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ORIGINAL PAPER

Improvisation versus guideline concordance in surgical antibiotic prophylaxis: a qualitative study

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Abstract

Purpose Surgical antibiotic prophylaxis (SAP) is a common area of antimicrobial misuse. The aim of this study was to explore the social dynamics that influence the use of SAP.

Methods 20 surgeons and anaesthetists from a tertiary referral hospital in Australia participated in semi-structured interviews focusing on experiences and perspectives on SAP prescribing. Interview data were analysed using the framework approach.

Results Systematic analysis of the participants' account of the social factors influencing SAP revealed four themes. First, antibiotic prophylaxis is treated as a low priority with the competing demands of the operating theatre environment. Second, whilst guidelines have increased in prominence in recent years, there exists a lack of confidence in their ability to protect the surgeon from responsibility for infectious complications (thus driving SAP over-prescribing). Third, non-concordance prolonged duration of SAP is perceived to be driven by benevolence for the individual patient. Finally, improvisation with novel SAP strategies is reported as ubiquitous, and acknowledged to confer a sense of reassurance to the surgeon despite potential non-concordance with guidelines or clinical efficacy.

Conclusions Surgical-specific concerns have thus far not been meaningfully integrated into antimicrobial stewardship (AMS) programmes, including important dynamics of confidence, trust and mitigating fear of adverse infective events. Surgeons require specific forms of AMS support to enact optimisation, including support for strong collaborative ownership of the surgical risk of infection, and intra-specialty (within surgical specialties) and inter-specialty (between surgery, anaesthetics and infectious diseases) intervention strategies to establish endorsement of and address barriers to guideline implementation.

Keywords Antimicrobial stewardship · Surgical antibiotic prophylaxis · Clinician behaviour · Qualitative research

Background

SAP in the context of global resistance

Surgical antibiotic prophylaxis (SAP) is an extremely high-volume area of hospital antimicrobial use, accounting for 15.5% of all hospital antimicrobial prescriptions in Australia, and significant antimicrobial use internationally [1–3]. In the context of a global environment of escalating antimicrobial resistance, SAP is therefore a critical area in which to optimise antibiotic use, to reduce the pressure for antimicrobial resistance (AMR) development, and therefore to preserve antimicrobial options for the future, and to reduce toxicities and risk of *Clostridium difficile* that is associated with inappropriate antimicrobial use [4, 5]. Long-term optimisation of antimicrobial use, of which SAP appropriateness is an important part, will be a crucial strategic to avoid the impending antimicrobial crisis.

Surgical antibiotic prophylaxis: an evidence-based intervention

The evidence for the administration of SAP is well established and is therefore a critical area for optimising quality

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of care in hospitals to reduce hospital acquired infection rates and improve morbidity and mortality associated with operative interventions [6–9]. Interventions to improve compliance with SAP guidelines have been published, with the successful use of collaborative change processes that include audit and feedback [10, 11]. However, there is little known about the effect of such interventions over prolonged time periods, and limited information about the factors that cause such significant overprescribing in this area.

Non-concordance with therapeutic guidelines in SAP

Guidelines are used to streamline the application of a shared body of theoretical knowledge to individual patient clinical scenarios. However, when guidelines are applied to clinical practice, the anticipated uniformity of practice often does not occur. Within SAP, suboptimal practice despite established clinical guidelines occurs both in Australia and internationally [1, 12]. SAP is often inappropriately prolonged [13], re-dosing intra-operatively in prolonged operations is commonly forgotten [14] and prophylaxis is frequently given for operations in which it is not indicated [15]. Non-compliance in this area of antibiotic use and its importance for the antimicrobial optimisation agenda are recognised in international strategies for AMR management, including the EU Guidelines for the Prudent Use of Antimicrobials in Human Health, which lists "audit of perioperative antimicrobial prophylaxis indication, choice, timing and duration" as an essential component of hospital-based AMS programmes [16].

Understanding non-concordance: the social influences on antibiotic prescribing, and SAP

There is a growing body of research exploring the social and behavioural influences on antibiotic prescribing decisions more broadly [17–20]. The design and implementation of behavioural interventions to optimise prescribing is a strategy in international AMR action plans. A previous qualitative study of anaesthetists, surgeons and nurses, described disagreement about basic aspects of SAP such as the value of prolonged prophylaxis, antibiotic choice, and the definition of SAP [21]. Country-level analysis associates cultural characteristics such as uncertainty avoidance with the use of prolonged SAP [22]. Yet, little detail is known about what underpins enduring practices in SAP (e.g. clinician emotions, institutional cultures, professional norms, and site idiosyncrasies, etc.). In this study, we aimed to explore through semi-structured interviews the experiences and perceptions of surgeons and anaesthetists around SAP prescription and administration, to provide insight into social factors which may be barriers to implementation of evidence-based practice in this area of antibiotic use.

Methods

This study was conducted at a teaching hospital in New South Wales, Australia, in 2017. Ethical approval was granted by South Eastern Sydney Local Health District Human Research Ethics Committee HREC/15/POWH/246.

Data collection

A convenience sampling strategy was used to choose the hospital setting and potential participants. Convenience sampling is a recognised sampling technique whereby participants are recruited and selected based on their proximity and accessibility to the researchers (in this case in a nearby collaborating hospital). A formal invitation letter and participant information and consent form (via email) was sent to 71 doctors which included all of the surgical doctors within the participating hospital. Participating doctors voluntarily responded to the invitation, and completed an individual face-to-face interview semi-structured interview. Of these, 20 doctors (17 surgeons and 3 anaesthetists) volunteered to participate in semi-structured qualitative interviews, during 2016 and 2017. Of the 17 surgeons, 10 were senior and 7 were junior. The 3 anaesthetists included 2 senior and 1 junior participant. 14 participants were male, and 6 were female. The interviews were based on a preformulated guide, initially informed by existing literature, and continually adapted to incorporate emerging issues raised by participants [23]. Interviews were focused on the following domains: experiences of antibiotic use and AMR more broadly; experiences and perspectives on the use of surgical antibiotic prophylaxis; experiences of interprofessional work within the operating theatre; and perspectives on antimicrobial stewardship and the place of AMS within surgery.

Data analysis

The thematic analysis of the data was driven by a framework approach [24], which included the following steps: (1) familiarisation—in which the researchers reviewed the interview transcripts; (2) identification of framework—key themes and issues identified around which the data were organised; (3) indexing—application of themes to text; (4) charting—use of headings and sub-headings to build up a picture of the data as a whole; and (5) mapping and interpretation—in which associations were clarified and explanations worked towards. Initially, two members of the research team (authors A and C) independently coded the data. These were then cross-checked by authors A, B and

C to facilitate the development of themes, moving towards an overall interpretation of the data. Analytic rigour was enhanced by searching for negative, atypical and conflicting or contradicting cases in coding and theme development [25–27]. Inter-rater reliability was ensured by integrating a number of research team members in the final analysis [24, 27]. All audio recordings, transcripts, coding reports and notes were retained and added to documentation of research aims, design and sampling and recruitment processes and practices to form an audit trail. The COREQ qualitative research reporting checklist was used to ensure comprehensive reporting [28].

Results

Participants

Twenty doctors (17 surgeons and 3 anaesthetists) volunteered to participate during 2016 and 2017. Interviews lasted between 20 and 60 min, and participant recruitment continued until research team members agreed that data saturation was reached. Of the 17 surgeons, 10 were senior and 7 were junior. The 3 anaesthetists included 2 senior and 1 junior participant. Fourteen participants were male, and 6 were female. The surgical specialties represented included; general surgery, neurosurgery, orthopaedic surgery, colorectal surgery, urology, transplant surgery, cardiothoracic surgery, vascular surgery and renal surgery.

Antimicrobial prophylaxis as a low priority in the operating theatre

Multiple participants reflected on the complexity of processes occurring in theatre, particularly in emergency situations or in prolonged operations, which resulted in antimicrobial prophylaxis being perceived as a low priority. Indicative quotations are shown in Table 1. The inconsistency of re-dosing of antibiotics in prolonged operations was discussed by a number of participants. The timing of re-dosing was described as reliant on the memory of the anaesthetist and the surgeon (when and if they remembered, relative to other pressures and priorities). The likelihood of re-dosing occurring was influenced by a number of issues including the emergency of the operation, the clinical concern for infection of the surgeon for that specific operation, and the complexity of the operation. An interesting contrast reported by two participants was the situation of high risk, complex organ transplant operations where participants described that procedures were highly protocolised and therefore guideline-based SAP was strictly followed.

Guideline relevance and lack of confidence in their ability to protect against adverse consequences

There were diverse opinions among participants around the application and relevance of therapeutic guidelines in SAP prescribing (see Table 2 for indicative quotations). Participants perceived that there was an increased awareness of guideline-based SAP in recent years and indeed a number of participants described an increasing trend towards compliance with SAP guidelines, but some described mistrust in the evidence around guidelines. One participant described mistrust in the ability of the guidelines to protect the surgeon from fault if an infectious complication occurred. However, this participant reflected that if AMS advice had been sought, they perceived there was an additional layer of protection against litigation to the surgeon. Multiple participants discussed the use of prophylaxis for operations in which SAP is not indicated by guidelines, or the addition of antibiotics over and above usual guideline recommendations. This was described by several participants as driven by fear of infectious complications. Junior doctors were reported as more likely to request inappropriate prophylaxis.

Table 1 Antibiotic prophylaxis is a low priority in the operating theatre: indicative quotations

Participant	Indicative quote
D9 consultant surgeon	Four hours < laughter>. Often, and we try to re-dose at 4 h as well, if we remember. Often we don't, but if we remember we'll say, "Yep, it's been 3 or 4 h. Give them another shot of antibiotics"
D10 consultant anaesthetist	If there's a really long case that goes on for 12 or 14 h, you're just sitting there going dum-de-dum-de-dum and if you don't set your clock or have something in your head to say, "I've got to re-dose", you will forget
D1 consultant surgeon	Now, depending on how long the case goes for we might give another dose of antibiotics during the case. So I tend to do that more in spinal surgery because we tend to have big cuts, with a large exposed wound, so after 4 or 5 h we tend to ask for another dose of antibiotics. With a cranial case I probably don't get as fastidious in some ways, mainly because most of my operations don't take that long, but even if they do I'm probably concentrating a lot more so I don't remember to mention it
D13 consultant surgeon	Because they're [transplant patients] going to be immunocompromised because of the drugs you give them, they're sick to start with. So all the medicines to give, antibiotics, et cetera, is all planned in advance

Table 2 Contesting guideline credibility: indicative quotations

Participant	Indicative quote
D2 junior surgeon	There are occasions I think where, for some other reason, particularly with empirical prescribing where a gut feeling or anecdotal evidence or just probably a previous experience with certain antibiotics will dictate the prescribing practice over the guideline, but I think since the stewardship and the prophylactic guidelines that have been rolled out over the last couple of years, I think there has been more of an awareness that it is the best thing to do, at least most of the time
D7 junior surgeon	I think if you followed the guidelines and the patient had an adverse outcome and you didn't consult an expert, then you've got a problem, I suspect. Whereas, if you'd followed the guidelines, thought something's not right, got a specialist consult and they said, "That sounds fine", at least you've done what you can. You've spoken to the people who are experts in this and they've said it sounds all right
D8 consultant anaesthetist	I can't remember the last time a surgeon said, "I'm not listening to the guidelines. I'm just giving what I give". It just doesn't happen anymore. It used to, but it doesn't anymore
D4 consultant surgeon	The majority of people would have prophylactic antibiotics. Some people, like if it's a simple skin lesion excision, may not have prophylactic antibiotics. We usually do give prophylactic antibiotics even for diagnostic laparoscopies, although I think there's some evidence that that's not probably necessary
D9 consultant surgeon	So it's not in the guideline, but we'll give it... out of fear
D7 junior surgeon	You've gone and looked up your therapeutic guidelines or you've spoken to your senior surgeon or your fellow and said, "Look, this is the case. Normally we'd do this. Do you think that's all right? Should we add something?" Occasionally we often add something else to the usual regimen, which may not make sense. It makes sense at the time
D10 consultant anaesthetist	So they may not often always follow—and that's useful having the guidelines on the wall where we would say, "Well, the guideline says we don't have to give them", and the surgical registrar often will want to give them... I think junior surgical registrars are far more likely to say, "Give it out for everything", and maybe even junior surgeons
D10	I know from my experience with registrars, especially surgical registrars, they're far more likely to say, "Let's give an antibiotic", than not

Benevolence and non-concordant prolonged prophylaxis

Prolonged antibiotic prophylaxis, beyond antibiotic guideline duration recommendations, was discussed by multiple participants. As shown in Table 3, the influences resulting in prolonged prophylaxis were reflected upon by participants, and included; providing an extra perceived layer of safety for the surgeon (safety from both litigation and also from personal responsibility for a complication), conferring a sense of having done everything possible for the patient to prevent an infectious complication, and conforming to perceived peer practice (including the significant influence from specialist training years) for a particular operation. Participants discussing these factors all reflected on the recognised discord between evidence and these practices.

Table 3 Benevolence and non-concordant prolonged prophylaxis: indicative quotations

Participant	Indicative quote
D11 junior anaesthetist	And I have no doubt, and I can see exactly why they do it. I'm not saying I wouldn't do anything differently, but if you've got a patient that [says] "I really don't want an infection. Let's just continue the antibiotics for another 48 h", there's no basis for it. It's just that it makes you feel like you're doing everything you can to prevent it
D14 consultant surgeon	So they're the patients that I rarely might—They're 2 days of IV antibiotics as a prophylaxis and then I might say, "Pal, I'm really worried about you. I'm going to send you home on some oral Keflex for the next 2 weeks". Now, is there any science behind that? Absolutely zero. None. I mean, I accept that there is no science behind the maybe once or twice a year decision to send someone home on a couple of weeks of antibiotics just for the hell of it
D20 consultant surgeon	… I tend to run them with antibiotics longer, just oral. Again, most of that is not based on evidence. It's based on what everybody else around the world does. So being the one that stands out and goes, "Well I'm not going to continue the oral antibiotics for 5 days"
D1	There's also a very common day-to-day example which is covering the antibiotics for 24 h after the case, which I think almost every surgeon I know will do. But if you ask us to show the evidence we know there isn't great evidence and I think there is a few things in medicine we do because it makes us feel better rather than producing a tangible benefit

An organisational culture of improvisation as the norm

Multiple participants from different surgical specialties reported improvised antibiotic prophylaxis strategies such as irrigation of wounds with antibiotic solutions (such as gentamicin) and soaking grafts or prostheses in antibiotic solutions prior to implantation. Indicative quotations are shown in Table 4. Participants reflected on the lack of evidence for such procedures, but perceived that there was limited harm from such techniques and reported increased surgical "comfort" with a procedure through using such idiosyncratic techniques.

Discussion

The persistent mis-use of SAP necessitates an in-depth understanding of what drives enduring suboptimal practices in Australia and beyond, and indeed, what limits change through AMS. In this study, we sought to provide novel insight into some of the perceived factors which mediate current practices, in the Australia surgical context. The insights emergent in this study should be viewed in relation to broader work revealing the disjunctions between attempts at regulation to support evidence-based practice, and the potential conflict of regulatory practices with traditional medical values [17]. There has been increasingly sophisticated and widespread dissemination of clinical guidelines around SAP at a national level (both in Australia and internationally), and regulatory frameworks are placing considerable emphasis on improving practices across the health sector. However, this study demonstrates that where there is a low priority/attention on the antibiotic decision, high prioritisation of a position of benevolence and risk reduction, and high regard for the preservation of clinical autonomy (including a right to improvisation), the influence of clinical guidelines and regulatory practices may be significantly limited.

There are two concurrent dynamics evident here. The presence of *norms* and the importance of *improvisation*—both of which may work against guideline concordance. Norms may not be guideline-defined norms, but may represent unwritten rules of practice determined by social, professional and institutionally specific influences. Norms may also represent what is considered a priority in a given situation—for example, as described in this data, it may be the norm for SAP decision-making to be a peripheral issue for the surgical team. Improvisation, and the appropriateness of utilising improvisation in any given situation, is key to high-quality clinical practice, but identifying when improvisation is both appropriate and safe is critical.

The perception of antibiotics and antibiotic decision-making being a peripheral issue is not isolated to SAP—previous work by the authors has demonstrated that antibiotic decision-making is sidelined both in ward rounds and in discussions with consultants, with prioritisation of other clinical issues that are considered more important [17]. The acute nature of the operating theatre environment, particularly in emergent situations, is described in this study to reduce attention on antibiotic re-dosing intra-operatively. Antibiotic decision-making in theatre involves communication between different team members—primarily the surgeon and anaesthetist. Non-technical skills (NTS) such as communication have previously been found to be suboptimal in the majority of operating theatre adverse events, and also are demonstrated to be reduced in crisis situations [29, 30]. The results of this study indicate SAP decision-making as an inherently peripheral issue, and secondly, the sidelining

Table 4 An organisational culture of improvisation as the norm: indicative quotations

Participant	Indicative quote
D1 consultant surgeon	We occasionally will use topical antibiotics in the irrigation, gentamicin or vancomycin. We don't put gentamicin or vancomycin into the brain, but it tends to be in the lumbar spine. The evidence isn't great and I often feel that it makes me feel better and it actually makes a difference. I think when we use shunts I tend to soak it in an antibiotic solution before we put it in
D3 consultant surgeon	No, just physiological saline or Hartmann's solution, whatever the nurse—It's got gentamicin in it. They put the gentamicin in as a wash… [gap in interview]… A little bit of gentamicin in the wash doesn't affect anything, but the washing-out probably does and, to me, it appears to be—In my personal experience is it's good, but it's harmless and very cheap. I mean, it's only an extra 2 or 3 l of saline
D6 junior surgeon	Yeah, there's probably two surgeons that I know that get gentamicin in their wash. So I'm washing wounds out and they always want me to put gentamicin in it. It's a sub-therapeutic dose of just—I don't know what it does, but they just want it in there. It makes them feel better, I think
D14 consultant surgeon	So in theatres, both public and private, we normally put antibiotics into the irrigation… Traditionally it was always gentamicin… [gap in interview]… I actually do recall some years back, is there an RCT that has said irrigation versus irrigation plus genta, there isn't one… So what do I use now as prophylaxis with the irrigation? I just tell them to put in some Keflin, so the same stuff that's going into their drip… If it can go in there, why can't I put it in there? Again, evidence zero, surgical comfort 100%

of SAP decision-making in operative emergencies. Errors in communication around SAP and SAP prescribing are likely to increase under such circumstances.

Unwritten rules or norms of practice, including accepted (non-guideline based) prolonged SAP duration for particular operations/specialties are described in this study. The phenomenon of unwritten 'rules' guiding medical decision-making has previously been described in operating theatre settings where doctors have been demonstrated to disregard clinical guidelines in deference to rules determined by social groups and influences within their professional streams [31]. Similarly, in the context of SAP, this data supports the existence of a 'back stage' of social norms, which shape action, and which need to be acknowledged with AMS processes. Consideration of the origin, and perpetuating factors underlying such rules, will be critical in the design and implementation of sustainable strategies to optimise SAP prescribing. The ability to challenge norms must first rely on identifying that they exist, and then realising that they result in behaviour that does not conform to evidence-based practice. In this study more junior doctors were reported by participants to more commonly request inappropriate SAP than senior doctors. Education and confidence around appropriate antimicrobial prescribing is reported as variable between medical schools in a multicentre study in the United States [32]. This study would suggest that education to optimise antimicrobial use should not only incorporate appropriate prescribing choices, but the influences of hierarchy and social norms on prescribing decisions.

This data demonstrates clearly through the frequent description of unconventional SAP techniques (such as gentamicin washes), the significance and impact of improvisation in SAP decision-making. Improvisation is well recognised in healthcare (and in other industries) [33], occurring as a result of a desire to circumvent a perceived workflow block, and different professional streams may be more or less tolerant of improvisation by others within their stream. Doctors, for example, have been shown to be more tolerant of improvisation than nurses [25]. In daily clinical practice, doctors are required to judge when a patient fits within parameters that indicate a guideline-based standard of care, and to decide when the patient is significantly outside a guideline to require individualised or improvised care. It is clear from the case of SAP, and specifically detailed in the accounts in this study which document frequent occurrence of non-evidence-based strategies, that improvisations are utilised in situations where usual guideline-based practice would be expected to be safe and achieve good clinical outcomes. In addition, this data suggests that individual doctors' decision-making and improvisation may result in care that is both non-compliant with evidence-based practice and has the potential to put the patient at risk (prolonged antibiotics, unconventional use of potentially toxic antibiotics such as gentamicin). It was evident in the accounts presented here that the improvisation behaviours described within SAP prescribing are driven by concern around adverse patient outcomes, a sense of benevolence towards the patient (held by the surgeon), and an internalised sense of what is perceived conventional practice for a particular operation. The issue raised from this data is the apparent limitation in doctors' ability to identify when improvisation and individualisation of patient care is appropriate, and when it detracts from the quality of care they provide.

Conclusion

These results indicate the following challenges for AMS teams seeking to optimise SAP. Firstly, the importance of the SAP decision must be made more significant to critical team players in the operating theatre—that is, the surgical and anaesthetic teams. Second, identification of the existence of unwritten guidelines which significantly influence SAP choice and duration is required, and the design of interventions that address the discord between evidence-based practice and these (unwritten) norms. This will necessarily require collaborative, inter-specialty (infectious diseases, anaesthetics, surgery) based consensus building around SAP guidelines. Where group agreement (within a specialty) is present, there may be a shift in the perception of the unwritten rules within an institutional setting. In addition, consideration of the influence of professional autonomy as a barrier to guideline-based care is an important issue in streamlining practice. Consideration of these significant perceived barriers to guideline-based SAP would seem important in designing sustainable AMS interventions in this area.

This study has various limitations. First, the focus of the study was on participants' attitudes and perspectives on SAP, thus the results cannot show actual behaviours around SAP practice. Second, although appropriate for a qualitative study, and albeit inclusive of a diverse range of surgical specialties, it only captures the experiences of participants from one hospital setting. Hence, these findings cannot be transferred to other experiences in other settings, despite providing important themes and theoretical insights likely to have resonance with many other settings. Third, participants were self-selected and thus the sample might only reflect particular views about SAP. Future research in different hospital settings and the perspectives of operating theatre nurses and antimicrobial stewardship team members would be valuable. Social influences on prescribing may be significantly different in different cultural environments and with differing resource levels. Qualitative research on surgical antibiotic prophylaxis prescribing influences in different countries would be extremely informative.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

Ethical standards This study was approved by South Eastern Sydney Local Health District Human Research Ethics Committee (HREC/15/POWH/246). All persons gave their informed consent prior to their inclusion in the study. Details that might disclose the identity of the subjects under study have been omitted.

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