Tonsillectomy rates in the South African private healthcare sector

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List of Abbreviations/Acronyms

AAO-HNS	American Academy of Otolaryngology – Head and Neck Surgery
CPR	Clinical prediction rule
ENT	Ear, nose and throat
NHS	National Health Service
OSA	Obstructive sleep apnoea
OSAS	Obstructive sleep apnoea syndrome
SDB	Sleep disordered breathing
SIGN	Scottish Intercollegiate Guidelines Network
STATS SA	Statistics South Africa
UK	United Kingdom
USA	United States of America

Abstract

Background. Adeno-/tonsillectomy is a commonly performed procedure with internationally standardised and recognised indications. Despite this, there exists considerable international (190 – 850/100 000 people ≤19 years of age) and regional variation in adeno-/tonsillectomy rates. This variation has been ascribed to differences in clinical practice and referral patterns, as well as social and family factors, rather than differences in clinical need or regional morbidity.

Objectives. To describe the adeno-/tonsillectomy rate in the South African private healthcare sector, and regional variations thereof. To compare local rates with international rates and to assess current trends in adeno-/tonsillectomy clinical practice.

Methods. Analysis of adeno-/tonsillectomy data from January 2012 to December 2013, provided by the largest South African private healthcare funder, accounting for 31% of the medical scheme market. Rates are expressed per 100 000 people ≤19 years of age.

Results. The tonsillectomy rate in the South African private healthcare sector was 1888/100 000 people ≤19 years of age in 2012. In 2013, the rate dropped significantly (p-value <0.001) to 1755/100 000. Both are more than double the highest national tonsillectomy rate reported in the literature. There was also considerable regional variation in the adeno-/tonsillectomy rate within South Africa. Otorhinolaryngologists are responsible for approximately 80% of adeno-/tonsillectomies performed in the South African private healthcare sector.

Discussion. The South African tonsillectomy rate is very high when compared to international trends and varies regionally within the country. The literature does not support an increased burden of disease as the reason behind this. Rather, it is differences in training and clinical practice of clinicians, as well as social and family factors that have been implicated.

Conclusion. The adeno-/tonsillectomy rate in the South African private healthcare sector is substantially higher than international norms. The reasons for this discrepancy require further consideration and investigation.

PART A: RESEARCH PROTOCOL

Tonsillectomy rates in the South African private healthcare sector

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Key Words: Tonsillectomy, tonsillectomies, adeno-/tonsillectomy, rates, regional variation, South Africa, private sector, private healthcare, health insurance

Introduction and literature review

Indications for tonsillectomy in the United Kingdom (UK) National Health Service (NHS) are based on the well-established recommendations made by *Paradise et al* in 2002.[1] The *American Academy of Otolaryngology-Head and Neck Surgery* (AAO-HNS) published similar recommendations in 2011.[2] *Table 1* summarises the Scottish, Italian and AAO-HNS recommendations.[2]

Table 1: Tonsillectomy guidelines/recommendations

Table 9. Comparison of Scottish, Italian, and American Guidelines

Parameter	Scottish Guideline	Italian Guideline	AAO-HNS Guideline
Audience	Multidisciplinary	Multidisciplinary	Multidisciplinary
Target population	Children (4-16 y) and adults	Children and adults	Children (1-18 y)
Scope	Management of sore throat and indications for tonsillectomy	Appropriateness and safety of tonsillectomy	Management of children who are candidates for tonsillectomy
Methods	Based on a priori protocol; systematic literature review; SIGN scale of evidence quality	Systematic literature review; PNLG scale of evidence quality	Based on a priori protocol; systematic literature review; AAP scale of evidence quality
Recommendations			
Recurrent infection	Tonsillectomy should be considered for recurrent, disabling sore throat due to acute tonsillitis when the episodes are well documented and adequately treated that meet the Paradise criteria (**Table 5**) for frequency of illness	Tonsillectomy is indicated in patients with at least 1 y of recurrent tonsillitis (5 or more episodes per year) that is disabling and impairs normal activities, but only after an additional 6 mo of watchful waiting to assess the pattern of symptoms using a clinical diary	Tonsillectomy is an option for children with recurrent throat infection that meets the Paradise criteria (**Table 5**) for frequency, severity, treatment, and documentation of illness
Pain control	Recommendation for adequate dose of acetaminophen for pain relief in children	Recommendation to administer acetaminophen before and after surgery	Recommendation to advocate (ie, provide information, prescribe, etc) for pain relief and educate caregivers about the importance of managing and reassessing pain
Antibiotics	No statement regarding perioperative antibiotics	Recommendation for short-term perioperative antibiotics[a]	Recommendation against perioperative antibiotics
Steroids	Recommendation for a single intraoperative dose of dexamethasone	Recommendation for a single intraoperative dose of dexamethasone	Recommendation for a single intraoperative dose of dexamethasone
Sleep-disordered breathing	NA	Recommendation for diagnostic testing in children with suspected sleep respiratory disorders	Recommendation to counsel caregivers about tonsillectomy as a means to improve health in children with sleep-disordered breathing (and comorbid conditions)
Polysomnography	NA	Recommendation for polysomnography when pulse oximetry results are not conclusive in agreement with Brouillette criteria	Recommendation to counsel caregivers about tonsillectomy as a means to improve health in children with abnormal polysomnography
Surgical technique	NA	Recommendation for "cold" technique	NA
Hemorrhage	NA	NA	Recommendation that the surgeon document primary and secondary hemorrhage posttonsillectomy at least annually
Adjunctive therapy	Recommendation against *Echinacea purpurea* for treatment of sore throat Recommendation for acupuncture in patients at risk for PONV where antiemetic drug use is not suitable	NA	NA

Even though these accepted indications for tonsillectomy exist, wide variation in tonsillectomy rates have been reported across the world, including the UK,[3,4] Germany,[5] Japan,[6] Canada,[7] the United States of America (USA),[1] Italy[8] and Denmark.[9] Such variations are generally ascribed to differences in clinical practice and training, rather than differences in clinical need.[10] Furthermore, research from Germany,[5] the USA[3] and Italy[8] illustrate wide regional variation in the number of tonsillectomies performed per capita (tonsillectomy rates) within the country investigated.

In Germany, the annual average tonsillectomy rate (with/without adenoidectomy) between 2007 and 2010 was reported as 480/100 000 for children and adolescents ≤19 years of age.[5] This rate is in keeping with international norms.[3] On closer inspection, however, the tonsillectomy rate varied up to 3-fold among German federal states. There was an even greater variation when tonsillectomy rates were analysed at a district level, with rates in some districts being up to eight times higher than in other districts *(Figure 1)*. The frequency of surgery was >30% above the national average in 71/412 districts. The regional variation in the tonsillectomy rates was greatest for children <4years of age and the degree of variation decreased with advancing age *(Figure 2)*.

Figure 1: Annual rate of tonsillectomy (with or without adenoidectomy) per 10 000 children and adolescents ≤19 years of age in Germany, according to district of residence for period 2007-2010. [5]

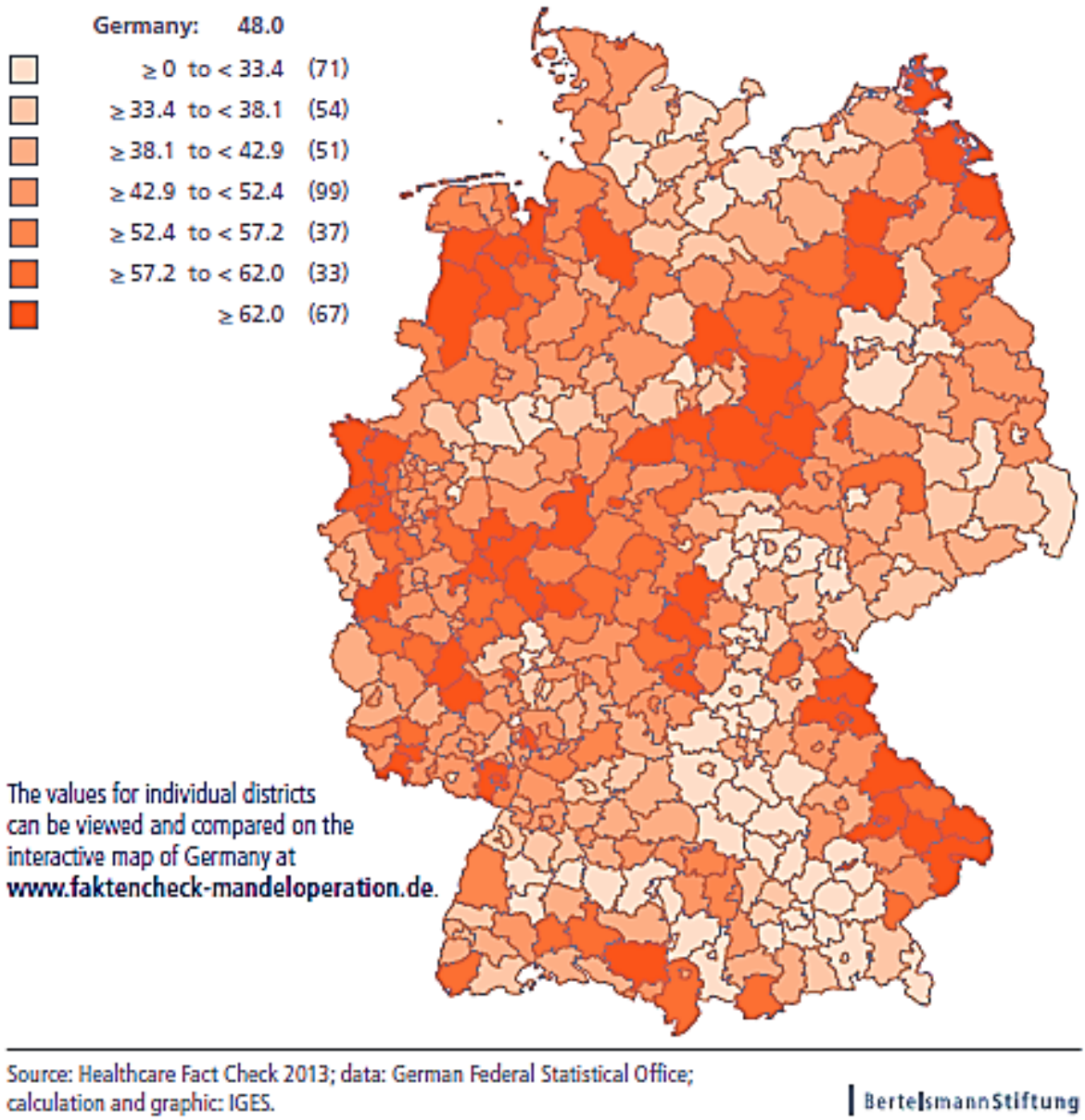
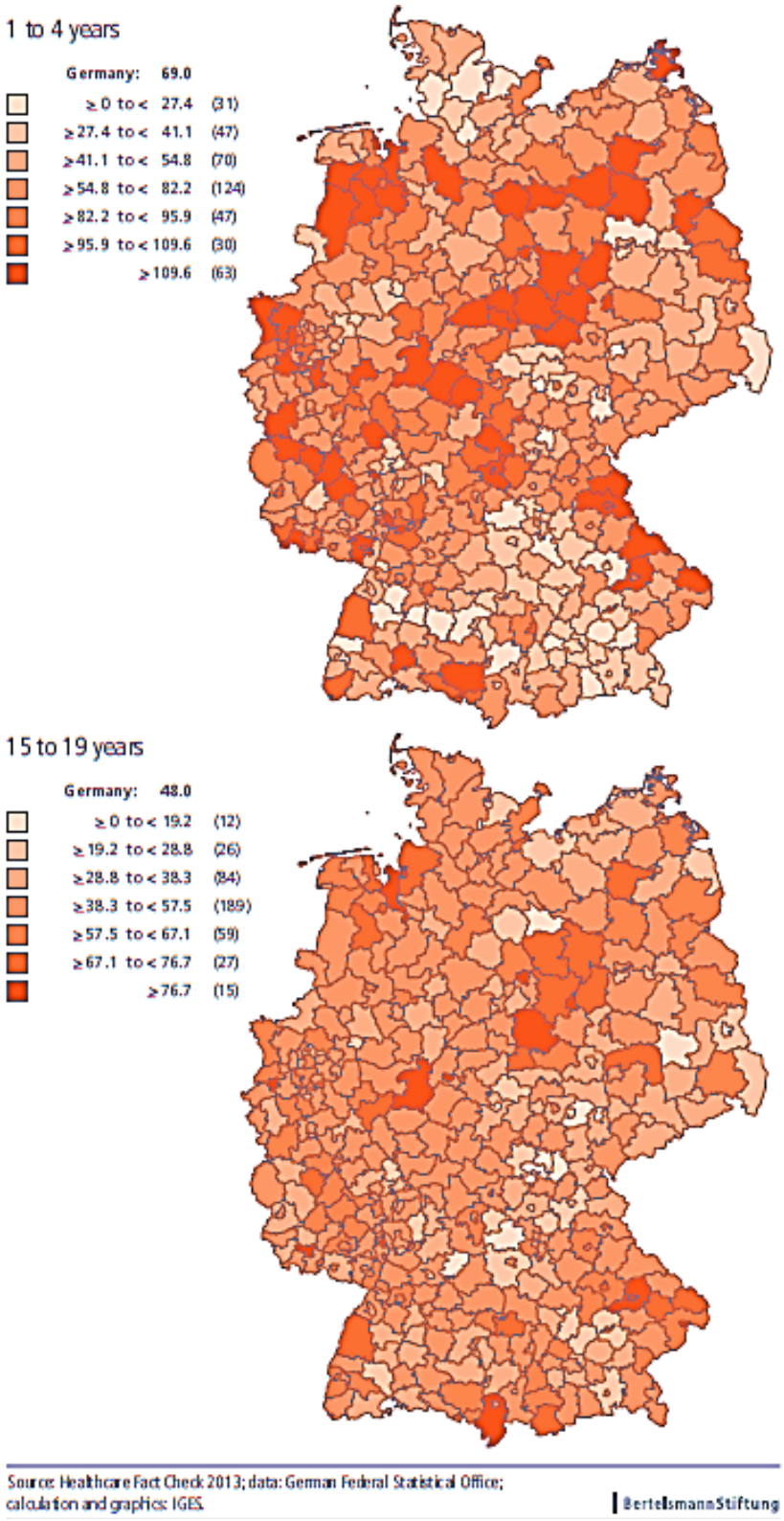


Figure 2: Tonsillectomy and tonsillotomy rates (with or without adenoidectomy) per 10 000 children and adolescents ≤19 years of age in Germany, according to age groups in 2010, according to district of residence.[5]



Suleman et al (2010)[3] reported a national annual tonsillectomy rate, for the NHS in England, of 304/100 000 children <15yrs of age (95% CI 320-324). Despite clear NHS guidelines on when tonsillectomy should be recommended to patients, tonsillectomy rates varied 7-fold across local authority areas in England, from as low as 102/100 000 (95% CI 83-125) to as high as 754/100 000 (95% CI 690-822).[3]

In the USA, *Boss et al* (2006)[11] reported that tonsillectomy rates in children aged 13-17 years old (33.8/10 000) were lower than in children 7-12 years of age (91.3; P < .05) and 0-6 years of age. Compared with the South of America, tonsillectomy rates were lower in the West (29/10 000 versus 125/10 000; P < .01) and not significantly different in other regions. Compared with large central metropolitan areas, tonsillectomy rates were higher in small/medium metropolitan areas (118/10 000 versus 42/10 000; P < .05), and not significantly different in large fringe or non-metropolitan areas. Tonsillectomy rates in children insured by Medicaid in the USA were similar to those insured privately. [9]

Study rationale

South African tonsillectomy rates, how they compare with international norms and whether regional variations exist, have not previously been reported. Determining the tonsillectomy rate in the South African private healthcare sector will assist as a tool in comparing South African practice with international trends. It will also aid in justifying recommendations regarding the modification of local tonsillectomy indications, to align South African practice with internationally accepted norms.

Methodology

Aims and objectives

1. To determine:
    a. South African tonsillectomy rates in the health insured population ≤19yrs of age.
    b. How South African tonsillectomy rates compare with international norms.
    c. Whether variation exists between different geographical regions in South Africa.
    d. Whether variation exists between different age groups in South Africa.

2. Should it be found that tonsillectomy rates in South Africa exceed international norms, or that significant geographical and/or age variations exist, then a secondary objective of this study would be to attempt an explanation of local trends and potentially modify local tonsillectomy rates by educating doctors (otolaryngologists, paediatricians, family practitioners) and the public regarding internationally accepted and locally relevant indications for tonsillectomy.

Research design

This study is a retrospective descriptive study.

Due to limited resources and the immense strain on the state healthcare sector, uninsured South African patients have limited access to tonsillectomies at state hospitals, where the indications for such surgical procedures are often modified to be locally relevant and to ensure a sustainable service. At the *Red Cross War Memorial Children's Hospital* in Cape Town, tonsillectomy and adenoidectomy are reserved almost exclusively for children experiencing significant upper airway obstruction secondary to adenotonsillar hypertrophy. As such, data on tonsillectomy rates in state hospitals is of little benefit for this study. However, approximately 17% of South Africans have private health insurance and can have tonsillectomy and adenoidectomy procedures done in private hospitals.

Procedure

Data will be obtained from Discovery Health, the largest private healthcare funder in South Africa, insuring 31% of privately insured South Africans. The following data will be obtained and analysed in Discovery insured patients 19 years of age or younger:

Study participants

A.) Number of Discovery insured patients (number per year: 2012-2013)

- Nationally: Overall; 0-4yrs; 5-15yrs; 16-19yrs
- Provincially: Overall; 0-4yrs; 5-15yrs; 16-19yrs
- Regionally: Overall; 0-4yrs; 5-15yrs; 16-19yrs

Inclusion criteria:

- Member of Discovery Medical Scheme during the calendar years 2012-2013
- 19 years of age and younger

Exclusion criteria:

- Older than 19 years of age

Sample size:

31% of privately insured South Africans, 19 years of age and younger.

B.) Number of tonsillectomies (+/- adenoidectomy) per year: 2012-2013

- Nationally: Overall; 0-4yrs; 5-15yrs; 16-19yrs
- Provincially: Overall; 0-4yrs; 5-15yrs; 16-19yrs
- Regionally: Overall; 0-4yrs; 5-15yrs; 16-19yrs

Inclusion criteria:

- Member of Discovery Medical Scheme during the calendar years 2012-2013
- 19 years of age and younger
- Had a tonsillectomy +- adenoidectomy during the calendar years 2012-2013

Exclusion criteria:

- Older than 19 years of age

Sample size:

Following a preliminary enquiry, it was found that the number of tonsillectomies (+- adenoidectomies) performed in the Discovery-insured patient population was 15 989 in 2012 and 16 583 in 2013. This includes those older than 19 years of age undergoing tonsillectomy, eliminating some patients from the ultimate sample population.

Number of Ear, Nose and Throat (ENT) surgeons, per province/region, performing tonsillectomies +- adenoidectomies

Sampling and recruitment

Information and statistics will be drawn from the existing Discovery Health database.

<u>Validity</u>

Discovery Health provides medical aid to the overwhelming majority of privately insured South Africans, yielding a large and representative study population. Discovery also offers a range of insurance packages, catering to all income groups. As such, a tonsillectomy rate described within this population can be applied to the South African private healthcare sector in general.

Reliability

Discovery Health applies a meticulous, standardised patient data collection system. This ensures reliable and accurate data collection.

Analysis of results

Data will be analysed to satisfy the ***objectives*** of the study. The South African tonsillectomy rate will be determined as number of tonsillectomies performed per capita, and expressed as follows:

- National tonsillectomy rate
- Provincial tonsillectomy rate
- Regional tonsillectomy rate

Comparisons will be drawn with rates described in other countries.

Ethical considerations

Autonomy

Not applicable in this study.

Beneficence

Should this study indicate a higher tonsillectomy rate in South Africa when compared to the rest of the world, an awareness campaign could be implemented to bring the South African rate in line with international and accepted norms. This could prevent unnecessary operations and reduce exposure to the hazards of avoidable surgery.

Non-maleficence

No potential harm to study population.

Confidentiality

Data will be extracted from the existing Discovery Health database. The researcher will at no point have access to personal patient information, such as the identities of patients or surgeons.

Justice

All patients meeting the inclusion criteria will be included in the study, the results of which will be dispersed within the medical fraternity locally and internationally, ensuring distributive justice.

Risks and benefits for study participants

No risks or benefits to study participants.

Consent

No consent required as no personal information will be received, analysed or published.

References

1 Paradise JL, Bluestone CD, Colborn DK, Bernard BS, Rockette HE, Kurs-Lasky M. Tonsillectomy and adenotonsillectomy for recurrent throat infection in moderately affected children. Pediatrics. 2002;110(1):7-15.

2 Baugh RF, Archer SM, Mitchell RB, et al. Clinical practice guideline: Tonsillectomy in children. Otolaryngol Head Neck Surg. 2011;144(1 Suppl):S1-30.

3 Suleman M, Clark M, Goldacre M, Burton M. Exploring the variation in paediatric tonsillectomy rates between English regions: A 5-year NHS and independent sector data analysis. Clinical Otolaryngology. 2010;35(2):111-117.

4 Al-Hussaini A, Owens D, Tomkinson A. Health costs and consequences: Have UK national guidelines had any effect on tonsillectomy rates and hospital admissions for tonsillitis? European Archives of Oto-Rhino-Laryngology. 2013;270(6):1959-1965.

5 Tonsillectomy in Germany: Marked regional variations in the most common inpatient operation performed on children and adolescents: Faktencheck Gesundheit Mandeloperation: Healthcare Fact Check 2013: German Federal Statistical Office.

6 Fujihara K, Koltai PJ, Hayashi M, Tamura S, Yamanaka N. Cost-effectiveness of tonsillectomy for recurrent acute tonsillitis. Annals of Otology, Rhinology and Laryngology. 2006;115(5):365.

7 Martens PJ, Need to Know Team, Fransoo R, Burchill C, Burland E. Health status and healthcare use patterns of rural, northern and urban Manitobans: Is Romanow right? Healthcare Policy. 2006;2(1):108-127.

8 Materia E, Di Domenicantonio R, Baglio G, et al. Epidemiology of tonsillectomy and/or adenoidectomy in Italy. Pediatr Med Chir. 2004;26(3):179-186.

9 Vestergaard H, Wohlfahrt J, Westergaard T, Pipper C, Rasmussen N, Melbye M. Incidence of tonsillectomy in Denmark, 1980 to 2001. Pediatr Infect Dis J. 2007;26(12):1117-1121.

10 Capper R, Canter R. Is there agreement among general practitioners, paediatricians and otolaryngologists about the management of children with recurrent tonsillitis? Clinical Otolaryngology & Allied Sciences. 2001;26(5):371-378.

11 Boss EF, Marsteller JA, Simon AE. Outpatient tonsillectomy in children: Demographic and geographic variation in the United States, 2006. J Pediatr. 2012;160(5):814-819.

12 Blair R, McKerrow W, Carter N, Fenton A. The Scottish tonsillectomy audit. The Journal of Laryngology & Otology. 1996;110(20):1-25.

13 Capper R, Canter R. Is the incidence of tonsillectomy influenced by the family medical or social history? Clinical Otolaryngology & Allied Sciences. 2001;26(6):484-487.

14 Glover JA. The incidence of tonsillectomy in school children. 1938. Int J Epidemiol. 2008;37(1):9-19.

15 Goodman DC, Challener GJ. Tonsillectomy: A procedure in search of evidence. J Pediatr. 2012;160(5):716-718.

16 Lock C, Wilson J, Steen N, et al. Childhood tonsillectomy: Who is referred and what treatment choices are made? Baseline findings from the north of England and Scotland study of tonsillectomy and adenotonsillectomy in children (NESSTAC). Arch Dis Child. 2010;95(3):203-208.

17 Manickavasagam J, Ali S, Quraishi M. General practitioners' versus consultants' perspective on indications for paediatric tonsillectomy: Current trends. The Journal of Laryngology & Otology. 2012;126(02):163-167.

18 Marshall T, Anantharachagan A, Chan VG, Hoo SS, Yeo JC. How many tonsillectomies are evidence-based? Journal of Clinical Excellence. 2001;3(1):23-25.

19 Parker NP, Walner DL. Trends in the indications for pediatric tonsillectomy or adenotonsillectomy. Int J Pediatr Otorhinolaryngol. 2011;75(2):282-285.

20 Van Den Akker E, Hoes A, Burton M, Schilder A. Large international differences in (adeno) tonsillectomy rates. Clinical Otolaryngology & Allied Sciences. 2004;29(2):161-164.

21 Wasson J, Prinsley P. Tonsillectomy: Variation in practice reflecting regional variation in disease presentation. Clinical Otolaryngology. 2011;36(5):522-524.

22 Wilson JA, Steen IN, Lock CA, et al. Tonsillectomy: A cost-effective option for childhood sore throat? Further analysis of a randomized controlled trial. Otolaryngol Head Neck Surg. 2012;146(1):122-128.

PART B: LITERATURE REVIEW

Literature search strategy

A literature search was undertaken of the PubMed, Medline, Google Scholar and Cochrane databases for articles in journals that are listed on Index Medicus. The following keywords were used: “tonsillectomy”, “adeno-/tonsillectomy”, “adeno-/tonsillectomy children”, “adeno-/tonsillectomy rates”, “adeno-/tonsillectomy indications”, “adeno-/tonsillectomy complications”, “adeno-/tonsillectomy sleep disordered breathing” and “adeno-/ tonsillectomy obstructive sleep apnoea syndrome”. Review articles and systematic reviews were preferentially considered and included. Recent studies, published in the last 10 years, were favoured. Articles not written in English were excluded, although abstracts translated into English were considered.

Summary or interpretation of literature

Tonsillectomy, performed with or without adenoidectomy, is one of the most frequently performed surgical procedures in children. [1,2] In the USA, tonsillectomy is the second most common ambulatory procedure performed in children and accounts for one third of the procedures performed under general anaesthesia. [3] It is, however, a procedure that lacks evidence of effectiveness. [4] In addition, the natural history of tonsillar disease is for children to outgrow it. The tonsils are also understood to play a role in the functioning of the immune system, acting as the first line of defence against pathogens entering the body via the respiratory and gastrointestinal tracts. The tonsils are immunologically most active between the ages of 3 and 10, [5] after which they involute. [6] No studies have been able to demonstrate a clinically significant effect of tonsillectomy on immune system function, however. [7] Tonsillectomy is also a procedure associated with significant morbidity and a mortality rate ranging from 1 in 16 000 to 1 in 35 000. [8] Taking all these factors into account, it is apparent that every case being considered for adeno-/tonsillectomy should be thoroughly deliberated, weighing up potential benefit of the procedure against potential harm and risk, with thought processes and decisions being evidence-based. This decision-making process often involves a multidisciplinary healthcare team, in consultation with parents/caregivers.

Indications for adeno-/tonsillectomy

The two major indications for tonsillectomy are recurrent throat infections and sleep disordered breathing (SDB), both of which can impact significantly on general health and quality of life. [9] By definition, the term 'throat infection' includes both bacterial and viral infections of the palatine tonsils and/or pharynx. SDB refers to abnormalities of respiration/ventilation during sleep and encompasses a spectrum of disorders, ranging from primary snoring to obstructive sleep apnoea (OSA). It is important to note that the presence or absence of snoring does not confirm or exclude a diagnosis of SDB, as not all snorers have SDB and caregivers may not report intermittent snoring.

In the 1980s, Rosenfeld reported that roughly 80% of tonsillectomies performed at their institution in New York were being performed for infective indications i.e. recurrent tonsillitis or sore throat. [9] There has, however, been a dramatic shift in practice in recent years. In 2011, Parker et al. reported that 85% of tonsillectomies in American children <18 years of age were being performed for obstructive symptoms [10] i.e. SDB. This trend towards obstruction as the primary indication for adeno-/tonsillectomy is interesting, as evidence in support of this indication has been equivocal until fairly recently. Uncertainty as to the actual benefit of adeno-/tonsillectomy in SDB (especially the milder forms) has created a grey zone in the management of these patients. Otorhinolaryngologists often justify adeno-/tonsillectomy as necessary to resolve SDB, although science has not kept pace with convention.

Adeno-/tonsillectomy clinical practice in the UK (NHS) is based on the recommendations made by Paradise et al. in 1984 and 2002, and the SIGN 117 guidelines (Scottish Intercollegiate Guidelines Network, 2010). [11] The AAO-HNS published similar recommendations in 2011. [12] Various other groups have developed guidelines to aid clinicians in the decision-making process, most offering minor variations to the NHS and American recommendations. These guidelines are summarised in Table 1.

The implementation of the SIGN guidelines resulted in more efficient and effective use of healthcare resources in the UK [13]. Consequently, tonsillectomy rates in England, Scotland and Wales dropped to the lowest in Europe. However, in their 2009 position paper, ENT UK, a representative body of otorhinolaryngologists, expressed concern that too few

tonsillectomies were being performed and that hospital admissions for tonsillitis and peritonsillar abscesses had increased considerably. They concluded that current guidelines might exclude patients who would benefit from tonsillectomy. [14]

Although studies since the 1970s have defined a suitable candidate population, many clinicians are still uncertain as to the indications for tonsillectomy. [15] In certain instances, only 35% of patients undergoing adeno-/tonsillectomy have been shown to meet the published criteria. [16] Even more concerning is Marshall's finding that only a quarter of patients undergoing tonsillectomy for recurrent throat infection met evidence-based criteria. [17] Despite this, the Scottish tonsillectomy audit notes that between 63.3% and 89.8% of patients referred to ENT surgeons with recurrent tonsillitis, sore throat or obstructive symptoms, are booked for tonsillectomy on their first visit to an outpatient ENT clinic. [18] This suggests that ENT surgeons are generally liberal when promoting tonsillectomy as a therapeutic option and often forego a period of watchful waiting, despite the recommendation of the guidelines to observe patients for a period of at least 6 months. Evidence also points to the fact that ENT surgeons are more likely to break existing guidelines in favour of performing surgery rather than withholding surgery. [19]

As ENT surgeons are unlikely to be managing patients suffering from acute episodes of throat infection/sore throat, the onus rests on primary healthcare providers/general practitioners/paediatricians to provide surgeons with as much information as possible to make an evidence-based decision on whether adeno-/tonsillectomy is indicated and likely to be of benefit. This includes information such as frequency of throat infections, associated clinical factors and the socioeconomic impact of the disease on the family of the patient. As such, the decision to proceed with adeno-/tonsillectomy requires multidisciplinary collaboration between general practitioners, paediatricians, ENT surgeons and parents/caregivers. This requires agreement on the diagnostic features of sore throat/tonsillitis/throat infection and the indications for surgery. Such agreement or consensus does not exist.

Relative indications for surgery include recurrent episodes requiring hospitalisation, peritonsillar abscess, febrile seizures, orthodontic concerns or malocclusion, tonsiliths, halitosis, family history of rheumatic heart disease or glomerulonephritis and tonsillar

asymmetry (to exclude malignancy on histological specimen.) The evidence supporting these indications is limited and of lesser quality. In such instances, shared decision making is promoted.

Tonsillectomy is often justified on the anecdotal opinion of parents whose children have undergone the procedure, claiming a dramatic improvement in their general health and behaviour. [18,20] The behavioural and cognitive effects of OSA are particularly worrisome to parents. [21] As such, forceful parents might be more inclined to convince surgeons of the need for surgery.

Factors such as the number of days of school missed by a child as a result of tonsillitis, tonsil size, the number of antibiotic courses completed and recurrent ear infections, are often used to justify tonsillectomy, but are not included in any of the guidelines. [22] The costs incurred as a result of frequent throat infections are, however, substantial. These include the direct costs of consultation fees, transport and medication costs. Indirect costs include school and caregiver work absenteeism. Although not included in the guidelines, the economic burden of disease is unequivocal, with an estimated 35 million days lost from school or work annually in the UK alone. [14]

To the authors' knowledge, no developing countries have published tonsillectomy guidelines or indications relevant to the developing world. Of five African countries polled (Kenya, Rwanda, Sudan, Uganda and Zimbabwe), all have adopted the Paradise Criteria, the SIGN Guidelines or the AAO-HNS Clinical Practice Guidelines, or hybridised versions thereof. The South African Society of Otorhinolaryngology-Head and Neck Surgery has not adopted an official stance on the matter.

Table 1: Indications for tonsillectomy

	Paradise Criteria	Scottish Guideline	AAO-HNS*
Frequency of throat infections	≥7 in preceding year OR ≥5 per year in preceding 2 years OR ≥3 per year in preceding 3 years	≥7 in preceding year OR ≥5 per year in preceding 2 years OR ≥3 per year in preceding 3 years	≥7 in preceding year OR ≥5 per year in preceding 2 years OR ≥3 per year in preceding 3 years
Clinical features	**In addition to sore throat, one or more of the following:** Temperature > 38.3°C OR Cervical lymphadenopathy (tender or >2cm) OR Tonsillar exudate OR Culture positive for group A β-haemolytic streptococcus	NA	**In addition to sore throat, one or more of the following:** Temperature > 38.3°C OR Cervical lymphadenopathy (tender or >2cm) OR Tonsillar exudate OR Culture positive for group A β-haemolytic streptococcus
Modifying factors: Favouring tonsillectomy if frequency criteria not met	NA	NA	Multiple antibiotic allergy/intolerance History of peritonsillar abscess PFAPA (Periodic fever, Aphthous stomatitis, Pharyngitis and Adenitis)
Antibiotics	Administered in conventional dose for suspected/proven streptococcal episodes	NA	
Documentation	Each episode and associated clinical features recorded	Episodes should be well documented	Each episode and associated clinical and social features recorded
Sleep disordered breathing/ polysomnography		NA	Counsel caregivers re tonsillectomy as means to improve health in children with abnormal sleep study. Ask about comorbidities that might improve with tonsillectomy: Growth retardation, poor school performance, enuresis, behavioural problems
Watchful waiting	12-month period of observation, due to tendency of throat infections to improve over time.		

*American Academy of Otolaryngology – Head and Neck Surgery

Tonsillectomy rates and regional/international variation

For the NHS in England, Suleman et al [24] reported a national annual tonsillectomy rate of 304/100 000 children <15yrs of age (95% CI 320-324). Tonsillectomy rates varied 7-fold across local authority areas in England, from as low as 102/100 000 (95% CI 83-125) to as high as 754/100 000 (95% CI 690-822). This substantial variation was even greater when tonsillectomy data from the independent healthcare sector (representing 15% of ENT activity in the UK) was factored into the calculations. In Scotland, regional tonsillectomy rates varied between 63 and 179/100 000, roughly a 3-fold variation. [18]

In the USA, Boss et al [1] reported that tonsillectomy rates in the West of America were lower than in the South (29/10 000 versus 125/10 000; $P < .01$) and not significantly different in other regions. Compared with large central metropolitan areas, tonsillectomy rates were higher in small/medium sized metropolitan areas (118/10 000 versus 42/10 000; $P < .05$), and not significantly different in large fringe or non-metropolitan areas. Tonsillectomy rates in children insured by the state funded Medicaid program in the USA were similar to those insured by private sources. It is also interesting to note that the tonsillectomy rate in the USA has been steadily declining in recent times, [1] as evidence in support of the procedure has been found to be equivocal. A similar trend is evident in the UK, with only a quarter the number of tonsillectomies being performed in the modern era compared with the early 20th century. [25]

In Germany, the annual average tonsillectomy rate (with/without adenoidectomy) between 2007 and 2010 was reported as 480/100 000, for children and adolescents ≤19 years of age. [26] This rate is in keeping with international norms. On closer inspection, however, the tonsillectomy rate varied up to 3-fold among German federal states. There was an even greater variation when tonsillectomy rates were analysed at a district level, with rates in some districts being up to eight times higher than in other districts. The frequency of surgery was >30% above the national average in 71 of 412 districts.

In Italy, the national tonsillectomy rate across all age groups in the year 2000 was reported as 106/100 000 people. [27] This rate is lower than the rate reported in other countries, as it includes the adult population over 19 years of age, a group in which relatively fewer tonsillectomies are performed. Similarly though, the regional Italian tonsillectomy rate was

noted to vary from as low as 35/100 000 in Basilicata, to 190/100 000 in Piemonte, representing roughly a 5-fold variation. This prompted the Italian National Program for Guidelines to develop recommendations guiding clinical practice with regard to adeno-/tonsillectomy.

For such a common procedure, with internationally recognised and standardised indications, it is interesting to note that there exists significant international variation in the tonsillectomy rate. Furthermore, tonsillectomy rates show considerable regional variation within the same country. It therefore appears that there is no clear management protocol for children suffering from recurrent tonsillitis.

International tonsillectomy rates reported in the literature have been summarised in Table 2. Authors have expressed this rate differently. To allow for comparisons to be drawn, these rates have been adjusted and expressed per 100 000 people <19 years of age.

Table 2: International tonsillectomy rates, expressed per 100 000 people ≤ 19 years of age

Country	Year published	Rate per 100 000
Canada [28]	2004	190
England [24]	2010	304*
Scotland [28]	2004	450
Germany [26]	2013	480
Finland [28]	2004	605
Australia [28]	2004	620
Belgium [28]	2004	685
Netherlands [28]	2004	790
USA [1]	2012	791
Northern Ireland [28]	2004	850

*Tonsillectomy rate for children <15 years of age

Factors implicated in international and regional variation in adeno-/tonsillectomy rates

International and regional variation in adeno-/tonsillectomy rates has been ascribed to differences in clinical practice and referral patterns, rather than differences in clinical need or regional morbidity. [29,30,30,31] Capper and Canter [22] found that amongst the role players managing tonsillitis and SDB, general practitioners, otorhinolaryngologists and paediatricians failed to agree on the diagnostic features of tonsillitis, pharyngitis and upper respiratory tract infections. There was also professional disagreement on the indications for tonsillectomy amongst the groups and a statistically significant difference in perceived benefit of the procedure and expectations regarding the post-operative improvement in

symptoms (frequency of sore throats, irregular breathing, irritability and poor concentration). Tucker [32] highlights the fact that even amongst otorhinolaryngologists, there is disagreement about the significance of the signs and symptoms in children with recurrent tonsillitis. Bloor [33] noted that the attitude of otorhinolaryngologists towards tonsillectomy was also partly responsible for regional variation in the tonsillectomy rate. These differences in opinion and clinical practice reflect the uncertainty surrounding the clinical effectiveness and cost-effectiveness of the procedure.

Differences in the postgraduate training of otorhinolaryngology registrars has also been shown to influence surgical practice and regional tonsillectomy rates. [34] In addition, social class appears to play a role. In the past, tonsillectomy was performed far more frequently in children of higher socioeconomic status. This social class association has, however, been reversed. According to the 2005 Chief Medical Officer's Report (UK), tonsillectomy is now more common in children from less affluent backgrounds. [25] This is supported by the findings of international studies, which show that when access to healthcare is universally available, children of a lower socioeconomic status undergo tonsillectomy more frequently. [35,36] Physician to population ratio and patient proximity to a medical facility (geographical access barriers) have also been cited as playing a role in determining tonsillectomy rates. [37]

Tonsillectomy is more common in non-breastfed children, presumably due to the immunity conferred by breast milk to breastfed children. [38] The parental use of psychotropic medication and parental smoking in the home environment are also associated with higher tonsillectomy rates. [39,40] Children with a parent or sibling who underwent a tonsillectomy are more likely to undergo the procedure. [41] It appears that membership of private medical schemes may also play a role. Fergusson [42] reports that privately insured children under 7 years of age are more likely to undergo adeno-/tonsillectomy than their uninsured counterparts.

Some maintain that variation in adeno-/tonsillectomy rates reflect geographical differences in morbidity or burden of disease. Wasson and Prinsley [43] advise that any regional variation in tonsillectomy rate should be interpreted with caution. They suggest that where national guidelines are adopted and adhered to, variation might just represent regional variation in disease presentation and not a flouting of evidence-based guidelines. They reported a

tonsillectomy rate at a single university hospital that varied by as much as 100% over a 10-year period. This variation correlated with the frequency of acute tonsillitis and peritonsillar abscess disease presentation requiring admission to hospital for treatment.

Risk versus benefit of adeno-/tonsillectomy

The risk and potential complications of tonsillectomy are well documented and include the anaesthetic risk of laryngospasm; laryngeal oedema; aspiration; respiratory compromise; endotracheal tube ignition and cardiac arrest; as well as the intraoperative risk of blood loss; trauma to the teeth, tongue, pharynx, larynx and soft palate, lip, eye and mandible; and postoperative complications such as haemorrhage; delayed feeding and dehydration; nausea and vomiting; pain and otalgia; post-obstructive pulmonary oedema; velopharyngeal insufficiency; voice changes and nasopharyngeal stenosis. [44] Taking these risks into account, patients being considered for tonsillectomy should satisfy strict evidence-based criteria, aiding selection of those patients in whom benefit of the procedure exceeds risk.

Sore throat/throat infections as an indication for surgery:

Many are of the opinion that the stated benefits of tonsillectomy have been exaggerated. In their landmark non-randomised and randomised-controlled studies conducted in Pittsburgh (USA) in 1984 and 2002, Paradise et al. [23,45] set out to determine the efficacy of tonsillectomy in reducing the number and severity of subsequent throat infections. In their initial study, eligibility required children to be severely affected by recurrent throat infections and meet stringent inclusion criteria in 4 categories: frequency of throat infection, clinical features, treatment and documentation. These criteria are termed the 'Paradise criteria.' They noted that tonsillectomy is efficacious in reducing the number and severity of throat infections for 2 years, and possibly a third year, following surgery. The study concluded that the degree of benefit experienced justified tonsillectomy in those meeting the strict inclusion criteria, but also emphasised that many children treated non-surgically improved spontaneously. The benefit seems modest: cases (tonsillectomy group) suffered 1.9 fewer episodes of throat pain in the first postoperative year, when compared to controls (non-tonsillectomy group.) Curiously, however, the sore throat associated with performing the surgery was excluded from the data. Controls (non-tonsillectomy group) experienced only 1.17 episodes of throat infection in the first postoperative year, 1.03 episodes in the second year and 0.45 episodes in the third year.

In the follow-up study, the 'Paradise criteria' were relaxed somewhat to evaluate whether or not tonsillectomy would afford equivalent benefit to those children less severely affected than those in the previous trial. Findings were that controls (non-tonsillectomy group) experienced 0.43; 0.31 and 0.16 episodes of throat infection in the first, second and third postoperative years respectively. Cases (tonsillectomy group) suffered 0.1 episodes of throat infection in the year post surgery. The study concludes that the limited benefit conferred by tonsillectomy in moderately affected children is outweighed by the risk, morbidity and cost of the surgery. In both studies, the mean number of days of sore throat in the 12 months following surgery was not statistically different between the operated and the non-operated group.

Other studies reported that in children on waiting lists for adeno/-tonsillectomy, 18.6-50% of individuals no longer required surgery after a follow-up period of up to 3 years. [46-50] This points towards the understanding that there is a spontaneous reduction in rates of recurrent infection over time.

It has long been accepted that tonsillectomy in children suffering from recurrent throat infections may dramatically improve quality of life, reduce the number of visits to healthcare providers and reduce antibiotic use. [51] The evidence in support of this opinion is limited and of poor quality. Most trials investigating efficacy of the procedure [23,45,52] display bias due to poorly-defined entrance criteria, non-randomised selection of cases, exclusion of the most severely affected patients and reliance on caregivers for data collection. However, in a 2014 update of a 2009 Cochrane review [4] assessing the effectiveness of tonsillectomy (with or without adenoidectomy) in reducing the frequency and severity of sore throat in patients with chronic or recurrent acute tonsillitis, the following conclusions were reached:

- Surgery, when compared to non-surgical management, reduced the number of episodes and duration of sore throat in children in their first postoperative year. Modest benefit can be expected at most. Operated patients experienced 1.4 fewer episodes of sore throat in the first year postoperatively, at the cost of 1 sore throat as a consequence of surgery.

- When episodes of moderate or severe sore throat were considered, only 0.2 fewer episodes of pain were experienced in the first postoperative year, at the cost of 1 sore throat as a consequence of surgery.
- Children with the most severe symptoms were most likely to experience benefit from surgical management.
- Some children's symptoms resolve without any surgery.
- Tonsillectomy prevents tonsillitis, but the effect of surgery on pharyngitis-related sore throats is much less predictable.
- No firm conclusions can be made on the effectiveness of surgical as opposed to non-surgical management as there is insufficient information available.
- Any potential 'benefit' from tonsillectomy must be weighed up against the risks of the procedure, such as primary and secondary haemorrhage and postoperative pain and discomfort.

Sleep disordered breathing as an indication for surgery:

Sleep disordered breathing is common. Primary snoring is evident in up to 10% of children [53] and the prevalence of OSA in the paediatric population is 1-4%. [54] It is concerning to note that 30-40% of children clinically diagnosed with SDB demonstrate behavioural problems, including enuresis, attention deficit hyperactivity disorder, aggression, anxiety, depression and somatisation. [55,56] There is also an association between OSA and poor school performance, and a quality of life similar to that experienced by children suffering from chronic diseases like asthma or juvenile rheumatoid arthritis. [57,58] SDB has been shown to be associated with increased healthcare utilisation and cost, stemming from 40% more hospital visits and, overall, a 215% higher healthcare usage when compared with a control population. This is primarily due to their increased rate of respiratory tract infections. [59] The obstructive sleep apnoea syndrome (OSAS) is associated with various adverse effects on health and wellbeing, including cognitive and behavioural deficits. [60] Adenotonsillar hypertrophy has been identified as the most common cause of SDB/OSAS and adenotonsillectomy is often regarded as the primary management option.

Tonsillar hypertrophy is defined as grade 3+ or 4+ tonsils according to the scale devised by Brodsky. [61] This implies that hypertrophied tonsils fill >50% of the transverse oropharyngeal space. Combined volume of the adenoids and tonsils correlates more closely with severity of

SDB than tonsil size alone. It must also be noted that tonsil and adenoid size is one of the factors potentially contributing to multifactorial or multilevel upper airway obstruction, with craniofacial anatomy, obesity and neuromuscular tone also contributing to the airway patency. In such instances, one might expect polysomnographic parameters to remain abnormal following tonsillectomy, with patients experiencing residual or recurrent symptoms of SDB. [62,63] Most children experience a degree of improvement in their SDB following tonsillectomy, but only 60-70% of patients experience complete resolution of their symptoms. Only 10-25% of obese children experience resolution of their symptoms. [62] It is important for parents to be aware of this and not to harbour unrealistic expectations of improvement in symptoms following surgery. This is another factor potentially influencing the decision of whether or not to proceed with surgery.

Overnight polysomnography is the gold standard in making the diagnosis of SDB. The *American Academy of Paediatrics* advises polysomnography in all children suspected of experiencing SDB, prior to surgical intervention. [12] Other physicians feel that it is not necessary to request polysomnography this frequently, as it gives no insight into the impact of the sleep disorder on the patient's general wellbeing. Otorhinolaryngologists request polysomnography in less than 10% of children undergoing adeno-/tonsillectomy. [64]

A literature review performed by Garetz [65] in 2006 suggested that adenotonsillectomy, performed against a backdrop of SDB, demonstrated improvements in behaviour, neurocognitive function, quality of life, and vocal quality. Similar studies have demonstrated improvement in physical and emotional symptoms, as well as daytime functioning. [66-68] In children with OSA, pulmonary hypertension was also shown to normalise on post-tonsillectomy echocardiography. Although most studies showed improvement in at least one outcome measure, these results are potentially misleading as none of the studies was randomised.

The CHAT trial (Childhood Adenotonsillectomy Trial) [69] published in 2013 was devised to address this shortcoming. 464 children with OSAS, aged 5-9 years of age, were randomly assigned to early adenotonsillectomy or watchful waiting. Outcome measures included general health, polysomnographic findings, behavioural and neurocognitive changes, assessed at baseline and 7 months after adenotonsillectomy. The study concluded that in

children of school going age with OSAS, surgery offered no improvement in attention or executive function. There was, however, improvement in behaviour, quality of life and polysomnographic findings following surgery, supporting early adenotonsillectomy in children with OSAS. This benefit was greater in obese children, although 33% of them had residual OSAS postoperatively. It should be noted that outcome measures showed improvement in the watchful waiting group too, but not to the same extent. Polysomnography, for example, improved in 79% of children undergoing surgery, and nearly half (46%) of the children in the watchful waiting group. With few adverse events, the CHAT trial supported the safety of both surgery and watchful waiting, but emphasised the importance of close monitoring of the watchful waiting group. Watchful waiting was deemed a valid therapeutic option.

Black children have been shown to suffer from more severe OSAS than white children, with less improvement in their polysomnographic findings postoperatively. [4,70] Black children did, however, show a relatively greater improvement in polysomnographic findings after early adenotonsillectomy, as opposed to watchful waiting. [4]

Cost-effectiveness of adeno-/tonsillectomy

The literature is conflicting when considering the cost-effectiveness of performing tonsillectomy versus watchful waiting. In the USA, Chang et al [71] describe a healthcare saving of 33% in the two years following adenotonsillectomy compared to the two years preceding surgery. This saving is the result of 32% fewer outpatient visits and 66% less antibiotic use, but only represents a fraction (37%) of the cost of performing an adenotonsillectomy. Tarasiuk [59] similarly demonstrated a 30% reduction in healthcare costs in Israel in children with SDB who underwent adenotonsillectomy. In the UK [72], the cost of managing a child with recurrent sore throats over a 2-year period equated to about a third of the cost of managing the patient surgically, with the modest benefit in the tonsillectomy group of 3.5 episodes of sore throat fewer over the 2-year period.

It seems prudent to try and avoid unnecessary surgery in children with recurrent throat infections who have a favourable natural history and are likely to improve on their own. It is also important to note that watchful waiting does not imply inaction, but rather close monitoring and documentation of each episode of tonsillitis. In the Netherlands, Buskens [16]

concluded that in children suffering from mild to moderate throat infections and adenotonsillar hypertrophy (who did not satisfy Paradise Criteria [45]), surgery was associated with a significant increase in costs and only minimal benefit to patients. The surgical group experienced a negligible 0.21 fewer episodes of fever and throat infections per year and 0.53 fewer upper respiratory tract infections per year, with a 47% increase in cost. 6% of patients experienced surgery-related adverse events.

Identification of gaps or needs for further research

Comparative developing world adeno-/tonsillectomy rates

In general, there is a paucity of data describing adeno-/tonsillectomy rates in the developing world. It would be interesting to determine the overall South African adeno-tonsillectomy rate (including the state sector) and to compare this rate with other developing countries.

Rheumatic fever prophylaxis

Rheumatic fever is a multi-system inflammatory disease occurring predominantly in the developing world. This autoimmune inflammatory process, with a tendency to recur, is a potential complication resulting from group A beta-haemolytic streptococcal pharyngeal infection. Rheumatic fever is associated with significant morbidity and possible mortality, especially as a result of cardiac manifestations, termed rheumatic heart disease. Valve insufficiency, cardiac failure and pericarditis are the most the common cardiac manifestations. Prevention of rheumatic fever involves two approaches. Primary prevention is aimed at preventing rheumatic fever in patients with proven streptococcal throat infection, through the appropriate use of antibiotics. In the developing world setting, however, access to laboratory facilities is limited and a clinical prediction rule (CPR) is often employed. Clinical features are used to predict which cases of sore throat are likely to be attributable to group A beta-haemolytic streptococcus, and antibiotics are administered without necessarily confirming infection. Secondary prevention aims to prevent recurrent rheumatic fever in those previously afflicted. The *American Heart Association* advises the prophylactic administration of antibiotics for a duration determined by risk stratification.

Authorities and policy-makers in the field of rheumatic heart disease have expressed interest in the link between tonsillectomy rates and rates of rheumatic heart disease in developing countries. Relaxing the adeno-/tonsillectomy selection criteria and performing adeno-/tonsillectomy more liberally or in high-risk groups could theoretically assist in

lowering unacceptably high rates of rheumatic fever/rheumatic heart disease in the developing world. Studies dating back to the 1920's investigated the risk of rheumatic fever recurrence following tonsillectomy. Results were conflicting. Ingerman and Wilson [73] noted that 76% of cases (previous rheumatic fever, had tonsillectomy) experienced recurrence of rheumatic manifestations within one to eleven years post tonsillectomy. In comparison, 80% of controls (previous rheumatic fever, no tonsillectomy performed) experienced recurrence. There was a negligible 4% difference in recurrence rates between cases and controls. They concluded that the high recurrence rate in both groups was attributable to infection originating in multiple sites i.e. tonsils, teeth, ears, sinuses and lymph nodes. In stark contrast, Lawrence [74] described a 49% rheumatic fever recurrence rate prior to tonsillectomy and a 36% recurrence rate following tonsillectomy, in the same group. He concluded that tonsillectomy was the most important means of preventing acute rheumatic fever and rheumatic manifestations. Kaiser, [75] in a study population of 48 000 children, found that the incidence of rheumatic fever in tonsillectomised children was 1.9%, compared to 3% in non-tonsillectomised children. He concluded that those having undergone tonsillectomy were less likely to suffer an initial episode of rheumatic fever and recurrence of episodes thereafter.

Whether or not tonsillectomy should be considered as a reasonable prophylactic option in rheumatic fever is a question that has yet to be answered adequately. At present, tonsillectomy in rheumatic fever does not form part of the *American Heart Association* guidelines.

References

1 Boss EF, Marsteller JA, Simon AE. Outpatient tonsillectomy in children: demographic and geographic variation in the United States, 2006. J Pediatr 2012;160(5):814-819.

2 Owings MF, Kozak LJ. Ambulatory and inpatient procedures in the United States, 1996. Vital Health Stat 13 1998 Nov;(139):1-119.

3 Cullen KA, Hall MJ, Golosinskiy A, National Center for Health Statistics (US). Ambulatory surgery in the United States, 2006. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics; 2009.

4 Burton MJ, Glasziou PP, Chong LY, Venekamp RP. Tonsillectomy or adenotonsillectomy versus non-surgical treatment for chronic/recurrent acute tonsillitis. The Cochrane Library 2014.

5 Richardson MA. Sore throat, tonsillitis, and adenoiditis. Med Clin North Am 1999;83(1):75-83.

6 Jung KY, Lim HH, Choi G, Choi JO. Age-related changes of IgA immunocytes and serum and salivary IgA after tonsillectomy. Acta Otolaryngol Suppl 1996;523:115-119.

7 Paulussen C, Claes J, Claes G, Jorissen M. Adenoids and tonsils, indications for surgery and immunological consequences of surgery. Acta Otorhinolaryngol Belg 2000;54(3):403-408.

8 Pratt LW, Gallagher RA. Tonsillectomy and adenoidectomy: incidence and mortality, 1968--1972. Otolaryngol Head Neck Surg (1979) 1979 Mar-Apr;87(2):159-166.

9 Rosenfeld RM, Green RP. Tonsillectomy and adenoidectomy: changing trends. Ann Otol Rhinol Laryngol 1990 Mar;99(3 Pt 1):187-191.

10 Parker NP, Walner DL. Trends in the indications for pediatric tonsillectomy or adenotonsillectomy. Int J Pediatr Otorhinolaryngol 2011;75(2):282-285.

11 Hussein M, Bingham B, Buchan L, Dawson A. Scottish Intercollegiate Guidelines Network 117 (2010) Management of sore throat and indications for tonsillectomy. A national clinical guideline. 2010.

12 Baugh RF, Archer SM, Mitchell RB, Rosenfeld RM, Amin R, Burns JJ, et al. Clinical practice guideline: tonsillectomy in children. Otolaryngol Head Neck Surg 2011 Jan;144(1 Suppl):S1-30.

13 Clement WA, Dempster JH. Implementation by Scottish otolaryngologists of the Scottish Intercollegiate Guidelines Network document Management of Sore Throats and the Indications for Tonsillectomy: four years on. The Journal of Laryngology & Otology 2004;118(05):357-361.

14 ENT U. Indications for tonsillectomy: position paper. 2009.

15 Darrow DH, Siemens C. Indications for tonsillectomy and adenoidectomy. Laryngoscope 2002;112(S100):6-10.

16 Buskens E, van Staaij B, van den Akker J, Hoes AW, Schilder AG. Adenotonsillectomy or watchful waiting in patients with mild to moderate symptoms of throat infections or adenotonsillar hypertrophy: a randomized comparison of costs and effects. Archives of Otolaryngology–Head & Neck Surgery 2007;133(11):1083-1088.

17 Marshall T, Anantharachagan A, Chan VG, Hoo SS, Yeo JC. How many tonsillectomies are evidence-based? Journal of Clinical Excellence 2001;3(1):23-25.

18 Blair R, McKerrow W, Carter N, Fenton A. The Scottish tonsillectomy audit. The Journal of Laryngology & Otology 1996;110(20):1-25.

19 Brown P, Ryan R, Yung M, Browne J, Copley L, Cromwell D. The National Prospective Tonsillectomy Audit: Final Report of an Audit Carried out in England and Northern Ireland Between 2003 and 2004. London, United Kingdom: Royal College of Surgeons of England 2005.

20 Conlon B, Donnelly M, McShane D. Improvements in health and behaviour following childhood tonsillectomy: a parental perspective at 1 year. Int J Pediatr Otorhinolaryngol 1997;41(2):155-161.

21 Chervin RD, Ruzicka DL, Giordani BJ, Weatherly RA, Dillon JE, Hodges EK, et al. Sleep-disordered breathing, behavior, and cognition in children before and after adenotonsillectomy. Pediatrics 2006;117(4):e769-778.

22 Capper R, Canter R. Is there agreement among general practitioners, paediatricians and otolaryngologists about the management of children with recurrent tonsillitis? Clinical Otolaryngology & Allied Sciences 2001;26(5):371-378.

23 Paradise JL, Bluestone CD, Bachman RZ, Colborn DK, Bernard BS, Taylor FH, et al. Efficacy of tonsillectomy for recurrent throat infection in severely affected children: results of parallel randomized and nonrandomized clinical trials. N Engl J Med 1984;310(11):674-683.

24 Suleman M, Clark M, Goldacre M, Burton M. Exploring the variation in paediatric tonsillectomy rates between English regions: a 5-year NHS and independent sector data analysis. Clinical Otolaryngology 2010;35(2):111-117.

25 Donaldson L. Chief Medical Officer's Report. 2005.

26 Volbracht E. Tonsillectomy in Germany: Marked regional variations in the most common inpatient operation performed on children and adolescents: Faktencheck Gesundheit Mandeloperation: Healthcare Fact Check 2013: German Federal Statistical Office. 2013.

27 Materia E, Di Domenicantonio R, Baglio G, Marchisio P, Perletti L, Lispi L, et al. Epidemiology of tonsillectomy and/or adenoidectomy in Italy. Pediatr Med Chir 2004 May-Jun;26(3):179-186.

28 Van Den Akker E, Hoes A, Burton M, Schilder A. Large international differences in (adeno) tonsillectomy rates. Clinical Otolaryngology & Allied Sciences 2004;29(2):161-164.

29 Cummins RO, Jarman B, White PM. Do general practitioners have different "referral thresholds"? Br Med J (Clin Res Ed) 1981 Mar 28;282(6269):1037-1039.

30 Fleming D, Crombie D, Cross K. An examination of practice referral rates in relation to practice structure, patient demography and case mix. Health Trends 1991;23(3):100-104.

31 Wilkin D, Smith AG. Variation in general practitioners' referral rates to consultants. J R Coll Gen Pract 1987 Aug;37(301):350-353.

32 Tucker A. The current status of tonsillectomy-a survey of otolaryngologists. Clinical Otolaryngology & Allied Sciences 1982;7(6):367-372.

33 Bloor MJ, Venters GA, Samphier ML. Geographical variation in the incidence of operations on the tonsils and adenoids. The Journal of Laryngology & Otology 1978;92(10):883-895.

34 Roos NP, Roos Jr LL, Henteleff PD. Elective surgical rates—do high rates mean lower standards? Tonsillectomy and adenoidectomy in Manitoba. N Engl J Med 1977;297(7):360-365.

35 Bisset AF, Russell D. Grommets, tonsillectomies, and deprivation in Scotland. BMJ 1994 Apr 30;308(6937):1129-1132.

36 Croxford R, Friedberg J, Coyte P. Socio-economic status and surgery in children: myringotomies and tonsillectomies in Ontario, Canada, 1996–2000. Acta Paediatrica 2004;93(9):1245-1250.

37 Mayer ML, Beil HA, von Allmen D. Distance to care and relative supply among pediatric surgical subspecialties. J Pediatr Surg 2009;44(3):483-495.

38 Pisacane A, Impagliazzo N, De Caprio C, Criscuolo L, Inglese A, Pereira de Silva MC. Breast feeding and tonsillectomy. BMJ 1996 Mar 23;312(7033):746-747.

39 Bain DJ, Sales CM. Referring children to an ENT department and prescribing psychotropic drugs to their mothers. Br Med J (Clin Res Ed) 1981 Aug 29;283(6291):585-587.

40 Strachan DP, Cook DG. Health effects of passive smoking. Parental smoking, middle ear disease and adenotonsillectomy in children. Thorax 1998 Jan;53(1):50-56.

41 Fried D. On tonsillectomy: mom's personal experience. The Lancet 1995;346(8976):714.

42 Fergusson DM, Horwood LJ. Private medical insurance and elective surgery during early childhood. N Z Med J 1985 Jul 10;98(782):538-540.

43 Wasson J, Prinsley P. Tonsillectomy: variation in practice reflecting regional variation in disease presentation. Clinical Otolaryngology 2011;36(5):522-524.

44 Acevedo JL, Shah RK, Brietzke SE. Systematic review of complications of tonsillotomy versus tonsillectomy. Otolaryngol Head Neck Surg 2012 Jun;146(6):871-879.

45 Paradise JL, Bluestone CD, Colborn DK, Bernard BS, Rockette HE, Kurs-Lasky M. Tonsillectomy and adenotonsillectomy for recurrent throat infection in moderately affected children. Pediatrics 2002;110(1):7-15.

46 Woolford T, Ahmed A, Willatt D, Rothera M. Spontaneous resolution of tonsillitis in children on the waiting list for tonsillectomy. Clinical Otolaryngology & Allied Sciences 2000;25(5):428-430.

47 Wood B, Wong Y, Theodoridis C. Paediatricians look at children awaiting adenotonsillectomy. The Lancet 1972;300(7778):645-647.

48 Fox R, Temple M, Owens D, Short A, Tomkinson A. Does tonsillectomy lead to improved outcomes over and above the effect of time? A longitudinal study. The Journal of Laryngology & Otology 2008;122(11):1197-1200.

49 Freeland AP, Curley JW. The consequences of delay in tonsil surgery. Otolaryngol Clin North Am 1987 May;20(2):405-408.

50 Prim M, de Diego J, Larrauri M, Diaz C, Sastre N, Gavilan J. Spontaneous resolution of recurrent tonsillitis in pediatric patients on the surgical waiting list. Int J Pediatr Otorhinolaryngol 2002;65(1):35-38.

51 Goldstein NA, Stewart MG, Witsell DL, Hannley MT, Weaver EM, Yueh B, et al. Quality of life after tonsillectomy in children with recurrent tonsillitis. Otolaryngology-Head and Neck Surgery 2008;138(1):S9-S16.

52 van Staaij BK, van den Akker EH, Rovers MM, Hordijk GJ, Hoes AW, Schilder AG. Effectiveness of adenotonsillectomy in children with mild symptoms of throat infections or adenotonsillar hypertrophy: open, randomised controlled trial. BMJ 2004 Sep 18;329(7467):651.

53 Urschitz MS, Wolff J, Sokollik C, Eggebrecht E, Urschitz-Duprat PM, Schlaud M, et al. Nocturnal arterial oxygen saturation and academic performance in a community sample of children. Pediatrics 2005 Feb;115(2):e204-9.

54 Ali NJ, Pitson DJ, Stradling JR. Snoring, sleep disturbance, and behaviour in 4-5 year olds. Arch Dis Child 1993 Mar;68(3):360-366.

55 Basha S, Bialowas C, Ende K, Szeremeta W. Effectiveness of adenotonsillectomy in the resolution of nocturnal enuresis secondary to obstructive sleep apnea. Laryngoscope 2005;115(6):1101-1103.

56 Goldstein NA, Post JC, Rosenfeld RM, Campbell TF. Impact of tonsillectomy and adenoidectomy on child behavior. Archives of Otolaryngology–Head & Neck Surgery 2000;126(4):494-498.

57 Baldassari CM, Mitchell RB, Schubert C, Rudnick EF. Pediatric obstructive sleep apnea and quality of life: a meta-analysis. Otolaryngology-head and neck surgery 2008;138(3):265-273.

58 Gozal D. Sleep-disordered breathing and school performance in children. Pediatrics 1998 Sep;102(3 Pt 1):616-620.

59 Tarasiuk A, Simon T, Tal A, Reuveni H. Adenotonsillectomy in children with obstructive sleep apnea syndrome reduces health care utilization. Pediatrics 2004 Feb;113(2):351-356.

60 Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J, et al. Diagnosis and management of childhood obstructive sleep apnea syndrome. Pediatrics 2012 Sep;130(3):e714-55.

61 Brodsky L. Modern assessment of tonsils and adenoids. Pediatr Clin North Am 1989 Dec;36(6):1551-1569.

62 Friedman M, Wilson M, Lin H, Chang H. Updated systematic review of tonsillectomy and adenoidectomy for treatment of pediatric obstructive sleep apnea/hypopnea syndrome. Otolaryngology-Head and Neck Surgery 2009;140(6):800-808.

63 Suen JS, Arnold JE, Brooks LJ. Adenotonsillectomy for treatment of obstructive sleep apnea in children. Archives of Otolaryngology–Head & Neck Surgery 1995;121(5):525-530.

64 Mitchell RB, Pereira KD, Friedman NR. Sleep-Disordered Breathing in Children: Survey of Current Practice. Laryngoscope 2006;116(6):956-958.

65 Garetz SL. Behavior, cognition, and quality of life after adenotonsillectomy for pediatric sleep-disordered breathing: summary of the literature. Otolaryngology-Head and Neck Surgery 2008;138(1):S19-S26.

66 Mitchell RB, Kelly J. Behavior, neurocognition and quality-of-life in children with sleep-disordered breathing. Int J Pediatr Otorhinolaryngol 2006;70(3):395-406.

67 Flanary VA. Long-term effect of adenotonsillectomy on quality of life in pediatric patients. Laryngoscope 2003;113(10):1639-1644.

68 de Serres LM, Derkay C, Sie K, Biavati M, Jones J, Tunkel D, et al. Impact of adenotonsillectomy on quality of life in children with obstructive sleep disorders. Archives of Otolaryngology–Head & Neck Surgery 2002;128(5):489-496.

69 Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, et al. A randomized trial of adenotonsillectomy for childhood sleep apnea. N Engl J Med 2013;368(25):2366-2376.

70 Redline S, Tishler PV, Schluchter M, Aylor J, Clark K, Graham G. Risk factors for sleep-disordered breathing in children: associations with obesity, race, and respiratory problems. American Journal of Respiratory and Critical Care Medicine 1999;159(5):1527-1532.

71 Chang JJ, Buchanan P, Geremakis C, Sheikh K, Mitchell RB. Cost analysis of tonsillectomy in children using medicaid data. J Pediatr 2014;164(6):1346-1351.

72 Wilson JA, Steen IN, Lock CA, Eccles MP, Carrie S, Clarke R, et al. Tonsillectomy: a cost-effective option for childhood sore throat? Further analysis of a randomized controlled trial. Otolaryngol Head Neck Surg 2012 Jan;146(1):122-128.

73 Ingerman E, Wilson MG. RHEUMATISM: ITS MANIFESTATIONS IN CHILDHOOD TODAY: TONSILLECTOMY IN ITS RELATION TO THE RECURRENCE OF RHEUMATISM. J Am Med Assoc 1924;82(10):759-764.

74 LAWRENCE WS. EFFECT OF TONSILLECTOMY ON THE RECURRENCE OF ACUTE RHEUMATIC FEVER AND CHOREA A STUDY OF NINETY-FOUR CHILDREN. J Am Med Assoc 1920;75(16):1035-1041.

75 Kaiser AD. Incidence of Rheumatism, Chorea and Heart Disease in Tonsillectomized Children: A Control Study. J Am Med Assoc 1927;89(27):2239-2245.

76 Rosefsky JB. Tonsillectomies and Adenotonsillectomies—Will the Debate Never Be Over? Pediatrics 2003;112(1):205-205.

77 Government SA. Stats SA GHS 2013: General Household Survery 2013. 2014;P0318.

78 Ataguba J. Health care financing in South Africa: moving towards universal coverage. Continuing Medical Education 2010;28(2).

79 Johnson LB, Elluru RG, Myer CM. Complications of adenotonsillectomy. Laryngoscope 2002;112(S100):35-36.

80 Vijayashree M, Viswanatha B, Sambamurthy B. Clinical and Bacteriological Study of Acute Tonsillitis. 2012;1(2):3.

PART C: ARTICLE MANUSCRIPT

Tonsillectomy rates in the South African private healthcare sector

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Abstract

Background. Adeno-/tonsillectomy is a commonly performed procedure with internationally standardised and recognised indications. Despite this, there exists considerable international (190 – 850/100 000 people ≤19 years of age) and regional variation in adeno-/tonsillectomy rates. This variation has been ascribed to differences in clinical practice and referral patterns, as well as social and family factors, rather than differences in clinical need or regional morbidity.

Objectives. To describe the adeno-/tonsillectomy rate in the South African private healthcare sector, and regional variations thereof. To compare local rates with international rates and to assess current trends in adeno-/tonsillectomy clinical practice.

Methods. Analysis of adeno-/tonsillectomy data from January 2012 to December 2013, provided by the largest South African private healthcare funder, accounting for 30% of the medical scheme market. Rates are expressed per 100 000 people ≤19 years of age.

Results. The tonsillectomy rate in the South African private healthcare sector was 1 888/100 000 people ≤19 years of age in 2012. In 2013, the rate dropped significantly (p-value <0.001) to 1 755/100 000. This is more than double the highest national tonsillectomy rate reported in the literature. There was also considerable regional variation in the adeno-/tonsillectomy rate within South Africa. Otorhinolaryngologists are responsible for approximately 80% of adeno-/tonsillectomies performed in the South African private healthcare sector.

Discussion. The South African tonsillectomy rate is very high when compared to international trends and varies regionally within the country. The literature does not support an increased burden of disease as the reason behind this. Rather, it is differences in training and clinical practice of clinicians, as well as social and family factors that have been implicated.

Conclusion. The adeno-/tonsillectomy rate in the South African private healthcare sector is substantially higher than international norms. The reasons for this discrepancy require further consideration and investigation.

Background

Tonsillectomy, performed with or without adenoidectomy, is one of the most frequently performed surgical procedures in children. [1,2] In the United States of America (USA), tonsillectomy accounts for one third of the paediatric procedures performed under general anaesthesia. [3] It is, however, a procedure that lacks evidence of being clinically effective [4] and cost-effective. [5] It is interesting to note that the tonsillectomy rate in the USA has been steadily declining in recent times, [1] as evidence in support of the procedure has been found to be equivocal. A similar trend is evident in the United Kingdom (UK), with only a quarter the number of tonsillectomies being performed in the modern era compared with the early 20th century. [6]

The two major indications for tonsillectomy are recurrent throat infections and sleep disordered breathing (SDB), both of which can impact significantly on general health and quality of life. [7] In the 1980s, 80% of tonsillectomies were performed for infective indications i.e. recurrent tonsillitis or sore throat. [7] There has, however, been a shift in clinical practice in recent years. In 2011, 85% of tonsillectomies were performed for obstructive symptoms i.e. sleep disordered breathing. [8] Despite well-established, evidence-based guidelines having been published by various groups (Table 1), the indications for tonsillectomy remain controversial and have been a source of much debate amongst the role players managing these patients. [9] It is surprising to note, therefore, that for such a common procedure with internationally recognised and standardised indications, there exists significant international variation in tonsillectomy rates (Table 2). Furthermore, tonsillectomy rates show considerable regional variation within the same country. This variation has been ascribed to differences in clinical practice and referral patterns, as well as social [10] and family factors [11], rather than differences in clinical need or regional morbidity. [12,13,13,14]

Between 2000 and 2005, Suleman et al. [15] reported a national annual tonsillectomy rate of 304/100 000 children <15years of age (95% CI 320-324) for the National Health Service (NHS) in England. Tonsillectomy rates varied 7-fold across local authority areas in England, from as low as 102/100 000 (95% CI 83-125) to as high as 754/100 000 (95% CI 690-822). This substantial variation was even greater when tonsillectomy data from the independent

healthcare sector (representing 15% of ear, nose and throat activity in the UK) was factored into the calculations. In Scotland in 1992, regional tonsillectomy rates varied between 63 and 179/100 000, roughly a 3-fold variation. [16]

In the USA, Boss et al. [1] reported that tonsillectomy rates in the West of America were lower than in the South (29/10 000 versus 125/10 000; $P < .01$) and not significantly different in other regions. Compared with large central metropolitan areas, tonsillectomy rates were higher in small/medium sized metropolitan areas (118/10 000 versus 42/10 000; $P < .05$), and not significantly different in large fringe or non-metropolitan areas. Tonsillectomy rates in children insured by the state funded Medicaid program in the USA were similar to those insured by private sources.

In Germany, the annual average adeno-/tonsillectomy rate between 2007 and 2010 was reported as 480/100 000 for children and adolescents ≤19 years of age. [17] The tonsillectomy rate varied up to 3-fold among German federal states. There was an even greater variation when tonsillectomy rates were analysed at a district level, with rates in some districts being up to eight times higher than in other districts. The frequency of surgery was >30% above the national average in 71 of 412 districts.

The South African adeno-/tonsillectomy rate has never been described before. It has therefore been difficult to compare local practice to international norms. Describing the adeno-/tonsillectomy rate is a daunting task, due to the complexity of the South African healthcare system, comprising both public and private sectors. In 2013, the private healthcare sector catered for the 18% of the population (9.7 million people) [18] who could afford the monthly premiums or those who were willing to pay a fee for private healthcare. Despite only serving 18% of the population, approximately 79% of doctors working in South Africa are employed in the private healthcare sector. [19] This audit focused on the private healthcare sector and excluded the resource-constrained public healthcare sector, as adeno-/tonsillectomy in the state sector is generally reserved for children with severe SDB, due to poor access to healthcare and specialist services. Uninsured South African patients therefore have limited access to tonsillectomy at state hospitals, where the indications for such surgical procedures are often modified to be locally relevant and ensure sustainable service provision. The public sector serves 82% of the population (43.4 million people).

Despite serving the vast majority of South Africa's population, only 21% of doctors working in South Africa are employed in the public healthcare sector. The public healthcare system is heavily burdened, with facilities overcrowded, underfunded and understaffed.

It has long been accepted that tonsillectomy in children suffering from recurrent throat infections improves quality of life, reduces the number of visits to healthcare providers and reduces antibiotic use. [20] However, evidence supporting surgery for infective/sore throat indications is equivocal. Most trials investigating efficacy of the procedure [21-23] display bias due to poorly defined entrance criteria, non-randomised selection of cases, exclusion of the most severely affected patients and reliance on caregivers for data collection. In a 2014 Cochrane review [4] assessing the effectiveness of adeno-/tonsillectomy in reducing the frequency and severity of sore throat in patients with chronic or recurrent acute tonsillitis, the following conclusions were reached:

- Surgery, when compared to non-surgical management, reduced the number of episodes and duration of sore throat in children in their first postoperative year. Modest benefit can be expected at most. Operated patients experienced 1.4 fewer episodes of sore throat in the first year postoperatively, at the cost of 1 sore throat as a consequence of surgery.
- When episodes of moderate or severe sore throat were considered, only 0.2 fewer episodes of pain were experienced in the first postoperative year, at the cost of 1 sore throat as a consequence of surgery.
- Children with the most severe symptoms were most likely to experience benefit from surgical management.
- Some children's symptoms resolve without any surgery.
- Tonsillectomy prevents tonsillitis, but the effect of surgery on pharyngitis-related sore throats is much less predictable.
- No firm conclusions can be reached on the effectiveness of surgical as opposed to non-surgical management as there is insufficient information available.
- Any potential 'benefit' from tonsillectomy must be weighed up against the risks of the procedure, such as primary and secondary haemorrhage and postoperative pain and discomfort.

  Adeno-/tonsillectomy is, therefore, a procedure in search of evidence.

Table 1: Indications for adeno-/tonsillectomy

	Paradise Criteria	Scottish Intercollegiate Guideline Network (SIGN)	AAO-HNS*
Frequency of throat infections	≥7 in preceding year OR ≥5 per year in preceding 2 years OR ≥3 per year in preceding 3 years	≥7 in preceding year OR ≥5 per year in preceding 2 years OR ≥3 per year in preceding 3 years	≥7 in preceding year OR ≥5 per year in preceding 2 years OR ≥3 per year in preceding 3 years
Clinical features	**In addition to sore throat, one or more of the following:** Temperature >38.3°C OR Cervical lymphadenopathy (tender or >2 cm) OR Tonsillar exudate OR Culture positive for group A β-haemolytic streptococcus		**In addition to sore throat, one or more of the following:** Temperature >38.3°C OR Cervical lymphadenopathy (tender or >2 cm) OR Tonsillar exudate OR Culture positive for group A β-haemolytic streptococcus
Modifying factors: Favouring tonsillectomy if frequency criteria not met			Multiple antibiotic allergy/intolerance History of peritonsillar abscess PFAPA (Periodic fever, Aphthous stomatitis, Pharyngitis and Adenitis)
Antibiotics	Administered in conventional dose for suspected/proven streptococcal episodes		
Documentation	Each episode and associated clinical features recorded	Episodes should be well documented	Each episode and associated clinical and social features recorded
Sleep disordered breathing/ polysomnography			Counsel caregivers about tonsillectomy as a means to improve health in children with abnormal polysomnography. Ask about comorbid conditions that might improve with tonsillectomy: growth retardation, poor school, performance, enuresis, behavioural problems
Watchful waiting	Observe for 12 months, due to tendency of throat infections to improve over time		

* American Academy of Otolaryngology-Head and Neck Surgery

Table 2: International tonsillectomy rates, expressed per 100 000 people ≤ 19 years of age

Country	Year published	Rate per 100 000
Canada [24]	2004	190
England [15]	2010	304*
Scotland [24]	2004	450
Germany [17]	2013	480
Finland [24]	2004	605
Australia [24]	2004	620
Belgium [24]	2004	685
Netherlands [24]	2004	790
USA [1]	2012	791
Northern Ireland [24]	2004	850

*Tonsillectomy rate for children <15 years of age

Objectives

The South African tonsillectomy rate has, to the authors' knowledge, never been reported. This audit set out to describe the tonsillectomy rate in the South African private healthcare sector, which compares favourably with health systems in the developed world and countries in which tonsillectomy rates have been reported. The objective was to define both national and regional adeno-/tonsillectomy rates. Determining the tonsillectomy rate in the South African private healthcare sector would provide a tool enabling comparisons of South African practice with international trends. It would also aid in justifying recommendations regarding the modification of local tonsillectomy indications, to align South African practice with internationally accepted norms. This audit also set out to identify and comment on trends in clinical practice with regard to adeno-/tonsillectomy in the South African private healthcare sector.

Methods

A retrospective review of the 2012 and 2013 adeno-/tonsillectomy data from Discovery Health Medical Scheme, South Africa's largest private healthcare insurer, was performed. Of the 18% (9.7 million people) of South Africans with private medical insurance, Discovery Health Medical Scheme accounts for a 30% (approximately 2.7 million people) market share. Of this sample, 771 720 people in 2012 and 797 310 people in 2013 were 19 years of age or younger. This cohort comprised the study population. This correlates with most international studies, where the national tonsillectomy rate has been calculated for this age

group. Using STATA® data analysis and statistical software, we calculated the South African tonsillectomy rate per 100 000 people ≤ 19 years of age and compared this rate with international rates reported in the literature. The regional tonsillectomy rate was also calculated for 16 geographical regions defined by Discovery Health. 95% confidence intervals were calculated for both the national and regional tonsillectomy rates. We also calculated the percentage of adeno-/tonsillectomies performed by ear, nose and throat (ENT) surgeons and the percentage performed by general practitioners, as well as the ENT surgeon to patient ratio, both nationally and regionally.

Adeno-/tonsillectomy data for the same period was also sourced from Bonitas Medical Fund, another of South Africa's large private medical aid providers. Bonitas insures 7% of privately insured South Africans, roughly 650 000 people in 2013. Of this sample, 204 842 people in 2012 and 228 429 people in 2013 were 19 years of age or younger. The national adeno-/tonsillectomy rate within the Bonitas-insured population was calculated and compared to the Discovery Medical Scheme rate.

Results

Within the Discovery Health Medical Scheme cohort, a total of 14 574 and 13 989 adeno-/tonsillectomies were performed in 2012 and 2013 respectively. The South African private healthcare sector adeno-/tonsillectomy rate in 2012 was 1 888/100 000 people ≤19 years of age. The rate dropped significantly to 1 755/100 000 in 2013 (p-value <0.001). Both are more than double the highest tonsillectomy rate reported in the literature. There was also considerable regional variation in the adeno-/tonsillectomy rate within South Africa (p-value =0.046; pooled two-year data). In 2012 and 2013, the highest regional rate was observed in the West Coast/Karoo/Cape Town Northern Suburbs region: 2 754/100 000 and 2 507/100 000 people ≤19years of age respectively. The lowest adeno-tonsillectomy rate was reported in Polokwane in 2012 (1 307/100 000) and East London in 2013 (1 445/100 000). From 2012 to 2013, 4 regions demonstrated an increase in adeno-/tonsillectomy rate: the Overberg, the Garden Route, East London and Polokwane. This goes against the national reduction in rate observed over the same period. Results are summarised in Table 2 and Figure 1.

Table 2: Regional variation in the South African adeno-/tonsillectomy rate /100 000 for Discovery-insured population ≤19 years of age

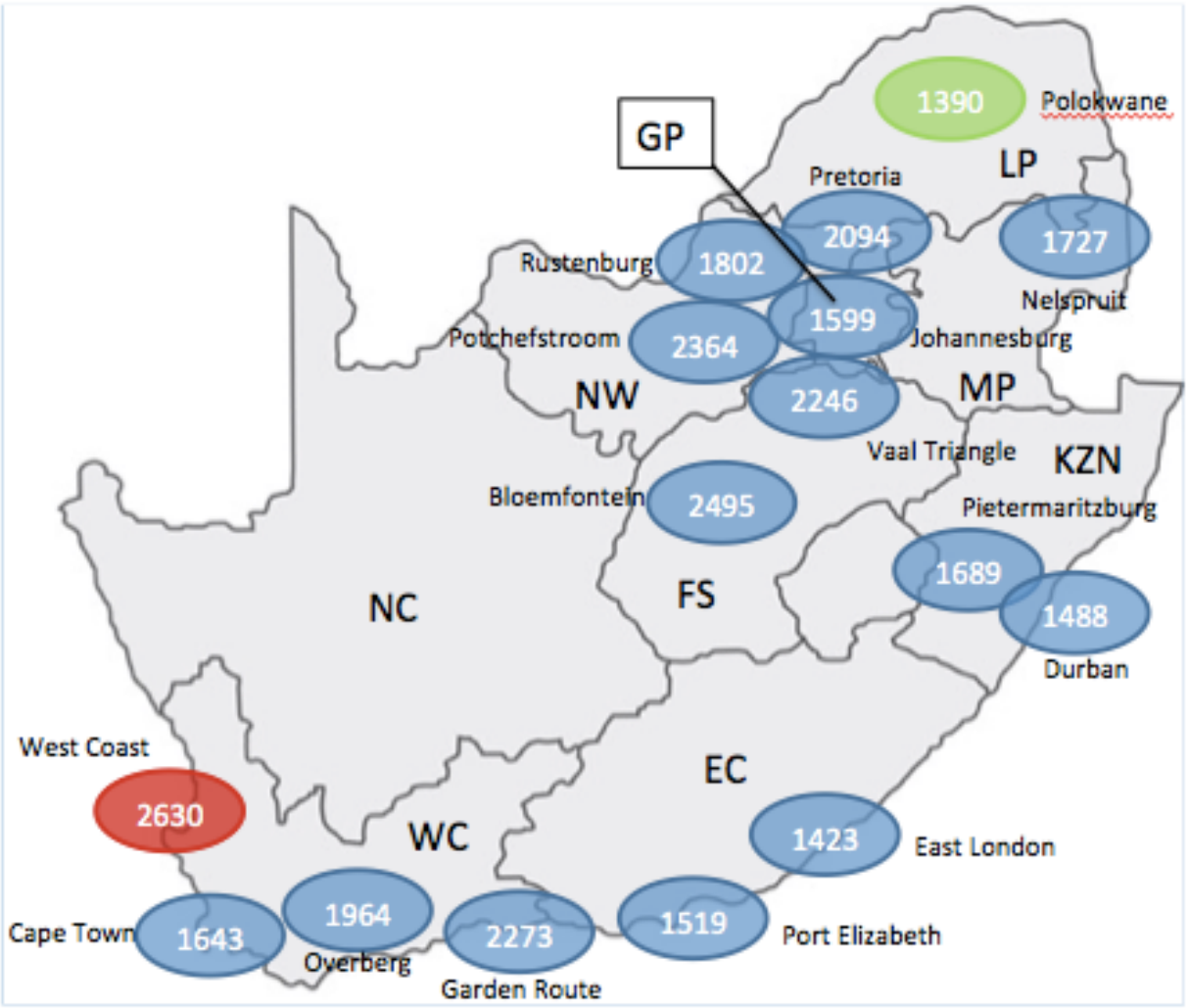
Region	Tonsillectomy rate 2012 (95% CI)	Tonsillectomy rate 2013 (95% CI)	Average rates 2012/2013
Polokwane	1 307 (1123-1513)	1 473 (1281-1688)	1 390
East London	1 400 (1220-1597)	1 445 (1265-1642)	1 423
Durban	1 516 (1439-1596)	1 459 (1384-1535)	1 488
Port Elizabeth	1 569 (1411-1739)	1 468 (1316-1632)	1 519
Johannesburg	1 668 (1620-1717)	1 530 (1485-1577)	1 599
Cape Town Peninsula	1 694 (1579-1815)	1 592 (1482-1708)	1 643
Pietermaritzburg	1 822 (1626-2037)	1 555 (1375-1752)	1 689
Nelspruit	1 794 (1558-2055)	1 659 (1434-1908)	1 727
Rustenburg	1 902 (1668-2160)	1 701 (1484-1945)	1 802
Overberg	1 852 (1634-2091)	2 075 (1848-2323)	1 964
Pretoria	2 218 (2132-2305)	1 969 (1890-2045)	2 094
Vaal Triangle	2 250 (2000-2522)	2 241 (1998-2506)	2 246
Garden Route	2 198 (1926-2488)	2 348 (2069-2655)	2 273
Potchefstroom	2 460 (2197-2746)	2 268 (2019-2539)	2 364
Bloemfontein*	2 586 (2402-2781)	2 404 (2230-2589)	2 495
West Coast/Karoo†	2 753 (2629-2882)	2 507 (2391-2628)	2 630
South Africa overall‡	**1 888 (1858-1919)**	**1 755 (1726-1784)**	**1 820**

* Includes Northern Cape

† Includes Cape Town Northern Suburbs

‡ Calculated on national data; not an average of regional rates

Figure 1: Regional variation in the South African adeno-/tonsillectomy rate /100 000 for Discovery-insured population ≤19 years of age



Key	Province	Population	%GDP*
EC	Eastern Cape	7M (12.7%)	7.7%
FS	Free State	2.8M (5.3%)	5.1%
GP	Gauteng	13.4M (23.7%)	33.8%
KZN	KwaZulu-Natal	11.1M (19.8%)	16%
LP	Limpopo	5.8M (10.4%)	7.3%
MP	Mpumalanga	4.3M (7.8%)	7.6%
NC	Northern Cape	1.2M (2.2%)	2%
NW	North West	3.7M (6.8%)	6.8%
WC	Western Cape	6.3M (11.3%)	13.7%
Total		55.6M (100%)	100%

*Provincial socioeconomic status represented as percentage contribution to GDP

General practitioners performed 2 726 of the 13 989 adeno-/tonsillectomies in 2013, i.e. about 20%. Otorhinolaryngologists operated on the remaining 11 263 patients, i.e. 80% of adeno-/tonsillectomies performed in 2013 were performed by ENT surgeons (p-value <0.001). The percentage of adeno-/tonsillectomies performed by otorhinolaryngologists varied widely from region to region. In the Overberg, otorhinolaryngologists performed more than 99% of procedures. However, in the Vaal triangle, otorhinolaryngologists performed only 28% of adeno-/tonsillectomies.

There did not appear to be any correlation between regional tonsillectomy rate and proportion of tonsillectomies performed by otorhinolaryngologists as opposed to general practitioners. In the three regions with the highest adeno-/tonsillectomy rates, Potchefstroom, Bloemfontein and the West Coast/Karoo, otorhinolaryngologists performed 53%, 75% and 91% of procedures respectively. Similarly, in the three regions with the lowest adeno-/tonsillectomy rates, Polokwane, East London and Durban, otorhinolaryngologists performed 41%, 91% and 88% of procedures. As such, regional tonsillectomy rates seem to reflect local practice preferences, rather than surgeon qualification.

Also noted, was that the ENT surgeon to patient (≤19 years of age) ratio ranged from 1:1 809 along the Garden Route, to 1:4 889 in Johannesburg. Once again, there was poor correlation between regional ENT surgeon to patient ratio and regional adeno-/tonsillectomy rate. In the three regions with the highest adeno-/tonsillectomy rates, ENT surgeon to patient ratio ranged from 1:2 666 in Bloemfontein (the fourth lowest ratio in South Africa) to 1:4 424 in Potchefstroom (the third highest ratio in South Africa). These findings are summarised in Table 3.

Table 3: Regional breakdown of the number of general practitioners and ENT surgeons performing adeno-/tonsillectomies in 2013, and the regional division of labour

Region	Number of GPs performing adeno-/tonsillectomy	Number of ENT surgeons performing adeno-/tonsillectomy	ENT surgeon to patient ratio (≤19 years of age)	Percentage of adeno-/tonsillectomies performed by ENT surgeon
Bloemfontein*	51	11	1:2 666	75%
Cape Town Peninsula	12	15	1:3 245	97%
Durban	36	27	1:3 652	88%
East London	5	5	1:3 240	91%
Garden Route	6	6	1:1 809	91%
Johannesburg	104	58	1:4 889	76%
Nelspruit	3	3	1:3 919	96%
Overberg	1	6	1:2 426	99%
Pietermaritzburg	13	9	1:1 930	47%
Polokwane	21	3	1:4 775	41%
Port Elizabeth	23	7	1:3 309	53%
Potchefstroom	34	3	1:4 424	53%
Pretoria	97	41	1:2 919	88%
Rustenburg	10	3	1:4 249	63%
Vaal Triangle	31	5	1:2 749	28%
West Coast/Karoo†	29	24	1:2 897	91%
South Africa overall	**476**	**226**	**1:3 528**	**80%**

* Includes Northern Cape

† Including Cape Town Northern Suburbs

The national adeno-/tonsillectomy rate calculated in the Bonitas-insured population was 1 164/100 000 people ≤19 years of age in 2012 (95% CI 1 118-1 212) and 1 166/100 000 in 2013 (95% CI 1 121-1 211). This rate is lower than the rate calculated in the Discovery-insured population (p-value =0.317), but still higher than international norms. The finding of an elevated tonsillectomy rate in the South African private healthcare sector is therefore not limited to the Discovery-insured population, but reproducible by at least one other insurer, suggesting a market trend.

Discussion

The South African tonsillectomy rate in the private healthcare sector (Discovery Medical Scheme-insured population) is significantly greater than that reported in the literature in other countries. It is roughly 10 times the rate described in Canada and more than double the highest reported rate, that of Northern Ireland. This finding was not limited to a single medical aid provider. The Bonitas adeno-/tonsillectomy rate was roughly 6 times greater than the Canadian rate. There is also significant regional variation in the adeno-/tonsillectomy rates within South Africa.

These findings raise an important question:

What causes international and regional variation in adeno-/tonsillectomy rates and why is the South African rate the highest in the literature?

Contributing factors are discussed below.

1. ***Differences in training***
   Differences in postgraduate training of otorhinolaryngology registrars have been shown to influence surgical practice and regional tonsillectomy rates. [25] In addition, Bloor [26] noted that the otorhinolaryngologist attitude towards tonsillectomy was partly responsible for regional variation. The Paradise Criteria are applied at the authors' institution. Allowance is however made for deviation from the guidelines at the clinician's discretion, if it is deemed reasonable, rational and in the best interests of the patient. Similarly, all otorhinolaryngology training units in South Africa apply the Paradise Criteria, the guidelines devised by the Scottish Intercollegiate Guidelines Network (SIGN) or the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) Clinical Practice Guidelines, occasionally with minor variations thereof.

2. ***Lack of consensus amongst role players managing throat infections/SDB***
   Capper and Canter [27] found that amongst those managing tonsillitis and SDB, general practitioners, otorhinolaryngologists and paediatricians failed to agree on the diagnostic features of tonsillitis, pharyngitis and upper respiratory tract

infections. There was also professional disagreement on the indications for tonsillectomy amongst the groups and a statistically significant difference in perceived benefit of the procedure and expectations regarding the post-operative improvement in symptoms (frequency of sore throats, irregular breathing, irritability and poor concentration). As ENT surgeons are unlikely to be managing patients suffering from acute episodes of throat infection/sore throat, they rely on primary healthcare providers/general practitioners to provide them with as much information as possible to make an evidence-based decision on whether adeno-/tonsillectomy is indicated and likely to be of benefit. This includes information such as frequency of throat infections, associated clinical factors and socioeconomic as well as family impact of the disease. Tucker [28] highlights the fact that even amongst otorhinolaryngologists, there is disagreement about the significance of the signs and symptoms in children with recurrent tonsillitis. It therefore appears that there is no clear management protocol for children suffering from recurrent tonsillitis and SDB. This generalised lack of consensus is concerning and efficient patient care can only be provided if all role players, reliant on one another in managing these children, are in agreement.

3. ***Variation in the implementation of evidence-based guidelines***

Although studies since the 1970s have defined a suitable candidate population, many clinicians are still uncertain as to the indications for tonsillectomy. [29] In certain instances, only 35% of patients undergoing adeno-/tonsillectomy have been shown to meet the published criteria. [30] Even more concerning is Marshall's finding that only a quarter of patients undergoing tonsillectomy for recurrent throat infection met evidence-based criteria. [31] Despite this, the Scottish tonsillectomy audit notes that between 63.3% and 89.8% of patients referred to ENT surgeons because of recurrent tonsillitis, sore throat or obstructive symptoms are booked for tonsillectomy on their first visit to an outpatient ENT clinic. [16] This suggests that ENT surgeons are generally liberal when promoting tonsillectomy as a therapeutic option and often forego a period of watchful waiting, despite the recommendation of the guidelines to observe patients for a period of at least 6 months. Evidence also points

to the fact that surgeons are more likely to break existing guidelines in favour of performing surgery rather than withholding surgery. [32]

When tonsillectomy is considered for SDB, overnight polysomnography is the gold standard in confirming the diagnosis and making recommendations with regard to management. The American Academy of Paediatrics advises polysomnography in all children suspected of experiencing SDB, prior to surgical intervention. [33] Others feel that it is not necessary to request polysomnography this liberally, as it gives no insight into the impact of the sleep disorder on the patient's general wellbeing. Otorhinolaryngologists request polysomnography in less than 10% of children undergoing adeno-/tonsillectomy. [34]

Although protocol-driven healthcare has its place in modern medicine, the authors of this study agree that it is ill advised to implement guidelines blindly, at the expense of physician insight, acumen and experience. The other extreme would be to flout guidelines entirely and enable doctors to operate on patients at their discretion. Whether or not this is reasonable practice is debatable and beyond the scope of this article.

4. ***Inconclusive evidence on the effectiveness and benefit of adeno-/tonsillectomy***
In their landmark trials conducted in Pittsburgh in 1984 and 2002, Paradise et al. [21,23] set out to determine the efficacy of adeno-/tonsillectomy in reducing the number and severity of subsequent throat infections. In his initial study, eligibility required children to satisfy the 'Paradise criteria.' He noted that tonsillectomy is efficacious in reducing the number and severity of throat infections for 2 years, and possibly a third year, following surgery. The study concluded that the degree of benefit experienced justified tonsillectomy in those meeting the strict inclusion criteria, but also emphasised that many children treated non-surgically improved spontaneously. The benefit seems modest as best. In the follow-up study, the 'Paradise criteria' were relaxed somewhat to evaluate whether or not tonsillectomy would afford equivalent benefit to those children less severely affected than those in the previous trial. The study concludes that the limited benefit conferred by tonsillectomy in moderately affected children is outweighed by the risk, morbidity and cost of the surgery. In both studies, the mean number of days of sore throat in

the 12 months following surgery was not statistically different between the operated and the non-operated group. Other studies reported that in children on waiting lists for adeno-/tonsillectomy, 18.6%-50% of individuals no longer required surgery with a follow-up period of up to 3 years. [35-39] This points towards the understanding that there is a spontaneous reduction in rates of recurrent infection over time.

A 2006 literature review [40] suggested that adeno-/tonsillectomy, performed against a backdrop of SDB, demonstrated improvements in behaviour, neurocognitive function, quality of life, and vocal quality. Similar studies have demonstrated improvement in physical and emotional symptoms, as well as daytime functioning. [41-43] In children with obstructive sleep apnoea (OSA), pulmonary hypertension was also shown to normalise on post-tonsillectomy echocardiography. Although most studies showed improvement in at least one outcome measure, these results are potentially misleading, as none of the studies was randomised. The CHAT trial (Childhood Adenotonsillectomy Trial) [44] published in 2013 was devised to address this shortcoming. 464 children with obstructive sleep apnoea syndrome (OSAS), aged 5-9 years of age, were randomly assigned to either early adenotonsillectomy or watchful waiting. Outcome measures included general health, polysomnographic findings, behavioural and neurocognitive changes, assessed at baseline and 7 months after adenotonsillectomy. The study concluded that in children of school going age with OSAS, surgery offered no improvement in attention or executive function. There was, however, improvement in behaviour, quality of life and polysomnographic findings following surgery, supporting early adenotonsillectomy in children with OSAS. This benefit was greater in obese children, although 33% of them had residual OSAS postoperatively. It should be noted that outcome measures showed improvement in the watchful waiting group too, but not to the same extent. Polysomnography, for example, improved in 79% of children undergoing surgery, and nearly half (46%) of the children in the watchful waiting group. With few adverse events, the CHAT trial supported the safety of both surgery and watchful waiting, but emphasised the importance of close monitoring of the watchful waiting group. Watchful waiting was deemed a valid therapeutic option.

In addition, tonsillar disease is often outgrown, the tonsils contribute to the protective functioning of the immune system, and adeno-/tonsillectomy is a procedure associated with significant morbidity [45] and a mortality rate ranging from 1 in 16 000 to 1 in 35 000. [46]. The risk and potential complications of adeno-/tonsillectomy are well documented and include the anaesthetic risk of laryngospasm; laryngeal oedema; aspiration; respiratory compromise; endotracheal tube ignition and cardiac arrest; as well as the intraoperative risk of blood loss; trauma to the teeth, tongue, pharynx, larynx and soft palate, lip, eye and mandible; and postoperative complications such as haemorrhage; delayed feeding and dehydration; nausea and vomiting; pain and otalgia; post-obstructive pulmonary oedema; velopharyngeal insufficiency; voice changes and nasopharyngeal stenosis. [45,47] As such, the decision to offer patients an adeno-/tonsillectomy should not be a knee jerk response, but a deliberated process, deemed to be in their best interests. Failure to meet the indications for adeno-/tonsillectomy puts the patient at risk unnecessarily, with very little proven benefit.

5. ***Social, geographical and family factors***

In the past, tonsillectomy was performed far more frequently in children of higher socioeconomic status. The social class association has, however, been reversed. According to the 2005 Chief Medical Officer's Report (UK), tonsillectomy is now more common in children from less affluent backgrounds. [6] This is supported by the findings of international studies, which show that when access to healthcare is universally available, children of a lower socioeconomic status undergo tonsillectomy more frequently. [10,48] In their study in India to assess the bacteriology of acute tonsillitis, Vijayashree et al. [49] noted that 61% of cases came from a low-income group, 35% came from a middle-income group and only 4% came from a high-income group. The reasons cited for this preponderance of lower socioeconomic groups include poverty, malnutrition, unhygienic living conditions, illiteracy and poor access to healthcare. Like India, South Africa is a developing country, with an unemployment rate of 25% and a poverty level of 56.8% (STATS SA 2013). It is therefore possible that acute tonsillitis is encountered more frequently in children of a lower socioeconomic standing and that the burden of disease (frequency and/or

severity) in South Africa is greater than in the developed world. This could account for the high South African adeno-/tonsillectomy rate, except that most patients making use of the private healthcare sector are of a high socioeconomic standing, comparable with the developed world. To the authors' knowledge, no developing countries have reported an adeno-/tonsillectomy rate for comparison.

Physician to population ratio and patient proximity to a medical facility (geographical access barriers) have also been cited as potential factors contributing to variation in adeno-/tonsillectomy rates. [50] We found no such correlation in our study.

Tonsillectomy is often justified on the anecdotal opinion of parents whose children have undergone the procedure, claiming a dramatic improvement in their children's general health and behaviour. [16,51] The perceived benefit of the procedure thus leads parents to request adeno-/tonsillectomy, as they believe surgery to be in the best interests of their children. These opinions are largely uninformed. However, parental preference or attempts at persuading doctors can interfere in the process of devising an appropriate management plan. Children with a parent or sibling who underwent tonsillectomy are also more likely to undergo the procedure. [11] The behavioural and cognitive effects of OSAS are particularly worrisome to parents. [52] As such, concerned parents might be more inclined to convince surgeons on the need for surgery. Often parents' desire for cure and complete resolution of symptoms drives their insistence. Most children experience a degree of improvement in their SDB following tonsillectomy, but only 60-70% of patients experience complete resolution of their symptoms. Only 10-25% of obese children experience resolution of their symptoms. [53] It is important for parents to be aware of this and not to harbour unrealistic expectations of improvement in symptoms. This might change parental attitudes towards surgery.

6. ***Private practice funding model dictating clinical practice***

Fergusson et al. [54] report that privately insured children under 7 years of age are more likely to undergo adeno-/tonsillectomy than their uninsured counterparts. It is conceivable that parents paying a premium for healthcare might feel entitled to dictate the nature of the management of their children and request surgical intervention. Similarly, doctors being reimbursed by patients might feel compelled to accede to their requests. Whether or not this occurs or is reasonable practice is debatable and beyond the scope of this article. South African private health insurers do not enforce evidence-based selection of patients for tonsillectomy. As such, this is a system open to over servicing of patients.

7. ***'Soft indications' for adeno-/tonsillectomy***

Relative indications for surgery include recurrent episodes of tonsillitis requiring hospitalisation, peritonsillar abscess, febrile seizures, orthodontic concerns or malocclusion, tonsiliths, halitosis, family history of rheumatic heart disease or glomerulonephritis and tonsillar asymmetry (to exclude malignancy on histological specimen.) The evidence supporting these indications is limited and of a lesser quality than the evidence upon which established guidelines are based. In such instances, shared decision making is promoted. Factors such as the number of days of school missed by a child as a result of tonsillitis, tonsil size, the number of antibiotic courses completed and recurrent ear infections, are often used to justify tonsillectomy, but are not included in any of the guidelines. [27] The costs incurred as a result of frequent throat infections are substantial. These include the direct costs of consultation fees, transport and medication costs. Indirect costs include school and caregiver work absenteeism. Although cost and socioeconomic impact of disease are not included in the guidelines, the burden of disease is unequivocal, with an estimated 35 million days lost from school or work annually in the UK alone. [55] However, in the UK, the cost of managing a child with recurrent sore throats over a 2-year period equated to about a third of the cost of managing the patient surgically, with the modest benefit in the tonsillectomy group of 3.5 episodes of sore throat fewer over the 2-year period. [5]

In summary, with so many additional considerations complicating the decision making process, it seems as though the need for adeno-/tonsillectomy is open to interpretation and determined by the significance attached to each of the abovementioned factors by the healthcare provider involved.

Limitations: Retrospectively reviewing medical aid data, as an indication of clinical practice, rendered us reliant on data provided by medical schemes and our audit subject to patient selection bias. The tonsillectomy rate was described only in the private healthcare sector, presumably therefore amongst children of a higher socioeconomic status. The ethnicity of our patients has also not been reported, precluding an assessment of tonsillectomy trends in different ethnic groups.

We have described the tonsillectomy rate in approximately 37% of the privately insured population (Discovery Health and Bonitas Medical Scheme), admittedly only a snapshot of the market. Collaboration between medical schemes would be required to report a more representative national private sector tonsillectomy rate. It would also be interesting to determine the overall South African adeno-/tonsillectomy rate, including the state sector, and to compare this rate with other developing countries. This would prove challenging, as there exists no uniform reporting system or surgical registry in the South African state healthcare sector.

Indications for tonsillectomy are not recorded routinely by medical schemes and we cannot comment on the indications cited by surgeons to justify tonsillectomy in the South African private healthcare sector.

The authors feel that the findings of this study justify prospective analyses of tonsillectomy practice in the future. Assessing adherence to evidence-based guidelines and monitoring of tonsillectomy indications and rates are potential future avenues for research. It is also hoped that other developing countries will be encouraged to publish tonsillectomy rates.

Conclusions

The South African tonsillectomy rate is very high when compared with international trends and it also varies regionally within the country. The literature does not support an increased burden of disease as the reason behind this. Rather, it is differences in training and clinical practice of clinicians, as well as social and family factors that have been implicated. It is hoped that this article generates awareness amongst those managing children with recurrent sore throats and SDB, around current best, evidence-based practice. Whether consideration for adeno-/tonsillectomy should be protocol/check-sheet driven or if surgery should be offered at the attending surgeons' discretion, is debatable. The authors, however, feel that it would be a useful exercise to develop evidence-based, locally relevant indications for adeno-/tonsillectomy to guide clinical practice in South Africa.

Acknowledgements

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References

1 Boss EF, Marsteller JA, Simon AE. Outpatient tonsillectomy in children: demographic and geographic variation in the United States, 2006. J Pediatr 2012;160(5):814-819.

2 Owings MF, Kozak LJ. Ambulatory and inpatient procedures in the United States, 1996. Vital Health Stat 13 1998 Nov;(139)(139):1-119.

3 Cullen KA, Hall MJ, Golosinskiy A, National Center for Health Statistics (US). Ambulatory surgery in the United States, 2006. : US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics; 2009.

4 Burton MJ, Glasziou PP, Chong LY, Venekamp RP. Tonsillectomy or adenotonsillectomy versus non-surgical treatment for chronic/recurrent acute tonsillitis. The Cochrane Library 2014.

5 Wilson JA, Steen IN, Lock CA, Eccles MP, Carrie S, Clarke R, et al. Tonsillectomy: a cost-effective option for childhood sore throat? Further analysis of a randomized controlled trial. Otolaryngol Head Neck Surg 2012 Jan;146(1):122-128.

6 Donaldson L. Chief Medical Officer's Report. 2005.

7 Rosenfeld RM, Green RP. Tonsillectomy and adenoidectomy: changing trends. Ann Otol Rhinol Laryngol 1990 Mar;99(3 Pt 1):187-191.

8 Parker NP, Walner DL. Trends in the indications for pediatric tonsillectomy or adenotonsillectomy. Int J Pediatr Otorhinolaryngol 2011;75(2):282-285.

9 Rosefsky JB. Tonsillectomies and Adenotonsillectomies—Will the Debate Never Be Over? Pediatrics 2003;112(1):205-205.

10 Bisset AF, Russell D. Grommets, tonsillectomies, and deprivation in Scotland. BMJ 1994 Apr 30;308(6937):1129-1132.

11 Fried D. On tonsillectomy: mom's personal experience. The Lancet 1995;346(8976):714.

12 Cummins RO, Jarman B, White PM. Do general practitioners have different "referral thresholds"? Br Med J (Clin Res Ed) 1981 Mar 28;282(6269):1037-1039.

13 Fleming D, Crombie D, Cross K. An examination of practice referral rates in relation to practice structure, patient demography and case mix. Health Trends 1991;23(3):100-104.

14 Wilkin D, Smith AG. Variation in general practitioners' referral rates to consultants. J R Coll Gen Pract 1987 Aug;37(301):350-353.

15 Suleman M, Clark M, Goldacre M, Burton M. Exploring the variation in paediatric tonsillectomy rates between English regions: a 5-year NHS and independent sector data analysis. Clinical Otolaryngology 2010;35(2):111-117.

16 Blair R, McKerrow W, Carter N, Fenton A. The Scottish tonsillectomy audit. The Journal of Laryngology & Otology 1996;110(20):1-25.

17 Volbracht E. Tonsillectomy in Germany: Marked regional variations in the most common inpatient operation performed on children and adolescents: Faktencheck Gesundheit Mandeloperation: Healthcare Fact Check 2013: German Federal Statistical Office. 2013.

18 Government SA. Stats SA GHS 2013: General Household Survery 2013. 2014;P0318.

19 Ataguba J. Health care financing in South Africa: moving towards universal coverage. Continuing Medical Education 2010;28(2).

20 Goldstein NA, Stewart MG, Witsell DL, Hannley MT, Weaver EM, Yueh B, et al. Quality of life after tonsillectomy in children with recurrent tonsillitis. Otolaryngology-Head and Neck Surgery 2008;138(1):S9-S16.

21 Paradise JL, Bluestone CD, Bachman RZ, Colborn DK, Bernard BS, Taylor FH, et al. Efficacy of tonsillectomy for recurrent throat infection in severely affected children: results of parallel randomized and nonrandomized clinical trials. N Engl J Med 1984;310(11):674-683.

22 van Staaij BK, van den Akker EH, Rovers MM, Hordijk GJ, Hoes AW, Schilder AG. Effectiveness of adenotonsillectomy in children with mild symptoms of throat infections or adenotonsillar hypertrophy: open, randomised controlled trial. BMJ 2004 Sep 18;329(7467):651.

23 Paradise JL, Bluestone CD, Colborn DK, Bernard BS, Rockette HE, Kurs-Lasky M. Tonsillectomy and adenotonsillectomy for recurrent throat infection in moderately affected children. Pediatrics 2002;110(1):7-15.

24 Van Den Akker E, Hoes A, Burton M, Schilder A. Large international differences in (adeno) tonsillectomy rates. Clinical Otolaryngology & Allied Sciences 2004;29(2):161-164.

25 Roos NP, Roos Jr LL, Henteleff PD. Elective surgical rates—do high rates mean lower standards? Tonsillectomy and adenoidectomy in Manitoba. N Engl J Med 1977;297(7):360-365.

26 Bloor MJ, Venters GA, Samphier ML. Geographical variation in the incidence of operations on the tonsils and adenoids. The Journal of Laryngology & Otology 1978;92(10):883-895.

27 Capper R, Canter R. Is there agreement among general practitioners, paediatricians and otolaryngologists about the management of children with recurrent tonsillitis? Clinical Otolaryngology & Allied Sciences 2001;26(5):371-378.

28 Tucker A. The current status of tonsillectomy-a survey of otolaryngologists. Clinical Otolaryngology & Allied Sciences 1982;7(6):367-372.

29 Darrow DH, Siemens C. Indications for tonsillectomy and adenoidectomy. Laryngoscope 2002;112(S100):6-10.

30 Buskens E, van Staaij B, van den Akker J, Hoes AW, Schilder AG. Adenotonsillectomy or watchful waiting in patients with mild to moderate symptoms of throat infections or adenotonsillar hypertrophy: a randomized comparison of costs and effects. Archives of Otolaryngology–Head & Neck Surgery 2007;133(11):1083-1088.

31 Marshall T, Anantharachagan A, Chan VG, Hoo SS, Yeo JC. How many tonsillectomies are evidence-based? Journal of Clinical Excellence 2001;3(1):23-25.

32 Brown P, Ryan R, Yung M, Browne J, Copley L, Cromwell D. The National Prospective Tonsillectomy Audit: Final Report of an Audit Carried out in England and Northern Ireland Between 2003 and 2004. London, United Kingdom: Royal College of Surgeons of England 2005.

33 Baugh RF, Archer SM, Mitchell RB, Rosenfeld RM, Amin R, Burns JJ, et al. Clinical practice guideline: tonsillectomy in children. Otolaryngol Head Neck Surg 2011 Jan;144(1 Suppl):S1-30.

34 Mitchell RB, Pereira KD, Friedman NR. Sleep-Disordered Breathing in Children: Survey of Current Practice. Laryngoscope 2006;116(6):956-958.

35 Woolford T, Ahmed A, Willatt D, Rothera M. Spontaneous resolution of tonsillitis in children on the waiting list for tonsillectomy. Clinical Otolaryngology & Allied Sciences 2000;25(5):428-430.

36 Wood B, Wong Y, Theodoridis C. Paediatricians look at children awaiting adenotonsillectomy. The Lancet 1972;300(7778):645-647.

37 Fox R, Temple M, Owens D, Short A, Tomkinson A. Does tonsillectomy lead to improved outcomes over and above the effect of time? A longitudinal study. The Journal of Laryngology & Otology 2008;122(11):1197-1200.

38 Freeland AP, Curley JW. The consequences of delay in tonsil surgery. Otolaryngol Clin North Am 1987 May;20(2):405-408.

39 Prim M, de Diego J, Larrauri M, Diaz C, Sastre N, Gavilan J. Spontaneous resolution of recurrent tonsillitis in pediatric patients on the surgical waiting list. Int J Pediatr Otorhinolaryngol 2002;65(1):35-38.

40 Garetz SL. Behavior, cognition, and quality of life after adenotonsillectomy for pediatric sleep-disordered breathing: summary of the literature. Otolaryngology-Head and Neck Surgery 2008;138(1):S19-26.

41 Mitchell RB, Kelly J. Behavior, neurocognition and quality-of-life in children with sleep-disordered breathing. Int J Pediatr Otorhinolaryngol 2006;70(3):395-406.

42 Flanary VA. Long-term effect of adenotonsillectomy on quality of life in pediatric patients. Laryngoscope 2003;113(10):1639-1644.

43 de Serres LM, Derkay C, Sie K, Biavati M, Jones J, Tunkel D, et al. Impact of adenotonsillectomy on quality of life in children with obstructive sleep disorders. Archives of Otolaryngology–Head & Neck Surgery 2002;128(5):489-496.

44 Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, et al. A randomized trial of adenotonsillectomy for childhood sleep apnea. N Engl J Med 2013;368(25):2366-2376.

45 Johnson LB, Elluru RG, Myer CM. Complications of adenotonsillectomy. Laryngoscope 2002;112(S100):35-36.

46 Pratt LW, Gallagher RA. Tonsillectomy and adenoidectomy: incidence and mortality, 1968-1972. Otolaryngol Head Neck Surg (1979) 1979 Mar-Apr;87(2):159-166.

47 Acevedo JL, Shah RK, Brietzke SE. Systematic review of complications of tonsillotomy versus tonsillectomy. Otolaryngol Head Neck Surg 2012 Jun;146(6):871-879.

48 Croxford R, Friedberg J, Coyte P. Socio-economic status and surgery in children: myringotomies and tonsillectomies in Ontario, Canada, 1996–2000. Acta Paediatrica 2004;93(9):1245-1250.

49 Vijayashree M, Viswanatha B, Sambamurthy B. Clinical and Bacteriological Study of Acute Tonsillitis. group 2012;1(2):3.

50 Mayer ML, Beil HA, von Allmen D. Distance to care and relative supply among pediatric surgical subspecialties. J Pediatr Surg 2009;44(3):483-495.

51 Conlon B, Donnelly M, McShane D. Improvements in health and behaviour following childhood tonsillectomy: a parental perspective at 1 year. Int J Pediatr Otorhinolaryngol 1997;41(2):155-161.

52 Chervin RD, Ruzicka DL, Giordani BJ, Weatherly RA, Dillon JE, Hodges EK, et al. Sleep-disordered breathing, behavior, and cognition in children before and after adenotonsillectomy. Pediatrics 2006;117(4):e769-e778.

53 Friedman M, Wilson M, Lin H, Chang H. Updated systematic review of tonsillectomy and adenoidectomy for treatment of pediatric obstructive sleep apnea/hypopnea syndrome. Otolaryngology-Head and Neck Surgery 2009;140(6):800-808.

54 Fergusson DM, Horwood LJ. Private medical insurance and elective surgery during early childhood. N Z Med J 1985 Jul 10;98(782):538-540.

55 ENT U. Indications for tonsillectomy: position paper. 2009.

PART D: SUPPORTING DOCUMENTATION

Departmental Research Committee approval

UNIVERSITY OF CAPE TOWN

Department of Surgery

Departmental Research Committee
Professor Anwar Suleman Mall
J-45 Room Old Main Building, Groote Schuur Hospital,
Observatory 7925, South Africa
Tel (021) 406 6168/6232/6227 Fax (021) 448 6461
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1st December 2014

Dr P Douglas-Jones
Department of Surgery
Division of Otolaryngology
Groote Schuur Hospital
University of Cape Town

Dear Dr Douglas-Jones,

RE: PROJECT 2014/117

PROJECT TITLE: Tonsillectomy rates in the South African Private Healthcare Sector

The above proposal was reviewed by the Department of Surgery Research Committee and I am pleased to inform you that the committee approved the study.

Please use the above project number in all future correspondence.

Yours sincerely

PROFESSOR ANWAR S MALL
CHAIRMAN: RESEARCH COMMITTEE

Human Research Ethics Committee approval

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492 • **Facsimile** [021] 406 6411
Email: Sumayah.ariefdien@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

15 January 2015

HREC/REF: 016/2015

Prof J Fagan
Otorhinolaryngology
H-53
OMB

Dear Prof Fagan

Project Title: TONSILLECTOMY RATES IN THE SOUTH AFRICAN PRIVATE HEALTHCARE SECTOR (MMed-candidate -Dr P Douglas-Jones)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above mentioned study.

Approval is granted for one year until the 30 January 2016.

Please submit a progress form, using the standardised Annual Report Form, if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

We acknowledge that the following student:-Dr P Douglas-Jones is also involved in this project.

Please provided approval from Discovery for our records.

Please note that the on-going ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHI

Federal Wide Assurance Number: FWA0 01637.

Hrec/ref:016/2015

UNIVERSITY OF CAPE TOWN

Record Reviews/Audits/Collection of Biological Specimens/Repositories/Databases/Registries

HREC office use only (FWA			
This serves as notification		**umentation described below.**	
☑ Approved	Annual p	enewal date	28/2/17
☐ Not approved	See attached comments		
Signature Chairperson of the HREC		Date Signed	4/2/16

04 FEB 2016

UNIVERSITY OF CAPE TOWN

r to complete the following:

1. Protocol information

Date (when submitting this form)	4/02/2016.		
HREC REF Number	016/2015	Current Ethics Approval was granted until	31/01/2016.
Protocol title	TONSILLECTOMY RATES IN THE SOUTH AFRICAN PRIVATE HEA SECTOR		
Principal Investigator			
Department / Office Internal Mail Address	DIVISION OF OTORHINOLAR HSF OMB UCT johannes.fagan@uct.ac.za.		
1.1 Does this protocol receive US Federal funding?		☐ Yes	☑ No

2. Protocol status (tick ✓)

☐	Research-related activities are ongoing
☑	Data collection is complete, data analysis only
Please indicate (in the block below) the titles and HREC reference numbers of any projects currently making use of the Database/registry/repository	

3. Protocol summary

Total number of records or specimens collected, reviewed or stored since the original approval		10 000+
Total number of records or specimens collected, reviewed or stored since last progress report		
Have any research-related outputs (e g. publications, abstracts, conference presentations) resulted from this research? If yes, please list and attach with this report	☐ Yes	☑ No

4. Signature

Signature of PI		Date	4/2/2016.

Please complete the Closure form (FNS019) if the study is completed within the approval period)

Data capture

Discovery Health data

Total admissions and total length of stay (LOS) for all patients between 0 and 19 per region that had a tonsillectomy done

YR	REGION	AGE BAND FLAG	ADMISSION COUNT	LENGTH OF STAY	TOTAL DHMS MEMBERS IN AGE BAND IN REGION
2012	Bloemfontein	0_4	414	425	8 842
2012	Cape Peninsula	0_4	401	406	14 632
2012	Durban	0_4	717	790	28 655
2012	East London	0_4	111	111	4 511
2012	East Rand	0_4	531	558,5	13 495
2012	Garden Route	0_4	118	118	2 847
2012	Johannesburg	0_4	617	634	24 512
2012	Johannesburg North & Surrounds	0_4	1361	1398,5	47 699
2012	Maritzburg	0_4	157	162	4 634
2012	Nelspruit	0_4	130	131	3 695
2012	Overberg	0_4	139	140	3 871
2012	Polokwane	0_4	105	114	4 380
2012	Port Elizabeth	0_4	180	180,5	6 792
2012	Potchefstroom	0_4	183	183	3 530
2012	Pretoria	0_4	1425	1452	36 237
2012	Rustenburg	0_4	117	118	3 842
2012	Vaal Triangle	0_4	171	171,5	3 915
2012	West Coast & Karoo	0_4	1216	1245,5	20 904
2013	Bloemfontein	0_4	424	439,5	9 108
2013	Cape Peninsula	0_4	406	412,5	14 662
2013	Durban	0_4	737	846,5	28 892
2013	East London	0_4	118	118	4 548
2013	East Rand	0_4	539	594	13 616
2013	Garden Route	0_4	128	128,5	2 859
2013	Johannesburg	0_4	657	679,5	24 475
2013	Johannesburg North & Surrounds	0_4	1361	1404	48 928
2013	Maritzburg	0_4	135	145	4 685
2013	Nelspruit	0_4	117	118	3 584
2013	Overberg	0_4	180	180,5	3 933
2013	Polokwane	0_4	116	121,5	4 531
2013	Port Elizabeth	0_4	161	161,5	6 569
2013	Potchefstroom	0_4	168	168	3 595
2013	Pretoria	0_4	1360	1406,5	37 341
2013	Rustenburg	0_4	105	112	3 955
2013	Vaal Triangle	0_4	175	175	4 134
2013	West Coast & Karoo	0_4	1145	1165	21 191
2012	Bloemfontein	05 to 15	304	306,5	14 870
2012	Cape Peninsula	05 to 15	367	372,5	25 487
2012	Durban	05 to 15	663	735	51 449
2012	East London	05 to 15	101	101	8 531
2012	East Rand	05 to 15	418	429	23 978
2012	Garden Route	05 to 15	102	102	5 840

2012	Johannesburg	05 to 15	536	566	42 063
2012	Johannesburg North & Surrounds	05 to 15	964	983	79 811
2012	Maritzburg	05 to 15	144	153	9 389
2012	Nelspruit	05 to 15	74	74	6 179
2012	Overberg	05 to 15	109	112	7 542
2012	Polokwane	05 to 15	71	71	7 276
2012	Port Elizabeth	05 to 15	157	157	12 374
2012	Potchefstroom	05 to 15	126	126	6 875
2012	Pretoria	05 to 15	1035	1047	60 706
2012	Rustenburg	05 to 15	116	122,5	6 787
2012	Vaal Triangle	05 to 15	112	111	6 895
2012	West Coast & Karoo	05 to 15	584	600,5	35 784
2013	Bloemfontein	05 to 15	269	269,5	15 556
2013	Cape Peninsula	05 to 15	341	344,5	26 548
2013	Durban	05 to 15	635	673,5	53 421
2013	East London	05 to 15	108	108	8 945
2013	East Rand	05 to 15	336	339,5	24 946
2013	Garden Route	05 to 15	120	120	6 035
2013	Johannesburg	05 to 15	442	455,5	43 692
2013	Johannesburg North & Surrounds	05 to 15	881	896	85 023
2013	Maritzburg	05 to 15	128	141	9 529
2013	Nelspruit	05 to 15	72	72	6 432
2013	Overberg	05 to 15	109	110	7 806
2013	Polokwane	05 to 15	90	90	7 713
2013	Port Elizabeth	05 to 15	161	162	12 763
2013	Potchefstroom	05 to 15	123	124	7 174
2013	Pretoria	05 to 15	915	922	63 984
2013	Rustenburg	05 to 15	104	106	6 925
2013	Vaal Triangle	05 to 15	128	128	7 292
2013	West Coast & Karoo	05 to 15	558	567	37 587
2012	Bloemfontein	16_19	13	13,5	4 553
2012	Cape Peninsula	16_19	38	44	7 475
2012	Durban	16_19	77	103,5	15 987
2012	East London	16_19	8	8	2 675
2012	East Rand	16_19	24	28	7 360
2012	Garden Route	16_19	14	14	1 959
2012	Johannesburg	16_19	38	46	11 630
2012	Johannesburg North & Surrounds	16_19	71	88	22 833
2012	Maritzburg	16_19	10	13,5	3 042
2012	Nelspruit	16_19	4	4	1 722
2012	Overberg	16_19	13	14,5	2 681
2012	Polokwane	16_19	4	4	2 112
2012	Port Elizabeth	16_19	23	23	3 783
2012	Potchefstroom	16_19	9	9,5	2 520
2012	Pretoria	16_19	90	94	18 051
2012	Rustenburg	16_19	5	5	1 884
2012	Vaal Triangle	16_19	11	12,5	2 258
2012	West Coast & Karoo	16_19	46	49	10 366
2013	Bloemfontein	16_19	12	12,5	4 658
2013	Cape Peninsula	16_19	28	30	7 462
2013	Durban	16_19	66	91	16 283
2013	East London	16_19	8	8	2 706
2013	East Rand	16_19	25	26,5	7 445
2013	Garden Route	16_19	7	7	1 965
2013	Johannesburg	16_19	41	63,5	11 835
2013	Johannesburg North & Surrounds	16_19	57	70	23 582
2013	Maritzburg	16_19	7	10,5	3 153
2013	Nelspruit	16_19	6	6	1 741
2013	Overberg	16_19	13	13,5	2 815
2013	Polokwane	16_19	5	5	2 080
2013	Port Elizabeth	16_19	18	18	3 833
2013	Potchefstroom	16_19	10	12	2 502
2013	Pretoria	16_19	81	85,5	18 343

2013	Rustenburg	16_19	8	9	1 866
2013	Vaal Triangle	16_19	5	5,5	2 319
2013	West Coast & Karoo	16_19	40	44,5	10 745

ENT's per region doing tonsillectomies in children between 0 and 19 years

YR	DOCTOR REGION	DOCTOR COUNT
2012	Bloemfontein	11
2013	Bloemfontein	11
2013	Cape Peninsula	15
2012	Cape Peninsula	15
2012	Durban	29
2013	Durban	27
2012	East London	4
2013	East London	5
2013	East Rand	4
2012	East Rand	4
2012	Garden Route	6
2013	Garden Route	6
2012	Johannesburg	26
2013	Johannesburg	26
2012	Johannesburg North & Surrounds	30
2013	Johannesburg North & Surrounds	28
2013	Maritzburg	9
2012	Maritzburg	8
2012	Nelspruit	3
2013	Nelspruit	3
2013	Overberg	6
2012	Overberg	6
2012	Polokwane	4
2013	Polokwane	3
2012	Port Elizabeth	7
2013	Port Elizabeth	7
2012	Potchefstroom	3
2013	Potchefstroom	3
2013	Pretoria	43
2012	Pretoria	41
2013	Rustenburg	3
2012	Rustenburg	3
2012	Vaal Triangle	5
2013	Vaal Triangle	5
2012	West Coast & Karoo	26
2013	West Coast & Karoo	24

Bonitas Medical Fund data

Bonitas Tonsillectomy Admissions

Admit Year	No of Admissions	Hospital Cost of Admission	Total Cost of Admission
2012	2385	R 14 990 762	R 21 651 553
2013	2663	R 18 616 792	R 27 096 061
2014	2629	R 20 441 026	R 29 606 809

Note: The above table only includes data for patients who were under the age of 19 at the time of admission.

	201206	201306	201406
Number Of Beneficiaries	204 842	228 429	236 011

```
. cii 204842 2385, poisson

                                                    -- Poisson  Exact --
    Variable |   Exposure        Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      204842   .0116431   .0002384      .0111805      .01212

. cii 228429 2663, poisson

                                                    -- Poisson  Exact --
    Variable |   Exposure        Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      228429   .0116579   .0002259      .0112193     .0121093
```

STATA

Overall South African tonsillectomy rate 2012/2013

```
. cii 797310 13989, poisson

                                                    -- Poisson  Exact --
    Variable |   Exposure        Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      797310   .0175452   .0001483      .0172557     .0178384

.
. cii 771720 14574, poisson

                                                    -- Poisson  Exact --
    Variable |   Exposure        Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      771720   .0188851   .0001564      .0185797     .0191942
```

Regional tonsillectomy rates and 95% CI

(See overleaf)

```
. cii 9108 424, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      9108   .0465525   .0022608      .0422263    .0512016

. cii 14662 406, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     14662   .0276906   .0013743      .0250623    .0305197

.
. cii 28892 737, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     28892   .0255088   .0009396      .0237002    .0274189

.
. cii 4548 118, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      4548   .0259455   .0023885      .0214758    .0310711

.
. cii 13616 539, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     13616   .0395858   .0017051       .036314    .0430732

.
. cii 2859 128, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      2859   .0447709   .0039572      .0373513    .0532327

.
. cii 24475 657, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     24475   .0268437   .0010473      .0248301    .0289772

.
. cii 48928 1361, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     48928   .0278164    .000754       .026358    .0293344

.
. cii 4685 135, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      4685   .0288154     .00248      .0241598    .0341065

.
. cii 3584 117, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      3584   .0326451    .003018      .0269984    .0391243

.
. cii 3933 180, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      3933   .0457666   .0034112      .0393247    .0529628

.
. cii 4531 116, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      4531   .0256014    .002377      .0211549    .0307065

.
. cii 6569 161, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      6569   .0245091   .0019316      .0208694    .0286009

.
. cii 3595 168, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      3595   .0467316   .0036054      .0399321    .0543569

.
. cii 37341 1360, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     37341   .0364211   .0009876      .0345109    .0384095

.
. cii 3955 105, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      3955   .0265487   .0025909      .0217142    .0321388

.
. cii 4134 175, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      4134   .0423319      .0032      .0362922    .0490894

.
. cii 21191 1145, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     21191   .0540324   .0015968      .0509476    .0572551

.
. cii 15556 269, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     15556   .0172924   .0010543      .0152875    .0194871

.
. cii 26548 341, poisson

                                                    -- Poisson  Exact --
    Variable |  Exposure       Mean    Std. Err.      [95% Conf. Interval]
-------------+------------------------------------------------------------
             |     26548   .0128447   .0006956      .0115174    .0142829

.
. cii 53421 635, poisson

                                                    -- Poisson  Exact --
```

```
. cii 53421 635, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       53421    .0118867   .0004717        .01098    .0128483

. cii 8945 108, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        8945    .0120738   .0011618       .0099044    .0145772

. cii 24946 336, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       24946    .0134691   .0007348       .0120672    .0149891

. cii 6035 120, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        6035     .019884   .0018152       .0164858    .0237764

. cii 43692 442, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       43692    .0101163   .0004812        .009195    .0111048

. cii 85023 881, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       85023    .0103619   .0003491       .0096889    .0110693

. cii 9529 128, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        9529    .0134327   .0011873       .0112066    .0159715

. cii 6432 72, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        6432     .011194   .0013192       .0087586     .014097

. cii 7806 109, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        7806    .0139636   .0013375       .0114656    .0168443

. cii 7713 90, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        7713    .0116686     .00123       .0093829    .0143427

. cii 12763 161, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       12763    .0126146   .0009942       .0107413    .0147206

. cii 7174 123, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        7174    .0171452   .0015459       .0142494    .0204567

. cii 63984 915, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       63984    .0143005   .0004728       .0133888    .0152579

. cii 6925 104, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        6925    .0150181   .0014726       .0122708    .0181969

. cii 7292 128, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        7292    .0175535   .0015515       .0146445    .0208711

. cii 37587 558, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       37587    .0148456   .0006285       .0136392      .01613

. cii 4658 12, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        4658    .0025762   .0007437       .0013312    .0045001

. cii 7462 28, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        7462    .0037523   .0007091       .0024934    .0054232

. cii 16283 66, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |       16283    .0040533   .0004989       .0031348    .0051568

. cii 2706 8, poisson

    Variable |    Exposure        Mean   Std. Err.      -- Poisson  Exact --
                                                       [95% Conf. Interval]
-------------+----------------------------------------------------------------
             |        2706    .0029564   .0010452       .0012764    .0058253

. cii 7445 25, poisson
```

```
. cii 2706 8, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       2706   .0029564   .0010452    .0012764    .0058253

. cii 7445 25, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       7445    .003358   .0006716    .0021731     .004957

. cii 1965 7, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       1965   .0035623   .0013464    .0014322    .0073398

. cii 11835 41, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      11835   .0034643    .000541      .002486    .0046997

. cii 23582 57, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      23582   .0024171   .0003202    .0018307    .0031316

. cii 3153 7, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       3153   .0022201   .0008391    .0008926    .0045743

. cii 1741 6, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       1741   .0034463   .0014069    .0012647    .0075011

. cii 2815 13, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       2815   .0046181   .0012808     .002459    .0078971

. cii 2080 5, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       2080   .0024038    .001075    .0007805    .0056098

. cii 3833 18, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       3833   .0046961   .0011069    .0027832    .0074218

. cii 2502 10, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       2502   .0039968   .0012639    .0019166    .0073503

. cii 18343 81, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      18343   .0044159   .0004907    .0035068    .0054885

. cii 1866 8, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       1866   .0042872   .0015158    .0018509    .0084476

. cii 2319 5, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |       2319   .0021561   .0009642    .0007001    .0050316

. cii 10745 40, poisson

    Variable |  Exposure       Mean    Std. Err.   -- Poisson  Exact --
                                                    [95% Conf. Interval]
-------------+------------------------------------------------------------
             |      10745   .0037227   .0005886    .0026595    .0050692
```

South African Medical Journal: Instruction to authors

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Journal references: Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. Stat Med 1998;289(1):350-355. [http://dx.doi.org/10.1000/hgjr.182] [PMID: 2764753]

Book references: Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101. *Chapter/section in a book:* Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.

Internet references: World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).

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