Cost effectiveness modelling of a 'watchful monitoring strategy' for impacted third molars *vs* prophylactic removal under GA: an Australian perspective

A. A. Anjrini,[1] E. Kruger*[1] and M. Tennant[1]

IN BRIEF

- Analyses the direct cost, indirect cost and loss of productivity associated with impacted teeth removal on an Australian national level, using a comprehensive novel model which could be used by other comparable jurisdictions.
- Suggests that the presence of guidelines in Australia would result in avoiding significant, and arguably unnecessary, costs to society.

RESEARCH

Objective To develop a national level cost model of both the direct and indirect costs of hospitalisations for impacted teeth in Australia. This model will then be used to compare a watchful monitoring strategy for impacted third molars *versus* prophylactic removal under GA, and calculate possible cost savings in the scenario where Australia would adopt guidelines comparable to the UK. **Methods** Western Australian real hospitalisation data for impacted/embedded teeth removal for 2008/2009 were extrapolated into a national, Australian-wide cost-distribution model for removal strategy. The components of a watchful monitoring strategy were calculated over a one-year, and 20-year period. Cost estimates for both strategies were then compared. **Results** 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 proposed guidelines would lead to an annual figure of 83,850 individuals avoiding hospitalisation and shifting to watchful monitoring strategy, and an annual reduction of costs ranging between $420–513 million. **Conclusion** With no evidence to support the prophylactic removal of asymptomatic wisdom teeth, a proposed watchful monitoring strategy is a more cost-effective alternative in the Australian context.

INTRODUCTION

The prevalence of third molar impaction in the general population is high, and has been reported to range between 18–68%.[1–3] A global debate over the management strategy for impacted, symptomless third molars[4–9] is continuing. One approach is to prophylactically remove them to prevent crowding of lower incisors, as well as to prevent possible pathologies such as caries of adjacent teeth,[10,11] periodontal disease,[12–16] cyst formation and infection, abscess or cellulitis.[17,18] While this approach is supported by the American Association of Oral and Maxillofacial Surgeons,[5] the prophylactic removal of impacted third molars was not supported by the American Public Health Association since 2008.[19] Similarly in Europe, this approach was not supported by several reports such as Belgian Healthcare Knowledge Centre report[20] (2012), Scottish National Clinical Guideline report[21] (1999), Swedish health technology assessment[22] (2010), Royal College of Surgeons of England report[23] (1997) and National Institute for Clinical Excellence (NICE) guidelines[24] (2000). At the other end of the spectrum of the debate is the strategy to closely monitor those impacted teeth over the rest of the life of the patient (watchful monitoring). The argument behind this approach is mainly to prevent complications of extractions, such as pain, bleeding, swelling, dry socket, trismus, damage to the nerve and to the temporomandibular joint, with the rate of complications reported to be between 4.6%[25] and 21%[26]. In comparing these two models, the cost effectiveness of each strategy is an important factor in the design of healthcare policies and therapeutic guidelines.

In Australia, impacted teeth (mostly third molars) are usually removed under general anaesthesia by an oral maxillofacial surgeon. This procedure has been shown to be associated with insured individuals and at a relatively young age.[27] Furthermore, it has been recently reported[28] that the rates of hospitalisations for impacted teeth were one of the highest in the world, with Western Australia having rates of hospitalisation almost seven-times (690%) that of England, where third molar removals are restricted to symptomatic cases, since 2000.[15] Those findings suggest that about 85% of third molar removals in Australia are likely to be prophylactic.[28]

The hypothesis of this study was that, in the Australian context, the direct and indirect costs associated with third molar removal in hospital would be substantially higher that the costs associated with the proposed watchful monitoring strategy. The aim was to estimate the number and characteristics of hospitalised patients for removal of impacted teeth, and use this to develop a national level cost model of both the direct and indirect costs of hospitalisations in Australia. This model will then be used to compare both strategies, and calculate possible cost savings in the scenario where Australia would adopt guidelines comparable to the UK.

METHOD

Baseline data

The base data was obtained from the Western Australian Hospital Morbidity Data System

[1]Department of Anatomy, Physiology and Human Biology, The University of Western Australia, 35 Stirling Highway, Crawley WA, Perth, 6009, Australia
*Correspondence to: Professor Estie Kruger
Email: estie.kruger@uwa.edu.au

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under appropriate ethical data release. Ethics approval for this study was obtained from the Human Ethics Committee of the University of Western Australia.

Every episode of discharge from all private and public hospitals in Western Australia for the financial year 2008/2009 for removal of impacted or embedded teeth as the principal oral condition, as classified by the International Classification of Diseases, Tenth Revision, Australian Modification (ICD-10-AM), was included in the dataset.[29] The analysis also included patient age, insurance status and primary place of residency at the time of hospitalisation. All dollars presented in this study are Australian dollars, and at a fixed cost of living as at 2009, unless otherwise stated.

National model based on WA

Rates calculation

The rate calculations for Western Australian Hospitalisation were then measured using population data obtained from the Australian Bureau of Statistics 2006 Census. Age, insurance status and socioeconomic indexes for areas (SEIFA) category were included as risk indicators. These driving variables have previously been shown to be strongly linked to third molar extraction rates in Australia.[27] It is noted that the 2006 census data was chosen as to be closest to the 2008/2009 hospitalisation base data. The age variable was divided into four sub-sets: 15–19, 20–24, 25–29 and 30–34 years. As those age groups comprise 80% of all cases reported, ages <14 years and >35 years were not included as the small numbers would skew the modelling. The insurance status variable has two subsets: insured and non-insured. SEIFA is the nationally accepted coding for socioeconomic advantage and disadvantage in Australia. The five categories (subsets) for SEIFA are: most disadvantaged, above average disadvantaged, average disadvantaged, below average disadvantaged and least disadvantaged. A total of 40 distinct rates of third molar extraction were computed dependent on the mix of the variables subsets. SPSS version 21 was used to produce the required population-based rates.

Distribution of model nationally

Australia is divided by the Australian Bureau of Statistics into 1,353 non-overlapping/no-gaps statistical local areas (SLAs). The population data across each of the 1,353 SLAs were distributed by age, health insurance status and SEIFA. Using Microsoft Excel (2003), the hospitalisation rate for each population subset derived from the Western Australian morbidity data was applied across Australia to the appropriate population subset (age, health insurance status, SEIFA) within each statistical local area.

Table 1 The number, proportion and cost of modeled cases of third molar extraction per State per annum of Australia

	Cases				Cost pa ($ millions)		
State	Insured	Non-insured	Total	%	Insured	Non-insured	Total
NSW	25,516	6,402	31,918	32.6	144	29	173
VIC	20,195	5,069	25,264	25.8	113	22	135
QLD	15,172	3,808	18,980	19.4	87	17	104
SA	5,868	1,469	7,337	7.5	33	7	40
WA	7,789	1,949	9,738	9.9	45	9	54
TAS	1,747	436	2,183	2.2	10	2	12
NT	527	134	6,61	0.7	3	1	4
ACT	1,493	375	1,868	1.9	8	2	10
Grand total	**78,307**	**19,642**	**97,949**	**100.0**	**444**	**88**	**532**

Table 2 The number, proportion and cost of third molar extraction cases per geographic area of Australia per annum

Geographic area	Hospitalisations	%	Cost pa ($ millions)
Major cities of Australia	59,432	60.7	316
Inner regional Australia	23,914	24.4	128
Outer regional Australia	10,734	11.0	62
Remote Australia	2,764	2.8	18
Very remote Australia	1,105	1.1	8
Total	**97,949**	**100**	**532**

Table 3 Average individual cost (Australian dollars) of third molar removal under GA

	Insured	Non-insured
Direct hospitalisation cost	2,644	2,644
Additional out of pocket direct cost	1,170	N/A
Indirect cost (Absenteeism + Travel)	1,850	1,850
Total	**5,664**	**4,494**

Table 4 Average individual cost (Australian dollars) of third molar watchful monitoring strategy

Comprehensive oral examination	60.3
Orthopantomogram	47.4
Combined cost of monitoring protocol	107.7
Cost for ten monitoring sessions (20 y)	1,077

Accessibility

The degree of remoteness of each statistical local area was obtained from the Australian Bureau of Statistics website[30] using the Australian Standard Geographical Classification (ASGC) Remoteness Area Correspondences, 2006. The ASGC classification divides Australia by remoteness into five groups: major cities Australia (R1), inner regional Australia (R2), outer regional Australia (R3), remote Australia (R4) and very remote Australia (R5). For SLAs that fall into two categories of ASGC classification, the group with higher percentage was chosen.

Direct costs

The Australian Refined Diagnosis Related Group (AR-DRG) version 5.1 was used to calculate the direct cost. Estimated cost of care was determined for each episode using the national standard diagnostic related group (DRG) average price. For insured individuals, out of pocket additional hospital costs were added. Three estimated levels (low, medium and high) of this additional cost were calculated, based on the data from the Australian Institute of Health and Welfare.[31]

Indirect cost

Loss of productivity (absenteeism) was calculated using average sick leave days associated with wisdom teeth removal under general anaesthesia, which is 5.7 days as reported by Edwards *et al.*[32] The average cost to the economy per day was calculated as average day earning, which is 20% of average weekly earnings estimated by the Australian Bureau of Statistics in November 2013 at $1498.7.[33]

Most hospitalisations for impacted teeth are performed in the major cities and patients living in R2, R3, R4 and R5 need to travel to hospital. To account for travelling days, an extra one, two and three days were allocated for patients living in R3, R4 and R5 respectively. An estimated cost for transport was allocated to each of the five geographic groups (R1 to R5). Travel cost was estimated on three levels (low, medium and high) to account for different methods of transport.

Cost calculation of watchful monitoring strategy

The watchful monitoring strategy includes a proposed plan of active surveillance over time of retained asymptomatic impacted third molars. This plan includes clinical examination and panoramic radiography every two years.[34] The retention period extends for the life of the patient until wisdom teeth become symptomatic and removed, or until they fully erupt. However, to establish a cost comparison over a reasonable period, the proposed retention period included in this study was 20 years,[35] considering initial examination at the age of 15 as a high proportion of hospitalisations for impacted teeth in Australia starts at that age.[36]

Average cost of comprehensive oral examination (Australia wide) was retrieved from the Australian Dental Association Fees survey for 2012.[37] Panoramic imaging (bulk billed) cost was retrieved from Medicare Australia Benefits Schedule as at August 2014.[38] A scenario of Australian rates dropping to UK rates was analysed. Although an Orthopantomograph (OPG) was included at every clinical visit, it would be expected that a clinician would show judgement in this decision. However, for the sake of the modelling the maximum one per clinical examination was taken.

RESULTS

Direct and indirect cost of hospitalisations

Number of cases

The estimated number of hospitalisations for impacted teeth in Australia, in 2008/2009 for the age group 15–34 years was 97,949. Insured patients accounted for 78,307 (80%) and non-insured patients for 19,642 (20%). The distribution over the States and Territories of Australia is shown in Table 1. The distribution of hospitalisation cases over the five remoteness area groups is shown in Table 2, with group R1, (major cities of Australia n = 59,433) and R2 (inner regional Australia n = 23,915) accounting for 85% of the hospitalisations.

Direct cost

The annual direct cost of hospitalisations, excluding out of pocket cost, was estimated to be 259 million with individual DRG cost of $2644 for each hospitalisation. Approximately 85% of this amount ($207 million) was paid by insured patients. Out of pocket cost, paid to hospitals by insured patients, was estimated to range between $58–156 million, with a medium calculation of $91 million. In total, the direct cost of hospitalisations ranged between $317–415 million, with the medium calculation being $350 million.

Indirect costs

Indirect cost (absenteeism and transport) was estimated to be $178 million (low), $181 million (medium) and $183 million (high) with average individual costs of $1850. The total combined direct and indirect cost would range between $496 million (low), $531 million (medium) and $599 million (high). These cost figures are related to age groups 15–34 years only, which represents 80% of hospitalisations. Table 3 summarises the individual average cost of tooth removal under general anaesthesia.

Individual cost of watchful monitoring strategy

The estimated individual cost for 20 years of watchful monitoring, which includes ten clinical examinations ($60.3) and panoramic radiographs ($47.4), was $1077 (Table 4). Therefore the estimated annualised cost (noting that the recommended examinations was every two years) was $53.8, which is approximately 1% of the estimated total cost of single episode of removal.

Cost implications for the adoption of watchful monitoring

The scenario of Australian rates of hospitalisation dropping to UK rates[28] following the adoption of the watchful monitoring strategy revealed a possible reduction by 85%, with an annual number of 83,850 individuals avoiding hospitalisation, and shifting to a watchful monitoring strategy and an annual reduction of costs ranging between $420–513 million, depending on the scenario of the calculation and inclusive of the ongoing watchful monitoring of those patients that fell outside the criteria for extraction.

DISCUSSION

Dentists are often faced with the situation of asymptomatic, disease-free impacted teeth, and are usually tempted to provide treatment for those cases. The decision between two treatment options, that is, prophylactic removal or retention, is left to the individual judgements of dentists, with the exception of the UK. There, the practice of prophylactic removal of third molars has been discouraged for nearly two decades, with clear guidelines issued by NICE in 2000 to limit third molar removal to only pathological situations, such as untreatable tooth decay, abscesses, cysts or tumours, disease of the tissues around the tooth and if the tooth is in the way of other surgery.[24]

The prophylactic removal of impacted wisdom teeth has been traditionally advocated in Australia and the widely provided argument was to avoid dental infections and oral cellulitis, especially at older age.[39] It would be expected, following this reasoning, that the rates of submandibular cellulitis would be higher in the UK, which has 85% less wisdom teeth removals.[28] It has been recently shown that this is not the case, and the actual rates of oral cellulitis in Australia was significantly higher than in the UK for the period between 1999 and 2008.[40]

One reason for this attitude in Australia might be that oral maxillofacial surgery is considered predominantly a dental speciality, dealing mainly with pathology in the jaws and related structures and the removal of impacted wisdom teeth, which constitute a major percentage of oral maxillofacial work in Australia.[36] This is not necessarily the case in the UK, where oral maxillofacial surgery is considered more of a medical speciality with a wider scope of practice extending to pathology in the face and neck area.

The model used in our research was based on actual and projected Australian data and did not take in consideration the cost of possible complications associated with both strategies, such as post-operative infection, nerve injury/paresthesia in the case of removal strategy, as well as the scenario in which a disease-free wisdom tooth becomes symptomatic during the watchful monitoring period and needs removal. However, a previously published study by Edwards *et al.*[41] in the UK used probability data for possible outcomes of both strategies which were entered into a decision tree. They concluded that, in the UK, mandibular third molar retention is less costly to the NHS, more effective for the patient and more

cost-effective to both parties than removal.

One limitation of this study may be the accuracy of the indirect cost estimates regarding absenteeism. Absenteeism measurement is affected by different patient factors, such as being unemployed or a student, and this information was not available in the database for each case of hospitalisation. However, the Australia unemployment rate is approximately 6%,[42] and the majority of individuals hospitalised (80%) have private health insurance, which is highly correlated[43] to having employment. As for the age group 15–19, the Australian Bureau of Statistics states that only 42% are employed.[42] However, it is implied that a parent or carer, who is most likely employed, will take an absence from work and stay with their child.

The results of our research reveals that the controversial practice of prophylactic asymptomatic wisdom teeth removal is responsible for an extremely high expenditure by Medicare, insurance companies and individuals, as well as a considerable loss of productivity. An alternative watchful monitoring strategy was shown to be more cost effective with minimal annual cost.

The UK experience with NICE guidelines since 2000 has been evaluated[44,45] and although the overall number of removal of third molar episodes has decreased significantly, there has been a slow increase in the number of episodes since 2005, mostly due to caries to adjacent teeth and at an older age. A criticism of NICE guidelines by Mansoor *et al.*[46] in 2014 was that the recommended 'standard routine programme of dental care' for asymptomatic, disease-free impacted third molars, is not straightforward when it comes to radiographic examination, as bitewing and periapical radiographs are usually not helpful for radiographic examination of wisdom teeth.[46] A more focused surveillance for adjacent caries was also recommended by Renton *et al.*[44] The proposed watchful monitoring strategy, including an OPG every two years and a thorough clinical examination for periodontal pockets and caries would be an improved version of the NICE prescription.

In conclusion, with no evidence to support or refute the prophylactic removal of asymptomatic wisdom teeth,[47] proposed watchful monitoring strategy is a more cost effective alternative in the Australian context.

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