Anaesthetists' knowledge of antibiotics for surgical prophylaxis

Jonathan Jocum

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of

Master of Medicine in Anaesthesiology

Johannesburg, 2016

Declaration

I, Jonathan Jocum declare that this research report is my own work.

It is being submitted for the degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has never been submitted before for any degree or examination at this or any other University.

…….

…….. day of November, 2016

Abstract

Background: Surgical site infection (SSI) is the second most common hospital-acquired infection and results in increased morbidity and mortality and a longer hospital stay. Surgical antibiotic prophylaxis (SAP) is one component of broader strategies to reduce rates of SSI. Adherence to SAP guidelines is generally sub-optimal globally, with knowledge of appropriate SAP being a factor that affects this. This results in less effective prevention of SSI.

Objectives: To describe awareness amongst anaesthetists at university-affiliated hospitals of available SAP guidelines and to describe their knowledge on the subject. Comparisons between senior and junior anaesthetists were assessed.

Methodology: A prospective descriptive study design using a self-administered questionnaire. The study population was the anaesthetists in a university-affiliated Department of Anaesthesiology in Johannesburg, South Africa.

Results: The analysis included 135 completed questionnaires from the department's anaesthetists. A total of 15.6% of participants followed a specific guideline in their practice, 28% for senior anaesthetists vs. 4.2% for junior anaesthetists. The overall mean score for knowledge was 56.2%, 59.3% for senior anaesthetists vs. 53.6% for junior anaesthetists, which was statistically significant (p-value <0.001). Overall knowledge was found to be poor and specifically, knowledge regarding indication for prophylaxis, antibiotic re-dosing interval, and duration of prophylaxis, was poor.

Conclusion: The anaesthetists had poor knowledge regarding SAP. While the difference in knowledge between senior and junior anaesthetists was statistically significant, we feel that this difference would not be substantial enough to have a clinical impact. We recommend improving the knowledge of the anaesthetists regarding SAP as well as the development of local SAP guidelines.

Acknowledgements

I would like to acknowledge the following people and institutions for their invaluable input and assistance:

Mrs Helen Perrie

Mrs Juan Scribante

Dr Warren Lowman

Dr Des Lines

Prof Analee Milner

Dr Brad Yudelowitz

Mrs Hilary Jocum

University of the Witwatersrand Medical Library

Department of Anaesthesiology at the University of the Witwatersrand

List of figures

List of tables

List of abbreviations

SAP: Surgical antibiotic prophylaxis

Wits: University of the Witwatersrand

SSI: Surgical site infection

HAI: Hospital-acquired infection

SIGN: Scottish Intercollegiate Guideline Network

ASHP: American Society of Health-System Pharmacists

ICU: Intensive Care Unit

RTI: Respiratory tract infection

WDGMC: Wits Donald Gordon Medical Centre

SAAGAR: South Australian Expert Advisory Group on Antimicrobial Resistance

SAASP: South African Antibiotic Stewardship Programme

NHS: National Health Service

SASA: South African Society of Anaesthesiologists

BMJ: British Medical Journal

WHO: World Health Organization

SI: Système Internationale

IQR: Inter-quartile range

SD: Standard deviation

NICE: National Institute for Clinical Excellence

Table of Contents

Section 1: Literature Review:

This literature review will begin by discussing the justification of the practice of surgical antibiotic prophylaxis (SAP). The effects of poor antibiotic prescribing policy and the reasons behind the need for clear antibiotic prescribing guidelines will then be explored. Following this, the literature documenting current compliance with antibiotic guidelines will be examined. The factors affecting guideline compliance in general, the issues that affect antibiotic prescribing as a whole and the problems facing correct administration of SAP will be delved in to. The review will then explore what surveys have been conducted regarding antibiotic prescribing and will end with an analysis of the principles of SAP and what guidelines are available to the anaesthetists of the Department of Anaesthesiology at the University of the Witwatersrand (Wits).

1.1 Why do we practice surgical antibiotic prophylaxis?

Surgical site infection (SSI) is the second most prevalent type of hospital-acquired infection (HAI) (1). The incidence of SSI depends on the specific procedure. The benefit of SAP is related to how much it reduces SSI and the severity of the consequences of SSI. For example, when doing a colonic anastomosis, prophylactic antibiotics decrease SSI and reduce mortality. In total hip replacement, prophylaxis decreases long-term morbidity. Although for most surgery the benefit only relates to short-term morbidity, the value of this is still significant (2).

The short term consequences of SSI for the patient include a prolonged and more painful hospital stay. The Scottish Intercollegiate Guidelines Network's (SIGN) guideline on antibiotic prophylaxis in surgery (2) quotes one study in the United Kingdom showing an additional hospital stay of 6.5 days at a cost of £3 246 per patient. There is also evidence that prevention of SSI is associated with a faster return to normal activity. SSI thus remains an important outcome measure for quality of surgical care (2).

On the other hand, there are risks to SAP. These include the risk of allergic and anaphylactic reactions, antibiotic-associated diarrhoea, Clostridium difficile infection, antibiotic resistance and multi-resistance carriage (2). The latter two risks will be further elaborated on later in this review.

Ultimately, the final decision regarding the benefit versus risk of antibiotic prophylaxis for each patient will be contingent on their risk of SSI, the severity of the consequences of SSI and how effective SAP is in reducing SSI in that specific operation weighed against the risks of the antibiotic to the patient (2).

The list of risk factors for SSI is a long one (2). A discussion of these factors is beyond the scope of this review. Suffice to say, it should be remembered that SAP is just one aspect of broader strategies to reduce SSI.

1.2. Why do we have antibiotic guidelines?

Antibiotic use in hospitals today is high and there is great variation in extent of use across countries (3). Lucet et al (3) note that many studies have found that greater antibiotic use leads to higher resistance rates, while more sparing antibiotic use had the opposite effect. Despite this, most infectious disease experts believe that concern about resistance is not prominently taken in to account when prescribing antibiotics in individual patients (3). A survey of junior doctors in France and Scotland found that only 63% of doctors thought that resistance was a problem in their own practicing environment. Furthermore, their ideas on the cause of antibiotic resistance were at odds with the available evidence (4).

There is widespread acceptance that antibiotic use is a causal factor in selecting and maintaining antibiotic-resistant bacteria. Gould (5), however, states that “it is also responsible for increasing transmissibility and pathogenicity of multi-resistant bacteria, and may actually be increasing the number of hospital-acquired infections.” The mechanism for this starts with suppression of normal flora by antibiotics. This will increase the proportion of resistant bacteria present, thereby making it easier for the patient to contaminate their surrounding environment. Furthermore, certain antibiotics are known to modulate phage induction, horizontal gene transfer, alter expression of binding proteins and increase biofilm formation (5).

Gould goes on to state that the accumulating data suggests that most nosocomial infections are from endogenous bacteria, rather than transmitted microbes. This makes the use of inappropriate antibiotics particularly hazardous in patients already colonised with resistant bacteria (5). Combined with the previously stated knowledge

on the prevalence of nosocomial infections, the relevance for surgical antibiotic prophylaxis is even more pertinent.

While high antibiotic use contributes to antibiotic resistance, the corollary may also be true. Gould explains that mathematical models have shown that curtailing prescribing of antibiotics may reduce antibiotic resistance (5). An example of how antibiotic misuse leads to resistance can be seen in the Republic of Georgia. Georgia lacks drug-prescribing regulations, and all drugs, bar psychotropics, are available over the counter without a prescription (6). As a result, about 95% of the Georgian population self-treat and avoid physicians. In 2008, surveillance showed that 20% of tuberculosis cases were multi-drug resistant compared to a world-wide estimate of 3.4% of all new cases (6).

Correct antibiotic use is based on a number of principles, namely the correct indication, the correct drug with an appropriate antimicrobial spectrum, the right dosage and dosing interval, and changing or stopping on time (7). The benefit of using the correct antibiotic and dosage is self-evident. The benefits of changing or stopping on time relate to decreasing antibiotic use and thereby possibly decreasing bacterial resistance (5), while the timing of antibiotic administration relates to the effectiveness of preventing surgical site infection. A landmark study by Classen et al (8) noted that a delay of more than two hours from prophylactic antibiotic administration to skin incision was associated with a 6.7 times higher incidence of wound infection.

Many organisations have drawn up guidelines to describe the practice of antibiotic prophylaxis in detail in an effort to reduce wound infection rates and promote rational antibiotic use.

1.3 Are guidelines being followed?

The conclusion from the evidence that has emerged over the last few decades is that adherence to antibiotic prescribing guidelines is poor worldwide. In what follows, some of the more prominent studies that have documented the extent of this will be discussed.

1.3.1 International

Starting with a broad overview, Ng et al (9) conducted a review of studies published from 1980 to 2011on surgeons' compliance with guidelines for SAP. A wide variation in compliance with guidelines was noted, ranging from 0% to 70%, with extensive misuse of prophylactic antibiotics.

In 1999 antibiotic prophylaxis for surgery was evaluated in a Brazilian academic hospital (10). The choice to use antibiotic prophylaxis was correct in 75% of cases. However, of these cases only 3% complied with the full regimen described in the guidelines.

An audit at a tertiary level academic hospital in Canada in 2003 sought to investigate how well three strategies to prevent complications in colorectal surgery were being applied (11). One of these strategies was antibiotic prophylaxis. They found that only 5% of patients were treated appropriately with preoperative prophylaxis and without postoperative doses. A total of 95% of patients were treated inappropriately with antibiotics postoperatively.

Van Kasteren et al (12), performed a multicentre audit in 2003, comprising 10% of the hospitals in the Netherlands. Prescription of antibiotics for surgical prophylaxis was compared to the local hospital guidelines. There were five factors taken into account, namely antibiotic choice, duration of prophylaxis, dose, dosing interval and timing of first dose. Adherence to each individual parameter was 92%, 82%, 89%, 43% and 50% respectively. Thus compliance with some of the individual aspects was high, however, adherence to all aspects was only 28%. They further identified some of the barriers to guideline adherence: lack of awareness of guidelines, lack of agreement of the surgeons with the guidelines and organisational and logistic factors (12). These barriers will be discussed further in section 1.4. The Netherlands is noted to have a restrictive policy of antibiotic use (12). It is reasonable to expect that countries with fewer restrictions on antibiotic use could conceivably have lower figures for guideline compliance.

In 2007, Choi et al (13) conducted a retrospective survey of SAP in six large tertiary hospitals in South Korea. There were 1914 patients included who underwent arthroplasty, hysterectomy or colon surgery. They found that less than 1% of patients

received SAP that complied with published guidelines. Delving deeper into these results, 74% of cases received an inappropriate dose, 11.2% received antibiotics within the correct time-frame and a mere 0.2% had their antibiotic course terminated within 24 hours of surgery (13).

A prospective study in 2008 in a large Greek hospital examined adherence to national antibiotic prophylaxis guidelines in elective general surgical cases (1). Antibiotic prophylaxis was over-prescribed, being given to 19% of patients inappropriately. Only 70% of patients received an agent recommended by the guideline. All patients received the antibiotics at induction, leading the authors to conclude that timing of antibiotic administration was correct in all cases. Adherence to correct duration of prophylaxis was low, with only 36% complying with guidelines, and the remainder of patients receiving prophylaxis inappropriately for days after surgery. Combining all the parameters they assessed the overall compliance at 36.3%. Within this overall result, total compliance for the sub-groups of lung, breast, thyroid and colorectal surgery was 0% (1).

A retrospective review of surgical antibiotic prophylaxis, published in 2014, was carried out in a tertiary hospital in Abu Dhabi (14). The objective of the study was to assess adherence to local hospital SAP guidelines. Overall adherence to hospital guidelines was 32%. Antibiotic selection, timing of first dose and treatment duration had compliance rates of 26%, 31% and 40.3% respectively (14).

A similar retrospective study from 2014 (15) sought to evaluate compliance of an Iranian academic hospital with the American Society of Health-System Pharmacists (ASHP) Surgical Antibiotic Prophylaxis Guidelines. A total of 759 patients who underwent surgery at the hospital were included in the study. No specific guidelines were endorsed at the hospital at the time of the study. Antibiotic prophylaxis was only provided in 22.2% of procedures that required it, while antibiotics were given unnecessarily in 10% of cases that did not require it. The administered antibiotic was appropriate in 62% of procedures, while duration of prophylaxis exceeded guideline stipulation in 40% of cases. Dose of antibiotic was discordant with the guidelines in 59% of cases (15).

The CareTrack Australia study, was an endeavour designed to establish baseline estimates of the appropriateness of care delivered across Australia for a number of

selected medical conditions (16). Hooper et al (16) extracted data from an applicable random sample of the CareTrack Australia study in 2015. They showed a 38% adherence to antibiotic prophylaxis guidelines. In the same year, Graham et al (17) conducted a national audit of antibiotic prophylaxis in Great Britain and Ireland in elective laparoscopic cholecystectomy. They suggested that 20 000 doses of antibiotics were administered unnecessarily annually for just this procedure, at a cost of £100 000.

1.3.2 South African

While the South African literature on antibiotic guideline adherence appears to be scant, one important study examined antibiotic use in ICUs. Paruk et al (18) conducted a prospective, descriptive study across all public and private sector ICUs in South Africa. Inappropriate antibiotics were initiated in roughly 55% of patients, in keeping with international literature, but still unacceptably high. Duration of antibiotic treatment was not appropriate in 72% of patients, while de-escalation was infrequently practiced. Importantly, the authors found a statistically significant association of inappropriate antibiotic use with increased mortality (27% versus 11%) (18).

1.4 How can guideline adherence be improved?

This question relates to quality of care, a field that has developed extensively in the last 10 to 20 years (7). It is a complex question that cannot be answered simply. A number of studies have probed what factors lie behind guideline adherence and how it can be improved. There is a need to attain insight into the problems behind inappropriate antibiotic use as well as the effectiveness of interventions that have been implemented to change it, if there is to be any good attempt at improving it (7).

1.4.1 Why do physicians not follow guidelines?

A good starting point may be to ask why physicians do not follow guidelines in general. Only recently have we started to gain insight into the processes and factors responsible for changing physicians' practice (19). Cabana et al (19) undertook a systematic review of studies that sought to explain the barriers to physicians' adherence to clinical guidelines.

Their review included 76 articles about 120 different surveys, probing 293 possible barriers to guideline adherence. The barriers taken from the articles were grouped into common themes and thereafter arranged into large clusters depending on whether they influenced the physicians' behaviour, knowledge or attitude. Although behaviour can be manipulated without knowledge or attitude being changed, the authors assert that behaviour change that is based on affecting knowledge and attitudes is likely to be more sustainable. The discussion below will examine the authors' seven categories of barriers, namely "lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, inertia of previous practice and external barriers (19)".

Lack of awareness

Lack of awareness as a potential barrier to adherence of guidelines was assessed by 46 studies. The percentage of participants who felt lack of awareness of guidelines was a barrier varied from 1% to 84% depending on the specific guideline. However, for 78% of the guidelines at least 10% of those surveyed were not aware of the guideline's existence (19).

Lack of familiarity

Simple awareness of a guideline does not guarantee that it will be adhered to. Lack of familiarity appeared to be more prevalent than purely a lack of the awareness of the guideline's existence (19).

Lack of agreement

Thirty-three surveys examined many potential reasons for clinicians not agreeing with the guidelines. More than 10% of participants disagreed with a guidelines as a consequence of differences in interpretation of the existing evidence, cost, discomfort, disagreement with the risk-benefit weigh-up, the opinion that the guidelines were over-simplifications or that it diminished their autonomy (19).

Lack of self-efficacy

Self-efficacy refers to a person's belief that they can perform a certain task, in this case, adhering to a guideline. In 15 of 19 studies, at least 10% of participants

reported a lack of self-efficacy. This deficiency will affect whether certain behaviours will be initiated and sustained despite other barriers (19).

Lack of outcome expectancy

This refers to an expectation that a certain action will result in a particular outcome. If a clinician believes that a specific guideline will not lead to an improved outcome, he/she will be less likely to adhere to it. The percentage of participants that viewed this as a barrier to following guidelines ranged between 8% and 90% across the eight surveys that explored this (19).

Inertia of previous practice

In all 14 surveys that examined this, more than 20% of participants viewed “inertia of previous practice” as an obstacle to guideline compliance. Cabana et al (19) explain that the readiness for change model “describes behaviour change as a continuum of steps that include pre-contemplation, contemplation, preparation, action and maintenance”. The data seem to indicate that almost half the physicians were still in the pre-contemplation stage (19).

External barriers

These were further divided into three categories (19):

- guideline- related such as guidelines being confusing, cumbersome and inconvenient
- patient-related such as patient preference or patients disagreeing with a guideline
- environmental-related such as poor resources, logistical problems, insufficient staff and lack of time.

The authors conclude by suggesting that this framework could be used as a “differential diagnosis” for poor guideline adherence. They further emphasise that an intervention that may be helpful in one setting may be less so in another. An intervention would have to be tailored to the specific setting (19).

1.4.2 What factors affect antibiotic prescribing?

Hulscher el al (7) wrote a review in 2010 of all the factors affecting appropriate and inappropriate antibiotic prescribing. The review starts off by noting that analyses into controlled studies for implementing guidelines and changing the behaviour of health professionals suggests that there is no method that can effectively be used for all problems. An exploration of the relevant factors lies at the core of any programme that is to be effective at improving behaviour (7).

The authors divide these factors into four groups, namely “patient knowledge and behaviour; knowledge, opinions and behaviour of medical professionals; organisation of care; and cultural and socio-economic context (7)”.

Patient knowledge and behaviour

Lack of knowledge on antibiotic resistance as well as differences between viral and bacterial infections and expectations of receiving an antibiotic all have major influences on physicians’ prescribing inappropriately. Therefore any programme aimed at improving antibiotic use would have to target, in part, the public at large. The authors quote the Belgian national programme from 2000-2002 as an example. A 26% decrease in antibiotic use was observed when the public were educated (7).

Knowledge, opinions and behaviour of medical professionals

Here the factors include uncertainty in diagnosis, incomplete knowledge, fear of complications and fear of disciplinary action. The most important factor, however, was perceived expectations of the patient. Studies have shown that this latter factor is one of the main considerations in pressuring doctors into inappropriate antibiotic prescribing (7).

Organisation of care

This refers to aspects relating to “coordination and collaboration between professionals, agreement on and transfer of the information, logistics of the care process and the control and monitoring of the systems in place” (7). Hulscher et al (7) conclude that the best interventions in this regard are: having an antibiotic formulary, using an antibiotic order form with restrictions, utilizing automatic stop orders on prescriptions, ensuring the availability of telephonic advice, improving

logistics, and improving collaboration between doctors, pharmacists and microbiologists (7).

Cultural and socio-economic context

Many factors are at play here, of which three important ones will be briefly mentioned (7).

The pharmaceutical industry has always exercised significant influence on the prescribing of medicines. They are progressively addressing consumers directly with aggressive marketing. In many countries antibiotics are also available without prescription. Furthermore, the capability to order drugs over the internet is also making antibiotic use more difficult to control (7).

The mechanism of health care funding can also explain differences in antibiotic prescribing. Compensation structures for the health professionals involved may give incentives to prescribe is certain ways (7).

Culture is an important factor that influences the ideas that people in a society have about the cause (and solution) of their illnesses, coping strategies and the way in which they access health care. An example the authors use compares Germany and France in terms of healthcare seeking behaviour and antibiotic use. In Germany people predominantly assume a “wait-and-see” approach to bronchial infections, while in France people visit their doctor early specifically to obtain an antibiotic (7).

A systematic review of the qualitative research led Rodrigues et al (20) to classify factors affecting antibiotic prescribing in a slightly different manner. This review included 35 studies of which 26 were purely qualitative, while nine were both quantitative and qualitative. The method of data collection was varied and included semi-structured interviews, questionnaires and focus group discussions (20).

The factors they identified as affecting antibiotic prescription were then divided into two groups, namely intrinsic (to the prescriber) and extrinsic. These factors will be discussed below.

Intrinsic factors

These were further grouped into physicians' attitudes and socio-demographic factors. Detailed under physicians' attitudes were "indifference, complacency, fear of serious complications, fear of patients dying, lack of confidence, diagnostic uncertainty, the desire for a quick fix and having others assuming responsibility". Socio-demographic factors (eg. age, sex, level of training) were only investigated by a few studies and the results were not consistent (20).

Extrinsic factors:

These were further divided into three categories, namely "patient-related factors, healthcare-system-related factors and the impact of three other factors, namely the influence of pharmaceutical companies, cost saving and financial incentives (20)".

Patient-related factors that were identified as having an effect on antibiotic prescribing were the patient's signs and symptoms, the patient's desire for a quick fix, co-morbidities, pregnancy, allergies, anxiety, educational level and economic and social factors. Healthcare-system-related factors that impacted antibiotic prescribing were time pressure, influence of group exposures, public-health considerations, lack of diagnostic facilities and patients' health insurance. In the last group, cost saving and financial incentives were identified as factors affecting antibiotic prescription but few studies looked at these factors (20).

1.4.3 Factors influencing surgical antibiotic prophylaxis

Gagliardi et al (21) did a review, in 2009, of peer-reviewed English-language quantitative and qualitative studies seeking to elucidate factors or interventions that influenced adherence to SSI prophylaxis guidelines. Nineteen studies were included in the review. Of these, seven were purely descriptive while twelve were interventional, comparing adherence of cohorts before and after the introduction of interventions aimed at improving quality of care.

The findings were that numerous factors interact to cause obstacles to appropriate antibiotic administration. These include "individual knowledge, attitude, beliefs and practice; team communication and allocation of responsibilities for antibiotic

prophylaxis; and institutional support for promoting and monitoring antibiotic prophylaxis" (21).

1.5 Interventions to improve guideline compliance

1.5.1 Multiple intervention studies

A study in Houston by Kao et al (22) in 2010 used a staggered cohort design looking at the result of several targeted interventions on antibiotic guideline compliance. The study was done at two hospitals and previous research had been conducted to identify barriers unique to each hospital. The hospital-specific targeted interventions were developed based on this research. They found an overall improvement in guideline adherence but the extent of the improvement differed significantly between the two hospitals. In concluding, the authors suggested that any interventions be hospital-specific. (22)

Regev-Yochay et al (23) noted that single strategy interventions frequently failed to promote judicious antibiotic prescription. In view of this, they conducted a randomized controlled study, published in 2011, aiming to show the benefit of a multifaceted intervention in improving antibiotic prescribing. The study design used a cluster randomized controlled structure with paediatric practices as the unit of randomization. A total of 52 practices were randomized to the intervention and control groups (26 each), with data collected over a period of six years. Interactive workshops were held at the beginning of the study for the intervention group in order to: compile local guidelines for diagnosis and management of respiratory tract infections (RTIs); improve RTI diagnosis; promote awareness of antibiotic resistance; emphasize prescribing antibiotics only when required; and using "parents as partners" by improving doctor-parent communication. The interventions were intensive during the first year and became gradually less intensive thereafter (23).

The primary outcome was annual antibiotic prescription rates and secondary outcomes were specific antibiotic class prescription rates. The number of patients seen per year in each group (intervention and control) was between 43 677 and 49 998 (23).

Parents' desire for antibiotics before the campaign was compared with that during the campaign period. A decrease of 47% in parents' wish for antibiotics was

observed. A significant decrease in antibiotic prescription rates of 22% was observed among the control group during the first year of the intervention. However, the intervention group showed an even greater reduction of 40%. This reduction was maintained throughout the three year intervention period and during the year of follow-up in both groups (23).

A novel hallmark of this study was its emphasis on doctors' engaging and committing to the educational process. The smaller but significant decrease in antibiotic prescription rates observed in the control group suggests an element of cross-contamination. This refers to the intervention having an indirect effect on the control group, explained by the authors as probably due to professional and social interaction (23). This may suggest that by setting an example or standard, one group of physicians may influence the behaviour of other physicians.

A search of the literature revealed two systematic reviews of RCTs assessing the effect of an intervention on antibiotic guideline adherence:

Fleming et al (24) did a systematic review in 2013 on RCTs looking at the effect of an intervention on antibiotic prescribing in long-term care facilities. Only four studies met criteria to be included and it was noted that the quality of the evidence was low. However, the conclusion they drew is that that a multi-faceted intervention is effective and it is difficult to attribute an increase in guideline adherence to one specific intervention (24).

A more encompassing systematic review from the Cochrane Collaboration in 2013 included 89 studies looking at improving antibiotic prescribing for hospital in-patients (25). The review used RCTs, controlled clinical trials, controlled-before-after and interrupted times series studies. The intervention was required to have a component that aimed at improving hospital inpatient antibiotic prescribing by reducing unnecessary treatment or increasing appropriate treatment. Data describing the effects of the intervention on microbial or clinician outcomes or antibiotic prescribing had to be included.

Meta-analysis was used to compare restrictive interventions versus purely persuasive interventions. Restrictive interventions had significantly greater impact on

prescribing outcome at one month and six months but the differences at 12 months and 24 months were not significant (25).

The authors stressed the importance of assessing the effect of interventions on clinical outcome. To that end, a meta-analysis showed that four interventions designed to improve appropriate prescribing for pneumonia were associated with significant reductions in mortality (risk ratio 0.89, 95% CI 0.82 to 0.97), while nine interventions aimed at decreasing superfluous antibiotic prescribing were not associated with significantly higher mortality (risk ratio 0.92, 95% CI 0.81 to 1.06). A decrease in Clostridium difficile infections and infection or colonization with aminoglycoside- or cephalosporin-resistant-gram-negative bacteria, methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus faecalis was seen with interventions that were designed to decrease excessive prescribing (25).

The picture that emerges from the literature is that any successful intervention should be intensive and multi-faceted to have the greatest effect. However, a multi-faceted intervention is very complex to coordinate and there are challenges to its implementation.

A multi-faceted interventional study, published in 2015, was carried out in Texas by Putnam et al (26). The intervention consisted of targeted interventions, carried out in three cycles, to address barriers to guideline adherence that were identified. These interventions took place over the course of three years and focused on behaviour change, engaging with the various stakeholders and iterative process evaluations. Despite the multiple facets to the interventions, overall adherence to the guidelines remained unchanged. The authors attributed this to poor dissemination and implementation of the intervention cycles (26).

A 2015 study by So et al (27) achieved improved compliance with a paediatric SAP guideline using a multifaceted intervention. The intervention consisted of posting the guideline in operating rooms and in the online formulary, keeping only recommended antibiotics in theatre, training incoming trainees, using antibiotic verification, having computerized alerts for inappropriate postoperative prophylaxis and email notification when guidelines were not followed. There were significant improvements in all outcome measures, namely appropriate antibiotic use (51.6% to 67%), complete

guideline compliance (26.2% to 53.2%), correct dosage (77.5 to 90.7%), timing (83.3% to 95.8%), re-dosing (62.5% to 95.8%) and duration (47.1% to 65.3%) (27).

1.5.2 Single intervention studies

A few studies have assessed the efficacy of a single or less intensive intervention on guideline adherence. The results, briefly discussed below, showed minimal improvement in prescribing.

A prospective interventional study, published in 2010, was performed in Turkey (28). It used an educational program lasting one month and then assessed for an improvement in guideline adherence. While certain aspects of guideline adherence improved modestly, overall compliance rate did not (28).

Sutherland et al (29) conducted an interventional study in a large tertiary academic medical centre in New England, published in 2014. The intervention was to audit a random sample of surgical cases for compliance with guidelines for antibiotic prophylaxis and to notify the responsible clinician of the errors made and to subsequently use it as an opportunity to educate staff. Anaesthesiologists and surgeons were both included in the audit. The number of repeat offenders declined and the authors felt that clinicians do modify clinical behaviour after being notified of an error. However, there was no statistically significant decline in the total number of error notifications (29).

1.5.3 Structuring an intervention for improving SAP:

Gagliardi et al (21) used the results of their review on factors influencing SAP to suggest a framework which one could use to conduct an environmental assessment into the practice of antibiotic prophylaxis in a specific setting. The authors state that an environmental assessment is the starting point in implementing a new practice and that it is a more holistic approach to improving standard of care than continuing education because it considers multiple factors. Individual knowledge, beliefs and attitudes, and team-related problems can be assessed with a questionnaire. Factors relating to institutional support could be identified through interviews with health workers, managers and infection control personnel. A content analysis could gauge compatibility of existing policies with guidelines (21).

The review identified several strategies that improved antibiotic prophylaxis prescribing recommendations. Written orders specifying delivery of antibiotics in the operating room, individual clinician performance data, continuing education and reminders all improved antibiotic prophylaxis. Educational meetings are recommended to be interactive instead of being didactic, and individual feedback and follow up subsequent to regular audit are encouraged. Clinicians have a higher likelihood of complying with guidelines if they have been involved in their development. The authors conclude by advocating further research to evaluate the effectiveness of various strategies for improving SAP (21).

1.6 What surveys have been done on doctors' knowledge of antibiotics?

Lucet et al (3) undertook a cross-sectional survey in 2011 in two academic hospitals in Paris. They aimed to investigate doctors' knowledge and perceptions about antibiotic prescription. There were 206 participants who completed the survey which included vignettes (as a surrogate for practice), and a questionnaire relating to cognitive factors that are involved in prescribing. This, to their knowledge, was the first study to investigate knowledge and cognitive factors relating to antibiotic prescription in a quantitative manner (3).

They found that doctors' knowledge varied substantially across specialties but interestingly did not differ significantly between junior and senior clinicians. Intensivists and anaesthesiologists had the best knowledge, while surgeons fared the worst in this aspect. Two cognitive factors were associated with better knowledge, namely the perceived susceptibility of the patient to the risks of inappropriate prescribing, and perceived self-efficacy in complying with recommendations and guidelines. Thus improving knowledge could be crucial to achieving better antibiotic prescription (3).

Algabe-Briggs et al (30), carried out a survey of anaesthetists' opinions regarding perioperative antibiotic therapy, published in 2013. The majority of anaesthetists felt that the surgeon was responsible for selecting the antibiotic but that both surgeons and anaesthetists were responsible for their administration. Approximately 70% believed their training in the selection of antibiotics was inadequate (30).

A survey published in 2015 was undertaken across four of 17 provinces in Lao People's Democratic Republic (31). It aimed to assess the knowledge, attitude and practices of doctors towards antibiotic prescription. The results indicate insufficient knowledge in many areas. The data showed that 59.8% of doctors felt they had inadequate information about antibiotics, 29% felt unnecessary prescriptions were harmless, 75% felt it was difficult to select the correct antibiotic and almost all welcomed educational programmes (31).

A survey in Naples in 2015 examined doctors' knowledge of antibiotic therapy in a tertiary university hospital. The key question of the survey examined the main criterion for antibiotic choice. The number of respondents that answered this incorrectly was 68%, showing that antibiotic therapy is often chosen using inappropriate criteria (32).

Feuerstein et al (33) conducted a study using a questionnaire on physicians' knowledge of antibiotic prophylaxis before upper gastrointestinal endoscopy. It was administered to physicians (specialised in internal medicine and sub-specialties) and asked them whether or not they would administer antibiotics for various scenarios. The median mark was 70% for the yes/no questionnaire. The authors found a correlation of knowledge with self-reported familiarity with guidelines (33).

1.7 What SAP guidelines are relevant to the South African anaesthetist?

1.7.1 Principles of SAP

The cornerstones of rational and appropriate SAP prescribing are discussed below.

Choice of antibiotic:

The antibiotic selected for prophylaxis must cover the expected pathogens at the specific site of operation. The choice of antibiotic must consider local patterns of antibiotic resistance. The chosen antibiotics may be the same as those used for treatment of established infection, however, narrow-spectrum and usually less expensive antibiotics are preferred as the first choice for SAP (2).

Timing of administration:

Antibiotic prophylaxis given too early or too late reduces the efficacy of the antibiotic and may increase the risk of SSI. Evidence regarding optimal timing is difficult to interpret as it is based on studies including different types of surgical procedures. Current recommendation is for intravenous prophylactic antibiotics to be administered within 60 minutes before skin incision. The fluoroquinolones and vancomycin which require one to two hours to infuse should be started 90-120 minutes before skin incision (2, 34).

Dosage selection

There is wide acceptance that the dosage of antibiotic for prophylaxis is the same as that for therapy of an active infection (2).

Duration of prophylaxis

For a great number of commonly performed operations, there is extensive evidence that a single dose of antibiotic is adequate. There is no evidence that longer courses of prophylaxis have any further benefit. A single dose of antibiotic with a long enough half-life to achieve activity for the duration of the operation is the recommendation. Additional doses may be indicated for longer surgery or when using shorter-acting agents. In the event of major blood loss (more than 1500ml in adults or more than 25ml/kg in children), it is recommended to consider giving an additional dose of antibiotic. For arthroplasty, prophylaxis can be extended to 24 hours, and cardiac surgery for 48 hours (2, 35).

Is Prophylaxis indicated?

A general guide is that antibiotic prophylaxis should be administered for clean surgery involving placement of prostheses or implants as well as for clean-contaminated and contaminated surgery (2, 36). Antibiotics administered in emergency surgery with contaminated or dirty wounds is considered treatment and thus beyond the scope of prophylaxis guidelines (2).

There are some exceptions to the above general rules. The SIGN (2) and the ASHP (34) examine the evidence for specific procedures. These guidelines give a

recommendation based on the available evidence and also indicate the strength of this evidence.

No local SAP guidelines exist at the academic hospitals affiliated to Wits with the exception of the university-private sector partnership of the Wits Donald Gordon Medical Centre (WDGMC). The discussion below will examine some prominent international guidelines followed by the available South African guidelines.

1.7.2 International SAP Guidelines

USA guidelines: ASHP – Clinical Guidelines for Antimicrobial Prophylaxis in Surgery (34)

This is an extensive 89 page document. It provides tables and detailed text regarding all aspects of SAP, namely timing of first dose, re-dosing intervals, duration of prophylaxis and acceptable agents and doses for each specific surgery. It explores the evidence for prophylaxis in each specialty and rates the strength of the evidence. The document is not suitable to be distributed as a working guideline in hospitals due to its length but can be used as a basis for compiling a local more user-friendly guideline (34).

Scottish Guidelines: SIGN – Antibiotic Prophylaxis in Surgery (2014 update) (2)

This is a 74 page document similar in scope to the ASHP document, which provides detailed guidelines for prophylaxis in specific types of surgery. It explores the evidence for prophylaxis in each type of surgery and gives recommendations based on the content and strength of the evidence. The document, however, does not recommend specific agents to be used in specific procedures. The depth of the document lends itself as being useful as a basis to form local guidelines (2).

South Australian Expert Advisory Group on Antimicrobial Resistance (SAAGAR) - Surgical Antibiotic Prophylaxis Guidelines (37)

This guideline exists as a set of separate documents, each document covering SAP in an individual specialty/procedure type. For each individual specialty, it gives recommendations regarding indication for prophylaxis, timing of prophylaxis, specific agents and doses recommended, dosing interval and duration of prophylaxis. In

contrast to the previous two guidelines discussed, these guidelines do not explore the evidence base behind the recommendations (37).

British Guidelines: Royal Devon and Exeter NHS Foundation Trust – Adult surgical antibiotic prophylaxis guidelines (38)

This guideline is included an example of a comprehensive user-friendly local guideline which covers all the pertinent factors to be considered in SAP. Timing of first dose, re-dosing interval and duration of prophylaxis are all explicitly and clearly stated. A table lists specific types of surgery and indicates whether or not prophylaxis is required. For each procedure there are up to four antibiotic options, namely a first choice, a second choice in mild penicillin allergy, a second choice in severe penicillin allergy and a choice for a patient with MRSA. The dosage of each antibiotic is provided. The guideline is presented on one page and it is colour-coded and easy to read (38).

1.7.3 South African Guidelines

South African Society of Anaesthesiologists (SASA) - Guidelines for Infection Control in South Africa (36)

These guidelines are very brief and general. They recommend antibiotic prophylaxis for clean surgery involving implants or prostheses, clean-contaminated surgery and contaminated surgery. No procedure-specific guidance is given. The guidelines also discuss the timing of prophylaxis (30-60 minutes before skin incision) and emphasize that prophylaxis should not extend beyond the surgical procedure. Re-dosing is stated as only being necessary if the surgery is longer than the half-life of the antibiotic. There are, however, no specific drug recommendations or doses for specific procedures and the guideline recommends consulting a local formulary (36).

South African Antibiotic Stewardship Programme (SAASP) – A pocket guide to antibiotic prescribing or adults in South Africa, 2015 (39)

A general document on antibiotic prescribing with two pages dedicated to SAP. Only one choice of antibiotic is given, and procedure types are grouped in a few general categories with no details. Minimal reference is made to the timing of antibiotic

administration, duration of prophylaxis and re-dosing intervals. The guidelines recommend referring to local policies (39).

WDGMC - Antibiotic Surgical Prophylaxis Guideline (35)

These unpublished locally developed guidelines are presented as a flow diagram and tables. They are more comprehensive and specific than other South African guidelines discussed. Duration of prophylaxis, timing of prophylaxis and re-dosing intervals are all clearly set out. Doses of individual drugs are set out in a table. Another table gives specific antibiotic choices for each type of surgery (colo-rectal, gastro-duodenal, biliary tract, kidney transplant, liver transplant, pancreas, head & neck, vascular & thoracic, gynaecology, orthopaedics, urology). Each surgery has a primary option, secondary option and an option for beta-lactam allergy. Not all specialties are covered in the guidelines, only the specialities that operate at the hospital. The guideline does not discuss which types of surgery do not require prophylaxis. The authors used the four international guidelines discussed above, amongst a few others, as a basis for the guidelines (35).

Guidelines addressing SAP seem to be very general and insufficiently developed in South African public service hospitals. With the exception of the WDGMC, there are no local guidelines at the hospitals affiliated to the Wits Medical School.

1.8 References

1. Tourmousoglou C, Yiannakopoulou E, Kalapothaki V, et al. Adherence to guidelines for antibiotic prophylaxis in general surgery: a critical appraisal. *J Antimicrob Chemother*. 2008;61(1):214-8.
2. Scottish Intercollegiate Guideline Network. Antibiotic prophylaxis in surgery Edinburgh 2014 [Accessed 20-November-2015]. Available from: http://www.sign.ac.uk.
3. Lucet J, Nicolas-Chanoine M, Roy C, et al. Antibiotic use: knowledge and perceptions in two university hospitals. *J Antimicrob Chemother*. 2011;66:936-40.
4. Pulcini C, Williams F, Molinari N, et al. Junior doctors' knowledge and perceptions of antibiotic resistance and prescribing: a survey in France and Scotland. *Clin Microbiol Infect*. 2011;17(1):80-7.
5. Gould I. Antibiotic policies to control hospital acquired infection. *J Antimicrob Chemother*. 2008;61(4):763-5.
6. Kandelaki K, Lundborg C, Marrone G. Antibiotic use and resistance: a cross-sectional study exploring knowledge and attitudes among school and institution personnel in Tbilisi, Republic of Georgia. *BioMed Central Research Notes*. 2015;8(495):1-8.
7. Hulscher M, Van der Meer J, Grol R. Antibiotic use: how to improve it? *Int J Med Microbiol*. 2010;300(6):351-6.
8. Classen D, Evans R, Pestotnik S, et al. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N Engl J Med*. 1992;326(5):281-6.
9. Ng R, Chong C. Surgeons' adherence to guidelines for surgical antimicrobial prophylaxis – a review. *Australas Med J*. 2012;5(10):534-40.
10. Heineck I, Ferreira M, Schenkel E. Prescribing practice for antibiotic prophylaxis for 3 commonly performed surgeries in a teaching hospital in Brazil. *Am J Infect Control*. 1999;27(3):296-300.
11. Wasey N, Baughan J, De Gara C. Prophylaxis in elective colorectal surgery: the cost of ignoring the evidence. *Can J Surg*. 2003;46(4):279-84.
12. Van Kasteren M, Kullberg B, De Beer A, et al. Adherence to local guidelines for surgical antibiotic prophylaxis: a multicentre audit in Dutch hospitals. *J Antimicrob Chemother*. 2003;51(6):1389-96.
13. Choi W, Song J, Hwang J, et al. Appropriateness of antibiotic prophylaxis for major surgery in Korea. *Infect Control Hosp Epidemiol*. 2007;28(8):997-1002.
14. El Hassan M, Elnour A, Farah F, et al. Clinical pharmacists' review of surgical antimicrobial prophylaxis in a tertiary hospital in Abu Dhabi. *Int J Clin Pharm*. 2015;37(1):18-22.
15. Rafati M, Shiva A, Ahmadi A, et al. Adherence to American Society of Health-System Pharmacists Surgical Antibiotic Prophylaxis guidelines in a teaching hospital. *J Res Pharm Pract*. 2014;3(2):62-6.
16. Hooper T, Hibbert P, Hannaford N, et al. Surgical site infection - a population-based study in Australian adults measuring compliance with and correct timing of appropriate antibiotic prophylaxis. *Anaesth Intensive Care*. 2015;43(4):461-8.
17. Graham H, Vasireddy A, Nehra D. A national audit of antibiotic prophylaxis in elective laparoscopic cholecystectomy *RCS Annals*.96(5):377-80.
18. Paruk F, Richards G, Scribante J, et al. Antibiotic prescription practices and their relationship to outcome in South African intensive care units: Finding of the Prevalence of Infection in South African Intensive Care Units (PISA) Study. *S Afr Med J*. 2012;102(7):613-6.
19. Cabana M, Rand C, Powe N, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA*. 1999;282(15):1458-65.
20. Rodrigues A, Roque F, Falcao A, et al. Understanding physician antibiotic prescribing behaviour: a systematic review of qualitative studies. *Int J Antimicrob Agents*. 2013;41(3):203-12.

21. Gagliardi A, Fenech D, Eskicioglu C, et al. Factors influencing antibiotic prophylaxis for surgical site infection prevention in general surgery: a review of the literature. *Can J Surg*. 2009;52(6):481-9.
22. Kao L, Lew D, Doyle P, et al. A tale of 2 hospitals: A staggered cohort study of targeted interventions to improve compliance with antibiotic prophylaxis guidelines. *Surgery* 2010;148(2):255-62.
23. Regev-Yochay G, Raz M, Dagan R, et al. Reduction in antibiotic use followng a cluster randomized controlled multi-faceted intervention: The Israeli Judicious Antibiotic Prescription Study *Clinical Infectious Diseases*. 2011;53(1):33-41.
24. Fleming A, Browne J, Byrne S. The effect of interventions to reduce potentially inappropriate antibiotic prescribing in long-term care facilities: a systematic review of randomised controlled trials. *Drugs Aging*. 2013;30(6):401-8.
25. Davey P, Brown E, Charani E, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients (Review): *Cochrane Libr*; 2013 [Accessed 4-November-2015]. Available from: http://www.cochranelibrary.com/.
26. Putnam L, Chang C, Rogers N, et al. Adherence to surgical antibiotic prophylaxis remains a challenge despite multifaceted interventions. *Surgery*. 2015;158(2):413-8.
27. So J, Aleem I, Tsang D, et al. Increasing compliance with an antibiotic prophylaxis guideline to prevent paediatric surgical site infection: before and after study. *Ann Surg*. 2015;262(2):403-8.
28. Ozgun H, Ertugrul B, Soyder A, et al. Peri-operative antibiotics prophylaxis: Adherence to guidelines and effects of educational intervention. *Int J Surg*. 2010;8(2):159-63.
29. Sutherland T, Beloff J, Lightowler M, et al. Description of a multidisciplinary initiative to improve SCIP measures related to pre-operative antibiotic prophylaxis compliance: a single-center success story. *Patient Saf Surg*. 2014;8(37):1-7.
30. Algabe-Briggs O, Obembe B. A survey on selection and administration of perioperative antibiotics by anaesthetists. *West Afr J Med*. 2013;32(1):3-7.
31. Quet F, Vlieghe E, Leyer C, et al. Antibiotic prescription behaviours in Lao People's Democratic Republic: a knowledge, attitude and practice survey. *Bull World Health Organ*. 2015;93(4):219-27.
32. Gentile I, Landolfo D, Buonomo A, et al. A survey on antibiotic therapy knowledge among physicians of a tertiary care and university hospital. *Infez Med*. 2015;23(1):12-7.
33. Feuerstein D, Sethi S, Tapper E, et al. Current knowledge of antibiotic prophylaxis guidelines regarding GI open-access Endoscopic procedure is inadequate. *Gastrointest Endosc*. 2015;82(2):268-75.
34. Bratzler D, Dellinger E, Olsen K, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm*. 2013;70(3):195-283.
35. WDGMC Infection Control and Pharmacy Comittee. Wits Donald Gordon Medical Centre Antibiotic Surgical Prophylaxis Guideline 2013.
36. South African Society of Anaesthetists. SASA Guidelines for infection control in Anaesthesia in South Africa 2014 [Accessed 2-November-2015]. Available from: http://www.sasaweb.com/.
37. South Australian Expert Advisory Group on Antibiotic Resistance (SAAGAR). Surgical Antibiotic Prophylaxis Guidelines 2013 - 2014 [Accessed 6 November 2015]. Available from: http://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/clinical+resources/clinical+topics/medicines+and+drugs/antimicrobial+guidelines/antimicrobial+guidelines.
38. Royal Devon and Exeter NHS Foundation Trust. Adult Surgical Antibiotic Prophylaxis Guidelines 2010 [Accessed 30 October 2015]. Available from: http://www.rdehospital.nhs.uk/docs/prof/antimicrobial/Surgical_prophylaxis_guidelines.pdf.
39. Wasserman S, Boyles T, Mendelson M. A pocket guide to antibiotic prescribing for adults in South Africa, 2015: Federation of Infectious Diseases Societies of Southern Africa; 2015 [Accessed 30 October 2015]. Available from: http://www.fidssa.co.za/A_SAASP_Home.asp.

Section 2: Authors guidelines

This article will be submitted to the journal “BMJ Quality & Safety” in the category “original article”. Below are the author’s guidelines copied from the journal website on 4-June-2016, available from the website: http://qualitysafety.bmj.com/

Instructions for Authors

Editorial policy

BMJ Quality & Safety (formerly Quality & Safety in Health Care) is a leading international peer review journal in this growing area of quality and safety improvement. It provides essential information for those wanting to reduce harm and improve patient safety and the quality of care. The journal reports and reflects research, improvement initiatives and viewpoints and other discursive papers relevant to these crucial aims with contributions from researchers, clinical professionals and managers and experts in organisational development and behaviour.

BMJ Quality & Safety aims to contribute actively to the debate about the quality and safety of health care by exploring subjects and ideas (from both routine clinical and managerial practice and research) which concern and inform this debate and which focus on real benefits to patients.

The journal attempts to handle the review process and publication as expeditiously as possible. The review process is usually completed within 4 weeks (mean 20 days), but can take longer in some instances.

Article types and word counts

The word count excludes the title page, abstract, tables, acknowledgements and contributions and the references. For non-native English speakers we now offer a professional editing service.

Original Articles

Original Articles report research and studies relevant to quality of health care. They may cover any aspect, from clinical or therapeutic intervention, to promotion, to prevention. They should usually present evidence indicating that problems of quality of practice may exist, or suggest indications for changes in practice, or contribute towards defining standards or developing measures of outcome. Alternatively, they should contribute to developing approaches to measuring quality of care in routine practice. The journal is interprofessional and welcomes articles from anyone whose

work is relevant, including health professionals, managers, practitioners, researchers, policy makers, or information technologists.

Word count: 3000-4000 words
Structured abstract up to 275 words in length
Tables/Illustrations: up to 5 tables or illustrations; appendices that present additional methodological details or other relevant materials that may be of interest to readers can also be included with the intention of aiding peer reviewers or providing them as online material for interested readers.

Research checklists should be uploaded during the submission process. If these are not applicable to your research please state the reason in your cover letter.

Plagiarism Detection

BMJ is a member of CrossCheck by CrossRef and iThenticate. iThenticate is a plagiarism screening service that verifies the originality of content submitted before publication. iThenticate checks submissions against millions of published research papers, and billions of web content. Authors, researchers and freelancers can also use iThenticate to screen their work before submission by visiting www.ithenticate.com.

Preparing your manuscript

All material submitted is assumed to be submitted exclusively to the journal unless otherwise stated. Submissions may be returned to the author for amendment if presented in the incorrect format.

Manuscript documents are deleted from our systems 6 months after completion of the peer review process.

Cover letter

Your cover letter should inform the Editor of any special considerations regarding your submission, including but not limited to:

- Details of related papers by the same author(s) already published or under consideration for publication.

- Details of previous reviews of the submitted article.

Copies of related papers, previous Editors' and reviewers' comments, and responses to those comments can be submitted using the File Designation "Supplementary file for Editors only". Editors encourage authors to submit previous communications as doing so is likely to expedite the review process.

Title page

The title page must contain the following information:

- Title of the article.
- Full name, postal address, e-mail and telephone number of the corresponding author.
- Full name, department, institution, city and country of all co-authors.
- Up to five keywords relevant to the content of your manuscript. This will enable us to identify the most suitable reviewers for your manuscript.
- Word count, excluding title page, abstract, references, figures and tables.

Manuscript format

The manuscript must be submitted as a Word document. PDF is not accepted.

The manuscript should be presented in the following order:

- Title page.
- Abstract, or a summary for case reports (Note: references should not be included in abstracts or summaries).
- Main text separated under appropriate headings and subheadings using the following hierarchy: BOLD CAPS, bold lower case, Plain text, Italics.
- Tables should be in Word format and placed in the main text where the table is first cited.
- Tables must be cited in the main text in numerical order.

- Acknowledgments, Competing Interests, Funding and all other required statements. Reference list.

Images must be uploaded as separate files (view further details under the Figures/illustrations section). All images must be cited within the main text in numerical order and legends should be provided at the end of the manuscript.

Appendices should be uploaded using the File Designation "Supplementary File" and cited in the main text.

Please remove any hidden text headers or footers from your file before submission.

Style

Abbreviations and symbols must be standard. SI units should be used throughout, except for blood pressure values which should be reported in mm Hg.

Whenever possible, drugs should be given their approved generic name. Where a proprietary (brand) name is used, it should begin with a capital letter.

Acronyms should be used sparingly and fully explained when first used.

Figures/illustrations

Images must be uploaded as separate files. All images must be cited within the main text in numerical order and legends must be provided (ideally at the end of the manuscript).

Colour images and charges

For certain journals, authors of unsolicited manuscripts that wish to publish colour figures in print will be charged a fee to cover the cost of printing. Refer to the specific journal’s instructions for authors for more information.

Alternatively, authors are encouraged to supply colour illustrations for online publication and black and white versions for print publication. Colour publication online is offered at no charge, but the figure legend must not refer to the use of colours.

Tables

Tables should be in Word format and placed in the main text where the table is first cited. Tables must be cited in the main text in numerical order. Please note that tables embedded as Excel files within the manuscript are NOT accepted. Tables in Excel should be copied and pasted into the manuscript Word file.

Tables should be self-explanatory and the data they contain must not be duplicated in the text or figures. Any tables submitted that are longer/larger than 2 pages will be published as online only supplementary material.

References

Authors are responsible for the accuracy of cited references and these should be checked before the manuscript is submitted.

Citing in the text

References must be numbered sequentially as they appear in the text. References cited in figures or tables (or in their legends and footnotes) should be numbered according to the place in the text where that table or figure is first cited. Reference numbers in the text should be inserted immediately after punctuation (with no word spacing)—for example,[6] not [6].

Where more than one reference is cited, these should be separated by a comma, for example,[1, 4, 39]. For sequences of consecutive numbers, give the first and last number of the sequence separated by a hyphen, for example,[22-25]. References provided in this format are translated during the production process to superscript type, and act as hyperlinks from the text to the quoted references in electronic forms of the article.

Please note that if references are not cited in order the manuscript may be returned for amendment before it is passed on to the Editor for review.

Preparing the reference list

References must be numbered consecutively in the order in which they are mentioned in the text.

Only papers published or in press should be included in the reference list. Personal communications or unpublished data must be cited in parentheses in the text with the name(s) of the source(s) and the year. Authors should request permission from the source to cite unpublished data.

Journals from BMJ use a slightly modified version of Vancouver referencing style (see example below). The style template is available via Endnote. Note that The BMJ uses a different style.

BMJ reference style

List the names and initials of all authors if there are 3 or fewer; otherwise list the first 3 and add 'et al.' (The exception is the Journal of Medical Genetics, which lists all authors). Use one space only between words up to the year and then no spaces. The journal title should be in italic and abbreviated according to the style of Medline. If the journal is not listed in Medline then it should be written out in full.

Example references

Journal article

13 Koziol-Mclain J, Brand D, Morgan D, et al. Measuring injury risk factors: question reliability in a statewide sample. *Inj Prev* 2000;6:148–50.

Chapter in book

14 Nagin D. General deterrence: a review of the empirical evidence. In: Blumstein A, Cohen J, Nagin D, eds. Deterrence and Incapacitation: Estimating the Effects of Criminal Sanctions on Crime Rates. Washington, DC: National Academy of Sciences 1978:95–139.

Book

15 Howland J. Preventing Automobile Injury: New Findings From Evaluative Research. Dover, MA: Auburn House Publishing Company 1988:163–96.

Abstract/supplement

16 Roxburgh J, Cooke RA, Deverall P, et al. Haemodynamic function of the carbomedics bileaflet prosthesis [abstract]. *Br Heart J* 1995;73(Suppl 2):P37.

Electronic citations

Websites are referenced with their URL and access date, and as much other information as is available. Access date is important as websites can be updated and URLs change. The "date accessed" can be later than the acceptance date of the paper, and it can be just the month accessed.

Electronic journal articles

Morse SS. Factors in the emergency of infectious diseases. *Emerg Infect Dis* 1995 Jan-Mar;1(1). www.cdc.gov/nciod/EID/vol1no1/morse.htm (accessed 5 Jun 1998).

Electronic letters

Bloggs J. Title of letter. *Journal name* Online [eLetter] Date of publication. url eg: Krishnamoorthy KM, Dash PK. Novel approach to transseptal puncture. *Heart* Online [eLetter] 18 September 2001. http://heart.bmj.com/cgi/eletters/86/5/e11#EL1

PLEASE NOTE: RESPONSIBILITY FOR THE ACCURACY AND COMPLETENESS OF REFERENCES RESTS ENTIRELY WITH THE AUTHOR.

Permissions

If you are using any material e.g. figures, tables or videos that have already been published elsewhere, you must obtain permission to reuse them from the copyright holder (this may be the publisher rather than the author) and include any required permission statements in the figure legends. This includes your own previously published material, if you are not the copyright holder.

It is the author’s responsibility to secure all permissions prior to publication.

Statistics

Statistical analyses must explain the methods used.

Research reporting guidelines

Authors are encouraged to use the relevant research reporting guidelines for the study type provided by the EQUATOR Network. This will ensure that you provide enough information for editors, peer reviewers and readers to understand how the research was performed and to judge whether the findings are likely to be reliable.

Section 3: Draft Article to *BMJ Quality & Satefy*

Cover letter to the editor

20-July-2016

Dear Sir/Madam

I thank you in advance for kindly considering our research entitled “Anaesthetists’ Knowledge of Antibiotic for Surgical Prophylaxis”

The emergence of antibiotic stewardship programs worldwide has brought the issue of judicious antibiotic use to the fore in recent years. The objective of these programs is to improve treatment of infectious diseases thereby improving morbidity and mortality as well as possibly decreasing the burden of ever increasing antimicrobial resistance. Surgical antibiotic prophylaxis (SAP) is an integral part of the drive to decrease surgical site infections (SSI). SSI significantly increases short-term morbidity, length of hospital stay and hospital costs, and in some clinical situations also results in an increase in long-term morbidity and mortality. The safety of our patients and the quality of care given to them is greatly compromised when the practice of SAP is deficient.

A review of the literature reveals that SAP is practiced poorly worldwide, in both developing and developed countries. As a developing country we face significant budgetary and staff constraints that make the provision of judicious SAP even more challenging. At our hospitals, anaesthetists play a central role in the selection and administration of SAP. Our research investigates the knowledge of anaesthetists regarding SAP and provides compelling evidence that it is lacking and provides an area to target in seeking to improve the administration of SAP and decrease the incidence of SSI. To the best of our knowledge, no study has previously been conducted to assess the knowledge of anaesthetists about this subject. A solid knowledge base is one essential pre-requisite for a broad strategy to improve the administration of SAP. We feel our research would be beneficial for an international audience since the problem of substandard SAP appears to be a global problem.

BMJ Quality and Safety is the first journal this manuscript has been submitted to. This is also the first study we have conducted on the subject of SAP.

Thank you for your time and consideration.

Sincerely

Jonathan Jocum

MBChB DA(SA)

Department of Anaesthesiology, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg.

Anaesthetists' Knowledge of Antibiotics for Surgical Prophylaxis

Corresponding author:

- Name: Jonathan Jocum
- Address: University of the Witwatersrand, Health Sciences Campus, 7 York Road, Johannesburg, 2193, South Africa
- Email: jocumj@yahoo.com
- Telephone: +27 84 764 1212
- Institution: Department of Anaesthesiology, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

Co-authors

- Juan Scribante, Department of Anaesthesiology, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
- Helen Perrie, Department of Anaesthesiology, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
- Warren Lowman, Infection Prevention and Control, Clinical Microbiology, Wits Donald Gordon Medical Centre, Johannesburg, South Africa

Key words: Antibiotics, surgical prophylaxis, anaesthetist, knowledge

Word count: 3593 (Abstract: 255)

ABSTRACT

Background: Surgical site infection (SSI) is the second most common hospital-acquired infection and results in increased morbidity and mortality and a longer hospital stay. Surgical antibiotic prophylaxis (SAP) is one component of broader strategies to reduce rates of SSI. Adherence to SAP guidelines is generally sub-optimal globally, with knowledge of appropriate SAP being a factor that affects this. This results in less effective prevention of SSI.

Objectives: To describe awareness amongst anaesthetists at university-affiliated hospitals of available SAP guidelines and to describe their knowledge on the subject. Comparisons between senior and junior anaesthetists were assessed.

Methodology: A prospective descriptive study design using a self-administered questionnaire. The study population was the anaesthetists in a university-affiliated Department of Anaesthesiology in Johannesburg, South Africa.

Results: The analysis included 135 completed questionnaires from the department's anaesthetists. A total of 15.6% of participants followed a specific guideline in their practice, 28% for senior anaesthetists vs. 4.2% for junior anaesthetists. The overall mean score for knowledge was 56.2%, 59.3% for senior anaesthetists vs. 53.6% for junior anaesthetists, which was statistically significant (p-value <0.001). Overall knowledge was found to be poor and specifically, knowledge regarding indication for prophylaxis, antibiotic re-dosing interval, and duration of prophylaxis, was poor.

Conclusion: The anaesthetists had poor knowledge regarding SAP. While the difference in knowledge between senior and junior anaesthetists was statistically significant, we feel that this difference would not be substantial enough to have a clinical impact. We recommend improving the knowledge of the anaesthetists regarding SAP as well as the development of local SAP guidelines.

BACKGROUND

Surgical site infection (SSI) is the second most prevalent type of hospital-acquired infection HAI.[1] Short-term consequences of SSI include a longer and more protracted hospital stay with the associated increased cost. In certain types of surgery, for example, in colonic surgery, SSI may also result in increased mortality.[2] Patients with SSI are 60% more likely to be admitted to ICU, five times more likely to be re-admitted to hospital and are twice as likely to die.[3] The incidence of SSI is thus an important outcome measure of the quality of surgical care.[2] The importance of SAP is exemplified by the WHO including it as one of the pre-incision checks in the WHO surgical safety checklist.[4]

Surgical antibiotic prophylaxis (SAP) is one component of a broader strategy to decrease SSI. The benefit of SAP relates to how effectively it prevents SSI and how severe the consequences of SSI are in each specific procedure.[2] Guidelines on SAP assess these factors and give recommendations on antibiotic prophylaxis for each procedure.

Certain important principles underpin the practice of SAP. In order to achieve the goals of effective prophylaxis, the antibiotics should have activity against the organisms that are likely to contaminate the site of surgery, they should be given in doses and intervals sufficient to achieve satisfactory tissue concentration during the procedure and should be administered for the shortest period possible in order to reduce adverse effects, cost and resistance as far as possible.[5]

The existence of SAP guidelines is mostly to ensure optimal use of SAP to decrease the incidence of SSI. However, antibiotic guidelines also exist in order to minimise indiscriminate and injudicious use of antibiotics, which Gould[6] notes to be a causative factor in selecting and maintaining antibiotic-resistant bacteria. In spite of the existence of guidelines, the evidence that has emerged over the last two decades indicates that adherence to antibiotic prescription guidelines is poor worldwide. This manifests as a safety risk to patients as the failure to practice appropriate SAP increases the burden of SSI with its associated sequelae.

In 1999, SAP was evaluated in a Brazilian academic hospital and it was found that only 3% of cases complied fully with the guidelines.[7] In the Netherlands, a multi-

centre audit by Van Kasteren,[8] in 2003 found that only 28% of cases adhered to all aspects of SAP guidelines. In South Korea, a study by Choi et al[9] in 2007 found compliance to be less than 1%. Similar studies examining SAP guideline compliance in Greece,[10] Abu Dhabi[11] and Australia[12] found rates of compliance to be 36%, 32% and 38% respectively.

The question of why doctors do not follow guidelines is a conundrum that has only relatively recently been investigated and addressed.[13] Gagliardi et al[14] conducted a review, in 1999, of English-language peer-reviewed studies which aimed to elucidate factors that affect adherence to SAP guidelines. Their findings were that numerous factors interact to obstruct the provision of appropriate antibiotic administration. These include “individual knowledge, attitude, beliefs and practice; team communication and allocation of responsibilities for antibiotic prophylaxis; and institutional support for promoting and monitoring antibiotic prophylaxis.”[14]

The authors of the review[14] built on their results of the causative factors influencing SAP to suggest a framework which one could use to conduct a comprehensive assessment into the practice of antibiotic prophylaxis in a specific setting. They state that an environmental assessment is the starting point in implementing a new practice and that it is a more holistic approach to improving the standard of care than simply continuing education, because it considers multiple factors. Individual knowledge, beliefs and attitudes, and team-related problems can be assessed with a questionnaire. Factors relating to institutional support could be identified through interviews with healthcare workers, managers and infection control personnel. A content analysis could be used to gauge compatibility of existing policies with guidelines.[14] Investigating the cause of poor SAP is thus a complex and multi-faceted task. Knowledge is but only one aspect of influence.

The literature on studies assessing doctor’s knowledge of SAP is limited. In 2015 Feuerstein et al[15] conducted a study assessing physicians’ knowledge of prophylactic antibiotics in gastro-intestinal endoscopic procedures. They found the median mark to be 70%. To the best of our knowledge, there have been no studies to date assessing the knowledge of doctors, in general or anaesthetists specifically, regarding appropriate SAP administration.

The primary objectives of the study were to describe awareness of anaesthetists of available SAP guidelines and to describe their knowledge regarding appropriate SAP. A secondary objective was to compare knowledge between senior and junior anaesthetists.

METHODOLOGY

Study design and population

A prospective descriptive research design was used for the study.

The study population was anaesthetists working in the Department of Anaesthesiology at the University of the Witwatersrand (Wits) in Johannesburg, South Africa. The department consists of 21 medical officers (junior anaesthetists without specialist training), 112 registrars (specialists-in-training), and 76 consultant anaesthetists. Their scope of practice is across five academic hospitals in Johannesburg. Convenience sampling was used and a sample size of more than 60% of the department's anaesthetists was targeted.

A knowledge-based questionnaire was handed out to anaesthetists at departmental academic meeting between March 2016 and May 2016. Participation was voluntary and anonymity and confidentiality were maintained.

Development of questionnaire

A questionnaire was developed by the authors, based on the literature available on the topic, thereby ensuring content validity. Face validity of the questionnaire was obtained by consulting with a specialist medical microbiologist and two senior specialist anaesthetists, including one who is an expert in pharmacology.

The questionnaire included demographic information and questions surrounding awareness of SAP guidelines. Following this, the questionnaire covered participants' knowledge of five key principles of appropriate SAP, namely: timing of the first dose of SAP; re-dosing intervals; duration of prophylaxis; antimicrobial spectrum required for specific procedures; and decision making on whether prophylaxis is indicated or not. The structure of these five areas was as follows:

Timing of first dose: One question asking the correct time-frame in relation to skin incision in which the first dose of prophylaxis must be administered. Two further questions asking which antibiotics are exceptions to this rule and within what time frame they should be administered. These questions applied to vancomycin and the fluoroquinolones due their need to be administered as infusions over one to two hours.

Duration of prophylaxis: A single open-ended question on the optimal duration of prophylaxis in most surgical procedures.

Re-dosing interval: A table with six antibiotics in which participants had to state the interval for re-dosing for each, should further dosing be required.

Antimicrobial spectrum: A table with five different procedures listed. Participants had to tick one or more of three boxes corresponding to gram-positive bacteria, gram negative bacteria and anaerobes according to what spectrum of antibacterial coverage they thought was needed for the procedure. The range of procedures included incision though the skin as well as various other body viscera: upper gastro-intestinal, colonic, gynaecological, urological and respiratory tract.

Indication for prophylaxis: Participants had to tick one of two boxes (yes or no) regarding whether they thought prophylaxis was indicated for 16 different procedures.

Scoring of questionnaire

There are no local guidelines at the university-affiliated hospitals in Johannesburg, with the exception of one of the smaller hospitals which has produced an unpublished guideline. In the absence of ubiquitous local guidelines, the memorandum by which the questionnaire was marked was based on a collation of three international guidelines and two South African guidelines (including the one local guideline), namely: The Scottish Intercollegiate Guideline Network (SIGN) – Antibiotic Prophylaxis in Surgery;[2] The South Australia Expert Advisory Group on Antimicrobial Resistance (SAAGAR) – Surgical Antibiotic Prophylaxis Guideline;[16] The American Society of Health-systems Pharmacists (ASHP) – Clinical practice guidelines for antimicrobial prophylaxis in surgery;[5] The Wits Donald Gordon Medical Centre (WDGMC) - Antibiotic Surgical Prophylaxis Guideline; (WDGMC,

2014) and the South African Antibiotic Stewardship Programme (SAASP) - A pocket guide to antibiotic prescribing for adults in South Africa.[17]

Data analysis

Data was analysed using GraphPad InStat version 3.1 and Microsoft Excel® 2010. Continuous variables were described using means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Comparisons were done using t-test for parametric data or Mann-Whitney U-test, Fischer's Exact test and Chi-squared test for non-parametric data. Categorical data were represented as numbers and percentages. Distribution of data was assessed for normality using the Kolmogorov-Smirnov test. A p-value of ≤0.05 was considered statistically significant.

RESULTS

Sample realisation

A total of 160 questionnaires were handed out, of which 139 (86.9%) questionnaires were returned. Four questionnaires were excluded as they were returned blank. Therefore 135 questionnaires were included in the study (n=135), equating to a response rate of 84.4% and a sample size of 66.6% of the department.

Demographics

Table 1 represents the demographics of the participants in the study. Junior anaesthetists were defined as medical officers or registrars in years one to three of training. Senior anaesthetists were defined as consultants and registrars in their fourth year of training.

Table 1 Demographics of participants

Demographics	Number (n)	Percentage (%)
Gender		
Male	44	32,6
Female	91	67,4
Professional designation		
Medical officer	27	20,0
1st year registrar	14	10,4
2nd year registrar	13	9,6
3rd year registrar	17	12,6
4th year registrar	24	17,8
Consultant	40	29,6
Seniority		
Junior anaesthetist	71	52,6
Senior anaesthetist	64	47,4
Experience in anaesthesia		
≥ 5 years	80	59,3
< 5 years	55	40,7

Awareness of SAP guidelines

Of the total participants, 27 (20%) could name an existing SAP guideline. Furthermore only 21 (15.6%) participants followed a guideline in their practice. Broken down into junior and senior anaesthetists, 3 (4.2%) and 18 (28.1%) participants followed a guideline respectively. This difference was statistically significant (p-value 0.0002). The most commonly used guideline was the South African Society of Anaesthetists' (SASA) guideline, stated by 7 (5.2%) participants, followed by the National Institute of Clinical Excellence (NICE) guidelines, stated by 2 (1.5%) participants. A further 12 different guidelines were each stated once.

Knowledge of SAP

Tables 2 and 3 summarise the results of the knowledge of the participants. Table 2 represents the overall score of the participants and the sections in which there were multiple questions. Table 3 represents the results of the sections with a single question in each. P-values are stated for comparison between senior and junior anaesthetists.

Table 2 Knowledge of participants

Knowledge	Score in percentage Mean (SD) or Median (IQR)
Overall score	
All participants	56.2 (8.2)
Senior anaesthetists	59.3 (7.6)
Junior anaesthetists	53.6 (8.0)
p-value	**<0.0001**
Re-dosing interval	
All participants	40 (20 – 60)
Senior anaesthetists	40 (20 - 60)
Junior anaesthetists	20 (20 – 40)
p-value	**0.071**
Spectrum of cover	
All participants	80 (66.7 – 93.3)
Senior anaesthetists	83.3 (71.7 – 88.3)
Junior anaesthetists	80.0 (60.0 – 93.3)
p-value	**0.39**
Indication for prophylaxis	
All participants	65.0 (11.9)
Senior anaesthetists	68.8 (11.0)
Junior anaesthetists	61.9 (11.4)
p-value	**0.0005**

Table 3 Knowledge of participants

Knowledge	Participants answering correctly n (%)
Timing of first dose	
All participants	128 (95.6)
Senior anaesthetists	61 (95.3)
Junior anaesthetists	68 (95.7)
p-value	**1.0**
Timing exception (Vancomycin)	
All participants	23 (17.0)
Senior anaesthetists	14 (21.9)
Junior anaesthetists	9 (12.7)
p-value	**0.17**
Timing exception (Fluroquinolones)	
All participants	0 (0)
Senior anaesthetists	0 (0)
Junior anaesthetists	0 (0)
Duration of prophylaxis	
All participants	49 (36.3)
Senior anaesthetists	32 (50.0)
Junior anaesthetists	17 (23.9)
p-value	**0.0017**

Pertaining to the results on re-dosing interval, the percentage of participants who answered correctly for each individual antibiotic is represented in Figure 1. The p-values for comparison between senior and junior anaesthetists for cefazolin, amoxicillin-clavulanic acid, piperacillin-tazobactam, clindamycin, cefuroxime and cefoxitin are 0.178, 0.289, 0.603, 0.434, 0.087, and 1.000 respectively, none of which are statistically significant.

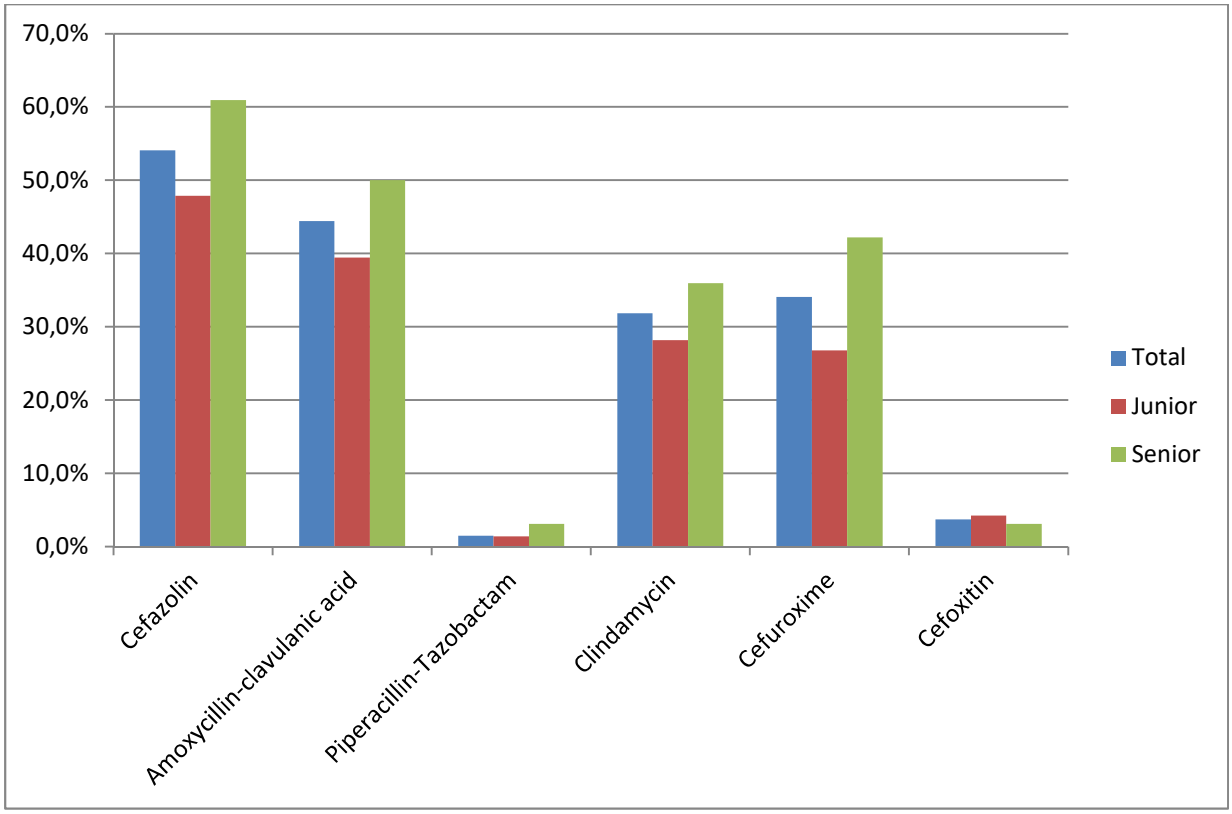

Figure 1 Percentage of participants correct: re-dosing interval for each antibiotic

Breaking down the results of the section of whether prophylaxis is indicated or not, Figure 2 shows the percentage of total participants who correctly answered whether or not prophylaxis was required for each individual procedure

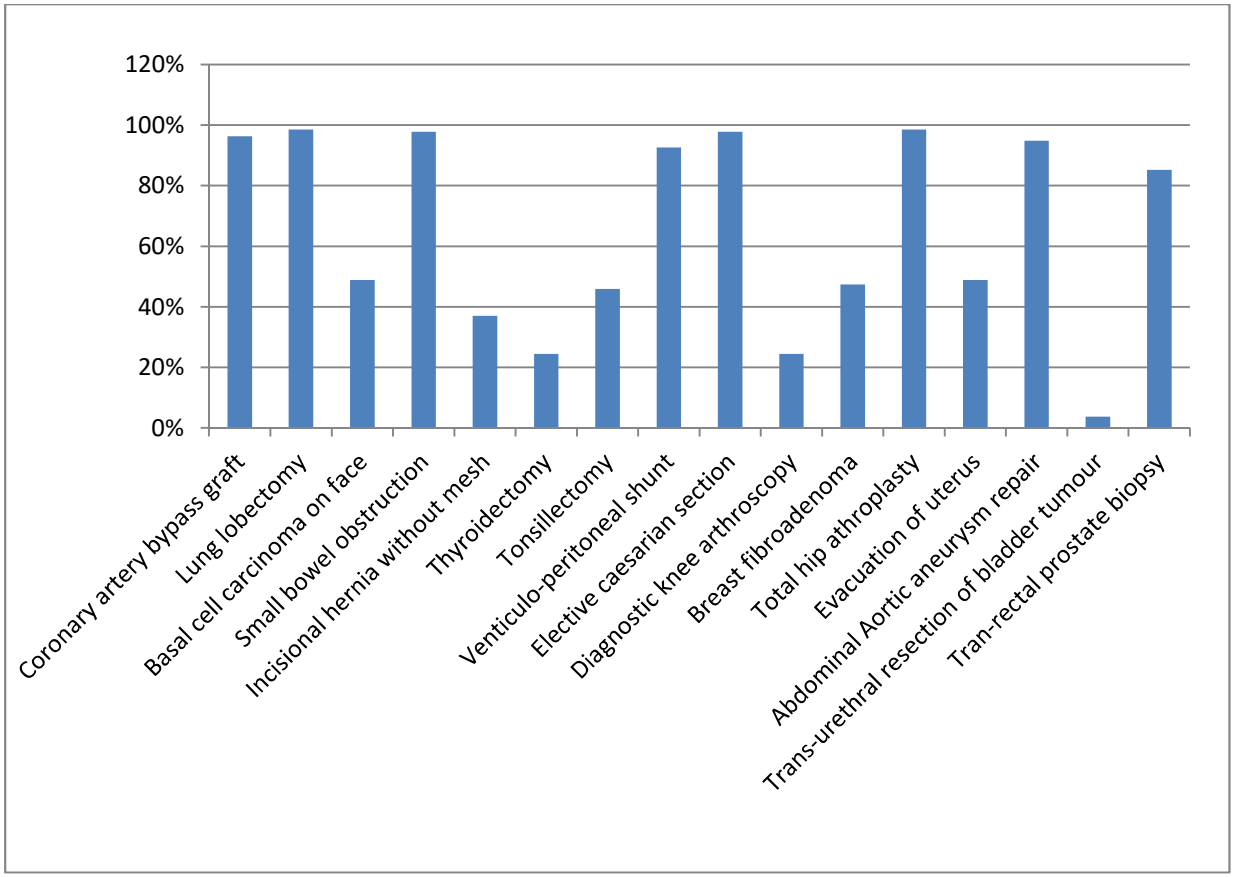

Figure 2 Percentage of participants correctly answering whether prophylaxis is indicated or not for each procedure.

Pertaining to the question regarding the duration of prophylaxis, the correct answer was for the duration of the procedure only. This was supported by the guidelines on which the marking memorandum was based. A subgroup of participants answered the duration of prophylaxis as being beyond the duration of surgery, but less than 24 hours. If this group of participants was considered to be correct, as the ASHP guidelines, but not the other guidelines suggest, then the total number of correct participants is 91 (67.4%) with 52 (81.3%) senior anaesthetists and 39 (54.9%) junior anaesthetists). The difference between senior and junior anaesthetists remains statistically significant with a p-value of 0.0021.

DISCUSSION

The results of the questionnaire indicate that the knowledge amongst anaesthetists at Wits regarding SAP is poor, with the mean score for the questionnaire being 56.2%. To the best of our knowledge, no study examining the knowledge of

anaesthetists regarding SAP has previously been done. However, a number of studies allude to doctors having poor knowledge about antibiotics. Quet et al[18] surveyed doctors about knowledge, attitude and practice regarding antibiotics. They found that 59.8% of participants thought that they had insufficient knowledge, although their knowledge was not directly tested. Algabe-Briggs et al[19] surveyed anaesthetists about how they perceived their own knowledge regarding SAP and found that 75% thought their training in antibiotic selection and administration was inadequate. In 2015, Feuerstein[15] surveyed physicians regarding their knowledge of prophylactic antibiotics in gastro-intestinal endoscopy and found the median mark to be 70%. Thus our results are not unexpected but are of concern, since correct administration of SAP is critical to decreasing SSI and improving the quality of surgical care.

While senior anaesthetists scored only slightly higher than junior anaesthetists (mean mark of 59.3% vs 53.6%), the difference was statistically significant. This indicated that some knowledge of SAP is gained during specialist training. However, we feel that this difference in knowledge (5.6%) would not be enough to translate into a difference in clinical outcome. This is an important point since the senior anaesthetists are role models for the junior anaesthetists and oversee their teaching and training. This result is also not entirely surprising. Lucet et al[20] surveyed the knowledge of doctors relating to antibiotic prescribing in general. They found that knowledge did not differ significantly between senior and junior doctors.

Awareness of available SAP guidelines was particularly poor with very few anaesthetists following any guideline. The NICE guidelines and the SASA guidelines, the two most-commonly followed guidelines, were not included in the marking memorandum of the questionnaire since they are very short documents with insufficient detail. The lack of knowledge of any SAP guideline is somewhat expected due to participants having poor knowledge about SAP. Gagliardi's[14] review concludes that good knowledge is one of the factors that improves adherence to SAP guidelines. Furthermore the lack of widely available local guidelines at the university-affiliated hospitals possibly plays a role in anaesthetists not being informed and knowledgeable about SAP, since the availability of a guideline would be expected to bring the subject to their attention.

The knowledge of the anaesthetists varied considerably across the five principles of SAP that were examined. Knowledge was lacking in certain aspects and to varying degrees.

Re-dosing interval

The median mark for this section was 40% for all participants. Junior anaesthetists scored significantly lower than their senior peers. The two antibiotics for which the highest number of participants correctly knew the re-dosing interval were cefazolin (54.4%) and amoxicillin-clavulanic acid (44.4%). This is possibly explained by the fact that these two antibiotics are amongst the most commonly used antibiotics for SAP at the university-affiliated hospitals. The poorer scores for clindamycin, cefuroxime, cefoxitin and piperacillian-tazobactam may partly be explained by their infrequent use and availability for SAP at these hospitals.

Antimicrobial spectrum of cover (antibiotic selection)

In the absence of widely available local guidelines against which to mark participants' choice of antibiotic, judging the correctness of a specific antibiotic was deemed to be difficult and not fully objective, since some antibiotic choices for a certain procedure may not be considered first line for prophylaxis but also may not be entirely incorrect in their spectrum of coverage. For example, the use of amoxicillin-clavulanic for prophylaxis in hip arthroplasty. As a surrogate, we tested the participants' understanding of the spectrum of antimicrobial cover required.

The median score of all participants was 80%, with no statistically significant difference between junior and senior anaesthetists. In a survey of antibiotic choice at a tertiary academic hospital, Gentile et al[21] showed that 68% of doctors used incorrect criteria in selecting antibiotic choice. In contrast Van Kasteren et al[8] showed that 92% of doctors in Dutch hospitals selected the correct antibiotic. However, in those hospitals, local guidelines were available and endorsed.

Correct indication for prophylaxis

The mean mark for this section was 65.0%. Senior anaesthetists had higher scores than junior anaesthetists which was statistically significant. It must be kept in mind

that due to the yes/no nature of this section, participants had a 50% chance of getting each question correct. Our conclusion is therefore that this result is poor.

The procedures for which the fewest number of participants answered correctly, were, in descending order: trans-urethral resection of bladder tumour, diagnostic knee arthroscopy, thyroidectomy, incisional hernia, tonsillectomy, breast fibroadenoma excision, evacuation of the uterus and basal cell carcinoma of the face excision. In all these procedures, prophylaxis is not indicated. This implies that the participants are over-prescribing antibiotic prophylaxis, with the unnecessary risk of adverse reactions, increased costs and possibly increasing the risk of bacterial resistance. In all eight procedures in which prophylaxis was indicated, the number of participants who scored correctly was in excess of 80%. The greater problem thus appears to be over-prescription of SAP, rather than inappropriate omission of SAP.

The finding of inadequate knowledge regarding whether prophylaxis is indicated or not, is in keeping with the academic literature. In their critical appraisal of the literature in 2007, Tourmousoglou et al[10] noted that 19% of patients inappropriately received SAP when it was not indicated. In data extracted from the CareTrack Australia study, Hooper at al[12] found that 72% of patients who did not need prophylaxis received antibiotics unnecessarily. Furthermore, Rafati et al[22] found that only 22.2% of patients received SAP when it was indicated and 10% of patients received it inappropriately.

Timing of first dose

A total of 95.6% of participants knew that SAP had to be administered within an hour of skin incision, with results between junior and senior anaesthetists not being significantly different. The results of this section reflect good knowledge surrounding this aspect. The prospective study by Tourmousoglu[10] showed that 100% of patients received their dose of prophylaxis on time. In contrast, the audit by Van Kasterens et al[8] showed that the timing of the first dose of prophylaxis was correct in only 50% of cases. A review by El Hassan et al[11] in Abu Dhabi showed that the timing of administration was incorrect in 69.3% of cases. These latter two studies, however, audited practice and it must be noted that there are factors other than knowledge that affect practice.

Only 17% of participants knew that vancomycin was an exception to the guideline of administering SAP within an hour of incision since it is required to be given as an infusion over one to two hours. Of these participants, only 43.5% knew the correct timing. No participants identified the fluoroquinolones as an exception to the rule. One possible explanation for these very poor scores is that these drugs are rarely used and are not freely available in the university-affiliated hospitals.

Duration of prophylaxis

Most guidelines state that prophylaxis should only be continued for the duration of the surgery, with a few exceptions such as cardiac surgery and possibly arthroplasty surgery.[2] Only 36.3% of participants knew this. Significantly fewer junior anaesthetists (23.9%) answered this question correctly compared to senior anaesthetists (50%).

A large portion of the participants felt that prophylaxis should be continued beyond the duration of the surgery and beyond 24 hours. It would appear that unnecessary extra dosing postoperatively is a problem in SAP in the university-affiliated hospitals. This carries the problems relating to unnecessary dosing described earlier. In the review by Hassan et al[11] 59.7% of patients received SAP for longer than 24 hours while in a study by Rafati et al[22] in an Iranian hospital, this number was 40.2%.

Consequences of poor SAP

The incidence of SSI differs significantly across surgical disciplines.[23] A study by De Lissovoy et al[24] calculated the incidence of SSI to be 20% of the total number of a projected 1.7 million HAIs in the USA every year. They estimated a burden of an additional one million hospital-days at a cost of close to $1.6 billion annually as a result of SSI. The authors also note that the treatment of SSI frequently requires antibiotic treatment which may contribute to driving antibiotic resistance. Furthermore, the increased hospital stay puts patients at risk of other complications such as pressure ulcers or further HAIs from the use of urinary catheters and bloodstream catheters.[24] The SIGN quotes a United Kingdom study showing that SSI results in an average of 6.5 extra days of hospital admission. They also note that in certain specialties, SSI results in increased mortality and long-term morbidity.[2]

Limitations

The lack of widely available local guidelines has hindered our ability to construct sections of the questionnaire regarding the participants' choice of specific antibiotics for prophylaxis. As elaborated on earlier, we used spectrum of cover as a surrogate.

Many of the questions in the questionnaire were yes/no answers with a 50% chance of choosing the correct answer, or involved ticking the correct boxes. The results of these questions may possibly be influenced by guessing. There is also a possibility of data contamination since participants were targeted over a period of time.

Our study is contextual and possibly the results may not be extrapolated to other centres in South Africa or overseas where there are established guidelines.

CONCLUSIONS

The Wits anaesthetists showed poor overall knowledge of SAP with unsatisfactory scores regarding indication for prophylaxis, duration of prophylaxis and re-dosing interval. Knowledge of correct timing of prophylaxis was found to be good, while the data on spectrum of bacterial cover appears to indicate acceptable knowledge. While senior anaesthetists achieved higher scores overall than junior anaesthetists, the difference in knowledge appears likely to be insufficient to have a clinical impact on providing good SAP. We recommend that SAP receive greater attention in the training curriculum of registrars. Local anaesthesia journals and continuing medical educations programmes could focus on the topic of SAP as a means of improving all anaesthetists' knowledge. Awareness campaigns should also be considered.

The lack of widely available local guidelines at the university-affiliated hospitals in which the study population works may contribute to the lack of knowledge and poor awareness of guidelines surrounding SAP. We further recommend that a multidisciplinary team of clinical, nursing, administrative and management stakeholders at these hospitals set about compiling guidelines for SAP as a step towards improving the provision of appropriate SAP and decreasing SSI.

Ethics approval: Ethical clearance was obtained from the Human Research Ethics Committee of the University of the Witwatersrand in Johannesburg, South Africa.

Competing interests: None declared.

REFERENCES

1. Burke J. Infection control - a problem for patient safety. *N Engl J Med*. 2003;348(7):651-6.
2. Scottish Intercollegiate Guideline Network. Antibiotic prophylaxis in surgery Edinburgh 2014 [Accessed 20-November-2015]. Available from: http://www.sign.ac.uk.
3. Kirkland K, Briggs J, Trivette S, et al. The Impact of Surgical-Site Infections in the 1990's: Attributable mortality, Excess lenght of hospitalization, and Extra Costs. *Infect Control Hosp Epidemiol*. 1999;20(11):725-30.
4. World Health Organization. WHO surgical safety checklist [Accessed 10-July-2016]. Available from: http://www.who.int/patientsafety/safesurgery/ss_checklist/en/.
5. Bratzler D, Dellinger E, Olsen K, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm*. 2013;70(3):195-283.
6. Gould I. Antibiotic policies to control hospital acquired infection. *J Antimicrob Chemother*. 2008;61(4):763-5.
7. Heineck I, Ferreira M, Schenkel E. Prescribing practice for antibiotic prophylaxis for 3 commonly performed surgeries in a teaching hospital in Brazil. *Am J Infect Control*. 1999;27(3):296-300.
8. Van Kasteren M, Kullberg B, De Beer A, et al. Adherence to local guidelines for surgical antibiotic prophylaxis: a multicentre audit in Dutch hospitals. *J Antimicrob Chemother*. 2003;51(6):1389-96.
9. Choi W, Song J, Hwang J, et al. Appropriateness of antibiotic prophylaxis for major surgery in Korea. *Infect Control Hosp Epidemiol*. 2007;28(8):997-1002.
10. Tourmousoglou C, Yiannakopoulou E, Kalapothaki V, et al. Adherence to guidelines for antibiotic prophylaxis in general surgery: a critical appraisal. *J Antimicrob Chemother*. 2008;61(1):214-8.
11. El Hassan M, Elnour A, Farah F, et al. Clinical pharmacists' review of surgical antimicrobial prophylaxis in a tertiary hospital in Abu Dhabi. *Int J Clin Pharm*. 2015;37(1):18-22.
12. Hooper T, Hibbert P, Hannaford N, et al. Surgical site infection - a population-based study in Australian adults measuring compliance with and correct timing of appropriate antibiotic prophylaxis. *Anaesth Intensive Care*. 2015;43(4):461-8.
13. Hulscher M, Van der Meer J, Grol R. Antibiotic use: how to improve it? *Int J Med Microbiol*. 2010;300(6):351-6.
14. Gagliardi A, Fenech D, Eskicioglu C, et al. Factors influencing antibiotic prophylaxis for surgical site infection prevention in general surgery: a review of the literature. *Can J Surg*. 2009;52(6):481-9.
15. Feuerstein D, Sethi S, Tapper E, et al. Current knowledge of antibiotic prophylaxis guidelines regarding GI open-access Endoscopic procedure is inadequate. *Gastrointest Endosc*. 2015;82(2):268-75.
16. South Australian Expert Advisory Group on Antibiotic Resistance (SAAGAR). Surgical Antibiotic Prophylaxis Guidelines 2013 - 2014 [Accessed 6 November 2015]. Available from: http://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/clinical+resources/clinical+topics/medicines+and+drugs/antimicrobial+guidelines/antimicrobial+guidelines.
17. Wasserman S, Boyles T, Mendelson M. A pocket guide to antibiotic prescribing for adults in South Africa, 2015: Federation of Infectious Diseases Societies of Southern Africa; 2015 [Accessed 30 October 2015]. Available from: http://www.fidssa.co.za/A_SAASP_Home.asp.
18. Quet F, Vlieghe E, Leyer C, et al. Antibiotic prescription behaviours in Lao People's Democratic Republic: a knowledge, attitude and practice survey. *Bull World Health Organ*. 2015;93(4):219-27.

19. Algabe-Briggs O, Obembe B. A survey on selection and administration of perioperative antibiotics by anaesthetists. *West Afr J Med*. 2013;32(1):3-7.
20. Lucet J, Nicolas-Chanoine M, Roy C, et al. Antibiotic use: knowledge and perceptions in two university hospitals. *J Antimicrob Chemother*. 2011;66:936-40.
21. Gentile I, Landolfo D, Buonomo A, et al. A survey on antibiotic therapy knowledge among physicians of a tertiary care and university hospital. *Infez Med*. 2015;23(1):12-7.
22. Rafati M, Shiva A, Ahmadi A, et al. Adherence to American Society of Health-System Pharmacists Surgical Antibiotic Prophylaxis guidelines in a teaching hospital. *J Res Pharm Pract*. 2014;3(2):62-6.
23. Coello R, Charlett A, Wilson J, et al. Adverse impact of surgical site infections in English hospitals. *J Hosp Infect*. 2005;60(2):93-103.
24. de Lissovoy G, Fraeman K, Hutchins V, et al. Surgical site infection: Incidence and impact on hospital utilization and treatment costs. *Am J Infect Control*. 2009;37(5):387-97.

Section 4: Appendices

4.1 Ethics approval

R1449 Dr Jonathan Jocum et al

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160111

NAME: (Principal Investigator)	Dr Jonathan Jocum et al
DEPARTMENT:	Anaesthesiology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Anaesthetists' Knowledge of Antibiotics for Surgical Prophylaxis
DATE CONSIDERED:	20/01/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Juan Scribante
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	22/02/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and ONE COPY returned to the Research Office Secretary in Room 10004, 10th floor, Baragwanath Hospital, Phase 1 Clinical Building, Parktown, University of the Witwatersrand.

I fully understand the conditions under which I am authorized to carry out the above-mentioned research and I undertake to observe compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.**

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

4.2 Postgraduate approval

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 0271717172219
Tel: 0271717172076

Reference: Ms Thokozile Nhlapo
E-mail: thokozile.nhlapo@wits.ac.za

04 February 2016
Person No: 1177100
PAG

Dr J Jocum
102 Herbet Baker Street
Groenkloof
Pretoria
0181
South Africa

Dear Dr Jocum

Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled *Anaesthetists' knowledge of antibiotics for surgical prophylaxis* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Section 5: Annexure

Proposal

5.1 Introduction

Surgical site infection (SSI) is the second most prevalent type of nosocomial infection (1). It results in serious short-term morbidity and often long-term morbidity and mortality (2). The Scottish Intercollegiate Guideline Network (2) quotes a United Kingdom study showing that SSI resulted in an average of 6.5 days longer hospital stay at a cost of £3 246 per patient.

Surgical antibiotic prophylaxis (SAP) is one aspect of broader strategies to decrease the incidence of SSI. The evidence for the benefit of SAP, when used appropriately, includes a decrease in hospital stay, faster return to normal activity and in certain types of surgery a decrease in mortality. SSI therefore remains an important outcome measure for quality of care in surgery (2).

In order for SAP to achieve the desired effect of decreasing SSI, a number of criteria need to be met. These include selecting the correct antibiotic and dose, for the appropriate procedure, administered at the correct time, and continued for the right duration (2, 3). The downside of antibiotic usage is it fuels antibiotic resistance and increases the transmissibility and pathogenicity of multi-resistant bacteria. Mathematical models have, however, indicated that modifying antibiotic prescribing can potentially reduce antibiotic resistance (4). Thus the reason for having guidelines relating to antibiotic prescribing is two-fold. They are necessary to promote rational antibiotic use in order to increase their efficacy at achieving the desired outcome, as well as to attempt to decrease antibiotic resistance (2, 3).

The accumulating evidence of the last few decades has shown that adherence to antibiotic prescribing guidelines is poor all over the world. A study in Brazil (5) in 1999 showed that only 3% of surgical cases complied with the guidelines on antibiotic prophylaxis. At a Canadian academic hospital in 2003, their compliance with SAP guidelines was 5% (6). In the Netherlands, a country with a restrictive antibiotic policy, a multicentre audit showed a total SAP guideline compliance rate of 28% (7). Comparable studies from Greece (1), Abu Dhabi (8), Iran (9) and Australia

(10) have showed similarly poor results. In the South African context, Paruk et al (11) found inappropriate antibiotic use in ICU's to be unacceptably high.

Thus the question of how can one improve guideline adherence comes to the fore. It is a complex question with no simple answer. The last two decades have seen various authors tackle this question. A systematic review by Cabana et al (12) summarised the barriers to guideline implementation in general as including "lack of awareness of guidelines, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, inertia of previous practice and a myriad of external barriers". A review on the factors affecting antibiotic prescribing by Hulscher et al (3) includes patient's knowledge and behaviour as well as medical professionals' knowledge, opinions and behaviour, organisation of health care and the broader cultural and socio-economic context. In the context of adherence to SAP guidelines specifically, further factors including team communication, allocation of responsibility and institutional logistics also come into play (13).

The problem of poor guideline adherence is multi-factorial and complex (3, 12). There are a number of studies that have looked at improving adherence to antibiotic prescribing guidelines (14-21). The conclusion of these studies is that any intervention has to be hospital-specific since the barriers in one setting are not the same as another. Multiple intervention studies have had more success than single intervention studies as have the more intensive interventions.

In describing the structure of an intervention to improve SAP, Gagliardi et al (13) suggests conducting an "environmental assessment". This would be to investigate the knowledge, attitude and beliefs of doctors, team-related communication, institutional support, and concordance of policies with existing guidelines (13). The issue of assessing doctors' knowledge of SAP guidelines is one principle of this assessment and is a key aspect of investigating the factors that hinder SAP guideline compliance.

A few surveys have been conducted around knowledge and opinions of doctors regarding antibiotics (22-25). Lucet et al (22) surveyed doctors about their knowledge and perceptions surrounding antibiotic prescription across a number of specialities. They found great variation in doctors' knowledge. A 2015 study (24) in

Lao People's Republic found that almost 60% of doctors felt they had inadequate knowledge about antibiotics. A survey in the same year in Italy (25) found that 68% of doctor's were using incorrect criteria to prescribe antibiotics. Focusing more specifically on anaesthetists and SAP, a survey by Algabe-Briggs (23) examined anaesthetist's opinions with respect to SAP. They found that 70% anaesthetists felt that their knowledge on the subject was deficient.

5.2 Problem statement

Adherence to antibiotic prescribing guidelines is poor all around the world (5-10). Doctors' knowledge regarding antibiotics is one of several factors affecting adherence to antibiotic guidelines (13). The literature suggests that doctors' knowledge of antibiotics in general is poor (22-25). Anaesthetists are required to have good knowledge of SAP, since they are involved in its selection and administration. The knowledge of anaesthetists regarding SAP at the University of Witwatersrand (Wits) is not known.

5.3 Aim

The aim of this study is to describe the knowledge of anaesthetists working in the Department of Anaesthesiology at Wits, regarding the appropriate administration of SAP.

5.4 Objectives

The primary objectives of this study are to**:**

- describe awareness of anaesthetists of available SAP guidelines
- describe the knowledge of anaesthetists regarding appropriate SAP.

A secondary objective is to compare knowledge of SAP between junior and senior anaesthetists.

5.5 Research assumptions

The following definitions will be used in the study.

Anaesthetist: is any qualified doctor working in the Department of Anaesthesiology including medical officers, registrars and consultants.

Medical officer: is a qualified doctor practising in the Department of Anaesthesiology under specialist supervision. Medical officers with more than 10 years of experience in anaesthesia are career medical officers and are considered consultants.

Registrar: is a qualified doctor who is registered with the Health Professional Council of South Africa as a trainee anaesthetist.

Consultant: is a specialist anaesthetist or career medical officer.

Junior anaesthetist: is a medical officer or registrar in their first three years of training.

Senior anaesthetist: is a registrar in their fourth year of training or a consultant.

Adequate knowledge: is a total questionnaire score of 80% or greater

5.6 Demarcation of study field

The study will be conducted in the Department of Anaesthesiology, affiliated to the Faculty of Health Sciences at Wits. The department consists of 21 medical officers, 112 registrars, 12 career medical officers and 74 specialist anaesthetists.

5.7 Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Postgraduate Committee, Wits.

The study will be a knowledge-based study using an anonymous self-administered questionnaire. Participation will be voluntary and consent is implied by completion of

the questionnaire. No identifying information will be requested of the participants. Only the researcher and supervisors will have access to the raw data. These measures will ensure anonymity and confidentiality.

If knowledge regarding SAP is found to be inadequate, the Head of Department will be notified in order to institute appropriate educational interventions.

Data will be stored securely for six years after completion of study.

The study will be conducted according to the principles of the Declaration of Helsinki (26) and the South African Guidelines for Good Clinical Practice (27).

5.8 Data collection

5.8.1 Research design

A prospective contextual, descriptive research design will be followed in this study.

In a prospective study, the study population is followed over time to observe an outcome (28). In this study, the data will be collected at the time the study takes place.

Contextual refers to a specific group or population (29). This study is contextual as it will be done on a specific group, namely anaesthetists working in the Department of Anaesthesiology at Wits.

A descriptive study is one in which a population's characteristics are described, in order to answer a specific question about the population, without attempting to establish causality (28). The knowledge that anaesthetists have about appropriate SAP will be described.

5.8.2 Study population

The study population consists of all anaesthetists working in the Department of Anaesthesiology.

5.8.3 Study sample

Sample method

In this study a convenience sampling method will be used which is appropriate for a descriptive study (30). Convenience sampling involves the sampling of participants who are readily available to the researcher. The sample will consist of anaesthetists attending the departmental academic meetings.

Sample size

The sample size will be realised by the number of responses gained. A response rate of 60% (131 participants) of the department's anaesthetists will be considered acceptable, but 80% (175 participants) will be targeted.

Inclusion and exclusion criteria

Inclusion criteria are:

- all anaesthetists attending the department's academic meetings
- who are willing to participate
- partially complete questionnaires.

Exclusion criteria are:

- blank questionnaires
- illegible questionnaires
- interns.

5.8.4 Collection of data

Development of questionnaire

Self-report techniques are used when the objective is to determine what a population knows. A good method to collect this data is by means of a questionnaire which is easy for the participants to complete and the researcher to administer and score (28).

Although there have been surveys that have included the testing of knowledge of doctors regarding SAP, none have been found that focused solely on this issue, with most focusing on practice, attitudes, beliefs and opinions.

A questionnaire (Appendix 1) was developed by the researcher, based on the literature available on the topic thereby ensuring content validity. Face validity of the questionnaire was obtained by consulting with a medical microbiologist and two senior specialist anaesthetists, including one who is an expert in pharmacology. In the absence of local guidelines at the Wits-affiliated hospitals, the memorandum by which the questionnaire will be marked (included in Appendix 1) is based on a collation of three international guidelines and two South African guidelines: Scottish Intercollegiate Guideline Network – Antibiotic prophylaxis in surgery (2); South Australia Expert Advisory Group on Antibiotic Resistance – Surgical Antibiotic Prophylaxis Guideline (31); American Society of Health-systems Pharmacists – Clinical practice guidelines for antimicrobial prophylaxis in surgery (32); Wits Donald Gordon Medical Centre Antibiotic Surgical Prophylaxis Guideline (33); and South African Antibiotic Stewardship Programme - A pocket guide to antibiotic prescribing for adults in South Africa (34).

The questionnaire starts by asking the following demographic information: gender, professional designation and years of experience in anaesthesia. The next section asks participants about awareness of SAP guidelines. Following this, the questionnaire covers participants' knowledge of timing and duration of prophylaxis and re-dosing intervals. Thereafter, two tables test participants' knowledge of antimicrobial spectrum required for specific procedures and whether prophylaxis is indicated or not.

Data collection process

Before distribution of the questionnaires, all sheets will be numbered to keep track of questionnaires completed, and to calculate a response rate.

Data will be collected at the Department of Anaesthesiology's academic meetings. The chairperson will be approached for permission to address the meeting. The researcher will explain the aim of the study and invite participation.

Questionnaires will be distributed and anaesthetists can decide whether to participate or not. Those who agree to participate will receive an information letter (Appendix 2) describing the studies aims and objectives along with the questionnaire. The questionnaire will take approximately 20 minutes to complete. The researcher will be present during completion of the questionnaire to assist with queries and to prevent data contamination.

After completion of the questionnaire, the participant will place the questionnaire into a sealed box for collection.

5.8.5 Data analysis

Data will be entered on a Microsoft Excel® spread-sheet and analysed using GraphPad InStat version 3.1. Descriptive and inferential statistics will used. Categorical data will be summarised using frequencies and percentages. Continuous variable will be described using means and standard deviations or medians and interquartile ranges depending on the distribution of the data. Comparisons will be done using t-tests or Mann-Whitney U-tests.

5.9 Significance of the study

SAP is a cornerstone of preventing SSI. Inappropriate SAP results in a decreased efficacy in achieving the prevention of sepsis (35) and also contributes to the increasing burden of antibiotic resistance (4). Guidelines have been developed by many organisations to guide rational use of antibiotic for surgical prophylaxis. Despite this, adherence to guidelines and rational prescribing has been poor all around the world (5-10).

The outcome of this study may result in improved SAP in the Department of Anaesthesiology, Wits. This may contribute to a decrease in SSI, a shorter hospital stay, cost saving and potentially less antibiotic resistance.

5.10 Validity and reliability of study

Validity of a study, according to Botma et al (36) refers to “the degree to which a measurement represents a true value” and reliability is “the consistency of the measure achieved”.

This study will maintain validity and reliability by:

- using a standard questionnaire that has face and content validity
- having the researcher present during the completion of questionnaire to answer any questions and prevent data contamination
- maintaining anonymity, ensuring a non-threatening environment
- checking every tenth data entry point on the spread-sheets for accuracy.

5.11 Potential limitations of the study

This study is contextual in the Department of Anaesthesiology at Wits and therefore may not be generalizable to other departments of anaesthesiology. However, since any intervention to improve SAP needs to be hospital-specific (15), this study will be useful for improving SAP at the hospitals affiliated to the department.

Sample size will be dependent on the attendance at the weekly meetings and willingness to participate in the study. Since convenience sampling will be used, this might not adequately represent the knowledge of the whole department but rather the knowledge of those attending the meeting.

5.12 Project outline

Activity	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	July 2016
Proposal preparation										
Chapter 1, 2, 3										
Proposal Submission										
Ethics Approval										
Postgraduate approval										
Data Collection										
Data analysis										
Chapter 4, 5										
Submission										

5.13 Financial plan

The Department of Anaesthesiology will bear the cost of printing and paper for the proposal, ethics and postgraduate approvals and questionnaires.

Item	**Number**	**Cost**	**Total**
Printing	1200	R1 per page	R1200
Binding	3	R200 per copy	R600
Total			R1800

5.14 References

1. Tourmousoglou C, Yiannakopoulou E, Kalapothaki V, et al. Adherence to guidelines for antibiotic prophylaxis in general surgery: a critical appraisal. *J Antimicrob Chemother*. 2008;61(1):214-8.
2. Scottish Intercollegiate Guideline Network. Antibiotic prophylaxis in surgery Edinburgh 2014 [Accessed 20-November-2015]. Available from: http://www.sign.ac.uk.
3. Hulscher M, Van der Meer J, Grol R. Antibiotic use: how to improve it? *Int J Med Microbiol*. 2010;300(6):351-6.
4. Gould I. Antibiotic policies to control hospital acquired infection. *J Antimicrob Chemother*. 2008;61(4):763-5.
5. Heineck I, Ferreira M, Schenkel E. Prescribing practice for antibiotic prophylaxis for 3 commonly performed surgeries in a teaching hospital in Brazil. *Am J Infect Control*. 1999;27(3):296-300.
6. Wasey N, Baughan J, De Gara C. Prophylaxis in elective colorectal surgery: the cost of ignoring the evidence. *Can J Surg*. 2003;46(4):279-84.
7. Van Kasteren M, Kullberg B, De Beer A, et al. Adherence to local guidelines for surgical antibiotic prophylaxis: a multicentre audit in Dutch hospitals. *J Antimicrob Chemother*. 2003;51(6):1389-96.
8. El Hassan M, Elnour A, Farah F, et al. Clinical pharmacists' review of surgical antimicrobial prophylaxis in a tertiary hospital in Abu Dhabi. *Int J Clin Pharm*. 2015;37(1):18-22.
9. Rafati M, Shiva A, Ahmadi A, et al. Adherence to American Society of Health-System Pharmacists Surgical Antibiotic Prophylaxis guidelines in a teaching hospital. *J Res Pharm Pract*. 2014;3(2):62-6.
10. Hooper T, Hibbert P, Hannaford N, et al. Surgical site infection - a population-based study in Australian adults measuring compliance with and correct timing of appropriate antibiotic prophylaxis. *Anaesth Intensive Care*. 2015;43(4):461-8.
11. Paruk F, Richards G, Scribante J, et al. Antibiotic prescription practices and their relationship to outcome in South African intensive care units: Finding of the Prevalence of Infection in South African Intensive Care Units (PISA) Study. *S Afr Med J*. 2012;102(7):613-6.
12. Cabana M, Rand C, Powe N, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA*. 1999;282(15):1458-65.
13. Gagliardi A, Fenech D, Eskicioglu C, et al. Factors influencing antibiotic prophylaxis for surgical site infection prevention in general surgery: a review of the literature. *Can J Surg*. 2009;52(6):481-9.
14. Regev-Yochay G, Raz M, Dagan R, et al. Reduction in antibiotic use followng a cluster randomized controlled multi-faceted intervention: The Israeli Judicious Antibiotic Prescription Study *Clinical Infectious Diseases*. 2011;53(1):33-41.
15. Kao L, Lew D, Doyle P, et al. A tale of 2 hospitals: A staggered cohort study of targeted interventions to improve compliance with antibiotic prophylaxis guidelines. *Surgery* 2010;148(2):255-62.
16. Fleming A, Browne J, Byrne S. The effect of interventions to reduce potentially inappropriate antibiotic prescribing in long-term care facilities: a systematic review of randomised controlled trials. *Drugs Aging*. 2013;30(6):401-8.
17. Davey P, Brown E, Charani E, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients (Review): *Cochrane Libr*; 2013 [Accessed 4-November-2015]. Available from: http://www.cochranelibrary.com/.
18. Putnam L, Chang C, Rogers N, et al. Adherence to surgical antibiotic prophylaxis remains a challenge despite multifaceted interventions. *Surgery*. 2015;158(2):413-8.
19. So J, Aleem I, Tsang D, et al. Increasing compliance with an antibiotic prophylaxis guideline to prevent paediatric surgical site infection: before and after study. *Ann Surg*. 2015;262(2):403-8.

20. Sutherland T, Beloff J, Lightowler M, et al. Description of a multidisciplinary initiative to improve SCIP measures related to pre-operative antibiotic prophylaxis compliance: a single-center success story. *Patient Saf Surg*. 2014;8(37):1-7.
21. Ozgun H, Ertugrul B, Soyder A, et al. Peri-operative antibiotics prophylaxis: Adherence to guidelines and effects of educational intervention. *Int J Surg*. 2010;8(2):159-63.
22. Lucet J, Nicolas-Chanoine M, Roy C, et al. Antibiotic use: knowledge and perceptions in two university hospitals. *J Antimicrob Chemother*. 2011;66:936-40.
23. Algabe-Briggs O, Obembe B. A survey on selection and administration of perioperative antibiotics by anaesthetists. *West Afr J Med*. 2013;32(1):3-7.
24. Quet F, Vlieghe E, Leyer C, et al. Antibiotic prescription behaviours in Lao People's Democratic Republic: a knowledge, attitude and practice survey. *Bull World Health Organ*. 2015;93(4):219-27.
25. Gentile I, Landolfo D, Buonomo A, et al. A survey on antibiotic therapy knowledge among physicians of a tertiary care and university hospital. *Infez Med*. 2015;23(1):12-7.
26. World Medical Association. WMA Declaration of Helsinki - Ethical principles for medical research involving human subjects. Fortaleza, Brazil: World Medical Association, 2013.
27. Department of Health. Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa. Pretoria, South Africa: 2006.
28. Brink H, van der Walt C, van Rensburg G. Fundamentals of Research Methodology for Healthcare Professionals. Ristic D, editor. Cape Town: Juta & Company Ltd; 2012.
29. De Vos A, Strydom H, Fouche C, et al. Research at Grass Roots. De Vos A, editor. Pretoria: Van Schaik; 1998.
30. Burns N, Grove S. The Practice of Nursing Research. Henderson L, Robertson R, editors. Missouri: Saunders Elsevier; 2009.
31. South Australian Expert Advisory Group on Antibiotic Resistance (SAAGAR). Surgical Antibiotic Prophylaxis Guidelines 2013 - 2014 [Accessed 6 November 2015]. Available from: http://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/clinical+resources/clinical+topics/medicines+and+drugs/antimicrobial+guidelines/antimicrobial+guidelines.
32. Bratzler D, Dellinger E, Olsen K, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm*. 2013;70(3):195-283.
33. WDGMC Infection Control and Pharmacy Comittee. Wits Donald Gordon Medical Centre Antibiotic Surgical Prophylaxis Guideline 2013.
34. Wasserman S, Boyles T, Mendelson M. A pocket guide to antibiotic prescribing for adults in South Africa, 2015: Federation of Infectious Diseases Societies of Southern Africa; 2015 [Accessed 30 October 2015]. Available from: http://www.fidssa.co.za/A_SAASP_Home.asp.
35. Classen D, Evans R, Pestotnik S, et al. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N Engl J Med*. 1992;326(5):281-6.
36. Botma Y, Greeff M, Mulaudzi F, et al. Research in health sciences. South Africa: Pearson Education South Africa; 2010.

Appendix 1: Questionnaire with Memorandum

Demographics:

Please mark the appropriate boxes

1. Gender:

Male	
Female	

2. Professional designation:

Medical Officer	
Registrar 1st year	
Registrar 2nd year	
Registrar 3rd year	
Registrar 4th year	
Consultant / Career Medical Officer	

3. Experience in anaesthesia:

< 5 years	
> 5 years	

Knowledge section:

Please answer the following questions in the spaces provided

4. Are you aware of any guidelines on surgical antibiotic prophylaxis?

……

If yes, which ones?

International: ……...

Local: ……

5. In your practice, do you adhere to any specific guideline on surgical antibiotic prophylaxis?

……

If yes, which one/s?

……

6. What is the optimal time frame, in relation to skin incision, to administer most prophylactic antibiotics?

Within an hour of skin incision**……..……..**

7. Which antibiotic/s is/are the exception to the above general rule?

Vancomycin and fluoroquinolones**…….**

8. When should administration of the antibiotic/s in question 7 begin?

90 -120 minutes before skin incision**……..**

9. As a general rule, how long should prophylaxis be continued for?

The duration of surgery only **……..**

10. How many hours after the initial dose of antibiotic would a 2nd dose of the following antibiotics be administered in prolonged surgery? Please write in boxes provided.

Cefazolin	4
Co-amoxyclav	4
Piperacillin/tazobactam	2
Clindamycin	6
Cefuroxime	4
Cefoxitin	2

11. What spectrum of bacteria should prophylaxis for the following procedures cover? Please mark the appropriate block/s?

Procedure	Gram pos	Gram neg	Anaerobic
Knee replacement	x		
Right Hemi-colectomy	x	x	x
Trans-urethral resection of prostate		x	
Total abdominal hysterectomy	x	x	x
Partial gastrectomy	x	x	
Lung lobectomy	x		

12. For the following procedures please indicate whether antibiotic prophylaxis is indicated or not (Mark the correct box):

Procedure	**Yes**	**No**
Coronary artery bypass graft	X	
Lung lobectomy	X	
Excision basal cell carcinoma of face		X
Small bowel obstruction	X	
Incisional hernia repair without mesh		X
Thyroidectomy for benign multinodular goitre		X
Tonsillectomy (elective)		X
Ventriculo-peritoneal shunt insertion	X	
Elective caesarean section	X	
Diagnostic knee arthroscopy		X
Excision of breast fibroadenoma		X
Total Hip Arthroplasty	X	
Evacuation of uterus for incomplete miscarriage		X
Abdominal aortic aneurysm repair	x	
Trans-urethral resection bladder tumour		X
Trans-rectal prostate biopsy	x	

Thank you for participating in this survey.

Appendix 2: Participant's information sheet

Dear Colleague

My name is Jonathan and I am a registrar in the Wits Department of Anaesthesiology. I would like to invite you to participate in a research study entitled, "Anaesthetists' Knowledge of Antibiotics for Surgical Prophylaxis". This study will be submitted to the Faculty of Health Sciences at Wits in partial fulfilment of my MMed degree.

This study aims to determine the knowledge of anaesthetists in Wits Department of Anaesthesiology regarding surgical antibiotic prophylaxis. Anaesthetists are intimately involved in administering antibiotics for surgical prophylaxis in an attempt to decrease surgical site sepsis. It is not known whether the knowledge of anaesthetist's in the department is adequate. A self-administered questionnaire will be the means of determining this.

Participation is voluntary and consent will be implied on completion of the questionnaire. All information will be anonymous as no personal information is required to complete the questionnaire. No penalty will be incurred for not participating in the study.

All questionnaires, whether completed or not, should be placed into the sealed collection box supplied. Numbering of questionnaires is simply for practical purposes when data capturing occurs. No numbers will identify the participants involved. Questionnaire contents will only be viewed by my supervisors and I.

The questionnaire should not take longer than 20 minutes to complete and participants are encouraged not to share the information provided on the questionnaires as this will give an inaccurate representation of the knowledge in the department.

No incentives will be provided for the completion of the questionnaire. Identifying the current knowledge regarding surgical antibiotic prophylaxis will assist in our continued professional development and aim to provide better quality of care to our patients. The results and appropriate recommendations will be communicated to the Head of Department of the Department of Anaesthesiology at Wits.

Your time is greatly appreciated. Any questions regarding this study can be directed to the following people:

- Chairperson of the HREC: (011) 717-1234
- Jonathan Jocum (researcher): 084 764 1212

Sincerely,

Jonathan Jocum