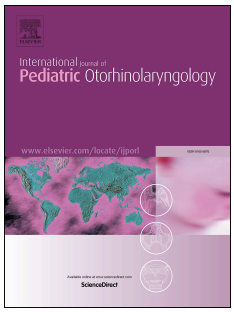
Accepted Manuscript



An innovative approach to improve ear, nose and throat surgical access for remote living Cape York Indigenous children

Susan P. Jacups, Denise Newman, Deborah Dean, Ann Richards, Kate M. McConnon

PII: S0165-5876(17)30324-5

DOI: 10.1016/j.ijporl.2017.07.011

Reference: PEDOT 8615

To appear in: *International Journal of Pediatric Otorhinolaryngology*

Received Date: 15 May 2017

Revised Date: 11 July 2017

Accepted Date: 12 July 2017

Please cite this article as: S.P. Jacups, D. Newman, D. Dean, A. Richards, K.M. McConnon, An innovative approach to improve ear, nose and throat surgical access for remote living Cape York Indigenous children, *International Journal of Pediatric Otorhinolaryngology* (2017), doi: 10.1016/j.ijporl.2017.07.011.

An innovative approach to improve ear, nose and throat surgical access for remote living Cape York Indigenous children

Authors: Susan P. Jacups[1,2*], Denise Newman[1], Deborah Dean[1], Ann Richards[1], Kate M McConnon[1,3]

[1]Medical Services, Torres and Cape York Hospital and Health Service (TCHHS)
[2]The Cairns Institute, James Cook University, Australia (JCU)
[3]Institute of Health Innovation, Macquarie University, Australia

* Corresponding author: Susan P. Jacups

Susan Jacups,
Medical Services, Torres and Cape York Hospital and Health Service,
Citi Building Level 9 46-48 Sheridan Street, Cairns QLD 4870, Australia
E: susan.jacups@health.qld.gov.au

Denise Newman,
Medical Services, Torres and Cape York Hospital and Health Service,
Citi Building Level 9 46-48 Sheridan Street, Cairns QLD 4870, Australia
E: denise. newman@health.qld.gov.au

Deborah Dean
Medical Services, Torres and Cape York Hospital and Health Service,
Citi Building Level 9 46-48 Sheridan Street, Cairns QLD 4870, Australia
E: debi.dean@health.qld.gov.au

Ann Richards
Medical Services, Torres and Cape York Hospital and Health Service,
Citi Building Level 9 46-48 Sheridan Street, Cairns QLD 4870, Australia
E: ann.richards@health.qld.gov.au

Kate M McConnon
Medical Services, Torres and Cape York Hospital and Health Service,
Citi Building Level 9 46-48 Sheridan Street, Cairns QLD 4870, Australia
E: kate.mcconnon@health.qld.gov.au

An innovative approach to improve ear, nose and throat surgical access for remote living Cape York Indigenous children

ABSTRACT

Introduction: On a background of high rates of severe otitis media (OM) with associated hearing loss, children from the Torres Strait and Cape York region requiring ear, nose and throat (ENT) surgery, faced waiting times exceeding three years. After numerous clinical safety incidents were raised, indicating a failure of the current system to deliver appropriate care, the governing Hospital and Health service opted to deliver surgical care through an alternate process. ENT surgeries were performed on 16 consented children from two remote locations via the private health care system, funded by a health provider partnership.

Methods: We examined the collaboration processes alongside clinical findings from this ENT surgery. Collated patient data, included patient demographics, clinical and audiometry presentation features were reviewed and compared pre and post-operatively. Cost savings associated with the use of TeleHealth post-operatively were briefly examined.

Results: Surgeries were successfully completed in all 16 children. The reported mean waitlist time for ENT surgery was 1.2 years. Pre-surgery pure-tone average hearing thresholds were reported at left: 30.9dB, right: 38.2dB. The majority of presentations were for bilateral OM with Effusion (69%). Post-surgical follow up indicated successful clinical outcomes in 80% of patients and successful hearing outcomes in 88% of patients. Mean difference pure-tone average hearing thresholds, left: 8.4dB and right: 11.2dB. Furthermore, the majority of patients reported improved hearing and breathing. The use of TeleHealth for post-operative review enabled a minimum cost saving of AUD$21,664 for these 16 children. Overall, a high level of staffing resources was required to successfully coordinate this intense surgical activity.

Conclusion: This innovative approach to a health system crisis enabled successful ENT surgical and hearing outcomes in 16 children, whose waitlisted time grossly exceeded state health recommendations. Using private health facilities funded by a health partnership, while unlikely to be a suitable model of care for routine service delivery; may be applied as an adjunct service model when blockages and delays lead to sub-standard service provision. This approach may be applicable to other health care facilities when facing extended elective surgery wait times in ENT or other specialty areas.

Key words: Indigenous, Otits Media, child, Tympanoplasty, chronic disease, Otitis Media with Effusion/*therapy, Audiometry, Pure-Tone, middle ear pathology, Hearing Loss, Conductive/etiology,"Telehealth", "Telemedicine"

1. INTRODUCTION

Internationally, ear disease especially otitis media, is reported at higher rates in Indigenous children than non-Indigenous, as described from Australia, Canada, USA, Peru and New Zealand[1-7]. Furthermore, remote living children are more likely to suffer ear disease infections than children living in urban settings, in Indigenous and non-Indigenous populations [7-10]. Hearing loss associated with middle ear pathology is similarly higher in Indigenous versus non-Indigenous populations across the world [1, 3, 11].

The sequelae of childhood ear infections include long-term hearing loss [12], and delays in speech development, which in-turn have been found to be strongly associated with reduced socialisation, learning difficulties and poor academic outcomes [13-16]; the consequences of childhood ear, nose and throat (ENT) infections can greatly reduce an individual's potential [14, 17].

Early intervention for otitis media can effectively restore hearing to adequate levels with medical management [18]; however, when otitis media has not responded to medical treatment ENT surgery may be considered to improve hearing outcomes [19]. Standard surgical procedures that address otitis media associated hearing loss include tympanostomy tubes ("grommets"), with or without adenoidectomy, and tympanic membrane repair [11, 19-21], can improve hearing sufficiently to avoid the need for hearing aids in most cases [19].

1.1 Setting

The Torres Strait and Cape York region, an area of 130,300 square kilometres includes the Torres Strait Islands, Figure 1, support a population of approximately 25,000 people, of whom 68.2% identify as Aboriginal or Torres Strait Islander [22]. Presently, there are no published rates of ear disease or hearing loss available for this area, so often national rates of disease, are presented in lieu of more accurate information [1]. Unpublished data collected between 2012-2013 from five remote Cape York communities, indicate high rates of ear disease and associated hearing loss in this population. These data, obtained from routine school screening from 401 Indigenous children in 2012 and 384 Indigenous children in 2013, identified otitis media (OM) associated ear perforations (in one or both ears) in 7% (standard deviation (sd): 5%) of children during both 2012 and 2013. Currently discharging ears were reported in 4% (sd: 3%) during 2012 and 4% (sd: 4%) during 2013 (Tregenza, 2017, Apunipima Cape York Health Council, unpublished data). Furthermore, hearing loss reported from this unpublished data as pure tone average hearing thresholds in one or both ears ≥30dB were identified in 18% (sd: 10%) of children during 2012 and 14% (sd:10%) during 2013; with ≥35dB hearing threshold in one or both ears identified in 12% (sd:7%) of children during 2012 and 10% (sd:3%) during 2013.

Figure 1: Torres and Cape York Health and Hospital Service region, source: Queensland Health 2017

Standard processes for management of ear pathology, with associated hearing loss across this remote region, include access to an ENT specialist review provided by the

closest referral hospital. However, increasing delays and blockages at the referral centre resulted in wait times exceeding three years for elective ENT surgery, such that during 2016 several safety concerns were raised and Patient Related Incident Management System (PRIME) clinical incidents were reported for investigation, indicating a failure of the current system to deliver appropriate care according to state health recommended guidelines [24].

In response to these reported clinical incidents, the regional Health and Hospital Service (HHS) sought to mitigate patient risks associated with long wait times for ENT surgery by undertaking an innovative approach to surgical access for remote living children. This innovative approach, which was co-funded and co-coordinated by a partnership across several health organisations, delivered surgery to a group of 16 children through the private health system. This short term solution addressed an acute elective surgery backload crisis within the public hospital system and mitigated escalating patient clinical incident risks.

We sought to review this innovative service provision model and present findings alongside the clinical and hearing outcomes of patients, as a quality assurance process to inform the development of improved ENT services within the region. Findings may be applicable to other Health services faced with a backload of elective surgical waitlists that routinely place patients at increased risk.

2. MATERIAL AND METHODS

2.1 Processes

This innovative approach addressing excessive elective surgery wait times involved a co-funding partnership between Torres and Cape HHS and CheckUP Australia, a not-for-profit organisation funded through the Commonwealth Department of Health, and Apunipima CYHC, to deliver ENT surgery through the Private health care system. Patient surgery and travel were largely funded by CheckUP, through the Eye and Ear Surgical Services program, a federally funded service aimed to reduce hearing loss associated with ear pathology. CheckUP funding covered costs associated with theatre and hospital bed time, anaesthetics and surgeon fees for 16 children within the private health care system. Travel included airplane charter for patients plus their escort carers to travel distances of over 800 kilometres. The coordination and planning of all processes was led by Torres and Cape Hospital and Health Service, who shortlisted patients, flew to remote communities to meet patients and their escorts and provided logistical coordination for ground connections and essential health assessments. This building of relationships and establishing trust between health service providers and patient escorts was essential to process success. Apunipima CYHC supported surgery with an Indigenous Health worker to support family communication.

Surgery was conducted on 20-21st September, 2016 at two private hospitals in Cairns as same-day procedures. Standard patient consent processes and hospital admission processes were adhered throughout. Patients were clinically reviewed one day pre-surgery, post-surgery, and then again six weeks after surgery at their home community Health Centre using TeleHealth Flexican Otoscope or the Welch Allyn

USB Otoscope. Post op audiology was performed at least 6 weeks post-operatively in their home communities by Apunipima audiologist.

2.2 Patient selection

All long term Category (Cat) 2 (90 day) ENT surgical waitlisted children, 0-15 years, by community, were reviewed from referral data submitted to the regional referral hospital. Each record was individually clinically assessed (authors KM, AR & DN) for inclusion suitability in this surgical cohort. Inclusion criteria were defined by Queensland Health's Clinical Prioritisation Criteria for on-going ear ill-health, such as Otitis Media with Effusion (OME) or dry ear perforation, removal of foreign bodies, adenoidectomy or mastoidectomy associated with moderate to severe hearing loss, with pure tone average hearing thresholds (35+ dB) [24, 25]. Thus the primary aim of this ENT surgery was to facilitate hearing, although it is noted that breathing benefits may be gained by successful surgery for ear conditions.

Patients were prioritised according to need and the availability of recent clinical (patient record) information. The majority of patients had attended an ENT appointment within the last 18 months; one patient, known to the ENT surgeon who had conducted tympanic membrane repair on one ear previously, had missed several ENT appointments due to boarding school attendance; this child was retained on the list as recent contact verified he still warranted surgery. Some patients required recent audiology testing (less than 12 months old), and this was coordinated prior to ENT surgery with the Apunipima outreach audiologist.

2.3 Patient review

Of the 16 patients selected, data were extracted on; patient demographics: age, gender, ethnicity and location; clinical information: history of ear condition, Otitis Media, as clinically reported in ENT specialist records; audiology: pure-tone average hearing thresholds; , , referral categorisation (Cat) level, their wait times , and the surgical procedures to be undertaken. Post-operatively clinical review information was documented at day one and at 6 weeks via TeleHealth review. Audiology pure tone average hearing thresholds were conducted post-operatively by the visiting audiologist when next in the community (6 -8 weeks post-op). The remoteness classification was later calculated from patient location by applying the Modified Monash Model (MMM) [26].

2.4 Data analysis

All data were collected, stored and examined using Microsoft Excel 2010. Analyses were limited to descriptive statistics. Discrete data were presented as counts and percentages and continuous data were presented as means with range and standard deviation (sd) . While the inclusion of a cost analysis would greatly benefit this paper and strengthen this manuscript's position to inform policy change in this area, a comprehensive economic analysis is beyond the scope of this study; however, we have included a brief cost estimate of savings potentially gained through the use of TeleHealth for post-op review when compared to a standard face to face ENT consultation review.

2.5 Ethics

This study has been reviewed by the Far North Queensland Human Research Ethics Committee and granted an exemption from full ethical review as it qualifies as a quality assurance activity; reference number HREC/17/QCH/3-1111 QA.

3. RESULTS

3.1 Clinical evaluation

The long term Cat 2 ENT waitlist for early 2016 included 127 patients, mean waiting time was 332 days (11 months) (range in days: 96-1349 (3.7 years)). We excluded patients who required a recent ENT review. Once these patients were removed we arrived at a list of 43 children from five remote communities. Further patients were removed from the list if they could no longer be contacted at their most recent fixed address. To facilitate the ease of progression of this intense logistic operation, requiring two days of back-to-back surgery, we reduced the number of communities to two.

TeleHealth was not available to review patients pre-operatively therefore some minor discrepancies were noted between the original ear condition diagnosis and the presenting ear pathology identified upon review one day prior to surgery. We finally arrived at 16 children and their demography is presented below, Table 1.

Table 1: Demography of 16 ENT surgical patients

Table 2: Clinical characteristics pre and post-surgery, 16 ENT surgical patients

3.1.1 Post-operative review

In this surgical list there were no presentations of cholesteatoma requiring mastoidectomy. Of the two patients presenting with CSOM, both received adenoidectomy to assist Eustachian tube drainage and breathing; one child received myringotomy to both ears as tympanic membranes were intact; while the other child received an ear toilet under anaesthesia, Table 2. No complications were reported during the immediate post-operative period.

3.1.2 Follow-up review

All patients but one attended the six week clinical follow up visit, while five patients were out of community and did not attend the 6-8 week audiology assessment. Clinical findings indicate complete clinical resolution in 80% at six weeks post-operative, with mild localised infections or wetness found in 3 patients, who were recommended topical antibiotic drops as treatment. Audiology tested pure tone average hearing thresholds were found to improve by mean difference left: 8.4dB and right: 11.2dB, Table 2. Hearing, sleeping and speech improvements are also presented in Table 2. Reports from patient carers almost immediately after the surgery indicated that they noticed improvements in their child's sleeping, breathing, hearing, behaviour and concentration.

3.2 Process evaluation

The funding for this surgery was made available by health organisation partner underspends in other budgeted areas, which could legitimately be transferred to Ear surgery funding streams. It is unlikely that this level of funding will be available for

routine surgical service delivery. The organisation and coordination of these surgical processes were enabled through in-kind staffing contributions from the HHS. Surgery planning, including travel, accommodation, food and ground transport required two or more staff members in attendance for the duration of the scheduled surgical activity. The resource commitment to support this intense activity was extensive and far exceeded the routine service delivery resource allocation.

3.3 TeleHealth evaluation

The use of TeleHealth for post-op review was paramount to review efficiency for time and costs. TeleHealth enabled patients to remain within their communities for their 20-30 minute video conference meeting with digital Otoscope ear view. Patients felt comfortable with the procedure and they greeted their surgeon on the video link prior to having their ears examined by a clinician using a digital Otoscope. The use of TeleHealth meant there was no travel requirement for either patient or clinician, offering a time and cost efficient model of care for this service.

Estimates calculated from the use of TeleHealth for post-operative review when compared to routine face to face ENT review were costed per individual: Total TeleHealth review ~AUS$335, not including time or salary component required for coordinating, hosting and delivering TeleHealth. Costs for delivering one standard ENT review consultation in Cairns specialist rooms~ $198. Flight costs for one patient and their escort ranged from $1,689 to $2,493 depending on flight availability. These costs do not include administration costs required to book and process flights and payments, or staffing time needed to coordinate flights with patients and their families and document this coordination within the patient and clinic records. In summary, the potential cost savings of using TeleHealth for ENT specialist review when compared with standard consultation room review range from AUD$1,354 to $2,158 per patient. For 16 patients the minimum cost saving is estimated to be AUD$21,664 for using TeleHealth to review patients post-operatively when compared to routine face to face consultation review.

4. DISCUSSION

This innovative approach, through a co-funding partnership, enabled successful fast-tracking of ENT surgery to be delivered to a cohort of 16 children. Our findings indicate that surgical interventions for the management of OM were clinically successful and improved hearing and speech in these young children at least 6 weeks post-op in 80% of children. Carer's also reported significant improvements in their child's sleeping, breathing, hearing, behaviour and concentration; these combined benefits could then assist their learning and development.

The presenting ear and hearing loss for this cohort were typical of what has been reported previously for this population (Tregenza, 2017, Apunipima CYHC, unpublished data). Our findings for surgical intervention indicate successful clinical outcomes for this surgery cohort, at 6 weeks post-op, with improvements to hearing averaging 8-11dB on audiometry reported up to two months post-op. Findings from other studies on ear health report high rates of ear disease associated with bacterial and or viral pathogens recorded from high risk populations, including remote living Indigenous Australians [27-31]; however, few report on hearing impairment as a consequence of those high rates of ear disease [11, 32, 33]. We believe that this is the

first study to report ear surgery outcomes for the Cape York region, including audiometry findings pre and post-surgery. These findings will provide a baseline for future work to be compared against and enable planning and management strategies to be implemented that address ear and hearing health.

In this study TeleHealth used for post-operative review was crucial to success, enabling a minimum cost saving of AUD$21,664. TeleMedicine has been used extensively for ENT pre-surgery planning and post-surgical review across remote areas of Alaska [34-36]. Findings from these studies indicate high intra-provider diagnostic concordance between the in-person examination and the corresponding image review (79-85%)[34-36]. Furthermore, TeleHealth or TeleMedicine is recognised nationally and internationally as an effective cost saving method of delivering ENT health services; other benefits include improved patient outcomes, reduced costs and time, and reduced carbon impacts [37-44]. One study from remote Alaska reported routine wait times reduced by 31% to 2.9 months and only 3% of patients were required to wait 5 months or longer using the new telemedicine model of care for ENT appointments [45]. Other remote Alaskan publication reported findings from Store and Forward TeleMedicine use between an audiologist to an ENT specialist to guide referrals and ear condition management. Over 57 months, 1,458 patients were reviewed this way. Travel was prevented for 85% encounters, resulting in significant travel cost avoidance of US $496,420 [46].
Closer to home, a community-based mobile telehealth screening service for Aboriginal and Torres Strait Islander children in Australia, was found to successfully provide specialist review and treatment planning at a distance [49], and a Queensland TeleHealth scoping study identified that face to face consultations for ENT consultations could be reduced by 89% if TeleHealth were used appropriately[50].

Our study sample were from very remote locations with an MMM category of 7 and the majority were Indigenous (87.5%). It is well established that many remote living Aboriginal and Torres Strait Islander community residents live in extreme disadvantage, with lower than the Australian median household incomes and poor environmental conditions including overcrowded houses [51] [27, 52]. Indeed, household numbers for Indigenous Australians in remote communities exceed those of non-Indigenous by an average of three persons [53] [54, 55]. Overcrowded living conditions and poor hygiene are established risks for ear disease in children, as they promote high rates of bacterial carriage with increased likelihood of cross-infection, usually between siblings. To address ear disease in this context, in the absence of substantial socioeconomic change, improvements to early treatment with community based (including household) management of ear disease may see reductions in progression of ear disease to hearing loss [54, 55].

The elective surgery wait times for this cohort averaged 11 months, which grossly exceeded state health recommendations [24]. We found no reports in the published literature comparing ENT surgical wait time between urban, rural and remote areas. However, a comparison can be made with data available on a government website from a major urban public hospital during the same period (2015-16). Data from this period indicate elective myringotomy median wait times were 65 days [56]. This comparison highlights the unconscionably long wait times faced by remote living children requiring ENT surgery.

Extended patient wait times for elective surgery are a great source of patient and staff dissatisfaction, nationally and internationally [58-61]. To improve the timeliness of services, many health systems have introduced policies that address wait times, with some reported successes. Policies as identified from 12 Organisation for Economic Co-operation and Development (OECD) countries, indicated approaches to reduce waiting times can be made by tackling either supply or demand [60]. Findings from these two categories identified that supply, which boosts surgical capacity through financial incentives, boasts some successes by increasing elective surgery supply at critical times[60]; while policies that address demand apply tighter clinical thresholds as qualification criteria for surgical waiting lists or explicit rationing of elective surgery services [62]. One highlighted limitation to the reduction approach for patient outcomes follows that prioritisation is based on clinical need and not on ability to benefit [63]; resulting in prioritisation of surgical procedures offered to patients at the ends of their lives, over their younger and healthier counterparts who may benefit further [59]. Similarly, the promotion of private health insurance reported the weakest evidence for successful reduction of elective wait times in the public health system [60] [64] [61]. Findings from these 12 OECD countries reported that optimal approaches are even-handed between supply and demand [60].

We approached elective surgery waitlists by increasing surgical supply through an injection of funds, as facilitated by a health care provider partnership utilising federally funded specific Ear surgery funding streams. It is unlikely that this level of funding will be available for routine surgery. Furthermore, the staffing resources allocated for this intense coordination activity was extremely high, and unlikely to be sustained long-term or for use as a model of care for routine service delivery.

4.1 Limitations

This audit enabled the identification of several limitations and areas for improvement. Firstly, this study was not designed to identify which surgical techniques are best suited as management of OM presentations within a high risk population; such as the use of grommets for OM management which has been raised by others as research that needs to be undertaken [19]. Secondly, this clinical audit and process review did not include a costing or economic evaluation, which would have provided financial information to further guide decision making and policies for future ENT service delivery. However, in the absence of health partner co-funding, it is unlikely that this model of care could be sustained as routine service delivery, for only with the financial backing of health partners was this innovation financially feasible as an adjunct to existing elective surgical services when blockages and delays lead to sub-standard health provision with associated reported clinical incidents. An economic analysis of this work is currently being considered by the authors, and this may include a comparison of these costs with an alternate sustainable model of care.

5. CONCLUSIONS

This study has succeeded in mitigating patient risk by facilitating surgical access for a poorly serviced population. Access to ENT surgery for these children will improve their hearing sufficiently to smooth their learning processes and provide them with a more optimistic trajectory, which may have otherwise been delayed by significant hearing loss.

This study highlights the difficulty and additional resourced required to provide health care to patients living in rural and remote locations. These people frequently report poorer access to screening, referral and have longer wait times. Furthermore, the coordination of their travel and care is complex and requires additional resources with many more checks to ensure things go smoothly. In the absence of substantial socioeconomic improvement, ear health and hearing loss is likely to continue impact the lives of remote living Indigenous children, although community lead improvements to ear health management may see reductions in progression of ear disease to hearing loss.

The use of a co-funding model of care through a health provider partnership may be applicable to other Hospital Health services, when faced with extended elective surgery wait times in ENT, or other specialty areas, which pose risks to patient safety and optimal health outcomes. And lastly, this study highlights the importance of conducting reviews and audits to maintain quality service delivery by examining and reviewing standard and alternate approaches to patient care. By conducting an audit using existing data sources, no additional research needed to be undertaken, which could have placed patients at risk of harm.

ACKNOWLEDGEMENTS

We wish to thank all Primary Health Care providers: TCHHS, Apunipima CYHC, CheckUp, RFDS, for funding this surgery, and Audiologists from Australian Hearing, Cairns Audiology, and Apunipima CYHC, especially Kristen Tregenza. These hard working clinicians and administrators provide quality clinical and administrative services to these remote locations. We also wish to thank Dr Suki Ahluwalia and his delightful administration staff, in particular Maria Winger and Darcy Inglis, from Coral Coast ENT, and the Ramsay Health group for the provision of private hospital services to this group of children. Lastly, we wish to thank the two anonymous reviewers who suggested many improvements, while providing great insight into the value of this manuscript to drive policy change.

REFERENCES

[1] Australian Bureau of Statistics, Australian Aboriginal and Torres Strait Islander Health Survey: First Results, Australia, 2012-13 City: Australian Bureau of Statistics, 2013.
[2] Czechowicz JA, Messner AH, Alarcon-Matutti E, Alarcon J, Quinones-Calderon G, Montano S, Zunt JR. **Hearing impairment and poverty: the epidemiology of ear disease in Peruvian schoolchildren**. Otolaryngol Head Neck Surg, 142 (2010) 272-277.
[3] Moore JA. **Comparison of risk of conductive hearing loss among three ethnic groups of Arctic audiology patients**. Journal Of Speech, Language, And Hearing Research: JSLHR, 42 (1999) 1311-1322.
[4] Davidson J, Hyde ML, Alberti PW. **Epidemiologic patterns in childhood hearing loss: a review**. International Journal Of Pediatric Otorhinolaryngology, 17 (1989) 239-266.
[5] Gibney KB, Morris PS, Carapetis JR, Skull SA, Smith-Vaughan HC, Stubbs E, Leach AJ. **The clinical course of acute otitis media in high-risk Australian Aboriginal children: a longitudinal study**. BMC Pediatr, 5 (2005) 16.
[6] McCallum J, Craig L, Whittaker I, Baxter J. **Ethnic differences in acute hospitalisations for otitis media and elective hospitalisations for ventilation tubes in New Zealand children aged 0-14 years**. The New Zealand Medical Journal, 128 (2015) 10-20.
[7] Kong K, Coates HL. **Natural history, definitions, risk factors and burden of otitis media**. Med J Aust, 191 (2009) S39-43.
[8] Abbott P, Gunasekera H, Leach AJ, Askew D, Walsh R, Kong K, Girosi F, Bond C, Morris P, Lujic S, Hu W, Usherwood T, Tyson S, Spurling G, Douglas M, Schubert K, Chapman S, Siddiqui N, Murray R, Rabbitt K, Porykali B, Woodall C, Newman T, Reath J. **A multi-centre open-label randomised non-inferiority trial comparing watchful waiting to antibiotic treatment for acute otitis media without perforation in low-risk urban Aboriginal and Torres Strait Islander children (the WATCH trial): study protocol for a randomised controlled trial**. Trials, 17 (2016) 119.
[9] Smith AC, Brown C, Bradford N, Caffery LJ, Perry C, Armfield NR. **Monitoring ear health through a telemedicine-supported health screening service in Queensland**. J Telemed Telecare, 21 (2015) 427-430.
[10] Anggraeni R, Hartanto WW, Djelantik B, Ghanie A, Utama DS, Setiawan EP, Lukman E, Hardiningsih C, Asmuni S, Budiarti R, Rahardjo SP, Djamin R, Mulyani T, Mutyara K, Carosone-Link P, Kartasasmita CB, Simões EAF. **Otitis media in indonesian urban and rural school children**. The Pediatric Infectious Disease Journal, 33 (2014) 1010-1015.
[11] Nienhuys TG, Boswell JB, McConnel FB. **Middle ear measures as predictors of hearing loss in Australian aboriginal schoolchildren**. International Journal Of Pediatric Otorhinolaryngology, 30 (1994) 15-27.
[12] Kaspar A, Kei J, Driscoll C, Swanepoel DW, Goulios H. **Overview of a public health approach to pediatric hearing impairment in the Pacific Islands**. International Journal Of Pediatric Otorhinolaryngology, 86 (2016) 43-52.
[13] DiGiacomo M, Davidson PM, Abbott P, Delaney P, Dharmendra T, McGrath SJ, Delaney J, Vincent F. **Childhood disability in Aboriginal and Torres Strait Islander peoples: a literature review**. Int J Equity Health, 12 (2013) 7.

[14] Mak D, MacKendrick A, Bulsara M, Coates H, Lannigan F, Lehmann D, Leidwinger L, Weeks S. **Outcomes of myringoplasty in Australian Aboriginal children and factors associated with success: a prospective case series**. Clin Otolaryngol Allied Sci, 29 (2004) 606-611.
[15] Chase PA, Boggs TL. **Speech-language-hearing health disparities in young children**. Perspectives on School-Based Issues, 9 (2008) 151-154.
[16] Cripps AW, Kyd J. **Bacterial otitis media: current vaccine development strategies**. Immunology And Cell Biology, 81 (2003) 46-51.
[17] Lehmann D, Arumugaswamy A, Elsbury D, Finucane J, Stokes A, Monck R, Jeffries-Stokes C, McAullay D, Coates H, Stanley FJ. **The Kalgoorlie Otitis Media Research Project: rationale, methods, population characteristics and ethical considerations**. Paediatr Perinat Epidemiol, 22 (2008) 60-71.
[18] Morris PS. **Management of otitis media in a high risk population**. Australian Family Physician, 27 (1998) 1021-1029.
[19] O'Leary SJ, Triolo RD. **Surgery for otitis media among Indigenous Australians**. Med J Aust, 191 (2009) S65-68.
[20] Wullstein H. **Theory and practice of tympanoplasty**. Trans Am Laryngol Rhinol Otol Soc, (1956) 548-565; discussion, 565-547.
[21] O'Leary S, Veldman JE. **Revision surgery for chronic otitis media: recurrent-residual disease and hearing**. The Journal Of Laryngology And Otology, 116 (2002) 996-1000.
[22] Australian Bureau of Statistics, Population by Age and Sex, Regions of Australia. City: Australian Bureau of Statistics,, 2014.
[23] Acuin J, World Health Organization. Chronic suppurative otitis media : burden of illness and management options. City: World Health Organization, 2004.
[24] Queensland Health, Perforated eardrum/chronic suppurative otitis media (CSOM). City: Queensland Government, 2016.
[25] Queensland Health, Otitis media – with effusion (OME or glue ear). City: Queensland Government, 2016.
[26] Australian Government DoH, Modified Monash Model Suburb and Locality Classification. 21/12/2016 ed. City: Department of Health, 2016.
[27] Morris PS, Leach AJ, Silberberg P, Mellon G, Wilson C, Hamilton E, Beissbarth J. **Otitis media in young Aboriginal children from remote communities in Northern and Central Australia: a cross-sectional survey**. BMC Pediatr, 5 (2005) 27.
[28] Morris P. **Chronic suppurative otitis media**. BMJ Clinical Evidence, 2012 (2012).
[29] Moran DJ, Waterford JE, Hollows F, Jones DL. **Ear disease in rural Australia**. The Medical Journal Of Australia, 2 (1979) 210-212.
[30] Leach AJ, Morris PS, Mathews JD. **Compared to placebo, long-term antibiotics resolve otitis media with effusion (OME) and prevent acute otitis media with perforation (AOMwiP) in a high-risk population: a randomized controlled trial**. BMC Pediatr, 8 (2008) 23.
[31] Leach AJ. **Otitis media in Australian Aboriginal children: an overview**. International Journal Of Pediatric Otorhinolaryngology, 49 Suppl 1 (1999) S173-S178.
[32] Bagshaw RJ, Wall EH, Dowswell G, Martin TPC, Smith MCF. **Hearing impairment in otitis media with effusion: a cross-sectional study based in Pokhara, Nepal**. International Journal Of Pediatric Otorhinolaryngology, 75 (2011) 1589-1593.

[33] Saunders JE, Vaz S, Greinwald JH, Lai J, Morin L, Mojica K. **Prevalence and etiology of hearing loss in rural Nicaraguan children**. The Laryngoscope, 117 (2007) 387-398.
[34] Patricoski C, Kokesh J, Ferguson AS, Koller K, Zwack G, Provost E, Holck P. **A comparison of in-person examination and video otoscope imaging for tympanostomy tube follow-up**. Telemed J E Health, 9 (2003) 331-344.
[35] Kokesh J, Ferguson AS, Patricoski C, Koller K, Zwack G, Provost E, Holck P. **Digital images for postsurgical follow-up of tympanostomy tubes in remote Alaska**. Otolaryngol Head Neck Surg, 139 (2008) 87-93.
[36] Kokesh J, Ferguson AS, Patricoski C. **Preoperative planning for ear surgery using store-and-forward telemedicine**. Otolaryngol Head Neck Surg, 143 (2010) 253-257.
[37] Ellis I, Cheek C, Jaffray L, Skinner T. **Making a case for telehealth: measuring the carbon cost of health-related travel**. Rural Remote Health, 13 (2013) 2723.
[38] Ward MM, Ullrich F, Mueller K, Rural Health R, Policy C, Rupri Center for Rural Health Policy Analysis UoICoPHDoHM, Policy. **Extent of telehealth use in rural and urban hospitals**. Rural Policy Brief, (2014) 1-4.
[39] Shore JH, Brooks E, Savin DM, Manson SM, Libby AM. **An economic evaluation of telehealth data collection with rural populations**. Psychiatr Serv, 58 (2007) 830-835.
[40] Marcin JP, Shaikh U, Steinhorn RH. **Addressing health disparities in rural communities using telehealth**. Pediatr Res, 79 (2016) 169-176.
[41] Smith AC, Scuffham P, Wootton R. **The costs and potential savings of a novel telepaediatric service in Queensland**. BMC Health Serv Res, 7 (2007) 35.
[42] Bradford NK, Caffery LJ, Smith AC. **Telehealth services in rural and remote Australia: a systematic review of models of care and factors influencing success and sustainability**. Rural Remote Health, 16 (2016) 4268.
[43] Nguyen K-H, Smith AC, Armfield NR, Bensink M, Scuffham PA. **Cost-Effectiveness Analysis of a Mobile Ear Screening and Surveillance Service versus an Outreach Screening, Surveillance and Surgical Service for Indigenous Children in Australia**. Plos One, 10 (2015) e0138369-e0138369.
[44] Bergmo TS. **An economic analysis of teleconsultation in otorhinolaryngology**. Journal Of Telemedicine And Telecare, 3 (1997) 194-199.
[45] Hofstetter PJ, Kokesh J, Ferguson AS, Hood LJ. **The Impact of Telehealth on Wait Time for ENT Specialty Care**. Telemedicine and e-Health, 16 (2010) 551-556.
[46] Kokesh J, Ferguson AS, Patricoski C, LeMaster B. **Traveling an audiologist to provide otolaryngology care using store-and-forward telemedicine**. Telemedicine Journal And E-Health: The Official Journal Of The American Telemedicine Association, 15 (2009) 758-763.
[47] Kokesh J, Ferguson AS, Patricoski C. **The Alaska experience using store-and-forward telemedicine for ENT care in Alaska**. Otolaryngologic Clinics Of North America, 44 (2011) 1359.
[48] Kokesh J, Ferguson AS, Patricoski C. **Telehealth in Alaska: delivery of health care services from a specialist's perspective**. Int J Circumpolar Health, 63 (2004) 387-400.
[49] Elliott G, Smith AC, Bensink ME, Brown C, Stewart C, Perry C, Scuffham P. **The feasibility of a community-based mobile telehealth screening service for Aboriginal and Torres Strait Islander children in Australia**. Telemedicine Journal And E-Health: The Official Journal Of The American Telemedicine Association, 16 (2010) 950-956.

[50] Caffery LJ, Farjian M, Smith AC. **Telehealth interventions for reducing waiting lists and waiting times for specialist outpatient services: A scoping review**. J Telemed Telecare, 22 (2016) 504-512.
[51] Australian Bureau of Statistics, Census of Population and Housing (ABS Table Builder). City, 2011.
[52] Morris PS, Leach AJ, Halpin S, Mellon G, Gadil G, Wigger C, Mackenzie G, Wilson C, Gadil E, Torzillo P. **An overview of acute otitis media in Australian Aboriginal children living in remote communities**. Vaccine, 25 (2007) 2389-2393.
[53] Abbasi Z, Aboriginal and Torres Strait Islander people. City: Australian Bureau of Statistics, 1998.
[54] Jacups SP. **The continuing role of Haemophilus influenzae type b carriage surveillance as a mechanism for early detection of invasive disease activity**. Hum Vaccin, 7 (2011) 1254-1260.
[55] Jacups SP, Morris PS, Leach AJ. **Haemophilus influenzae type b carriage in Indigenous children and children attending childcare centers in the Northern Territory, Australia, spanning pre- and post-vaccine eras**. Vaccine, 29 (2011) 3083-3088.
[56] Australian Institute of Health and Welfare, Waiting times for surgery: Ear, nose and throat surgery. City: Australian Institute of Health and Welfare, 2017.
[57] Australian Institute of Health and Welfare, Elective surgery waiting times 2014-15. City: Australian Institute of Health and Welfare, 2015.
[58] Van Doorslaer E, Clarke P, Savage E, Hall J. **Horizontal inequities in Australia's mixed public/private health care system**. Health Policy, 86 (2008) 97-108.
[59] Oudhoff JP, Timmermans DR, Knol DL, Bijnen AB, van der Wal G. **Waiting for elective general surgery: impact on health related quality of life and psychosocial consequences**. BMC Public Health, 7 (2007) 164.
[60] Kreindler SA. **Policy strategies to reduce waits for elective care: a synthesis of international evidence**. Br Med Bull, 95 (2010) 7-32.
[61] Duckett SJ. **Living in the parallel universe in Australia: public Medicare and private hospitals**. CMAJ, 173 (2005) 745-747.
[62] Siciliani L, Hurst J. **Tackling excessive waiting times for elective surgery: a comparative analysis of policies in 12 OECD countries**. Health Policy, 72 (2005) 201-215.
[63] Oudhoff JP, Timmermans DR, Rietberg M, Knol DL, van der Wal G. **The acceptability of waiting times for elective general surgery and the appropriateness of prioritising patients**. BMC Health Serv Res, 7 (2007) 32.
[64] Segal L. **Why it is time to review the role of private health insurance in Australia**. Australian Health Review, 27 (2004) 3-15.

Table 1: Demography of 16 ENT surgical patients

	Number	percentage
Gender		
Male	8	50%
Female	8	50%
Location		
Remote Indigenous community	13	81%
Remote mining town	3	19%
MMM classification of 7 (very remote)	16	100%
Indigenous status		
Indigenous	14	87.5%
Non-Indigenous	2	12.5%
Age years (mean and range)	8.9	4-17, sd-3.2

Table 2: Clinical characteristics pre and post-surgery, 16 ENT surgical patients

Presenting ear condition		
Bilateral OME	11	69%
Unilateral OME + CSOM (with long-term grommet requiring surgical removal)	1	6%
CSOM- for adenoidectomy, ear toilet and EUA*	2	13%
Dry perforated TM	2	13%
Audiology findings		
Left ear (mean: min-max)	30.9dB	15-45dB, sd-12.7dB
Right ear (mean: min-max)	38.2dB	25-55dB, sd-11.0dB
Surgical Waitlist categorisation		
Category 2 (appointment within 90 days)	16	100%
Mean surgical waitlist time (days)	445 (1.2 yrs)	130-928 (4.3mth-2.5yrs), sd-275
Surgery performed		
Adenoidectomy	1	6%
Adenoidectomy & Myringotomy	8	50%
Myringoplasty	2	13%
Adenoidectomy & Grommets	4	25%
Adenoidectomy & 1 Grommet removal & 1 Myringotomy	1	6%
Outcomes		
Post-op clinical outcomes at day 1 post op		
No post-operative issues	16	100%
Post-op clinical outcomes at 6/52 n=15		
Ear dry and clean, no sign of infection	12	80%
Signs of ear infection in one ear	3	20%
Fail to attend 6/52 post op review	1	-
Symptoms and quality of life		
Sleeping well	11	69%
Hearing well	14	88%
Speech improved	6	38%
Post-op Audiology outcomes at 6-8/52		
Left ear (mean: min-max) (n=11)	22.7dB	15-35, sd-5.2
Right ear (mean: min-max) (n=11)	27.7dB	20-45, sd-9.0

*EUA- Examination Under Anaesthesia

Figure 1: Torres and Cape York Health and Hospital Service region, source: Queensland Health 2017