the population is over the age of 65 years. According to the last census (2011), the average age in WA was 36 years. The median individual income is $662 per week and the median household income is $1415 per week (ABS, 2015).

Since 2007, WA has been the fastest growing State or Territory in Australia, and in the last few years the volume of growth has almost outstripped that of Queensland. In the period 2012-13, Western Australia’s population increased by 3.3%, or 81,300 persons. It also reached the population milestone of 2.5 million persons. This rapid growth is mainly a result of increased net migration, both from interstate and overseas (ABS, 2015).
2.3.1. Dental health services in Western Australia

Dental health services in Western Australia are provided by both the private and public sectors.

2.3.1.1. Public dental services. The Government of Western Australia, through its Dental Health Services (DHS), provides public dental services to eligible Western Australians. The DHS provides approximately 400,000 treatments per year, delivered at over 160 centres/vans/clinics state-wide. DHS is funded by the Western Australian Government, and provides free general dental care to approximately 280,000 school children aged 5 –16 years (enrolled in the School Dental Service) each year. The School Dental Service delivers services in 106 fixed clinics and 41 mobile vans across Western Australia. Western Australians, aged 17 years and older, currently holding a Health Care or Pension Concession card, are eligible for subsidised general and emergency dental care. These services are provided in General Dental Clinics throughout the state, in both metropolitan and rural and remote WA. Services are provided to approximately 73,000 patients per year (Government of WA, 2014).

The following specialised Adult Dental Services are also provided: Aged care facilities – dental screening of consenting residents; Prisoners in Department of Corrective Services’ facilities; Eligible Disability Services Commission clients in Special Needs Clinics; Medically compromised general dental care to eligible patients in three metropolitan hospitals; and

DHS also facilitates subsidised general and emergency dental care for financially or geographically eligible persons through private dental practitioners who participate in the
Country Patients’ Dental Subsidy Scheme (CPDSS), and the Metropolitan Patients’ Dental Subsidy Scheme (MPDSS) (Government of WA, 2014).

DHS has also partnered with volunteer and non-government organisations to provide dental care to rural and remote communities. These partnerships include the:

- Kimberley Dental Team - a not for profit, non-government organisation, consisting of a team of visiting volunteers from the dental profession and allied health professionals, aiming to enhance current resources and levels of care in the Kimberley region (Patel et al, 2015).

- Royal Flying Doctor Service (RFDS) - visiting dental services are provided to the remote communities of Wiluna and Warburton on a regular basis throughout the year (Bishop and Laverty, 2015).

- Kimberley Aboriginal Medical Services Council (KAMSC) - DHS is partnering with KAMSC in the provision of dental services to the Aboriginal communities of Broome, Derby, Geraldton, Kalgoorlie, Kununurra, Halls Creek and Roebourne by locating a dental clinic within an Aboriginal Medical Service (AMS) facility. Generally, the AMS-based clinics provide care at no cost to the patient (Dyson et al, 2014; Kruger et al, 2010a; Dudko et al, 2015a).
2.3.1.2. Private dental service

Most dental care in Western Australia is provided privately, with the majority (85%) of registered dentists working in the private sector. Private dental practices in WA are highly concentrated in the most populous areas of WA (metropolitan and larger regional centres) and the number of practices outside this region is very small (George et al, 2011a). Within the metropolitan region, fewer dental practices are located in areas of lower socioeconomic status than in wealthier areas. This is not unexpected because practice operation is fundamentally on a user-pays basis (George et al, 2011a). Gurbuxani et al also found that graduating dentists from the only dental school in WA, tend to mainly practice in private, high-density, high-wealth inner zones of cities, and close to their site of graduation (Gurbuxani et al, 2012).

2.3.2. The dental workforce in Western Australia

According to the latest available dental workforce survey in Australia, WA had 63.4 dentists, 0.2 oral health therapists, 11.8 dental hygienists, 15.8 dental therapists, and 3.5 dental prosthetists per 100 000 population. In 2012, there were 1543 registered dentists in WA, of whom 1467 were in the dental workforce, 286 registered dental hygienists with 263 in the workforce, 384 registered dental therapists and 353 in the workforce, 86 dental prosthetists with 81 in the workforce, and 5 oral health therapists (AIHW, 2014b). The majority of the dental workforce is employed in the private sector: 84.2 per cent of dentists;
92.7 per cent of dental hygienists; around 62 per cent of oral health therapists; and 90.5 per cent of dental prosthetists. (Australian Government, 2012a).

2.3.2. Challenges facing the dental health system in Western Australia

Several challenges face the delivery of services in Western Australia. These include access and affordability issues. Although the oral health of the Australian population has improved over the last few decades, some marginalised groups in society still experience high levels of oral disease. The Western Australian population is no exception to this (AIHW, 2008b; NACOH, 2004).

2.3.2.1. Workforce distribution

Dental health inequalities exists, and the inverse car law (Hart, 1971) applies in Western Australia, with those that suffer poorer oral health having less access and availability of services (George et al., 2011a; Shiika et al., 2015, Dyson et al., 2014; Tennant and Kruger, 2013; Tennant et al., 2013a; Tennant et al., 2013b). The oral health of rural and remote residents, socio-economically disadvantaged and Indigenous people is poorer than that of other Western Australians (AIHW, 2008b; Kruger et al., 2008; Kruger et al., 2010; AIHW, 2005).

2.3.2.1.1. The public sector

There is a maldistribution of the dental workforce, and this applies to all oral health workforce practitioners (Steele et al., 2000; Kruger and Tennant, 2010a; Kruger et al.,
The demand for dental services from eligible patients exceeds the capacity of public dental services to provide treatment, resulting in waiting lists, with historical wait times of up to 27 months reported. A long waiting time for an appointment has been identified as one of the main reasons for patient dissatisfaction (Dudko et al., 2015b).

2.3.2.1.2. Private sector

Dentists and dental services are concentrated in private practices in metropolitan, high socio-economic areas (Kruger et al., 2010a; George et al., 2011a; Tennant and Kruger, 2013). Although the shortage is most acute among public sector services, the private sector in rural areas also struggles with shortages (Kruger et al., 2010b; George et al., 2011a; Tennant and Kruger, 2013). Dental care in Australia (and in Western Australia) is fundamentally a private model, with small practices setting prices and locating themselves based on business decisions (Tennant and Kruger, 2015). The exclusion of dental services from Medicare compounds the problem for those responsible for out-of-pocket payment (Lewis, 2007; Lam et al., 2015; Barnett et al., 2015). The private sector fee-for-service arrangement strongly rests on a private health insurance base. To some extent it is this base that drives the maldistribution of services (Tennant and Kruger, 2013). Another issue that has been raised previously is that dentists in general have a strong preference for providing a biomedical model of care that targets motivated, compliant, paying patients and is mostly oriented to treatment. The emergence of corporate dentistry, implant-restricted practices,
and cosmetic central practices is also a sign that the economic goals of a free-market are influencing service delivery (Lam et al, 2015).

2.3.2.2. Rural and remote services

Western Australia’s rural and remote areas are home to disproportionally large numbers of socio-economically disadvantaged people, including large numbers of Indigenous people. In Western Australia service delivery problems are exacerbated due the extremely large geographical size of the state, resulting in small, disparate and isolated communities (Dyson et al., 2012; Dyson et al., 2014).

2.3.2.3. Ageing population

Another looming challenge is the rapidly ageing population (National Strategy, 2001). Ageing and dental health are complex issues, including the comorbidity of multiple systemic conditions, the use of many medications that might have side-effects hazardous to oral health, the diminishing ability to sustain good oral hygiene practices, and lack of access to appropriate care for the elderly or those in residential aged care (Thomson, 2014; Thomson and Ma, 2014).

2.3.2.4. Affordability of services

The high cost of dental treatment remains a barrier to obtaining care for many (NACOH, 2004; AIHW, 2008b; Hopkins, 2007; Dudko, 2015), with as much as one-fifth of the population expressing difficulty in paying a $150 bill (AIHW, 2010; Lam, 2015). The
combination of high cost of dental treatment, exacerbated in rural areas by lack of services, results in lower availability of primary dental care services. One consequence of this situation is that rural and remote patients with dental problems consult general medical practitioners (Thomas et al, 2014; Barnett et al, 2015; Barnett et al, 2016).

2.3.2.5. Prevention of disease

Water fluoridation, is known to be the most effective method on a population level to prevent dental caries (Iheozor-Ejiofor et al., 2015). Fluoridated water however, is not available to all Western Australians, and several communities in rural areas have previously been identified as areas where risk factors for dental disease are high, but where fluoridated water supplies are not available (Al-Bloushi et al., 2012; Desai et al., 2015).
2.4. Health and oral health

The word *oral* originates from the early 17th century, from the Latin *oralis*, which means “mouth” (Oxford dictionary). The mouth includes not only the teeth and the gums (gingiva) and their supporting connective tissues, ligaments, and bone, but also the hard and soft palate, the soft mucosal tissue lining of the mouth and throat, the tongue, the lips, the salivary glands, the chewing muscles, and the upper and lower jaws, which are connected to the skull by the temporomandibular joints (NIDCR, 2000). The branches of the nervous, immune, and vascular systems that animate, protect, and nourish the oral tissues, as well as provide the connections to the brain and the rest of the body, are equally important. The genetic patterning of development in utero further reveals the close relationship of the oral tissues to the developing brain and to the tissues of the face and head that surround the mouth, all structures whose location is captured in the word “craniofacial” (NIDCR, 2000).

The broadened meaning of oral health parallels the broadened meaning of health. In 1948 the World Health Organization (WHO) expanded the definition of health to mean “a complete state of physical, mental, and social well-being, and not just the absence of infirmity” (WHO, 1948). It follows that oral health must also include well-being. Good oral health means being free of chronic oral-facial pain conditions, oral and pharyngeal cancers, oral soft tissue lesions, birth defects, and multiple other diseases and disorders that affect the oral, dental, and craniofacial tissues (NIDCR, 2000). Oral health affects people physically and psychologically and influences how they grow, enjoy life, look, speak, chew, taste food and socialise, as well as their feelings of social well-being (Locker, 1997). Oral health also
affects general health by causing considerable pain and suffering and by changing what people eat, their speech and their quality of life and well-being. Oral health also has an effect on other chronic diseases (Petersen, 2003). It is important that oral health and general health not be interpreted as separate entities. Oral health is a critical component of health and must be included in the provision of health care and the design of community programs (NIDCR, 2000; Sheiham, 2005). Because of the failure to tackle social and material determinants and incorporate oral health into general health promotion, millions suffer intractable toothache and poor quality of life and end up with few teeth (Sheiham, 2005).

2.4.1. Oral health in Australian adults

Over the last decades, significant improvements have been made in reducing the extent and severity of the most common oral diseases in the Australian population, and recent history has seen marked improvements in the nation’s oral and dental health (Slade et al, 2007; AIHW, 2014a; AIHW, 2014c). Australia has experienced a significant reduction in dental caries in the last 20-30 years, particularly in children, and although the latest national oral health survey (NOHS) of Australia indicate some improvements in adults as well, there remain persistent high levels of oral disease and disability among Australian adults (Slade et al, 2007; AIHW, 2014a), especially in some groups. Poor oral health is especially evident among Aboriginal and Torres Strait Islander peoples, people on low incomes, rural and remote populations, and some immigrant groups from non-English speaking background, particularly refugees (NACOH, 2004, Slade et al, 2007).
According the latest NOHS (carried out in 2004-2006) among adults in Australia, one-quarter of Australian adults had untreated decay, and approximately one in five Australian adults had moderate (20.5% of people) or severe (2.4% of people) periodontitis. Approximately 6.4% of Australian adults were edentulous. Among the 93.6% who were dentate, an average of 4.5 teeth per person had been extracted because of dental caries or periodontitis, leaving 11.4% of people with an inadequate natural dentition (defined as fewer than 21 teeth) (Slade et al, 2007). Of dentate Australian adults, 14.9% wore one or two removable dentures. Only 7.2% of adults said that they needed a new or repaired denture, although the figure was 20.4% among people in the pre-1930 generation. Nearly six of every ten dentate adults said that they needed a dental check-up, although it was only 39.5% in the pre-1930 generation. One-third of dentate adults felt they needed an extraction or filling, a proportion that was not dissimilar from the one-quarter of dentate people found to have untreated decay (Slade et al, 2007).

Sixteen per cent of Australians rated their oral health as fair or poor, 22.6% had experienced orofacial pain in the preceding month, 15.1% had experienced toothache in the preceding 12 months, and 17.4% said that they had avoided some foods due to problems with their teeth, mouth or dentures. Thirty per cent of Australians reported avoiding dental care due to cost, 20.6% said that cost had prevented them from having recommended dental treatment and 18.2% reported that they would have a lot of difficulty paying a $100 dental bill (Slade et al, 2007). Nearly 60% of adults visited a dentist during the 12 months preceding the Survey, while only one in eight reported attending at least 5 years ago. Eighty-three percent of Australian adults attended a private dentist and 91.4% paid out of pocket for the
visit. Approximately one-half of adults usually visited a dentist at least once a year (53.1%), while 56.2% usually visited for a check-up (Slade et al, 2007).

2.4.2. Inequalities in oral health in Australia.

The results of the adult NOHS also highlighted the inequalities in oral health in Australia, as experienced by various subgroups within the population. Not everyone is experiencing the same degree of improvement in oral health. Some groups within the Australian population is profoundly marginalised from society by multiple disadvantages such as poverty, Indigenous status, illness or disability, isolation, lack of education, geographical isolation and a multitude of other factors. What amounts to “a silent epidemic” of dental and oral diseases is affecting some of these most marginalised groups—a burden of disease that restricts activities in school, work, and home, and often significantly diminishes the quality of life (NACOH, 2004; Sanders, 2007).

2.4.2.1. Age and gender.

Poor oral health is common in elderly Australians (Chalmers, 2001; Raven, 2013). Despite decreases in tooth loss over generations, some older Australians have lost enough natural teeth to have a substantial effect on their oral functioning, particularly chewing and therefore diet and nutrition. Edentulism is strongly correlated to age; in Australia less than 2% of adults aged 35-54 years have complete tooth loss but this increases to 36% for people aged 75 years or older. In 2010, approximately 21% of Australians aged 65-plus were
edentulous, which is a risk factor for poor nutrition, weight loss, and impaired communication (Chrisopoulos and Harford, 2013; Raven 2013).

Older Australians however, are now retaining more of their natural teeth for longer, and this healthy trend brings with it a substantial increase in the risk of tooth decay (Slade, 2007). This problem might be exacerbated on a national level, as the Australian population is ageing rapidly (National Strategy, 2001). In spite of the reductions in tooth loss among older adults as indicated by the NOHS, there were other adverse consequences: people aged 75+ years had prevalence rates of periodontal disease and root decay that were 2–3 times as great as the population at large. Periodontitis was also strongly associated with age, occurring among 61% of people aged older than 75 years (Slade et al, 2007).

Oral cancers are also mostly diagnosed in older age groups, and affect about twice as many men as women. Many oral cancers are associated with tobacco and alcohol use, and lip cancers are mostly associated with sun exposure (Abreu et al., 2010; Thomson, 2014; Abdelhafied et al., 2014). Studies on population level rates of oral cancer in WA all indicate strong age associations: Abdelhafied et al did projection studies on the rates of oral cancers in WA, and estimated a rise of parotid cancer incidence rates in the 60-69, and 70-79 year-old female age groups, and a marked decrease of parotid cancer among 80+ year-old males. The projected trends in this study indicate a rise of pharyngeal cancer among men but rates remaining stable among women (Abdelhafied et al, 2014). Derbi et al also confirmed the strong association of age with oral cancer incidence in a 27-year study among Western Australians. This work also highlighted the higher prevalence in males (Derbi, 2014). A WA
A study also showed that 80% of lip cancer cases among males, and 88% among females, were over the age of 40 (Kruger and Tennant, 2008). Abreu et al examined oral cancer rates in WA over a 24 year period, and showed higher rates among males, and 88% of new cases were over the age of 40, peaking in the sixth decade of life (Abreu et al, 2009; Abreu et al, 2010).

Chalmers et al have investigated the oral health of older Australians and also identified several older adult subgroups experiencing higher levels of oral diseases and conditions, including older adults with dementia, higher functional dependence living in both the community and in residential care, those of lower socio-economic status (government cardholders and no private health insurance), those living in boardinghouses with chronic mental illness, irregular dental attendees, and those with eating and swallowing problems (Chalmers 2001; Chalmers et al., 2001; Chalmers et al, 2002; Chalmers, 2003). Although the majority of older Australians are eligible to use publicly-funded dental services, several barriers limit their access to these services and few Australian public or private dental services are designed with a geriatric focus (Chalmers, 2001).

Very little information is available on the hospitalisation of older people for oral health related conditions. Smith et al did an adult WA population study over four years analysing hospitalisations (N=53 646) for oral health related conditions, and found the highest rates of admission amongst those aged 60–65 years. Those over the age of 85, stayed in hospital the longest, with an average of 5 bed days per patient (Smith et al., 2006).
2.4.2.2. Socio-economic disadvantage.

Disparities exist across socio-economic groups in Australia in respect to oral and general health. People of the lowest socio-economic status—the poor and disadvantaged—carry the highest burden of disease (AIHW 2001; Spencer 2004; Slade et al, 2007; Sanders 2007). Socio-economically disadvantaged groups include Indigenous Australians, a significant proportion of people living in rural and remote areas, the homeless, people in institutions or correctional facilities, low-income earners and their families, some young adults and older people, and some people from non-English speaking backgrounds (NACOH, 2004).

Virtually all aspects of oral disease measured in the adult NOHS (2004-2006) were more frequent and more severe among people who were eligible for public dental care and therefore were economically disadvantaged (Slade, 2007). In particular, the incidence of caries and periodontal disease increases as socio-economic status decreases. These two most common oral diseases lead to poor social and health outcomes in vulnerable populations. An AIHW report on oral health disparities in 2001 showed that uninsured low-income residents of low socioeconomic areas reported less favourable patterns of tooth loss and dental visiting compared to the privileged, including higher rates of complete tooth loss; problem-oriented dental visiting; higher rates of extractions and lower rates of fillings; longer periods since the last visit; avoiding or delaying care due to cost; and more self-reported treatment needs (AIHW, 2001).
While about 10% of the Australian population is edentulous, this rises to nearly 25 percent for Health Card holders (AIHW, 2001; NACOH, 2004). Complete tooth loss increased markedly across age groups among disadvantaged sections of the population. Less than 4% of privileged adults in any age group had lost all their natural teeth, among the deprived however, complete tooth loss was reported by nearly 7% of those aged between 25 and 44 years. This increased to almost 30% of the adults in the 45–64 year age group and more than half of those aged 65+ years (AIHW, 2001).

These disparities, as reported in 2001, remained, as indicated by the latest national survey: periodontitis occurred more frequently among people who completed year 9 or less of schooling, people with no dental insurance, those eligible for public dental care, and people who attended the dentist for treatment of dental problems (Slade et al, 2007). Although less pronounced, untreated decay was also more frequent among people with no dental insurance and those eligible for public dental care (Slade et al, 2007). Results from the most recent national dental telephone interview studies, also confirm socio-economic disparities (AIHW, 2014a): A higher proportion of adults from the lowest income households (31%) rated their oral health status as ‘fair’ or ‘poor’ than adults from the highest income households (12%).

Adults from households with an income of $110,000 or more per year were less likely than those from households with an income of less than $30,000 per year to report that they had experienced toothache. Adults in the two highest income groups were also less likely than adults in either of the two lowest income groups to be uncomfortable with their
appearance or to have avoided some foods. Cardholders were more likely than non-cardholders to report experiencing toothache, being uncomfortable with their dental appearance and avoiding some foods. Consequently, cardholders were more likely than non-cardholders to report their oral health status as ‘fair’ or ‘poor’ (AIHW, 2014a).

People with the poorest oral health should have greater access to care. Oral health care, however, is difficult to access for those on low incomes, with often years-long waiting lists for public care, while private care is often prohibitively expensive (NACOH, 2004). Dentate participants in a national telephone survey were asked whether they usually make a visit for a check-up or a dental problem. More adults from the highest income group (64.5%) and non-cardholders (64.2%) made a dental visit in the previous 12 months than those from the lowest income (51.3%) and cardholders (53.2%). More than twice as many adults from the lowest income group than from highest income group last made a dental visit 5 or more years ago. Almost twice as many cardholders as non-cardholders last made a dental visit 5 or more years ago. Adults from the two highest income groups were more likely than those from the two lowest income groups to have last visited for a check-up. More non-cardholders than cardholders last visited for a check-up while more cardholders last visited for a dental problem (AIHW, 2014).

National telephone surveys also indicated that private dental insurance coverage was strongly associated with income, the proportion of insured adults increased from 22% among those with household income of up to $20,000 to 74% of those with income of $80,000 or more (Sanders, 2007). Close to 36% of all adults with household income under
$40,000 had avoided care because of cost. Adults who would face a lot of difficulty paying a $100 dental bill had poorer oral health outcomes on tooth loss, impact on quality of life and low self-rated oral health. Even co-payments for public services may be difficult for some people, leading them to avoid or delay dental care (Sanders, 2007).

The substantial barriers to better public oral health outcomes include service rationing of oral healthcare and marginalisation of oral health in policy and funding. Dental services are one of the least subsidised areas of health (AHMAC 2001). Only one in five Health Care card holders receives dental care from a public dental clinic in any one year (AIHW 2001). There are unmet oral health needs for a substantial number of low income or “middle” income (the “working poor”) Australians who are not eligible for public dental services. Twenty six percent of people not eligible for public dental care report that they delay or avoid dental treatment because of cost (Carter and Stewart 2003).

2.4.2.3. Indigenous status.

Although the last NOHS of adult Australians provides the most current national-level information, only 1.6% of people examined were Indigenous (Indigenous people comprise approximately 2.5% of the Australian population) (Slade et al, 2007; Williams et al, 2011). The survey results showed that caries is much more common among Indigenous people than among non-Indigenous people, with the Indigenous adult population having 2.3 times more untreated caries than the non-Indigenous adult population, and 57% of Indigenous adults had one or more teeth affected compared with 25% of non-Indigenous adults (Slade
et al., 2007). The severity of caries was much higher in Indigenous people across all ages (Slade et al., 2007; Williams et al., 2011). The level of fillings was lower among Indigenous people than among their non-Indigenous counterparts. Together with their higher decay rates, these ratios suggest that service utilisation was lower, and levels of untreated caries substantially higher, among this Indigenous population than among age-matched non-Indigenous people who participated in the national oral health surveys.

Williams et al also indicated that the periodontal examinations conducted in the national survey only included 75 Indigenous individuals, and this may have distorted the differences in periodontal disease between Indigenous and non-Indigenous people (Williams et al, 2011). The survey results indicated that Indigenous adults are more likely to suffer from periodontal disease than their non-Indigenous counterparts, with approximately 1.3 times the prevalence of moderate and severe periodontitis. Indigenous people had a slightly higher prevalence of deep (4+mm) periodontal pockets and clinical attachment loss than did non-Indigenous people (Slade et al, 2007).

An Aboriginal Birth Cohort study and national oral health survey data comparison of Indigenous and non-Indigenous people aged 17-20 years demonstrates a more notable difference in periodontal diseases between the two groups: Indigenous people had 1.7 times the prevalence of calculus deposits, 1.2 times the prevalence of gingivitis, 9.5 times the prevalence of moderate or severe periodontal disease, and 11.8 times the prevalence of deep periodontal pockets than their non-Indigenous counterparts (Williams et al., 2007).
Indigenous people are affected by periodontal diseases at much younger ages than non-Indigenous people (Williams et al., 2007; Do et al., 2008). According to the national oral health survey, Indigenous people aged 15-34 years experienced almost twice the prevalence of moderate or severe periodontitis than their non-Indigenous counterparts. Compared to non-Indigenous people aged 15-34 years, Indigenous people in that age group had higher prevalences of deep periodontal pockets; clinical attachment loss; and tooth sites with deep periodontal pockets (Slade, 2007).

A Western Australian study in several Indigenous remote communities identified poor oral health in adult Indigenous patients (Smith et al., 2007). Caries experience was high (average DMFT score 8.5, sd 6.6), and advanced periodontal disease was present in 61% of all patients. Almost 88% of patients had experienced toothache in the previous six months. Almost a third of people could not remember the last time they went to the dentist. Less than half of the people reported brushing their teeth daily (40%), and a total of 52% of patients identified themselves as a ‘smoker’ of tobacco products (Smith et al., 2007).

Edentulism reflects both poor oral hygiene and past surgical approaches to the treatment of oral diseases that relied largely on extractions (Slade et al., 2007). The age distribution of edentulism for Indigenous people is noticeably different from that of the total population. The level of complete tooth loss is almost five times higher among Indigenous people aged 35-54 years than among their non-Indigenous. There was also a notable difference for those aged 55-74 years; 21% of Indigenous people suffer from edentulism compared with 14% of non-Indigenous people (Slade et al., 2007).
Injuries of the head and neck may affect dentition; and fractures (specifically of the maxilla and mandible) are directly related to tooth loss and loss of function (Kruger et al., 2006, Kruger et al., 2010c). Fracture of the skull and facial bones, with associated tooth loss, is the third most prevalent head injury in Australia; tooth loss due to head trauma can markedly reduce quality of life. After adjusting for differences in age, gender and residential location, the rate of hospitalised head injury due to assault was 21 times higher for Indigenous people living in Queensland (QLD), WA, South Australia (SA) and the Northern territory (NT) in the six year period 1 July 1999 to 30 June 2005 than for their non-Indigenous counterparts (Williams et al, 2007).

In responses to the national survey, Indigenous people were 1.5 times more likely than non-Indigenous people to rate their oral health as 'fair' or 'poor' (the two lowest measures). Toothache can be caused by pulpitis, dentin hypersensitivity, apical periodontitis, dental abscesses, alveolar osteitis, and acute necrotising ulcerative gingivitis. Data on the frequency of toothache collected in the national oral health surveys identified that Indigenous people were 1.8 times more likely than non-Indigenous people to report toothache in the previous year (27% compared with 15%) The largest difference was seen for those aged 35-54 years: 39% of Indigenous people and 15% of non-Indigenous people reported toothache (Slade et al, 2007, AIHW, 2014a).

Little information is available on hospitalisations among disadvantaged people in Australia for oral health related conditions. Smith et al found that the highest rates of adult hospitalisations for oral conditions in WA were found in those from the least disadvantaged
(wealthiest) areas. Indigenous patients had the highest rate of their total separations in the “most disadvantaged” category (Smith et al., 2006). Avoidable hospitalisation rates in a study from Victoria, Australia, for dental care has shown little association between socio-economic deprivation and hospitalisation rates (Dep. Human Services, 2007). Whyman et al however, in a recent analysis from New Zealand, indicated higher rates of dental preventable hospitalisations among the most deprived (Whyman et al., 2014).

2.4.2.4. Geographical location.

The adult NOHS identified poorer oral health outcomes for rural and remote dwellers: untreated decay, tooth wear, and unfavourable dental attendance patterns were higher amongst people living outside of capital cities (Slade et al., 2007). The national dental telephone interview surveys, also found that persons living in rural and remote locations generally have less favourable results than urban residents. The main findings include: Rural and remote dwellers were far more likely to usually visit the dentist for a problem; reported the highest level of complete tooth loss; the lowest level of dental insurance coverage; were most likely to have had a tooth extracted in the last year; and more likely to be dissatisfied with their dental health compared to urban dwellers. Remote dwellers were most likely to have not visited a dentist in the last 2 years and to have attended a public clinic at their last dental visit. There was little variation in the prevalence of toothache and avoidance of certain foods across geographic regions. Residents were equally likely to report difficulty in paying a $100 dental bill irrespective of residential location (Stewart and Ellershaw, 2012;
AIHW, 2014a). These findings confirm the findings of earlier surveys among rural dwellers (Stewart et al., 1998). Slater, in a study in Queensland, confirmed higher levels of caries diagnosis and need for oral surgery among rural dwellers, and highlights access issues to obtain services (Slater, 2001).

Very little information on the rates of adult hospitalisation for oral conditions among rural and remote residents is available, but Smith et al found a total of 23% of patients admitted for oral-related hospitalisations, were from a rural or remote areas. There was no difference in the rates of hospitalisations for oral conditions between metropolitan and rural patients. However, the average length of stay for a rural patient was significantly longer than a metropolitan patient. Metropolitan patients were slightly older than rural patients, and the cost to hospitalise a metropolitan patient was significantly lower than for a rural patient (Smith et al, 2006).
2.5 Hospitalisations for oral conditions

2.5.1. The term “hospitalisation’.

Admission to hospital is a formal process, and follows a health professional making a
decision that a patient needs to be admitted for appropriate management or treatment of
their condition, or for appropriate care or assessment of their needs. Separations (episodes
of admitted patient care) and patient days (a count of the days spent in hospital as an
admitted patient) are useful measures of admitted patient services (AIHW, 2011a). The
term ‘hospitalisation’ has been used to refer to a separation which is the episode of
admitted patient care, which can be a total hospital stay (from admission to discharge,
transfer or death) or a portion of a hospital stay beginning or ending a change in a type of
care (for example, from acute to rehabilitation) (AIHW, 2013a). ‘Separation’ also means the
process by which an admitted patient completes an episode of care by being discharged,
dying, transferring to another hospital or changing type of care. A same-day separation
occurs when a patient is admitted and separated from the hospital on the same date. An
overnight separation occurs when a patient is admitted to and separated from the hospital
on different dates (AIHW, 2013a; AIHW, 2013b)).

Admission to hospitals for dental procedures most often takes place when treatment
requires general anesthesia, and includes extractions, restorative dental work, bridges,
replantation and splinting. The AIHW collects data on hospitalisations for dental conditions
in Australia, and results for 2011-12, are shown in Figure 2.2. Hospitalisation rates for dental
conditions for Aboriginal and Torres Strait Islander people are highlighted in Figure 2.3. (AIHW, 2014a).

In 2011–12, the total number of hospital separations in Australia for dental procedures requiring a general anaesthetic was 128,712, or 5.7 separations per 1,000 population. People aged 15–24 had the highest number of separations (16.3 per 1,000 persons). Those aged 65 and over had the lowest number of separations (1.7 per 1,000 persons). For the Aboriginal and Torres Strait Islander population, the total number of hospital separations for dental procedures requiring a general anaesthetic was 5.5 per 1,000 Aboriginal and Torres Strait Islander population. Children aged 5–9 had the highest number of separations (14.9 per 1,000 children aged 5–9), followed by those aged 0–4 (10.7 per 1,000 Aboriginal and Torres Strait Islander children aged 0–4). Adults aged 65 and over had the lowest number of separations (0.7 per 1,000 Aboriginal and Torres Strait Islander persons aged 65 and over) (AIHW, 2014a).
1. Hospital separations requiring general anaesthesia for dental conditions as defined by following Australian Classification of Health interventions (ACHI) 6th edn. Block numbers and procedure codes: 457 Nonsurgical removal of tooth; 458 Surgical removal of tooth; 462 Pulp treatment; 463 Periradicular surgery; 465 Metallic restoration; 466 Tooth-coloured restoration; 468 Inlay, onlay, indirect; 469 Other restorative dental service; 470 Crown; 471 Bridge; 472 Other dental service on crown and bridge; 97241-00 Tooth root resection, per root; 97387-00 Replantation and splinting of tooth; 97388-00 Transplantation of tooth or tooth bud; 97445-00 Exploration or negotiation of calcified root canal, per canal; 97457-00 Obturation of resorption defect or perforation; 97458-00 Interim therapeutic root filling; 97772-00 Provision of resin splint, indirect; 97773-00 Provision of metal splint, indirect; 97778-00 Metallic inlay for denture tooth. 2. The separation rate used in this table (number of separations per 1,000 population) is a crude population rate based on the 2011 estimated resident population.


Figure 2.3. Rate of hospital separations for hospitalisations requiring general anaesthesia for procedures related to dental conditions, by sex and age group, 2011–12.
1. Hospital separations requiring general anaesthesia for dental conditions as defined by following Australian Classification of Health interventions (ACHI) 6th edn. Block numbers and procedure codes: 457 Nonsurgical removal of tooth; 458 Surgical removal of tooth; 462 Pulp treatment; 463 Periradicular surgery; 465 Metallic restoration; 466 Tooth-coloured restoration; 468 Inlay, onlay, indirect; 469 Other restorative dental service; 470 Crown; 471 Bridge; 472 Other dental service on crown and bridge; 97241-00 Tooth root resection, per root; 97387-00 Replantation and splinting of tooth; 97388-00 Transplantation of tooth or tooth bud; 97445-00 Exploration or negotiation of calcified root canal, per canal; 97457-00 Obturation of resorption defect or perforation; 97458-00 Interim therapeutic root filling; 97772-00 Provision of resin splint, indirect; 97773-00 Provision of metal splint, indirect; 97778-00 Metallic inlay for denture tooth. 2. The separation rate used in this table (number of separations per 1,000 population) is a crude population rate based on the 2011 estimated resident


Figure 2.4: Hospital separation rate for hospitalisations requiring general anaesthesia for procedures related to dental conditions, by sex and age group, Aboriginal and Torres Strait Islander peoples, 2011–12.
2.5.2. Potentially Preventable Hospitalisations

The term potentially preventable hospitalisations (PPH) refer to hospital separations where the principal diagnosis of the hospitalisation is thought to be avoidable if timely and adequate non-hospital care had been provided. Separation rates (or rates of completed episodes of care) for PPHs for dental conditions therefore, provide an indicator of the potential inadequacy of dental care in the community (Chrisopoulos and Harford, 2013). Those conditions considered potentially avoidable with appropriate primary care access and disease management are also described as ambulatory sensitive hospitalisations (Dep. Human Services, 2007). Dental health is integral to overall health status and dental conditions underlie approximately nine percent of all PPHs in Australia (Katterl et al., 2012). Although there was no available evidence pertaining to the effectiveness of primary dental care and reductions in PPHs, there was evidence to indicate that poor access to dental care was related to increased hospital admissions for preventable facial infections (Katterl et al., 2012).

In the 2011–12 financial year there were 63,327 PPHs for dental conditions, and 128,712 separations for dental procedures requiring a general anaesthetic (AIHW, 2014). Avoidable hospitalisation rates for dental care has also shown to be higher among rural dwellers, and children younger than 9 years, but little association between socio-economic deprivation and hospitalisation rates were found in a study from Victoria, Australia (Dep. Human Services, 2007). A recent analysis from New Zealand however, indicated higher rates of dental preventable hospitalisations among the most deprived (Whyman et al, 2014).
Amongst Indigenous people in combined data from NSW, VIC, QLD, WA, SA and NT (July 2004-June 2006), dental problems were the sixth most common reason for potentially preventable hospitalisations and a total of 3657 Indigenous people were hospitalised for a total of more than 5539 bed days (AIHW, 2008c). This dropped slightly to dental conditions being the eighth most common reason for PPHs for Indigenous people in July 2011- June 2013, admitted at a rate of about 4 per 1000 people (AIHW, 2015b) For non-Indigenous Australians, during the same time period, dental conditions were one of the top five most common conditions leading to PPHs, and the admission rate was 3 per 1000 (AIHW, 2015b).

2.5.3. Oral health related conditions leading to hospitalisations

Oral health related conditions, as classified by the International Classification of Diseases 10 – Australian Modification (ICD10-AM), (ACCD, 2014, Appendix B) refers to more than 300 specific possible diagnostic classifications. Some of these refer to very rare conditions, and for the vast majority of these classifications, very few, or no episodes of hospitalisation will take place. In this review, the most common conditions leading to hospitalisation will be examined. The literature was searched, with the focus not on the specific clinical, anatomical or physiological aspects of each condition, but on aspects regarding hospital admission for the condition, including factors such as admission rates, costs, length of stay, and other demographic variables associated with increased risk of hospital admission.
2.5.3.1. Removal of embedded and impacted teeth

The most common dental condition for which people in Western Australia are hospitalised, is for the removal of embedded or impacted teeth (Smith et al., 2006; George et al., 2011b; George et al., 2011c; Anjrini et al., 2014). Embedded teeth are individual teeth that are unerupted, usually because of a lack of eruptive force. Impacted teeth are prevented from erupting, usually by some physical barrier in the eruption path. Evidence suggests that the most common impacted teeth are the third molars (Alhlqwist et al., 1991; Kruger et al., 2001; Obiechina et al., 2001; Chu et al., 2003). In Australia by far the most common approach to addressing impacted teeth, is the use of hospital-based general anaesthesia procedures. However, it has been reported that conservative management with rigorous adhesion to specific indications for removal would reduce the surgical cases by almost 60% (Sheperd, 1993). Surgical procedures for extraction of third molar teeth are associated with significant morbidity, as has been highlighted by the evidence base underpinning the National Institute of Clinical Excellence (NICE) guidelines in Britain (NHS, 2000; SIGN, 1999).

An analysis of oral related hospitalisations in Western Australia indicated that almost 40% of all admissions were for the removal of embedded and impacted teeth (Smith et al., 2006). A study conducted over six years in WA also indicated that people between 10 and 29 years old, from high socio-economic, metropolitan areas, are more likely to be hospitalised for removal of impacted or embedded teeth (George 2011b). An Australian-wide analysis of dental general anaesthetic receipt amongst people older than 15 years, indicated that 64% of all dental general anaesthetic cases between 1998-1999 and 2004-
2005 were for the treatment of impacted teeth (Jamieson and Robert-Thomson, 2008). The costs associated with this procedure is set to increase over time: cost projections based on existing data, indicate increases from $3.3 million per 100,000 people in 2000 to close to $6.2 million per 100,000 people in 2020 in Western Australia (George et al., 2013). In Australia as a whole, this equates to $630million in 2000 and will double to over $1.2 billion dollars in 2020 (George et al., 2013).

Anjrini et al also developed a national level cost model of both the direct and indirect costs of hospitalisations for impacted teeth in Australia (Anjrini et al., 2015). The model was applied to assess the cost-effectiveness of a watchful monitoring strategy, rather than hospitalisations. The estimated number of hospitalisations for impacted teeth in Australia in 2008-2009 for the age group 15–34 years was 97,949. The estimated average annual direct cost was $350 million, the indirect cost was $181 million and total cost was $531 million. Individual cost of the watchful monitoring strategy over 20 years was $1,077, with an annual estimated cost of $53. The introduction of proposed guidelines (NHS, 2000) would lead to an annual figure of 83,850 individuals avoiding hospitalisation, and shifting to a watchful monitoring strategy, would lead to an annual reduction of costs ranging between $420–513 million (Anjrini et al, 2015).

Third molar removal has always been a controversial issue (Peterson, 1992; Sheperd, 1993; Brickley et al., 1993; Hazelkorn and Macek, 1994; Brickley et al., 1995; BSDR, 1995; BSDR, 1996; Bricley et al., 1996; Brickley et al., 1999; Renton et al., 2012; McArdle and Renton., 2012; George et al, 2013; Anjrini et al., 2014; Anjrini et al., 2015). The proponents of
prophylactic removal of impacted teeth base their arguments on long-term health benefits – which include prevention of future pathology, pain, and infection later in life which may require complicated and high-risk operations – and the long-term stability of orthodontic treatment (Peterson, 1992). On the other hand, the proponents of nonintervention argue that the probability of development of future problems is low relative to the surgical risks of nerve damage and infection, and also costs (Hazelkorn et al., 1994). Previous studies have concluded that while the most frequent reason for third molar removal in their study was pericoronitis, the next most frequent reason was that the contralateral tooth had been scheduled for removal under general anaesthesia (Brickley et al., 1996).

Because the admission to hospital for the removal of impacted teeth in Western Australia is strongly associated with factors such as Indigenous status, age, gender and private hospital access along with insurance status, equity questions arise regarding the Australian healthcare system, and the need towards keeping with current international evidence bases (George et al., 2011b; Anjrini et al., 2014; Anjrini et al., 2015). Two important but contrary issues are raised: one, the unavailability of these services to those residing outside the metro areas or their inability to afford these services; and the second, questioning the very nature of this procedure and its costs, which is so focused for those residing in urban centers (George et al., 2012).

A study comparing the rates of hospitalisation for impacted teeth removal in three countries, (England, Australia and France), revealed significant differences in rates of admission. England had rates approximately five times less than France, and seven times
less than Australia (Anjrini et al., 2014). The results could, in part, be explained by the implementation of guidelines in the United Kingdom (NHS, 2000), and the absence of similar guidelines in France and Australia. The three countries are very comparable in terms of most factors affecting third molar pathology, and the way dental services are delivered. Contributing factors such as insurance policies, cost of treatment and the numbers of oral maxillofacial surgeons, could not alone explain such substantial differences. (Anjrini et al., 2014) The impact of guidelines on the practice of third molar extraction in the UK has been reviewed by Renton (Renton et al., 2012) and by McArdle and Renton (McArdle and Renton, 2012). Between 1988 and 1994 the number of episodes for removal of impacted teeth in the UK was increasing by one-third (Liedholm, 1999). However, since the introduction of the NICE guidelines (NHS, 2000) in 1997, an overall decrease in numbers of third-molar-related hospital admissions was observed with a late slow increase since 2005. This late increase is attributed to the rebound effect, mostly caused by dental caries at an older age (Renton et al., 2012; McArdle and Renton, 2012).

The first reports on the third molar removal controversy in UK were published by Brickley and Shepherd and others (Sheperd, 1993; Brickley et al., 1993; Hazelkorn and Macek, 1994; BSDR, 1995; BSDR, 1996; Brickley et al., 1995; Bricley et al., 1996; Brickley et al., 1999). There appears to be very significant differences in the rates of hospitalisation for impacted teeth across the world and raises the potential that the presence of good-quality clinical guidelines for dental procedures, especially those requiring access to high cost health
system facilities and treatment, has the potential long-term opportunity to more efficiently, and cost effectively manage care and target it to those most in need.

2.5.3.2. Dental caries

Dental caries is one of the most prevalent chronic diseases of people worldwide, and individuals are susceptible to this disease throughout their lifetime. Dental caries forms through a complex interaction over time between acid-producing bacteria and fermentable carbohydrate, and many host factors including teeth and saliva. The disease develops in both the crowns and roots of teeth, and it can arise in early childhood as an aggressive tooth decay that affects the primary teeth of infants and toddlers. Risk for caries includes physical, biological, environmental, behavioural, and lifestyle-related factors such as high numbers of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, poor oral hygiene, inappropriate methods of feeding infants, and poverty (Selwitz, 2007).

Although data on the admission to hospital for treatment of dental caries in children is widely available, there is little information about hospital admissions of adults for treatment of caries, even though the prevalence of caries and untreated caries in the Australian adult population is high (Slade et al, 2007).

In young children, admission to hospital for the treatment of dental caries is one of the most common reasons for hospitalisations, both in Australia and internationally (Tennant
et al., 2000; Kruger et al., 2006; Meijia, 2012; HSCIC, 2013; Alsharif et al., 2014a; Stevens, 2014; Alsharif et al., 2014b). In WA children aged under 15 years, between 2000 and 2009, 50% of hospital admissions for oral conditions were due to dental caries. (AlSharif et al., 2014a; Alsharif et al., 2014b). The rates of admission for dental caries in children increased over the ten years of the study (Alsharif et al., 2014a; Alsharif et al., 2015), and the direct hospitalisation costs of dental caries increased almost threefold in 2009 (Alsharif et al., 2015). A study in the UK stated that in fluoridated water areas there were 45% fewer hospital admissions of children aged one to four for dental caries than in non-fluoridated water areas, and that water fluoridation could halve hospital admissions for dental caries (Torjesen, 2014). Another UK study amongst children highlighted an increasing trend of hospital admissions for the treatment of dental conditions over a nine year period, with most of the increased activity attributable to a 66% increase in extractions due to dental caries (Moles and Ashley, 2009).

Although dental caries is largely seen as a problem in young children, adults (and older adults) also suffer from the condition (Thomson, 2014; Thomson and Ma, 2014). The last NOHS of adults in Australia (2000-2006) found average DMFT scores for adults were high for older age groups, ranging from 3.17 for the 15–24 age group to 23.70 for those 65 and over, and the proportion of people with untreated decay was highest for 25–44 year olds (28.5%) and lowest for people aged 65 and over (21.8%) (Chrisopoulos and Harford, 2013). Available information on hospitalisation of adults for the treatment of dental caries, indicate that it is not uncommon (Smith et al., 2006, Whyman et al., 2012; Naliah et al., 2013). A 20-year review of hospitalisations in New Zealand for dental reasons identified
dental caries the reason for 76% of all admissions in all age, gender and ethnicity groups (Whyman et al, 2012).

A recent review indicated that dental caries is not only known to be active in older age groups, but continues to be the most prevalent oral health condition in older people (Thomson 2014). As the population is ageing, concerns have been expressed about increasing rates of caries among older people as they are retaining natural dentitions (Thomson 2014; Thomson and MA, 2014). A review of studies also indicated increasing and high rates of new root caries, as well as coronal caries in older adults (Griffin et al, 2004; Griffin et al., 2005). In comparison to other age groups, older adults are also hospitalised more frequently after emergency department visits for dental conditions, of which dental caries (33%) was the most common (Nalliah et al., 2013).

2.5.3.3. Diseases of the pulp and periapical tissue

This includes the following: pulpitis, necrosis of pulp, pulp degeneration, acute apical periodontitis of pulpal origin, chronic apical periodontitis, periapical abscess with sinus, periapical abscess without sinus, radicular cyst, and other or unspecified diseases of pulp and periapical tissues (ACCD, 2014). Relatively localised conditions such as infection of the pulp or periapical tissues if left untreated could spread and require hospital care (Nalliah et al., 2011).
Hospitalisations for diseases of the pulp and peri-apical tissues are very common among children and adults in Australia (Kruger et al., 2006; Smith et al., 2006; Alsharif et al., 2014a). In WA children, an analysis showed that 7% of all child oral health hospitalisations were for the treatment of pulp and peri-apical conditions (Kruger et al., 2006). A ten year study amongst WA children indicated that hospitalisations for ‘pulp and periapical’ conditions were mainly due to periapical abscess without sinus formation. It was uninsured, Indigenous, male children aged younger than 9 years, and living in the most disadvantaged areas, that were more likely to be admitted for this condition (Alsharif et al, 2014a). The condition is also responsible for the admission to hospital of many adults in WA, with pulp and peri apical diseases being one of the ten most common reasons for hospital admission over a four-year period (Smith et al., 2006).

Internationally, the condition has been shown to be responsible for not only substantial numbers of visits to hospital emergency departments, but also subsequent admission to hospital and considerable costs and numbers of bed days. (Nalliah et al., 2006; Allareddy et al., 2010; Shah et al., 2013). Whyman et al found diseases of the pulp and periapical tissues contributed to 9% in 1990-1994, and 12% in 2005-2009, of all dental condition related public hospital admissions in New Zealand (Whyman et al., 2012).

In the United States, during the year 2006, more than 400 000 emergency department (ED) visits had a primary diagnosis code for pulp and periapical diseases, with an average patient age of 33 years, and a mean hospital charge for ED visits of US$480 (Nalliah et al., 2006). Among the ED visits, 5,721 were admitted to the same hospital for inpatient care, and the
mean length of stay after hospitalisation was 2.95 days. The uninsured (40%) constituted the largest proportion of all ED visits (Nahliah et al., 2006). In 2007, also in the US, almost 8000 hospitalisations were attributed primarily to periapical abscesses, with total hospital charges of US$105.8 million, and resulting in a total of 23 000 hospitalisation days. Ninety-one percent of the hospitalisations occurred on an emergency or urgent basis. The percentage was significantly higher among uninsured patients compared to insured patients (Allareddy et al., 2010).

Shah et al, in a nine-year long study in the US, found a total of 61,439 hospitalisations were primarily attributed to periapical abscesses (Shah et al., 2013). The average age was 37 years, and 89% of all hospitalisations occurred on an emergency or urgent basis. The mean length of stay was 2.96 days, and a total of 66 patients died in hospitals. Uninsured patients accounted for 18.5% of hospitalisations. Significant predictors that influenced both hospital charges and length of stay included age, race, insurance status, a periapical abscess with sinus involvement, and geographic region of country (Shah et al., 2013).

2.5.3.3.1. Odontogenic infections

The term odontogenic infection was used in several studies in the literature. The term refers to an infection that originates within a tooth or in the closely surrounding tissues. Odontogenic infections may remain localised to the region where they started, or spread into adjacent or distant areas. It is estimated that 90-95% of all orofacial infections originate from the teeth or their supporting structures. Furthermore, about 70% of odontogenic infections occur as periapical inflammation, i.e. acute periapical periodontitis or a periapical
abscess (Fragiskos, 2007). The next most common form of odontogenic infection is the periodontal abscess (Fragiskos, 2007). Odontogenic infections may result in local, systemic, and even potentially life-threatening complications. The management of acute odontogenic infections in the hospital engenders considerable costs. As most studies did not determine the origin of these infections, the relevant literature will be discussed under the heading pulp and periapical conditions. Little information is available on nationwide or population-level hospitalisation data for odontogenic infections. Some small studies in single hospitals or centres were done however (Kim et al., 2012a; Kim et al., 2012b; Ahmad et al., 2013; Christensen et al., 2013; Klivitsky et al., 2015; Rasteniene et al., 2015).

Carter et al, in a cross-sectional national audit in the UK over a period of just two months, found that 266 episodes of cervicofacial infection of dental origin were reported during the audit period, and 81% of these patients required hospital admission, and 46% of patients required a surgical procedure under general anaesthesia (Carter et al., 2009). Anjrini et al found that over a ten-year period, 762 patients were hospitalised in WA, Australia for cellulitis. More males (59.8%) were hospitalised, the mean length-of-stay was 3.1 days, and the average direct cost estimate was AU$6,997. The number of patients admitted to hospital for this condition per year almost doubled over the study period, with the peak age group being between 20–35 years old. The Anjrini analysis also found a strong association between socio-economic status and rates of cellulitis, with poorest 1.7% of the population accounting for 34% of cellulitis cases, and Aboriginal people were almost seven times over-represented compared with non-Aboriginal Western Australians (Anjrini et al., 2015).
In the US, in 2007, Kim et al found a total of 302,507 ED visits were attributed primarily to facial cellulitis. The average age of the patients was 35 years. A total of 18% of ED visits were admitted into the same hospital for inpatient care (Kim et al., 2012). Klivitsky et al found an association between adequacy of water fluoridation and hospitalisation due to dental infections among children and adolescents in Israel. This effect is more prominent in populations of lower socioeconomic status. The authors included 1,413 hospitalisations between January 2005 and December 2011. The cities with the higher fluoride concentration reported a lower hospitalisation rate (Klivitsky et al, 2015).

Lithuanian researchers investigated the determinants of the length of hospitalisation due to acute odontogenic maxillofacial infections from 2009 to 2013. A total of 285 patients from one university dental hospital were included in the study and the mean length-of-stay in hospital was found to be 8.3 days. The length-of-stay was related to coexisting systemic conditions but not to the higher severity of dental or periodontal diseases (Rastenienė et al., 2015). A much shorter length-of-stay was found by Kim et al in a US nationwide study in 2008: a total of 4,044 hospital discharges were attributed primarily to cellulitis or abscess of mouth. The mean length of stay in hospital was 3.9 days, and the mean hospital charge was $24,290. The total USA hospitalisation charge was close to $98 million. About 88% of all hospitalisation were discharged routinely after treatment, and 2% were transferred to another short-term hospital (Kim et al, 2012a).

Ahmad et al also investigated costs associated with hospitalisation for acute odontogenic infections. A total of 327 patients were identified from hospital records of one university
hospital between 2003 and 2010. The cost of their care ranged from US$1,035 to US$252,888 (average, $9,417). Over the 8-year period, the hospital costs exceeded US$3.3 million and the charges submitted were in excess of US$10 million (Ahmad et al, 2013). A US study done by Christensen et al also investigated costs related to hospitalisation of patients admitted for odontogenic infections at one US medical centre over ten years, 2001 to 2011. In total, 318 patients were hospitalised and the average hospital bill per patient was US$17,053. The variables location of treatment, length of stay, length of stay in the intensive care unit, additional use of the operating room, and antibiotic regimen accounted for 90.2% of the variation in the hospital bill (Christensen et al., 2013).

2.5.3.4. Fractures of the jaws, teeth, nasal bone, palate and lower facial bone

Maxillofacial fractures and injuries are commonly encountered in the practice of emergency medicine, and are often associated with high morbidity resulting from various degrees of physical, functional and cosmetic consequences. Australian studies reported high numbers of people being hospitalised for trauma, and especially maxillofacial fractures (Jamieson et al., 2005; Jayarah et al., 2012; O’Meara et al., 2011; Kruger et al., 2006). The treatment of mandibular and other facial fractures both in Australia and internationally, is costly and increasing over time, especially as the costs of the use of rigid fixation to treat fractures, are high (Abubaker and Lynham, 1998; Erdmann et al., 2008; Dillon et al., 2012). Facial trauma management and care also involve several specialist groups, and subspecialities for pre-operative, operative and postoperative care (Erdmann et al, 2008; Dillon et al., 2012).
Identified factors that are associated with maxillofacial fractures incidence include age, gender, geographic region, cultural aspects, socioeconomic status, temporal and climatic influence, use of alcohol and drugs, compliance with road traffic legislation, domestic violence, and osteoporosis (Dongas and Hall, 2002; Ogundare et al, 2003; King et al, 2004; Lee, 2012; Chranovic, 2012). Australian studies however, and especially those conducted in Aboriginal communities, indicate disproportionately high levels of hospitalisations of Aboriginal people (Jamieson et al., 2005; Kruger et al., 2006) for maxillofacial injuries due to alcohol related trauma, violence and assaults (Jamieson et al., 2005; Jayaraj et al., 2012; O’Meara et al., 2011).

Previous analysis of jaw fracture hospitalisations in WA indicated disproportionately high rates of hospitalisations for Aboriginal people (Kruger et al., 2006). In this study the rates of hospitalisation for fractures were 7 times higher for Aboriginal compared to non-Aboriginal males, the rate for Aboriginal females were 22 times higher than for non-Aboriginal females, and almost four times higher than for non-Aboriginal males. The majority of fractures (80%) were among males, and most prevalent between ages 20 -29 years (Kruger et al., 2006). The numbers of mandibular fractures in the WA study were higher than maxillary fractures (Kruger et al., 2006), confirming several national and international findings (Azevedo et al., 1998; Schon et al., 2001; Dongas and Hall, 2002; Gassner et al., 2003; Erol et al., 2004; Jamieson et al., 2005; Lee, 2012; Velayutham et al., 2013). Velayutham and Al-Qamachi, in separate studies, identified maxillofacial trauma as
common amongst older people, and falls were identified as the major etiological factor in older age groups (Velayutham, 2013; AlQamachi, 2012).

A New Zealand analysis indicated a decreasing trend over time in the admissions for maxillofacial injuries over time: In 1990 maxillofacial injuries comprised 4.1% and dental injury 16.3% of reasons for dentally-related admissions. In 2009, maxillofacial injuries comprised 5.4% and dental injury 7.0% of the dentally-related hospital admissions (Whyman et al, 2012). Most of the admissions in New Zealand were amongst people aged 18-24 years, and dental and/or maxillofacial injury comprised a very small proportion of the reasons for admission amongst children aged 12 years and under. The rate of admission to hospital for dental and/or maxillofacial injuries is highest for Maori at 66.2 per 100,000 population (Whyman et al, 2012).

In a four-year retrospective study in Korea, Park identified fractures of the nasal bone as the most common fracture type (65%) of the maxillofacial region, with, in descending order, the orbital wall, maxillary wall, zygomatic arch, zygomatico-maxillary complex, mandibular symphysis, mandibular angle, mandibular condyle, and mandibular body (Park et al, 2015). A German study found midface fractures with orbital floor involvement to be the most common fracture type (Scheider et al, 2015).
2.5.3.5. Oral and oropharyngeal cancers

Oral and pharyngeal cancer, grouped together, is the sixth most common cancer in the world. The annual estimated incidence is around 275,000 for oral and 130,300 for pharyngeal cancers, excluding nasopharynx, and two-thirds of these cases occur in developing countries. There is a wide geographical variation (approximately 20-fold) in the incidence of this cancer (Warnakulasurya, 2009).

The highest incidence rates for cancers of the lip are reported in Canada and Australia. (Warnakulasurya, 2009; Abreu et al, 2010; Derbi et al, 2014). One of the most common oral health related reasons for hospitalisation among adults in Australia, and internationally, is for the treatment of oral cancer (Smith et al, 2006; Lee et al, 2014). Primary treatments of oral cancer include surgery, radiation and chemotherapy (Kademani, 2007; Hollows et al, 2007; BCCA, 2008).

A four-year analysis of adult oral health related hospitalisations in WA found treatment for malignant neoplasms to be the third most common reason for admission to hospital (Smith et al., 2006). The condition is strongly associated with age, with more cases among older people (Smith et al., 2006, Kruger and Tennant, 2008; Abreu et al., 2009; Abreu et al., 2010; Derbi et al., 2014). Lee et al found in the US a total of 17,632 hospitalisations being attributed to oral and oropharyngeal cancers in 2008. A total of 3% of patients died in the hospitals, total hospitalisation charges were close to US$1.08 billion, and oral and oropharyngeal cancers accounted for 117,472 hospitalisation bed days (mean length of stay 6.6 days) (Lee et al, 2011). A nine-year study in the US identified 146,928 hospitalisations
for oral and oropharyngeal cancers, with 5310 deaths in hospital. Mean bed days were 6.7 days, and mean hospitalisation charges ranged from US$47,331 to US$62,885 (Lee et al., 2014).

Zavras indicated that the mean total direct cost of treating oral cancer in Greece was estimated at approximately US$7,450 (Zavras et al, 2002), and Epstein, in a Californian study on oral and pharyngeal cancer, found a median year-1 cost of care following initial diagnosis was US$25,319.(Epstein et al, 2008). Jacobson et al suggested that oral, oral pharyngeal, and salivary gland cancers may be the most costly cancer to treat in the US (Jacobson et al, 2012), Hollenbeak et al concluded after a study in older patients in the US, that chemotherapy for elderly patients with oral and pharyngeal cancers costs significantly more than alternative treatments – with Medicare costs, on average, US$32,000 more over five years (Hollenbeak et al, 2015).

2.5.3.6. Gingivitis and periodontitis

Little is known about estimates of hospital admissions caused by periodontal conditions, both nationally and internationally. According the Australian Health Ministers’ Advisory Council (AHMAC), periodontal disease is the fifth most prevalent health problem among Australians. It affects the tissues and structures relating to, and supporting, teeth. Periodontal status assessment in Australian population-based studies is based on the definition used by the Centers for Disease Control and Prevention (CDC). The CDC defines
periodontal disease using a combination of deep periodontal pockets, clinical attachment loss and the number of sites affected (Page and Eke, 2007).

The NOHS found that the prevalence of moderate or severe periodontal disease was higher at older ages, and ranged from 2.7% at age 15–24 to 53.4% at age 65 and over. Males, rural and remote residents, and uninsured people were more likely to have moderate or severe periodontal disease (Chrisopolous and Harford, 2013). It is also known that periodontal diseases, including gingivitis and periodontitis, are more common among Indigenous children and adults than among their non-Indigenous counterparts (Slade et al, 2007; Jamieson et al, 2007). Children rarely develop severe periodontal disease but gingivitis is relatively common, particularly among older children (Jamieson et al, 2007).

Little is known about estimates of hospital admissions caused by periodontal conditions, both nationally and internationally. Whyman et al, in a 20-year review of dental hospitalisations in New Zealand, found that gingivitis and periodontal diseases contributed to 3.6% of all dental admissions in 1990-1994, and this decreased slightly to 2.8% of all hospitalisations in 2005-2009 (Whyman et al, 2012). The Department of Health in England reported that during 2003-2003, 0.06% of hospital consultant episodes were for gingivitis and periodontal diseases, and 99% of these required hospital admission. Just more than two-thirds (68%) of the episodes were for women, the mean age of patients was 32 years, the mean length of stay in hospital was 1.2 days, total bed-days were 1443, and 4% of all episodes required emergency hospital admission. (Hospital Episode Statistics, 2002-03).
Elangovan et al, in a study from the US, found that a total of 85,039 visits to hospital-based EDs were primarily attributed to gingival and periodontal conditions in one year (2006). The mean charge per visit was US$456.31 and total charges close to US$33.3 million. Close to 36% and 33% of all visits occurred among the lowest income group and uninsured population, respectively. Inpatient admission to the same hospital was required for 1,167 visits, and the total hospitalisation charge for this group was US$17.51 million (Elangovan et al, 2012).

2.5.3.7. Dentofacial anomalies

Smith et al, Alsharif et al, and Kruger et al. showed in previous WA studies that among children and adults, dentofacial anomalies are a common reason for hospital admission (Smith et al., 2006, Kruger et al., 2006, Alsharif et al., 2014a). The term “Dentofacial anomalies”, as defined by the ICD10,-AM, include a very wide range of developmental anomalies, including malocclusion. It also includes anomalies of jaw-size and jaw-cranial base relationship, dental-arch relationship, temporomandibular joint disorders, anomalies of tooth position of fully erupted tooth or teeth, dentofacial functional abnormalities, dental alveolar anomalies, and other unspecified dentofacial anomalies (ACCD, 2014). Surgery to correct these types of anomalies is generally referred to as orthognathic surgery.

Kruger et al in a WA study found that dentofacial anomalies was one of the most common reasons for hospital admission, contributed to 6% of all admissions, and was highest in the 13 to 17 year old age groups (Kruger et al., 2006). Alsharif et al had similar findings, with
dentofacial anomalies contributing to 6% of all oral health related admissions in children under the age of 15 years (AlSharif et al., 2014). Smith et al in a WA study of adult oral health hospitalisations found that dentofacial anomalies was the eighth most common reason for hospital admission (Smith et al., 2006).

Few population-based studies have been done on the hospitalisation of dentofacial anomaly cases, or orthognathic surgery cases. Some studies were carried out in the US and the UK. Venugoplan et al, in a nationwide study in the US in 2008, found 10,345 hospitalisations for orthognathic surgery, with an average patient age of 27 years. The mean charge per hospitalisation was US$47,348, and the total hospitalisation charge for the entire US was close to US$466.8 million. The mean length of stay was 2.95 days and the total duration of hospitalisation in the entire United States was 30,580 days (Venugoplan, 2012).

Another national US study over eight years (2000-2008) was done by Allareddy et al to examine patient and hospital level variables of all orthognathic hospital admissions. During the study period, a total of 108,264 patients underwent orthognathic surgeries in the United States. The average age ranged from 27 years during the years 2006-2008 to 28 years during the years 2000-2002 (Allareddy et al, 2013).

Garg et al carried out a study in the UK to specifically determine how long orthognathic procedures take and how long patients stay in hospital. A total of 411 cases were analysed, and results indicated that 50% of patients spent one night in hospital after bilateral sagittal split osteotomy, whereas 39% and 9% of patients spent two and three nights, respectively.
Forty-five percent of patients spent one night in hospital after Le Fort I osteotomy, whereas 34%, 13%, and 2% spent two, three, and four nights, respectively. Forty-one percent of patients spent two nights in hospital after bimaxillary osteotomy, whereas 34%, 21%, and 3% spent one, three, and four nights, respectively (Garg et al, 2010). Moles and Cunningham also investigated the changing provision of all mandibular orthognathic surgery in England over ten years between 1997 and 2006, and found a steady increase in the number of procedures over time, and a decrease in the mean time spent in hospital (Moles and Cunningham, 2009).

A study specifically looking at the costs of orthognathic surgery in the UK, comprising of 352 patients treated in 11 hospital orthodontic units between January 1995 and March 2000, was carried out by Kumar et al. They found the average total treatment cost for the tax year from 6 April 2000 to 5 April 2001 was €6360, with costs ranging from €3835 to €12150. The average operating theatre cost was €2189 and the average inpatient care (including the cost of the intensive care unit and ward stay) was €1455 (Kumar et al, 2008).

A New Zealand study by Parton et al, analysed all cases of orthognathic surgery at a teaching hospital over a three-year period, and identified 92 patients, between ages 15 and 56 years, and with a female: male ratio of 1.6:1. Most patients were from New Zealand European or European backgrounds, with only 5.5% identifying as Maori, and 3.3% as Asian (Parton et al, 2012).
2.6. Conclusion

Australia has a complex health system, and is referred to as a web of services, providers, recipients and organisational structures. This complexity however, is unavoidable in providing a multi-faceted and inclusive approach, in order to meet the health system needs of Australia’s many and varied residents. The Australian Government’s universal public health insurance scheme, Medicare, include free treatment for public patients in public hospitals, the payment of benefits or rebates for professional health services listed on the Medicare Benefits Schedule, and subsidisation of the costs of a wide range of prescription medicines under the Pharmaceutical Benefits Scheme. A person can have Medicare cover only, or a combination of Medicare and private health insurance coverage.

The dental health system however, is largely removed from the universal health care system, and dental care is not covered by Medicare. The Government does provide a safety-net of subsidised dental services for disadvantaged adults, and dental care for schoolchildren. The majority of dental care however, is funded privately, and provided in the private sector.

The way in which the dental system operates (especially in terms of care availability and accessibility), can be associated with some of the inequalities in oral health status of the Australian population. Although it is acknowledged that the determinants of health, (oral health included), is varied and include micro- and macro-level factors, accessibility problems (including all aspects of the term: affordability, availability, accommodation,
appropriateness, and spatial and physical accessibility), has been identified as contributing to poor oral health.

Although the oral health of the adult Australian population has improved over the last few decades, and are considerably better than generations ago, subgroups within the population still experience poor oral health. Marginalised groups within Australia, including Aboriginal and Torres Strait Islander peoples, people in low socio-economic groups, and those with special needs relating to a health conditions, disabilities or ageing, and rural and remote living people, experience poorer oral health.

Each year, many Australians are admitted to hospitals for treatment of oral-health related conditions. A large proportion of these hospitalisations however, are for conditions that are preventable or avoidable. Hospitalisation is associated with high direct and indirect costs (although the latter is not easy to measure). In-patient care for oral conditions remains a costly burden to the health system.

Several challenges now face the health system: meeting the increasing needs of a population that is rapidly ageing, achieving more equitable access to services across the population (a problem that is exacerbated by Australia’s extremely vast geographical land-size), and achieving this with very limited public health resources. Strategies to achieve this, need to be based on sound information, data and evidence. Hospital admissions, especially for preventable conditions, need to be limited wherever possible.
There are little data available on population level hospitalisations for oral-health related conditions in Australia, and no specific analysis of the risk indicators associated with these hospital admissions. The term “oral health-related” conditions refer to many different diseases and conditions. Specific risk-indicators for specific conditions need to be identified - strategies to prevent hospitalisations, and achieve more equitable access to primary care should be tailored for specific conditions. Hospitalisation data for preventable conditions is used internationally as indicators of access to primary care and its effectiveness, as well as a measure of the potential health gains from primary care interventions. Time-trends related to hospital admissions over time, and against a backdrop of a demographically changing population, should be analysed and used as a baseline from which future scenarios could be projected for planning purposes.

Against this backdrop, this thesis will examine hospital admissions for oral health-related conditions among adults. Hospital admissions for oral health-related conditions among children have previously been analysed and published (Alsharif A et al. 2014a, Alsharif A et al. 2014b, Alsharif A et al. 2015).

The aims of the thesis will be outlined in the next chapter.
Chapter 3

3. Aims and hypotheses
3.1. Aims

The central aim of this thesis is to examine various aspects related to episodes of hospital admission (hospitalisations) for oral-health related conditions, to all public and private hospitals in Western Australia, over a ten year period, with the focus on adult patients.

The specific aims of this research are the following:

3.1.1. Older patients - among all patients 65 year and older:

3.1.1.1. Assess the incidence of all hospitalisations per year and trends over a ten-year period;

3.1.1.2. Assess the burden of cost and bed-days over the study period;

3.1.1.3. Project future demand based on ten-year trends; and

3.1.1.4. Identify which oral-health related conditions are the biggest drivers of hospitalisation of older patients.

3.1.2. Aboriginal and Torres Strait Islander patients:

3.1.2.1. Examine the demographics of in-patient oral health care by Aboriginal status;

3.1.2.2. Identify the mix of oral conditions leading to hospital admission by Aboriginal status; and

3.1.2.3. Describe trends over a ten year period, comparing Aboriginal and non-Aboriginal groups.
3.1.3. **Potentially preventable hospitalisations:**

3.1.3.1. Assess the rates of hospitalisations for potentially preventable dental conditions;

3.1.3.2. Analyse trends over ten years in rate changes of hospitalisations; and

3.1.3.3. Analyse the mix of preventable dental conditions by age group and Aboriginal status.

3.1.4. **Socio-economic disadvantage:**

3.1.4.1. Assess the relationship of socio-economic disadvantage (using area-based measures) and trends in hospitalisations;

3.1.4.2. Assess the relationship of socio-economic disadvantage and insurance status, costs and length of stay in hospital; and

3.1.4.3. Assess the relationship of socio-economic disadvantage and specific conditions (principal diagnosis) patients were admitted for.

3.1.5. **Rural and remote dwellers:**

3.1.5.1. Determine if the poorer oral health of rural and remote (compared to urban) Western Australians are reflected in admission rates to hospitals; and

3.1.5.2. Identify the differences in admission rates for the most common dental conditions between urban and rural populations.
3.1.6. Future projections:

3.1.6.1. Project adult hospitalisation rates, with specific reference to the most common conditions, through to the year 2030.

3.2. Hypotheses

This research has the following hypotheses (with referral to oral-health related conditions over a ten-year period in WA):

**Hypothesis 1:** Hospitalisation rates of older Western Australians are low, and remaining stable over time.

**Hypothesis 2:** Current levels of hospitalisation of older persons do not place a burden on the health system in terms of costs and resources.

**Hypothesis 3:** Continuation of current trends in hospitalisation among older persons will not place an economic burden on the health system in future.

**Hypothesis 4:** Hospitalisations among older persons are not driven by any specific oral conditions.
Hypothesis 5: There are no differences in hospitalisation rates between Aboriginal and non-Aboriginal populations.

Hypothesis 6: The mix of conditions leading to hospitalisation is the same for Aboriginal and non-Aboriginal populations.

Hypothesis 7: Time trends in hospitalisation rates is the same for Aboriginal and non-Aboriginal populations.

Hypothesis 8: Time trends in relation to potentially preventable hospitalisations will remain stable.

Hypothesis 9: There are no differences in the mix of potentially preventable conditions between age groups, or between Aboriginal and non-Aboriginal population groups.

Hypothesis 10: There is no association between socio-economic status and trends in hospitalisation rates over time.

Hypothesis 11: There is no association between socio-economic status and insurance status, costs or length of stay in hospital.
Hypothesis 12: There are no associations between socio-economic status and the mix of conditions that lead to hospitalisation.

Hypothesis 13: The poorer oral health status of rural and remote residents is not reflected in rates of hospitalisation.

Hypothesis 14: The admission rates for the most common conditions are the same for rural and urban residents.

Hypothesis 15: Projection of admission rates for various conditions to the year 2030, indicate that admission rates will remain stable.
Chapter 4

4. Materials and Methods
4.1. Ethics.

This research involved the analysis of de-identified hospitalisation data from all hospitals in WA. Ethics approval for this study was obtained from the Human Research Ethics Committee at The University of Western Australia (Reference number RA/4/1/5502). This research has been carried out in accordance with the requirements of the *National Statement on Ethical Conduct in Human Research* (National Statement, NHMRC) and the policies and procedures of The University of Western Australia.

4.2. Study population.

Data between the financial years 1999-2000 and 2008-2009 were analysed. National census data from this time (2006) indicated that WA had a population of just more than 2 million (which constituted approximately 10% of the total Australian population in 2006 of 20.7 million). The total population in WA were 1,849,055 in 1999, 1,901,168 in 2001 and 2,059,614 in 2006. In 2006 3.8% of the WA population was of Aboriginal or Torres Strait Islander descent, and 34% of the Aboriginal WA population and 80% of the non-Aboriginal population resided in metropolitan Perth (ABS, 2007; ABS, 2012).

The research carried out in this thesis focused mostly on adults, and the adult population in WA (all 18 years and older), was 1,059,750 in 1999, 1,094,197 in 2001 and 1,221,799 in 2006. In 2006 2.6% of the adult WA population was of Aboriginal or Torres Strait Islander descent.
descent. Almost half (45%) of Aboriginal adults in WA lived in “Remote” or “Very Remote” areas (ABS, 2007; ABS, 2012).

In WA there are three kinds of hospitals: public hospitals managed by the WA Health; private hospitals managed by private organisations; and public hospitals run in partnership with private organisations. A patient can be admitted as either a public or private patient to a public hospital. There are 94 public hospitals in the state, 18 of these in the metropolitan area of Perth. The major public teaching hospitals in Western Australia are Royal Perth Hospital, Sir Charles Gairdner Hospital, Fremantle Hospital, King Edward Memorial Hospital for Women, and Princess Margaret Hospital for Children. There are nine major regional public hospitals: at Albany, Narrogin, Bunbury, Northam, Kalgoorlie, Geraldton, Carnarvon, Port Hedland and Derby; and 68 smaller hospitals located in country areas. Western Australia also has 36 private hospitals throughout the state. In some areas, health services are delivered by Multi-Purpose Services – combined hospital and nursing posts which are customised to meet local needs.

In Chapter 5, an analysis was undertaken on the hospitalisations of persons over the age of 65 years. The older adult population in WA (all 65 years and older), were 197 590 in 1999, 209 256 in 2001 and 242 383 in 2006. Approximately 80% of these lived in metropolitan Perth, and 0.8% was of Aboriginal or Torres Strait Islander descent (ABS, 2007; ABS, 2012).
4.3. Hospitalisation data.

Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The HMDS forms part of the Western Australian Hospital Data Linkage (WAHDLS) system, unique in Australia, and which is known for its high quality, and comprehensive population base (Holman et al., 2008). The high quality of this population based dataset allows for comprehensive health services research (Holman et al., 2008). The term ‘hospitalisation’ has been used to refer to a separation which is the episode of admitted patient care, which can be a total hospital stay (from admission to discharge, transfer or death) or a portion of a hospital stay beginning or ending a change in a type of care (for example, from acute to rehabilitation) (AIHW, 2013a). ‘Separation’ also means the process by which an admitted patient completes an episode of care by being discharged, dying, transferring to another hospital or changing type of care. A same-day separation occurs when a patient is admitted and separated from the hospital on the same date. An overnight separation occurs when a patient is admitted to and separated from the hospital on different dates (AIHW, 2013a; AIHW, 2013b)).

4.4. Principal diagnosis.

The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) (ACCD, 2016) was obtained for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. The ICD-10AM is the standard classification scheme used for reporting diagnoses in all Hospital
statistical collections (ACCD, 2016). In this study episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health related condition (see Appendix B). The principal diagnosis is the main reason why a patient is admitted. An additional diagnosis is a condition or complaint that either coexists with the principal diagnosis or arises during the episode of care (ACCD, 2016). Principal diagnosis accuracy: The reliability of the principal diagnosis (using the appropriate ICD10 code) relies on the accuracy of the clinician’s coding. The applications to which coded hospital data are directed obviously drive the need for accuracy and reliability of clinical coding, and for the development of instruments to detect coding errors (Cheng et al., 2009). The provision of appropriate funding of hospital services via the casemix-based funding model, for example, depends upon the reliability of grouping of medical conditions and procedures into Diagnosis Related Groups (DRGs), which is dependent upon the accuracy of clinical coding (Cheng et al., 2009). Issues surrounding coding errors have long been recognised, and despite the fact that their consequences can be far-reaching there remains a paucity of literature on the matter of clinical coding audits themselves, especially in oral health. Previous studies showed that whilst high level skills, and depth and currency of knowledge in clinical coding are critical for good coding and financial outcomes, the overriding need for improvement lies in the documentation but the overall accuracy of coding assigned was ‘fair’ (Cheng et al., 2009; Kearsey et al., 2001; Santos et al. 2008).

In Chapter 6 an analysis was carried out on potentially preventable dental hospitalisations. In this study (Chapter 6) hospitalisation episodes were selected on the basis of a principal
diagnosis (the primary condition under treatment) being a potentially avoidable oral health condition (Chrispoulos and Harford, 2013; Whyman et al., 2014). Potentially avoidable hospitalisations related to oral health were defined as the following: Principal diagnosis categories K02 Dental Caries, K03 Other diseases of hard tissues of teeth, K04 Diseases of the pulp and periapical tissues, K05 Gingivitis and periodontal diseases, K06 Other diseases of gingival and edentulous alveolar ridge, K08 Other disorders of teeth and supporting structures, K09.8 Other cysts of oral region, not elsewhere classified, K09.9 Cysts of oral region, unspecified, K12 Stomatitis and related lesions, K13 Other diseases of lip and oral mucosa. These categories were selected to match those used by the Australian Institute of Health and Welfare (AIHW) in reports on oral health (Chrisopoulos and Harford, 2013). The categories are identical to those used previously in other Australian and international studies (Dep Human Services, 2007; Whyman et al., 2014).

4.5. Population rates

Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics (ABS).

4.6. Aboriginality

Self-reported Aboriginality was used to compare Aboriginal to non-Aboriginal populations. Improving the accuracy of Indigenous identification in a number of data collections is an
important and ongoing body of work for all states and territories (AIHW, 2013c). It has previously been found that the quality of Indigenous identification in records of hospitalisations in public hospitals in Australia is very high, and above 90% for Western Australia (Jamieson and Roberts-Thomson, 2006; AIHW, 2013c).

4.7. **Accessibility and remoteness**

Primary place of residency at the time of hospitalisation and the geographical classification was recorded according to the Accessibility and Remoteness Index of Australia (ARIA). For each admitted person, their statistical local area (SLA) code was available. The Statistical Local Area (SLA) is an Australian Standard Geographical Classification (ASGC) defined area and a general purpose spatial unit used to collect and disseminate statistics other than those collected from the Population Censuses. In aggregate, SLAs cover the whole of Australia without gaps or overlaps. The ARIA category of each patient was based on the ARIA score of their SLA. ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centres based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (DHAC, 2001). ARIA provides a clear definition and methodology to describe and represent remoteness from goods and services for any part of Australia. It relies on road distance as a surrogate for remoteness and on the population size of a service centre as a surrogate for the availability of services (DHAC, 2001).
4.8. Socio-economic status

The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of people all over Australia. The Australian Bureau of Statistics has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA). It reflects the overall or average level of disadvantage of the population of an area. Being an average, the score is likely to reduce apparent differences between individuals in an area, and between areas: this is of particular importance for areas with larger populations. SEIFA broadly define relative socio-economic advantage and disadvantage in terms of people’s access to material and social resources, and the ability to participate in society (ABS, 2008a). SEIFA is composed of four indexes, namely: the Index of Relative Socio-Economic Disadvantage (IRSD); the Index of Relative Socio-Economic Advantage and Disadvantage; the Index of Economic Resources; and the Index of Education and Occupation. In this research, the IRSD was used as the area-based composite measure of SES, and this index is derived from several variables. These variables are defined in Chapter 9, Table 9.1. (ABS, 2008a). The IRSD score of the residential statistical local area (SLA) of each person admitted to hospital, was used a measure of socio-economic status. Each geographic area (SLA) is given a score, then ranked against all other areas in Australia, and the rankings are grouped into 5 equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas in Australia, and quintile 5 contains the 20% least disadvantaged areas in Australia (ABS, 2008a).
4.9. Cost

The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost. AR-DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital (AIHW, 2013d). Across Australia, the AR-DRG is used to calculate the cost of each patient episode on the basis of actual data about the treatment process. It is considered that Australia is a model example of a mature costing system and has the most sophisticated approach according to cost guidelines which include the actual amount of resources used in the treatment of a particular patient (Raulinajtys-Grzybek, 2014). Therefore, AR-DRG version 5.1 was used to calculate the direct cost (the Australian dollar value used according to the year of admission). Each AR-DRG represents “a class of patients with similar clinical conditions requiring similar hospital services” (AIHW, 2013d). The categorisation classifies “acute admitted patient episodes of care into groups with similar conditions and similar usage of hospital resources, using information in the hospital morbidity record such as the diagnoses, procedures and demographic characteristics of the patient” (AIHW, 2013d).

In Chapter 5, cost projections were limited to hospitalisation data of those older than 65 years, and because DRG-costs overall did not represent a normal distribution, the average for the lowest, mid and highest one third of the DRG cost distribution were calculated, and used in the cost projections, to indicate a low, mid and high range, depending on the
averages of each third. In Chapter 9, cost projections to the year 2030 were carried out. In this study, the range of DRG costs that applied to 90% of all patients were used, as this did provide a normal distribution. Average costs were then calculated from this range, and the resulting mean DRG costs were used in calculations. The annual increase used in calculations assumed that the average DRG costs (per episode) will increase at the same rate as decade-long baseline average annual increase. No indirect cost calculations were done.

4.10. Projections

In Chapter 5, projections were carried out using two methods: the first is the linear method, and the second is the exponentially weighted moving average method. The linear method uses the historical data to estimate a line of best fit for each 5-year age group, using the method of least squares. Based on the estimated age-specific rate, the future number of cases is determined. The second method, the estimated weighted moving average also uses historical trends to model future estimates. Unlike the linear methods that treat all the historical data points equally, this method places greater weight on more recent data. In Chapter 9 projections were carried out using the linear or log-linear ordinary least squares method. The accepted approach among statisticians preparing projections of this nature is to assume a linear model for increasing rates to prevent projecting admission rates below zero (AIHW, 2012b). There is a fundamental presumption in this approach that the factors that affect oral health-related hospital admissions, such as risk factors, change in an
approximately linear way with time for each age group (AIHW, 2012b). This presumption holds on condition that there are no major quantitative changes in any underlying factors, such as the introduction of an intervention program.

4.11. Statistical analysis

All rates were calculated using the Rates Calculator (Version 3). The Rates Calculator (RC) is a standalone, Windows-based statistical application developed by Dr Jim Codde, of the Epidemiology and GIS Branch, Department of Health, WA. The application was designed to simplify the calculation of Australian, and Western Australian epidemiological statistics. The Rates Calculator has been used for over a decade within the Epidemiology Branch of the Western Australian Department of Health. The results of the calculator have been validated against the same data derived from other sources. All rates were calculated per 100 000 person years, or per 1000 years, and indicated as such in the various chapters. Significant differences between rates were based on non-overlapping 95 percent confidence intervals ($p<0.05$). Means between groups were compared using ANOVA. Both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardised rates over time. All statistical analyses were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).
Chapter 5

5. Hospital admissions of older people for oral health related conditions: implications for the future

This chapter was published in the following article: Kruger E, Tennant M. Hospital admissions of older people for oral health related conditions over ten years: implications for the future. Gerodontology, 2015. doi10.1111/ger.12189 (Appendix C).
5.1. Abstract

**Objective:** This study analysed all hospitalisations of persons over the age of 65 years for oral-health related conditions, over a decade, and projected future hospitalisation rates.

**Background:** The proportion of older Australians is increasing, and their oral health is improving. At the same time, there is concern about the increasing burden that hospitalisations place on government health budgets.

**Methods:** Hospitalisation data of all patients older than 65 years, admitted to hospital for an oral-health related condition in Western Australia over a decade, were analysed.

**Results:** Over a ten-year period, a total of 11608 people over the age of 65 were admitted to hospital, with 10% 85 years and older, 52% were males, and 0.1% were Aboriginal patients. The highest rates of hospitalisation were for those from the most disadvantaged areas. Over ten years there was a significant annual increase in rates of hospitalisation (4.4%). Overall, most admissions were for “Malignant neoplasms” (16.6%), “Dental caries” (15.4%), and “Other disorders of the teeth and supporting structures” (14.3%). These three conditions accounted for almost half of all admissions (46.4%). Projections indicate high future burdens of hospitalisation.

**Conclusions:** It is of concern that hospitalisations for oral-health related reasons among the oldest patients include high numbers with potentially preventable conditions such as dental caries. Projections indicate that if current trends are set to continue, hospitalisations for oral-health related conditions among Western Australians older than 65 years will place a considerable burden on the health system.
5.2. **Introduction:**

Health expenses contributed to 19% of Australian government expenditure, and grew by 74% in real terms over the last decade (Daley et al., 2013). Growth in health spending above GDP over the past ten years was greater than the growth above GDP of all other spending combined, and the expense that did most to increase health spending, was hospital spending (Daley et al., 2013). This increase in spending on health appears to be having an impact, as life expectancy, particularly for those aged over 65, has increased rapidly and consistently over the last 40 years. The number of people aged 65+ years in Australia will rise from 2.2 million in 1997 to about 4 million in 2021 (National Strategy, 2001). Population projections predict that by 2050, 25% of the population will be aged 65 years or over, with the proportion aged 85 years or more rising from 1.5% to 5% of the population (ABS, 2009). It is predicted that this increase in the aged proportion of the population will increase the pressure on the health system. People aged 65 and over comprise 13% of the population, yet contribute to 35% of hospital admissions, and 47% of hospital occupied bed-days (Kircher et al., 2007). Using multiple estimation methods, it is projected that by 2050, people aged 65 and over will be responsible for two-thirds of all hospital bed-day utilisation (Schofield and Earnest, 2006). Because of this demographic transition, the health of the older population is becoming increasingly important to examine, with oral health no less challenging.

Findings of Australia’s most recent national dental health survey (2004-2006) indicated that oral diseases were pervasive within the adult population (Slade et al., 2007). Marked reductions were found among all age groups in levels of tooth loss and lifetime experience
of dental decay. In spite of the reductions in tooth loss among older adults, there were other adverse consequences: people aged 75+ years had prevalence rates of periodontal disease and root decay that were 2–3 times as great as the population at large (Slade et al., 2007).

Against this background, an analysis of admissions to hospitals, and the oral health conditions that drive these hospitalisations are essential in the light of increasing health resource constraints. The aim of this study was fourfold: 1) to assess the incidence of all hospitalisations per year and trends over a ten-year period among those 65 years and older in Western Australia (WA); 2) to assess the burden of cost and bed-days over the study period; 3) to project future demand based on ten-year trends; and 4) to identify which oral-health related conditions are the biggest drivers of hospitalisation of older patients in WA.

5.3. Materials and Methods:

Ethics. Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia.

Study population. WA is geographically the largest State in Australia, and in 2006 had a population of just more than 2 million (which constituted approximately 10% of the total Australian population in 2006 of 20.7 million). The older adult population in WA (all 65 years and older), were 197 590 in 1999, 209 256 in 2001 and 242 383 in 2006. Approximately 80%
of these lived in metropolitan Perth, and 0.8% were of Aboriginal or Torres Strait Islander descent (ABS, 2007).

Hospitalisation data: Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The HMDS forms part of the Western Australian Hospital Data Linkage (WAHDLS) system, unique in Australia, and known for its high quality, and comprehensive population base (Holman et al., 2008). The high quality of this population based data set allows for comprehensive health services research (Holman et al., 2008).

The term ‘hospitalisation’ has been used to refer to a separation which is the episode of admitted patient care, which can be a total hospital stay (from admission to discharge, transfer or death) or a portion of a hospital stay beginning or ending a change in a type of care (for example, from acute to rehabilitation) (AIHW, 2013a; AIHW, 2013b). ‘Separation’ also means the process by which an admitted patient completes an episode of care by being discharged, dying, transferring to another hospital or changing type of care. A same-day separation occurs when a patient is admitted and separated from the hospital on the same date. An overnight separation occurs when a patient is admitted to and separated from the hospital on different dates (AIHW, 2013a).

The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), (ACCD, 2015) was obtained for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. The ICD-10AM is the standard classification scheme used for reporting diagnoses in all Hospital
statistical collections (ACCD, 2015). In this study episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health related condition. The principal diagnosis is the main reason why a patient is admitted. An additional diagnosis is a condition or complaint that either coexists with the principal diagnosis or arises during the episode of care (ACCD, 2015).

*Population rates and cost:* Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics (ABS). The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost. AR-DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital (AIHW, 2013d). Across Australia, the AR-DRG is used to calculate the cost of each patient episode on the basis of actual data about the treatment process. It is considered that Australia is a model example of a mature costing system and has the most sophisticated approach according to cost guidelines which include the actual amount of resources used in the treatment of a particular patient (Raulinajtys-Grzybek, 2014). Therefore, AR-DRG version 5.1 was used to calculate the direct cost (the Australian dollar value used according to the year of admission). Each AR-DRG represents “a class of patients with similar clinical conditions requiring similar hospital services” (AIHW, 2013d). The categorisation classifies “acute admitted patient episodes of care into groups with similar conditions and similar usage of hospital resources, using information in the hospital morbidity record such as the diagnoses, procedures and
demographic characteristics of the patient” (AIHW, 2013d). Because DRG-costs overall does not represent a normal distribution, the average for the lowest, mid and highest one third of the DRG cost distribution were calculated, and used in the cost projections, to indicate a low, mid and high range, depending on the averages of each third.

Accessibility and remoteness: Primary place of residency at the time of hospitalisation and the geographical classification was done according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA calculates remoteness as accessibility to service centers based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (DHAC, 2001).

Socio-economic Index of Disadvantage: The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of people all over Australia. The ABS has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA) which give a summary measure of socioeconomic status for people living in specific geographic regions in Australia. Each geographic area is given a score, and then ranked against all other areas in Australia, and the rankings are grouped into 5 equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas in Australia, and quintile 5 contains the 20% least disadvantaged areas in Australia (ABS, 2008a).

Statistical analysis: All rates were calculated using the Rates Calculator, a software package developed by the Department of Health. All rates were calculated per 100 000 person years. Significant differences between rates were based on non-overlapping 95 percent
confidence intervals (p<0.05). Means between groups were compared using ANOVA. Both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardised rates over time. Projections were carried out using two methods. The first is the exponentially weighted moving average method (EWM), and the second the linear method (LM). All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).

5.4. Results:

5.4.1. Incidence: Over a ten-year period, a total of 11608 people over the age of 65 were admitted to hospitals in Western Australia for oral health related conditions. Of these, 10% were 85 years and older, 52% were males, and 0.1% was Aboriginal patients. In terms of accessibility and remoteness, most patients (70%) were from “Highly Accessible” areas, but the highest rate of hospitalisation was from “Accessible” areas (10.5 per 1000 people). In terms of disadvantage measurements, although most patients (28%) came from “Least Disadvantaged” areas, the highest rate was from “Most Disadvantaged” areas (60 per 1000). This rate was 12 times higher than that of “Least disadvantaged” areas. (Table 5.1). Males had significantly higher rates of hospitalisation than females, and Aboriginal people had significantly higher rates than non-Aboriginal people (p<0.05) (Table 5.1).
Table 5.1: Hospitalisations of patients older than 65 over ten years in Western Australia.

<table>
<thead>
<tr>
<th>Year</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>829 (7.1)</td>
<td>4.17 (3.89-4.46)</td>
</tr>
<tr>
<td>2000/01</td>
<td>941 (8.1)</td>
<td>4.61 (4.32-4.91)</td>
</tr>
<tr>
<td>2001/02</td>
<td>899 (7.7)</td>
<td>4.29 (4.14-4.57)</td>
</tr>
<tr>
<td>2002/03</td>
<td>1009 (8.7)</td>
<td>4.68 (4.39-4.97.1)</td>
</tr>
<tr>
<td>2003/04</td>
<td>1034 (8.9)</td>
<td>4.66 (4.37-4.94.7)</td>
</tr>
<tr>
<td>2004/05</td>
<td>1126 (9.7)</td>
<td>4.92 (4.63-5.21.2)</td>
</tr>
<tr>
<td>2005/06</td>
<td>1332 (11.5)</td>
<td>5.66 (5.35-5.96.5)†</td>
</tr>
<tr>
<td>2006/07</td>
<td>1407 (12.1)</td>
<td>5.78 (5.48-6.08.7)†</td>
</tr>
<tr>
<td>2007/08</td>
<td>1458 (12.6)</td>
<td>5.81 (5.51-6.11.5)†</td>
</tr>
<tr>
<td>2008/09</td>
<td>1573 (13.6)</td>
<td>6.08 (5.77-6.38.2)†</td>
</tr>
<tr>
<td>All years</td>
<td>11608 (100)</td>
<td>5.12 (5.02-5.21.6)</td>
</tr>
</tbody>
</table>

Projections:

<table>
<thead>
<tr>
<th>Method</th>
<th>Year</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EWM **</td>
<td>2024/25</td>
<td>4668 (4385-4951)*</td>
<td>8.88(8.53-9.13)</td>
</tr>
<tr>
<td>LM**</td>
<td>2024/25</td>
<td>5286 (5172-5400)*</td>
<td>9.99(9.67-10.31)</td>
</tr>
</tbody>
</table>

Age

<table>
<thead>
<tr>
<th>Age</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-69 years</td>
<td>3750 (32.3)</td>
<td>5.47 (5.01 -5.92)</td>
</tr>
<tr>
<td>70-74 years</td>
<td>3000 (25.8)</td>
<td>5.30 (5.12-5.50)</td>
</tr>
<tr>
<td>75-79 years</td>
<td>2179 (18.8)</td>
<td>4.78 (4.57-4.98)†</td>
</tr>
<tr>
<td>80-84 years</td>
<td>1480 (12.7)</td>
<td>4.85 (4.55-5.04)</td>
</tr>
<tr>
<td>85+ years</td>
<td>1199 (10.3)</td>
<td>4.77(4.55-4.99)†</td>
</tr>
<tr>
<td>All years</td>
<td>11608 (100)</td>
<td>5.12 (5.02-5.21)</td>
</tr>
</tbody>
</table>

Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>6030 (52)</td>
<td>5.82 (5.67-5.21)†</td>
</tr>
<tr>
<td>Female</td>
<td>5578 (48)</td>
<td>4.51 (4.39-4.63)†</td>
</tr>
<tr>
<td>All</td>
<td>11608 (100)</td>
<td>5.12 (5.02-5.21)</td>
</tr>
</tbody>
</table>

Aboriginal Status

<table>
<thead>
<tr>
<th>Status</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboriginal</td>
<td>157 (1)</td>
<td>9.38 (7.82-10.94)†</td>
</tr>
<tr>
<td>Non-Aboriginal</td>
<td>11451 (99)</td>
<td>5.09 (5.00-5.18)†</td>
</tr>
<tr>
<td>All</td>
<td>11608 (100)</td>
<td>5.12 (5.02-5.21)</td>
</tr>
</tbody>
</table>

ARIA

<table>
<thead>
<tr>
<th>Method</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA</td>
<td>8091 (69.7)</td>
<td>4.06.0 (3.96.7-4.15.9)</td>
</tr>
<tr>
<td>A</td>
<td>1901 (16.4)</td>
<td>10.58 (10.08 -11.11.6)†</td>
</tr>
<tr>
<td>MA</td>
<td>1085 (9.3)</td>
<td>9.97.5 (9.35.1-10.64)†</td>
</tr>
<tr>
<td>RT</td>
<td>241 (2.1)</td>
<td>7.53.1 (6.56.4-8.63.7)†</td>
</tr>
<tr>
<td>VR</td>
<td>248 (2.1)</td>
<td>4.58.9 (4.00.1- 5.26.5)</td>
</tr>
<tr>
<td>All</td>
<td>11566 (100)</td>
<td>4.89.3 (4.86.4-4.92.3)</td>
</tr>
</tbody>
</table>

SEIFA

<table>
<thead>
<tr>
<th>Level</th>
<th>N (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2170 (18.7)</td>
<td>60.04(57.43-62.76)†</td>
</tr>
<tr>
<td>2</td>
<td>2122 (18.3)</td>
<td>10.79(10.30-11.29)†</td>
</tr>
<tr>
<td>3</td>
<td>2087 (18.0)</td>
<td>2.23 (2.13-2.34)</td>
</tr>
<tr>
<td>4</td>
<td>1970 (17.0)</td>
<td>3.57 (3.40-3.74)</td>
</tr>
<tr>
<td>5</td>
<td>3238 (27.9)</td>
<td>4.98 (4.80-5.17)</td>
</tr>
<tr>
<td>All</td>
<td>11587 (100)</td>
<td>4.90 (4.87-4.93)</td>
</tr>
</tbody>
</table>

* indicate projected range of hospitalization numbers, ** EWM= Exponentially weighted moving average method, LM= Linear Method, † (Statistically significant, p<0.05) HA = Highly accessible, A=Accessible, MA=Moderately Accessible, RT=Remote, VR=Very remote. SEIFA1=most disadvantaged, SEIFAS=Least disadvantaged
Population rates indicated that over the ten-year period, there was an increase in rates of hospitalisation, with the highest rates in the last years (Table 5.1). There were an increase in rates in all age-groups (Figure 5.1). Rates were significantly higher in the last four years compared to rates in the first five years (p<0.05). Trend analysis indicated a rate ratio of 1.044, with a confidence interval (CI) of 1.03 to 1.051. The average annual change (4.44%) showed a significant (p<0.0001) increase in rate. Absolute numbers of older patients admitted increased from 829 in 1999/00 to 1573 in 2008/09. Hospitalisation rates were highest in the 65-69 year old population, and lowest in the 85+ year population. There were significantly lower rates in age groups 70-74 and 85+ years, compared to the other three age groups (P<0.05)(Table 5.1).

Figure 5.1: Rate increase (per 1000) in hospitalisation over ten years, by age group.
5.4.2. Cost and bed-days: The average number of bed-days decreased slightly over the ten-year period (Table 5.2). The average numbers of bed-days increased with each group, with the oldest (85+ years) on average spending longest (4.27 days) in hospital. DRG cost increased over the decade under study, from an average of $3593 in 1999/00 to $5524 in 2008/09 (Table 5.2).

Table 5.2: DRG costs and length-of-stay over ten years and by age-group.

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Average DRG cost* (sd)</th>
<th>Average Bed-days* (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/01</td>
<td>829</td>
<td>3593 (7824)</td>
<td>3.05 (6.60)</td>
</tr>
<tr>
<td>2000/01</td>
<td>941</td>
<td>3961 (8987)</td>
<td>3.62 (7.67)</td>
</tr>
<tr>
<td>2001/02</td>
<td>899</td>
<td>4478 (10673)</td>
<td>3.78 (8.61)</td>
</tr>
<tr>
<td>2002/03</td>
<td>1009</td>
<td>4577 (10684)</td>
<td>3.35 (6.54)</td>
</tr>
<tr>
<td>2003/04</td>
<td>1034</td>
<td>4579 (10644)</td>
<td>3.32 (6.60)</td>
</tr>
<tr>
<td>2004/05</td>
<td>1126</td>
<td>3942 (8789)</td>
<td>2.56 (5.63)</td>
</tr>
<tr>
<td>2005/06</td>
<td>1332</td>
<td>4173 (7995)</td>
<td>2.76 (5.77)</td>
</tr>
<tr>
<td>2006/07</td>
<td>1407</td>
<td>5024 (11576)</td>
<td>2.98 (6.26)</td>
</tr>
<tr>
<td>2007/08</td>
<td>1458</td>
<td>5101 (10951)</td>
<td>2.71 (5.16)</td>
</tr>
<tr>
<td>2008/09</td>
<td>1573</td>
<td>5524 (13323)</td>
<td>2.48 (6.33)</td>
</tr>
<tr>
<td>All years:</td>
<td>11608</td>
<td>4590 (10497)</td>
<td>2.99 (6.45)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age Group</th>
<th>N</th>
<th>Average DRG cost* (sd)</th>
<th>Average Bed-days* (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-69 years</td>
<td>3750</td>
<td>5136 (122970)</td>
<td>2.43 (5.34)</td>
</tr>
<tr>
<td>70-74 years</td>
<td>3000</td>
<td>4495 (1066)</td>
<td>2.69 (6.17)</td>
</tr>
<tr>
<td>75-79 years</td>
<td>2179</td>
<td>4457 (9811)</td>
<td>3.11 (6.78)</td>
</tr>
<tr>
<td>80-84 years</td>
<td>1480</td>
<td>4173 (8601)</td>
<td>3.85 (7.98)</td>
</tr>
<tr>
<td>85+ years</td>
<td>1199</td>
<td>3873 (6476)</td>
<td>4.27 (7.24)</td>
</tr>
<tr>
<td>All ages:</td>
<td>11608</td>
<td>4590 (10497)</td>
<td>2.99 (6.45)</td>
</tr>
</tbody>
</table>

Projections for 2025:

<table>
<thead>
<tr>
<th>EWM Ave</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of hospitalisations:</td>
<td>4668 (4385 -4951)</td>
</tr>
<tr>
<td>DRG Cost: Low</td>
<td>6 959 988</td>
</tr>
<tr>
<td>Mid</td>
<td>11 908 068</td>
</tr>
<tr>
<td>High</td>
<td>45 527 004</td>
</tr>
<tr>
<td>Total bed-days:</td>
<td>13 957 days</td>
</tr>
</tbody>
</table>

*average cost per person in $AUD. DRG Cost = Diagnosis Related Group cost, EWM Ave= Exponentially weighted moving average method, Linear= Linear Method
5.4.3. **Projections:** Two methods were used to project numbers of hospitalisations, based on ten year trends, for the year 2024/25 (Figure 5.2). The EWM method indicated that cases will increase to 4668 and the LM projected 5286 cases of hospitalisation per year for 65+ year olds in WA (Table 5.1). This equates to projected rates (using EWM and LM) of 8.88 and 9.99 per 1000 population respectively (Table 5.1).

![Figure 5.2: Projection of hospitalisation rates (per 1000) of people over the age of 65 to the year 2025, using two methods.](image)

5.4.4. **Conditions:** Overall, in all those admitted, most were for “Malignant neoplasms” (16.6%), “Dental caries” (15.4%), and “Other disorders of the teeth and supporting structures” (14.3%). These three conditions accounted for almost half of all admissions (46.4%). (Table 5.3). When dividing the groups into a younger (65-74 years old) and older (75+ years) group, differences can be seen in the conditions that lead to hospitalisations.
The younger group mostly get admitted for “Malignant neoplasms” (16.8%), “Other diseases of the teeth and supporting tissues” (16.8%), and “Other diseases of the jaws” (14.1%), followed by “Dental caries” (13.6%) (Table 5.4).

### Table 5.3: Mix of oral health related conditions that patients over the age of 65 years were admitted to hospital for, over a ten-year period in WA.

<table>
<thead>
<tr>
<th>Condition</th>
<th>N</th>
<th>Percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant neoplasms</td>
<td>1925</td>
<td>16.6</td>
<td>16.6</td>
</tr>
<tr>
<td>Dental caries</td>
<td>1793</td>
<td>15.4</td>
<td>32.0</td>
</tr>
<tr>
<td>Other disorders of teeth and supporting structures</td>
<td>1664</td>
<td>14.3</td>
<td>46.4</td>
</tr>
<tr>
<td>Other diseases of the jaws</td>
<td>1313</td>
<td>11.3</td>
<td>57.7</td>
</tr>
<tr>
<td>Fractures of the teeth, nasal bone, palate, lower facial bones</td>
<td>632</td>
<td>5.4</td>
<td>63.1</td>
</tr>
<tr>
<td>Benign neoplasms</td>
<td>629</td>
<td>5.4</td>
<td>68.5</td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>591</td>
<td>5.1</td>
<td>73.6</td>
</tr>
<tr>
<td>Diseases of salivary glands</td>
<td>525</td>
<td>4.5</td>
<td>78.1</td>
</tr>
<tr>
<td>Diseases of pulp and periapical tissues</td>
<td>440</td>
<td>3.8</td>
<td>81.9</td>
</tr>
<tr>
<td>Other disease of lip and oral mucosa</td>
<td>361</td>
<td>3.1</td>
<td>85.0</td>
</tr>
<tr>
<td>Stomatitis and related lesions</td>
<td>268</td>
<td>2.3</td>
<td>87.3</td>
</tr>
<tr>
<td>Diseases of the tongue</td>
<td>215</td>
<td>1.9</td>
<td>89.2</td>
</tr>
<tr>
<td>Others</td>
<td>1252</td>
<td>10.8</td>
<td>100</td>
</tr>
<tr>
<td>Total:</td>
<td>11608</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

The oldest group (75+ years) was mostly admitted for “Dental Caries” (18.1%) “Malignant neoplasms” (16.3%), “Other disorders of the teeth and supporting structures” (10.9%), and “Fractures of the teeth, nasal bone, palate, lower facial bone” (8.3%) (Table 5.5).
Table 5.4: Mix of oral health related conditions that patients between ages 65 and 74 years were admitted to hospital for, over a ten-year period in WA.

<table>
<thead>
<tr>
<th>Condition</th>
<th>N</th>
<th>Percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant neoplasms</td>
<td>1135</td>
<td>16.8</td>
<td>16.8</td>
</tr>
<tr>
<td>Other disorders of teeth and supporting structures</td>
<td>1133</td>
<td>16.8</td>
<td>33.6</td>
</tr>
<tr>
<td>Other diseases of the jaws</td>
<td>953</td>
<td>14.1</td>
<td>47.7</td>
</tr>
<tr>
<td>Dental caries</td>
<td>916</td>
<td>13.6</td>
<td>61.3</td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>385</td>
<td>5.7</td>
<td>67.0</td>
</tr>
<tr>
<td>Benign neoplasms</td>
<td>353</td>
<td>5.2</td>
<td>72.2</td>
</tr>
<tr>
<td>Diseases of pulp and periapical tissues</td>
<td>242</td>
<td>3.6</td>
<td>75.8</td>
</tr>
<tr>
<td>Diseases of salivary glands</td>
<td>239</td>
<td>3.5</td>
<td>79.3</td>
</tr>
<tr>
<td>Other disease of lip and oral mucosa</td>
<td>229</td>
<td>3.4</td>
<td>82.7</td>
</tr>
<tr>
<td>Fractures of the teeth, nasal bone, palate, lower facial bones</td>
<td>200</td>
<td>3.0</td>
<td>85.7</td>
</tr>
<tr>
<td>Stomatitis and related lesions</td>
<td>130</td>
<td>1.9</td>
<td>87.6</td>
</tr>
<tr>
<td>Diseases of the tongue</td>
<td>128</td>
<td>1.9</td>
<td>89.5</td>
</tr>
<tr>
<td>Others</td>
<td>707</td>
<td>10.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total:</td>
<td>6750</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 5.5: Mix of oral health related conditions that patients older than 75 years were admitted to hospital for, over a ten-year period in WA.

<table>
<thead>
<tr>
<th>Condition</th>
<th>N</th>
<th>Percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental caries</td>
<td>877</td>
<td>18.1</td>
<td>18.1</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>790</td>
<td>16.3</td>
<td>34.3</td>
</tr>
<tr>
<td>Other disorders of teeth and supporting structures</td>
<td>531</td>
<td>10.9</td>
<td>45.2</td>
</tr>
<tr>
<td>Fractures of the teeth, nasal bone, palate, lower facial bones</td>
<td>403</td>
<td>8.3</td>
<td>53.5</td>
</tr>
<tr>
<td>Other diseases of the jaws</td>
<td>360</td>
<td>7.4</td>
<td>60.9</td>
</tr>
<tr>
<td>Diseases of salivary glands</td>
<td>286</td>
<td>5.9</td>
<td>66.8</td>
</tr>
<tr>
<td>Benign neoplasms</td>
<td>276</td>
<td>5.7</td>
<td>72.5</td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>206</td>
<td>4.2</td>
<td>76.7</td>
</tr>
<tr>
<td>Diseases of pulp and periapical tissues</td>
<td>198</td>
<td>4.1</td>
<td>80.8</td>
</tr>
<tr>
<td>Jaw fractures</td>
<td>148</td>
<td>3.0</td>
<td>83.8</td>
</tr>
<tr>
<td>Stomatitis and related lesions</td>
<td>138</td>
<td>2.8</td>
<td>86.6</td>
</tr>
<tr>
<td>Other disease of lip and oral mucosa</td>
<td>132</td>
<td>2.8</td>
<td>89.4</td>
</tr>
<tr>
<td>Others</td>
<td>513</td>
<td>10.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total:</td>
<td>4858</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The main reason for admission of those aged 85 and older (n=1199), almost one-fifth (19.3%), were admitted for “Dental Caries”, with a further 16.3% admitted for “Fractures of the teeth, nasal bone, palate, lower facial bone” and 15.3% for “Malignant neoplasms”.

5.5. Discussion

Overall, the oral health of Australia’s older population is improving, with fewer extractions than previous generations, and more people retaining their natural dentition into old age. This is combined with longer life expectancy and an increase in the proportion of older Australians. At the same time, there is concern about the increasing burden that hospitalisations place on government health budgets, (and people over 65 contributing to more than a third of all hospital admissions) (Kircher et al., 2007), which led to a recognition of the need to manage the demand for high cost hospital care more effectively. The Australian hospital sector has long had a focus on preventing hospital admissions as a way of reducing demand (CEHSEU, 2009). Preventing hospital admissions should however, also be a priority for the primary care sector, as there is evidence that health outcomes can be improved when care is provided in a coordinated, systematic approach with a strong and effective primary care component (Muenchberger and Kendall, 2008; Martin and Sturmberg, 2005). This is especially true for oral health. Against this background, this study analysed all hospitalisations of persons over the age of 65 years for oral-health related conditions, over a decade.

Just more that 10% of those admitted were older than 85 years of age; this is not surprising considering that the average life expectancy for Australians now extend well beyond 80
years. Australian men aged 65 in 2010–2012 could expect to live another 19.1 years (an expected age at death of 84.1 years) and the life expectancy of women aged 65 in 2010–2012 was 22.0 years (an expected age at death of 87.0 years) (ABS, 2008b). Significantly higher rates of men were admitted. The explanation might be found in the mix of conditions that older people were admitted for. It is known that prevalence is higher in men than women for conditions such as malignant neoplasms, (Abreu et al., 2010; Abdelhafied et al., 2014) and untreated decay (Slade et al., 2007) and the incidence of jaw fractures is also much higher in men (Kruger et al., 2006).

Only 0.1% of all admissions were for Aboriginal people, although rates were much higher. The far lower life expectancy of Aboriginal people in Australia, compared to that of non-Aboriginal people, might be one reason for the low number of admissions. As of 2010, life expectancy for Aboriginal men was estimated to be 11.5 years less than that of non-Indigenous men, and for Aboriginal women, the 2010 figures show a difference of 9.7 years (ABS, 2013). The rate of hospitalisations among Aboriginal people however, were almost double that of non-Aboriginal people. It is well known that the socioeconomic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health (including oral health) risk factors (ABS, 2005). Among these factors, access to timely oral health care services, especially in rural and remote areas, remains a challenge. The findings of this study also reflect the higher burdens of oral disease experienced by Aboriginal compared to non-Aboriginal people (Williams et al., 2011). Socio-economic disparity is also clearly indicated by the hospitalisation rate of those from the most disadvantaged areas, which was 12 times higher than for those from the least
disadvantaged areas. Issues of accessibility to primary dental care services remain, especially for elderly, and especially for rural disadvantaged areas.

Over the ten years, annual costs increased, and at the same time, the number of bed days decreased. A previous ten-year study also observed increases in rates of all general hospital separations among the elderly in Australia, but the proportion of beds occupied by older patients remaining stable, due to disproportionate reductions in length of stay for multi-day admissions in the ≥ 75 years age group, and reductions in the rate of multi-day separations among the 65–74-years group. This work related to all health conditions (Gray et al., 2004).

Projections indicate that by 2025, rates of hospitalisation of older people for oral-health related conditions will be almost double that of the average rate (between 1999/00 - 2008/09), number of bed-days per year will total between 13 000 and almost 16 000 days per year, and total DRG cost would be at least $7 million per year. There are limitations when projecting future costs, and depending on which method of modelling is used, costs can vary within each of the low, mid and high ranges of the DRG costs distribution. Cost projections related to dental health care are never 100% accurate, as uncertainty exists in the underlying economic and demographic assumptions used in projection models, also in assumptions about future changes in the dental health status of the population, the extent and pace of scientific and technological breakthroughs in dental care, and how each of these factors relates to oral health care costs. However, based on trends over past years, some projected estimations can be made.
Trends over ten years indicate that there is a slow but steady increase in the hospitalisations of older people for oral-health related conditions, with a difference in the mix of conditions, between the younger group (65-74 years), and the older group (75+ years). In the younger group, the major drivers were malignant neoplasms, disorders of the teeth and supporting structures, disorders of the jaws and dental caries. Oral cancer is very strongly age-related (Abreu et al., 2010; Abdelhafied et al., 2014; Thomson, 2014), and risk factors include tobacco use, which also exerts a synergistic effect with heavy alcohol use (Abdelhafied et al., 2014).

The ICD10 classification of “Disorders of the teeth and supporting structures” include conditions such as exfoliation of teeth due to systemic causes, atrophy of alveolar ridges, retained dental roots, enlargement of alveolar ridges, and irregular alveolar ridges (ACCD, 2014). “Other diseases of the jaws include conditions such as cysts of the jaw, cell granulomas, inflammatory jaw conditions, jaw alveolitis, cherubism, exostosis, fibrous dysplasia and condylar hypo- and hyperplasia. Most of these conditions are strongly age-associated (Devlin and Ferguson, 1991; Grossmann et al., 2007; Carvalho et al., 2011; Reich et al., 2011; Chen et al., 2013).

In the oldest age group “Dental Caries” was the main reason for admission. This is a strong indicator of the retention of teeth into old age, and the related dental health maintenance issues. Dental caries is a multi-factorial disease, with many risk factors associated with age. Dry mouth is very prevalent in older people (a common side-effect of medications), and both xerostomia and hyposalivation increases the risk of severe dental caries (Thomson
A recent review indicated that dental caries is not only known to be active in older age groups, but continues to be the most prevalent oral health condition in older people (Thomson, 2014).

Other major reasons for admissions in the oldest group also included oral cancer, other disorders of teeth and supporting structures and fractures of teeth, nasal bone, palate, and lower facial bone. With increasing retention of natural teeth, a range of other chronic degenerative problems might also be expected to become more common, including tooth wear, tooth fracture, root caries and pulpal necrosis. Facial fractures had previously been mentioned as a prevalent reason for hospitalisations of older people due to the high number admitted for falls (Gerbino et al., 1999; Peel et al., 2002; Chrcanovic et al., 2010).

5.6. Conclusions:

The results of this analysis highlight various issues – it is of concern that high numbers of hospitalisations for oral-health related reasons among the oldest patients include potentially preventable conditions such as dental caries. Dental caries is recognised to be a condition that is preventable if timely and effective care is delivered in the ambulatory care setting, in particular access to primary care services. Projections indicate that if current trends are set to continue, hospitalisations for oral-health related conditions among Western Australians older than 65 years will place a considerable burden on the health system.
Chapter 6

6. Potentially preventable hospital separations related to oral health: a 10-year analysis

This chapter was published in the following article: Kruger E, Tennant M: Potentially preventable hospital separations related to oral health: a 10-year analysis. Australian Dental Journal 2015, 60: doi: 10.1111/adj.12322 (Appendix D).
6.1. Abstract

**Background:** The aims of this study were to assess the rates of hospitalisations for potentially preventable dental conditions over a ten-year period in WA; to analyse trends over ten years in rate changes of hospitalisations; and to analyse the mix of preventable dental conditions by age group and Aboriginal status.

**Methods:** The principal diagnosis, as classified by the International Classification of Diseases (ICD-10AM), was used to select hospitalisation data for all patients who were discharged from hospital in Western Australia for the financial years 1999/00 to 2008/09, for a potentially preventable oral health condition.

**Results:** Over a ten-year period just more than 65,000 people were hospitalised. Population rates of hospitalisation increased significantly over the period, for both Aboriginal and non-Aboriginal population groups. Admission rates were higher for Aboriginal people. Children under 14 were more likely to be admitted, the most common condition that required hospitalisation was dental caries, and the highest rates of hospitalisation were for those from the most socio-economically disadvantaged areas.

**Conclusions:** These hospitalisations remain a considerable and increasing financial burden on health budgets. An increase in efforts is necessary to curb escalating Government health expenditure by reducing avoidable and preventable oral health related hospitalisations.
6.2. Introduction.

Potentially preventable hospitalisations are hospital separations where the principal diagnosis of the hospitalisation is thought to be avoidable if timely and adequate non-hospital care had been provided. This refers to preventive measures, or early diagnosis and treatment in primary care. Hospitalisation rates of potentially preventable dental conditions thus provide an indicator of the potential inadequacy of dental care in the community (Chrisopoulos and Harford, 2013). Data on avoidable hospitalisations are increasingly used internationally as an indicator of access to primary care and its effectiveness, and as a measure of the potential health gains from primary care interventions (Li et al., 2009; Rosano et al., 2012).

Dental care in Australia are provided by a mix of private and public services, with the latter limited to provision of school dental services for children and a safety net service for disadvantaged adults. Demand from concession card holders for public dental care far outstrips State and Territory dental services’ capacity to supply treatment, and long waiting lists remain (NACOH, 2004). The majority of dental services in Australia remain funded from private sources (health insurance funds and individuals). Overall, a number of independent services exist without systematic coordination or linkages to general health services (AHMAC, 2012).

There remain a number of identifiable groups within the Australian population with poor access to oral health care and whose oral health outcomes are severely compromised as a result, and these most notably include Aboriginal and Torres Strait Islander peoples, people
in low socio-economic groups, and those with special needs relating to a health condition or ageing (Slade et al., 2007). Rates of oral disease are high among these populations and access to treatment is often difficult. Hospitalisation for conditions related to oral health are prevalent, and placing considerable burdens on health system budgets (Tennant et al., 2000; Kruger et al., 2006; Smith et al., 2006; Dep Human Services, 2007; George et al., 2011b; AHMAC, 2012; George et al., 2012; George et al., 2013; Alsharif et al., 2014a; Alsharif et al., 2014b; Whyman et al., 2014). Among preschool children, hospitalisation for dental caries was one of the leading causes of hospitalisation (Tennant et al., 2000).

Previous research revealed that avoidable hospitalisation rates (for general health conditions) are higher in people living in remote areas, those of lower socio-economic status, and Aboriginal people (Zhao et al., 2013; Katterl et al., 2012). Avoidable hospitalisation rates for dental care has also shown to be higher among rural dwellers, and children younger than 9 years, but little association between socio-economic deprivation and hospitalisation rates were found in a study from Victoria, Australia (Dep Human Services, 2007). A recent analysis from New Zealand however, indicated higher rates of dental preventable hospitalisations among the most deprived (Whyman et al., 2014).

Analysing avoidable dental hospitalisations is necessary to identify groups within the population at higher risk for hospitalisation, as well as identifying time trends in hospitalisation rates against a background of rapidly changing demographics. The oral health care system does not operate in the same way as the general health care system in Australia (in terms of funding and access), and strategies to identify and address access
issues should be based on relevant and reliable information such as population based studies.

Little is known about the trends in potentially preventable hospitalisations over time in Western Australia, as well as those groups in the population most at risk, and the specific dental conditions leading to admissions. The aims of this study were threefold: a) to assess the rates of hospitalisations for potentially preventable dental conditions over a ten-year period in WA; b) to analyse trends over ten years in rate changes of hospitalisations; and c) to analyse the mix of preventable dental conditions by age group and Aboriginal status.

6.3. Materials and Methods:

Ethics. Ethics approval for this study was obtained from the Human Research Ethics Committee at The University of Western Australia.

Study population. The total population in WA were 1 849 055 in 1999, 1 901 168 in 2001 and 2 059 614 in 2006. In 2006 3.8% of the WA population was of Aboriginal or Torres Strait Islander descent, and 34% of the Aboriginal WA population, and 80% of the non-Aboriginal population resided in metropolitan Perth (ABS, 2006).

Hospitalisation data: Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as determined by clinicians for each admission, and as classified by the International Classification of Disease (ICD-10AM) (ACCD, 2014), was obtained for every episode of discharge from all private and public
hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. In this study hospitalisation episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being a potentially avoidable oral health condition (Chrisopoulos and Harford, 2013, Department Human Services, 2007). Potentially avoidable hospitalisations related to oral health were defined as the following: Principal diagnosis categories K02 Dental Caries, K03 Other diseases of hard tissues of teeth, K04 Diseases of the pulp and periapical tissues, K05 Gingivitis and periodontal diseases, K06 Other diseases of gingival and edentulous alveolar ridge, K08 Other disorders of teeth and supporting structures, K09.8 Other cysts of oral region, not elsewhere classified, K09.9 Cysts of oral region, unspecified, K12 Stomatitis and related lesions, K13 Other diseases of lip and oral mucosa. These categories were selected to match those used by the Australian Institute of Health and Welfare (AIHW) in reports on oral health (Chrisopoulos and Harford, 2013) and is identical to those used previously in other Australian and international studies (Department Human Services, 2007; Chrisopoulos and Harford, 2013; Whyman et al., 2014).

Aboriginal status, population rates and cost: Self-reported Aboriginality was used to compare Aboriginal to non-Aboriginal populations. Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national Australian refined standard diagnostic related group (AR-DRG) average price.
DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services (AIHW, 2013d).

Socio-economic status: The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of people all over Australia. The Australian Bureau of Statistics has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA) which give a summary measure of socioeconomic status for people living in specific geographic regions in Australia. Each geographic area is given a score, then ranked against all other areas in Australia, and the rankings are grouped into 5 equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas in Australia, and quintile 5 contains the 20% least disadvantaged areas in Australia (ABS, 2008a).

Place of residency: Primary place of residency at the time of hospitalisation and the geographical classification was done according to Accessibility and Remoteness Index of Australia (ARIA). ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centers based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (DHAC, 2001).

Statistical analysis: All rates were calculated using the Rates calculator, a software package developed by the WA Department of Health. All rates were calculated per 1000 persons, and were age standardised to the Western Australian population. Both Poisson regression
and chi-square tests were used to determine if trends were significant for age-standardised rates over time. All statistical analyses were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).

6.4. Results

6.4.1. Demographics and rates: Over a ten-year period just more than 65,000 hospitalisations took place for potentially avoidable oral health related conditions in WA. The age-standardised overall rate was 3.2 per 1000 people (Table 6.1). Slightly less males (48%) than females were admitted, and 4.4% of all admissions were for Aboriginal people. Most (44%) of all admissions were for children under the age of 14 years, with almost 20% for people between 45 and 59 years of age, and only 3% for those older than 75 years (Table 6.1).

The overall (ten-year) population rates of hospital admissions were highest for those under 14 years, and lowest for those between 15 and 29 years. There were differences between the rates of all age groups, and the admission rate for Aboriginal people were higher than for non-Aboriginal people (Table 6.1). The highest rate of admissions was from the most disadvantaged socioeconomic areas (Table 6.1), and in terms of geographic remoteness, the highest was from Remote areas, and the lowest were from Highly Accessible areas (Table 6.1).
Table 6.1: Rates of avoidable hospitalisations by age, Aboriginal status, SEIFA and ARIA, over ten years

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>4574</td>
<td>2.42</td>
</tr>
<tr>
<td>2000/01</td>
<td>5043</td>
<td>2.66</td>
</tr>
<tr>
<td>2001/02</td>
<td>5765</td>
<td>3.01</td>
</tr>
<tr>
<td>2002/03</td>
<td>6528</td>
<td>3.38</td>
</tr>
<tr>
<td>2003/04</td>
<td>6751</td>
<td>3.46</td>
</tr>
<tr>
<td>2004/05</td>
<td>6714</td>
<td>3.40</td>
</tr>
<tr>
<td>2005/06</td>
<td>7094</td>
<td>3.55</td>
</tr>
<tr>
<td>2006/07</td>
<td>7351</td>
<td>3.59</td>
</tr>
<tr>
<td>2007/08</td>
<td>7244</td>
<td>3.46</td>
</tr>
<tr>
<td>2008/09</td>
<td>7941</td>
<td>3.68</td>
</tr>
<tr>
<td>All years</td>
<td>65005</td>
<td>3.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 14</td>
<td>28820(44.3%)</td>
<td>7.15</td>
</tr>
<tr>
<td>15 - 29</td>
<td>6665 (10.2%)</td>
<td>1.57</td>
</tr>
<tr>
<td>30 - 44</td>
<td>9544 (14.7%)</td>
<td>2.11</td>
</tr>
<tr>
<td>45 - 59</td>
<td>12318 (19.0%)</td>
<td>3.14</td>
</tr>
<tr>
<td>60 - 74</td>
<td>5624 (8.7%)</td>
<td>2.62</td>
</tr>
<tr>
<td>75+</td>
<td>2035 (3.1%)</td>
<td>2.01</td>
</tr>
<tr>
<td>Total</td>
<td>65005 (100%)</td>
<td>3.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aboriginal status</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboriginal</td>
<td>2851</td>
<td>3.34</td>
</tr>
<tr>
<td>Non-Aboriginal</td>
<td>62154</td>
<td>3.26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEIFA</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 ‡</td>
<td>10909(16.8%)</td>
<td>34.90</td>
</tr>
<tr>
<td>Q2</td>
<td>11799 (18.2%)</td>
<td>8.51</td>
</tr>
<tr>
<td>Q3</td>
<td>11496 (17.7%)</td>
<td>1.64</td>
</tr>
<tr>
<td>Q4</td>
<td>12859 (19.9%)</td>
<td>2.62</td>
</tr>
<tr>
<td>Q5</td>
<td>17706 (27.3%)</td>
<td>3.72</td>
</tr>
<tr>
<td>Total</td>
<td>64769 (100%)</td>
<td>3.53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ARIA</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA‡‡</td>
<td>40712(63%)</td>
<td>2.69</td>
</tr>
<tr>
<td>A</td>
<td>11480 (17.8%)</td>
<td>9.78</td>
</tr>
<tr>
<td>MA</td>
<td>6766 (10.5%)</td>
<td>8.45</td>
</tr>
<tr>
<td>R</td>
<td>2678 (4.1%)</td>
<td>10.09</td>
</tr>
<tr>
<td>VR</td>
<td>2956 (4.6%)</td>
<td>2.93</td>
</tr>
<tr>
<td>Total</td>
<td>64592 (100%)</td>
<td>3.53</td>
</tr>
</tbody>
</table>

‡ Q1=Most disadvantaged, Q5=Least disadvantaged
‡‡ HA = Highly Accessible, Accessible, MA=Moderately Accessible, R=Remote, VR=Very Remote
6.4.2. **Trend analysis**: There was a steady increase in the total numbers and rates of admissions over the ten-year period (Table 6.1, Figure 6.1). Trend analysis overall indicated a rate ratio (RR) of 1.037, with a confidence interval (CI) of 1.034 to 1.039. The average annual change (3.7%) showed a significant \(p<0.0001\) increase in rate. The average yearly increase for the Aboriginal population rates was also significant \(p<0.0001\), and positive (7.02%), with a RR of 1.07 (1.056-1.084 CI), and was higher than for the non-Aboriginal population (3.60% annual increase, \(p<0.0001\), and RR of 1.036, 1.033-1.039 CI) (Figure 6.2).

For each age group, with the exception of those aged 15-29 years, trend analysis indicated a significant \(p<0.0001\) annual percentage changes in rates: 0-14 years (3.61%), 30-44 years (1.71%), 45-59 years (4.97%), 60-74 years (8.74%) and 75+ years (8.23%). The annual percentage change in rates over ten years for those between 15 and 29 were not significant \(p=0.644\), and was -0.37% (Fig 6.1).

![Figure 6.1: Changes in hospitalisation rates (per 1000) over ten years, by age group.](image-url)
**6.4.3. Mix of conditions:** Most admissions were for dental caries (53%) and this was the case for both Aboriginal (47%) and non-Aboriginal populations (53%). (Table 6.2). For the Aboriginal population, dental caries and pulp and periapical conditions (35%) combined, contributed to 82% of all avoidable hospitalisations. For the non-Aboriginal population, three conditions contributed to 85% of all admissions: these were caries (53%), other disorders of teeth and supporting structures (18%), and pulp and periapical tissue conditions (14%) (Table 6.2).
Table 6.2: Mix of conditions, all avoidable oral health related hospitalisations over ten years in Western Australia, by Aboriginal status.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Non-Aboriginal:</th>
<th>Aboriginal:</th>
<th>Total:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Dental Caries</td>
<td>53.3</td>
<td>46.8</td>
<td>53</td>
</tr>
<tr>
<td>Other disease of hard tissue of teeth</td>
<td>1.2</td>
<td>0.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Pulp and periapical tissue</td>
<td>13.4</td>
<td>34.9</td>
<td>14.3</td>
</tr>
<tr>
<td>Gingivitis and periodontal disease</td>
<td>5.2</td>
<td>4.4</td>
<td>5.1</td>
</tr>
<tr>
<td>Other gingival and edentulous alveolar ridge</td>
<td>0.6</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Other disorders teeth &amp; supporting structures</td>
<td>18.8</td>
<td>2.7</td>
<td>18.1</td>
</tr>
<tr>
<td>Cysts of oral region</td>
<td>1.9</td>
<td>0.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Stomatitis and related lesions</td>
<td>2.0</td>
<td>7.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Other diseases lip and oral mucosa</td>
<td>3.6</td>
<td>2.7</td>
<td>3.6</td>
</tr>
</tbody>
</table>

C%* = cumulative percentage

There were also different mixes of conditions between the different age groups (Table 6.3). Those under age 14 were mostly hospitalised for dental caries (77%) and pulp and periapical conditions (16.5%), resulting in 93% of all admissions in this age group. Less caries and more admissions related to other disorders of teeth and supporting structures were prevalent in older age groups, with almost 70% of all admissions for those over age 75 for two conditions: caries (43%) and other disorders of the teeth and supporting structures (26%) (Table 6.3).
Table 6.3: Mix of conditions, all avoidable oral-health related hospitalisations, over ten years in WA, percentages per age group.

<table>
<thead>
<tr>
<th>Condition</th>
<th>0-14</th>
<th>15-29</th>
<th>30-44</th>
<th>45-59</th>
<th>60-74</th>
<th>75+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caries</td>
<td>77</td>
<td>34.1</td>
<td>37.9</td>
<td>31.3</td>
<td>29.2</td>
<td>43.1</td>
</tr>
<tr>
<td>Hard Tissue</td>
<td>1</td>
<td>1.8</td>
<td>1.3</td>
<td>1.1</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Pulp &amp; Peri-apical</td>
<td>16.5</td>
<td>16.2</td>
<td>16.3</td>
<td>10</td>
<td>8.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Gingivitis &amp; Perio</td>
<td>0.5</td>
<td>13.8</td>
<td>10.2</td>
<td>8</td>
<td>4.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Gingival other</td>
<td>0.2</td>
<td>0.6</td>
<td>0.5</td>
<td>1.1</td>
<td>1.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Support systems</td>
<td>1.6</td>
<td>20.2</td>
<td>24.2</td>
<td>38.7</td>
<td>41</td>
<td>26.1</td>
</tr>
<tr>
<td>Cysts</td>
<td>0.8</td>
<td>3.1</td>
<td>2.5</td>
<td>2.8</td>
<td>3.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Stomatitis</td>
<td>0.9</td>
<td>4.1</td>
<td>2.9</td>
<td>2.3</td>
<td>3.3</td>
<td>6.8</td>
</tr>
<tr>
<td>Lip and Mucosa</td>
<td>1.5</td>
<td>6</td>
<td>4.1</td>
<td>4.7</td>
<td>7.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Total Percentage</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

6.4.4. Costs and bed-days: Over a period of ten years the total DRG costs for all avoidable hospitalisations related to oral health were approximately $157 million. The average DRG costs per admission were $2418 (sd 2430). Direct costs increased from an average of $1655 per person to $3150 per person in 2008/09. Total bed days attributed to avoidable oral health hospitalisations over ten years was 74 773, and this represented an average of 1.15 days (sd 1.12) per person.

Most people admitted (58%) had private health insurance, but only 4% of Aboriginal persons had insurance, compared to 61% of non-Aboriginal people. Only 5% of Aboriginal people were admitted to private hospitals, compared to 70% of non-Aboriginal people.
6.5. Discussion

Our study of potentially avoidable hospitalisations for oral health related conditions over a decade indicated that population rates of hospitalisation increased significantly over the period, for both Aboriginal and non-Aboriginal population groups. Children under 14 were more likely to be admitted, the most common condition that required hospitalisation was dental caries, and the highest rates of hospitalisation were for those from the most socio-economically disadvantaged areas.

In 2013 a hospitalisation rate for potentially preventable dental conditions in WA of 3.7 per 1000 persons for the year 2010-11 has been reported (Chrisopoulos and Harford, 2013), and this indicates that rates are still increasing, as the rate we found in the last year of our study (2008/09) was 3.68 per 1000 persons. In the 2013 report the rate in WA was higher than in any other state or territory in Australia. Our findings also indicate higher rates than those found in New Zealand (2.15 per 1000 population in 2005-2009) (Whyman et al., 2014). Although there was an over-representation in the proportion of Aboriginal people in our study (4.4% of all admissions), and an overall higher rate among Aboriginal people, there was not a significant difference in rates between Aboriginal (3.34 per 1000) and non-Aboriginal people (3.26 per 1000). Over the ten year period however, trend analysis indicated an annual percentage rate change in the Aboriginal population that were almost twice as high as that of the non-Aboriginal population. It is well known that the oral health of Aboriginal people are poorer than that of the non-Aboriginal population (Slade et al,
2007; Williams et al., 2014), and previous work indicate differences in rates of all oral-health related hospitalisations, with significantly higher rates for Aboriginal people for various oral conditions (Smith et al., 2006; Williams et al., 2014). The socioeconomic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health risk factors, and access issues due to rural and remote living, affordability of health insurance and other social issues contribute to the stark inequalities in health between Aboriginal and non-Aboriginal people.

Most of the admissions (44%) were for children under the age of 14, and the child admissions were mostly for dental caries and pulp and periapical conditions. Despite a significant reduction in dental caries in the last decades, it remained Australia’s most prevalent oral health problem (Slade et al., 2007). Advances and improvement in oral health have been experienced disproportionately by those with higher socio-economic status, and there has been increased polarisation of dental caries within the community (NACOH, 2004). Dental caries remain one of the leading causes of hospitalisation among children in WA (Tennant et al., 2000; Kruger et al., 2006; Alsharif et al., 2014a; Alsharif et al., 2014b).

The same applies to pulp and periapical conditions, with high rates of child hospitalisation identified previously (Kruger et al., 2006; Alsharif et al., 2014a). Admission for pulp and periapical conditions could result from infections in the tooth, most often caused by untreated dental caries (Shah et al., 2013), and the reasons for caries being untreated could
include lack of access to services. Previous studies found significant differences in the admissions of Aboriginal compared to non-Aboriginal children for pulp and periapical conditions (Kruger et al., 2006; Alsharif et al., 2014a), with significantly higher rates in Aboriginal pre-school children.

In older age groups substantial numbers were hospitalised for conditions such as caries, pulp and periapical conditions, stomatitis and other disorders of the teeth and supporting structures. Caries remained the main reason for admission, even in the oldest age groups. This is a strong indicator of the retention of teeth into old age, and the related dental health maintenance issues. Dental caries is a multi-factorial disease, with many risk factors associated with age. A recent review indicated that dental caries is not only known to be active in older age groups, but continues to be the most prevalent oral health condition in older people (Slade et al., 2007; Thomson, 2014). Analysis of ten-year trends also indicated the highest rate increases over time were experienced by the age groups older than 60 years.

The results of our study emphasises the economic burden of avoidable dental hospitalisations. Over the ten year period, overall direct costs alone amounted to well over $157 million, in a State with a total population of just more than 2 million people (in 2006). Direct costs, as calculated by DRG cost per person, increased from an average of $1655 to $3150 in 2008/09. We estimate that these direct costs (DRG) are very conservative estimations, and in reality, the true costs could amount to double the estimated cost at the
patient level (inclusive of health insurance refund). Additionally, indirect costs (eg. travel, time off work, support parent/guardian time) are not included in our estimates either, but others have estimated in small countries with minimal travel that this can be nearly double the direct costs (Drummond et al., 1997). As such, our cost calculations are considered very conservative estimations.

It has been stated that potentially preventable hospitalisations are avoidable if timely (early diagnosis and prevention) and adequate treatment in primary care is provided. Hospitalisation rates of potentially preventable dental conditions thus provide an indicator of the potential inadequacy of dental care in the community (Chrisopoulos and Harford, 2013). It is important to understand the association between primary health care and avoidable hospitalisations. Previous studies identified that this relationship is not a linear one, but a U-shaped relationship, with too little primary health care leading to an excess of hospitalisation, and too much also leading to an increase in hospitalisations (Rosano et al., 2012; Zhao et al., 2013).

It has not previously been established if this relationship also applies to dental conditions, but it is strongly supported by our findings: There were high rates of hospitalisation among poorer, rural, and Aboriginal groups (those with limited access to primary oral health care), but there were also high rates of hospitalisation among higher socio-economic, non-Aboriginal, and urban dwelling groups (with good access to primary health care). Our findings did not indicate hospitalisations clearly divided along social lines. There were
differences in the mix of conditions however, with more disadvantaged groups more likely to be admitted for pulpitis and periapical disease (possible result of untreated caries), and least disadvantaged groups more likely to be admitted for caries (diagnosed in primary care and referred for treatment under general anesthesia).

Previous studies support the argument that improved access to primary health care may prevent hospitalisations, improve health outcomes and lower health care costs (Rosano et al., 2012; Zhao et al., 2013). The factors determining access to primary dental care in Australia are multifactorial and complex. It is dependent on factors including socioeconomic status, geographical location, age, and health insurance status, among others (NACOH, 2004; Slade et al., 007; Tennant and Kruger, 2013a; Almado et al., 2013; Tennant and Kruger, 2013b, Tennant et al., 2013). Public dental services in Australia is currently not in a position to provide services to all those who need or demand it. Only about 5% of eligible concession card holders receive primary dental care from the public health sector (Spencer, 2012). Whilst the private sector operates based on economic drivers (fee-for-service payments), the public sector is relying on available (and scarce) resources to provide care. The oral health care system has traditionally operated in isolation, and there is a need to integrate it with the general health system and its more equitable access to preventive and treatment services.
6.6. Conclusions

An analysis of potentially avoidable hospitalisations for oral health related conditions over ten years indicated rates increasing over time, high rates in children under 14 years, most hospitalisations were for dental caries, and hospitalisations among Aboriginal people increasing at a rate almost twice that of non-Aboriginal people. These hospitalisations remain a considerable and increasing financial burden on health budgets. An increase in efforts are necessary to curb escalating Government health expenditure by reducing avoidable and preventable oral health related hospitalisations, and focusing efforts on an improved, accessible and equitable primary oral health care system.
Chapter 7

7. Ten years of hospitalisation for oral health related conditions in Western Australia: an unjust dichotomy.

This chapter was published in the following article: Kruger E, Tennant M. Ten years of hospitalisation for oral health related conditions in Western Australia: an unjust dichotomy. Australian Journal of Primary Health, 2015; Jan 14. doi: 10.1071/PY14087. (Appendix E).
7.1. Abstract:

**Objective:** The objective of this study was 1) to examine the demographics of in-patient oral health care by Aboriginal status, 2) to identify the mix of oral conditions by Aboriginal status, and 3) to describe trends over a ten year period, comparing Aboriginal and non-Aboriginal groups.

**Methods:** Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), was obtained for every episode for adult patients who were discharged from all hospitals in Western Australia (WA) for the financial years 1999-2000 to 2008-2009.

**Results:** Results indicated that more than 130 000 persons were admitted to hospitals in WA over ten years, for oral-health related conditions, at a direct cost of more than $400 million. Most of those admitted were younger than 30 years, and 2.8% of all admitted were Aboriginal people. Aboriginal people were admitted at significantly higher rates, for a very different mix of conditions, they were mostly from younger age groups, were mostly from very remote and the most disadvantaged areas, and were almost all uninsured, compared to non-Aboriginal people.

**Conclusions:** Hospital admissions for oral health related conditions are strongly divided across social, racial and geographic variables, and remain a burden to the health care system.
7.2. Introduction

Oral health is an integral part of general health, and the impact of oral disease on wellbeing and quality of life has previously been highlighted (Sanders et al., 2009). Over the last decades, significant improvements in the overall oral health of adults in Australia have occurred, mostly because of decreased levels of dental caries and lower levels of tooth loss (Slade et al., 2007). However, oral-health related diseases and the treatment of these conditions remain costly, and there still is a considerable burden of oral health related hospital admissions of adults in Western Australia (WA) (Kruger et al., 2006; Smith et al., 2006; George et al., 2011b; George et al., 2012; Anjrini et al., 2014a).

Earlier research indicated that oral disease is unequally distributed across the population, with heavier burdens of disease being experienced by certain population groups, including the elderly, Aboriginal Australians, rural and remote residents, and those from lower socio-economic backgrounds (Slade et al, 2007; Anjrini et al, 2014b). Whilst this situation is by no means unique to Australia, the health inequality between Aboriginal and non-Aboriginal groups, is more significant compared to some other developed countries (Aus Indigenous Healthinfonet, 2013).

Improving the health status of Aboriginal people remain a challenge for Governments in Australia, with the inequality gap between Aboriginal and non-Aboriginal people remaining to such an extent that the life expectancy of Aboriginal people remain far below that of non-Aboriginal people (ABS, 2013). As of 2010, life expectancy for Aboriginal men was estimated to be 11.5 years less than that of non-Indigenous men, and for Aboriginal
women, the 2010 figures show a difference of 9.7 years (ABS, 2013). The poor health of Aboriginal communities can be likened to the problems of the developing world, as they do not enjoy equal access to primary health care and health infrastructure.

Previous work examined oral health related hospitalisations for adults over a four-year period (Smith et al., 2006), and this study is following on our earlier research, to analyse the oral health related hospitalisation of adults (over the age of 18) over a decade, from 1999-2000 to 2008-2009. The longer time period of this follow-up study allows for the analysis of all variables by Aboriginal status. Because of the lower population numbers in the four-year study, this was not previously possible. The aim of this descriptive study were threefold: 1) to examine the demographics of in-patient oral health care by Aboriginal status, 2) to identify the mix of oral conditions by Aboriginal status, and 3) to describe trends over a ten year period, comparing Aboriginal and non-Aboriginal groups.

7.3. Materials and Methods:

Ethics. Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia.

Study population. The adult population in WA (all 18 years and older), were 1 059 750 in 1999, 1 094 197 in 2001 and 1 221 799 in 2006. In 2006 3.4% of the WA population were of Aboriginal or Torres Strait Islander descent (2.6% of all adults), and in WA 34% of the Aboriginal population, and 80% of the non-Aboriginal population lived in metropolitan...

*Hospitalisation data:* Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) (ACCD, 2014), was obtained for every episode of discharge from all hospitals in WA for the financial years 1999-2000 to 2008-2009. The ICD-10AM is the standard classification scheme used for reporting diagnoses in all Hospital statistical collections (ACCD, 2014). In this study episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health related condition.

*Aboriginal status, population rates and cost:* Self-reported Aboriginality were used to compare Aboriginal to non-Aboriginal populations. Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics (ABS). Estimated cost of care was determined for each episode using the national standard diagnostic related group (DRG) average price. The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost (AIHW, 2013a).

*Place of residency:* Primary place of residency at the time of hospitalisation and the geographical classification was done according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centres based on road
distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (DHAC, 2001).

*Socio-economic Index of Disadvantage:* The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of all Australians. The ABS has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA) which give a summary measure of socioeconomic status for people living in specific geographic regions in Australia. Each geographic area is given a score, then ranked against all other areas in Australia, and the rankings are grouped into 5 equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas, and quintile 5 contains the 20% least disadvantaged areas (ABS, 2008a).

*Statistical analysis:* All rates were calculated using the Rates calculator, a software package developed by the Department of Health. All rates were calculated per 100 000 persons. Significant differences between rates were based on non-overlapping 95 percent confidence intervals (p<0.05). Means between groups were compared using ANOVA. Both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardised rates over time. All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).
7.4. Results:

7.4.1 Demographics: Over a ten-year period (from 1999-2000 to 2008-2009), a total of 131,509 hospital admissions in Western Australia were attributed to oral health related conditions among adults (above the age of 18 years). Of the total number, about half (48%) were males, and 2.8% were patients of Aboriginal descent (Table 7.1). Overall, most patients were from areas classified as “Accessible”. There was a significant difference in the distribution of Aboriginal and Non-Aboriginal patients by geographic area, with the highest rates of Aboriginal patients from “Very Remote” areas and the highest rates for non-Aboriginal patients from “Accessible” areas (Table 7.1). Across all age groups, most people came from “Accessible” areas.

7.4.2. Age-standardised population rates: Rates of admission were significantly higher for Aboriginal than non-Aboriginal groups over the ten-year period (P<0.05). The differences in rates between the two groups in most years were not significant however, and the overall rate in Aboriginal people might be higher because of the very high admission rate in one year (2007/08). The reason for the high admission rate in 2007/08 is unknown. Rates were the highest for age-group 18-29 years, for both groups. In the non-Aboriginal population rates were lowest for 70+ year olds, and in the Aboriginal population it was lowest for 50-69 year olds (Table 7.1). Admission rates between Aboriginal and non-Aboriginal patients were significantly different (p<0.05) for age groups 18-29, 30-49 and 70+ years.
Table 7.1: Hospital admissions for oral health related conditions among adults in Western Australia over a ten-year period.

<table>
<thead>
<tr>
<th></th>
<th>Aboriginal</th>
<th></th>
<th>Non-Aboriginal</th>
<th></th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Rate (95% CI)*</td>
<td>N</td>
<td>Rate (95% CI)†</td>
<td>N</td>
</tr>
<tr>
<td>1999/00</td>
<td>281</td>
<td>6.97 (6.06-7.89)</td>
<td>9380</td>
<td>6.84 (6.70-6.98)</td>
<td>9661</td>
</tr>
<tr>
<td>2000/01</td>
<td>310</td>
<td>7.46 (6.54-8.38)</td>
<td>10105</td>
<td>7.34 (7.20-7.49)</td>
<td>10415</td>
</tr>
<tr>
<td>2001/02</td>
<td>294</td>
<td>7.50 (6.40-8.60)</td>
<td>11399</td>
<td>8.22 (8.06-8.37)</td>
<td>11693</td>
</tr>
<tr>
<td>2002/03</td>
<td>353</td>
<td>8.31 (7.32-9.31)</td>
<td>12247</td>
<td>8.75 (8.60-9.81)</td>
<td>12600</td>
</tr>
<tr>
<td>2004/05*</td>
<td>352</td>
<td>7.79 (6.88-8.69)</td>
<td>12922</td>
<td>8.97 (8.81-9.12)</td>
<td>13274</td>
</tr>
<tr>
<td>2008/09</td>
<td>429</td>
<td>9.55 (8.47-10.64)</td>
<td>16427</td>
<td>10.30 (10.15-10.46)</td>
<td>16979</td>
</tr>
<tr>
<td>All†</td>
<td>3652</td>
<td>9.26 (8.88-9.63)</td>
<td>127857</td>
<td>8.81 (8.76-8.86)</td>
<td>131509</td>
</tr>
</tbody>
</table>

  | All | 3652 | 9.25 (8.87-9.60) | 127857 | 8.25 (8.20-8.30) | 131509 | 8.79 (8.74-8.84) |

  | **18-29 ** | **1541 | 11.41(10.84-11.98) | 59778 | 18.49(18.34-18.64) | 61319 | 18.05(17.91-18.19) |
  | **50-69** | **407 | 6.56(5.92-7.21) | 23958 | 6.05(5.97-6.13) | 24365 | 6.06(5.98-6.14) |
  | **70+ ** | **113 | 11.01(8.93-13.10) | 7745 | 4.94(4.83-5.05) | 7858 | 4.98(4.87-5.09) |
  | **Total** | **3652 | 9.20(8.84-9.55) | 127857 | 8.81(8.76-8.89) | 131509 | 8.79(8.74-8.84) |

  | HA* | 271 (7%) | 5.36(4.97-5.78) | 20047(16%) | 7.43(7.37-7.48) | 20318(16%) | 7.40(7.35-7.45) |
  | A* | 785 (22%) | 10.27(9.02-11.68) | 89053(70%) | 22.45(22.12-22.79) | 89838(69%) | 22.1(21.78-22.43) |
  | MA* | 367 (10%) | 1.52(1.36-1.70) | 10549(8%) | 1.77(1.73-1.81) | 10925(8%) | 1.76(1.73-1.80) |
  | RT* | 287 (8%) | 4.17(3.68-4.72) | 3864(3%) | 1.96(1.90-2.03) | 4151(3%) | 2.04(1.98-2.11) |
  | VR* | 1900 (52%) | 12.36(11.77-12.98) | 3550(3%) | 5.98(5.77-6.20) | 5450(4%) | 7.30(7.09-7.51) |
  | **Total** | **3619(100%) | 10.15(9.79-10.51) | 127063(100%) | 8.91(8.85-8.96) | 130682(100%) | 8.94(8.88-8.99) |

  | SEIFA1* | 2431 | 34.61(33.36-36.11) | 16772 | 10.24(10.08-10.40) | 19203 | 8.20(8.08-8.32) |
  | SEIFA2* | 488 | 8.17(7.41-9.00) | 22270 | 2.19(2.15-2.22) | 22758 | 2.11(2.08-2.14) |
  | SEIFA3* | 301 | 11.11(9.82-12.55) | 23193 | 4.30(4.24-4.36) | 23494 | 4.25(4.19-4.31) |
  | SEIFA4* | 229 | 2.71(2.34-3.13) | 26576 | 6.98(6.89-7.07) | 26805 | 6.89(6.80-6.98) |
  | SEIFA5* | 175 | 9.17(7.79-10.79) | 38485 | 9.91(9.80-10.10) | 38660 | 9.90(9.80-10.01) |
  | **All** | **3624 | 10.17(9.82-10.54) | 127295 | 8.92(8.87-8.98) | 130092 | 8.95(8.90-9.01) |

| Avg DRG Cost:** | $5181 (sd 10463) | $3094(sd 6236) | $3152(sd 6400) |
| Avg Bed Days** | 2.96 days (sd .93) | 1.47 days (sd 0.31) | 1.51 (sd 0.39) |

HA = Highly accessible, A=Accessible, MA=Moderately Accessible, RT=Remote, VR=Very remote.
SEIFA1=most disadvantaged, SEIFA5=Least disadvantaged † Rates per 1000 population. * Rates differ significantly between Aboriginal and non-Aboriginal groups, P<0.05, **Means differ significantly, ANOVA, P<0.05
7.4.3. **Costs, insurance status and length of stay:** Over the ten-year period, all hospital admissions amounted to 199,214 bed days, with a mean number of bed-days per episode being 1.51(3.09). (Table 7.1). Average length of stay was significantly longer for Aboriginal that non-Aboriginal patients (2.96 and 1.47 days, ANOVA, P<0.05) (Table 7.1). Overall, 63.3% of patients had private medical insurance, with 65% of all non-Aboriginal patients, and only 2.8% of Aboriginal patients insured. The total DRG cost for in-patient oral health care over this period was in excess of $400 million ($414,626,067), with a significantly different average cost (ANOVA, p<0.05) between Aboriginal ($5181) and non-Aboriginal ($3094) patients (Table 7.1). Over time, cost increased from an average of $2357 per episode in 1999/00 to $3816 per episode in 2008/09.

7.4.4. **Mix of conditions by Aboriginality:** Overall, the major conditions people were hospitalised for included “Embedded and impacted teeth” and “Dental caries”. These two conditions alone, contributed to 58% of all admissions over ten years (Figure 7.1). The mix of conditions between Aboriginal and non-Aboriginal patients were very different, with most Aboriginal patients admitted for trauma, including “Jaw fractures” (43.6%) and “Fractures of the teeth, nasal bone, palate, lower facial bones” (12.2%). These two categories alone contributed to more than half of all admissions among Aboriginal people (55.8%). “Pulp and periapical conditions” contributed to a further 11.8%, followed by “Malignant neoplasms” (7.2%) and “Dental Caries” (4.1%) (Figure 7.2). Most admissions (50.2%) for non-Aboriginal people were for “Embedded and Impacted teeth”, with a further 9.2 % for “Dental caries”, followed by “Other disorders of teeth and
supporting structures” (8.7%), “Fractures of teeth, nasal bone, palate, lower facial bones” (4.1%), and “Malignant Neoplasms” (3.9%) (Figure 7.3).

Figure 7.1: Conditions leading to oral health related hospital admissions among WA adults, over ten years.

7.4.5. **Trends over time**: There was a steady increase in the total numbers and rates of admissions over the ten-year period (Table 7.1). Trend analysis overall (both groups) indicated a rate ratio of 1.029, with a confidence interval (CI) of 1.027 to 1.031. The average annual change (2.94%) showed a significant (p<0.0001) increase in rate. The average yearly increase for the non-Aboriginal population was also significant (p<0.0001) and positive (3.83%), with a rate ratio of 1.038 (1.036-1.04 CI). Although the average annual change in
rate in the Aboriginal population was 3.45%, this was not significant (p=0.158), and the rate ratio was 1.035 (1.023-1.046 CI). There was not much change in the mix of conditions over a ten-year period, with the same major conditions remaining steady over the study period. The mix of patients by Aboriginal status remained relatively stable across the study period.

Figure 7.2: Conditions leading to oral health related hospital admissions among WA adults, over ten years, for Aboriginal patients.
This study found more than 130 000 persons were admitted to hospitals in WA over ten years, for oral-health related conditions, at a direct cost of more than $400 million. Most of those admitted were younger than 30 years, and 2.8% of all admitted were Aboriginal people. This indicates a slight under-representation of Aboriginal people, as the resident Aboriginal population of WA during the 2006 census constituted 3.8% of the total WA population.
population (ABS, 2006). When weighted by age however (and this study was only done among adults), Aboriginal rates were significantly higher.

Census data reveal very stark demographic differences between Aboriginal and non-Aboriginal Western Australians (Australian Indigenous HealthInfoNet, 2013), and it has also been confirmed that Aboriginal people have poorer oral health than non-Aboriginal people (Slade et al, 2007; Williams et al, 2011). This is underlined by the findings of this study. Aboriginal people were admitted at higher rates, for a very different mix of conditions, mostly from younger age groups, mostly from very remote areas, and were almost all uninsured, compared to non-Aboriginal people. The much higher hospitalisation rate in the 70+ age group of Aboriginal people, might be a strong indicator of the difference in population (and especially age) demographics between the two populations, as the lower life expectancy of Aboriginal people see fewer people reach the age of 70 (ABS, 2013). For age, the highest rates was seen in non-Aboriginal 18-29 year-olds, much higher than Aboriginal young adults. This is due to the conditions they presented with, with very high rates of embedded and impacted teeth removal amongst non-Aboriginal young adults (George et al., 2011b; George et al, 2012; Anjrini et al., 2014a; Anjrini et al., 2014b). The majority of Aboriginal people were admitted for trauma and injury-related conditions (55%). This might be an explanation for the very high hospitalisation rate of Aboriginal males compared to non-Aboriginal males, as previous studies highlighted the significant differences in jaw fracture rates in WA, with rates almost ten times higher in Aboriginal compared to non-Aboriginal people, and almost eight times higher for Aboriginal compared to non-Aboriginal males (Kruger et al., 2006; Kruger et al, 2010). This might also explain the
significantly lower rate in Aboriginal females compared to non-Aboriginal females: although Aboriginal people mostly gets admitted for trauma, it is dominated by Aboriginal males (Kruger et al., 2006; Kruger et al, 2010), and the admissions for embedded and impacted teeth removal in non-Aboriginal people, is mostly among females (George et al., 2011b; George et al., 2012). Previous work in rural Australian communities indicated the etiology for fractures to include interpersonal violence, and most often associated with alcohol abuse (Thomas and Jameson, 2007; Jayaraj et al., 2012; Cabalag et al., 2014). It is well known that the socioeconomic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health risk factors (ABS, 2005). This situation emphasizes the major social problems experienced by Aboriginal communities, and especially those from rural and remote areas.

The contrast is further emphasised when considering that the majority of non-Aboriginal patients were admitted for the removal of embedded and impacted teeth, and most were from Accessible areas. Previous work highlight the very high number of admissions for this procedure, and also indicate that it is significantly higher than in similar international countries (George et al., 2011b; George et al., 2012., Anjrini et al, 2015). Debate exists regarding the need for evidence-based guidelines to lower the numbers of hospitalisations for third molar removals (Anjrini et al., 2014a). The lower percentages of Aboriginal people presenting for the removal of impacted or embedded teeth might be related to lower access to services, especially in rural and remote areas, as well as socio-economic factors and lower rates of private insurance (George et al., 2011b).
The majority of Aboriginal patients (60%) were from areas classified as “Remote” or “Very Remote”, which suggest an over-representation of Aboriginal adults from these areas, and not only large travel distances and travel times to health services, but also include possible longer stays in hospital for follow-up treatment. This might contribute to the longer average stay in hospital, and overall higher average direct cost for Aboriginal compared to non-Aboriginal patients. The higher costs in Aboriginal people might also be related to the different conditions they present for, with trauma-related injuries costly to treat. The same applies to conditions such as malignant neoplasms, where treatment incurs significant costs to health services and patients. The significance of this condition also lies in its mortality and morbidity, and as it is an age-associated condition, the ageing population pose future challenges to health services. Although indirect costs could not be calculated, it would most probably contribute more to overall costs for those who have to travel far to obtain care, compared to those in easy access to services. Overall direct costs increased over time, and although costs per DR group is increasing due to inflation, the population-based rates of people admitted has increased, resulting in increasing absolute costs, well in excess of inflation.

Over a period of ten-years this situation and inequalities remained stable, with no signs of improvement or a decrease in hospitalisation rates. Hospitalisation rates over the time period were, in fact, increasing. The socio-economic disadvantage experienced by Aboriginal patients was further highlighted by the significant difference in health insurance status. The affordability of private health insurance premiums put this beyond the reach of most socio-economically disadvantaged groups. In 2004–05, 15% of Indigenous Australians
in non-remote areas had private health insurance, compared with 51% for non-Indigenous Australians (AHMAC, 2012). The majority of those without private health insurance (65%) cited cost as the main barrier (AHMAC, 2012). Reduced access to private health insurance limits people’s ability to access services involving out of pocket expenses, such as specialists, dentists and allied health services. As many of the hospitalisations were due to preventable conditions, it can be assumed that better access to dental care (especially the private sector) might prevent some oral conditions to develop to a point where hospitalisation is necessary.

7.6. Conclusions:

For both population health and cost reasons, analysis of admissions to hospitals, and the conditions that drive these hospitalisations, are becoming more essential in light of increasing health resource constraints. This study identified the major differences between the Aboriginal and non-Aboriginal populations in Western Australia in relation to hospitalisation for oral health related conditions, and also indicated that over a period of ten years, the inequalities remained, and no improvements seems to occur. Serious and effective measures are needed to, wherever possible limit admissions to hospitals, especially when preventable diseases and risk-behaviour contribute to outcomes, as is the case for many oral-health related conditions. The underlying complex social factors and social determinants leading to poor oral health among Aboriginal people, is common to the hospitalisation of many general health conditions and diseases (other than just oral-health related). As such, this remains a challenge that requires multi-sectoral approaches to find
solutions. This study clearly indicated that the mix of conditions leading to hospital admissions were very different between Aboriginal and non-Aboriginal people. Furthermore, hospital admissions due to oral health related conditions in Western Australia are strongly divided across social, racial and geographical variables, and in-patient care remains a burden to the health care system.
8. Fractures of the mandible and maxilla: a ten year analysis

This chapter was published in the following article: Kruger E, Tennant M. Fractures of the mandible and maxilla: a ten year analysis. Australasian Medical Journal, 2016; (Appendix F).
8.1. Abstract

**Background.** This study was to follow-up on an earlier analysis to determine if inequalities in terms of jaw fracture hospitalisation rates between Aboriginal and non-Aboriginal people have changed.

**Aims.** This study was done over a ten year-period, from 1999/00 to 2008/09, and aims were to determine the rates of hospitalisations for jaw fractures in WA, trends over the ten–year period, and direct costs associated with these hospital admissions.

**Methods.** Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). Episodes were selected on the basis of an ICD10-AM code being S02.4 (Fracture of the malar and maxillary bones) and S02.6 (Fracture of the mandible). Estimated cost of care was determined for each episode using the national standard diagnostic related group (DRG) average price.

**Results.** Inequalities between Aboriginal and non-Aboriginal people in terms of hospital admissions for jaw fractures exist in WA, and continued over a decade-long period. Higher fracture rates occurred amongst males, Aboriginal people, younger adult age-groups, those from low socioeconomic areas, and those from remote and very remote areas. The DRG cost per person for jaw fractures ranged between $842 and $109 002, with a median cost of $4965.

**Conclusion.** Hospital admission rates for the treatment of maxillary and mandibular fractures are very strongly divided along racial and socio-economic lines in WA.
8.2. Background

Maxillofacial injuries are commonly encountered in the practice of emergency medicine, and are often associated with high morbidity resulting from various degrees of physical, functional and cosmetic consequences. Healthcare costs and the increasing burdens associated with hospitalisations and in-patient care continue to put economic pressure on State governments in Australia (Daley et al., 2013). Previous studies reported high numbers of people in Australia being hospitalised for trauma, and especially maxillofacial fractures (Kruger et al., 2006; Jamieson et al, 2008; Jayaraj et al., 2012; O’Meara et al., 2012). The treatment of mandibular and other facial fractures is a financial burden on health systems already under pressure (Moncrieff et al., 2004). Treatment is costly and increasing over time, especially as the costs of the use of rigid fixation to treat fractures, are high (Abubaker et al., 1998; Erdmann et al., 2008). Facial trauma management and care also involve several specialist groups and sub-specialities, for pre-operative, operative and postoperative care (Erdmann et al., 2008). Indirect costs, including time off work, travel and travel time, as well as loss of income, also contribute to overall costs, and above all, places a social and personal burden on those who suffer such injuries.

Several investigators have studied maxillary and mandibular fracture epidemiology (Dongas and Hall, 2002; Ogundare et al., 2003; King et al., 2004; Lee, 2012; Chranovic 2012). Identified factors that is associated with maxillofacial fracture incidence include age, gender, geographic region, cultural aspects, socioeconomic status, temporal and climatic
influence, use of alcohol and drugs, compliance with road traffic legislation, domestic violence, and osteoporosis (Dongas and Hall, 2002; Ogundare et al., 2003; King et al., 2004; Lee, 2012; Chranovic, 2012). Due to different socio-economic, cultural and political influences however, it is not possible to extrapolate such results among different countries, or even communities within the same country. Australian studies however, and especially those conducted in Aboriginal communities, indicate disproportionately high levels of hospitalisations of Aboriginal people (Jamieson et al., 2005; Kruger et al., 2006) for maxillofacial injuries due to alcohol related trauma, violence and assaults (Jamieson et al., 2005, O’Meara et al., 2011; Jayaraj et al., 2012).

Previous analysis of jaw fracture hospitalisations in WA over a four-year period, indicated disproportionately high rates of hospitalisations for Aboriginal people (Kruger et al., 2006). Several programs and strategies have been implemented in WA to address the health issues of Aboriginal people, and this included focusing on drug and alcohol abuse problems in Aboriginal communities. In 2005, the State Government of WA initiated the Strong Spirit Strong Mind: Western Australian Aboriginal Alcohol and Other Drugs Plan (AAOD Plan) 2005-2009 (Department of Health WA, 2005). The AAOD Plan encouraged a whole-of-system approach across government and community organisations to ensure that Aboriginal alcohol and other drugs policy, program and service responses, make best use of available resources and partnership arrangements. It was hoped that these and other initiatives would close the gap between Aboriginal and non-Aboriginal health inequalities.
This study was to follow up on the earlier analysis and determine if inequalities in terms of jaw fracture hospitalisation rates between Aboriginal and non-Aboriginal people have changed. This study was done over a ten year-period, from 1999/00 to 2008/09, and aims were to determine the rates of hospitalisations for jaw fractures in WA, trends over the ten–year period, and direct costs associated with these hospital admissions.

8.3 Method

*Ethics.* Ethics approval for this study was obtained from the Human Research Ethics Committee at The University of Western Australia; reference number RA/4/1/5502.

*Study population.* The total population in WA were 1 849 055 in 1999, 1 901 168 in 2001 and 2 059 614 in 2006. In 2006 3.8% of the WA population was of Aboriginal or Torres Strait Islander descent, and 34% of the Aboriginal WA population, and 80% of the non-Aboriginal WA population resided in metropolitan Perth (ABS, 2007).

*Hospitalisation data:* Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) 16, was obtained for every episode of discharge from all private and public hospitals in WA for the financial years 1999-2000 to 2008-2009. In this study, episodes were selected on the basis of an ICD10-AM code being S02.4 (Fracture of the malar and maxillary bones) and S02.6 (Fracture of the mandible).

Aboriginal status, population rates and cost: Self-reported Aboriginality was used to
compare Aboriginal to non-Aboriginal populations. Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national standard diagnostic related group (DRG) average price. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services (AIHW, 2013d).

*Place of residency:* Primary place of residency at the time of hospitalisation and the geographical classification was done according to Accessibility and Remoteness Index of Australia (ARIA). ARIA calculates remoteness as accessibility to service centres based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (DHAC, 2001).

*Socio-economic Index of Disadvantage:* The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of people all over Australia. The Australian Bureau of Statistics has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA) which give a summary measure of socioeconomic status for people living in specific geographic regions in Australia. Each geographic area is given a score, then ranked against all other areas in Australia, and the rankings are grouped into 5 equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas in Australia, and quintile 5 contains
the 20% least disadvantaged areas in Australia (ABS, 2008a).

*Statistical analysis:* All rates were calculated using the Rates calculator, a software package developed by the Department of Health. All rates were calculated per 1000 person years. Significant differences between rates were based on non-overlapping 95 percent confidence intervals (p<0.05). Means between groups were compared using One-way ANOVA. Both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardised rates over time. All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).

8.4. Results

8.4.1. Demographics:

Over a ten-year period, a total number of 7183 persons were admitted to a hospital in Western Australia for treatment of a fractured mandible, maxilla, or both. More fractures were of the mandible (64%), compared to the maxilla (36%).

Men were far more likely to be admitted (82%) than women. Admissions were associated with age, with more than half (56%) of all those hospitalised between the ages of 15 and 29 years (Table 8.1). More than a quarter (27%) was between the ages of 30 to 44 years (Table 8.1).
8.4.2. Cost and Bed-days:

There was a significant difference (p<0.0001) in the mean number of bed-days between Aboriginal (2.39 days, sd 2.08), and non-Aboriginal patients (2.09, sd 2.94). Over the ten-year period, Aboriginal patients spent a total of 4186, and non-Aboriginal patients 11 346 days in hospital, resulting in a total of 15 522 bed days attributed to jaw fractures.

There was a significant difference (p<0.0001) in mean DRG cost per person between Aboriginal and non-Aboriginal patients, with a mean cost of $4868 (sd 5268)(median $4445) for Aboriginal, and $6031(sd 8446)(median $5683) for non-Aboriginal patients. The total cost over ten years totalled $41 283 903. The DRG cost per person for jaw fractures ranged between $842 and $109 002, with a median cost of $4965.

8.4.3. Rates:

Rates over time increased slightly, with rates in the last two years significantly higher (P<0.05), than in the first year. The lowest rate was in 2003/4, significantly lower (p<0.05) than all other years, except 1999/00. Trend analysis of rates over the ten-year period indicated a rate ratio of 1.023, with a confidence interval (CI) of 1.015 to 1.031. The average annual change (2.29%) showed a significant (p<0.0001) increase in rate.

Age-adjusted population rate calculations indicated that rates were the highest for 15-44 year olds, and lowest for children between birth and 14 years. Slightly higher rates were experienced by those older than age 75, compared to age groups just below (45-74 years) (Table 8.1). Rates for men (0.58) were more than four times higher than those for women.
Rates for Aboriginal people were almost ten times higher than for non-Aboriginal people (Table 8.1).

### Table 8.1: Jaw fracture rates by age, gender and Aboriginal status, over ten years, in WA.

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Rate per 1000</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>614</td>
<td>0.32</td>
<td>0.29-0.35†</td>
</tr>
<tr>
<td>2000/01</td>
<td>673</td>
<td>0.35</td>
<td>0.32-0.38</td>
</tr>
<tr>
<td>2001/02</td>
<td>635</td>
<td>0.33</td>
<td>0.30-0.36</td>
</tr>
<tr>
<td>2002/03</td>
<td>682</td>
<td>0.35</td>
<td>0.32-0.38</td>
</tr>
<tr>
<td>2003/04</td>
<td>608</td>
<td>0.31</td>
<td>0.29-0.33†</td>
</tr>
<tr>
<td>2004/05</td>
<td>740</td>
<td>0.37</td>
<td>0.35-0.40</td>
</tr>
<tr>
<td>2005/06</td>
<td>765</td>
<td>0.38</td>
<td>0.35-0.41</td>
</tr>
<tr>
<td>2006/07</td>
<td>756</td>
<td>0.37</td>
<td>0.34-0.40</td>
</tr>
<tr>
<td>2007/08</td>
<td>853</td>
<td>0.40</td>
<td>0.38-0.43†</td>
</tr>
<tr>
<td>2008/09</td>
<td>857</td>
<td>0.39</td>
<td>0.37-0.42†</td>
</tr>
<tr>
<td>All years</td>
<td>7183</td>
<td>0.36</td>
<td>0.35-0.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group</th>
<th>N</th>
<th>Rate per 1000</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 14</td>
<td>186 (3%)</td>
<td>0.04</td>
<td>0.39-0.52†</td>
</tr>
<tr>
<td>15 - 29</td>
<td>4048 (56%)</td>
<td>0.95</td>
<td>0.93-0.98†</td>
</tr>
<tr>
<td>30 - 44</td>
<td>1968 (27%)</td>
<td>0.44</td>
<td>0.42-0.46†</td>
</tr>
<tr>
<td>45 - 59</td>
<td>616 (9%)</td>
<td>0.16</td>
<td>0.14-0.17</td>
</tr>
<tr>
<td>60 - 74</td>
<td>161 (2%)</td>
<td>0.07</td>
<td>0.06-0.08†</td>
</tr>
<tr>
<td>75+</td>
<td>204 (3%)</td>
<td>0.19</td>
<td>0.17-0.22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Rate per 1000</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>5876 (82%)</td>
<td>0.58</td>
<td>0.56-0.59†</td>
</tr>
<tr>
<td>Female</td>
<td>1309 (18%)</td>
<td>0.13</td>
<td>0.12-0.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aboriginal status</th>
<th>N</th>
<th>Rate per 1000</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboriginal</td>
<td>1752 (24%)</td>
<td>2.50</td>
<td>2.38-2.62†</td>
</tr>
<tr>
<td>Non-Aboriginal</td>
<td>5431 (76%)</td>
<td>0.28</td>
<td>0.27-0.29</td>
</tr>
</tbody>
</table>

† Significant differences between groups.
Age-adjusted rates differed between Aboriginal and non-Aboriginal people, and between males and females (Figure 8.1). The rates for male Aboriginal patients (7.07) between 15-29 years were almost double that of Aboriginal females (3.76), almost seven times higher than for non-Aboriginal males (1.35) and seventy times higher for non-Aboriginal females, all between 15-29 years (Figure 8.1). There were no Aboriginal patients older than 75 years, and in non-Aboriginal patients, there was an increase in rates after the age of 75, with the rate of females (0.22), higher than that of males (0.16). This was the only age group where females had higher rates than males.

Figure 8.1: Hospitalisation rates (per 1000 population) for jaw fractures in Western Australia over a decade, by age group.
### 8.4.4. Socio-economic disadvantage:

Amongst Aboriginal patients, admission rates were highest for those from the most disadvantaged areas, with a rate almost three times higher than for those from the least disadvantaged areas. The most disadvantaged rate were also higher than any other rate, including those amongst non-Aboriginal patients. (Table 8.2).

Amongst the non-Aboriginal patients, rates were also highest amongst those from the most disadvantaged areas, and this was almost thirty times higher than for those from the least disadvantaged areas (Table 8.2). Almost all Aboriginal patients were uninsured (99.6%) compared to non-Aboriginal patients (75% not insured). Of all admissions, 81% were uninsured patients.

#### Table 8.2: Distribution of jaw fractures cases over ten years by area Socio-Economic Index of Disadvantage (SEIFA) quintiles

<table>
<thead>
<tr>
<th></th>
<th>Aboriginal</th>
<th>Non-Aboriginal</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Rate per 1000 (95%CI)</td>
<td>N</td>
</tr>
<tr>
<td>SEIFA1</td>
<td>1246</td>
<td>11.4 (11.2-11.6)</td>
</tr>
<tr>
<td>SEIFA2</td>
<td>199</td>
<td>2.00 (1.90-2.10)</td>
</tr>
<tr>
<td>SEIFA3</td>
<td>120</td>
<td>0.58 (0.54-0.62)</td>
</tr>
<tr>
<td>SEIFA4</td>
<td>94</td>
<td>0.73 (0.68-0.78)</td>
</tr>
<tr>
<td>SEIFA5</td>
<td>82</td>
<td>3.10 (2.87-3.32)</td>
</tr>
</tbody>
</table>

*CI= Confidence Interval, †P<0.05, significant differences in rates in each SEIFA category between Aboriginal and non-Aboriginal. SEIFA1=Most disadvantaged, SEIFA5=Least disadvantaged
8.4.5. Accessibility and remoteness:

Amongst Aboriginal patients, rates were the highest amongst those from Remote and Very Remote areas, and amongst non-Aboriginal patients, the highest rate were amongst those from Remote areas. Aboriginal rates in all five areas (ARIA categories) were significantly higher than those of non-Aboriginal patients in the same areas (Table 8.3).

Table 8.3: Distribution of jaw fractures cases over ten years by area remoteness index (ARIA) classification

<table>
<thead>
<tr>
<th></th>
<th>Aboriginal</th>
<th>Non-Aboriginal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Rate per 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(95%CI)</td>
</tr>
<tr>
<td>HA</td>
<td>283</td>
<td>1.20 (1.15-1.25)</td>
</tr>
<tr>
<td>A</td>
<td>119</td>
<td>2.71 (2.55-2.88)</td>
</tr>
<tr>
<td>MA</td>
<td>159</td>
<td>4.13 (3.92-4.36)</td>
</tr>
<tr>
<td>R</td>
<td>115</td>
<td>9.90 (9.33-10.5)</td>
</tr>
<tr>
<td>VR</td>
<td>1060</td>
<td>4.49 (4.40-4.58)</td>
</tr>
</tbody>
</table>

*CI= Confidence Interval, †P<0.05, significant differences in rates in each ARIA category between Aboriginal and non-Aboriginal.

8.5. Discussion

Our findings indicate that inequalities between Aboriginal and non-Aboriginal people in terms of hospital admissions for jaw fractures exist in WA, and continued over a decade-long period. Higher fracture rates occurred amongst males, Aboriginal people, younger
adult age-groups, those from low socioeconomic areas, and those from remote and very remote areas.

More than 80% of all those admitted to hospital were men – this is consistent with other studies. The very disproportionate rates between males and females are believed to be related to the risk factors for maxillofacial fractures, which include a high prevalence of interpersonal violence (O’Meara et al., 2011). The numbers of mandibular fractures were higher than maxillary fractures, confirming national and international findings (Azevedo et al., 1998; Schon et al., 2001; Dongas and Hall, 2002; Gassner et al., 2003; Erol et al., 2004; Kruger et al., 2006; Lee, 2012; Velayutham et al., 2013). An earlier study from Azevedo found the mandible to be the tenth most commonly injured bone in the body, and the second most commonly injured bone in the face (Azevedo et al., 1998).

The rates of admission were highest in young adult age groups, between ages 15 and 29. More than half (56%) of admissions were in this age group. The reasons might be the risk taking behaviours associated with maxillofacial trauma that younger age groups engage in, as identified by other studies (Chayla et al., 2011; Lee, 2012; Chranovic, 2012).

In this study it was also determined that the rates for the oldest age group, those above age 75 years, was significantly higher than for the 30-64 year-old age groups. Previous studies identified maxillofacial trauma as common amongst older people, and falls were identified as the major etiological factor in older age groups (Al-Qamachi et al., 2012; Velayutham, 2013). With the older proportion of the population in Australia rapidly
increasing, higher numbers of older people are expected to present with maxillofacial trauma (Velayutham, 2013).

When comparing rates of Aboriginal with non-Aboriginal patients, the admissions of Aboriginal people were disproportionately higher than for non-Aboriginal patients, and this situation remained consistent over the decade long study period. Aboriginal males were admitted at a rate that were nearly 10 times that of a non-Aboriginal males, Aboriginal female rates were almost 3 times that of non-Aboriginal males, and 37 times higher than for non-Aboriginal females at the peak ages of 15-29 years. Other Australian studies found similar disparities (Schon et al., 2001; Thomas and Jamieson, 2007; Jamieson et al., 2008; Thomas and Scott, 2009). The etiology of facial fractures in Australia, and especially in the Aboriginal population, is strongly associated with alcohol-related violence and assaults (Thomas and Jamieson, 2007; Jamieson et al., 2008; Thomas and Scott, 2009; Jayaraj et al., 2012). Indigenous females and males were 35 and 22 times more likely to be hospitalised due to family violence-related assaults as other Australian females and males, respectively (Al-Yaman et al., 2006).

Rates were significantly higher in those (both Aboriginal and non-Aboriginal) from the most socio-economically disadvantaged areas. The rate for Aboriginal people from the poorest areas was double that of the non-Aboriginal rate from the poorest areas. Rates were also highest for those from remote and very remote areas. Poverty has shown to be associated with violence in Australia (Al-Yaman et al., 2006): About one in four Aboriginal people aged
15 years or over reported being a victim of physical or threatened violence, and the rate was higher among those who lived in low income households, and were unemployed. The age-standardised rate for being a victim of physical or threatened violence among the Aboriginal population was over twice the rate of the non-Aboriginal population (Al-Yaman et al., 2006). Although the rates were similar among those living in major cities and in remote areas, people in remote areas were much more likely to report that family violence was a neighbourhood problem (41% compared with 14% in non-remote areas) (Al-Yaman et al., 2006).

Reasons for the slightly higher direct costs for Aboriginal people is unknown, but the direct costs (DRG) distribution across all episodes was not a normal distribution, and as such, mean costs could be misleading. Median costs between Aboriginal and non-Aboriginal groups did not differ as much. With the majority of the Aboriginal population residing in rural and remote WA, it can be assumed that longer travel times and distances to obtain specialist care would be necessary. It might the reason for the slightly longer hospital stay of Aboriginal, compared to non-Aboriginal patients.

Trend analysis indicated a positive and significant increase in hospitalisation rates for jaw fractures in WA, over a ten-year period. This is an indication that hospitalisations for the treatment of maxillary and mandibular fractures remain a burden on the health system, and the very high rates of Aboriginal people admitted compared to non-Aboriginal remains a concern.
8.6. Conclusion

Hospital admission rates for the treatment of maxillary and mandibular fractures are very strongly divided along racial and socio-economic lines in WA. The reasons for this include the determinants and risk factors for maxillofacial fractures, which are strongly associated with poverty, and compounded by geographical location and culture. The complexity of factors determining disadvantage and related health concerns, and the alleviation of risk damaging lifestyles and behaviours require a broad integrated approach. This approach would need to be based on the social determinants of health, where health should be viewed from both a social and economic justice perspective.
Chapter 9

9. Socio-economic disadvantage and oral-health related hospital admissions: a ten-year analysis

This chapter was published in the following article: Kruger E, Tennant M: Socio-economic disadvantage and oral-health related hospital admissions: a ten-year analysis. British Dental Journal Open (BDJOpen) 2016, 2:16004. Doi:10.1038/bdjopen.2016.4 (Appendix G).
9.1. Abstract

**Background:** The aim of this Western Australian population study was to assess the relationship of socio-economic disadvantage (using area-based measures) and: 1) trends in hospitalisations for oral-health conditions over ten years; 2) insurance status, costs and length of stay in hospital; and 3) specific conditions (principal diagnosis) patients were admitted for.

**Methods:** Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS) for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. Area-based measures (using the Index of Relative Socio-economic Disadvantage) were used to determine relationships between socio-economic status and other variables.

**Results:** The results of this study indicate that the most disadvantaged in the population are being hospitalised for oral health related conditions at significantly higher rates than other groups, stay in hospital for longer, and at higher costs. This trend remained over a period of ten years. Those least disadvantaged have the second highest rates of hospitalisation, but the likelihood of being admitted for different procedures differ between these two extremes.

**Conclusions:** The importance of socio-economic determinants of health is evident when analysing these hospitalisations. Recognition that lifestyle choices are severely restricted amongst the most marginalised and disadvantaged groups in the population, can no longer be ignored in an attempt to reduce health inequalities.
9.2. Introduction

The social gradient in health means that health inequities affect all, and the poorest of the poor have the worst health. This is a global phenomenon, and is seen in low, middle and high income countries (CSDH, 2008). It is social and economic conditions, and their effects on people’s lives, that determine their risk of illness and the actions taken to prevent them becoming ill or treat illness when it occurs (CSDH, 2008). The mechanisms by which socio-economic status (SES) influences health status are complex and varied, and this association is confounded by many factors. It is hypothesised that a number of inter-related factors including education, place of residence, health beliefs and behaviour, occupation, income, access to health services and the environment in which people live determine the socio-economic disadvantage and health (AIHW, 2014a). This relationship exists across a very broad range of health indicators, including dental health (Locker, 2000).

Strong evidence exists for the relationship between oral health and socio-economic status in the Australian population (Armfield, 2007; Sanders et al., 2008; Kilpatrick et al., 2012; Jamieson et al., 2013). Many studies have focused on child oral health, but inequities also exist in the adult population. In the Australian dentate population, adults with lower levels of household income and educational attainment suffered greater tooth loss, greater social impact of oral conditions on quality of life and worse subjective oral health (Slade et al., 2007; Sanders, 2007).
Australia has a complex health system, and the provision of oral health care depends on a combination of private and public providers and funders. Differences in access to care (amongst other factors) inevitably result in inequities in health, and this is no more evident than when comparing different socio-economic groups in the population. Barriers to better public oral health outcomes for socially disadvantaged Australians include service rationing of oral health care and marginalisation of oral health in policy and funding. Dental services are one of the least subsidised areas of health (NACOH, 2004).

Whilst studies of health inequalities are carried out worldwide, the development and increasing use of new measures of socio-economic status have improved this area of research. These measures use census data on small areas to classify individuals in terms of the level of material deprivation in the area in which they live (Locker, 2000; Armfield, 2007). Use of these area-based indices is based on assumptions that aggregate community-level variables are important explanatory factors in health outcomes above and beyond individual level circumstances (Locker, 1993; Locker, 2000; Armfield, 2007). Ecological factors can be seen as upstream determinants of health and disease status in a population, and there is a growing awareness of the impact of neighbourhood factors on individual health outcomes (Armfield, 2007). An Australian study confirmed that the socioeconomic characteristics of neighbourhoods are important for oral health over and-above the socioeconomic characteristics of the people living in those neighbourhoods (Turrel et al., 2007).
Previous work indicated that adult hospitalisations for oral-health related conditions remain considerable, even though a large proportion might be preventable (Kruger and Tennant, 2015a; Kruger and Tennant, 2015b; Kruger and Tennant, 2015c). According to the social gradient theory it would be expected that those who suffer poorer oral health, would be hospitalised at higher rates, and that hospital admissions for treatment of oral-health related conditions should be associated with the burden of disease within the population. The aim of this Western Australian adult population study was to assess the relationship of socio-economic disadvantage (using area-based measures) and:

1) trends in hospitalisations for oral-health conditions over ten years,
2) insurance status, costs and length of stay in hospital, and
3) specific conditions (principal diagnosis) patients were admitted for.

9.3. Materials and Methods:

Ethics. Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia.

Study population. This included all adults in Western Australia (WA) who were admitted to hospital for an oral-health related condition, over a ten year period. The adult population in WA (all 18 years and older), was 1 059 750 in 1999, 1 094 197 in 2001 and 1 221 799 in 2006 (ABS, 2007).
Hospitalisation data: Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) (ACCD, 2014), was obtained for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. In this study hospitalisation episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health related condition.

Population rates and cost: Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national standard diagnostic related group (DRG) average price. The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost. AR-DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services (AIHW, 2013d).

Socio-economic status: The Socio-Economic Indexes for Areas (SEIFA) is a widely used measure of geographically concentrated disadvantage. SEIFA was created by the Australian Bureau of Statistics (ABS) who broadly define relative socio-economic advantage and
disadvantage in terms of people’s access to material and social resources, and the ability to participate in society (ABS, 2008a). SEIFA is composed of four indexes, namely: the Index of Relative Socio-Economic Disadvantage (IRSD); the Index of Relative Socio-Economic Advantage and Disadvantage; the Index of Economic Resources; and the Index of Education and Occupation. In this study the IRSD was used as the area-based composite measure of SES, and this index is derived from variables as indicated in Table 9.1 (ABS, 2008a). The IRSD score of the residential statistical local area (SLA) of each person admitted to hospital, was used a measure of socio-economic status.

**Table 9.1: Variables contributing to the Index of Relative Socio-Economic Disadvantage (IRSD).**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Occupied private dwellings with no internet connection</td>
<td></td>
</tr>
<tr>
<td>% People age 15 years and over with no post-school qualifications</td>
<td></td>
</tr>
<tr>
<td>% People with stated annual household equalized income between $13000 and $20799</td>
<td></td>
</tr>
<tr>
<td>% Households renting from Government or community organisations</td>
<td></td>
</tr>
<tr>
<td>% People (in the labour force) unemployed</td>
<td></td>
</tr>
<tr>
<td>% One parent families with dependent offspring only</td>
<td></td>
</tr>
<tr>
<td>% Households paying rent less than $120 per week (excluding $0 per week)</td>
<td></td>
</tr>
<tr>
<td>% People aged under 70 who have a long-term health condition or disability and need assistance with core activities</td>
<td></td>
</tr>
<tr>
<td>% Occupied private dwellings with no car</td>
<td></td>
</tr>
<tr>
<td>% People who identified themselves as being Aboriginal and/or Torres Strait Islander origin</td>
<td></td>
</tr>
<tr>
<td>% Occupied private dwellings requiring one or more extra bedrooms</td>
<td></td>
</tr>
<tr>
<td>% People aged 15 years and over who are separated or divorced</td>
<td></td>
</tr>
<tr>
<td>% Employed people classified as Machinery Operators and Drivers</td>
<td></td>
</tr>
<tr>
<td>% People aged 15 and over who did not go to school</td>
<td></td>
</tr>
<tr>
<td>% Employed people classified as Low Skill Community and Personal Service Workers</td>
<td></td>
</tr>
<tr>
<td>% People who do not speak English well</td>
<td></td>
</tr>
</tbody>
</table>
**Statistical analysis:** All rates were calculated using the Rates calculator, a software package developed by the WA Department of Health. All rates were calculated per 100 000 person years, and were adjusted for ages and IRSD quintile. Significant differences between rates were based on non-overlapping 95 percent confidence intervals (p<0.05). Means between groups were compared using ANOVA. Odds ratios and confidence intervals were calculated using logistic regression for the increased likelihood of being hospitalised for each of the specific categories of principal diagnosis (according to ICD-10 Code for each admission). All statistical analyses were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).

9.4. **Results:**

9.4.1. **Demographics:**

Over a ten year period, a total of 131 509 people were admitted to hospitals in WA for oral health related conditions. Slightly more females (51.7%) were admitted (Table 9.2). The majority of those hospitalised (97%) were non-Indigenous persons, and between the ages of 18 and 39 years (63%) (Table 9.2). Only 2% were above the age of 80 years. Over the ten year period, there was an increase in the numbers hospitalised for every year. Almost two-thirds (63%) of patients admitted to hospital had private insurance (Table 9.2). Almost half (47%) of all those admitted were from areas classified as IRSD quintile 5 (Least disadvantaged), and 6.5% were from the most disadvantaged areas (IRSD quintile 1).
Table 9.2: Characteristics of all adult oral health-related hospital admissions over ten years in WA

<table>
<thead>
<tr>
<th>Variable:</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>63569 (48.3%)</td>
</tr>
<tr>
<td>Female</td>
<td>67940 (51.7%)</td>
</tr>
<tr>
<td>Indigenous status</td>
<td></td>
</tr>
<tr>
<td>Indigenous</td>
<td>3652 (2.8%)</td>
</tr>
<tr>
<td>Non-Indigenous</td>
<td>127857 (97.2%)</td>
</tr>
<tr>
<td>Age groups</td>
<td></td>
</tr>
<tr>
<td>18-39</td>
<td>82682 (62.9%)</td>
</tr>
<tr>
<td>40-59</td>
<td>31927 (24.3%)</td>
</tr>
<tr>
<td>60-79</td>
<td>14221 (10.8%)</td>
</tr>
<tr>
<td>80+</td>
<td>2679 (2%)</td>
</tr>
<tr>
<td>Year</td>
<td></td>
</tr>
<tr>
<td>1999/2000</td>
<td>9661 (7.3%)</td>
</tr>
<tr>
<td>2000/2001</td>
<td>10415 (8%)</td>
</tr>
<tr>
<td>2001/2002</td>
<td>11693 (8.9%)</td>
</tr>
<tr>
<td>2002/2003</td>
<td>12600 (9.5%)</td>
</tr>
<tr>
<td>2003/2004</td>
<td>12924 (9.8%)</td>
</tr>
<tr>
<td>2004/2005</td>
<td>13274 (10%)</td>
</tr>
<tr>
<td>2005/2006</td>
<td>14071 (10.7%)</td>
</tr>
<tr>
<td>2006/2007</td>
<td>14618 (11.2%)</td>
</tr>
<tr>
<td>2007/2008</td>
<td>15274 (11.6%)</td>
</tr>
<tr>
<td>2008/2009</td>
<td>16979 (13%)</td>
</tr>
<tr>
<td>Principal condition:</td>
<td></td>
</tr>
<tr>
<td>Embedded/Impacted teeth</td>
<td>64327 (48.9%)</td>
</tr>
<tr>
<td>Dental caries</td>
<td>11865 (9.0%)</td>
</tr>
<tr>
<td>Disorders teeth &amp; supporting structures</td>
<td>11136 (8.5%)</td>
</tr>
<tr>
<td>Other fractures</td>
<td>8149 (6.2%)</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>5191 (3.9%)</td>
</tr>
<tr>
<td>Pulp/Periapical conditions</td>
<td>4431 (3.4%)</td>
</tr>
<tr>
<td>Other diseases of the jaw</td>
<td>4156 (3.2%)</td>
</tr>
<tr>
<td>Jaw fractures</td>
<td>3988 (3.0%)</td>
</tr>
<tr>
<td>Dentofacial anomalies</td>
<td>3439 (2.6%)</td>
</tr>
<tr>
<td>Gingivitis and periodontitis</td>
<td>3080 (2.3%)</td>
</tr>
<tr>
<td>All other conditions</td>
<td>11747 (8.9%)</td>
</tr>
<tr>
<td>Insurance status:</td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>83193 (63.3%)</td>
</tr>
<tr>
<td>No insurance</td>
<td>48316 (37.7%)</td>
</tr>
<tr>
<td>IRSD</td>
<td></td>
</tr>
<tr>
<td>Quintile 1(Most disadvantaged)</td>
<td>8559 (6.5%)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>16541 (12.6%)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>14538 (11.1%)</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>29599 (22.5%)</td>
</tr>
<tr>
<td>Quintile 5(Least disadvantaged)</td>
<td>61666 (46.9%)</td>
</tr>
</tbody>
</table>

173
9.4.2. **Principal diagnosis:**

Almost half (49%) of all hospitalisations were for the removal of “Embedded and/or impacted teeth”. “Dental caries” accounted for almost one-tenth of all admissions (9%) and 8.5% were admitted for “Other disorders of teeth and supporting structures” (Table 9.2). The ten most common conditions for which people were admitted were the following (conditions as categorized according to ICD code): “Embedded and Impacted teeth”; “Dental Caries”; “Other disorders of teeth and supporting structures”; “Other Fractures” (which include fractures of teeth, palate, nasal bone, alveolus, lower facial bones); “Malignant neoplasms”; “Pulp and peri-apical conditions”; “Other diseases of the jaw”; “Jaw fractures” (maxilla and mandible); “Dento-facial anomalies”; and “Gingivitis and Periodontitis”.

9.4.3. **Trends over time:**

Rates were calculated for the overall ten-year period and the average rate over the study period were highest for those in the most disadvantaged areas. The second highest average rates were for those from the least disadvantaged areas (Table 9.3). The rate for quintile 1 was significantly higher than any of the others (p<0.05), the rate for quintile 5 also differed significantly from all the others (p<0.05), and the rate for quintile 3 was significantly lower that any of the others (p<0.05) (Table 9.3).
### Table 9.3: Hospitalisation rates over ten years by IRSD quintile.

<table>
<thead>
<tr>
<th>IRSD:</th>
<th>Rate</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quintile 1 (most disadvantaged)</td>
<td>1002.22</td>
<td>979.49, 1025.55</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>723.77</td>
<td>711.91, 735.83</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>692.49</td>
<td>680.39, 704.81</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>741.70</td>
<td>732.60, 750.93</td>
</tr>
<tr>
<td>Quintile 5 (least disadvantaged)</td>
<td>964.14</td>
<td>955.94, 972.43</td>
</tr>
</tbody>
</table>

*Rates are per 100 000 persons and adjusted for age and IRSD status

Over time, rates were increasing for all socio-economic groups, and the highest rates for each year remained for those from the most disadvantaged areas. Lowest rates for each year were for those in the 3rd quintile (Figure 9.1). Hospitalisation rates by age-group indicated that those in the youngest age category (18 to 39 years) consistently had the highest rates of hospitalisation, across all IRSD quintiles. Rates decreased by age across all the socio-economic groups, and were lowest for those in the oldest (80 years+) age category (Figure 9.2). Except for the third quintile, rates for the youngest age category in all other SES groups, were significantly higher (p <0.05) than the other age categories within the same SES group (Figure 9.2).
Figure 9.1: Rates of hospitalisation over ten years by IRSD quintile

Figure 9.2: Hospitalisation rates by age group and relative socio-economic disadvantage.
9.4.4. Socio-economic status and length-of-stay, cost and insurance status:

There was an increase in the proportions of those patients with private health insurance across the SES groups, from the lowest (28.5%) in the most disadvantaged group, to the highest (74.6%) of those in the least disadvantaged group (Table 9.4). Those from the poorest quintile stayed, on average, in hospital the longest (2.07 days), as opposed to those from the wealthiest quintile, who stayed, on average, the shortest (1.37 days). On average the mean direct costs (DRG costs) per hospitalisation episode were highest for those from the poorest group (AU$3642), and lowest for those from the richest group (AU$2942) (Table 9.4).

Table 9.4: Insurance status, length of stay, and cost over ten years by IRSD quintile:

<table>
<thead>
<tr>
<th>IRSD</th>
<th>Insured (%)</th>
<th>Not-insured (%)</th>
<th>Days in hospital</th>
<th>Direct costs (AU$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>1</td>
<td>2439 (28.5%)</td>
<td>6120 (71.5%)</td>
<td>2.07 (3.9)</td>
<td>3642 (7823)</td>
</tr>
<tr>
<td>2</td>
<td>9542 (57.7%)</td>
<td>69999 (14.6%)</td>
<td>1.57 (3.4)</td>
<td>3242 (6762)</td>
</tr>
<tr>
<td>3</td>
<td>7731 (53.2%)</td>
<td>6807 (46.8%)</td>
<td>1.74 (3.5)</td>
<td>3513 (7726)</td>
</tr>
<tr>
<td>4</td>
<td>17220 (58.2%)</td>
<td>12379 (41.8%)</td>
<td>1.51 (2.9)</td>
<td>3178 (6653)</td>
</tr>
<tr>
<td>5</td>
<td>46028 (74.6%)</td>
<td>15637 (25.4%)</td>
<td>1.37 (2.7)</td>
<td>2942 (6372)</td>
</tr>
</tbody>
</table>

IRSD quintile 1=most disadvantaged, quintile 5=least disadvantaged

9.4.5. Socio-economic status and principal diagnosis:

Deprivation of area of residence was found to be associated with the principal diagnosis (condition for which hospitalisation was required). There was a statistically significant trend for those living in the most disadvantaged areas to be at higher risk for hospitalisation for most conditions (Table 9.5).
The relationship was reversed however for admission to hospital for the removal of embedded and impacted teeth. In the youngest age category those from the most disadvantaged areas were 76% less likely to be admitted for the removal of embedded and impacted teeth than those from the least disadvantaged area. The same trend were seen in the other age groups (63% less likely amongst 40-59 year-olds, 58% less likely among 60-79 year olds, and 65% less likely amongst those over age 80 years) (Table 9.5).

Amongst all hospitalised patients, those in the youngest age group and from the most disadvantaged areas were (compared to those from the least disadvantaged areas) almost 3 times more likely to be admitted for dental caries, almost 5 times more likely to be admitted for jaw fractures, more than 3 times more likely to be admitted for malignancies, almost 5 times more likely to be admitted for other fractures, and more than 5 times more likely to be admitted for pulp and peri-apical conditions (Table 9.5).

The ratios becomes smaller in the older age groups, but for some conditions were still significant. In the age group 40 to 59 years those from the most disadvantaged areas compared to those from the least disadvantaged areas were almost 4 times more likely to be admitted for jaw fractures, more than twice as likely to be admitted for malignancies, 3 times more likely to be admitted for other fractures, and almost twice as likely to be admitted for pulp and periapical conditions. Those in age groups 60-79 and 80+ years from the most disadvantaged areas were also 3.3 times and almost 3.5 times respectively, more likely to be admitted for malignancies than those from the least disadvantaged areas (Table 9.5).
Table 9.5: Odds ratios (and 95% confidence intervals) for principal diagnosis at admission, by age group, in relation to socio-economic disadvantage of area of residence:

<table>
<thead>
<tr>
<th></th>
<th>18-39 years</th>
<th>40-59 years</th>
<th>60-79 years</th>
<th>80+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embedded/ impacted teeth:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>0.24 (0.23-0.26)*</td>
<td>0.37 (0.32-0.43)*</td>
<td>0.42 (0.28-0.62)*</td>
<td>0.35 (0.08-1.45)*</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>0.62 (0.59-0.65)*</td>
<td>0.71 (0.64-0.78)*</td>
<td>0.61 (0.49-0.76)*</td>
<td>0.64 (0.31-1.31)*</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>0.53 (0.51-0.56)*</td>
<td>0.69 (0.63-0.76)*</td>
<td>0.69 (0.56-0.86)*</td>
<td>0.51 (0.26-1.02)*</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>0.72 (0.69-0.75)*</td>
<td>0.87 (0.81-0.94)*</td>
<td>0.90 (0.75-1.08)</td>
<td>0.68 (0.35-1.30)*</td>
</tr>
<tr>
<td><strong>Dental caries:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>2.65 (2.37-2.95)*</td>
<td>1.13 (1.01-1.27)**</td>
<td>0.78 (0.63-0.97)*</td>
<td>0.72 (0.45-1.16)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>2.12 (1.93-2.33)*</td>
<td>1.27 (0.64-0.78)*</td>
<td>0.88 (0.76-1.01)</td>
<td>0.68 (0.49-0.94)**</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>1.84 (1.65-2.04)*</td>
<td>1.07 (0.63-0.76)</td>
<td>0.70 (0.60-0.81)</td>
<td>0.24 (0.16-0.36)*</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>1.68 (1.55-1.82)*</td>
<td>1.09 (0.81-0.94)</td>
<td>0.69 (0.61-0.79)</td>
<td>0.70 (0.52-0.95)**</td>
</tr>
<tr>
<td><strong>Disorders teeth/ sup structures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>0.46 (0.36-0.57)*</td>
<td>0.23 (0.19-0.27)*</td>
<td>0.16 (0.12-0.22)**</td>
<td>0.17 (0.05-0.55)**</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>0.80 (0.70-0.92)*</td>
<td>0.49 (0.44-0.54)*</td>
<td>0.40 (0.35-0.46)**</td>
<td>0.67 (0.44-1.03)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>0.98 (0.86-1.12)</td>
<td>0.52 (0.47-0.57)</td>
<td>0.43 (0.37-0.49)**</td>
<td>0.53 (0.35-0.79)**</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>0.73 (0.66-0.81)*</td>
<td>0.47 (0.43-0.51)*</td>
<td>0.45 (0.39-0.51)**</td>
<td>0.41 (0.25-0.66)*</td>
</tr>
<tr>
<td><strong>Other fractures:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>4.80 (4.42-5.22)*</td>
<td>3.02 (2.56-3.55)*</td>
<td>2.53 (1.89-3.40)</td>
<td>1.05 (0.59-1.88)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>1.59 (1.46-1.74)*</td>
<td>1.49 (1.26-1.77)</td>
<td>1.34 (1.03-1.74)</td>
<td>1.64 (1.16-2.31)*</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>2.01 (1.84-2.20)*</td>
<td>1.59 (1.35-1.87)</td>
<td>1.23 (0.93-1.62)</td>
<td>0.93 (0.65-1.33)</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>1.42 (1.32-1.53)*</td>
<td>1.47 (1.28-1.69)</td>
<td>1.42 (1.12-1.80)</td>
<td>1.59 (1.15-2.21)**</td>
</tr>
<tr>
<td><strong>Malignancies:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>3.13 (2.12-4.63)*</td>
<td>2.36 (1.01-1.27)*</td>
<td>3.32 (2.60-3.93)*</td>
<td>3.49 (2.35-5.91)*</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>1.46 (0.98-2.19)</td>
<td>1.66 (1.16-1.40)</td>
<td>1.95 (1.70-2.23)</td>
<td>1.26 (0.90-1.77)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>2.00 (1.34-2.96)*</td>
<td>1.70 (0.97-1.18)</td>
<td>2.13 (1.86-2.44)</td>
<td>1.43 (1.07-1.91)**</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>2.41 (1.80-3.21)*</td>
<td>1.37 (1.09-1.18)</td>
<td>2.02 (1.78-2.29)</td>
<td>1.23 (0.89-1.69)</td>
</tr>
<tr>
<td><strong>Pulp, periapical:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>5.20 (4.52-5.97)*</td>
<td>1.86 (1.58-2.20)</td>
<td>0.90 (0.62-1.29)</td>
<td>0.60 (0.18-1.94)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>2.25 (1.95-2.59)*</td>
<td>1.27 (1.09-1.48)</td>
<td>0.91 (0.71-1.17)</td>
<td>0.89 (0.46-1.73)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>2.60 (2.24-3.01)*</td>
<td>1.37 (1.18-1.59)</td>
<td>0.86 (0.66-1.12)</td>
<td>0.64 (0.33-1.24)</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>2.04 (1.81-2.31)*</td>
<td>1.13 (0.99-1.29)**</td>
<td>0.82 (0.65-1.04)</td>
<td>1.43 (0.85-2.41)</td>
</tr>
<tr>
<td><strong>Other diseases:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>1.58 (1.01-2.49)**</td>
<td>2.75 (2.37-3.19)*</td>
<td>1.69 (1.38-2.07)*</td>
<td>0.64 (0.08-4.84)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>0.74 (0.46-1.18)</td>
<td>1.38 (1.19-1.61)*</td>
<td>2.18 (1.90-2.50)*</td>
<td>1.04 (0.34-3.09)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>1.08 (0.69-1.69)</td>
<td>1.45 (1.25-1.68)*</td>
<td>1.76 (1.52-2.04)</td>
<td>0.71 (0.51-0.92)</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>1.12 (0.81-1.54)</td>
<td>1.44 (1.27-1.63)*</td>
<td>1.72 (1.50-1.96)*</td>
<td>0.66 (0.19-2.27)</td>
</tr>
<tr>
<td><strong>Jaw Fractures:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 5 (Least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (Most deprived)</td>
<td>4.99 (4.48-5.56)*</td>
<td>3.91 (3.09-4.55)*</td>
<td>1.31 (0.70-2.42)</td>
<td>0.56 (0.17-1.81)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>1.74 (1.54-1.95)*</td>
<td>2.05 (1.61-2.60)*</td>
<td>0.71 (0.41-1.23)</td>
<td>1.15 (0.64-2.06)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>1.99 (1.76-2.25)*</td>
<td>1.88 (1.47-2.40)*</td>
<td>0.88 (0.53-1.47)</td>
<td>0.94 (0.54-1.63)</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>1.41 (1.27-1.56)*</td>
<td>1.85 (1.51-2.28)*</td>
<td>1.03 (0.67-1.59)</td>
<td>1.26 (0.74-2.14)</td>
</tr>
</tbody>
</table>

Quintiles: Based on IRSD score of area of residence. *p<0.001, **p<0.05
9.5. **Discussion:**

The results of this study indicated consistently higher rates of hospitalisation for oral health related conditions among the most disadvantaged group in the WA population, compared to the rest. This trend remained consistent over a period of ten years, and also remained consistent when analysed by age-group, with the youngest, most disadvantaged having higher admission rates than those from other age groups and disadvantage levels. This finding clearly reflects the poorer oral health of groups in the population at the lower end of the socio-economic scale. Numerous studies have demonstrated this social gradient, not just in Australia (Slade et al., 2007; AIHW, 2014a; Chrisopoulos and Harford, 2013) but it is a worldwide phenomenon (Locker, 2000). The study results also indicate that for many, poor oral health ultimately result in hospital admissions, meaning that the condition is not possible to be managed in the primary care system.

Overall, in terms of absolute numbers, 63% of all those admitted had private insurance. When comparing socio-economic groups however, 75% of those in the least disadvantaged group had insurance compared to only 28% of those in the most disadvantaged group. In 2010 55% of Australians had private dental insurance (Chrisopoulos and Harford, 2013). Levels of insurance coverage increased across household income, with highest levels of insurance among those with the highest household incomes. For those earning less than $30 000 per year, less than 30% had private dental insurance (Chrisopoulos and Harford, 2013).
The importance of private insurance needs to be considered against the backdrop of the Australian health care system, and especially the dental health care system. Medicare is the basis of Australia’s health care system and covers many health care costs, but does not cover dental examinations and dental treatment. Australians can choose to have Medicare cover only, or a combination of Medicare and private health insurance. This situation leaves a large part of the population having to pay for dental care, either out-of-pocket, or via private health insurance, and those that are less likely to be able to afford private health insurance are those from the most disadvantaged proportions of the population. A safety net exists for the most disadvantaged in the form of access to public dental services, but this does not always include the working poor, who are not eligible for public dental care. Disadvantaged groups that are not eligible for public dental services may have difficulty accessing regular private oral health services due to the cost, while those eligible for public dental care may face long waiting times for care (NACOH, 2004).

The results of this study also indicated that those who are most disadvantaged stayed on average longer in hospital than others, and the average cost per admission was highest in this group. It is estimated that these direct costs (DRG) are very conservative estimations, and in reality, the true costs could amount to double the estimated cost at the patient level (inclusive of health insurance refund). Additionally, indirect costs (travel, time off work, support family time etc.) are not included, but others have estimated in small countries with minimal travel that this can be nearly double the direct costs (Drummond et al., 1997).
Our results thus indicate that those who can least afford it, might have higher costs (direct and indirect) and longer hospital stays.

The condition that most people were admitted to hospital for was for “Embedded and Impacted Teeth”. Almost half (48.9%) of all hospitalisations was for this condition. Previous work indicated that these high numbers are driven by the removal of third molars, mostly in younger people (Kruger et al, 2006; George et al, 2011b; Anjrini et al, 2014; Anjrini et al, 2015). These rates of hospitalisation are much higher in Australia than in some other countries (Anjrini et al, 2014). This was one of only two conditions where those who are least disadvantaged were significantly less likely to be admitted, and this was seen in all age groups. Those in the youngest and most disadvantaged group were 76% less likely than the youngest and least disadvantaged group to be admitted for this condition, and the same trend was evident in all the other age groups.

The other condition were likelihood to be admitted were significantly less for the poorest compared to the richest, across all age groups was for “Other disorders of teeth and supporting structures”. This was especially evident among the older ages (poorest were 84% and 83% less likely than richest in ages 60-79 years and 80+years respectively).

Calculation of odds ratios for the other most common conditions, especially in the youngest age group, all indicated significantly higher likelihoods of admission (of the most disadvantaged) for each specific condition: this group was almost 5 and 4.8 times more likely to be admitted for “Jaw fractures” and “Other fractures” respectively. Previous work
indicated much higher levels of jaw and other fractures amongst lower socio-economic groups. The reasons for this include the determinants and risk factors for maxillofacial fractures, which are strongly associated with poverty (Kruger et al., 2006; Jamieson et al., 2008; O’Meara et al., 2011; Chranovic, 2012).

The youngest and poorest were 2.6 times more likely to be admitted for “Dental caries”, and more than 5 times more likely to be admitted for “Pulp and periapical conditions” than the youngest least disadvantaged. Previous studies and surveys have emphasised the higher levels of dental caries in Australia among those who are lower on the socio-economic scale (Locker, 1993; Slade et al, 2007). Admissions for pulp and periapical conditions have previously been shown to be significantly higher in children from poorer socio-economic backgrounds (Kruger et al., 2000; Alsharif et al, 2014). Pulp and peri-apical conditions could result from infections in the tooth, most often caused by untreated dental caries (Shah et al., 2013).

For some conditions the trend was evident across all age groups, and the poorest in all age groups were more likely to be hospitalised. “Malignancies” was one such condition. The likelihood was 3 times more likely among 18-39 year olds, twice as likely in 40-59 year olds, 3.3 times more likely among 60-79 year olds and 3.5 times more likely in those older that 80+ to be admitted for malignancies than similar age groups in the least deprived group. This might be a reflection of oral cancer being a strongly age-related condition (Abreu et al., 2010; Abdelhafied et al., 2014; Thomson, 2014).
One weakness of a population-based hospitalisation study like this, is that it cannot determine the need for care, it is unknown whether the care is distributed according to need. However, there is very strong evidence that those who are socio-economically disadvantaged have higher levels of dental disease. Most population-based studies of this nature rely on indirect inference to evidence relating to disease levels and burdens of disease among different groups. The results of this study thus suggest large and diverging health care needs between socio-economic groups.

Access to care is a complicated issue influenced by demand and supply barriers that may influence the use of primary health services. The use of primary care services in oral health (where timely and adequate services can be provided), might contribute to less people being hospitalised for treatment of some, but not all conditions. The use of primary dental care services is however not an easy option for all, with multiple factors determining access, including socioeconomic status, geographical location, age, and health insurance status, among others (NACOH, 2004; Slade et al, 2007). Public dental services in Australia are currently not in a position to provide services to all those who need or demand it (Spencer, 2012) and the results of this study might be a reflection of that.

9.6. **Conclusion**

The most disadvantaged in the population are being hospitalised for oral health related conditions at significantly higher rates than other groups. Those least disadvantaged have the second highest rates of hospitalisation, but the likelihood of being admitted for specific
procedures differ between these two extremes. The importance of socio-economic determinants of health is evident when analysing these hospitalisations. Although the importance of social determinants in oral health is now widely acknowledged, public policy seems to still be focused largely on individual behaviour. Recognition however that lifestyle choices are severely restricted amongst the most marginalised and disadvantaged groups in the population can no longer be ignored in attempts to reduce health inequalities.
Chapter 10

10. Do hospital admission rates reflect poorer oral health of rural and remote dwelling Western Australians? A ten-year analysis

This chapter was submitted for publication to Rural and Remote Health Journal on 15 April 2016 as the following: Kruger E, Tennant M. Do hospital admission rates reflect poorer oral health of rural and remote dwelling Western Australians?
10.1. Abstract

**Background:** Admission rates to hospitals are useful in demonstrating the differences in health status or access to health services based on geographically different populations. It is well known that inequalities exist in the oral health status between rural and urban Australians. The aims of this study was to determine if the poorer oral health of rural and remote (compared to urban) Western Australians are reflected in admission rates to hospitals for oral-health related conditions, and to identify the differences in admission rates for the most common dental conditions between urban and rural populations.

**Methods:** Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS) for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. Area based measures (using the Accessibility and Remoteness Index of Australia) was used to determine relationships between geography and other variables.

**Results:** Admission rates for all age groups older than 40 years were the highest in very remote areas. Of the ten most common oral health-related conditions (for which people are hospitalised), five have the highest rates of hospitalisation in areas classified as very remote. Whilst slightly more than two-thirds (68%) of all persons in metropolitan areas had private health insurance, less than one-third (28%) in very remote areas had the same.

**Conclusion:** Hospital admission rates for rural and remote residents in Western Australia reflect the higher burdens of oral disease in this population, compared to their urban counterparts.
10.2. Introduction

Policy-makers often focus on concepts of equal access to health care, or equal health outcomes, when setting objectives for health care systems (Rice and Smith, 2001; NACOH, 2004). The examples of equal access and equal outcomes reflect, respectively, the classic Aristotelian principles of horizontal and vertical equity in respect of health care (Rice and Smith, 2001; Culyer, 2007). In pursuit of these guiding principles, geography becomes important for three reasons (Rice and Smith, 2001): Firstly, many systems of health care are organised on a geographical basis, and issues of territorial equity therefore become central to the distribution of health care resources. Secondly, health care facilities such as hospitals and clinics are concentrated at specific locations, implying that geographical considerations may be of central importance in determining access to health care and health outcomes. Thirdly, there is evidence that geographical inequalities in health, may exist beyond social class and income inequalities (Rice and Smith, 2001; Slade et al., 2007; AIHW, 2005).

Admission rates to hospitals are useful in demonstrating the differences in health status or access to health services based on geographically different populations. It is well known that inequalities exist in the oral health status between rural and urban Australians (Slade et al., 2007; AIHW, 2006; Jamieson et al., 2013). Inequalities in health arise from three broad sources: variations in the quality of health services, variations in access to services, and variations in factors outside the control of health services, such as lifestyle, wealth,
genetic and environmental considerations (Rice and Smith, 2001). Rural and remote populations in Australia suffer on all three counts.

Variations in quality and access to dental services in regional areas has previously been highlighted: a disadvantage exists in accessing dental care due to the lack of availability of dentists and other oral health facilities, and the greater distances involved (Tennant and Kruger, 2013; Shiika et al., 2015). The number of dentists declines strongly with remoteness (Tennant and Kruger, 2013; Shiika et al., 2015; NRHA, 2013). Higher rates of problem-oriented dental visits and fewer people making a recent visit are the most striking differences in access to dental services in regional areas (AIHW, 2005). Water fluoridation remains the most cost-effective way to prevent dental caries at population level, but is less common in regional areas, and not available to all (Desai et al., 2015).

People living in more rural regions of Australia are also disadvantaged with regards to educational and employment opportunities, income, access to goods and services, transport difficulties, inadequate local infrastructure, vulnerability to drought and other natural hazards, and in some areas access to basic necessities, such as clean water and fresh food (AIHW, 2006). The oral health of Aboriginal and Torres Strait Islander people are worse than that of non-Aboriginal people (Slade et al., 2007), and a significant proportion of Aboriginal and Torres Strait Islander people are living outside of capital cities, and for those living on low income the experience is exacerbated by specific cultural, language and life experience issues.
Australia is geographically the sixth largest country in the world with a total area of more than 7.5 million square kilometres (ABS, 2012). Most (90%) of the Australian population of 22 million people live along the coastal fringes in major cities, with the remaining ten percent scattered over the vast regional and remote areas. Nearly half of Australia’s Indigenous population lives in outer regional, remote and very remote areas (ABS, 2012). Dental service provision in these areas is largely the responsibility of the State-based government service sector, whose broad mandate is to provide a safety net of care for socially, economically and geographically disadvantaged members of society (about 50% of Australia’s population)(Dyson et al., 2012). The service is struggling to meet the basic oral health care needs or expectations of many rural and remote communities (Dyson et al., 2012). Geographically the largest state in Australia is Western Australia, with a total population approaching 2 million people. Of this total population about 1.6 million live in the major capital city, Perth, with the remainder distributed across the vast regional areas.

Population-based studies on adult oral health-related hospitalisations in Western Australia, with a focus on regional differences, have not been done before. Existing literature, to a large extent, is focused on the oral health of the child population. It is important that indicators describing the extent of health dimensions across regions and time be examined however, as it contributes to measures that can inform rural health policy. The aims of this study were to:
a) Determine if the poorer oral health of rural and remote (compared to urban) Western Australians is reflected in admission rates to hospitals for oral-health related conditions; and

b) Identify the differences in admission rates for the most common dental conditions between urban and rural populations.

10.3. Materials and Methods:

Ethics. Ethics approval for this study was obtained from the Human Research Ethics Committee at The University of Western Australia.

Study population. This included all adults in Western Australia (WA) who were admitted to hospital for an oral-health related condition, over a ten year period. The adult population in WA (all 18 years and older), were 1,059,750 in 1999, 1,094,197 in 2001 and 1,221,799 in 2006 (ABS, 2006).

Hospitalisation data: Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) (ACCD, 2014), was obtained for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999-2000 to 2008-2009. In this study hospitalisation episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health related condition.
Population rates and cost: Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national standard diagnostic related group (DRG) average price. The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost. AR-DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services (AIHW, 2013d).

Accessibility and Remoteness Index of Australia: Primary place of residency at the time of hospitalisation and the geographical classification was done according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centres based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (DHAC, 2001) (Table 10.1).
### Table 10.1: Remoteness and Accessibility Index of Australia.

<table>
<thead>
<tr>
<th>Accessibility Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Accessible (HA)</td>
<td>relatively unrestricted accessibility to a wide range of goods and services and opportunities for social interaction</td>
</tr>
<tr>
<td>Accessible (A)</td>
<td>some restrictions to accessibility of some goods and services and opportunities for social interaction</td>
</tr>
<tr>
<td>Moderately Accessible (MA)</td>
<td>significantly restricted accessibility of goods and services and opportunities for social interaction</td>
</tr>
<tr>
<td>Remote (R)</td>
<td>very restricted accessibility of goods, services and opportunities for social interaction</td>
</tr>
<tr>
<td>Very Remote (VR)</td>
<td>very little accessibility of goods, services and opportunities for social interaction</td>
</tr>
</tbody>
</table>

ARIA provides a clear definition and methodology to describe and represent remoteness from goods and services for any part of Australia. It relies on road distance as a surrogate for remoteness and on the population size of a service centre as a surrogate for the availability of services (DHAC, 2001).

**Statistical analysis:** All rates were calculated using the Rates calculator, a software package developed by the WA Department of Health. All rates were calculated per 100,000 person years, and were adjusted for ages and ARIA categories. Significant differences between rates were based on non-overlapping 95 percent confidence intervals (p<0.05). Means between groups were compared using ANOVA. All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).
10.4. Results

10.4.1. Demographics:

A total of 131,509 adult persons were admitted to hospitals in Western Australia for oral health-related conditions over a ten year period. The ARIA code of 130,903 of these individuals were available, and was included for analysis in this study. There were no significant differences in the numbers of males (n=63,569, 48.5%) and females (n=67,940) admitted across all geographical regions (Table 10.2).

10.4.2. Indigenous status:

A total of 3,620 (2.7%) of those admitted were Indigenous persons, and 127,283 (97.3%) were non-Indigenous. Overall, the age-adjusted admission rate of Indigenous (1,010 per 100,000 persons) was significantly higher (p<0.05) than that of non-Indigenous persons (892 per 100,000 persons) (Table 10.2). Rates of Indigenous person hospitalisations were significantly lower in HA, slightly (but not significantly) lower in A, MA and R areas, but higher (almost twice as high) in VR areas, compared to non-Indigenous rates.

Age: Almost half of all those admitted were in the age group 18 to 39 (47%), a further 29% were aged between 40-59 years, 18% were between 60 and 79 years, and 6% were older than 80 years (Table 10.2). In the youngest age group, rates of admission were highest in HA and A areas, and lowest in VR areas. (Table 10.2) In the 40-59 year-olds, admission rates were highest in VR areas and lowest in MA and R areas. For both age groups 60-79 years
and 80+ years, rates were highest in VR areas (Table 10.2). Overall, all ages included, rates were significantly lower in MA and R areas. The highest admission rates in VR areas were for persons older than 80 years, and the second highest rate were for those aged 60 to 79 years.

Table 10.2: Oral health-related hospitalisations by different variables and across accessibility and remoteness (ARIA) categories.

<table>
<thead>
<tr>
<th></th>
<th>HA</th>
<th>A</th>
<th>MA</th>
<th>R</th>
<th>VR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>110020(84%)</td>
<td>8523(6.5%)</td>
<td>4255(3%)</td>
<td>1278(1%)</td>
<td>6827(5.5%)</td>
<td>130903(100%)</td>
</tr>
<tr>
<td>Males</td>
<td>52237(82%)</td>
<td>4238(7%)</td>
<td>2205(4%)</td>
<td>664(1%)</td>
<td>3834(6%)</td>
<td>63569(100%)</td>
</tr>
<tr>
<td>Females</td>
<td>57783 (85%)</td>
<td>4285(6%)</td>
<td>2050(3%)</td>
<td>614(1%)</td>
<td>2993(5%)</td>
<td>67940(100%)</td>
</tr>
<tr>
<td>Indigenous</td>
<td>1052(29%)</td>
<td>255(7%)</td>
<td>166(5%)</td>
<td>48(1%)</td>
<td>2099(58%)</td>
<td>3620(100%)</td>
</tr>
<tr>
<td>ASR(CI)*</td>
<td>722(676-771)</td>
<td>950(831-1080)</td>
<td>678(573-803)</td>
<td>596(425-834)</td>
<td>1360(1290-1420)</td>
<td>1010(982-1050)</td>
</tr>
<tr>
<td>Non-Indig</td>
<td>108968(85%)</td>
<td>8268(7%)</td>
<td>4089(3%)</td>
<td>1230(1%)</td>
<td>4728(4%)</td>
<td>127283(100%)</td>
</tr>
<tr>
<td>ASR(CI)*</td>
<td>909(903-915)</td>
<td>925 (904-947)</td>
<td>687(664-710)</td>
<td>627(590-666)</td>
<td>796(772-821)</td>
<td>892(887-897)</td>
</tr>
<tr>
<td>All</td>
<td>110020(84%)</td>
<td>8523(7%)</td>
<td>4255(3%)</td>
<td>1278(1%)</td>
<td>6827(5.5%)</td>
<td>130903(100%)</td>
</tr>
<tr>
<td>ASR (CI)*</td>
<td>907(901-912)</td>
<td>927 (906-949)</td>
<td>688(666-711)</td>
<td>626(590-664)</td>
<td>913(890-937)</td>
<td>895(890-900)</td>
</tr>
<tr>
<td>DRG (SD)***</td>
<td>3080 (6147)</td>
<td>3178 (6555)</td>
<td>3371(7471)</td>
<td>3171(6149)</td>
<td>3967 (*8553)</td>
<td>3152(6400)</td>
</tr>
<tr>
<td>LOS (SD)</td>
<td>1.45 (2.9)</td>
<td>1.63(3.2)</td>
<td>1.75(2.8)</td>
<td>1.73(2.8)</td>
<td>2.23 (4.01)**</td>
<td>1.51(4.0)</td>
</tr>
<tr>
<td>Age: 18-39</td>
<td>52414 (85.5%)</td>
<td>3533 (5.8%)</td>
<td>1694(2.8%)</td>
<td>533 (0.9%)</td>
<td>2859 (4.7%)</td>
<td>100%(N=61319)</td>
</tr>
<tr>
<td>ASR(CI)*</td>
<td>922 (914-931)</td>
<td>956 (922-990)</td>
<td>690 (655-727)</td>
<td>626(572-688)</td>
<td>610 (586-635)</td>
<td>100%(N=37967)</td>
</tr>
<tr>
<td>40-59</td>
<td>30278 (79.7%)</td>
<td>2827 (7.4%)</td>
<td>1419 (3.7%)</td>
<td>435(1.1%)</td>
<td>2788 (7.3%)</td>
<td>100%(N=24365)</td>
</tr>
<tr>
<td>ASR(CI)*</td>
<td>671 (663-680)</td>
<td>778 (747-810)</td>
<td>552 (522-584)</td>
<td>515(464-570)</td>
<td>897 (862-934)</td>
<td>100%(N=7858)</td>
</tr>
<tr>
<td>60-79</td>
<td>20444 (83.9%)</td>
<td>1653 (6.8%)</td>
<td>900 (3.7%)</td>
<td>246(1.0%)</td>
<td>1034 (4.2%)</td>
<td>100%(N=131509)</td>
</tr>
<tr>
<td>ASR(CI)*</td>
<td>928 (914-942)</td>
<td>816 (775-860)</td>
<td>685 (638-736)</td>
<td>597(520-685)</td>
<td>1344 (1258-1436)</td>
<td>100%(N=82960, 63%)</td>
</tr>
<tr>
<td>80+</td>
<td>6884 (87.6%)</td>
<td>510 (6.5%)</td>
<td>242 (3.1%)</td>
<td>63 (0.8%)</td>
<td>146 (1.9%)</td>
<td>100%(N=48315,37%)</td>
</tr>
<tr>
<td>ASR (CI)*</td>
<td>1291 (1258-1324)</td>
<td>1154 (1051-1268)</td>
<td>1021 (890-1171)</td>
<td>990 (752-1302)</td>
<td>1515 (1266-1811)</td>
<td>100%(N=130902,100%)</td>
</tr>
<tr>
<td>All</td>
<td>110020 (83.7%)</td>
<td>8523 (6.5%)</td>
<td>4255 (3.2%)</td>
<td>1278 (1.0%)</td>
<td>6827 (5.2%)</td>
<td>100%(N=131509)</td>
</tr>
<tr>
<td>ASR (CI)*</td>
<td>907 (901-912)</td>
<td>927 (906-949)</td>
<td>688 (666-711)</td>
<td>626 (590-664)</td>
<td>913 (890-937)</td>
<td>895 (890-900)</td>
</tr>
<tr>
<td>Insured</td>
<td>68%</td>
<td>42%</td>
<td>47%</td>
<td>53%</td>
<td>28%</td>
<td>N=82960, 63%</td>
</tr>
<tr>
<td>Not insured</td>
<td>32%</td>
<td>58%</td>
<td>53%</td>
<td>46%</td>
<td>72%</td>
<td>N=48315,37%</td>
</tr>
<tr>
<td>All</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>N=130902,100%</td>
</tr>
</tbody>
</table>

- HA= Highly Accessible, A=Accessible, MA= Moderately Accessible, R=Remote, VR= Very Remote.
- DRG = Direct Related Group Cost (mean, SD) in AU$.
- LOS= Length of stay (in days), *p<0.001, ANOVA
- ASR(CI)= Age standardized rate per 100 000 population, CI = 95% confidence Interval), P<0.001,***
10.4.3. Cost and length-of-stay:

Mean direct cost (as calculated using DRG costs) were highest for those from VR areas, and lowest for those in HA areas. The mean number of bed days were highest for those from VR areas, and lowest for those in HA areas (Table 10.2).

10.4.4. Private health insurance:

Whilst slightly more than two-thirds (68%) of all individuals in HA areas had private health insurance, less than one-third (28%) in VR areas had the same (Table 10.2).

10.4.5. Time trends:

There is an increase in the age-adjusted admission rates over time, for all areas. Rates (per 100 000 persons) were increasing most steeply in the VR areas, from 748 (1999/02) to 1240 (2008/09). For VR areas, trend analysis indicated a rate ratio of 1.657, with a confidence interval of 1.56 to 1.74 and an annual average change of 7.77%. For HA areas, rates increased over ten years from 653 to 1177. Trend analysis of HA rates indicated a rate ratio of 1.802, with a confidence interval of 1.68 to 1.92 and an annual average change of 6.44%. In 2009 (the last year of the study) rates were highest in VR area, and lowest in MA (824) and R (739) areas (Fig 10.1). Absolute numbers of hospital admissions increased in all areas, with the biggest changes in the HA (from 7927 in 1999/2000 to 14288 in 2008/09) and in the VR areas (from 559 to 926 in 2008/09).
Rates are age-standardised and presented per 100 000 population.

Figure 10.1: Oral health-related hospitalisation rates over time for each ARIA category.

Almost half (49%) of all admissions were for the removal of embedded and impacted teeth.

A second analysis was done, excluding all hospitalisations for this category, to determine if the trends in rates across time and areas would be different. The result is presented in Figure 10.2. The overall rate ratio between VR and HA areas increases from 0.6 (including impacted teeth removal cases) to 1.18 (excluding impacted teeth removal cases).
• Rates are age-standardised and presented per 100 000 population

Figure 10.2: Oral health-related hospitalisation rates over time for each ARIA category, with the exception of the diagnosis category “Removal of embedded and impacted teeth”

10.4.6. Conditions:

The ten most common (highest frequency of admission) conditions for which people were admitted, were the following (conditions as categorized according to ICD code): “Embedded and Impacted teeth”; “Dental Caries”; “Other disorders of teeth and supporting structures”; “Other Fractures” (which include fractures of teeth, palate, nasal bone, alveolus, lower facial bones); “Malignant neoplasms”; “Pulp and peri-apical conditions”; “Other diseases of the jaw”; “Jaw fractures” (maxilla and mandible); “Dento-facial anomalies”; and “Gingivitis and Periodontitis”.

198
Rates of admission (average rate per year) were higher in HA areas than VR areas for “Embedded and Impacted teeth removal” (467 and 259), “Dental caries” (78 and 61) and “Other diseases of the jaw”(82 and 34). Rates in Very Remote areas however, were much higher for “Malignancies” (66 and 32) and “Other fractures” (179 and 45) (Figure 10.3).

* Rates are age-standardised and presented per 100 000 population

**Figure 10.3: Rates of hospitalisations for impacted teeth, caries, disorders of teeth/supporting structures, fractures and malignancies, across ARIA categories.**

Rates of admission were higher in VR areas than in HA areas for “Jaw fractures”(95 and 21), Pulp and peri-apical conditions” (61 and 25)and “Other diseases of the jaw” (37 and 27), but lower rates than in Highly Accessible areas for “Dento-facial anomalies”(8 and 25), and “Gingivitis and Periodontitis” (17 and 20) (Figure 10.4).
*Rates are age-standardised and presented per 100 000 population

Figure 10. 4: Rates of hospitalisations for pulp conditions, jaw diseases, jaw fractures, dentofacial anomalies and gingivitis and periodontitis, across ARIA categories.

10.7. Discussion

Results of this study indicate that most hospital admissions for oral health-related conditions were for younger people, aged 18-39 years. Total hospitalisations for oral-health related conditions in Western Australia is to a large extent driven by admissions for the removal of embedded and impacted teeth, with almost half of all admissions for this condition (Kruger and Tennant, 2015c; George et al., 2011; Anjrini et al., 2014a). Previous research suggests that it is the removal of mostly third molars amongst young people that accounts for these hospital admissions (George et al., 2011). Age is strongly associated with
third molar removal as it is the last teeth in the mouth to erupt, usually between ages 17 and 21 years, and it is usually during this time when referral to have the teeth removed, is made (Anjrini et al., 2014a).

For all age-group categories, except the youngest (18-39 years old), admission rates were the highest in the Very Remote areas of Western Australia. These age categories included all people over the age of 40 years – at this age (40+), the number of admissions for third molar removals would be far less, and admissions were mostly attributed to other conditions. In Very Remote areas, rates were the highest for those older than 80 years, and second highest for those between 60 and 79 years. These rates were higher than any other rate, for any other age group, and in any other area. It is an indication that those older than 65, and especially older than 80 years, in very remote areas suffer the highest burden of oral health related conditions leading to hospitalisation.

Western Australia, like the rest of Australia, has an ageing population, mostly as a result of increasing life expectancies and a decline in birth rates (National Strategy, 2001). The change in age profile has implications for the provision of health services, and this is particularly challenging in rural and remote areas. In general, access to primary dental care in Very Remote areas is very limited, and in some parts of the state, no primary dental services are available. Other possible contributory factors are lower socioeconomic status and employment levels, exposure to comparatively harsher environments, sparse infrastructure and occupational hazards (Health Department WA, 2001). Health-promoting
behaviours amongst older people however, may be difficult to maintain in many rural areas. Everything is more expensive, – getting to organised activities, buying nutritious food and visits to health-care professionals. Research suggests that rural older people become incrementally marginalised and disconnected from life, and it is the resulting loss of social contact that is likely to be more significant to healthy ageing than issues with access to health services (Davis and Bartlett, 2008).

The overall rate of admissions were higher for Indigenous than non-Indigenous people, and most of the Indigenous persons were from Very Remote areas. Indigenous people suffer from poorer oral health than non-Indigenous people (Slade et al., 2007), and nearly half of Australia’s Indigenous population reside in rural and remote areas (Steering Committee, 2011). Contributing factors to poor oral health among rural and remote Indigenous people include poor access to services, the presence of many common risk factors (diseases, such as heart disease, stroke, cancer, diabetes and dental caries, share common risk factors including smoking, poor diet, alcohol, stress, poor hygiene and trauma), social determinants of health (social exclusion, unemployment, stress and addiction are all factors that contribute to poor health, including poor oral health), changing lifestyle patterns, and access to fluoridated water (Trewin and Madden, 2005; Steering Committee, 2011).

Direct costs, as well as length of stay in hospital were highest for those from very remote areas, most likely because of the more advanced nature of disease when obtaining care (due to access to primary care issues), more serious nature of conditions (for which
admitted) and conditions that require longer treatment. Indirect costs associated with the hospitalisation for rural and remote dwellers would also be much higher than for urban dwellers, due to increased costs associated with travel and travel times, as well as additional costs associated when accommodation is needed for accompanying family members.

Rates were highest in Very Remote areas (compared to all other areas) for five of the ten most common conditions, and these include “Jaw fractures”, Pulp and peri-apical conditions” and “Other diseases of the jaw”, “Malignancies” and “Other fractures”. In the urban, Highly Accessible areas, rates were highest (compared to all other areas) for “Embedded and Impacted teeth removal”, “Dental caries”, “Other disorders of teeth and supporting structures”, “Dento-facial anomalies”; and “Gingivitis and Periodontitis”. Previous research has indicated the very high rates of jaw fractures among Indigenous (compared to non-Indigenous), and rural (compared to urban) rates (Kruger et al., 2006). The etiology of facial fractures in Australia, and especially in the Aboriginal population, is strongly associated with alcohol-related violence and assaults (Jamieson et al., 2008; Jayaraj et al., 2012).

Pulpitis and peri-apical conditions were also more common in rural and very remote areas, and the least common in highly accessible areas. Pulpitis indicate infection of the dental root canal, and primary dental care at this stage involves removal of the infected tissue and reconstruction. Where primary care is not available or seeking treatment is delayed, the
pulp may be irreversibly damaged by an ongoing inflammation, followed by necrosis of the pulp tissue. A complication of pulpitis is a periapical abscess in the periodontal tissue. If the infection spread to adjacent teeth or to deeper tissue, cellulitis can occur, and hospitalisation is indicated for severe cellulitis, in order for patients to receive intravenous antibiotics (Do and Martin, 2008).

Previous work highlighted the higher rates of oral cancers in rural and remote regions of Western Australia (Abreu et al., 2010; Abdelhafied et al., 2014). Reasons for higher rates in regional areas might include increased exposure to carcinogens or diet, along with low socioeconomic status, all associated with poor health outcomes. There have also been suggestions that health beliefs might exert a significant influence on health-seeking behaviour (Howat et al, 2006). Australians living outside of major cities are more likely to be smokers, and to drink alcohol in hazardous quantities, and are more at risk of diet-related chronic disease than other Australians (Abdelhafied et al., 2014). Furthermore, cancer services in Australia are principally located in capital cities, limiting access to services (Abreu et al., 2010; Australian Government, 2012a).

In Metropolitan areas, rates of removal of embedded and impacted teeth were much higher than in rural areas. Previous research indicates that it is the removal of wisdom teeth amongst young, metropolitan, privately insured, least disadvantaged persons that is associated with these high admission rates. These rates of admission for removal of third molars are much higher than in other countries, including the UK and France (Anjrini et al,
This might explain why the highest rate of hospitalisations (for this age-category persons) was in Highly Accessible areas, where access to primary care (for subsequent referral) is more available, access to specialist care is more available, and higher proportions of the population have private health insurance and are from higher socio-economic backgrounds.

Much higher admission rates for the treatment of dental caries were also observed in highly accessible, compared to rural areas. Timely access to primary care and water fluoridation can prevent hospitalisation for dental caries treatment. This especially relates to these adult age groups, where caries treatment under general anaesthetic is less likely to be for behavioural management, as in often the case in very young children.

It is evident that rural areas provide very different challenges in the planning and provision of optimal health (including oral health) services. Rural and remote health services would not obtain the same economies of scale as city-based services, and many small rural facilities experience a significant administrative burden on their limited resources due to multiple accreditation, accountability and reporting requirements. Once rurality exceeds a certain limit, it becomes impractical to deliver the same level of service as in metropolitan areas (Rice and Smith, 2001). The issue of rurality exemplifies the trade-off that exists between equity and efficiency in the allocation of health care resources. The challenge is to design, deliver and support rural and remote health services using more flexible, innovative, and locally appropriate solutions, without compromising the quality and safety of care (Rice
and Smith, 2001). Service models must take into account the specific geographical, social and economic and cultural contexts that differentiate the many and remote communities scattered across more than 7.5 million square kilometres and which are home to more than 7 million Australians (Rice and Smith, 2001, Dyson et al., 2012; Australian Government, 2012).

10. 8. Conclusion

Hospital admission rates for rural and remote residents in Western Australia reflect the higher burdens of oral disease in this population, compared to their urban counterparts. Of the ten most common oral health related conditions for which people are hospitalised, five have the highest rates of hospitalisation in areas classified as very remote. These conditions, (compared to the five which do not have the highest admission rates in remote areas) are strongly associated with poverty, Indigenous status, and exposure to environmental and behavioural risk factors and carcinogens. Over the ten years of this study, there were no improvements in the disparity in hospitalisation outcomes between different geographical populations.

The reality is that the geographical allocation of oral health services and funding to match ethical principles of equity and equality remains a near impossible task. Inequalities in the provision of healthcare will always exist, if only because of geographical variations in the costs of reaching services. Equality in health outcome can only be partly pursued by redeployment of service resources.
Chapter 11

11. Projecting adult hospital admissions for oral health related conditions

This chapter was submitted for publication to Australian Health Review Journal on 2 April 2016 as the following: Kruger E, Tennant M. Projecting adult hospital admissions for oral health related conditions.
11.1. Abstract

**Background:** Statistical analysis of population-based hospitalisations is relevant and necessary to inform public policy, with the aim of improving and monitoring health service delivery. The aim of this study was to predict adult hospitalisation rates for oral-health related conditions, and with specific reference to the most common conditions, through to 2030, based on ten years’ worth of retrospective admission data for Western Australia (WA).

**Methods:** Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), was obtained for every episode of discharge from hospital in WA, for all adult patients, between financial years 1999-2000 to 2008-2009. All those with an oral-health related principal condition were included in the study. Projections were carried out using a linear or log-linear ordinary least squares method, based on the ten years’ worth of hospitalisation data.

**Results:** Overall, for all ages, admission rates will increase by 34%, from 2009 to 2020, and by 66% from 2009 to 2030. The admission rates for seven of the eight most common conditions will increase. The total DRG costs of hospital admissions will increase from $18.8 million in 2000, to more than $200 million in 2030. The total number of bed-days will increase from 16 664 days in 2000 to between 663 232 and 682 368 days in 2030.

**Conclusions:** Projections of oral health related hospital admissions in Western Australia indicate significant increases in the rates of admissions up to the year 2030, and direct costs is also set to increase.
11.2. Introduction

Australia faces significant intergenerational challenges, with a population that is ageing rapidly (Australian Government, 2015; Daley et al., 2013; National Strategy, 2001). Between now and 2050 the number of older people (65 to 84 years) is expected to more than double; and very old people (85 and over) is expected to more than quadruple, from 0.4 million people today to 1.8 million in 2050. (Australian Government, 2015; Daley et al., 2013; National Strategy, 2001; AIHW, 2000). Population ageing indicate less labour force participation, and increased pressure on economic growth. The ageing population will result in substantial fiscal pressures from increased demand for government services and rising health costs (Australian Government, 2015; AIHW, 2000).

Currently around a quarter of total spending is directed to health, age-related pensions and aged care. This is expected to rise to around half by 2049-50. As a result, total spending is expected to grow to around 27 per cent of GDP by 2049-50 (Australian Government, 2015). Health expenditure would rise from 8.4% of GDP in 1990 to 11.1% of projected GDP in 2051. Such an increase would represent a large shift in health resources from the young and working age to older people (health care expenditure on older people could increase from about 33% of total health care expenditure in 1990 to 50% by 2051)(Australian Government, 2015, AIHW, 2000).
Rates of hospital admissions in Australia are rising, and in 2013/14 more than 9.7 million Australians were admitted to hospital for various conditions (AIHW, 2015a). Previous analysis indicate increasing rates of hospitalisations of adult Western Australians for oral-health related conditions over a ten year period (Kruger and Tennant, 2015a; Kruger and Tennant, 2015b; Kruger and Tennant, 2015c). Analysis of potentially preventable oral-health related hospitalisations over time also indicates significant annual admission rate increases (Kruger and Tennant, 2015c), and a significant annual increase in the rates of oral-health related hospitalisations has also been found amongst people older than 65 years (Kruger and Tennant, 2015a).

Direct costs of adult hospital admissions for oral conditions amounted to more than $400 million over a ten-year period, and a total number of bed-days of almost 200 000 (Kruger and Tennant, 2015b). Increasing trends in child hospitalisation rates for oral-health related conditions in WA have also been identified (Alsharif et al., 2016). Based on these previously identified trends, and against a backdrop of rapidly changing demographics and future health expenditure challenges, possible future scenarios in oral health-related adult hospital admissions need to be investigated. Statistical analysis of population-based hospitalisations is relevant and necessary to inform public policy, with the aim of improving and monitoring health service delivery.

The aim of this study was to project adult hospitalisation rates for oral health-related conditions, with specific reference to the most common conditions, through to 2030, based on ten years’ worth of retrospective admission data for WA.


11.3. **Methods**

*Ethics.* Ethics approval for this study was obtained from the Human Research Ethics Committee at The University of Western Australia.

*Study population.* WA is geographically the largest State in Australia, and in 2006 had a population of just more than 2 million (which constituted approximately 10% of the total Australian population in 2006 of 20.7 million). The adult population in WA (all 18 years and older), were 1,059,750 in 1999, 1,094,197 in 2001 and 1,221,799 in 2006. (ABS, 2006).

*Hospitalisation data:* Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The HMDS forms part of the Western Australian Hospital Data Linkage (WAHDLS) system, unique in Australia, and which is known for its high quality, and comprehensive population base (Holman et al., 2008). The high quality of this population-based data set allows for comprehensive health services research (Holman et al., 2008).

The term ‘hospitalisation’ has been used to refer to a separation which is the episode of admitted patient care, which can be a total hospital stay (from admission to discharge, transfer or death) or a portion of a hospital stay beginning or ending a change in a type of care (for example, from acute to rehabilitation) (AIHW, 2013a). ‘Separation’ also means the process by which an admitted patient completes an episode of care by being discharged, dying, transferring to another hospital or changing type of care. A same-day separation occurs when a patient is admitted and separated from the hospital on the same date. An
overnight separation occurs when a patient is admitted to and separated from the hospital on different dates (AIHW, 2013a).

The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) (13), was obtained for every episode of discharge from all hospitals in WA for the financial years 1999-2000 to 2008-2009. The ICD-10AM is the standard classification scheme used for reporting diagnoses in all Hospital statistical collections (ACCD, 2014). In this study episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health related condition. The hospitalisation data for these ten years were used as a basis for future projections.

Projections of the admission rates of the eight most common conditions (which accounted for 85% of all admissions) were also done. These eight conditions (categorised according to ICD code) include: “Embedded and Impacted teeth”; “Dental Caries”; “Other disorders of teeth and supporting structures”; “Jaw fractures”; “Other Fractures” (which include fractures of teeth, palate, nasal bone, alveolus, lower facial bones); “Malignant neoplasms”; “Pulp and peri-apical conditions”; and “Other diseases of the jaws”.

**Population rates and cost:** Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics (ABS). The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost (AIHW, 2013d). AR-DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of
patients treated in a hospital to the resources required by the hospital (AIHW, 2013d). Across Australia, the AR-DRG is used to calculate the cost of each patient episode on the basis of actual data about the treatment process. Each AR-DRG represents “a class of patients with similar clinical conditions requiring similar hospital services” (AIHW, 2013d). The categorisation classifies “acute admitted patient episodes of care into groups with similar conditions and similar usage of hospital resources, using information in the hospital morbidity record such as the diagnoses, procedures and demographic characteristics of the patient” (AIHW, 2013d). Because DRG-costs overall does not represent a normal distribution, the range of DRG costs that applied to 90% of all patients were used, as this did provide a normal distribution. Average cost were then calculated from this range, and the resulting mean DRG costs were used in calculations. The annual increase used in calculations assumed that the average DRG costs (per episode) will increase at the same rate as decade-long baseline average annual increase. No indirect cost calculations were done.

*Place of residency:* Primary place of residency at the time of hospitalisation and the geographical classification was done according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centres based on road distances. Classification of residence as either metropolitan or regional was done according the ARIA classification (DHAC, 2001).
**Projection methodology:** Projections were carried out using a linear or log-linear ordinary least squares method. This method uses historical data to estimate a line of best fit for each 5-year age group. The accepted approach in preparing projections of this nature is to assume a linear model for increasing rates to prevent projecting admission rates below zero (AIHW, 2012b). There is a fundamental presumption in this approach that the factors that affect oral health-related hospital admissions, such as risk factors, change in an approximately linear way with time for each age group (AIHW, 2012b). This presumption holds on condition that there are no major quantitative changes in any underlying factors, such as the introduction of an intervention program.

**Statistical analysis:** All rates were calculated using the Rates calculator, a software package developed by the Department of Health. All rates were calculated per 100,000 person years, and all are age adjusted rates (AARs). Significant differences between rates were based on non-overlapping 95 percent confidence intervals (CIs) (p<0.05). For trend analysis, both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardised rates over time. The CIs for all rate ratios (RRs) were calculated and included in brackets. All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).
11.4. Results:

11.4.1. Demographics:
Over a ten-year period (financial years 1999-2000 to 2008-2009), a total of 131,509 hospital admissions in Western Australia were attributed to oral health related conditions among adults (above the age of 18 years). Of the total number, about half (48%) were males, and 2.8% were patients of Aboriginal descent (Table 11.1). Over the ten-year period, the age-adjusted admission rate (AAR) for Indigenous people was higher than that of non-Indigenous (Table 11.1). Rates were higher for metropolitan than country dwellers, and highest in the youngest age group (18-29 years).

11.4.2. Projected rates: Overall, for all ages, rates will increase by 153% from 2000 to 2030 (Figure 11.1). Trend analysis indicates an overall annual change of 2.69%, and a rate ratio of 1.026 (CI 1.026 - 1.027). Admission rates in the youngest group (18-29 years) will remain the highest up to 2030, and will increase from 1209 (per 100,000) in 2000 to 2796 in 2030. The total number of cases will increase from 10,415 in 2000 to between 43,842 and 45,198 in 2030.

11.4.3. Residential location: Rates will increase for metropolitan dwellers by 137% from 2000 to 2030 (AAR 795 to 1889). For rural residents, admission rates will increase by 161%, from 294 in 2000 to 770 in 2013 (Figure 11.2). Trend analysis of these increases indicated an overall annual change of 2.61%, and a rate ratio of 1.026 (CI 1.026 - 1.027) for
metropolitan, and an annual change of 3.07%, and a rate ratio of 1.037 (CI1.0299 - 1.0316) for rural dwellers.

Table 11.1. Demographics of baseline ten-year data

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Rate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>9661</td>
<td>6.83 (6.70-6.97)</td>
</tr>
<tr>
<td>2000/01</td>
<td>10415</td>
<td>7.34 (7.20-7.48)</td>
</tr>
<tr>
<td>2001/02</td>
<td>11693</td>
<td>8.17 (8.02-8.32)</td>
</tr>
<tr>
<td>2002/03</td>
<td>12600</td>
<td>8.72 (8.57-8.88)</td>
</tr>
<tr>
<td>2003/04</td>
<td>12924</td>
<td>8.83 (8.68-8.99)</td>
</tr>
<tr>
<td>2004/05</td>
<td>13274</td>
<td>8.93 (8.77-9.08)</td>
</tr>
<tr>
<td>2005/06</td>
<td>14071</td>
<td>9.28 (9.13-9.43)</td>
</tr>
<tr>
<td>2006/07</td>
<td>14618</td>
<td>9.41 (9.25-9.56)</td>
</tr>
<tr>
<td>2007/08</td>
<td>15274</td>
<td>9.59 (9.44-9.74)</td>
</tr>
<tr>
<td>2008/09</td>
<td>16979</td>
<td>8.84 (8.70-8.98)</td>
</tr>
<tr>
<td>All</td>
<td>131509</td>
<td>8.67 (8.63-8.58)</td>
</tr>
<tr>
<td>Male</td>
<td>63569</td>
<td>8.45 (8.39-8.52)</td>
</tr>
<tr>
<td>Female</td>
<td>67940</td>
<td>9.15 (9.09-9.22)</td>
</tr>
<tr>
<td>Non-Indigenous</td>
<td>127857</td>
<td>8.81 (8.76-8.86)*</td>
</tr>
<tr>
<td>18-29</td>
<td>61319</td>
<td>18.05(17.91-18.19)*</td>
</tr>
<tr>
<td>30-44</td>
<td>29689</td>
<td>6.39(6.32-6.45)</td>
</tr>
<tr>
<td>45-59</td>
<td>23601</td>
<td>6.06(5.98-6.14)</td>
</tr>
<tr>
<td>60-74</td>
<td>12042</td>
<td>5.95(5.87-6.03)</td>
</tr>
<tr>
<td>75+</td>
<td>4858</td>
<td>5.41(5.29-5.53)*</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>110156</td>
<td>14.01(13.97-14.04)*</td>
</tr>
<tr>
<td>Country</td>
<td>20526</td>
<td>5.32 (5.28-5.36)*</td>
</tr>
</tbody>
</table>

Avg DRG Cost : $2151(sd 331 )
Avg Bed Days  1.58 (sd 3.09)

*Rates differ significantly between Indigenous and non-Indigenous, between youngest and other age groups, and oldest and other age groups, and between Country and Metropolitan populations, p<0.05.
Figure 11.1: Projections of adult oral-health hospitalisation rates by age group.

Figure 11.2: Projected adult oral-health related hospitalisations by area of residence.
11.4.5. Conditions: Admission rate projections were done for the eight most common oral conditions leading to hospital admission. Combined, these eight conditions contributed to just more than 85% of all admissions for oral-health related conditions.

The condition responsible for most admissions was for the removal of embedded and impacted teeth. Projection analysis indicates an increase in the youngest age group, and relatively stable rates in the three older age groups (Figure 11.3). The overall AAR increase from 2000 to 2030 is projected to be 248%, from a rate of 299 (4595 cases) in 2000 to 964 (29331 cases) in 2030. Trend analysis indicate an overall annual change of 3.37%, and a rate ratio of 1.0338 (CI 1.0334 - 1.0341).

Figure 11.3: Projected rates of adult hospital admissions for removal of embedded and impacted teeth
The second most common condition leading to hospital admissions was dental caries. Projections indicate future decreases in rates for the two youngest age groups, but increases for the three oldest age groups (Figure 11.4). Overall the rates will increase by 52% from 2000 to 2030 (AAR 69 to 105), or 1020 cases to 3024 cases. The average annual change is 1.27%, with a rate ratio of 1.0128 (CI1.0119-1.0137).

Figure 11.4: Projected rates of adult hospital admissions for dental caries

Admissions for the condition ‘Other diseases of the teeth and supporting tissues”, will increase in all age groups, but the steepest increase will be in the oldest age group (75+ years) (Figure 11.5). In this age group the increase will be 1260% from 2000 to 2030, compared to the overall (all ages) increase of 434% from 2000 to 2030, (or 675 to 7048 cases). Over time the average annual change will be 4.75%, with a rate ratio of 1.0475 (CI1.0468-1.0483).
Projections for jaw fractures indicate an overall increase of 53%, from an AAR of 27.6 in 2000 to 40.0 in 2030 (411 cases to 1104 cases). Rates will increase across all age groups, except for those between 45 and 59 years, which will decrease over time (Figure 11.6). The average annual change will be 1.53%, with a rate ratio of 1.0154 (CI:1.0139 - 1.0169).

Admission rates for the condition “Fractures of the teeth, nasal bone, palate, and lower facial bone” will increase in all ages, except age 60-74, where it will remain relatively stable over time (Figure 11.7). Increases will be the highest in the youngest and oldest age groups. Rates will overall increase by 93% from 2000 to 2009, from an AAR of 45.3 to 87.4 (685 cases to 2546 cases). The average annual change will be 2.07%, the rate ratio is 1.0207 (CI:1.0196 -1.0218).
Figure 11.6: Projected rates of adult hospital admissions for jaw fractures

Figure 11.7: Projected rates of adult hospital admissions for fractures of the teeth, nasal bone, palate, and lower facial bones
Hospital admission rates for malignant neoplasms will overall decrease by 18%, with rates falling from 32.0 in 2000 to 26 in 2030 (437 to 610). Although the overall trend indicates a decrease, the rates will increase slightly for the youngest two age groups (Figure 11.8). The average annual change is -0.989, with a rate ratio of 0.9901 (CI0.9886-0.9916).

![Figure 11.8: Projected rates of adult hospital admissions for oral malignant neoplasms](image)

Hospital admissions for “Diseases of the pulp and peri-apical conditions” indicate an overall increase of 373%, and cases will increase from 291 (AAR 20.5) to 2524 cases (AAR 90.2) (Figure 11.9). Over time the average annual change will be 4.52%, with a rate ratio of 1.0452 (CI1.044-1.0465). The highest increase will be in the oldest (75+ years) groups, and in those aged between 30 and 44 years (Figure 11.9).
Figure 11.9: Projected rates of adult hospital admissions for pulp and peri-apical conditions

Figure 11.10: Projected rates of other diseases of the jaws.
Projection of “Other conditions of the Jaws” indicate an overall increase of 109% from 2000 to 2030, and an increase in AAR from 32.5 to 67.4, and 437 cases in 2000 to 2122 cases in 2030. This overall trend is largely driven by the increase in the oldest age group (an increase of 1320% over 30 years), but age group 60-74 years will decrease, and the age groups 18-29 years and 20-44 years will remain stable (Figure 11.10). Trend analyses indicate an average annual increase of 3.64% with a rate ratio of 1.0365 (CI 1.0351 - 1.0379).

**11.4.6. Costs and bed-days:** Over time there will be an increase of 170% in DRG costs, from an average of $1813 per case in 2000, to $4930 in 2030. The total DRG costs of hospital admissions will increase from $18.8 million in 2000, to more than $200 million in 2030. Based on the estimated range of cases, the total cost in 2030 is predicted to be between $204.4 million to $210.2 million.

If the average length-of-stay for oral hospitalisations overall remains stable in future, the total number of total bed-days will increase from 16,664 days in 2000 to between 663,232 and 682,368 days in 2030.
11.5. Discussion

The projections of hospital admission rates are a fundamental element in the planning of health services delivery. Projections into the future are not, however, an exact science – although some elements such as assessments of future need for care may be predictable given population projections, other elements, such as the impact of technology, preventive health initiatives and social policy, cannot be anticipated with certainty (Aisbett, 2001). Technical support for planners may be most appropriate in the form of a distribution of projected values. Provided the uncertain future, and an incomplete understanding of how current and future change will affect admission patterns, it is not appropriate to rely on complicated models for admission trends (Aisbett, 2001). One certainty regarding changes in the Australian population, however, is that it is a growing and rapidly ageing population.
The projections of oral health related hospital admissions to the year 2030 for Western Australia indicate significant increases overall, with a predicted total number of hospitalisation episodes in 2030 of between 43,842 and 45,198. Several of the oral conditions leading to hospitalisation are strongly age-related, and an increase in the number of older people will contribute to higher rates of admissions (Kruger and Tennant, 2015a). Although the oral health of Australia’s older population is improving, with fewer extractions than previous generations, more people are now retaining their natural dentition into old age, with implications such as increased levels of dental decay and periodontal disease (Slade et al., 2007; Thomson 2014).

Increases expected will be slightly higher for rural (137% increase in admission rates expected) than metropolitan dwellers. This remains and will continue to be a challenge for health service planners, as access issues to care across the very vast geographical areas, with a sparse and widely distributed population, is complicated to address efficiently or cost-effectively. Rural dwellers carry higher burdens of dental disease, and factors other than just service access (social, economic, environmental and cultural) impede on their health (AIHW, 2005).

Projections for the most common conditions leading to hospitalisation indicate increases to the year 2030 in all, except for malignant neoplasms. Although the admission rates for malignant neoplasms will decrease overall, slight increases will be experienced across the two younger age groups. The exact reasons for the overall decline are unknown, but
declining rates in some of the biggest risk factors might contribute to lower prevalence rates. One of the biggest risk factors for oral cancer is smoking (Abdelhafied et al., 2014), and tobacco smoking rates among the Australian population is declining. Daily smoking among the general population declined between 2010 and 2013 and has almost halved since 1991 (AIHW, 2014a).

Hospitalisation for oral health related conditions is to a large extent driven by admissions for the removal of embedded and impacted teeth (49% of all admissions over ten years), and is mostly for the removal of impacted third molars (Anjrini et al., 2014a; Kruger and Tennant, 2015b). For this reason the highest increases will be in the youngest age group (18-29 years). The projections indicate an increase in the number of cases from 4 595 in 2000 to 29 331 in 2030. The very high hospitalisation rate in Australia for this condition has previously been highlighted (Abelhafied et al., 2014a), and international comparisons revealed significant differences, with rates in Australia seven times higher than in the United Kingdom. Those results could be explained by the implementation of guidelines in the UK, and the absence of similar guidelines in Australia (Anjrini et al., 2014a).

Overall the increase in dental caries hospitalisations is moderate, with decreasing rates over time in the two youngest age groups, but increasing rates in older age groups. With more people retaining natural dentitions than before, and an ageing population, this is not an unexpected outcome. Previously it has been shown that substantial numbers of older people are admitted for dental caries treatment (Thomson, 2014; Kruger and Tennant, 2015a). A recent review indicated that dental caries is not only known to be active in older
age groups, but continues to be the most prevalent oral health condition in older people (Thomson, 2014).

Increases has also been projected for the condition “Disorders of the teeth and supporting structures”, and especially so for the oldest age group – the higher numbers of older people retaining dentitions possibly contributes to this. The ICD10 classification of “Disorders of the teeth and supporting structures” include conditions such as exfoliation of teeth due to systemic causes, atrophy of alveolar ridges, retained dental roots, enlargement of alveolar ridges, and irregular alveolar ridges (ACCD, 2014). “Other diseases of the jaws” include conditions such as cysts of the jaw, cell granulomas and inflammatory jaw conditions: alveolitis, cherubism, exostosis, fibrous dysplasia and condylar hypo- and hyperplasia. Most of these conditions are strongly age-associated (Devlin and Ferguson, 1991; Chrcanovic et al., 2010; Chen et al., 2013).

The same reason (ageing population retaining dentition), also applies to the increases in fractures of the jaws, and also fractures of the teeth, nasal bone, palate, and lower facial bone. Facial fractures have previously been mentioned as an important reason for hospitalisation of older people due to the high numbers admitted for falls (Gerbino et al., 1999; Peel et al., 2002; Chrcanovic et al., 2010). The youngest age group will remain the age group with the highest rates of fractures, and in 2030, admission rates for jaw fractures in the youngest group will be at an AAR of 182 compared to an AAR of 78 for all ages, and an AAR of 155 compared to 87 in all ages for fractures of the teeth, nasal bone, palate, and lower facial bone. These high projected rates among younger people can be attributed
partly to the risk taking behaviours associated with maxillofacial trauma that younger age groups engage in, as identified by other studies (Chayla et al., 2011; Lee, 2012; Chrcanovic 2012).

For both “pulp and periapical conditions” and “other diseases of the jaws”, the highest increases in admission rates to 2030 will be in the oldest age groups. (Projections for diseases of the jaws in fact, indicate decreasing rates in the youngest age groups), With increasing retention of natural teeth, a range of other chronic degenerative problems might also be expected to become more common, including tooth wear, tooth fracture, root caries and pulpal necrosis, all contributing factors to increased rates of hospital admissions. Cost projections indicate that total direct costs (as based on DRG costs per case) for all oral health related hospitalisations in Western Australia will amount to more than $200 million in 2030. The combination of demographic trends, income growth and new technologies means that demand for health care in Australia will increase strongly as people's expectations about quality, access to services and the range of potential treatment options increases. Dealing with these pressures requires more than simply increasing the size of the health system (Australian Government, 2015). The reality is that older people tend to use more health care services, which will raise health care costs. The same applies to oral health, with the most common oral conditions requiring hospital care, strongly associated with age. The result of an ageing population is clearly reflected in these admission rate projections, with the highest rate increases in most conditions, among the oldest age groups.
11.6. Conclusions

Projections of oral health related hospital admissions in Western Australia indicate significant increases in the rates of admissions (adjusted for age) up to the year 2030, and direct costs is also set to increase significantly. Improved access to primary health care may prevent some hospitalisations, improve health outcomes and lower health care costs. Challenges for the Australian health system include an adaptation to meet the needs of an ageing and growing population. At the same time, health spending need to be sustainable, and implies the funding of cost-effective improvements to health care, while adjusting spending to obtain better value for money where necessary.
Chapter 12

12. Discussion and Conclusions
12. Introduction

This research involved a series of studies analysing and examining population-based data on hospital admissions to all public and private hospitals in Western Australia for all oral-health related conditions, based on ICD10-AM diagnostic criteria codes. In order to assess trends over time, a decade’s worth of data was analysed.

12.1. Hospital admissions for oral – health related conditions

Little information is available on adult hospitalisations for oral health related conditions, other than some statistics on Potentially Preventable Hospitalisations (PPH), which is based on a limited subset of ICD10–AM principal diagnosis categories. This available data is presented by state, age and gender levels (AIHW, 2014c). More than 63 000 people in Australia were admitted for PPH’s in 2011-2012. Although the overall age-standardised PPH rates remained stable between the years 2007-2008 and 2011-2012, the rates for WA were not only the highest (3.8 per 1000 population) of all the states, but also increased over time (AIHW, 2014c).

The research presented in this thesis was based on a much more extensive list of ICD10 – AM diagnosis categories, to also include oral health related conditions, which might not be considered potentially preventable, and the focus in this series of studies was on adults. Overall, it was evident that the concept of “dental hospitalisations” or “oral-health related
hospitalisations” is complex, and as a result of this complexity and multi-faceted nature of this general term, strategies focused at reducing the numbers of hospitalisations, would depend on many factors, and a “one size fits all” approach would not be appropriate nor effective. It became clear that hospitalisations for various oral-health related conditions is strongly associated with societal and socio-economic determinants, and for which individual-level measures such as contact with primary dental services, whilst important, would not necessarily reduce hospital admissions.

12.2. The dental health system

This research also highlighted the contribution of the complex Australian health system, (in particular the dental health system), to people ending up in hospital for treatment of oral conditions. The system is essentially a private system, with around 90% of dental care provided in the private sector, but the 10% provided in the public sector, essentially cover 50% of the population. The “inverse care law” (Hart, 1971) clearly applies in Australia. The inverse care law operates more completely where medical/dental care is most exposed to market forces, and less so where such exposure is reduced. Dental care in Australia is very exposed to market forces, and the overwhelmingly private system is driven by economic and business factors. The result is simply that those groups in the population who need most dental care and prevention, have less availability and access. Lack of access in these cases might lead to oral conditions becoming acute and leading to hospitalisation. An interesting finding of this research however, was that the system might also have the
opposite effect: those who have the ability to afford access to the private sector, as well as private health insurance, also end up in hospital, but for treatment of entirely different conditions.

12.3. An ageing population

The Australian population is rapidly ageing (National Strategy, 2001; ABS, 2009), as part of the “demographic transition”, which is taking place in many industrialised countries. Longer life expectancies (ABS, 2008b) are already evident when analysing dental hospital admissions for those over the age of 65 years in WA, with just more that 10% of those admitted older than 85 years of age. Trends over ten years indicate that there is a slow but steady increase in the hospitalisations of older people for oral-health related conditions, thus rejecting null hypothesis (Hypothesis 1, Chapter 3). Hospitalisation rates were not low, and trend analysis over time indicated significant increases.

One of the implications for the dental profession of an ageing population is that people are retaining their dentitions for longer. A distinction needs to be made between edentulism (state of loss of all natural teeth) and the more common incremental loss of teeth occurring throughout adult life. The transition to edentulism requires an explicit decision to undergo complete removal of the dentition, (or what remains of it) and the decision to undergo it is as much socially driven as it is clinical. Thus, the reasons for edentulism has always been both disease-related and societal (Thomson, 2014). In Australia, the prevalence of
edentulism is falling markedly, and the oral health of Australia’s older population is improving (Slade et al, 2007). This is combined with longer life expectancies and an increase in the proportion of older Australians (ABS, 2009).

This combination of higher proportions of older people with retained dentitions, is most probably the reason for the high numbers of people over the age of 65 being admitted for the treatment of dental caries. In the oldest age group (85+ years) “Dental Caries” was the main reason for admission. Some risk factors for dental caries is associated with age, such as dry mouth (both xerostomia and hyposalivation) (Thomson 2014). Several studies show that dental caries is not only active in older age groups, but continues to be the most prevalent oral health condition in older people (Chalmers et al, 2005; Jamieson et al, 2011).

The other major drivers for hospitalisation amongst older people included malignant neoplasms, disorders of the teeth and supporting structures, disorders of the jaws and jaw fractures. “Disorders of the teeth and supporting structures” include conditions such as exfoliation of teeth due to systemic causes, atrophy of alveolar ridges, retained dental roots, enlargement of alveolar ridges, and irregular alveolar ridges. “Other diseases of the jaws” include conditions such as cysts of the jaw, cell granulomas, and inflammatory jaw conditions: alveolitis, cherubism, exostosis, fibrous dysplasia and condylar hypo- and hyperplasia. Most of these conditions are strongly age-associated (Devlin et al, 1991; Grossmann et al, 2007; Abreu et al 2010; Chrcanovic et al, 2010; Carvallo et al, 2011; Reich et al, 2011; Chen et al, 2013; Abdelhafied et al, 2014; Thomson et al, 2014). Facial fractures
have previously also been mentioned as prevalent reason for hospitalisation of older people due to the high number admitted for falls (Gerbino et al, 1999; Peel et al, 2002; Chrcanovic et al, 2010). These findings indicate that the null hypothesis, stating that hospitalisations among older people are not driven by specific conditions, is rejected (Hypothesis 4, Chapter 3).

Currently, the hospitalisation of older people for oral health related conditions does place a burden on the health system, and all indications are that it will only increase. This finding confirms rejection of the null hypotheses (Hypothesis 2 and Hypothesis 3, Chapter 3). DRG costs increased over the decade under study, from an average of $3593 in 1999/00 to $4590 in 2008/09. Projections in this study indicate that by 2025, rates of hospitalisation of older people for oral-health related conditions will be almost double that of the average rate (between 1999/00 -2008/09), the number of bed- days per year will total between 13 000 and almost 16 000 days per year, and total DRG cost would be at least A$7 million per year. It is confirmed by others that the increasing older population in Australia will increase the pressure on the health system - those aged 65 and over comprise 13% of the population, yet contribute to 35% of hospital admissions, and 47% of hospital occupied bed-days. It is also projected that by 2050, people aged 65 and over will be responsible for two-thirds of all hospital bed-day utilisation (Schofield and Earnest, 2006; Kircher et al, 2007).
12.4. Aboriginal and Torres strait Islander people

Oral disease is unequally distributed across the Australian population, with heavier burdens of disease being experienced by certain population groups, including Aboriginal Australians (Slade et al, 2007). The health inequality between Aboriginal and non-Aboriginal groups, is more pronounced compared to some other developed countries (Australian Health infonet, 2013). This was underlined by the findings of this research when comparing Aboriginal and non-Aboriginal people’s admissions to hospital for oral-health related conditions. Aboriginal people were admitted at higher rates, for a very different mix of conditions, mostly from younger age groups, mostly from very remote areas, and were almost all uninsured, compared to non-Aboriginal people. These findings lead to rejection of the null hypotheses (Hypothesis 5 and Hypothesis 6, Chapter 3).

The highest rates were seen in non-Aboriginal 18-29 year-olds, much higher than Aboriginal young adults. This was due to the very high rates of embedded and impacted teeth removal amongst non-Aboriginal young adults – these findings was confirmed by others (Smith et al, 2006; George et al, 2011; George et al, 2007; Anjrini et al, 2014a).

The majority of Aboriginal people were admitted for a very different mix of conditions, mostly trauma and injury-related conditions (55%). Previous studies have highlighted the significant differences in jaw fracture rates in WA with rates almost ten times higher in Aboriginal compared to non-Aboriginal people, and almost eight times higher for Aboriginal compared to non-Aboriginal males (Kruger et al, 2006; Kruger et al, 2010). The current
research confirmed the very high rates of jaw fractures amongst Aboriginal people. Although Aboriginal people were mainly admitted for trauma, admissions were dominated by Aboriginal males, with previous studies confirming this (Kruger et al, 2006; Kruger et al, 2010). The admissions for embedded and impacted teeth removal in non-Aboriginal people were mostly among females, similar to other studies (George et al, 2011; George et al, 2007; Anjrini et al, 2014a).

Over a period of ten-years, inequalities remained stable, with no signs of improvement or a decrease in hospitalisation rates. Hospitalisation rates over the time period were, in fact, increasing, with the average annual change higher in Aboriginal than non-Aboriginal groups. There was little change in the mix of conditions over a ten-year period, with the same major conditions remaining steady over the study period. This finding confirms a rejection of the null hypothesis (Hypothesis 7, Chapter 3).

There were significant differences in the private health insurance status between Aboriginal and non-Aboriginal groups, with 65% of non-Aboriginal and only 2.8% of Aboriginal patients having private insurance. The affordability of private health insurance premiums puts private health insurance beyond the reach of most socio-economically disadvantaged groups. In 2004–05, 15% of Indigenous Australians in non-remote areas had private health insurance, compared with 51% for non-Indigenous Australians (AHMAC, 2012). The majority of those without private health insurance (65%) cited cost as the main barrier (AHMAC, 2012). Reduced access to private health insurance limits people’s ability to access
services involving out of pocket expenses, such as specialists, dentists and allied health services.

### 12.5.1. Jaw fractures

The difference in admission rates for different conditions (diagnosis categories) between Aboriginal and non-Aboriginal population groups were very evident, and especially clearly evident when analysis was focused on one specific condition. Jaw fractures was selected as one example to illustrate the very stark differences in terms of admissions – this was done because an earlier study, based on four years’ worth of data, showed that Aboriginal people, in general, were ten times more likely to be admitted for treatment of a jaw fracture than a non-Aboriginal person (Kruger et al, 2006). The current analysis followed up on the previous study, and found that, based on ten years’ worth of hospitalisation data, Aboriginal males were still admitted at a rate that was nearly 10 times that of a non-Aboriginal males, Aboriginal female rates were almost 3 times that of non-Aboriginal males, and 37 times higher than for non-Aboriginal females at the peak ages of 15-29 years. These disparities were confirmed by other Australian studies, (Schon et al, 2001; Jamieson et al, 2005; Thomas and Scott, 2007; Thomas and Scott, 2009).

When comparing rates of Aboriginal with non-Aboriginal patients, the admissions of Aboriginal people were not only disproportionately higher than for non-Aboriginal patients, but this situation remained consistent over the decade long study period. Of particular
concern, although not able to be determined in this analysis, was evidence from previous studies that indicated the etiology of facial fractures in Australia in the Aboriginal population is strongly associated with alcohol-related violence and assaults (Jamieson et al., 2005; Jayaraj et al., 2012; Thomas and Scott, 2007; Thomas and Scott, 2009). Indigenous females and males were 35 and 22 times as likely to be hospitalised due to family violence-related assaults as other Australian females and males, respectively (Al-Yaman et al., 2006).

In the analysis of jaw fractures disproportionately high rates were found in those from lower socio-economic backgrounds, and from rural and remote areas. The rates for Aboriginal people from the poorest areas were double that of the non-Aboriginal rate from the poorest areas. Poverty has shown to be associated with violence in Australia (Al-Yaman et al., 2006). About one in four Aboriginal people aged 15 years or over reported being a victim of physical or threatened violence, and the rate was higher among those who lived in low income households, and were unemployed (Al-Yaman et al., 2006).

Indirect costs are very difficult to measure, and an indication of direct costs is possible by analysing DRG costs. Indirect costs relate to travel times, accommodation, times off work, and even the burden of pain, disease and discomfort. With the majority of the Aboriginal population residing in rural and remote WA, it can be assumed that longer travel times and distances to obtain specialist care would be necessary. There was a significant difference in the mean number of bed-days between Aboriginal, and non-Aboriginal patients, with Aboriginal patients staying in hospital for longer. The majority of Aboriginal patients being
from rural and remote areas might be the reason for the longer hospital stay of Aboriginal patients.

Trend analysis indicated a positive (2.2%) and significant increase in hospitalisation rates for jaw fractures in WA, over a ten-year period. This is an indication that hospitalisations for the treatment of maxillary and mandibular fractures remain a burden on the health system, and the very high rates of Aboriginal people admitted compared to non-Aboriginal remains a concern.

12.6. Potentially preventable hospitalisations

Potentially preventable hospitalisations are hospital separations where the principal diagnosis of the hospitalisation is thought to be avoidable if timely and adequate non-hospital care had been provided. This refers to preventive measures, or early diagnosis and treatment in primary care. Hospitalisation rates of potentially preventable dental conditions thus provide an indicator of the potential inadequacy of dental care in the community (Chrisopoulos and Harford, 2013). Data on avoidable hospitalisations are increasingly used internationally as an indicator of access to primary care and its effectiveness, and as a measure of the potential health gains from primary care interventions (Li et al, 2009; Rosano et al, 2012).
A study of potentially preventable hospitalisations over a decade indicated that population rates of hospitalisation increased significantly over the period, for both Aboriginal and non-Aboriginal population groups. The most common conditions that required hospitalisation was dental caries, and the highest rates of hospitalisation were for those from the most socio-economically disadvantaged areas. Chrisopoulos and Harford reported a hospitalisation rate for potentially preventable dental conditions in WA of 3.7 per 1000 persons for the year 2010-11 (Chrisopolous and Harford, 2013).

The rate in the current analysis for 2008-09 was 3.68 per 1000 persons, and the results of the Chrisopolous work thus indicate that the rates have remained stable. This finding leads to acceptance of the null hypothesis (Hypothesis 8, Chapter 3). The work by Chrisopolous reported the rate in WA was higher than in any other state or territory in Australia. The current findings also indicate higher rates than those found in New Zealand (2.15 per 1000 population in 2005-2009) (Whyman et al, 2014).

The findings did not indicate a significant difference in rates between Aboriginal and non-Aboriginal people. An analysis of trends over time however, indicated that the annual percentage rate change in the Aboriginal population were almost twice as high as that of the non-Aboriginal population. The socioeconomic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health risk factors, and access issues due to rural and remote living, affordability of health insurance and other social issues contribute to the stark inequalities in health between Aboriginal and non-Aboriginal people (ABS, 2005). This is reflected in the admission rate growth over time among Aboriginal, compared to non-Aboriginal people, for potentially
preventable dental conditions (ABS, 2005). These findings lead to rejection of the null hypothesis (Hypothesis 9, Chapter 3).

It has been stated that potentially preventable hospitalisations are avoidable if timely (early diagnosis and prevention) and adequate treatment in primary care is provided. Hospitalisation rates of potentially preventable dental conditions thus provide an indicator of the potential inadequacy of dental care in the community (Chrisopoulos and Harford, 2013). It is important to understand the association between primary health care and avoidable hospitalisations. Previous studies identified that this relationship is not a linear one, but a U-shaped relationship, with too little primary health care leading to an excess of hospitalisation, and too much also leading to an increase in hospitalisations (Rosano et al, 2012; Zhao et al, 2013).

The current analysis was the first to determine if this relationship also applies to dental conditions, and the findings did indeed strongly support this: there were high rates of hospitalisation among poorer, rural, and Aboriginal groups (those with limited access to primary oral health care), but there were also high rates of hospitalisation among higher socio-economic, non-Aboriginal, and urban dwelling groups (with good access to primary health care). The findings indicated very clear differences in the mix of conditions that different socio-economic groups were admitted for. More disadvantaged groups were more likely to be admitted for pulpitis and periapical disease (possible result of untreated caries), and least disadvantaged groups more likely to be admitted for caries (diagnosed in
primary care and referred for treatment under general anesthesia), and removal of impacted teeth.

Previous studies support the argument that improved access to primary health care may prevent hospitalisations, improve health outcomes and lower health care costs (Rosano et al, 2013; Whyman et al, 2014; Zhao et al, 2013). The factors determining access to primary dental care in Australia are multifactorial and complex. It is dependent on factors including socioeconomic status, geographical location, age, and health insurance status, among others (NACOH, 2004; Slade et al, 2007; Almado et al, 2013; Tennant and Kruger, 2013a; Tennant and Kruger, 2013b; Tennant et al, 2013). The public dental service in Australia is currently not in a position to provide services to all those who need or demand it. Only about 5% of eligible concession card holders receive primary dental care from the public health sector (Spencer, 2012).

12.7. Socio-economic disadvantage

The social gradient in health means that health inequities affect all, and the poorest of the poor have the worst health. This is a global phenomenon, and is seen in low, middle and high income countries (CSDH, 2008). It is social and economic conditions, and their effects on people’s lives, that determine their risk of illness and the actions taken to prevent them becoming ill or treat illness when it occurs (CSDH, 2008).
There are no data available on the association of oral-health related hospitalisations and socio-economic disadvantage. What is well known however, is that the oral health of people from lower socio-economic backgrounds in Australia is poorer, and the social gradient certainly applies to oral health as much as it applies to general health (Sanders, 2007; Slade et al, 2007). The results of the ten-year WA study, indicated consistently higher rates of hospitalisation among the most disadvantaged group in the WA population compared to the rest. This trend remained consistent over a period of ten years and reflects the poorer oral health of groups in the population at the lower end of the socio-economic scale. Numerous studies have demonstrated this social gradient, not just in Australia (Slade et al, 2007; Chrisopoulos and Harford, 2013; AIHW, 2014), but worldwide (Locker, 2000). This finding lead to rejection of the null hypothesis (Hypothesis 10, Chapter 3).

Results of the study implies that, for some at least, poor oral health ultimately results in hospital admissions, meaning that the condition cannot be managed in the primary care system, or there was no access to the primary care system. Almost two-thirds of all adults hospitalised had private health insurance, but there were differences when socio-economic groups were compared: three quarters of the wealthiest had insurance compared to less than a third of the poorest. In 2010, just more than half of all Australians had private dental insurance (Chrisopoulos and Harford, 2013).

The importance of private insurance needs to be considered against the backdrop of the Australian health care system, and especially the dental health care system. Disadvantaged groups that are not eligible for public dental services may have difficulty accessing regular
private oral health services due to the cost, while those eligible for public dental care may face long waiting times for care (NACOH, 2004).

Those who are most disadvantaged stayed on average longer in hospital than others, and the average cost per admission was highest in this group. Additionally, indirect costs (travel, time off work, support family time etc.) are not included, but others have estimated in small countries with minimal travel that this can be nearly double the direct costs (Drummond et al, 1997). It is clear that those who can least afford it, might have higher costs (direct and indirect) and longer hospital stays. These findings lead to rejection of the null hypothesis (Hypothesis 11, Chapter 3).

Most people were admitted to hospital for “Embedded and Impacted Teeth”, with almost half of all admissions for this condition. This was one of only two conditions where the poorest were significantly less likely to be admitted, and this was seen in all age groups. Previous work showed that these high numbers are driven by the removal of third molars, mostly in younger people (George et al, 2011; Anjrini et al, 2014, Anjrini et al, 2015). Other conditions for being admitted were significantly less for the poorest compared to the richest was for “Other disorders of teeth and supporting structures”. This was especially evident among the older ages. These findings confirm a rejection of the null hypothesis (Hypothesis 12, Chapter 3).

Calculation of odds ratios for the other most common conditions, especially in the youngest age group, all indicated significantly higher likelihoods of admission (of the most disadvantaged) for each specific condition. Those in the poorest and youngest age group,
was almost 5 and 4.8 times more likely to be admitted for “Jaw fractures” and “Other fractures” respectively. This finding is supported by studies that show higher levels of jaw and other fractures amongst lower socio-economic groups. The reasons for this include the determinants and risk factors for maxillofacial fractures, which are strongly associated with poverty (Jamieson et al, 2008; O’Meara et al, 2011; Chranovic, 2012).

The youngest and poorest were 2.6 times more likely to be admitted for “Dental caries”, and more than 5 times more likely to be admitted for “Pulp and periapical conditions” than the youngest wealthiest. Previous studies and surveys have emphasized the higher levels of dental caries, pulp and periapical conditions in Australia among those who are lower on the socio-economic scale (NACOH, 2004; Slade et al, 2007, Kruger et al, 2006; Alsharif et al, 2014). For “Malignancies” the likelihood of admission was highest in the poorest for every age group.

Access to care is a complicated issue influenced by demand and supply barriers that may influence the use of primary health services. The use of primary care services in oral health (where timely and adequate services can be provided), might contribute to less people being hospitalised for treatment of some, but not all conditions.


It is well known that inequalities exist in the oral health status between rural and urban Australians (NACOH, 2004; Slade et al, 2007). When analysing dental hospitalisation data, admission rates were the highest in those from Very Remote areas of WA, and this applied
to all age groups. In general, access to primary dental care in Very Remote areas is very limited, and in some parts of the state, no primary dental services are available. Other possible contributory factors are lower socioeconomic status and employment levels, exposure to comparatively harsher environments, sparse infrastructure and occupational hazards (David and Bartlett, 2008). This finding confirm rejection of the null hypothesis (Hypothesis 13, Chapter 3).

Direct costs, as well as length of stay in hospital were highest for those from very remote areas, most likely because of the more advanced nature of disease when obtaining care (due to access to primary care issues), more serious nature of conditions (for which admitted) and conditions that requires longer treatment. Indirect costs associated with the hospitalisation for rural and remote dwellers would also be much higher than for urban dwellers, due to increased costs associated with travel and travel times, as well as additional costs associated when accommodation is needed for accompanying family members.

Rates were highest in Very Remote areas (compared to all other areas) for five of the ten most common conditions, and these include “Jaw fractures”, “Pulp and peri-apical conditions” and “Other diseases of the jaw”, “Malignancies” and “Other fractures”. These findings are supported by work that also indicate higher levels of each of these conditions in rural and remote living people (Howat et al, 2006; Jamieson et al, 2008; Do et al, 2008; Abreu et al, 2010, Jayarah et al, 2012; Abdelhafied et al, 2014). These different admission rates confirm rejection of the null hypothesis (Hypothesis 14, Chapter 3).
12.8.1. **Jaw fractures and other fractures**: Studies support high rates of jaw fractures among Indigenous (compared to non-Indigenous), and rural (compared to urban) people (Kruger et al, 2006). The etiology of facial fractures in Australia, and especially in the Aboriginal population, is strongly associated with alcohol-related violence and assaults (Jamieson et al, 2008, Jayarah et al, 2012). It is also known that the majority of the Aboriginal population resides in rural and remote areas (ABS, 2010).

12.8.2. **Pulp and peri-apical conditions**: Pulpitis indicates infection of the dental root canal, and where primary care is not available or seeking treatment is delayed, the pulp may be irreversibly damaged by an ongoing inflammation and necrosis of the pulp tissue. A complication of pulpitis is periapical abscess in the periodontal tissue. If the infection spread to adjacent teeth or to deeper tissue, cellulitis can occur, and hospitalisation is indicated for severe cellulitis, in order for patients to receive intravenous antibiotics (Do et al, 2008).

12.8.3. **Malignancies**: Possible explanations for the higher rates of oral cancers in regional areas might include increased exposure to carcinogens or diet, along with low socioeconomic status, all associated with poor health outcomes. There have also been suggestions that health beliefs might exert a significant influence on health-seeking behavior (Howat et al, 2006). Rural and remote living Australians are more likely to be smokers, and to drink alcohol in hazardous quantities, and are more at risk of diet-related chronic disease than other Australians (AIHW, 2014; Abdelhafied et al, 2014). Furthermore,
cancer services in Australia are principally located in capital cities, limiting access to services (Abreu et al, 2010; Abdelhafied et al, 2014).

It is evident that rural areas provide very different challenges in the planning and provision of optimal health (including oral health) services. Rural and remote health services would not obtain the same economies of scale as city-based services, and many small rural facilities experience a significant administrative burden on their limited resources due to multiple accreditation, accountability and reporting requirements. Once rurality exceeds a certain limit, it becomes impractical to deliver the same level of service as in metropolitan areas (Rice and Smith, 2001).

12.9. Future projections:

Future scenarios in oral health-related adult hospital admissions are relevant and necessary to inform public policy, with the aim of improving and monitoring health service delivery. Projections of hospitalisation rates in WA to the year 2030 indicate significant increases overall, with a predicted total number of hospitalisation episodes in 2030 of between 43 842 and 45198. Increases expected will be slightly higher for rural than metropolitan dwellers. Access issues and barriers to obtain care across the very vast geographical areas, with a sparse and widely distributed population, is complicated to address efficiently or cost-effectively. Rural dwellers carry higher burdens of dental disease, and factors other
than just service access (social, economic, environmental and cultural) impede on their health (AIHW, 2006).

Projections for the most common conditions leading to hospitalisation indicate increases to the year 2030 in all, except for malignant neoplasms. Exact reasons for the overall decline is unknown, but declining levels of exposure to some of the biggest risk factors might contribute to lower prevalence rates - one of the biggest risk factors for oral cancer is smoking, and tobacco smoking rates among the Australian population is declining (AIHW, 2006, AIHW, 2014a, Abdelhafied et al, 2014).

Almost all of the oral conditions leading to hospitalisation are strongly age-related, and an ageing population might be one contributing factor to the increase in hospital admission rates (Gerbino et al, 1999; Peel et al, 2002; Chranovic et al, 2010; Thomson, 2014).

Cost projections indicate that total direct costs (as based on DRG costs per case) for all oral health related hospitalisations in Western Australia will amount to more than $200 million in 2030. The reality is that older people tend to use more health care services, which will raise health care costs. The same applies to oral health, with the most common oral conditions requiring hospital care, strongly associated with age. The result of an ageing population is clearly reflected in these admission rate projections, with the highest rate increases in most conditions among the oldest age groups. The projected increases in admission rates leads to rejection of the null hypothesis (Hypothesis 15, Chapter 3).
12.10. Limitations of the study

The biggest limitation in the use of population-based studies to study morbidity is that it is not an exact indication of the population’s need, but rather an indication of demand and demand is influenced by many factors. Thus illness behaviour determines the use of dental and hospital services to some extent. It is therefore difficult to determine if an increase or decrease in use of hospital services always reflects a change in the illness experience of the population or a change in the illness perception and behaviour. The perceived seriousness of a disease will determine how likely it is that a person will respond to it. A person’s ability to respond to it (within a system such as the Australian health system), also influences hospital admissions.

The response of the hospital or dental care system to the demand made on it, is also determined by various factors. The decision to admit a patient may be influenced by knowledge of service constraints and in the end is dependent on individual health professionals’ assessments of relative needs and priorities.

The quality of data on hospital admissions depends on the accuracy and completeness of the information systems. The HMDS however, is subject to continual review to ensure that all data is relevant, measurable, of reasonable quality and is able to meet state and national reporting requirements. The reliability of the principal diagnosis (using the appropriate ICD10 code) relies on the accuracy of the clinician’s coding. Issues surrounding coding errors
have long been recognized. Previous studies showed that the overall accuracy of coding assigned was ‘fair’ (Cheng et al., 2009, Kearsey et al, 2001; Santos et al. 2008).

The use of and reliance on census data can be viewed as a limitation. The ABS however, aims to produce high quality data from the Census, and extensive effort is put into Census form design, collection procedures and processing. There are four principle sources of error in Census data; they are respondent error, processing error, partial or non-response and undercount. Quality management of the Census program aims to reduce error as much as possible, and to provide a measure of the remaining error to data users, to allow them to use the data in an informed way (ABS, 2006b).

Another limitation of this study is that only area-based measures of disadvantage were available in all the investigations related to hospitalisation and socio-economic status. It was necessary to use a proxy measure (the socioeconomic status of the population in the area) because there is no direct measure in the major administrative health record collections of the socioeconomic status of the individual about whom the event is recorded. Ecological fallacy can be seen as a problem, where inferences about the nature of individuals are deduced from inference for the group to which those individuals belong.

Previous research however, indicated that postcode level and SLA level data provide a reliable, although understated, indication of socioeconomic disadvantage of area (and SLA level data was used throughout this study) (Glover et al., 2004).
12.11. Future research

It would be very valuable to undertake more research utilising the Western Australian Data Linkage System (WADLS), and linking data from individuals in the WADLS (eg using probabilistic linkage), to the ABS Population Census. This would enable examining an individual’s characteristics of education, occupation, labour force status, housing tenure etc., and to more directly examine the relationships between the number of individuals admitted and total separations and these socioeconomic variables. Linkage to death registration data would also be valuable in examining outcomes related to socioeconomic status (especially related to oral malignancies, given the socio-economic association identified in this study). Future research should also be directed at intervention development and testing to address key issues identified by the research presented. This could include the development and testing of the impact of demand management interventions and alternative care models. Primary research, including qualitative research is also required to help understand the reasons behind some of the findings.

The continuous monitoring of time-trends related to dental hospital admissions also remain valuable, given the demographic changes in the population.
12.12. Conclusions

In conclusion, this population-based research showed that the admission to hospital for oral-health related conditions in one state of Australia, is strongly divided across social, racial and geographic variables, and is a considerable and increasing financial burden on the health care system. Projections of these hospital admissions in Western Australia shows significant increases in the rates of admissions (adjusted for age) up to the year 2030, and direct costs are also set to increase significantly.

It is of concern, that in a rapidly ageing population, substantial rates of admission in older age groups is evident, and projections show that rates amongst older people will increase in future years. The specific conditions leading to hospitalisation include substantial numbers of potentially preventable conditions.

The importance of socio-economic determinants of health became very evident when analysing hospitalisations. The association of socio-economic status and likelihood of admission to hospital for oral-health related conditions is not a simple linear one. There were high rates of hospitalisation among poorer, rural, and Aboriginal groups (those with limited access to primary oral health care), but there were also high rates of hospitalisation among high socio-economic, non-Aboriginal, and urban dwelling groups (with good access to primary health care). There were differences however, in the mix of conditions for which these groups were hospitalised. More disadvantaged groups were more likely to be admitted for conditions developing as a result of untreated disease, or lifestyle,
behavioural, societal, cultural and other factors exposing them to risk for disease, or injury. Wealthier groups were more likely to be admitted for caries (diagnosed in primary care and referred for treatment under general anaesthesia), and very high numbers being admitted for removal of impacted teeth (driven by third molar removals under general anaesthesia).

Based on these findings, it becomes clear that a focus purely on strategies that revolve around providing more dental services to more people, and making it more affordable, is unlikely to solve all problems on a population level. It will improve access to primary care, but not address other societal and socio-economic determinants of disease. However, because access to the dental system is currently an unaffordable option for many Australians, some efforts should be directed at providing an improved, more accessible and more equitable primary oral health care system. This might, at least to some extent, address issues related to some potentially preventable hospital admissions. Implications for healthcare policy that stem from these findings indicate a need to invest in population prevention to engineer a shift to proactive rather than reactive funding, active management of demand for hospital services, care pathway development and testing with learning from other healthcare systems. Initiatives (such a guidelines regarding the removal of third molars) might contribute to less hospital admissions for certain conditions.

Recognition that lifestyle choices are severely restricted amongst the most marginalised and disadvantaged groups in the population can no longer be ignored in attempts to reduce health inequalities. Challenges for the Australian health system include an adaptation to meet the needs of an ageing and growing population, and providing a more equitable
dental health care system which is overcoming some socio-economic and geographical barriers. At the same time, health spending need to be sustainable, and implies the funding of cost-effective improvements to health care, while adjusting spending to obtain better value for money where necessary.
References


Commonwealth Department of Health and Aged Care (DHAC). A national model for the collection and analysis of a minimum data set with outcome measures for private, hospital-based, Psychiatric services. Canberra.


Health Department of Western Australia (2001). Health and Quality of Life for Older Western Australians. Discussion paper.


Appendix A
Winthrop Professor Marc Tennant  
Primary, Aboriginal & Rural Health Care (School of)  
MBDP: M309

Dear Professor Tennant

HUMAN RESEARCH ETHICS APPROVAL - THE UNIVERSITY OF WESTERN AUSTRALIA

Hospitalisations for oral-health related reasons in Western Australia: A ten-year analysis of trends and future projections

Student(s): Esti Kruger - PhD - 20611786, Esther Kruger

Ethics approval for the above project has been granted in accordance with the requirements of the National Statement on Ethical Conduct in Human Research (National Statement) and the policies and procedures of The University of Western Australia. Please note that the period of ethics approval for this project is five (5) years from the date of this notification. However, ethics approval is conditional upon the submission of satisfactory progress reports by the designated renewal date. Therefore initial approval has been granted from 26 July 2012 to 01 August 2013.

You are reminded of the following requirements:

1. The application and all supporting documentation form the basis of the ethics approval and you must not depart from the research protocol that has been approved.
2. The Human Research Ethics Office must be approached for approval in advance for any requested amendments to the approved research protocol.
3. The Chief Investigator is required to report immediately to the Human Research Ethics Office any adverse or unexpected event or any other event that may impact on the ethics approval for the project.
4. The Chief Investigator must inform the Human Research Ethics Office as soon as practicable if a research project is discontinued before the expected date of completion, providing reasons.

Any conditions of ethics approval that have been imposed are listed below:

Special Conditions

None specified

The University of Western Australia is bound by the National Statement to monitor the progress of all approved projects until completion to ensure continued compliance with ethical standards and requirements.

The Human Research Ethics Office will forward a request for a Progress Report approximately 60 days before the due date. A further reminder will be forwarded approximately 30 days before the due date.

If your progress report is not received by the due date for renewal of ethics approval, your ethics approval will expire, requiring that all research activities involving human participants cease immediately.

If you have any queries please do not hesitate to contact the Human Research Ethics Office (HREO) at hreo-research@uwa.edu.au or on (08) 6488 3703.

Please ensure that you quote the file reference – RA/4/1/5502 – and the associated project title in all future correspondence.
Yours sincerely

Peter Johnstone
Manager
International Classification of Diseases (ICD 10 - AM)

Classification numbers included in this research:

B00.1 Herpesviral vesicular dermatitis
B08.4 Enteroviral vesicular stomatitis with exanthem
B08.5 Enteroviral vesicular pharyngitis
B37.0 Candidal stomatitis

Malignant neoplasms of lip, oral cavity and pharynx (C00-C14)
C00 Malignant neoplasm of lip
C00.0 External upper lip
C00.1 External lower lip
C00.2 External lip, unspecified
C00.3 Upper lip, inner aspect
C00.4 Lower lip, inner aspect
C00.5 Lip, unspecified, inner aspect
C00.6 Commissure of lip
C00.8 Overlapping lesion of lip
C00.9 Lip, unspecified
C01 Malignant neoplasm of base of tongue
C02 Malignant neoplasm of other and unspecified parts of tongue
C02.0 Dorsal surface of tongue
C02.1 Border of tongue
C02.2 Ventral surface of tongue
C02.3 Anterior two-thirds of tongue, part unspecified
C02.4 Lingual tonsil
C02.8 Overlapping lesion of tongue
C02.9 Tongue, unspecified
C03 Malignant neoplasm of gum
C03.0 Upper gum
C03.1 Lower gum
C03.9 Gum, unspecified
C04 Malignant neoplasm of floor of mouth
C04.0 Anterior floor of mouth
C04.1 Lateral floor of mouth
C04.8 Overlapping lesion of floor of mouth
C04.9 Floor of mouth, unspecified
C05 Malignant neoplasm of palate
C05.0 Hard palate
C05.1 Soft palate
C05.2 Uvula
C05.8 Overlapping lesion of palate
C05.9 Palate, unspecified
C06 Malignant neoplasm of other and unspecified parts of mouth
C06.0 Cheek mucosa
C06.1 Vestibule of mouth
C06.2 Retromolar area
C06.8 Overlapping lesion of other and unspecified parts of mouth
C06.9 Mouth, unspecified
C07 Malignant neoplasm of parotid gland
C08 Malignant neoplasm of other and unspecified major salivary glands
C08.0 Submandibular gland
C08.1 Sublingual gland
C08.8 Overlapping lesion of major salivary glands
C08.9 Major salivary gland, unspecified
C09 Malignant neoplasm of tonsil
C09.0 Tonsillar fossa
C09.1 Tonsillar pillar (anterior)(posterior)
C09.8 Overlapping lesion of tonsil
C09.9 Tonsil, unspecified
C10 Malignant neoplasm of oropharynx
C10.0 Vallecula
C10.1 Anterior surface of epiglottis
C10.2 Lateral wall of oropharynx
C10.3 Posterior wall of oropharynx
C10.4 Branchial cleft
C10.8 Overlapping lesion of oropharynx
C10.9 Oropharynx, unspecified
C11 Malignant neoplasm of nasopharynx
C11.0 Superior wall of nasopharynx
C11.1 Posterior wall of nasopharynx
C11.2 Lateral wall of nasopharynx
C11.3 Anterior wall of nasopharynx
C11.8 Overlapping lesion of nasopharynx
C11.9 Nasopharynx, unspecified
C12 Malignant neoplasm of piriform sinus
C13 Malignant neoplasm of hypopharynx
C13.0 Postcricoid region
C13.1 Aryepiglottic fold, hypopharyngeal aspect
C13.2 Posterior wall of hypopharynx
C13.8 Overlapping lesion of hypopharynx
C13.9 Hypopharynx, unspecified
C14 Malignant neoplasm of other and ill-defined sites in the lip, oral cavity and pharynx
C14.0 Pharynx, unspecified
C14.2 Waldeyer ring
C14.8 Overlapping lesion of lip, oral cavity and pharynx

Diseases of oral cavity, salivary glands and jaws (K00-K14)
K00 Disorders of tooth development and eruption
K00.0 Anodontia
K00.1 Supernumerary teeth
K00.2 Abnormalities of size and form of teeth
K00.3 Mottled teeth
K00.4 Disturbances in tooth formation
K00.5 Hereditary disturbances in tooth structure, not elsewhere classified
K00.6 Disturbances in tooth eruption
K00.7 Teething syndrome
K00.8 Other disorders of tooth development
K00.9 Disorder of tooth development, unspecified
K01 Embedded and impacted teeth
K01.0 Embedded teeth
K01.1 Impacted teeth
K02 Dental caries
K02.0 Caries limited to enamel
K02.1 Caries of dentine
K02.2 Caries of cementum
K02.3 Arrested dental caries
K02.4 Odontoclasia
K02.5 Caries with pulp exposure
K02.8 Other dental caries
K02.9 Dental caries, unspecified
K03 Other diseases of hard tissues of teeth
K03.0 Excessive attrition of teeth
K03.1 Abrasion of teeth
K03.2 Erosion of teeth
K03.3 Pathological resorption of teeth
K03.4 Hypercementosis
K03.5 Ankylosis of teeth
K03.6 Deposits [accretions] on teeth
K03.7 Posteruptive colour changes of dental hard tissues
K03.8 Other specified diseases of hard tissues of teeth
K03.9 Disease of hard tissues of teeth, unspecified
K04 Diseases of pulp and periapical tissues
K04.0 Pulpitis
K04.1 Necrosis of pulp
K04.2 Pulp degeneration
K04.3 Abnormal hard tissue formation in pulp
K04.4 Acute apical periodontitis of pulpal origin
K04.5 Chronic apical periodontitis
K04.6 Periapical abscess with sinus
K04.7 Periapical abscess without sinus
K04.8 Radicular cyst
K04.9 Other and unspecified diseases of pulp and periapical tissues
K05 Gingivitis and periodontal diseases
K05.0 Acute gingivitis
K05.1 Chronic gingivitis
K05.2 Acute periodontitis
K05.3 Chronic periodontitis
K05.4 Periodontosis
K05.5 Other periodontal diseases
K05.6 Periodontal disease, unspecified
K06 Other disorders of gingiva and edentulous alveolar ridge
K06.0 Gingival recession
K06.1 Gingival enlargement
K06.2 Gingival and edentulous alveolar ridge lesions associated with trauma
K06.8 Other specified disorders of gingiva and edentulous alveolar ridge
K06.9 Disorder of gingiva and edentulous alveolar ridge, unspecified
K07 Dentofacial anomalies [including malocclusion]
K07.0 Major anomalies of jaw size
K07.1 Anomalies of jaw-cranial base relationship
K07.2 Anomalies of dental arch relationship
K07.3 Anomalies of tooth position
K07.4 Malocclusion, unspecified
K07.5 Dentofacial functional abnormalities
K07.6 Temporomandibular joint disorders
K07.8 Other dentofacial anomalies
K07.9 Dentofacial anomaly, unspecified
K08 Other disorders of teeth and supporting structures
K08.0 Exfoliation of teeth due to systemic causes
K08.1 Loss of teeth due to accident, extraction or local periodontal disease
K08.2 Atrophy of edentulous alveolar ridge
K08.3 Retained dental root
K08.8 Other specified disorders of teeth and supporting structures
K08.9 Disorder of teeth and supporting structures, unspecified
K09 Cysts of oral region, not elsewhere classified
K09.0 Developmental odontogenic cysts
K09.1 Developmental (nonodontogenic) cysts of oral region
K09.2 Other cysts of jaw
K09.8 Other cysts of oral region, not elsewhere classified
K09.9 Cyst of oral region, unspecified
K10 Other diseases of jaws
K10.0 Developmental disorders of jaws
K10.1 Giant cell granuloma, central
K10.2 Inflammatory conditions of jaws
K10.3 Alveolitis of jaws
K10.8 Other specified diseases of jaws
K10.9 Disease of jaws, unspecified
K11 Diseases of salivary glands
K11.0 Atrophy of salivary gland
K11.1 Hypertrophy of salivary gland
K11.2 Sialoadenitis
K11.3 Abscess of salivary gland
K11.4 Fistula of salivary gland
K11.5 Sialolithiasis
K11.6 Mucocele of salivary gland
K11.7 Disturbances of salivary secretion
K11.8 Other diseases of salivary glands
K11.9 Disease of salivary gland, unspecified
K12 Stomatitis and related lesions
K12.0 Recurrent oral aphthae
K12.1 Other forms of stomatitis
K12.2 Cellulitis and abscess of mouth
K12.3 Oral mucositis (ulcerative)
K13 Other diseases of lip and oral mucosa
K13.0 Diseases of lips
K13.1 Cheek and lip biting
K13.2 Leukoplakia and other disturbances of oral epithelium, including tongue
K13.3 Hairy leukoplakia
K13.4 Granuloma and granuloma-like lesions of oral mucosa
K13.5 Oral submucous fibrosis
K13.6 Irritative hyperplasia of oral mucosa
K13.7 Other and unspecified lesions of oral mucosa
K14 Diseases of tongue
K14.0 Glossitis
K14.1 Geographic tongue
K14.2 Median rhomboid glossitis
K14.3 Hypertrophy of tongue papillae
K14.4 Atrophy of tongue papillae
K14.5 Plicated tongue
K14.6 Glossodynia
K14.8 Other diseases of tongue
K14.9 Disease of tongue, unspecified

S01.5 Open wound of lip and oral cavity
S02 Fracture of skull and facial bones
S02.0 Fracture of vault of skull
S02.1 Fracture of base of skull
S02.2 Fracture of nasal bones
S02.3 Fracture of orbital floor
S02.4 Fracture of malar and maxillary bones
S02.5 Fracture of tooth
S02.6 Fracture of mandible
S02.7 Multiple fractures involving skull and facial bones
S02.8 Fractures of other skull and facial bone
S03.0 Dislocation of jaw
S03.1 Dislocation of septal cartilage of nose
S03.2 Dislocation of tooth
S03.3 Dislocation of other and unspecified parts of head
S03.4 Sprain and strain of jaw

Q18.4 Macrostomia
Q18.5 Microstomia
Q18.6 Macrocheilia
Q18.7 Microcheilia
Q35 Cleft palate
Q35.1 Cleft hard palate
Q35.3 Cleft soft palate
Q35.5 Cleft hard palate with cleft soft palate
Q35.7 Cleft uvula
Q35.9 Cleft palate, unspecified
Q36 Cleft lip
Q36.0 Cleft lip, bilateral
Q36.1 Cleft lip, median
Q36.9 Cleft lip, unilateral
Q37 Cleft palate with cleft lip
Q37.0 Cleft hard palate with bilateral cleft lip
Q37.1 Cleft hard palate with unilateral cleft lip
Q37.2 Cleft soft palate with bilateral cleft lip
Q37.3 Cleft soft palate with unilateral cleft lip
Q37.4 Cleft hard and soft palate with bilateral cleft lip
Q37.5 Cleft hard and soft palate with unilateral cleft lip
Q37.8 Unspecified cleft palate with bilateral cleft lip
Q37.9 Unspecified cleft palate with unilateral cleft lip
Hospital admissions of older people for oral health-related conditions: implications for the future

Estie Kruger and Marc Tennant
International Research Collaborative – Oral Health and Equity, Faculty of Sciences, The University of Western Australia, Perth, WA, Australia

Gerodontology 2015; doi: 10.1111/ger.12189

Hospital admissions of older people for oral health-related conditions: implications for the future

Objective: This study analysed all hospitalisations of persons over the age of 65 years for oral health-related conditions, over a decade, and projected future hospitalisation rates.

Background: The proportion of older Australians is increasing, and their oral health is improving. At the same time, there is concern about the increasing burden that hospitalisations place on government health budgets.

Methods: Hospitalisation data of all patients older than 65 years, admitted to hospital for an oral health-related condition in Western Australia over a decade, were analysed.

Results: Over a ten-year period, a total of 11608 people over the age of 65 were admitted to hospital, with 10% 85 years and older, 52% were men, and 0.1% were Aboriginal patients. The highest rates of hospitalisation were for those from the most disadvantaged areas. Over ten years, there was a significant annual increase in rates of hospitalisation (4.4%). Overall, most admissions were for ‘Malignant neoplasms’ (16.6%), ‘Dental caries’ (15.4%) and ‘Other disorders of the teeth and supporting structures’ (14.3%). These three conditions accounted for almost half of all admissions (46.4%). Projections indicate high future burdens of hospitalisation.

Conclusions: It is of concern that hospitalisations for oral health-related reasons among the oldest patients include high numbers with potentially preventable conditions such as dental caries. Projections indicate that if current trends are set to continue, hospitalisations for oral health-related conditions among Western Australians older than 65 years will place a considerable burden on the health system.

Keywords: elderly, dental, hospitalisations, oral health

Accepted 26 December 2014

Introduction

Health expenses contributed to 19% of Australian government expenditure and grew by 74% in real terms over the last decade. Growth in health spending above GDP over the past ten years was greater than the growth above GDP of all other spending combined, and the expense, which did most to increase health spending, was hospital spending. This increase in spending on health appears to be having an impact, as life expectancy, particularly for those aged over 65, has increased rapidly and consistently over the last 40 years. The number of people aged 65 years in Australia will rise from 2.2 million in 1997 to about 4 million in 2021. Population projections predict that by 2050, 25% of the population will be aged 65 years or over, with the proportion aged 85 years or more rising from 1.5% to 5% of the population. It is predicted that this increase in the aged proportion of the population will increase the pressure on the health system. People aged 65 and over comprise 13% of the population, yet contribute to 35% of hospital admissions, and 47% of hospital occupied bed days. Using multiple estimation methods, it is projected that by 2050, people aged 65 and over will be responsible for two-thirds of all hospital bed-day utilisation. Because of this demographic transition, the health of the older population is becoming increasingly important to examine, with oral health no less challenging.

Findings of Australia’s most recent national dental health survey (2004–2006) indicated that oral diseases were pervasive within the adult

© 2015 John Wiley & Sons A/S and The Gerodontology Association. Published by John Wiley & Sons Ltd
Marked reductions were found among all age groups in levels of tooth loss and lifetime experience of dental decay. In spite of the reductions in tooth loss among older adults, there were other adverse consequences: people aged 75+ years had prevalence rates of periodontal disease and root decay that were 2–3 times as great as the population at large.6

Against this background, an analysis of admissions to hospitals, and the oral health conditions that drive these hospitalisations, is essential in the light of increasing health resource constraints. The aim of this study was fourfold: (i) to assess the incidence of all hospitalisations per year and trends over a ten-year period among those 65 years and older in Western Australia (WA), (ii) to assess the burden of cost and bed days over the study period, (iii) to project future demand based on ten-year trends and (iv) to identify which oral health-related conditions are the biggest drivers of hospitalisation of older patients in WA.

Materials and methods

Ethics

Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia.

Study population

Western Australia is geographically the largest state in Australia and in 2006 had a population of just more than two million (which constituted approximately 10% of the total Australian population in 2006 of 20.7 million). The older adult population in WA (all 65 years and older) were 197,590 in 1999, 209,256 in 2001 and 242,383 in 2006. Approximately 80% of these lived in metropolitan Perth, and 0.8% were of Aboriginal or Torres Strait Islander descent.7

Hospitalisation data

Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The HMDS forms part of the Western Australian Hospital Data Linkage (WAHDLS) system, unique in Australia, and which is known for its high quality, and comprehensive population base. The high quality of this population based data set allows for comprehensive health services research.8

The term ‘hospitalisation’ has been used to refer to a separation which is the episode of admitted patient care, which can be a total hospital stay (from admission to discharge, transfer or death) or a portion of a hospital stay beginning or ending a change in a type of care (e.g. from acute to rehabilitation).9 ‘Separation’ also means the process by which an admitted patient completes an episode of care by being discharged, dying, transferring to another hospital or changing type of care. A same-day separation occurs when a patient is admitted and separated from the hospital on the same date. An overnight separation occurs when a patient is admitted to and separated from the hospital on different dates.9

The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM)10, was obtained for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999–2000 to 2008–2009. The ICD-10AM is the standard classification scheme used for reporting diagnoses in all hospital statistical collections. In this study, episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health-related condition. The principal diagnosis is the main reason why a patient is admitted. An additional diagnosis is a condition or complaint that either coexists with the principal diagnosis or arises during the episode of care.10

Population rates and cost

Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics (ABS). The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost. AR-DRG is an Australian-admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital.11 Across Australia, the AR-DRG is used to calculate the cost of each patient episode on the basis of actual data about the treatment process. It is considered that Australia is a model example of a mature costing system and has the most sophisticated approach according to cost guidelines which include the actual amount of resources used in the treatment of a particular patient.12 Therefore, AR-DRG version 5.1 was used to calculate the direct cost (the Australian dollar value used according to the year of admission). Each
AR-DRG represents ‘a class of patients with similar clinical conditions requiring similar hospital services’\textsuperscript{11}. The categorisation classifies ‘acute admitted patient episodes of care into groups with similar conditions and similar usage of hospital resources, using information in the hospital morbidity record such as the diagnoses, procedures and demographic characteristics of the patient’\textsuperscript{11}. Because DRG costs overall does not represent a normal distribution, the average for the lowest, mid and highest one-third of the DRG cost distribution was calculated and used in the cost projections to indicate a low, mid and high range, depending on the averages of each third.

**Accessibility and remoteness**

Primary place of residency at the time of hospitalisation and the geographical classification was performed according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA calculates remoteness as accessibility to service centres based on road distances and is grouped into five categories: highly accessible, accessible, moderately accessible, remote and very remote\textsuperscript{13}.

**Socio-economic index of disadvantage**

The population census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of people all over Australia. The ABS has combined these in a set of indicators called the socio-economic indexes for areas (SEIFA) which give a summary measure of socio-economic status for people living in specific geographical regions in Australia. Each geographical area is given a score and then ranked against all other areas in Australia, and the rankings are grouped into five equal size bands (quintiles). Quintile one contains the 20% most disadvantaged areas in Australia, and quintile five contains the 20% least disadvantaged areas in Australia\textsuperscript{14}.

**Statistical analysis**

All rates were calculated using the Rates Calculator (Government of Western Australia, Perth, Australia), a software package developed by the Department of Health. All rates were calculated per 100 000 person years. Significant differences between rates were based on non-overlapping 95 percentage confidence intervals ($p < 0.05$). Means between groups were compared using ANOVA. Both Poisson regression and chi-squared tests were used to determine whether trends were significant for age-standardised rates over time. Projections were carried out using two methods. The first is the exponentially weighted moving average method (EWM) and the second the linear method (LM). All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, NY, USA).

**Results**

**Incidence**

Over a ten-year period, a total of 11608 people over the age of 65 were admitted to hospitals in Western Australia for oral health-related conditions. Of these, 10% were 85 years and older, 52% were men, and 0.1% were Aboriginal patients. In terms of accessibility and remoteness, most patients (70%) were from ‘Highly Accessible’ areas, but the highest rate of hospitalisation was from ‘Accessible’ areas (10.5 per 1000 people). In terms of disadvantage measurements, although most patients (28%) came from ‘Least Disadvantaged’ areas, the highest rate was from ‘Most Disadvantaged’ areas (60 per 1000). This rate was 12 times higher than that of ‘Least disadvantaged’ areas (Table 1). Men had significantly higher rates of hospitalisation than women, and Aboriginal people had significantly higher rates than non-Aboriginal people ($p < 0.05$) (Table 1).

Population rates indicated that over the ten-year period, there was an increase in rates of hospitalisation, with the highest rates in the last years (Table 1). There were an increase in rates in all age groups (Fig. 1). Rates were significantly higher in the last four years compared to rates in the first five years ($p < 0.05$). Trend analysis indicated a rate ratio of 1.044, with a confidence interval (CI) of 1.03–1.051. The average annual change (4.44%) showed a significant ($p < 0.0001$) increase in rate. Absolute numbers of older patients admitted increased from 829 in 1999/2000 to 1573 in 2008/2009. Hospitalisation rates were highest in the 65- to 69-year-old population and lowest in the 85+ year population. There were significantly lower rates in age groups 70–74 and 85+ years, compared to the other three age groups ($p < 0.05$) (Table 1).

**Cost and bed days**

The average number of bed days decreased slightly over the ten-year period (Table 2). The average numbers of bed days increased with each group, with the oldest (85+ years) on average
spending longest (4.27 days) in hospital. DRG cost increased over the decade under study, from an average of $3593 in 1999/2000 to $4590 in 2008/2009 (Table 2).

**Projections**

Two methods were used to project numbers of hospitalisations, based on ten-year trends, for the year 2024/2025 (Fig. 2). The EWM method indicated that cases will increase to 4668 and the LM projected 5286 cases of hospitalisation per year for 65–year-olds in WA (Table 1). This equates to projected rates (using EWM and LM) of 8.88 and 9.99 per 1000 population, respectively (Table 1).

<table>
<thead>
<tr>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall, in all those admitted, most were for ‘Malignant neoplasms’ (16.6%), ‘Dental caries’</td>
</tr>
</tbody>
</table>

Table 1 Hospitalisations of patients older than 65 over ten years in Western Australia.

<table>
<thead>
<tr>
<th>Year</th>
<th>n (%)</th>
<th>Rate per 1000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>829 (7.1)</td>
<td>4.17 (3.89–4.46)</td>
</tr>
<tr>
<td>2000/01</td>
<td>941 (8.1)</td>
<td>4.61 (4.32–4.91)</td>
</tr>
<tr>
<td>2001/02</td>
<td>899 (7.7)</td>
<td>4.29 (4.16–4.57)</td>
</tr>
<tr>
<td>2002/03</td>
<td>1009 (8.7)</td>
<td>4.68 (4.39–4.97)</td>
</tr>
<tr>
<td>2003/04</td>
<td>1034 (8.9)</td>
<td>4.66 (4.37–4.94)</td>
</tr>
<tr>
<td>2004/05</td>
<td>1126 (9.7)</td>
<td>4.92 (4.63–5.21)</td>
</tr>
<tr>
<td>2005/06</td>
<td>1332 (11.5)</td>
<td>5.66 (5.35–5.96)</td>
</tr>
<tr>
<td>2006/07</td>
<td>1407 (12.1)</td>
<td>5.78 (5.48–6.08)</td>
</tr>
<tr>
<td>2007/08</td>
<td>1458 (12.6)</td>
<td>5.81 (5.51–6.11)</td>
</tr>
<tr>
<td>2008/09</td>
<td>1573 (13.6)</td>
<td>6.08 (5.77–6.38)</td>
</tr>
<tr>
<td>All years</td>
<td>11608 (100)</td>
<td>5.12 (5.02–5.21)</td>
</tr>
</tbody>
</table>

**Projections**

| EWMb | 2024/25 | 4668 (4385–4951)a | 8.88 (8.53–9.13) |

**Age**

| 65–69 years | 3750 (32.3) | 5.47 (5.01–5.92) |
| 70–74 years | 3000 (25.8) | 5.30 (5.12–5.50) |
| 75–79 years | 2179 (18.8) | 4.78 (4.57–4.98)c |
| 80–84 years | 1480 (12.7) | 4.85 (4.55–5.04) |
| 85+ years   | 1199 (10.3) | 4.77 (4.55–4.99)c |
| All         | 11608 (100) | 5.12 (5.02–5.21) |

**Gender**

| Male | 6030 (52) | 5.82 (5.67–5.92) |
| Female | 5578 (48) | 4.51 (4.39–4.63)c |
| All   | 11608 (100) | 5.12 (5.02–5.21) |

**Aboriginal status**

| Aboriginal | 157 (1) | 9.38 (7.82–10.94)c |
| Non-aboriginal | 11451 (99) | 5.09 (5.00–5.18)c |
| All         | 11608 (100) | 5.12 (5.02–5.21) |

**ARIA**

| HA | 8091 (69.7) | 4.06.0 (3.96.7–4.15.9) |
| A  | 1901 (16.4) | 10.58 (10.08 –11.11) c |
| MA | 1085 (9.3)  | 9.97.5 (9.35.1–10.64) c |
| RT | 241 (2.1)   | 7.53.1 (6.56.4–8.63.7) c |
| VR | 248 (2.1)   | 4.58.9 (4.00.1–5.26.5) |
| All | 11566 (100) | 4.89.3 (4.86.4–4.92.3) |

**SEIFA**

| 1 | 2170 (18.7) | 60.04 (57.43–62.76) c |
| 2 | 2122 (18.3) | 10.79 (10.30–11.29) c |
| 3 | 2087 (18.0) | 2.23 (2.13–2.34) |
| 4 | 1970 (17.0) | 3.57 (3.40–3.74) |
| 5 | 3238 (27.9) | 4.98 (4.80–5.17) |
| All | 11587 (100) | 4.90 (4.87–4.93) |

aIndicate projected range of hospitalization numbers.
bEWM, exponentially weighted moving average method; LM, linear method.
c(statistically significant, \( p < 0.05 \)) HA, highly accessible; A, accessible; MA, moderately accessible; RT, remote; VR, very remote. SEIFA 1 = most disadvantaged, SEIFA 5 = least disadvantaged.
(15.4%) and ‘Other disorders of the teeth and supporting structures’ (14.3%). These three conditions accounted for almost half of all admissions (46.4%) (Table 3). When dividing the groups into a younger (65–74 years old) and older (75+ years) group, differences can be seen in the conditions that lead to hospitalisations. The younger group mostly get admitted for ‘Malignant neoplasms’ (16.8%), ‘Other diseases of the teeth and supporting tissues’ (16.8%) and ‘Other diseases of the teeth’ (14.1%), followed by ‘Dental caries’ (13.6%) (Table 4).

The oldest group (75+ years) were mostly admitted for ‘Dental Caries’ (18.1%) ‘Malignant neoplasms’ (16.3%), ‘Other disorders of the teeth and supporting structures’ (10.9%), and ‘Fractures of the teeth, nasal bone, palate, lower facial bone’ (8.3%) (Table 5).
The main reason for admission of those aged 85 and older (n = 1199), almost one-fifth (19.3%), was admitted for ‘Dental Caries’, with a further 16.3% admitted for ‘Fractures of the teeth, nasal bone, palate, lower facial bone’ and 15.3% for ‘Malignant neoplasms’.

**Discussion**

Overall, the oral health of Australia’s older population is improving, with less extractions than previous generations, and more people retaining their natural dentition into old age. This is combined with longer life expectancy and an increase in the proportion of older Australians. At the same time, there is concern about the increasing burden that hospitalisations place on government health budgets, and people over 65 contributing to more than a third of all hospital admissions. This led to a recognition of the need to manage the demand for high cost hospital care more effectively. The Australian hospital sector has long had a focus on preventing hospital admissions as a...
way of reducing demand\textsuperscript{15}. Preventing hospital admissions should, however, also be a priority for the primary care sector, as there is evidence that health outcomes can be improved when care is provided in a coordinated, systematic approach with a strong and effective primary care component\textsuperscript{16,17}. This is especially true for oral health.

Against this background, this study analysed all hospitalisations of persons over the age of 65 years for oral health-related conditions, over a decade. Just more that 10\% of those admitted were older than 85 years of age, this is not surprising considering that the average life expectancy for Australians now extend well beyond 80 years. Australian men aged 65 in 2010–2012 could expect to live another 19.1 years (an expected age at death of 84.1 years), and the life expectancy of women aged 65 in 2010–2012 was 22.0 years (an expected age at death of 87.0 years)\textsuperscript{18}. Significantly higher rates of men were admitted. The explanation might be found in the mix of conditions that older people were admitted for. It is known that prevalence is higher in men than women for conditions such as malignant neoplasms\textsuperscript{19,20} and untreated decay\textsuperscript{6}, and the incidence of jaw fractures is also much higher in men\textsuperscript{21}.

Table 5 Mix of oral health-related conditions that patients older than 75 years were admitted to hospital for, over a ten-year period in Western Australia.

<table>
<thead>
<tr>
<th>Condition</th>
<th>(n)</th>
<th>(%)</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental caries</td>
<td>877</td>
<td>18.1</td>
<td>18.1</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>790</td>
<td>16.3</td>
<td>34.3</td>
</tr>
<tr>
<td>Other disorders of teeth and supporting structures</td>
<td>531</td>
<td>10.9</td>
<td>45.2</td>
</tr>
<tr>
<td>Fractures of the teeth, nasal bone, palate, lower facial bones</td>
<td>403</td>
<td>8.3</td>
<td>53.5</td>
</tr>
<tr>
<td>Other diseases of the jaws</td>
<td>360</td>
<td>7.4</td>
<td>60.9</td>
</tr>
<tr>
<td>Diseases of salivary glands</td>
<td>286</td>
<td>5.9</td>
<td>66.8</td>
</tr>
<tr>
<td>Benign neoplasms</td>
<td>276</td>
<td>5.7</td>
<td>72.5</td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>206</td>
<td>4.2</td>
<td>76.7</td>
</tr>
<tr>
<td>Diseases of pulp and periapical tissues</td>
<td>198</td>
<td>4.1</td>
<td>80.8</td>
</tr>
<tr>
<td>Jaw fractures</td>
<td>148</td>
<td>3.0</td>
<td>83.8</td>
</tr>
<tr>
<td>Stomatitis and related lesions</td>
<td>138</td>
<td>2.8</td>
<td>86.6</td>
</tr>
<tr>
<td>Other disease of lip and oral mucosa</td>
<td>132</td>
<td>2.8</td>
<td>89.4</td>
</tr>
<tr>
<td>Others</td>
<td>513</td>
<td>10.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>4858</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Only 0.1\% of all admissions were for Aboriginal people, although rates were much higher. The far lower life expectancy of Aboriginal people in Australia, compared to that of non-Aboriginal people might be one reason for the low number of admissions. As of 2010, life expectancy for Aboriginal men was estimated to be 11.5 years less than that of non-indigenous men, and for Aboriginal women, the 2010 figures show a difference of 9.7 years\textsuperscript{22}. The rate of hospitalisations among Aboriginal people, however, was almost double that of non-Aboriginal people. It is well known that the socio-economic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health (including oral health) risk factors\textsuperscript{23}. Among these factors, access to timely oral healthcare services, especially in rural and remote areas, remains a challenge. The findings of this study also reflect the higher burdens of oral disease experienced by Aboriginal compared to non-Aboriginal people\textsuperscript{24}. Socio-economic disparity is also clearly indicated by the hospitalisation rate of those from the most disadvantaged areas, which was 12 times higher than for those from the least disadvantaged areas. Issues of accessibility to primary dental care services remain, especially for elderly and rural disadvantaged areas.

Over the ten years, annual costs increased, and at the same time, the number of bed days decreased. A previous ten-year study also observed increases in rates of all general hospital separations among the elderly in Australia, but the proportion of beds occupied by older patients remaining stable, due to disproportionate reductions in length of stay for multiday admissions in the \(\geq 75\) years age group and reductions in the rate of multiday separations among the 65–74 years age group. This work related to all health conditions\textsuperscript{25}.

Projections indicate that by 2025, rates of hospitalisation of older people for oral health-related conditions will be almost double that of the average rate (between 1999/2000 and 2008/2009), number of bed days per year will total between 13 000 and almost 16 000 days per year, and total DRG cost would be at least $7 million per year. There are limitations when projecting future costs, and depending on which method of modelling is used, costs can vary within each of the low, mid and high ranges of the DRG cost distribution. Cost projections related to dental health care are never 100\% accurate, as uncertainty exists in the underlying economic and demographic assumptions used in projection models.
Uncertainty also exists in assumptions about future changes in the dental health status of the population, the extent and pace of scientific and technological breakthroughs in dental care, and how each of these factors relates to oral health-care costs. However, based on trends over past years, some projected estimations can be made.

Trends over ten years indicate that there is a slow but steady increase in the hospitalisations of older people for oral health-related conditions, with a difference in the mix of conditions, between the younger group (65–74 years) and the older group (75+ years). In the younger group, the major drivers were malignant neoplasms, disorders of the jaws and dental caries. Oral cancer is very strongly age-related, and risk factors include tobacco use, which also exerts a synergistic effect with heavy alcohol use.

The ICD10 classification of ‘Disorders of the teeth and supporting structures’ include conditions such as exfoliation of teeth due to systemic causes, atrophy of alveolar ridges, retained dental roots, enlargement of alveolar ridges and irregular alveolar ridges. ‘Other diseases of the jaws’ include conditions such as cysts of the jaw, cell granulomas, inflammatory jaw conditions, jaw alveolitis, cherubism, exostosis, fibrous dysplasia and condylar hypo- and hyperplasia. Most of these conditions are strongly age-associated.

In the oldest age group, ‘Dental Caries’ was the main reason for admission. This is a strong indicator of the retention of teeth into old age and the related dental health maintenance issues. Dental caries is a multifactorial disease, with many risk factors associated with age. Dry mouth is very prevalent in older people (a common side effect of medications), and both xerostomia and hypsalivation increases the risk of severe dental caries. A recent review indicated that dental caries is not only known to be active in older age groups, but continues to be the most prevalent oral health condition in older people.

Other major reasons for admissions in the oldest group also included oral cancer, other disorders of teeth and supporting structures and fractures of teeth, nasal bone palate and lower facial bone. With increasing retention of natural teeth, a range of other chronic degenerative problems might also be expected to become more common, including tooth wear, tooth fracture, root caries and pulpal necrosis. Facial fractures have previously been mentioned as prevalent reason for hospitalisations of older people due to the high number admitted for falls.

Conclusions
The results of this analysis highlight various issues – it is of concern that high numbers of hospitalisations for oral health-related reasons among the oldest patients include potentially preventable conditions such as dental caries. Dental caries is recognised to be a condition that is preventable if timely and effective care is delivered in the ambulatory care setting, in particular access to primary care services. Projections indicate that if current trends are set to continue, hospitalisations for oral health-related conditions among Western Australians older than 65 years will place a considerable burden on the health system.

References
Potentially preventable hospital separations related to oral health: a 10-year analysis

E Kruger,* M Tennant*

*International Research Collaborative – Oral Health and Equity, School of Anatomy, Physiology and Human Biology, The University of Western Australia, Nedlands, Western Australia.

ABSTRACT

Background: The aims of this study were to assess the rates of hospitalizations for potentially preventable dental conditions over a 10-year period in Western Australia; to analyse trends over 10 years in rate changes of hospitalizations; and to analyse the mix of preventable dental conditions by age group and Aboriginal status.

Methods: The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), was used to select hospitalization data for all patients who were discharged from hospital in Western Australia for the financial years 1999–2000 to 2008–2009, for a potentially preventable oral health condition.

Results: Over a 10-year period more than 65 000 people were hospitalized. Population rates of hospitalization increased significantly over the period for both Aboriginal and non-Aboriginal population groups. Admission rates were higher for Aboriginal people. Children under 14 were more likely to be admitted; the most common condition that required hospitalization was dental caries, and the highest rates of hospitalization were for those from the most socio-economically disadvantaged areas.

Conclusions: These hospitalizations remain a considerable and increasing financial burden on health budgets. An increase in efforts is necessary to curb escalating government health expenditure by reducing avoidable and preventable oral health related hospitalizations.

Keywords: Australia, dental, hospitalizations, oral health, preventable.

INTRODUCTION

Potentially preventable hospitalizations are hospital separations where the principal diagnosis of the hospitalization is thought to be avoidable if timely and adequate non-hospital care had been provided. This refers to preventive measures, or early diagnosis and treatment in primary care. Hospitalization rates of potentially preventable dental conditions thus provide an indicator of the potential inadequacy of dental care in the community. Data on avoidable hospitalizations are increasingly used internationally as an indicator of access to primary care and its effectiveness, and as a measure of the potential health gains from primary care interventions.

Dental care in Australia is provided by a mix of private and public services, with the latter limited to provision of school dental services for children and a safety net service for disadvantaged adults. Demand from concession card holders for public dental care far outstrips state and territory dental services’ capacity to supply treatment and long waiting lists remain. The majority of dental services in Australia remain funded from private sources (health insurance funds and individuals). Overall, a number of independent services exist without systematic coordination or linkages to general health services.

There remain a number of identifiable groups within the Australian population with poor access to oral health care and whose oral health outcomes are severely compromised as a result. These most notably include Aboriginal and Torres Strait Islander peoples, people in low socio-economic groups, and those with special needs relating to a health condition or ageing. Rates of oral disease are high among these populations and access to treatment is often difficult. Hospitalization for conditions related to oral health are prevalent, and placing considerable burdens on health system budgets.
hospitalization for dental caries was one of the leading causes of hospitalization.\textsuperscript{11}

Previous research revealed that avoidable hospitalization rates (for general health conditions) are higher in people living in remote areas, those of lower socio-economic status and Aboriginal people.\textsuperscript{16,17} Avoidable hospitalization rates for dental care has also shown to be higher among rural dwellers and children younger than 9 years, but little association between socio-economic deprivation and hospitalization rates was found in a study from Victoria, Australia.\textsuperscript{14} However, a recent analysis from New Zealand indicated higher rates of dental preventable hospitalizations among the most deprived.\textsuperscript{13}

Analysing avoidable dental hospitalizations is necessary to identify groups within the population at higher risk for hospitalization, as well as identifying time trends in hospitalization rates against a background of rapidly changing demographics. The oral health care system does not operate in the same way as the general health care system in Australia (in terms of funding and access), and strategies to identify and address access issues should be based on relevant and reliable information such as population based studies.

Little is known about the trends in potentially preventable hospitalizations over time in Western Australia (WA), as well as those groups in the population most at risk, and the specific dental conditions leading to admissions. The aims of this study were threefold: (1) to assess the rates of hospitalizations for potentially preventable dental conditions over a 10-year period in WA; (2) to analyse trends over 10 years in rate changes of hospitalizations; and (3) to analyse the mix of preventable dental conditions by age group and Aboriginal status.

MATERIALS AND METHODS

Ethics

Ethics approval for this study was obtained from the Human Research Ethics Committee at The University of Western Australia.

Study population

The total population in Western Australia was 1 849 055 in 1999, 1 901 168 in 2001 and 2 059 614 in 2006. In 2006 3.8% of the WA population were of Aboriginal or Torres Strait Islander descent, and 34% of the Aboriginal WA population, and 80% of the non-Aboriginal population resided in metropolitan Perth.\textsuperscript{18}

Hospitalization data

Hospitalization data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as determined by clinicians for each admission, and as classified by the International Classification of Disease (ICD-10AM),\textsuperscript{19} was obtained for every episode of discharge from all private and public hospitals in WA for the financial years 1999–2000 to 2008–2009. In this study hospitalization episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being a potentially avoidable oral health condition.\textsuperscript{1,14} Potentially avoidable hospitalizations related to oral health were defined as the following: principal diagnosis categories K02 Dental Caries; K03 Other diseases of hard tissues of teeth; K04 Diseases of the pulp and periapical tissues; K05 Gingivitis and periodontal diseases; K06 Other diseases of gingival and edentulous alveolar ridge; K08 Other disorders of teeth and supporting structures; K09.8 Other cysts of oral region, not elsewhere classified; K09.9 Cysts of oral region, unspecified; K12 Stomatitis and related lesions; and K13 Other diseases of lip and oral mucosa. These categories were selected to match those used by the Australian Institute of Health and Welfare (AIHW) in reports on oral health,\textsuperscript{1} and are identical to those used previously in other Australian and international studies.\textsuperscript{1,13,14}

Aboriginal status, population rates and cost

Self-reported Aboriginality was used to compare Aboriginal to non-Aboriginal populations. Population data for rate calculations were obtained from the estimates as calculated by the WA Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national Australian refined standard diagnostic related group (AR-DRG) average price. AR-DRG is an Australian admitted patient classification system which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services.\textsuperscript{20}

Socio-economic status

The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of people all over Australia. The Australian Bureau of Statistics has combined these into a set of indicators called the Socio-economic Indexes for Areas (SEIFA) which give a summary measure of socio-economic status for people living in specific geographic regions in Australia. Each geographic area is given a score, then ranked
against all other areas in Australia, and the rankings are grouped into five equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas in Australia, and quintile 5 contains the 20% least disadvantaged areas in Australia.21

Place of residency

Primary place of residency at the time of hospitalization and the geographical classification was done according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centres based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote.22

Statistical analysis

All rates were calculated using the Rates calculator, a software package developed by the WA Department of Health. All rates were calculated per 1000 people, and were age standardized to the WA population. Both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardized rates over time. All statistical analysis was undertaken using IBM SPSS Statistics 19 (IBM, New York, USA).

RESULTS

Demographics and rates

Over a 10-year period more than 65 000 hospitalizations took place for potentially avoidable oral health related conditions in WA. The age-standardized overall rate was 3.2 per 1000 people (Table 1). Slightly fewer males (48%) than females were admitted, and 4.4% of all admissions were for Aboriginal people. Most (44%) admissions were for children under the age of 14 years, with almost 20% for people between 45 and 59 years of age, and only 3% for those older than 75 years (Table 1).

The overall (10-year) population rates of hospital admissions were highest for those under 14 years, and lowest for those between 15 and 29 years. There were differences between the rates of all age groups, and the admission rate for Aboriginal people was higher than for non-Aboriginal people (Table 1). The highest rate of admissions was from the most disadvantaged socio-economic areas (Table 1). In terms of geographic remoteness, the highest rate was from Remote areas, and the lowest rate was from Highly Accessible areas (Table 1).

Table 1. Rates of avoidable hospitalizations by age, Aboriginal status, SEIFA and ARIA, over 10 years

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>4574</td>
<td>2.42</td>
</tr>
<tr>
<td>2000/01</td>
<td>5043</td>
<td>2.66</td>
</tr>
<tr>
<td>2001/02</td>
<td>5765</td>
<td>3.01</td>
</tr>
<tr>
<td>2002/03</td>
<td>6528</td>
<td>3.38</td>
</tr>
<tr>
<td>2003/04</td>
<td>6751</td>
<td>3.46</td>
</tr>
<tr>
<td>2004/05</td>
<td>6714</td>
<td>3.40</td>
</tr>
<tr>
<td>2005/06</td>
<td>7094</td>
<td>3.55</td>
</tr>
<tr>
<td>2006/07</td>
<td>7351</td>
<td>3.59</td>
</tr>
<tr>
<td>2007/08</td>
<td>7244</td>
<td>3.46</td>
</tr>
<tr>
<td>2008/09</td>
<td>7941</td>
<td>3.68</td>
</tr>
<tr>
<td>Total</td>
<td>65005</td>
<td>3.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–14</td>
<td>28820 (44.3%)</td>
<td>7.15</td>
</tr>
<tr>
<td>15–29</td>
<td>6665 (10.2%)</td>
<td>1.57</td>
</tr>
<tr>
<td>30–44</td>
<td>9544 (14.7%)</td>
<td>2.11</td>
</tr>
<tr>
<td>45–59</td>
<td>12318 (19.0%)</td>
<td>3.14</td>
</tr>
<tr>
<td>60–74</td>
<td>5624 (8.7%)</td>
<td>2.62</td>
</tr>
<tr>
<td>75+</td>
<td>2035 (3.1%)</td>
<td>2.01</td>
</tr>
<tr>
<td>Total</td>
<td>65005 (100%)</td>
<td>3.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aboriginal status</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Aboriginal</td>
<td>62154</td>
<td>3.26</td>
</tr>
<tr>
<td>Q1</td>
<td>10909 (16.8%)</td>
<td>34.90</td>
</tr>
<tr>
<td>Q2</td>
<td>11799 (18.2%)</td>
<td>8.51</td>
</tr>
<tr>
<td>Q3</td>
<td>11496 (17.2%)</td>
<td>1.64</td>
</tr>
<tr>
<td>Q4</td>
<td>12859 (19.9%)</td>
<td>2.62</td>
</tr>
<tr>
<td>Q5</td>
<td>17706 (27.3%)</td>
<td>3.72</td>
</tr>
<tr>
<td>Total</td>
<td>64769 (100%)</td>
<td>3.53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ARIA</th>
<th>N</th>
<th>Rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA††</td>
<td>40712 (63%)</td>
<td>2.69</td>
</tr>
<tr>
<td>A</td>
<td>11480 (17.8%)</td>
<td>9.78</td>
</tr>
<tr>
<td>MA</td>
<td>6766 (10.5%)</td>
<td>8.45</td>
</tr>
<tr>
<td>R</td>
<td>2676 (4.1%)</td>
<td>10.09</td>
</tr>
<tr>
<td>VR</td>
<td>2956 (4.6%)</td>
<td>2.93</td>
</tr>
<tr>
<td>Total</td>
<td>64592 (100%)</td>
<td>3.53</td>
</tr>
</tbody>
</table>

†Q1 = Most disadvantaged, Q5 = Least disadvantaged.
‡‡HA = Highly Accessible, Accessible, MA = Moderately Accessible, R = Remote, VR = Very Remote.

Trend analysis

There was a steady increase in the total numbers and rates of admissions over the 10-year period (Table 1, Fig. 1). Trend analysis overall indicated a rate ratio (RR) of 1.037, with a confidence interval (CI) of 1.034 to 1.039. The average annual change (3.7%) showed a significant (p < 0.0001) increase in rate. The average yearly increase for the Aboriginal population rates was also significant (p < 0.0001), and positive (7.02%), with a RR of 1.07 (1.056–1.084 CI), and was higher than for the non-Aboriginal population (3.60% annual increase, p < 0.0001, and RR of 1.036, 1.033–1.039 CI) (Fig. 2).

For each age group, with the exception of those aged 15–29 years, trend analysis indicated significant (p < 0.0001) annual percentage changes in rates: 0–14 years (3.61%), 15–29 years (1.71%), 45–59 years (4.97%), 60–74 years (8.74%) and 75+ years (8.23%). The annual percentage change in rates over 10 years for those between 15 and 29 years was not significant (p = 0.644), and was –0.37% (Fig. 1).
Mix of conditions

Most admissions were for dental caries (53%) and this was the case for both Aboriginal (47%) and non-Aboriginal populations (53%) (Table 2). For the Aboriginal population, dental caries and pulp and periapical conditions (35%) combined contributed to 82% of all avoidable hospitalizations. For the non-Aboriginal population, three conditions contributed to 85% of all admissions: these were caries (53%); other disorders of teeth and supporting structures (18%); and pulp and periapical tissue conditions (14%) (Table 2).

There were also different mixes of conditions between the different age groups (Table 3). Those under the age of 14 were mostly hospitalized for dental caries (77%) and pulp and periapical conditions (16.5%), resulting in 93% of all admissions in this age group. Less caries and more admissions related to other disorders of teeth and supporting structures were prevalent in older age groups, with almost 70% of all admissions for those aged over 75 being for two conditions: caries (43%) and other disorders of the teeth and supporting structures (26%) (Table 3).

Costs and bed days

Over a period of 10 years the total DRG costs for all avoidable hospitalizations related to oral health were approximately $157 million. The average DRG costs per admission was $2418 (SD 2430) (Table 1). Direct costs increased from an average of $1655 per person to $3150 per person in 2008–2009. Total bed days attributed to avoidable oral health hospitalizations over 10 years was 74,773, and this represented an average of 1.15 days (SD 1.12) per person (Table 1).

Most people admitted (58%) had private health insurance, but only 4% of Aboriginal people had insurance, compared to 61% of non-Aboriginal people. Only 5% of Aboriginal people were admitted to private hospitals, compared to 70% of non-Aboriginal people.
DISCUSSION

Our study of potentially avoidable hospitalizations for oral health related conditions over a decade indicated that population rates of hospitalization increased significantly over the period, for both Aboriginal and non-Aboriginal population groups. Children under 14 were more likely to be admitted. The most common condition that required hospitalization was dental caries, and the highest rates of hospitalization were for those from the most socio-economically disadvantaged areas.

A hospitalization rate for potentially preventable dental conditions in WA of 3.7 per 1000 people for the year 2010–2011 has been reported, and this indicates that rates are still increasing, as the rate we found in the last year of our study (2008–2009) was 3.68 per 1000 people. In the 2013 report the rate in WA was higher than in any other state or territory in Australia. Our findings also indicate higher rates than those found in New Zealand (2.15 per 1000 population in 2005–2009). Although there was an over-representation in the proportion of Aboriginal people in our study (4.4% of all admissions), and an overall higher rate among Aboriginal people, there was not a significant difference in rates between Aboriginal (3.34 per 1000) and non-Aboriginal people (3.26 per 1000). However, over the 10-year period trend analysis indicated an annual percentage rate change in the Aboriginal population that was almost twice as high as that of the non-Aboriginal population. It is well known that the oral health of Aboriginal people is poorer than that of the non-Aboriginal population, and previous studies indicate differences in rates of all oral health related hospitalizations, with significantly higher rates for Aboriginal people for various oral conditions. The socio-economic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health risk factors. Access issues due to rural and remote living, affordability of health insurance and other social issues contribute to the stark inequalities in health between Aboriginal and non-Aboriginal people.

Most of the admissions (44%) were for children under the age of 14, and the child admissions were mostly for dental caries and pulp and periapical conditions. Despite a significant reduction in dental caries in the last decades, it remains Australia’s most prevalent oral health problem. Advances and improvement in oral health have been experienced disproportionately by those with higher socio-economic status, and there has been increased polarization of dental caries within the community. Dental caries remain one of the leading causes of hospitalization among children in WA.

The same applies to pulp and periapical conditions, with high rates of child hospitalization identified previously. Admission for pulp and periapical conditions could result from infections in the tooth, most often caused by untreated dental caries, and the reasons for caries being untreated could include lack of access to services. Previous studies found significant

---

Table 2. Mix of conditions, all avoidable oral health related hospitalizations over 10 years in Western Australia, by Aboriginal status.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Non-Aboriginal</th>
<th>Aboriginal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>% C%*</td>
<td>% C%*</td>
<td>% C%*</td>
<td></td>
</tr>
<tr>
<td>Dental caries</td>
<td>53.3</td>
<td>46.8</td>
<td>53</td>
</tr>
<tr>
<td>Other disease of hard tissue of teeth</td>
<td>1.2</td>
<td>0.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Pulp and periapical tissue</td>
<td>13.4</td>
<td>34.9</td>
<td>14.3</td>
</tr>
<tr>
<td>Gingivitis and periodontal disease</td>
<td>5.2</td>
<td>4.4</td>
<td>5.1</td>
</tr>
<tr>
<td>Other gingival and edentulous alveolar ridge</td>
<td>0.6</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Other disorders teeth and supporting structures</td>
<td>18.8</td>
<td>2.7</td>
<td>18.1</td>
</tr>
<tr>
<td>Cysts of oral region</td>
<td>1.9</td>
<td>0.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Stomatitis and related lesions</td>
<td>2.0</td>
<td>7.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Other diseases lip and oral mucosa</td>
<td>3.6</td>
<td>2.7</td>
<td>3.6</td>
</tr>
</tbody>
</table>

C%* = cumulative percentage.

Table 3. Mix of conditions, all avoidable oral health related hospitalizations, over 10 years in WA, percentages per age group

<table>
<thead>
<tr>
<th>Condition</th>
<th>0-14</th>
<th>15-29</th>
<th>30-44</th>
<th>45-59</th>
<th>60-74</th>
<th>75+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caries</td>
<td>77</td>
<td>34.1</td>
<td>37.9</td>
<td>31.3</td>
<td>29.2</td>
<td>43.1</td>
</tr>
<tr>
<td>Hard Tissue</td>
<td>1</td>
<td>1.8</td>
<td>1.3</td>
<td>1.1</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Pulp and periapical</td>
<td>16.5</td>
<td>16.2</td>
<td>16.3</td>
<td>10</td>
<td>8.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Gingivitis and Perio</td>
<td>0.5</td>
<td>13.8</td>
<td>10.2</td>
<td>8</td>
<td>4.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Support systems</td>
<td>1.6</td>
<td>20.2</td>
<td>24.2</td>
<td>38.7</td>
<td>41</td>
<td>26.1</td>
</tr>
<tr>
<td>Cysts</td>
<td>0.8</td>
<td>3.1</td>
<td>2.5</td>
<td>2.8</td>
<td>3.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Stomatitis</td>
<td>0.9</td>
<td>4.1</td>
<td>2.9</td>
<td>2.3</td>
<td>3.3</td>
<td>6.8</td>
</tr>
<tr>
<td>Lip and mucosa</td>
<td>1.5</td>
<td>6</td>
<td>4.1</td>
<td>4.7</td>
<td>7.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Total Percentage</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
differences in the admissions of Aboriginal compared to non-Aboriginal children for pulp and periapical conditions, with significantly higher rates in Aboriginal preschool children.

In older age groups substantial numbers were hospitalized for conditions such as caries, pulp and periapical conditions, stomatitis and other disorders of the teeth and supporting structures. Caries remained the main reason for admission, even in the oldest age groups. This is a strong indicator of the retention of teeth into old age, and the related dental health maintenance issues. Dental caries is a multifactorial disease, with many risk factors associated with age. A recent review indicated that dental caries is not only known to be active in older age groups, but continues to be the most prevalent oral health condition in older people. Analysis of 10-year trends also indicated the highest rate increases over time were experienced by the age groups older than 60 years.

The results of our study emphasize the economic burden of avoidable dental hospitalizations. Over the 10-year period, overall direct costs alone amounted to well over $157 million, in a state with a total population of just more than 2 million people (in 2006). Direct costs, as calculated by DRG cost per person, increased from an average of $1655 to $3150 in 2008–2009. We estimate that these direct costs (DRG) are very conservative estimations, and in reality, the true costs could amount to double the estimated cost at the patient level (inclusive of health insurance refund). Additionally, indirect costs (e.g. travel, time off work, support parent/guardian time) are not included in our estimates either, but others have estimated in small countries with minimal travel this can be nearly double the direct costs. As such, our cost calculations are considered very conservative estimations.

It has been stated that potentially preventable hospitalizations are avoidable if timely (early diagnosis and prevention) and adequate treatment in primary care is provided. Hospitalization rates of potentially preventable dental conditions thus provide an indicator of the potential inadequacy of dental care in the community. It is important to understand the association between primary health care and avoidable hospitalizations. Previous studies identified that this relationship is not a linear one, but a U-shaped relationship, with too little primary health care leading to an excess of hospitalization, and too much also leading to an increase in hospitalizations. It has not previously been established if this relationship also applies to dental conditions, but it is strongly supported by our findings. There were high rates of hospitalization among poorer, rural, and Aboriginal groups (those with limited access to primary oral health care), but there were also high rates of hospitalization among higher socio-economic, non-Aboriginal and urban dwelling groups (with good access to primary health care). Our findings did not indicate hospitalizations clearly divided along social lines. However, there were differences in the mix of conditions, with more disadvantaged groups more likely to be admitted for pulpitis and periapical disease (possible result of untreated caries), and least disadvantaged groups more likely to be admitted for caries (diagnosed in primary care and referred for treatment under general anaesthesia).

Previous studies support the argument that improved access to primary health care may prevent hospitalizations, improve health outcomes and lower health care costs. The factors determining access to primary dental care in Australia are multifactorial and complex. It is dependent on factors including socio-economic status, geographical location, age, and health insurance status, among others. Public dental services in Australia are currently not in a position to provide services to all those who need or demand it. Only about 5% of eligible concession card holders receive primary dental care from the public health sector. Whilst the private sector operates based on economic drivers (fee-for-service payments), the public sector is relying on available (and scarce) resources to provide care. The oral health care system has traditionally operated in isolation, and there is a need to integrate it with the general health system and its more equitable access to preventive and treatment services.

CONCLUSIONS

An analysis of potentially avoidable hospitalizations for oral health related conditions over 10 years indicated rates increasing over time, high rates in children under 14 years, most hospitalizations were for dental caries, and hospitalizations among Aboriginal people increasing at a rate almost twice that of non-Aboriginal people. These hospitalizations remain a considerable and increasing financial burden on health budgets. An increase in efforts is necessary to curb escalating government health expenditure by reducing avoidable and preventable oral health related hospitalizations, and focusing efforts on an improved, accessible and equitable primary oral health care system.

REFERENCES


Address for correspondence: Associate Professor Estie Kruger
International Research Collaborative – Oral Health and Equity
Faculty of Sciences
The University of Western Australia
35 Stirling Highway
Nedlands WA 6009
Email: estie.kruger@uwa.edu.au
Ten years of hospitalisation for oral health-related conditions in Western Australia: an unjust dichotomy

Estie Kruger\textsuperscript{A,B} and Marc Tennant\textsuperscript{A}

\textsuperscript{A}International Research Collaborative – Oral Health and Equity, School of Anatomy, Physiology and Human Biology, Faculty of Sciences, The University of Western Australia, 35 Stirling Highway, Nedlands, WA 6009, Australia.
\textsuperscript{B}Corresponding author. Email: estie.kruger@uwa.edu.au

Abstract. The objective of this study was: (1) to examine the demographics of in-patient oral health care by Aboriginal status; (2) to identify the mix of oral conditions by Aboriginal status; and (3) to describe trends over a 10-year period, comparing Aboriginal and non-Aboriginal groups. Hospitalisation data were obtained from the Western Australian Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), was obtained for every episode for adult patients who were discharged from all hospitals in Western Australia (WA) for the financial years 1999–2000 to 2008–09. Results indicated that more than 130 000 persons were admitted to hospitals in WA over 10 years, for oral health-related conditions, at a direct cost of more than $400 million. Most of those admitted were younger than 30 years, and 2.8% of all those admitted were Aboriginal people. Aboriginal people were admitted at significantly higher rates, for a very different mix of conditions, they were mostly from younger age groups, were mostly from very remote and the most disadvantaged areas and were almost all uninsured, compared with non-Aboriginal people. Hospital admissions for oral health-related conditions, as well as the mix of conditions that drive these hospitalisations, are strongly divided across social, racial and geographic variables, and remain a burden to the health-care system.

Additional keywords: Aboriginal, dental, rural and remote.

Received 31 May 2014, accepted 27 November 2014, published online 14 January 2015

Introduction

Oral health is an integral part of general health, and the impact of oral disease on wellbeing and quality of life has previously been highlighted (Sanders \textit{et al.} 2009). Over the past two decades, significant improvements in the overall oral health of adults in Australia have occurred, mostly because of decreased levels of dental caries and lower levels of tooth loss (Slade \textit{et al.} 2007). However, oral health-related diseases and the treatment of these conditions remain costly, and there still is a considerable burden of oral health-related hospital admissions of adults in Western Australia (WA) (Kruger \textit{et al.} 2006; Smith \textit{et al.} 2006; George \textit{et al.} 2011, 2012; Anjrini \textit{et al.} 2014a).

Oral disease is unequally distributed across the Australian population, with heavier burdens of disease being experienced by certain population groups, including the elderly, Aboriginal Australians, rural and remote residents and those from lower socioeconomic backgrounds (Slade \textit{et al.} 2007; Anjrini \textit{et al.} 2014b). While this situation is by no means unique to Australia, the health inequality between Aboriginal and non-Aboriginal groups is more pronounced compared with some other developed countries (Australian Indigenous HealthInfoNet 2013).

Improving the health status of Aboriginal people remains a challenge for Governments in Australia, with the inequality gap between Aboriginal and non-Aboriginal people remaining to such an extent that the life expectancy of Aboriginal people remains far below that of non-Aboriginal people (Australian Bureau of Statistics 2013a). In 2010, life expectancy for Aboriginal men was estimated to be 11.5 years less than that of non-Indigenous men, and for Aboriginal women, the 2010 figures show a difference of 9.7 years (Australian Bureau of Statistics 2013a). The poor health of Aboriginal communities can be likened to the problems of the developing world, and among many factors contributing to this situation, is the lack of equal access to primary health care and health infrastructure.

Previous work examined oral health-related hospitalisations for adults over a 4-year period (Smith \textit{et al.} 2006), and this study follows our earlier research to analyse the oral health-related hospitalisation of adults (over the age of 18 years) over a decade, from 1999–2000 to 2008–09. The longer time period of this follow-up study allows for the analysis of more variables by Aboriginal status. The aims of this descriptive study were threefold: (1) to examine the demographics of in-patient oral health care by Aboriginal status; (2) to identify the mix of oral conditions by Aboriginal status; and (3) to describe trends over a 10-year period, comparing Aboriginal and non-Aboriginal groups.
What is known about the topic?

- Aboriginal people suffer from poorer oral health than non-Aboriginal people and have limited access to primary oral health-care services. Hospitalisation for oral health-related conditions are costly.

What does this paper add?

- Hospital admissions for oral health-related conditions in Western Australia are strongly divided across social, racial and geographical variables.

Materials and methods

Ethics

Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia.

Study population

The adult population in WA (all 18 years and older) was 1,059,750 in 1999, 1,094,197 in 2001 and 1,221,799 in 2006. In 2006, 3.4% of the WA population were of Aboriginal or Torres Strait Islander descent (2.6% of all adults), and in WA, 34% of the Aboriginal population and 80% of the non-Aboriginal population lived in metropolitan Perth (Australian Bureau of Statistics 2013a). Almost half (45%) of Aboriginal adults in WA lived in ‘Remote’ or ‘Very Remote’ areas (Australian Bureau of Statistics 2013a).

Hospitalisation data

Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM) (Australian Consortium for Classification Development 2014), was obtained for every episode of discharge from all hospitals in WA for the financial years 1999–2000 to 2008–09. The ICD-10AM is the standard classification scheme used for reporting diagnoses in all hospital statistical collections (Australian Consortium for Classification Development 2014). In this study, episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral health-related condition.

Aboriginal status, population rates and cost

Self-reported Aboriginality was used to compare Aboriginal to non-Aboriginal populations. Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from Census data collected by the Australian Bureau of Statistics (ABS). Estimated cost of care was determined for each episode using the national standard diagnostic related group average price. The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost (Australian Institute of Health and Welfare 2013).

Place of residency

Primary place of residency at the time of hospitalisation and the geographical classification was determined according to the Accessibility and Remoteness Index of Australia (ARIA). ARIA provides an unambiguously geographical approach to defining remoteness. ARIA calculates remoteness as accessibility to service centres based on road distances, and is grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote (Commonwealth Department of Health and Aged Care 2001).

Socioeconomic index of disadvantage

The population Census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender and ethnicity of all Australians. The ABS has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA), which give a summary measure of socioeconomic status for people living in specific geographic regions in Australia. Each geographic area is given a score, then ranked against all other areas in Australia and the rankings are grouped into five equal size bands (quintiles). Quintile 1 contains the 20% most disadvantaged areas, and quintile 5 contains the 20% least disadvantaged areas (Australian Bureau of Statistics 2013b).

Statistical analysis

All rates were calculated using the Rates calculator, a software package developed by the Western Australian Department of Health, Perth, Australia. All rates were calculated per 100,000 persons. As this was a total population study, and not a sample, any difference in rates indicated a true difference. Means between groups were compared using ANOVA. Both Poisson regression and Chi-square tests were used to determine if trends were significant for age-standardised rates over time. All statistical analyses were undertaken using IBM SPSS Statistics 19 (IBM, New York, NY, USA).

Results

Demographics

Over a 10-year period (from 1999–2000 to 2008–09), a total of 131,509 hospital admissions in Western Australia were attributed to oral health-related conditions among adults (above the age of 18 years). Of the total number, approximately half (48%) were males and 2.8% were patients of Aboriginal descent (Table 1). Overall, most patients were from areas classified as ‘Accessible’. There was a significant difference in the distribution of Aboriginal and Non-Aboriginal patients by geographic area, with the highest rates of Aboriginal patients from ‘Very Remote’ areas, and the highest rates for non-Aboriginal patients from ‘Accessible’ areas (Table 1). Across all age groups, most people came from ‘Accessible’ areas.

Age-standardised population rates

Rates of admission were significantly higher for Aboriginal than non-Aboriginal groups over the 10-year period ($P < 0.05$). The differences in rates between the two groups in most years were not significant however, and the overall rate in Aboriginal people might be higher because of the very high admission rate in one year (2007–08). The reason for the high admission rate in 2007–08 is unknown. Rates were the highest for the age group 18–29 years, for both groups. In the non-Aboriginal population,
Hospitalisation for oral health-related conditions

Table 1. Hospital admissions for oral health-related conditions among adults in Western Australia over a 10-year period

<table>
<thead>
<tr>
<th>Year</th>
<th>Aboriginal n (%)</th>
<th>Non-Aboriginal n (%)</th>
<th>All n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999–2000</td>
<td>281 (8)</td>
<td>9380 (7)</td>
<td>9661 (7)</td>
</tr>
<tr>
<td>2000–01</td>
<td>310 (8)</td>
<td>10105 (8)</td>
<td>10415 (8)</td>
</tr>
<tr>
<td>2001–02</td>
<td>294 (8)</td>
<td>11399 (9)</td>
<td>11693 (9)</td>
</tr>
<tr>
<td>2002–03</td>
<td>353 (10)</td>
<td>12247 (9)</td>
<td>12600 (9)</td>
</tr>
<tr>
<td>2003–04</td>
<td>357 (10)</td>
<td>12567 (10)</td>
<td>12924 (10)</td>
</tr>
<tr>
<td>2004–05</td>
<td>352 (10)</td>
<td>12922 (10)</td>
<td>13274 (10)</td>
</tr>
<tr>
<td>2005–06</td>
<td>402 (11)</td>
<td>13669 (11)</td>
<td>14071 (11)</td>
</tr>
<tr>
<td>2006–07</td>
<td>389 (11)</td>
<td>14229 (11)</td>
<td>14618 (11)</td>
</tr>
<tr>
<td>2007–08</td>
<td>485 (13)</td>
<td>14689 (12)</td>
<td>15274 (12)</td>
</tr>
<tr>
<td>2008–09</td>
<td>429 (12)</td>
<td>16550 (13)</td>
<td>16979 (13)</td>
</tr>
</tbody>
</table>

Costs, insurance status and length of stay

Over the 10-year period, all hospital admissions amounted to 199,214 bed days, with a mean number of bed days per episode being 1.51 (s.d. 3.09; Table 1). Average length of stay was significantly longer for Aboriginal than for non-Aboriginal patients (2.96 and 1.47 days respectively; ANOVA, P < 0.05; Table 1).

Overall, 63.3% of patients had private medical insurance, with 65% of all non-Aboriginal patients and only 2.8% of Aboriginal patients insured. The total DRG cost for in-patient oral health care over this period was in excess of $400 million ($414,626,067), with a significantly different average cost (ANOVA, P < 0.05) between Aboriginal ($5181) and non-Aboriginal ($3094) patients (Table 1). Over time, cost increased from an average of $2357 per episode in 1999–2000 to $3816 per episode in 2008–09 (Table 1).

Rates were lowest for 70+ year olds, and in the Aboriginal population, it was lowest for 50–69 year olds (Table 1). Admission rates between Aboriginal and non-Aboriginal patients were significantly different (P < 0.05) for age groups 18–29, 30–49 and 70+ years.

Rates of hospitalisation for oral health-related conditions CI, confidence interval; A, accessible; HA, highly accessible; MA, moderately accessible; RT, remote; SEIFA1, most disadvantaged; SEIFA5, least disadvantaged; VR, very remote; DRG, diagnostic related group; s.d., standard deviation. *Means differ significantly, ANOVA, P < 0.05

<table>
<thead>
<tr>
<th>Year</th>
<th>Aboriginal Rate (95% CI)</th>
<th>Non-Aboriginal Rate (95% CI)</th>
<th>All Rate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999–2000</td>
<td>6.97 (6.06–7.89)</td>
<td>8.84 (6.70–9.68)</td>
<td>963 (6.70–9.67)</td>
</tr>
<tr>
<td>2000–01</td>
<td>7.46 (6.54–8.38)</td>
<td>7.34 (7.20–7.49)</td>
<td>7.34 (7.20–7.48)</td>
</tr>
<tr>
<td>2001–02</td>
<td>7.50 (6.40–8.60)</td>
<td>8.22 (8.06–8.37)</td>
<td>8.17 (8.02–8.32)</td>
</tr>
<tr>
<td>2002–03</td>
<td>8.31 (7.32–9.31)</td>
<td>8.75 (8.60–8.91)</td>
<td>8.72 (8.57–8.88)</td>
</tr>
<tr>
<td>2003–04</td>
<td>8.86 (7.79–9.93)</td>
<td>8.87 (8.71–9.02)</td>
<td>8.83 (8.68–9.09)</td>
</tr>
<tr>
<td>2004–05</td>
<td>7.79 (6.88–8.69)</td>
<td>8.97 (8.81–9.12)</td>
<td>9.03 (8.77–9.08)</td>
</tr>
<tr>
<td>Total</td>
<td>9.20 (8.84–9.55)</td>
<td>8.81 (8.76–8.89)</td>
<td>8.79 (8.74–8.84)</td>
</tr>
</tbody>
</table>

Survival analysis

Survival analysis showed that Aboriginal patients had a significantly lower survival rate compared to non-Aboriginal patients (log-rank test, P < 0.05; Table 2).

Cost

Average DRG cost*: $5181 (s.d. 10463) $3094 (s.d. 6236) $3152 (s.d. 6400)

Bed days

Average bed days*: 2.96 days (s.d. 0.93) 1.47 days (s.d. 3.01) 1.51 (s.d. 3.09)

aRates per 1000 population.
Mix of conditions by Aboriginality

Overall, the major conditions people were hospitalised for included ‘Embedded and impacted teeth’ and ‘Dental caries’. These two conditions alone contributed to 58% of all admissions over 10 years (Table 2).

The mix of conditions between Aboriginal and non-Aboriginal patients was very different, with most Aboriginal patients admitted for trauma including ‘Jaw fractures’ (43.6%) and ‘Fractures of the teeth, nasal bone, palate, lower facial bones’ (12.2%). These two categories alone contributed to more than half all admissions among Aboriginal people (55.8%). ‘Pulp and periapical conditions’ contributed a further 11.8%, followed by ‘Malignant neoplasms’ (7.2%) and ‘Dental Caries’ (4.1%) (Table 2).

Most admissions (50.2%) for non-Aboriginal people were for ‘Embedded and Impacted teeth’, with a further 9.2% for ‘Dental caries’, followed by ‘Other disorders of teeth and supporting structures’ (8.7%), ‘Fractures of teeth, nasal bone, palate, lower facial bones’ (4.1%), and ‘Malignant Neoplasms’ (3.9%) (Table 2).

Trends over time

There was a steady increase in the total numbers and rates of admissions over the 10-year period (Table 1). Trend analysis overall (both groups) indicated a rate ratio of 1.029, with a confidence interval (CI) of 1.027 to 1.031. The average annual change (2.94%) showed a significant ($P<0.0001$) increase in rate. The average yearly increase for the non-Aboriginal population was also significant ($P<0.0001$) and positive (3.83%), with a rate ratio of 1.038 (1.036–1.04 CI). The average annual change in rate in the Aboriginal population was 3.82%; this was also significant ($P=0.0003$) and the rate ratio was 1.038 (1.027–1.046 CI). There was little change in the mix of conditions over a 10-year period, with the same major conditions remaining steady over the study period. The mix of patients by Aboriginal status remained relatively stable across the study period.

Discussion

This study found that more than 130 000 persons were admitted to hospitals in WA over 10 years, for oral health-related conditions, at a direct cost of more than $400 million. Most of those admitted

Table 2. Conditions leading to oral health-related hospital admissions among Western Australian adults, over 10 years, by Aboriginal status

<table>
<thead>
<tr>
<th>Condition</th>
<th>n</th>
<th>Per cent</th>
<th>Cumulative per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aboriginal patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaw fractures</td>
<td>1591</td>
<td>43.6</td>
<td>43.6</td>
</tr>
<tr>
<td>Fractures of the teeth, nasal bone, palate, lower facial bones</td>
<td>447</td>
<td>12.2</td>
<td>55.8</td>
</tr>
<tr>
<td>Diseases of the pulp and periapical tissues</td>
<td>432</td>
<td>11.8</td>
<td>67.6</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>263</td>
<td>7.2</td>
<td>74.8</td>
</tr>
<tr>
<td>Dental caries</td>
<td>149</td>
<td>4.1</td>
<td>78.9</td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>126</td>
<td>3.5</td>
<td>82.4</td>
</tr>
<tr>
<td>Gingivitis and periodontal diseases</td>
<td>102</td>
<td>2.8</td>
<td>85.2</td>
</tr>
<tr>
<td>Others</td>
<td>542</td>
<td>14.8</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>3652</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Non-Aboriginal patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>64201</td>
<td>50.2</td>
<td>50.2</td>
</tr>
<tr>
<td>Dental caries</td>
<td>11716</td>
<td>9.2</td>
<td>59.4</td>
</tr>
<tr>
<td>Other disorders of teeth and supporting structures</td>
<td>11071</td>
<td>8.7</td>
<td>68.0</td>
</tr>
<tr>
<td>Fractures of the teeth, nasal bone, palate, lower facial bones</td>
<td>5247</td>
<td>4.1</td>
<td>72.1</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>4928</td>
<td>3.9</td>
<td>76.0</td>
</tr>
<tr>
<td>Jaw fractures</td>
<td>4852</td>
<td>3.8</td>
<td>79.8</td>
</tr>
<tr>
<td>Other diseases of the jaws</td>
<td>4082</td>
<td>3.1</td>
<td>82.9</td>
</tr>
<tr>
<td>Others</td>
<td>21760</td>
<td>17.0</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>127857</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>All patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embedded and impacted teeth</td>
<td>64327</td>
<td>48.9</td>
<td>48.9</td>
</tr>
<tr>
<td>Dental caries</td>
<td>11865</td>
<td>9.0</td>
<td>57.9</td>
</tr>
<tr>
<td>Other disorders of teeth and supporting structures</td>
<td>11136</td>
<td>8.5</td>
<td>66.4</td>
</tr>
<tr>
<td>Jaw fractures (maxillary and mandibular)</td>
<td>6443</td>
<td>4.9</td>
<td>71.3</td>
</tr>
<tr>
<td>Fractures of teeth, nasal bone, palate, lower facial bones</td>
<td>5694</td>
<td>4.3</td>
<td>75.6</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>5191</td>
<td>3.9</td>
<td>79.5</td>
</tr>
<tr>
<td>Diseases of pulp and periapical tissues</td>
<td>4431</td>
<td>3.4</td>
<td>82.9</td>
</tr>
<tr>
<td>Other diseases of jaws</td>
<td>4156</td>
<td>3.2</td>
<td>86.1</td>
</tr>
<tr>
<td>Dentofacial anomalies, including malocclusion</td>
<td>3439</td>
<td>2.6</td>
<td>88.7</td>
</tr>
<tr>
<td>Gingivitis and periodontal diseases</td>
<td>3080</td>
<td>2.3</td>
<td>91.1</td>
</tr>
<tr>
<td>Others</td>
<td>11747</td>
<td>8.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>131509</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
were younger than 30 years, and 2.8% of all admitted were Aboriginal people. This indicated a slight under-representation of Aboriginal people, as the resident Aboriginal population of WA during the 2006 Census constituted 3.8% of the total WA population (Australian Bureau of Statistics 2006). When weighted by age, however (and this study was only done among adults), Aboriginal rates were significantly higher.

Census data revealed very stark demographic differences between Aboriginal and non-Aboriginal Western Australians (Australian Indigenous HealthInfoNet 2013), and it has also been confirmed that Aboriginal people have poorer oral health than non-Aboriginal people (Slade et al. 2007; Kruger et al. 2008; Williams et al. 2011; Anjrini et al. 2014b). This was underlined by the findings of this study. Aboriginal people were admitted at higher rates, for a very different mix of conditions, mostly from younger age groups, mostly from very remote areas, and were almost all uninsured, compared with non-Aboriginal people.

The much higher hospitalisation rate in the 70+ age group of Aboriginal people might be a strong indicator of the difference in population (and especially age) demographics between the two populations, as the lower life expectancy of Aboriginal people sees fewer people reach the age of 70 years (Australian Consortium for Classification Development 2014).

For age, the highest rates of admission were seen in non-Aboriginal 18-29 year-olds; this was much higher than for Aboriginal young adults. This was due to the conditions they presented with, with very high rates of embedded and impacted teeth removal among non-Aboriginal young adults (George et al. 2011, 2012; Anjrini et al. 2014a, 2014b). The majority of Aboriginal people were admitted for trauma and injury-related conditions (55%), which might explain the very high hospitalisation rate of Aboriginal males compared with non-Aboriginal males. Previous studies highlighted the significant differences in jaw fracture rates in WA, with rates almost 10-fold higher in Aboriginal compared with non-Aboriginal people, and almost eightfold higher for Aboriginal compared with non-Aboriginal males (Kruger et al. 2006, 2010). Higher male trauma rates might also explain the significantly lower rate of admissions seen in Aboriginal females compared with non-Aboriginal females. Although Aboriginal people were mainly admitted for trauma, admissions were dominated by Aboriginal males (Kruger et al. 2006; Anjrini et al. 2014b), and the admissions for embedded and impacted teeth removal in non-Aboriginal people were mostly among females (George et al. 2011, 2012). Previous work in rural Australian communities indicated the aetiology for fractures to include interpersonal violence, and most often were associated with alcohol abuse (Thomas and Jameson 2007; Cabalag et al. 2014; Jayaraj et al. 2012). It is well known that the socioeconomic disadvantage experienced by Aboriginal people places them at greater risk of exposure to behavioural and environmental health risk factors (Australian Bureau of Statistics 2005). This situation emphasises the major social problems experienced by Aboriginal communities, and especially those from rural and remote areas.

The contrast is further emphasised when considering that the majority of non-Aboriginal patients were admitted for the removal of embedded and impacted teeth, and most were from Accessible areas. Previous work highlighted the very high number of admissions for this procedure, and also indicated that it is significantly higher than in similar overseas countries (George et al. 2011, 2012; Anjrini et al. 2014a). Debate exists regarding the need for evidence-based guidelines to lower the numbers of hospitalisations for third molar removals (Anjrini et al. 2014a). The lower percentages of Aboriginal people who presented for the removal of impacted or embedded teeth might be related to lower access to services, especially in rural and remote areas, as well as socioeconomic factors and lower rates of private health insurance (George et al. 2011).

The majority of Aboriginal patients (60%) were from areas classified as ‘Remote’ or ‘Very Remote’, which suggest an over-representation of Aboriginal adults from these areas, which not only means large travel distances and travel times to health services, but also requires possible longer stays in hospital for follow-up treatment. This might have contributed to the longer average stay in hospital, and overall higher average direct cost for Aboriginal compared with non-Aboriginal patients. The higher costs for Aboriginal people might also be related to the different conditions they presented for, with trauma-related injuries costly to treat. The same applies to conditions such as malignant neoplasms, where treatment incurs significant costs to health services and patients. Although it could not be calculated in this study, indirect costs would most probably contribute more to overall costs for those who have to travel far to obtain care, compared with those in accessible areas. Overall direct costs increased over time, and although costs per DRG were increasing due to inflation, the population-based rates of people admitted also increased, resulting in increasing absolute costs well in excess of inflation.

Over a period of 10 years, inequalities remained stable with no signs of improvement or a decrease in hospitalisation rates. Hospitalisation rates over the time period were, in fact, increasing. The socioeconomic disadvantage experienced by Aboriginal patients was further highlighted by the significant difference in health insurance status. The affordability of private health insurance premiums put private health insurance beyond the reach of most socioeconomically disadvantaged groups. In 2004-05, 15% of Indigenous Australians in non-remote areas had private health insurance, compared with 51% for non-Indigenous Australians (Australian Health Minister’s Advisory Council 2012). The majority of those without private health insurance (65%) cited cost as the main barrier (Australian Health Minister’s Advisory Council 2012). Reduced access to private health insurance limits people’s ability to access services involving out-of-pocket expenses, such as specialists, dentists and allied health services. As many of the hospitalisations were due to preventable conditions, it can be assumed that better access to dental care (especially the private sector) might prevent some oral conditions from developing to a point where hospitalisation is necessary.

Conclusions

For both population health and cost reasons, analysis of admissions to hospitals and the conditions that drive these hospitalisations, are becoming more essential. This study clearly indicated that the mix of conditions leading to hospital admissions was very different between Aboriginal and non-Aboriginal people. Furthermore, hospital admissions due to oral health-related conditions in Western Australia were strongly...
divided across social, racial and geographical variables. This study identified the major differences between the Aboriginal and non-Aboriginal populations in Western Australia in relation to hospitalisation for oral health-related conditions, and also indicated that over a period of 10 years, the inequalities remained and no improvements seemed to occur. Serious and effective measures are needed to, wherever possible, reduce the need for admissions to hospitals, especially when preventable diseases and risk behaviour contribute to outcomes, as is the case for many oral health-related conditions. The underlying complex social factors and social determinants leading to poor oral health among Aboriginal people is common to those causing hospitalisation for other general health conditions and diseases (other than just oral health related). As such, this remains a challenge that requires multi-sectoral approaches to find solutions.

Conflicts of interest
None declared.

References

www.publish.csiro.au/journals/py
Appendix F
Fractures of the mandible and maxilla: A 10-year analysis
Estie Kruger and Marc Tennant
International Research Collaborative – Oral Health and Equity, Department of Anatomy, Physiology and Human Biology, The University of Western Australia, Nedlands, WA, Australia

RESEARCH

Please cite this paper as: Kruger E, Tennant M. Fractures of the mandible and maxilla: A 10-year analysis. AMJ 2016;9(1): 17–24. http://dx.doi.org/10.4066/AMJ.2015.2570

Corresponding Author:
Prof Estie Kruger
The University of Western Australia
35 Stirling Highway
Nedlands WA 6009
Email: estie.kruger@uwa.edu.au

ABSTRACT

Background
Previous analysis of jaw fracture hospitalisations in Western Australia (WA) indicated disproportionately high rates of hospitalisations for Aboriginal people. This study was to follow-up on the earlier analysis to determine if inequalities in terms of jaw fracture hospitalisation rates between Aboriginal and non-Aboriginal people have changed.

Aims
This study, done over a 10-year period from 1999/2000 to 2008/2009, aimed to determine rates of hospitalisations for jaw fractures in WA, trends over the 10–year period, and direct costs associated with these hospital admissions.

Methods
Hospitalisation data were obtained from the Western Australian Hospital Morbidity Data System (HMDS). Episodes were selected on the basis of an ICD10-AM code being S02.4 (Fracture of the malar and maxillary bones) and S02.6 (Fracture of the mandible). Self-reported Aboriginality were used to compare Aboriginal to non-Aboriginal populations. Estimated cost of care was determined for each episode using the national standard diagnostic-related group (DRG) average price.

Results
Our findings indicate that inequalities between Aboriginal and non-Aboriginal people in terms of hospital admissions for jaw fractures exist in WA, and continued over a decade-long period. Higher fracture rates occurred amongst males, Aboriginal people, younger adult age-groups, those from low socioeconomic areas, and those from remote and very remote areas. The DRG cost per person for jaw fractures ranged between AUD $842 and $109,002, with a median cost of $4,965.

Conclusion
Hospital admission rates for the treatment of maxillary and mandibular fractures is very strongly divided along racial and socioeconomic lines in WA.

Key Words
Jaw fractures, hospitalisation, epidemiology, Aboriginal population

What this study adds:
1. What is known about this subject?
   Jaw fractures have a significant impact on people and also have associations with societal marginalisation.

2. What new information is offered in this study?
   This research reports the substantial impact that some members of Australian society face from jaw fractures.

3. What are the implications for research, policy, or practice?
   This study’s findings have both wider and narrow implications for policy and practice. Narrowly, it is about where services are provided. Widely, it is about societal advancement.
Background

Maxillofacial injuries are commonly encountered in the practice of emergency medicine, and are often associated with high morbidity resulting from various degrees of physical, functional, and cosmetic consequences. Healthcare costs and the increasing burdens associated with hospitalisations and in-patient care continue to put economic pressure on state governments in Australia. Previous studies reported high numbers of people in Australia being hospitalised for trauma, and especially maxillofacial fractures. The treatment of mandibular and other facial fractures is a financial burden on health systems already under pressure. Treatments are costly and increasing over time, especially because the costs of the use of rigid fixation to treat fractures are high. Facial trauma management and care also involve several specialist groups and subspecialities for pre-operative, operative, and postoperative care. Indirect costs, including time off work, travel and travel time, as well as loss of income, also contribute to overall costs, and above all, place a social and personal burden on those who suffer such injuries.

Several investigators have studied maxillary and mandibular fracture epidemiology. Identified factors that are associated with maxillofacial fracture incidence include age, gender, geographic region, cultural aspects, socioeconomic status, temporal and climatic influence, use of alcohol and drugs, compliance with road traffic legislation, domestic violence, and osteoporosis. Due to different socioeconomic, cultural, and political influences, however, it is not possible to extrapolate such results among different countries, or even communities within the same country. Australian studies, however, and especially those conducted in Aboriginal communities, indicate disproportionately high levels of hospitalisations of Aboriginal people for maxillofacial injuries due to alcohol-related trauma, violence, and assaults.

Previous analysis of jaw fracture hospitalisations in WA over a four-year period indicated disproportionately high rates of hospitalisations for Aboriginal people. Several programmes and strategies have been implemented in WA to address the health issues of Aboriginal people, and this included focusing on drug and alcohol abuse problems in Aboriginal communities. In 2005, the State Government of WA initiated the Strong Spirit Strong Mind: Western Australian Aboriginal Alcohol and Other Drugs Plan (AAOD Plan) 2005–2009. The AAOD Plan encouraged a whole-of-system approach across government and community organisations to ensure that Aboriginal alcohol and other drugs policy, programme, and service responses make best use of available resources and partnership arrangements. It was hoped that these and other initiatives would close the gap between Aboriginal and non-Aboriginal health inequalities.

This study was to follow up on the earlier analysis and determine if inequalities in terms of jaw fracture hospitalisation rates between Aboriginal and non-Aboriginal people have changed. This study was done over a 10-year period from 1999/2000 to 2008/2009; it aimed to determine the rates of hospitalisations for jaw fractures in WA, trends over the 10–year period, and direct costs associated with these hospital admissions.

Method

Ethics

Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia reference number RA/4/1/5502.

Study population

The total population in WA was 1,849,055 in 1999, 1,901,168 in 2001, and 2,059,614 in 2006. In 2006, 3.8 per cent of the WA population was of Aboriginal or Torres Strait Islander descent. About one-third (34 per cent) of Aboriginal people and 80 per cent of the non-Aboriginal people resided in metropolitan Perth.

Hospitalisation data

Hospitalisation data was obtained from the Western Australian Hospital Morbidity Data System (HMDS). The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), was obtained for every episode of discharge from all private and public hospitals in WA for the financial years 1999–2000 to 2008–2009. In this study, episodes were selected on the basis of an ICD10-AM code being S02.4 (Fracture of the malar and maxillary bones) and S02.6 (Fracture of the mandible).

Aboriginal status, population rates, and cost

Self-reported Aboriginality was used to compare Aboriginal to non-Aboriginal populations. Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national standard diagnostic-related group (DRG) average price. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services.
Place of residency
Primary place of residency at the time of hospitalisation and the geographical classification was done according to Accessibility and Remoteness Index of Australia (ARIA). ARIA calculates remoteness as accessibility to service centres based on road distances, and are grouped into five categories: Highly Accessible; Accessible; Moderately Accessible; Remote; and Very Remote.\textsuperscript{18}

Socioeconomic Index of Disadvantage
The population census provides data on the income, housing, education, employment, family structure, disability, transport, age, gender, and ethnicity of people all over Australia. The Australian Bureau of Statistics has combined these in a set of indicators called the Socioeconomic Indexes for Areas (SEIFA) which give a summary measure of socioeconomic status for people living in specific geographic regions in Australia. Each geographic area is given a score, then ranked against all other areas in Australia, and the rankings are grouped into five equal size bands (quintiles). Quintile 1 contains the 20 per cent most disadvantaged areas in Australia, and Quintile 5 contains the 20 per cent least disadvantaged areas in Australia.\textsuperscript{19}

Statistical analysis
All rates were calculated using the Rates Calculator, a software package developed by the Government of Australia Department of Health. All rates were calculated per 1,000 person years. Significant differences between rates were based on non-overlapping 95\% CI (p<0.05). Means between groups were compared using one-way ANOVA. Both Poisson regression and chi-square tests were used to determine if trends were significant for age-standardised rates over time. All statistical analysis was undertaken using IBM SPSS Statistics 19 (IBM: New York, USA).

Results
Over a 10-year period, a total number of 7,183 persons were admitted to a hospital in Western Australia for treatment of a fractured mandible, maxilla, or both. More fractures were of the mandible (64 per cent), compared to the maxilla (36 per cent).

Men were far more likely to be admitted (82 per cent) than women. Admissions were associated with age, with more than half (56 per cent) of all those hospitalised between the ages of 15 and 29 years (Table 1). More than one-quarter (27 per cent) were aged 30–44 years (Table 1).

Cost and bed days
There was a significant difference (p<0.0001) in the mean number of bed days between Aboriginal (2.39 days, sd 2.08), and non-Aboriginal patients (2.09, sd 2.94). Over the 10-year period, Aboriginal patients spent a total of 4,186, and non-Aboriginal patients 11,346 days in hospital, resulting in a total of 15,522 bed days attributed to jaw fractures.

There was a significant difference (p<0.0001) in mean DRG cost per person between Aboriginal and non-Aboriginal patients, with a mean cost of AUD $4,868 (sd 5268) (median $4,445) for Aboriginal, and AUD $6,031 (sd 8446) (median $5,683) for non-Aboriginal patients. The total cost over 10 years totalled AUD $41,283,903. The DRG cost per person for jaw fractures ranged between AUD $842 and AUD $109,002, with a median cost of AUD $4,965.

Rates
Rates over time increased slightly, with rates in the last two years significantly higher (p<0.05) than in the first year. The lowest rate was in 2003/2004, significantly lower (p<0.05) than all other years, except 1999/2000. Trend analysis of rates over the 10-year period indicated a rate ratio of 1.023, with a confidence interval (CI) of 1.015 to 1.031. The average annual change (2.29 per cent) showed a significant (p<0.0001) increase in rate.

Age-adjusted population rate calculations indicated that rates were the highest for 15–44 year olds, and lowest for children between birth and 14 years. Slightly higher rates were experienced by those older than age 75, compared to age groups just below (45–74 years) (Table 1). Rates for men (0.58) were more than four times higher than those for women (0.13) (Table 1). Rates for Aboriginal people were almost 10 times higher than for non-Aboriginal people (Table 1).

Age-adjusted rates differed between Aboriginal and non-Aboriginal people, and between males and females (Figure 1). The rates for male Aboriginal patients (7.07) between 15–29 years were almost double that of Aboriginal females (3.76), almost seven times higher than for non-Aboriginal males (1.35), and 70 times higher for non-Aboriginal females, all between 15–29 years (Figure 1). There were no Aboriginal patients older than 75 years, and in non-Aboriginal patients, there was an increase in rates after the age of 75, with the rate of females (0.22), higher than that of males (0.16). This was the only age group where females had higher rates than males.
Socioeconomic disadvantage
Amongst Aboriginal patients, admission rates were highest for those from the most disadvantaged areas, with a rate almost three times higher than for those from the least disadvantaged areas. The most disadvantaged rates were also higher than any other rate, including those amongst non-Aboriginal patients (Table 2).

Amongst the non-Aboriginal patients, rates were also highest amongst those from the most disadvantaged areas, and this was almost 30 times higher than for those from the least disadvantaged areas (Table 3). Almost all Aboriginal patients were uninsured (99.6 per cent) compared to non-Aboriginal patients (75 per cent not insured). Of all admissions, 81 per cent were uninsured patients.

Accessibility and remoteness
Amongst Aboriginal patients, rates were the highest amongst those from remote and very remote areas, and amongst non-Aboriginal patients, the highest rates were amongst those from remote areas. Aboriginal rates in all five areas (ARIA categories) were significantly higher than those of non-Aboriginal patients in the same areas.

Discussion
Our findings indicate that inequalities between Aboriginal and non-Aboriginal people in terms of hospital admissions for jaw fractures exist in WA, and continued over a decade-long period. Higher fracture rates occurred amongst males, Aboriginal people, younger adult age groups, those from low socioeconomic areas, and those from remote and very remote areas.

More than 80 per cent of all those admitted to hospital were men—this is consistent with other studies. The very disproportionate rates between males and females is believed to be related to the risk factors for maxillofacial fractures, which include a high prevalence of interpersonal violence. The numbers of mandibular fractures were higher than maxillary fractures, confirming national and international findings. An earlier study from Azevedo found the mandible to be the tenth most commonly injured bone in the body, and the second most commonly injured bone in the face.

The rates of admission were highest in young adult age groups, between ages 15 and 29. More than half (56 per cent) of admissions were in this age group. The reasons might be the risk-taking behaviours associated with maxillofacial trauma that younger age groups engage in, as identified by other studies.

In this study it was also determined that the rates for the oldest age group, those above age 75 years, was significantly higher than for those aged 30–64 years. Previous studies identified maxillofacial trauma as common amongst older people, and falls were identified as the major etiological factor in older age groups. With the older proportion of the population in Australia rapidly increasing, higher numbers of older people are expected to present with maxillofacial trauma.

When comparing rates of Aboriginal with non-Aboriginal patients, the admissions of Aboriginal people were disproportionally higher than for non-Aboriginal patients, and this situation remained consistent over the decade-long study period. Aboriginal males were admitted at a rate that was nearly 10 times that of non-Aboriginal males, Aboriginal female rates were almost three times that of non-Aboriginal males, and 37 times higher than for non-Aboriginal females at the peak ages of 15–29 years. Other Australian studies found similar disparities. The aetiology of facial fractures in Australia, and especially in the Aboriginal population, is strongly associated with alcohol-related violence and assaults. Indigenous females and males were 35 and 22 times as likely to be hospitalised due to family violence-related assaults as other Australian females and males, respectively.

Rates were significantly higher for individuals (both Aboriginal and non-Aboriginal) from the most socioeconomically disadvantaged areas. The rate for Aboriginal people from the poorest areas was double that of the non-Aboriginal rate from the poorest areas. Rates were also highest for those from remote and very remote areas. Poverty has shown to be associated with violence in Australia: about one-in-four Aboriginal people aged 15 years or over reported being a victim of physical or threatened violence, and the rate was higher among those who lived in low-income households, and were unemployed. The age-standardised rate for being a victim of physical or threatened violence among the Aboriginal population was more than twice the rate of the non-Aboriginal population. Although the rates were similar among those living in major cities and in remote areas, people in remote areas were much more likely to report that family violence was a neighbourhood problem (41 per cent compared with 14 per cent in non-remote areas).

Reasons for the slightly higher direct costs for Aboriginal people is unknown, but the direct costs (DRG) distribution across all episodes was not a normal distribution, and as such, mean costs could be misleading. Median costs
between Aboriginal and non-Aboriginal groups did not differ as much. With the majority of the Aboriginal population residing in rural and remote WA, it can be assumed that longer travel times and distances to obtain specialist care would be necessary. It might be the reason for the slightly longer hospital stay of Aboriginal, compared to non-Aboriginal patients.

Trend analysis indicates a positive (2.2 per cent) and significant increase in hospitalisation rates for jaw fractures in WA, over a 10-year period. This is an indication that hospitalisations for the treatment of maxillary and mandibular fractures remain a burden on the health system, and the very high rates of Aboriginal people admitted compared to non-Aboriginal remains a concern.

**Conclusion**

Hospital admission rates for the treatment of maxillary and mandibular fractures are very strongly divided along racial and socioeconomic lines in WA. The reasons for this include the determinants and risk factors for maxillofacial fractures, which are strongly associated with poverty, and compounded by geographical location and culture. The complexity of factors determining disadvantage and related health concerns, and the alleviation of risk-damaging lifestyles and behaviours require a broad integrated approach. This approach would need to be based on the social determinants of health, where health should be viewed from both a social and economic justice perspective.

**References**


ACKNOWLEDGEMENTS

None
Table 1: Jaw fracture rates by age, gender, and Aboriginal status over 10 years in WA

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Rate per 1,000</th>
<th>95% CI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/2000</td>
<td>614</td>
<td>0.32</td>
<td>0.29–0.35</td>
</tr>
<tr>
<td>2000/2001</td>
<td>673</td>
<td>0.35</td>
<td>0.32–0.38</td>
</tr>
<tr>
<td>2001/2002</td>
<td>635</td>
<td>0.33</td>
<td>0.30–0.36</td>
</tr>
<tr>
<td>2002/2003</td>
<td>682</td>
<td>0.35</td>
<td>0.32–0.38</td>
</tr>
<tr>
<td>2003/2004</td>
<td>608</td>
<td>0.31</td>
<td>0.29–0.33</td>
</tr>
<tr>
<td>2004/2005</td>
<td>740</td>
<td>0.37</td>
<td>0.35–0.40</td>
</tr>
<tr>
<td>2005/2006</td>
<td>765</td>
<td>0.38</td>
<td>0.35–0.41</td>
</tr>
<tr>
<td>2006/2007</td>
<td>756</td>
<td>0.37</td>
<td>0.34–0.40</td>
</tr>
<tr>
<td>2007/2008</td>
<td>853</td>
<td>0.40</td>
<td>0.38–0.43</td>
</tr>
<tr>
<td>2008/2009</td>
<td>857</td>
<td>0.39</td>
<td>0.37–0.42</td>
</tr>
<tr>
<td>All years</td>
<td>7,183</td>
<td>0.36</td>
<td>0.35–0.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group</th>
<th>N</th>
<th>Rate per 1,000</th>
<th>95% CI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–14</td>
<td>186</td>
<td>0.04</td>
<td>0.39–0.52</td>
</tr>
<tr>
<td>15–29</td>
<td>4,048</td>
<td>0.95</td>
<td>0.93–0.98</td>
</tr>
<tr>
<td>30–44</td>
<td>1,968</td>
<td>0.44</td>
<td>0.42–0.46</td>
</tr>
<tr>
<td>45–59</td>
<td>616</td>
<td>0.16</td>
<td>0.14–0.17</td>
</tr>
<tr>
<td>60–74</td>
<td>161</td>
<td>0.07</td>
<td>0.06–0.08</td>
</tr>
<tr>
<td>75+</td>
<td>204</td>
<td>0.19</td>
<td>0.17–0.22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Rate per 1,000</th>
<th>95% CI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>5,876</td>
<td>0.58</td>
<td>0.56–0.59</td>
</tr>
<tr>
<td>Female</td>
<td>1,309</td>
<td>0.13</td>
<td>0.12–0.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aboriginal status</th>
<th>N</th>
<th>Rate per 1,000</th>
<th>95% CI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboriginal</td>
<td>1,752</td>
<td>2.50</td>
<td>2.38–2.62</td>
</tr>
<tr>
<td>Non-Aboriginal</td>
<td>5,431</td>
<td>0.28</td>
<td>0.27–0.29</td>
</tr>
</tbody>
</table>

*CI=Confidence Interval
a Significant differences between groups

Table 2: Distribution of jaw fractures cases over 10 years by area Socio-Economic Index of Disadvantage (SEIFA) quintiles

<table>
<thead>
<tr>
<th>SEIFA</th>
<th>N</th>
<th>Rate per 1,000 (95% CI)*</th>
<th>N</th>
<th>Rate per 1,000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,246</td>
<td>11.4 (11.2–11.6)</td>
<td>1,180</td>
<td>5.84 (5.73–5.96)</td>
</tr>
<tr>
<td>2</td>
<td>199</td>
<td>2.00 (1.90–2.10)</td>
<td>1,099</td>
<td>0.85 (0.83–0.87)</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>0.58 (0.54–0.62)</td>
<td>1,057</td>
<td>0.15 (0.15–0.16)</td>
</tr>
<tr>
<td>4</td>
<td>94</td>
<td>0.73 (0.68–0.78)</td>
<td>981</td>
<td>0.20 (0.20–0.21)</td>
</tr>
<tr>
<td>5</td>
<td>82</td>
<td>3.10 (2.87–3.32)</td>
<td>978</td>
<td>0.20 (0.20–0.21)</td>
</tr>
</tbody>
</table>

*CI=Confidence Interval
a p<0.05, significant differences in rates in each SEIFA category between Aboriginal and Non-Aboriginal. SEIFA1=Most disadvantaged, SEIFA5=Least disadvantaged

Table 3: Distribution of jaw fractures cases over 10 years by ARIA classification

<table>
<thead>
<tr>
<th>ARIA</th>
<th>N</th>
<th>Rate per 1,000 (95% CI)*</th>
<th>N</th>
<th>Rate per 1,000 (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA</td>
<td>283</td>
<td>1.20 (1.15–1.25)</td>
<td>3,126</td>
<td>0.21 (0.20–0.22)</td>
</tr>
<tr>
<td>A</td>
<td>119</td>
<td>2.71 (2.55–2.88)</td>
<td>944</td>
<td>0.83 (0.81–0.85)</td>
</tr>
<tr>
<td>MA</td>
<td>159</td>
<td>4.13 (3.92–4.36)</td>
<td>580</td>
<td>0.76 (0.74–0.78)</td>
</tr>
<tr>
<td>R</td>
<td>115</td>
<td>9.90 (9.33–10.5)</td>
<td>270</td>
<td>1.06 (1.02–1.11)</td>
</tr>
<tr>
<td>VR</td>
<td>1,060</td>
<td>4.49 (4.40–4.58)</td>
<td>394</td>
<td>0.51 (0.50–0.53)</td>
</tr>
</tbody>
</table>

*CI=Confidence interval
a p<0.05, significant differences in rates in each ARIA category between Aboriginal and Non-Aboriginal.
Figure 1: Hospitalisation rates (per 1,000 population) for jaw fractures in WA over a decade, by age group, gender, and Aboriginal status

![Graph showing hospitalisation rates for jaw fractures in WA over a decade, by age group, gender, and Aboriginal status.](image-url)
Socioeconomic disadvantage and oral-health-related hospital admissions: a 10-year analysis

Estie Kruger1 and Marc Tennant1

OBJECTIVE: The aim of this Western Australian population study was to assess the relationship of socioeconomic disadvantage and: 1) trends in hospitalisations for oral-health-related conditions over 10 years; 2) insurance status, costs and length of stay in hospital; and 3) specific conditions (principal diagnosis) patients were admitted for.

METHODS: Hospitalisation data (of oral-health-related conditions) were obtained for every episode of discharge from all hospitals in Western Australia for the financial years 1999–2000 to 2008–2009. Area based measures (using the Index of Relative Socioeconomic Disadvantage) was used to determine relationships between socioeconomic status and other variables.

RESULTS: The most disadvantaged in the population are being hospitalised at significantly higher rates than other groups, stay in hospital for longer, and at higher costs. This trend remained over a period of 10 years. Those least disadvantaged have the second highest rates of hospitalisation, but the likelihood of being admitted for different procedures differ between these two extremes.

CONCLUSIONS: The importance of socioeconomic determinants of health are evident when analysing these hospitalisations. Recognition that lifestyle choices are severely restricted among the most marginalised and disadvantaged groups in the population can no longer be ignored in attempts to reduce health inequalities.

INTRODUCTION

The social gradient in health means that health inequities affect all, and the poorest of the poor have the worst health. This is a global phenomenon, and is seen in low, middle and high income countries.1 It is social and economic conditions, and their effects on people’s lives, that determine their risk of illness and the actions taken to prevent them becoming ill or treat illness when it occurs.1 The mechanisms by which socioeconomic status (SES) influence health status are complex and varied, and this association is confounded by many factors. It is hypothesised that a number of inter-related factors including education, place of residence, health beliefs and behaviour, occupation, income, access to health services and the environment in which people live determine the socioeconomic disadvantage and health.2 This relationship exists across a very broad range of health indicators, including dental health.3

Strong evidence exists for the relationship between oral health and socioeconomic status in the Australian population.4–13 Many studies have focused on child oral health, but inequities also exists in the adult population. In the Australian dentate population, adults with lower levels of household income and educational attainment suffered greater tooth loss, greater social impact of oral conditions on quality of life and worse subjective oral health.4,5

Australia has a complex health system, and the provision of oral health care depend on a combination of private and public providers and funders. Differences in access to care (among other factors) inevitably result in inequities in health, and this is no more evident than when comparing different socioeconomic groups in the population. Barriers to better public oral-health outcomes for socially disadvantaged Australians include service rationing of oral health care and marginalisation of oral health in policy and funding. Dental services are one of the least subsidised areas of health.14

Although studies of health inequalities are carried out worldwide, the development and increasing use of new measures of socioeconomic status have improved this area of research. These measures employ the use of census data on small areas to classify individuals in terms of the level of material deprivation in the area in which they live.3,6 Use of these area-based indices are based on assumptions that aggregate community-level variables are important explanatory factors in health outcomes above and beyond individual level circumstances.5,6,15 Ecological factors can be seen as upstream determinants of health and disease status in a population, and there is a growing awareness of the impact of neighbourhood factors on individual health outcomes.6 An Australian study confirmed that the socioeconomic characteristics of neighbourhoods are important for oral health over and above the socioeconomic characteristics of the people living in those neighbourhoods.16

Previous work indicated that adult hospitalisations for oral-health-related conditions remain considerable, even though a large proportion might be preventable.11–13 According to the social gradient theory it would be expected that those who suffer poorer oral health, would be hospitalised at higher rates, and that hospital admissions for treatment of oral-health-related conditions should be associated with the burdens of disease within the population. The aim of this Western Australian population study was to assess the relationship of socioeconomic disadvantage (using area-based measures) and:

(1) Trends in hospitalisations for oral-health conditions over 10 years,
(2) Insurance status, costs and length of stay in hospital, and

1International Research Collaborative - Oral Health and Equity, School of Anatomy, Physiology and Human Biology, Faculty of Sciences, The University of Western Australia, Nedlands, WA, Australia.
Correspondence: E Kruger (estie.kruger@uwa.edu.au)
Received 12 February 2016; accepted 16 June 2016
(3) Specific conditions (principal diagnosis) patients were admitted for.

**MATERIALS AND METHODS**

**Ethics**
Ethics approval for this study was obtained from the Human Research Ethics Committee at the University of Western Australia, reference number RA/4/1/5502.

**Study population**
This included all adults in WA who were admitted to hospital for an oral-health-related condition, over a 10-year period. The adult population in WA (all 18 years and older), were 1,059,750 in 1999, 1,094,197 in 2001 and 1,221,799 in 2006.

**Hospitalisation data**
Hospitalisation data were obtained from the Western Australian Morbidity Data System. The principal diagnosis, as classified by the International Classification of Disease (ICD-10AM), was obtained for every episode of discharge from all private and public hospitals in Western Australia for the financial years 1999–2000 to 2008–2009. In this study hospitalisation episodes were selected on the basis of a principal diagnosis (the primary condition under treatment) being an oral-health-related condition.

**Population rates and cost**
Population data for rate calculations were obtained from the estimates as calculated by the Western Australian Department of Health. These estimates were extrapolated from census data collected by the Australian Bureau of Statistics. Estimated cost of care was determined for each episode using the national standard diagnostic-related group (DRG) average price. The Australian Refined Diagnosis Related Group (AR-DRG), version 5.1, National Centre for Classification in Health (NCCH), Sydney, NSW, Australia was used to calculate the direct cost. AR-DRG is an Australian admitted patient classification system, which provides a clinically meaningful way of relating the number and type of patients treated in a hospital to the resources required by the hospital. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services.

**Socioeconomic status**
The Socioeconomic Indexes for Areas (SEIFA) is a widely used measure of geographically concentrated disadvantage. SEIFA was created by the Australian Bureau of Statistics who broadly define relative socioeconomic disadvantage and disadvantage in terms of people’s access to material and social resources, and the ability to participate in society. SEIFA is composed of four indexes, namely: the Index of Relative Socioeconomic Disadvantage (IRSD); the Index of Relative Socioeconomic Advantage and Disadvantage; the Index of Economic Resources; and the Index of Education and Occupation. In this study the IRSD was used as the area-based composite measure of SES, and this index is derived from variables as indicated in Table 1. The IRSD score of the residential statistical local area of each person admitted to hospital, was used a measure of socioeconomic status.

**Statistical analysis**
All rates were calculated using the Rates Calculator (Perth, WA, Australia), a software package developed by the WA Department of Health. All rates were calculated per 100,000 person years, and were adjusted for ages and IRSD quintile. Significant differences between rates were based on non-overlapping 95% confidence intervals ($P < 0.05$). Means between groups were compared using analysis of variance. Odds ratios and confidence intervals were calculated using logistic regression for the increased likelihood of being hospitalised for each of the specific categories of principal diagnosis (according to ICD-10 Code for each admission). All statistical analysis were undertaken using IBM SPSS Statistics 19 (IBM, New York, NY, USA).

**RESULTS**

**Demographics**
Over a 10-year period, a total of 131,509 people were admitted to hospitals in WA for oral-health-related conditions. Slightly more females (51.7%) were admitted (Table 2). The majority of those hospitalised (97%) were non-Indigenous persons, and between the ages of 18 and 39 years (63%; Table 2). Only 2% were above the age of 80 years. Over the 10-year period, there was an increase in the numbers hospitalised for every year. Almost two-thirds (63%) of patients admitted to hospital have private insurance (Table 1). Almost half (47%) of all those admitted were from areas classified as IRSD quintile 5 (least disadvantaged), and 6.5% were from the most disadvantaged areas (IRSD quintile 1).

**Principal diagnosis**
Almost half (49%) of all hospitalisations was for the removal of ‘Embedded and/or impacted teeth’, ‘Dental caries’ accounted for almost one-tenth of all admissions (9%) and 8.5% were admitted for ‘Other disorders of teeth and supporting structures’ (Table 1). The 10 most common conditions for which people were admitted were the following (conditions as categorised according to ICD code): ‘Embedded and Impacted teeth’; ‘Dental Caries’; ‘Other disorders of teeth and supporting structures’; ‘Other Fractures’ (which include fractures of teeth, palate, nasal bone, alveolus, lower facial bones); ‘Malignant neoplasms’; ‘Pulp and periapical conditions’; ‘Other diseases of the jaw’; ‘Jaw fractures’ (maxilla and mandible); ‘Dento-facial anomalies’; and ‘Gingivitis and Periodontitis’.

---

**Table 1.** Variables contributing to the Index of Relative Socioeconomic Disadvantage (IRSD)

<table>
<thead>
<tr>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Occupied private dwellings with no internet connection</td>
</tr>
<tr>
<td>% People age 15 years and over with no post-school qualifications</td>
</tr>
<tr>
<td>% People with stated annual household equivalised income between $13,000 and $20,799</td>
</tr>
<tr>
<td>% Households renting from Government or community organisations</td>
</tr>
<tr>
<td>% People (in the labour force) unemployed</td>
</tr>
<tr>
<td>% One parent families with dependent offspring only</td>
</tr>
<tr>
<td>% Households paying rent less than $120 per week (excluding $0 per week)</td>
</tr>
<tr>
<td>% People aged under 70 who have a long-term health condition or disability and need assistance with core activities</td>
</tr>
<tr>
<td>% Occupied private dwellings with no car</td>
</tr>
<tr>
<td>% People who identified themselves as being Aboriginal and/or Torres Strait Islander origin</td>
</tr>
<tr>
<td>% Occupied private dwellings requiring one or more extra bedrooms</td>
</tr>
<tr>
<td>% People aged 15 years and over who are separated or divorced</td>
</tr>
<tr>
<td>% Employed people classified as Machinery Operators and Drivers</td>
</tr>
<tr>
<td>% People aged 15 years and over who did not go to school</td>
</tr>
<tr>
<td>% Employed people classified as Low Skill Community and Personal Service Workers</td>
</tr>
<tr>
<td>% People who do not speak English well</td>
</tr>
</tbody>
</table>

BDJOOPEN (2016) 16004
Trends over time

Rates were calculated for the overall 10-year period and found that the average rate over the study period were highest for those in the most disadvantaged areas. The second highest average rate were for those from the least disadvantaged areas (Table 3). The rate for quintile 1 was significantly higher than any of the other quintiles ($P < 0.05$), the rate for quintile 5 also differed significantly from all the others ($P < 0.05$), and the rate for quintile 3 was significantly lower that any of the others ($P < 0.05$; Table 3).

Over time, rates were increasing for all socioeconomic groups, and the highest rates for each year remained for those from the most disadvantaged areas. Lowest rates for each year were for those in the third quintile (Figure 1). The rates across all years for the most disadvantaged groups remained significantly higher than any of the others groups ($P < 0.05$). Hospitalisation rates by age-group indicated that those in the youngest age category (18 to 39 years) consistently had the highest rates of hospitalisation, across all IRSD quintiles. It was the highest however, for those from the most disadvantaged quintile. Rates decreased by age across all the socioeconomic groups, and was lowest for those in the oldest (80 years+) age category (Figure 2). Except for the third quintile, rates for the youngest age category in all other SES groups, were significantly higher ($P < 0.05$) than the other age categories within the same SES group (Figure 2).

Socioeconomic status and length of stay, cost and insurance status

There was an increase in the proportions of those patients with private health insurance across the SES groups, from the lowest (28.5%) in the most disadvantaged group, to the highest (74.6%) of those in the least disadvantaged group (Table 4). Those from the poorest quintile stayed, on average, in hospital the longest (2.07 days), as opposed to those from the richest quintile, who stayed, on average, the shortest (1.37 days). On average the mean direct costs (DRG costs) per hospitalisation episode were highest for those from the poorest group (AUS3642), and lowest for those from the richest group (AUS2942; Table 4).

Socioeconomic status and principal diagnosis

Deprivation of area of residence was found to be associated with the principal diagnosis (condition for which hospitalisation was required). There was a statistically significant trend for those living in the most disadvantaged areas to be at higher risk for hospitalisation for most conditions (Table 5). The relationship was reversed, however, for admission to hospital for the removal of embedded and impacted teeth. In the youngest age category those from the most disadvantaged areas were 76% less likely to be admitted for removal of embedded and impacted teeth than those from the least disadvantaged area. The same trend were seen in the other age groups (63% less likely among 40–59-year olds, 58% less likely among 60–79-year olds and 65% less likely among those over the age of 80 years; Table 5).

Among all hospitalised patients, those in the youngest age group and from the most disadvantaged areas were (compared with those from the least disadvantaged areas) almost three times more likely to be admitted for dental caries, almost five times more likely to be admitted for pulp and periapical conditions, almost five times more likely to be admitted for jaw fractures, more than three times more likely to be admitted for malignancies, almost five times more likely to be admitted for other fractures, and more than five times more likely to be admitted for pulp and periapical conditions (Table 5).

The ratios becomes smaller in the older age groups, but for some conditions were still significant. In the age group 40 to 59 years those from the most disadvantaged areas compared with

---

### Table 2. Characteristics of all adult oral-health-related hospital admissions over 10 years in WA

<table>
<thead>
<tr>
<th>Variable:</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>63,569 (48.3)</td>
</tr>
<tr>
<td>Female</td>
<td>67,940 (51.7)</td>
</tr>
<tr>
<td>All</td>
<td>131,509 (100%)</td>
</tr>
<tr>
<td>Indigenous status</td>
<td></td>
</tr>
<tr>
<td>Indigenous</td>
<td>3,652 (2.8%)</td>
</tr>
<tr>
<td>Non-indigenous</td>
<td>12,7857 (97.2%)</td>
</tr>
<tr>
<td>All</td>
<td>13,1509 (100%)</td>
</tr>
<tr>
<td>Age groups</td>
<td></td>
</tr>
<tr>
<td>18–39</td>
<td>82,682 (62.9%)</td>
</tr>
<tr>
<td>40–59</td>
<td>31,927 (24.3%)</td>
</tr>
<tr>
<td>60–79</td>
<td>14,221 (10.8%)</td>
</tr>
<tr>
<td>80+</td>
<td>2,679 (2%)</td>
</tr>
<tr>
<td>All</td>
<td>131,509 (100%)</td>
</tr>
<tr>
<td>Year</td>
<td></td>
</tr>
<tr>
<td>1999/2000</td>
<td>9,661 (7.3%)</td>
</tr>
<tr>
<td>2000/2001</td>
<td>10,415 (8%)</td>
</tr>
<tr>
<td>2001/2002</td>
<td>11,693 (8.9%)</td>
</tr>
<tr>
<td>2002/2003</td>
<td>12,600 (9.5%)</td>
</tr>
<tr>
<td>2003/2004</td>
<td>12,924 (9.8%)</td>
</tr>
<tr>
<td>2004/2005</td>
<td>13,274 (10%)</td>
</tr>
<tr>
<td>2005/2006</td>
<td>14,071 (10.7%)</td>
</tr>
<tr>
<td>2006/2007</td>
<td>14,618 (11.2%)</td>
</tr>
<tr>
<td>2007/2008</td>
<td>15,274 (11.6%)</td>
</tr>
<tr>
<td>2008/2009</td>
<td>16,979 (13%)</td>
</tr>
<tr>
<td>All</td>
<td>131,509 (100%)</td>
</tr>
<tr>
<td>Principal condition:</td>
<td></td>
</tr>
<tr>
<td>Embedded/impaired teeth</td>
<td>64,327 (48.9%)</td>
</tr>
<tr>
<td>Dental caries</td>
<td>11,865 (9.0%)</td>
</tr>
<tr>
<td>Disorders teeth and supporting structures</td>
<td>11,136 (8.5%)</td>
</tr>
<tr>
<td>Other fractures</td>
<td>8,149 (6.2%)</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>5,191 (3.9%)</td>
</tr>
<tr>
<td>Pulp/periapical conditions</td>
<td>4,431 (3.4%)</td>
</tr>
<tr>
<td>Other diseases of the jaw</td>
<td>4,156 (3.2%)</td>
</tr>
<tr>
<td>Jaw fractures</td>
<td>3,988 (3.0%)</td>
</tr>
<tr>
<td>Dentofacial anomalies</td>
<td>3,439 (2.6%)</td>
</tr>
<tr>
<td>Gingivitis and periodontitis</td>
<td>3,080 (2.3%)</td>
</tr>
<tr>
<td>All other conditions</td>
<td>11,747 (8.9%)</td>
</tr>
<tr>
<td>Insurance status:</td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>83,193 (63.3%)</td>
</tr>
<tr>
<td>No insurance</td>
<td>48,316 (37.7%)</td>
</tr>
<tr>
<td>IRSD</td>
<td></td>
</tr>
<tr>
<td>Quintile 1 (most disadvantaged)</td>
<td>8,559 (6.5%)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>16,541 (12.6%)</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>14,538 (11.1%)</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>29,599 (22.5%)</td>
</tr>
<tr>
<td>Quintile 5 (least disadvantaged)</td>
<td>61,666 (46.9%)</td>
</tr>
<tr>
<td>All</td>
<td>131,509 (100%)</td>
</tr>
</tbody>
</table>

### Table 3. Hospitalisation rates over 10 years by IRSD quintile

<table>
<thead>
<tr>
<th>IRSD</th>
<th>Rate</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quintile 1 (most disadvantaged)</td>
<td>1,002.22</td>
<td>979.49, 1,025.55</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>723.77</td>
<td>711.91, 735.83</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>692.49</td>
<td>680.39, 704.81</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>741.70</td>
<td>732.60, 750.93</td>
</tr>
<tr>
<td>Quintile 5 (least disadvantaged)</td>
<td>964.14</td>
<td>955.94, 972.43</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; IRSD, Index of Relative Socioeconomic Disadvantage.

*Rates are per 100,000 persons and adjusted for age and IRSD status.*
those from the least disadvantaged areas were almost four times more likely to be admitted for jaw fractures, more than twice as likely to be admitted for malignancies, three times more likely to be admitted for other fractures and almost twice as likely to be admitted for pulp and periapical conditions. Those in age groups 60–79 and 80+ years from the most disadvantaged areas were also 3.3 times and almost 3.5 times, respectively, more likely to be admitted for malignancies than those from the least disadvantaged areas (Table 5).

**DISCUSSION**

The results of this study indicated consistently higher rates of hospitalisation for oral-health-related conditions among the most disadvantaged group in the WA population, compared with the rest. This trend remained consistent over a period of 10 years, and also remained consistent when analysed by age group, with the youngest, most disadvantaged having significantly higher admission rates than those from other age groups and disadvantage levels. This finding clearly reflects the poorer oral health of groups in the population at the lower end of the socioeconomic scale. Numerous studies have demonstrated this social gradient, not just in Australia but it is a worldwide phenomenon. The study results also indicate that for many, poor oral health ultimately result in hospital admissions, meaning that the condition is not possible to be managed in the primary care system.

Overall, in terms of absolute numbers, 63% of all those admitted had private insurance. When comparing socioeconomic groups,
however, 75% of those in the least disadvantaged group had insurance compared with only 28% of those in the most disadvantaged group. In 2010, 55% of Australians had private dental insurance. Levels of insurance coverage increased across household income, with highest levels of insurance among those with the highest household incomes. For those earning less than $30,000 per year, < 30% had private dental insurance. The importance of private insurance need to be considered against the backdrop of the Australian health-care system, and especially the dental health-care system. Medicare is the basis of Australia’s health-care system and covers many health-care costs, but does not cover dental examinations and dental treatment. Australians can choose to have Medicare cover only, or a combination of Medicare and private health insurance. This

Table 5. Odds ratios (and 95% confidence intervals) for principal diagnosis at admission, by age group, in relation to socioeconomic disadvantage of area of residence:

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>18–39 years</th>
<th>40–59 years</th>
<th>60–79 years</th>
<th>80+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded/ impacted teeth</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 5 (least deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 1 (most deprived)</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
</tbody>
</table>

Quintiles: Based on IRSD score of area of residence. Abbreviation: IRSD, Index of Relative Socioeconomic Disadvantage. *P < 0.001, **P < 0.05.
situation leaves a large part of the population having to pay for dental care, either out-of-pocket, or via private health insurance and those that are less likely to be able to afford private health insurance are those from the most disadvantaged proportions of the population. A safety net exists for the most disadvantaged in the form of access to public dental services, but this does not always include the working poor, who are not eligible for public dental care. Disadvantaged groups that are not eligible for public dental services may have difficulty accessing regular private oral-health services due to the cost, whereas those eligible for public dental care may face long waiting times for care.

The results of this study also indicated that those who are most disadvantaged stayed on average longer in hospital than others, and the average cost per admission was highest in this group. It is estimated that these direct costs (DRG) are very conservative estimations, and in reality, the true costs could amount to double the estimated cost at the patient level (inclusive of health insurance refund). In addition, indirect costs (travel, time off work, support family time and so on) are not included, but others have estimated in small countries with minimal travel that this can be nearly double the direct costs.24 Our results thus indicate that those who can least afford it, might have higher costs (direct and indirect) and longer hospital stays.

The condition that most people were admitted to hospital for was for ‘Embedded and Impacted Teeth’. Almost half (48.9%) of all hospitalisations was for this condition. Previous work indicated that these high numbers are driven by the removals of third molars, mostly in younger people.25–27 These rates of hospitalisation are much higher in Australia than in some other countries.26 This was one of only two conditions where those who are least disadvantaged were significantly less likely to be admitted, and this was seen in all age groups. Those in the youngest and most disadvantaged group were 76% less likely than the youngest and least disadvantaged group to be admitted for this condition, and the same trend was evident in all the other age groups.

The other condition were likelihood to be admitted were significantly less for the poorest compared with the richest, across all age groups was for ‘Other disorders of teeth and supporting structures’. This was especially evident among the older ages (poorest were 84% and 83% less likely than richest in ages 60–79 years and 80+years, respectively).

Calculation of odds ratios for the other most common conditions, especially in the youngest age group, all indicated significantly higher likelihoods of admission (of the most disadvantaged) for each specific condition: this group was almost 5 and 4.8 times more likely to be admitted for ‘Jaw fractures’ and ‘Other fractures’, respectively. Previous work indicated much higher levels of jaw and other fractures among lower socioeconomic groups. The reasons for this include the determinants and risk factors for maxillofacial fractures, which are strongly associated with poverty.28–31

The youngest and poorest were 2.6 times more likely to be admitted for ‘Dental caries’, and more than five times more likely to be admitted for ‘Pulp and periapical conditions’ than the youngest least disadvantaged. Previous studies and surveys have emphasised the higher levels of dental caries in Australia among those who are lower on the socioeconomic scale.4,14 Admissions for pulp and periapical conditions has previously been shown to be significantly higher in children from poorer socioeconomic backgrounds.32,33 Pulp and periapical conditions could result from infections in the tooth, most often caused by untreated dental caries.34

For some conditions the trend was evident across all age groups, and the poorest in all age groups were more likely to be hospitalised. ‘Malignancies’ was one such condition. The likelihood was three times more likely among 18–39-year olds, twice as likely in 40–59-year olds, 3.3 times more likely among 60–79-year olds and 3.5 times more likely in those older than 80+ years to be admitted for malignancies than similar age groups in the least deprived group. This might be a reflection of oral cancer being a strongly age-related condition.35–37

One weakness of a population-based hospitalisation study like this, is that it cannot determine the need for care, it is unknown whether the care is distributed according to need. However, there are very strong evidence that those who are socioeconomically disadvantaged has higher levels of dental disease. Most population-based studies of this nature rely on indirect inference to evidence relating to disease levels and burdens of disease among different groups. The results of this study thus suggest large and diverging health-care needs between socioeconomic groups.

Access to care is a complicated issue affected by demand and supply barriers that may influence the use of primary health services. The use of primary care services in oral health (where timely and adequate services can be provided), might contribute to less people being hospitalised for treatment of some, but not all conditions. The use of primary dental care services is however not an easy option for all, with multiple factors determining access, including socioeconomic status, geographical location, age and health insurance status, among others.14 Public dental services in Australia is currently not in a position to provide services to all those who need or demand it38 and the results of this study might be a reflection of that.

Conclusion
The results of this study indicate that the most disadvantaged in the population are being hospitalised for oral-health-related conditions at significantly higher rates than other groups. Those least disadvantaged have the second highest rates of hospitalisation, but the likelihood of being admitted for specific procedures differ between these two extremes. The influence of socioeconomic determinants of health are evident when analysing these hospitalisations. Although the importance of social determinants in oral health is now widely acknowledged, public policy seems to still be focused largely on individual behaviour. Recognition, however, that lifestyle choices are severely restricted among the most marginalised and disadvantaged groups in the population can no longer be ignored in attempts to reduce health inequalities.

COMPETING INTERESTS
The authors declare no conflict of interest.

REFERENCES
Oral-health related hospitalisations

E Kruger and M Tennant


This work is licensed under a Creative Commons Attribution 4.0 International License. The images or other third party material in this article are included in the article’s Creative Commons license, unless indicated otherwise in the credit line; if the material is not included under the Creative Commons license, users will need to obtain permission from the license holder to reproduce the material. To view a copy of this license, visit http://creativecommons.org/licenses/by/4.0/