S Afr J Surg. 2024;62:254-260. Online first
https://doi.org/10.36303/SAJS.00158

S Afr J Surg
ISSN 038-2361

ENT SURGERY

Perioperative antibiotic practices amongst otorhinolaryngologists (ear, nose and throat surgeons) in South Africa

M White, J McGuire, S Peer

Division of Otorhinolaryngology, Department of Surgery, Faculty of Health Sciences, University of Cape Town, South Africa

Corresponding author, email: *matthewwhite86@yahoo.com*

Background: The primary goal of perioperative antibiotics is to reduce the rate of surgical site infections (SSI); however, in certain surgical procedures, the use of perioperative antibiotics has been shown to have no impact on the rate of SSI. Inappropriate use of antimicrobials increases cost, potential side effects and further promotes antibiotic resistance. This study aims to provide insight into the adherence of South African otorhinolaryngologists to available evidence-based international guidelines.
Methods: An electronic survey was sent to otorhinolaryngologists in South Africa.
Results: Ninety-two respondents indicated that they utilise the following resources to guide their decisions regarding perioperative antibiotic prescribing – anecdotal evidence 27% (25/92), practices of the surgeon's postgraduate training unit 28% (26/92), published international guidelines 28% (26/92), recommendation of their local hospital's microbiologists 14% (13/92). Respondents indicated they take the following factors into consideration to guide decisions regarding perioperative antimicrobial use – 48% (35/92) duration of surgery, 85% (78/92) degree of contamination of the surgical field, 8% (7/92) patient's age, 8% (7/92) degree of blood loss, 22% (20/92) HIV status of patient, and 22% (20/92) patient's access to hospital. Thirty-five per cent (32/92) of respondents indicated they audit their own rate of wound complications.
Conclusion: There is significant heterogeneity in the use of perioperative antibiotic prescribing practices and variable adherence to international consensus guidelines amongst ENT surgeons in South Africa. In light of the global increase in antibiotic resistance, this study highlights the need for increased awareness regarding the principles of antibiotic stewardship, pre-existing evidence-based guidelines and the need for a locally-generated South African otorhinolaryngology consensus guideline that promotes safe and rational use of perioperative antibiotic prophylaxis.
Keywords: perioperative antibiotics, surgical site prophylaxis, tonsillectomy, otorhinolaryngology

Introduction

The primary goal of perioperative antibiotic therapy is to reduce the rate of surgical site infections (SSI), defined as a local infection that occurs within 30 days of surgical incision or organ manipulation during surgery, or within a year of prosthetic implantation.[1] However, in certain surgical procedures the use of perioperative antibiotic therapy has been shown to have no impact on the rate of SSI. Irrational and inappropriate use of antimicrobials not only comes at increased cost and increased risk of side effects to the patient, but also promotes antimicrobial resistance (AMR). AMR is, arguably, one of the greatest current and future threats the health sector faces globally, accounting for approximately 700 000 deaths in 2016, projected to rise to 10 million by 2050.[2] Further to the commonly quoted potential side effects of antibiotics (e.g. gastrointestinal, anaphylaxis, candidiasis), more recent associations with antibiotic overuse reported in the literature include increased risk of obesity, diabetes, inflammatory bowel disease and asthma.[3]

The universally recognised philosophy of "antibiotic stewardship" should be considered prior to making any decisions regarding antimicrobials; the ethos of which is defined as "the optimal selection, dosage, and duration of antimicrobial treatment that results in the best clinical outcome for the treatment or prevention of infection, with minimal toxicity to the patient and minimal impact on subsequent resistance".[4] In otorhinolaryngology multiple evidence-based guidelines have been developed to help decision-making regarding antibiotic prophylaxis in ear, nose and throat (ENT), and head and neck surgery, that include those produced by the American Academy of Otolaryngology Head and Neck Surgery (AAO-HNS), the International Federation of Otorhinolaryngological Societies (IFOS),[3,5] as well as multiple universal surgical guidelines (Table I).[6,7] The majority of these guidelines across surgical disciplines are based on variations of the World Health Organization (WHO) classification of surgical wounds, which divides wounds into four groups, "*clean", "clean-contaminated", "contaminated"* and "*dirty or infected*".[6]

Despite the available guidelines, only a few international studies assessing adherence amongst ENT surgeons have been published. In 2015 Tulio et al. assessed the antibiotic practices amongst 448 ENT surgeons in the United States, and revealed that 42% of respondents used antibiotics routinely for tonsillectomies.[8] A similar rate of 31% was reported in an Australasian study conducted in 2019 by Ahmadzada et al. amongst 137 ENT surgeons.[9] Both studies have higher than expected antibiotic uses for tonsillectomy,

Table I: Evidence-based recommendations for perioperative antibiotic use in otolaryngologic procedures (level of evidence based on Oxford Centre for Evidence-Based Medicine)[3,5,6,13]

Procedure	Guideline recommendation	Level of evidence	Comments
Tonsillectomy	No perioperative antibiotic use	Level 1a, grade A	
Clean otological surgery	No perioperative antibiotic use	Level 1a, grade A	
Clean contaminated otological surgery	Intraoperative use only	Leve 2b, grade C	
Sinus surgery	No perioperative antibiotic use	Level 1a (postoperative), grade A (postoperative). Level 5 (intraoperative), grade D (intraoperative)	If > 48 hours packing/splint use antibiotic may be considered
Simple septorhinoplasty or rhinoplasty (primary, without grafting)	No perioperative antibiotic use	Level 1b, grade B	If > 48 hours packing/splint use antibiotic may be considered
Complex septorhinoplasty or rhinoplasty (revision with or without grafting)	intraoperative and postoperative antibiotics (< 24 hours)	Level 1b, grade B	If > 48 hours packing/splint use antibiotic may be considered
Skull base surgery (anterior, clean-contaminated)	Intraoperative and postoperative antibiotics (< 24 hours)	Level 2a, grade B	If > 48 hours packing/splint use antibiotic may be considered
Skull base surgery (lateral, clean)	Intraoperative antibiotic only	Level 1a, grade A	Based on inferences from the neurosurgical literature
Clean head and neck surgery	No perioperative antibiotic use	Level 1a, grade A	
Clean-contaminated head and neck surgery	Intraoperative and postoperative antibiotics < 48 hours	Level 1a, grade A	No benefit for short (< 48 hours) vs long course of postoperative antibiotics

despite a 2008 Cochrane Review that revealed no evidence to support the routine use of antibiotics in tonsillectomy.[10]

In South Africa and other developing nations, no studies have been conducted specifically assessing perioperative antibiotic practices amongst ENT surgeons. Furthermore, the developing world presents additional challenges when compared to developed world environments, including a higher rate of malnutrition, an increased burden of HIV and other infectious diseases, limited resources and poor access to healthcare and follow-up.[11,12]

This study provides insight into the adherence of local ENT surgeons to available evidence-based international guidelines and may also provide further unique information within our South African context.

Methods

A prospective cross-sectional study of the current trends of perioperative antimicrobial prescribing amongst ENT surgeons in South Africa was performed via an online survey that was distributed by email to all otorhinolaryngologists registered with the South African Society of Otorhinolaryngology Head and Neck Surgery. The respondents were requested to indicate their antimicrobial practices in multiple commonly performed ENT procedures across all subspecialties. Participation was voluntary and respondents remained anonymous.

Results

The survey was sent to 364 ENT surgeons in South Africa, 92 responded (25.3% response rate).

Figure 1 illustrates the relative factors respondents indicated they took into consideration to guide decisions regarding perioperative antimicrobial use.

Respondents indicated that they utilised the following resources to guide their decisions regarding perioperative antibiotic prescribing – practices of surgeon's postgraduate training unit 26/92 (28%); published international guidelines

Table II: Demographic characteristics of respondents

Characteristic		Respondents	*n* %
A.	Geographical distribution per province:		
	Western Cape	39	42
	Gauteng	24	26
	KwaZulu-Natal	17	18
	Free State	5	5
	Eastern Cape	3	3
	Northern Cape	2	2
	North-West	1	1
	Limpopo	1	1
	Mpumalanga	0	0
B.	Health Sector:		
	Private sector	57	62
	Government / state sector	27	29
	Both sectors	8	9
C.	Duration of practice post-qualification		
	< 5 years	15	16
	5–15 years	26	28
	15–30 years	30	33
	> 30 years	21	23
D.	Scope of practice or subspecialty interest		
	General ENT	60	65
	Otology / neurotology	15	16
	Paediatric otolaryngology	20	22
	Rhinology / anterior skull base	20	22
	Head and neck	12	13
	Facial plastics	3	3

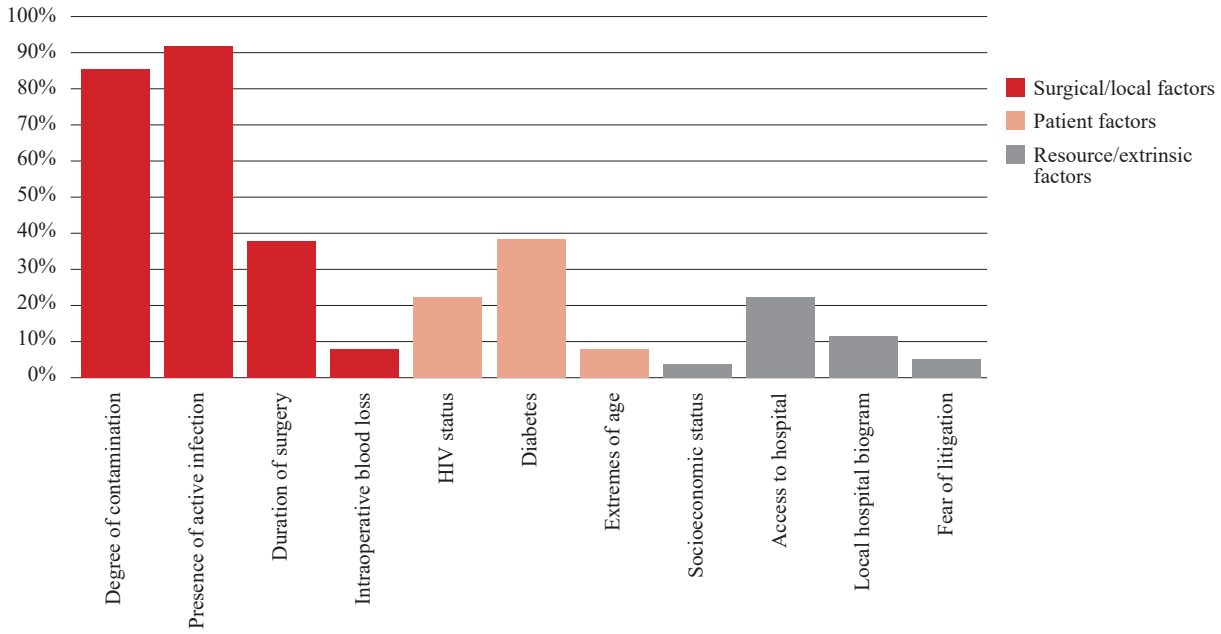

Figure 1: Factors taken into account with perioperative antibiotic use

26/92 (28%); personal experience/anecdotal evidence 25/92 (27%); recommendation of the local hospital's microbiologists 13/92 (14%); attending anaesthetist's discretion 0 (0%). Respondents were able to choose a combination of multiple factors for this question.

Thirty-two (35%) respondents indicated that they audit their own rates of wound sepsis or wound complications. Of those who audited their rates of wound sepsis 23/57 (40%) worked in the private sector, and 7/27 (26%) in the state sector.

Figure 2 illustrates the respondents' prescribing practices for eight common ENT procedures, specifically the relative percentage of respondents for each procedure who gave no antibiotics, intraoperative antibiotics only or postoperative antibiotics.

For elective paediatric tonsillectomy, 32/92 (35%) routinely prescribe perioperative antibiotics in all tonsillectomies, 56/92 (61%) do not prescribe any antibiotics, 4/92 (4%) prescribe only in tonsillectomies performed for recurrent tonsillitis. Of the 32/92 respondents who routinely prescribe antibiotics 21% prescribe a single dose at the time of induction, 9% prescribe for less than 48 hours postoperatively, 33% prescribe an extended course for more than 48 hours postoperatively, and 47% did not indicate. Most commonly prescribed antimicrobials included co-amoxiclav (47%), cefazolin (13%) and azithromycin (6%).

In clean elective head and neck surgery (no breach of upper aerodigestive tract or active infection that includes thyroidectomy, parotidectomy, excision of thyroglossal duct cyst, neck dissection), 46/92 (52%) do not prescribe any antibiotics, 20/92 (22%) prescribe induction dose of antibiotics only, 15/92 (17%) prescribe antibiotics for more than 48 hours postoperatively, and 7/92 (8%) prescribe for less than 48 hours postoperatively. Most commonly

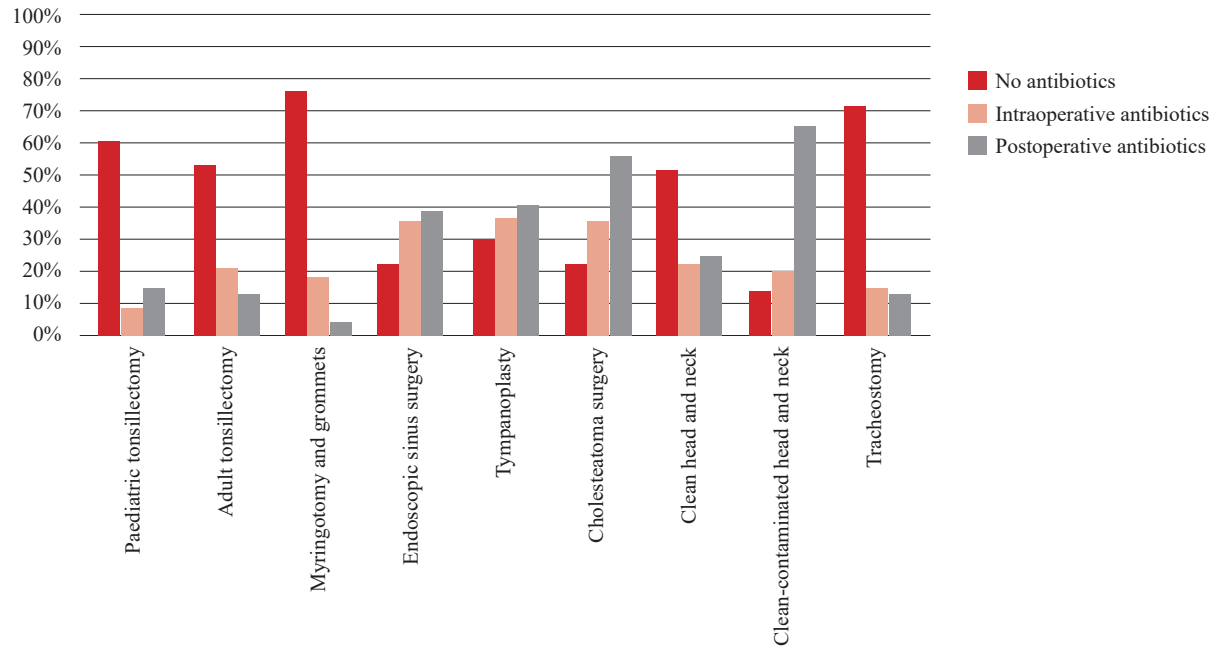

Figure 2: Prescribing practices for common ENT surgical procedures

Table III: Mitigating factors for routinely prescribing perioperative antibiotics – subgroup analysis in paediatric tonsillectomy

	Yes *n* (%)	No *n* (%)
Duration of practice		
< 5 years	5 (33%)	10 (67%)
5–20 years	10 (27%)	24 (65%)
> 20 years	17 (42%)	22 (55%)
Health Sector		
Private	24 (42%)	30 (53%)
Government / State	4 (15%)	22 (81%)
Both	4 (50%)	4 (50%)
Declared subspecialty / special interest		
Paediatric	8 (40%)	12 (60%)
Other ENT subspecialties	28 (39%)	44 (61%)

prescribed antibiotics included cefazolin (31%) and co-amoxiclav (45%).

For clean-contaminated elective head and neck surgery (breach of the upper aerodigestive tract that includes wide local excision of an oral cavity or oropharyngeal tumour, laryngectomy) 12/92 (14%) do not prescribe any antibiotics, 17/92 (20%) prescribe a single induction dose, 32/92 (39%) prescribe a prolonged course of antibiotics for more than 48 hours postoperatively, and 22/92 (27%) prescribe a short course for less than 48 hours postoperatively. Most commonly prescribed antibiotics included cefazolin (22%), co-amoxiclav (59%), clindamycin (1.2%) and azithromycin (1.2%).

Discussion

Our survey is the first of its nature conducted within Africa and the developing world context, and where 85% of the world's population lives in low to middle-income countries (LMIC).[16] As illustrated in Table III, it is reassuring to note that our local prescribing practices are comparable, if not more in line with international guidelines than those of high-income countries (HIC), as reflected in the studies from the United States, Australasia and Saudi Arabia.[8,9,14] Furthermore, the incidence of SSI has been shown to be higher in LMIC compared to HIC,[17] posing additional strain on already struggling health economies. Notwithstanding current evidence that suggests that in clean elective surgery, SSI rates appear to be declining in HICs at 1–4%, concerningly this decreasing trend has not been reflected in LMICs, remaining high at 8–30%,[18] and is likely related to the social determinants of health that plague LMICs.

The WHO identified that global antibiotic use increased by 39% from 2000–2015, reportedly fuelled by increasing use predominantly in LMICs.[19] Globally, it is projected that AMR will account for 10 million deaths per year and cost approximately 100 trillion US dollars per annum by 2050.[2] Data on AMR patterns in the LMICs are limited but suggest alarmingly high rates of resistant isolates,[20] resulting in a potentially disproportionate burden of disease in already struggling health systems. Inappropriate antimicrobial prescribing to prevent SSI is one of the key areas identified in global strategies to reduce AMR.

Multiple evidence-based guidelines have been developed to guide decisions regarding antibiotic prophylaxis in ENT, head and neck surgery, including ENT specific guidelines,[3,5] as well as universal surgical guidelines applicable across surgical disciplines.[6,7] Although evidence-based clinical guidelines are not practice mandates, they do aim to reduce variation and limit inappropriate deviations in medical care. Only 26/92 (28%) of our study's respondents based their prescribing practices on any form of local or international guidelines. While concerning, how does this compare to the other studies that assessed the use of clinical guidelines within ENT surgery communities? Padia et al. performed a study to assess the impact of the AAO-HNS 2011 guidelines against routine antibiotic use in a case series of 15 950 paediatric tonsillectomies. Prior to the publication of the guideline, 27 of 74 (36%) surgeons routinely gave antibiotics, whilst post-publication, this was reduced to 19 (26%) of surgeons.[21] In contrast, Milder et al. conducted a similar study in the United States between 2009–2012, finding a dramatic and sustained reduction of 86.5% ($p < 0.001$) in perioperative antibiotic use post publication of the AAO-HNS guidelines

Table IV: Summary comparing the use of antibiotics in common ENT procedures from our respondents with previously conducted surveys identified in the literature (results reflected in percentages)

Study	Geographical location	*n*	Prescribed antibiotic therapy	Tonsillectomy	Myringotomy +-Tympanostomy tubes	Endoscopic Sinus Surgery	Tympanoplasty	Mastoidectomy	Neck dissection	Laryngectomy
White et al. 2022	South Africa	92	-Perioperative	37	77 (ototopical) 18 (systemic)	75	56	53	58	85
			-None	57	14	22	43	22	52	14
Ahmadzada et al. 2019[7]	Australia & NZ	137	-Perioperative	30	49 (ototopical)	58	53	67	78	94
			-None	64	52	31	47	33	22	6
Valdez et al. 2015[6]	USA	442	-Perioperative	42	12 (not specified)	73	52	63	75	91
			-None	58	88	27	48	37	25	9
Al -Qahtani 2017[14]	Saudi Arabia	139	-Perioperative	89	50 (not specified)	100	100	100	-	-
			-None	11	51	0	0	0	-	-
Chiesa-Estomba et al. 2021[15]	International	435	-Perioperative	-	-	-	- -		61	92
			-None	-	-	-	-	-	39	8

in 2011.[22] In a 2012 European survey of 440 Dutch ENT surgeons, a 45% average non-compliance with general ENT guidelines was found.[23]

In a South African study by Gason et al. investigating antibiotic prescribing practices and adherence to guidelines in primary care centres in Cape Town, an overall guideline adherence rate of 45.1% was revealed. The main reasons for non-adherence cited included undocumented diagnosis (30.5%), antibiotic not indicated (21.6%), incorrect dose (12.9%), incorrect antibiotic (11.5%) and incorrect duration of therapy (9.5%).[24] In 2020, Schuster et al. prospectively assessed clinicians compliance with surgical antibiotic prophylaxis (SAP) guidelines in 192 surgical cases conducted at a tertiary academic hospital in Cape Town, South Africa. SAP was administered in 149/192 cases, overall 156/192 cases should have received SAP as per guideline recommendations. Where SAP was administered the choice of antibiotic was correct in 121 (77.6%) of cases, the correct dosage was given in 110 (70.5%) of cases and the timing of antibiotics was appropriate in 87 (55.8%) of cases. With an absolute compliance of 80/180 (44.4%).[25]

Several factors have been studied in the surgical literature to assess their impact on SSI rates, in an attempt to stratify risk and to guide decisions regarding the need and duration of antibiotic prophylaxis. Postulated factors with varying degrees of supporting evidence can be divided into 3 domains – surgical or wound related factors, patient-related factors and resource-dependent or extrinsic factors. Surgical factors include the presence of active infection, degree of wound contamination, breaks in surgical sterility, degree of intraoperative blood loss, requirement for blood transfusion, surgical duration, the use of implantable surgical prosthesis and microvascular free flap reconstruction. Patient-related factors include nutritional status, immunosuppression, tobacco use, alcohol use, adjuvant radio/chemotherapy, patient age, diabetes mellitus, anaemia and peripheral vascular disease.[26] Resource-related or extrinsic factors include the patient's socioeconomic status, access to hospital, access to clean water, access to sterile theatre facilities and equipment, access to a microbiologist with data on the profile of the local hospital's microbiome and pathogens.

Many of these factors are largely theoretical, each with varying degrees of supporting evidence, and there is no clear consensus on the particular significance each one of these factors carries. Figure 1 summarises the relative factors local respondents take into consideration when prescribing antibiotics perioperatively. Unique perhaps to our South African LMIC context was the consideration of the patient's retroviral status 20/92 (22%) and the patient's access to healthcare 20/92 (22%). The impact of HIV infection on surgical outcomes is controversial with variable outcomes reported in the literature. Consensus suggests that HIV-infected patients without AIDS-defining criteria have a similar surgical course and outcomes to non-infected patients. However, patients with low CD4 counts (< 50–200 cells/μl), high viral loads (> 30 000 copies/ml), associated malnutrition and opportunistic infections may be at higher risk for postoperative complications including SSI[27] Antibiotic prophylaxis purely on the basis of the HIV status of the patient is therefore not strongly indicated but should rather be considered in conjunction with other associated risk factors and biochemical markers of immunosuppression.

The impact of access to healthcare is an interesting concern raised by respondents in our study, reportedly out of concern that should postoperative infection arise, patients may not have timeous access to appropriate wound care and antimicrobial therapy. Despite no studies directly assessing the impact of access to care, Tod et al. demonstrated a statistically significant increase in SSI rates with lower income levels ($p < 0.0001$ for trend). Reasons for this disparity remain speculative, but the authors suggest this may be related to level of education, access to healthcare, and the extent of disease at the time of treatment.[27] A patient's socioeconomic status or lack of access to healthcare in isolation, can therefore not be a recommended indication to prescribe perioperative antibiotics. Perhaps an empiric course of antimicrobials in the event of the patient recognising signs and symptoms of SSI during the postoperative period is a consideration, should there be potential challenges in access to a healthcare facility identified prior to discharge. The literature also supports an expanding role for telemedicine for surveillance of postoperative wounds and identification of SSI as an alternative where logistically feasible.[28]

An interesting observation was that 5/92 (5.4%) respondents in our study, all who worked exclusively in the private sector, indicated that they were influenced by a concern of potential litigation by patients should SSI arise if an antibiotic was not prescribed perioperatively. This highlights an increasingly concerning phenomenon of defensive medicine; a practice in which, through perceived fears of potential litigation, clinicians adopt defensive behaviours which deviate from practice guidelines to mitigate the risk of litigation or to ensure a form of defence in the case of malpractice claims. This includes tendencies to over-prescribe medications and investigations. In an international survey conducted amongst specialists in infectious diseases and clinical microbiology, 21.2% (164/774) of respondents said they never worried about medicolegal liability, 45.1% (349/774) sometimes worried and 28.6% (221/774) frequently worried when prescribing antibiotics, with the majority of the respondents, 85% (525/618), acknowledging some defensive behaviour in antibiotic prescribing.[29] Practices of defensive medicine would likely be expected to potentially be higher in ENT surgery as it has been found to be more commonly practiced in surgical specialties and other specialties considered at high risk for malpractice liability.[30]

In a systematic review and meta-analysis in 2018, Patel et al. evaluated the role of perioperative antibiotic use in common ENT surgeries. It was concluded that level 1a evidence does not support the routine use of antibiotic prophylaxis for tonsillectomy, simple septorhinoplasty, endoscopic sinus surgery, clean otological surgery (tympanostomy tube insertion, tympanoplasty, stapedectomy, mastoidectomy) and clean head and neck surgery. However, there were variable levels of evidence to support the routine use of antibiotic prophylaxis for complex septorhinoplasty, skull base surgery (anterior and lateral), clean-contaminated otologic surgery (cholesteatoma, purulent otorrhoea), and clean-contaminated head and neck surgery (violation of aerodigestive tract).[3]

Tonsillectomy is one of the most frequently performed surgeries globally, and the second most common paediatric surgery performed in the United States where more than 500 000 tonsillectomies are performed annually.[31] While our results indicate that at 57%, the majority of ENT surgeons

in South Africa are compliant with established guidelines and do not prescribe antibiotics in tonsillectomies, 36.5% however continue to routinely use antibiotics in tonsillectomies, despite no supporting evidence for its routine use,[10] in addition to AAO-HNS guidelines strongly recommending against their routine use.[32] Our local findings are comparable to similar surveys conducted in the United States and Australasia which revealed routine antibiotic prescription rates in tonsillectomy of 26–42%.[8,9,21]

If we compare the rate of antibiotic prescribing between the state and private sector using the prescription of antibiotics in tonsillectomy as an indirect surrogate marker, we find an appreciably higher rate of antibiotic prescribing in the private sector at 42% vs 15%. This is in line with prior studies which have raised concern regarding suboptimal compliance with evidence-based guidelines in the use of antimicrobials within the private sector. In a 2019 study conducted in a private hospital in South Africa, Jacob et al. found that only 46.2% of empiric antibiotics prescribed were appropriate for drug choice, dose, and duration. Of the antimicrobials prescribed for surgical prophylaxis only 39.5% were deemed appropriate.[33] Van der Sandt et al. retrospectively compared SAP use for common paediatric procedures between a state academic hospital and a private hospital, finding the overall use of SAP at 32.3% vs 47.3% respectively.[34] The discrepancy in prescribing practices is of further concern as previous local and international studies have demonstrated exponentially higher tonsillectomy rates in the private sector. Crowson et al. through an international database analysis, including 31 countries, found a tonsillectomy rate of 159.1 in the private sector vs 131.1 per 100 000 citizens (p = 0.002) in the state sector.[35] Douglas Jones et al. reported an alarmingly high tonsillectomy rate in the South African private healthcare sector at 1888/100 000 citizens, which is more than double the highest national tonsillectomy rate in the literature.[36]

In summary, multiple studies have explored the role of perioperative antimicrobials in head and neck surgery. Current guidelines based on systematic reviews and multiple RCTs advise that in the absence of other confounding factors, no perioperative antibiotics are required in clean head and neck procedures, whilst antibiotics are recommended for clean-contaminated procedures (a breach of the aerodigestive tract),[3,5,37,38] however, duration of antibiotics for clean-contaminated procedures was not standardised. Villa et al. reported no difference in SSI rates between systemic antibiotic prophylaxis given for 1 vs 5 days.[37] Our survey illustrated a comparatively high rate of compliance with evidence-based guidelines in head and neck, with 46 (52%) respondents not prescribing antibiotics for clean head and neck procedures. This compared favourably to previous international surveys, at 22–39%.[8,9,14,15] For clean-contaminated head and neck procedures, 85% of respondents routinely prescribed perioperative antibiotics compared to 91–94% internationally.[8,9,15] Of the respondents, 12/92 declared a subspecialty interest in head and neck surgery. There was a 100% compliance rate with guideline recommendation for clean-contaminated procedures from these respondents.

A response rate of 25.3%, although low, compared favourably to prior international surveys 7–29%.[8,9,14] We acknowledge the inherent limitation of response bias associated with a survey-based study design, including the self-reporting nature of the study.

Conclusion

There is significant heterogeneity in the use of perioperative antibiotics prescribing practices and variable adherence to international consensus guidelines amongst ENT surgeons in South Africa. In light of the global increase in antibiotic resistance, this study highlights the need for increased awareness regarding the principles of antibiotic stewardship, pre-existing evidence-based guidelines and the need for a locally generated South African otorhinolaryngology consensus guideline that promotes safe and rational use of perioperative antibiotic prophylaxis.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding source to be declared.

Ethical approval

The study was approved by the Human Research Ethics Committee of the University of Cape Town (HREC Reference 211/2020) and the ENT Society of South Africa.

ORCID

J McGuire https://orcid.org/0000-0001-6816-8959
S Peer https://orcid.org/0000-0001-6326-1193

REFERENCES

1. Owens CD, Stoessel K. Surgical site infections: epidemiology, microbiology and prevention. J Hosp Infect. 2008;70:3-10. https://doi.org/10.1016/S0195-6701(08)60017-1.
2. O'Neill J. Tackling drug resistant infections globally: final report and recommendations. The Review on Antimicrobial Resistance. London, UK: Welcome Trust; 2016.
3. Patel PN, Jayawardena AD, Walden RL, Penn EB, Francis DO. Evidence-based use of perioperative antibiotics in otolaryngology. Otolaryngol Head Neck Surg. 2018;158(5):783-800. https://doi.org/10.1177/0194599817753610.
4. Doron S, Davidson LE. Antimicrobial stewardship. Mayo Clin Proc. 2011;86(11):1113-23. https://doi.org/10.4065/mcp.2011.0358.
5. Chiesa-Estomba CM, Lechien JR, Fakhry N, et al. Systematic review of international guidelines for perioperative antibiotic prophylaxis in head and neck surgery. A YO-IFOS Head & Neck Study Group Position Paper. Head Neck. 2019;41(9):3434-56. https://doi.org/10.1002/hed.25856.
6. World Health Organization. Global guidelines for the prevention of surgical site infection. World Health Organization; 2016.
7. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al. Centres for disease control and prevention guideline for the prevention of surgical site infection, 2017. JAMA Surgery. 2017;152(8):784-91. https://doi.org/10.1001/jamasurg.2017.0904.
8. Valdez TA, Marvin K, Bennett NJ, et al. Current trends in perioperative antibiotic use - a survey of otolaryngologists. J Otolaryngol Head Neck Surg. 2015;152(1):63-6. https://doi.org/10.1177/0194599814554551.
9. Ahmadzada S, Wong EH, Naidoo Y. Antibiotic prescribing practices in otolaryngology head and neck surgery in Australia and New Zealand: a survey of 137 specialists. Australian

Journal of Otolaryngology. 2019;2. https://doi.org/10.21037/ajo.2019.02.03.
10. Dhiwakar M, Clement W, Supriya M, McKerrow W. Antibiotics to reduce post-tonsillectomy morbidity. Cochrane Database of Syst Rev. 2012;12:CD005607. https://doi.org/10.1002/14651858.CD005607.pub4.
11. Kramer CV, Allen S. Malnutrition in developing countries. Paediatrics and Child Health. 2015;25(9):422-7. https://doi.org/10.1016/j.paed.2015.04.002.
12. Peters DH, Garg A, Bloom G, et al. Poverty and access to health care in developing countries. Ann N Y Acad Sci. 2008;1136(1):161-71. https://doi.org/10.1196/annals.1425.011.
13. Iocca O, Copelli C, Ramieri G, et al. Antibiotic prophylaxis in head and neck cancer surgery: Systematic review and Bayesian network meta-analysis. Head Neck. 2022;44(1):254-61. https://doi.org/10.1002/hed.26908.
14. Al-Qahtani AS, Alsharif FN, Al-Qahtaniy OA, et al. Perioperative antibiotic usage in otorhinolaryngology: A survey of current practice in Saudi Arabia. Saudi Journal of Otorhinolaryngology Head and Neck Surgery. 2017;19(1):11. https://doi.org/10.4103/1319-8491.275307.
15. Chiesa-Estomba CM, Calvo-Henriquez C, Gonçalves N, et al. Patterns of practice regarding surgical site infection prevention in head and neck surgery: An international survey. Acta Otorrinolaringol Esp. 2022;72(4):225-234. https://doi.org/10.1016/j.otorri.2021.06.004.
16. The World Bank. The World Bank Low and Middle Income Groups 2020. Available from: https://data.worldbank.org/country/XO.
17. Monahan M, Jowett S, Pinkney T, et al. Surgical site infection and costs in low- and middle-income countries: A systematic review of the economic burden. PloS one. 2020;15(6):e0232960. https://doi.org/10.1371/journal.pone.0232960.
18. Mehtar S, Wanyoro A, Ogunsola F, et al. Implementation of surgical site infection surveillance in low- and middle-income countries: A position statement for the International Society for Infectious Diseases. Int J Infect Dis. 2020;100:123-31. https://doi.org/10.1016/j.ijid.2020.07.021.
19. Klein EY, Milkowska-Shibata M, Tseng KK, et al. Assessment of WHO antibiotic consumption and access targets in 76 countries, 2000-15: An analysis of pharmaceutical sales data. Lancet Infect Dis. 2021;21(1):107-15. https://doi.org/10.1016/S1473-3099(20)30332-7.
20. Leopold SJ, van Leth F, Tarekegn H, Schultsz C. Antimicrobial drug resistance among clinically relevant bacterial isolates in sub-Saharan Africa: A systematic review. J Antimicrob Chemother. 2014;69(9):2337-53. https://doi.org/10.1093/jac/dku176.
21. Padia R, Olsen G, Henrichsen J, et al. Hospital and surgeon adherence to pediatric tonsillectomy guidelines regarding perioperative dexamethasone and antibiotic administration. Otolaryngol Head Neck Surg. 2015;153(2):275-80. https://doi.org/10.1177/0194599815582169.
22. Milder EA, Rizzi MD, Morales KH, et al. Impact of a new practice guideline on antibiotic use with pediatric tonsillectomy. JAMA Otolaryngol Head Neck Surg. 2015;141(5):410-6. https://doi.org/10.1001/jamaoto.2015.95.
23. Aarts MCJ, van der Heijden GJ, Siegers C, Grolman W, Rovers MM. Awareness of, opinions about, and adherence to evidence-based guidelines in otorhinolaryngology. Arch Otolaryngol Head Neck Surg. 2012;138(2):148-52. https://doi.org/10.1001/archoto.2011.1166.
24. Gasson J, Blockman M, Willems B. Antibiotic prescribing practice and adherence to guidelines in primary care in the Cape Town Metro District, South Africa. S Afr Med J. 2018;108(4):304-10. https://doi.org/10.7196/SAMJ.2018.v108i4.12564.
25. Schuster DS, Fagan JF, Flint MF, et al. Compliance with surgical antibiotic prophylaxis guidelines: a prospective descriptive study at a tertiary level hospital in Cape Town, South Africa. Southern African Journal of Anaesthesia and Analgesia. 2020;26(6):300-5. https://doi.org/10.36303/SAJAA.2020.26.6.2402.
26. Sepehr A, Santos BJG, Chou C, et al. Antibiotics in head and neck surgery in the setting of malnutrition, tracheotomy, and diabetes. Laryngoscope. 2009;119(3):549-53. https://doi.org/10.1002/lary.20078.
27. Zhang L, Liu B-C, Zhang X-Y, et al. Prevention and treatment of surgical site infection in HIV-infected patients. BMC Infect Dis. 2012;12(1):1-4. https://doi.org/10.1186/1471-2334-12-115.
28. Ng HJH, Huang D, Rajaratnam V. Diagnosing surgical site infections using telemedicine: A systematic review. 2022;20(4):e78-e85. https://doi.org/10.1016/j.surge.2021.05.004.
29. Tebano G, Dyar OJ, Beovic B, et al. Defensive medicine among antibiotic stewards: the international ESCMID AntibioLegalMap survey. J Antimicrob Chemother. 2018;73(7):1989-96. https://doi.org/10.1093/jac/dky098.
30. Jena AB, Seabury S, Lakdawalla D, Chandra A. Malpractice risk according to physician specialty. New Engl J Med. 2011;365(7):629-36. https://doi.org/10.1056/NEJMsa1012370.
31. Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. Natl Health Stat Report. 2009;11:1-25.
32. Mitchell RB, Archer SM, Ishman SL, et al. Clinical practice guideline: Tonsillectomy in children (update). Otolaryngol Head Neck Surg. 2019;160(Suppl 1):S1-S42. https://doi.org/10.1177/0194599818801757.
33. Jacob V, Mahomed S. Antimicrobial prescribing in the surgical and medical wards at a private hospital in KwaZulu-Natal, South Africa, 2019. S Afr Med J. 2021;111(6):582-6. https://doi.org/10.7196/SAMJ.2021.v111i6.15403.
34. Van Der Sandt N, Schellack N, Mabope LA, et al. Surgical antimicrobial prophylaxis among pediatric patients in South Africa comparing two healthcare settings. Pediatr Infect Dis J. 2019;38(2):122-6. https://doi.org/10.1097/INF.0000000000002072.
35. Crowson MG, Ryan MA, Rocke DJ, Raynor EM, Puscas L. Variation in tonsillectomy rates by health care system type. Int J Pediatr Otorhinolaryngol. 2017;94:40-4. https://doi.org/10.1016/j.ijporl.2017.01.014.
36. Douglas-Jones P, Fagan J. Tonsillectomy rates in the South African private healthcare sector. S Afr Med J. 2016;106(11):1134-40. https://doi.org/10.7196/SAMJ.2016.v106i11.10842.
37. Vila PM, Zenga J, Fowler S, Jackson RS. Antibiotic prophylaxis in clean-contaminated head and neck surgery: A systematic review and meta-analysis. Otolaryngol Head Neck Surg. 2017;157(4):580-8. https://doi.org/10.1177/0194599817712215.
38. Haidar YM, Tripathi PB, Tjoa T, et al. Antibiotic prophylaxis in clean-contaminated head and neck cases with microvascular free flap reconstruction: A systematic review and meta-analysis. Head Neck. 2018;40(2):417-27. https://doi.org/10.1002/hed.24988.