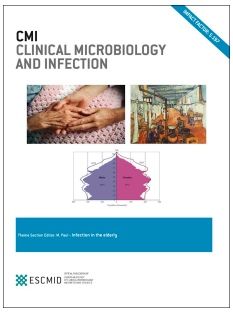
Accepted Manuscript



Understanding antibiotic decision making in surgery – a qualitative analysis

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PII: S1198-743X(17)30182-9

DOI: 10.1016/j.cmi.2017.03.013

Reference: CMI 897

To appear in: *Clinical Microbiology and Infection*

Received Date: 15 February 2017

Revised Date: 12 March 2017

Accepted Date: 16 March 2017

Please cite this article as: Charani E, Tarrant C, Moorthy K, Sevdalis N, Brennan L, Holmes AH, Understanding antibiotic decision making in surgery – a qualitative analysis, *Clinical Microbiology and Infection* (2017), doi: 10.1016/j.cmi.2017.03.013.

Title: Understanding antibiotic decision making in surgery – a qualitative analysis

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Abstract

Objective To investigate the characteristics and culture of antibiotic decision making in the surgical specialty.

Methods A qualitative study including ethnographic observation and face to face interviews with participants from six surgical teams at a teaching hospital in London was conducted. Over a three month period: 1) thirty ward rounds (WRs) (100 hours) were observed, 2) face-to-face follow up interviews took place with thirteen key informants, 3) multidisciplinary meetings on the management of surgical patients and daily practice on wards were observed. Applying these methods provided rich data for characterising the antibiotic decision making in surgery and enabled cross-validation and triangulation of the findings. Data from the interview transcripts and the observational notes were coded and analysed iteratively until saturation was reached.

Results The surgical team is in a state of constant flux with individuals having to adjust to the context in which they work. The demands placed on the team to be in the operating room, and to address the surgical needs of the patient means that the responsibility for antibiotic decision making is uncoordinated and diffuse. Antibiotic decision making is considered by surgeons as a secondary task, commonly delegated to junior members of their team and occurs in the context of disjointed communication.

Conclusion There is lack of clarity around medical decision making for treating infections in surgical patients. The result is sub-optimal and uncoordinated antimicrobial management. Developing the role of a perioperative clinician may help improve patient level outcomes and optimise decision making.

Introduction

A major proportion of the antibiotics prescribed within hospitals is for surgical patients [1–3]. Inappropriate antibiotic prescribing in surgery is widely reported, with patients at risk of receiving prolonged durations of antibiotics for prophylactic and therapeutic indications [2,3]. In addition, post-operative infections remain one of the most common and costly hospital acquired infections, and are associated with significant morbidity and mortality [4–8]. Despite numerous interventions, antibiotic prescribing in hospitals remains suboptimal[9]. Studies on antibiotic prescribing in surgical teams tend to focus primarily on improving surgical prophylaxis in the operating room (OR) and reducing surgical site infections (SSI) [9–12]. Unlike primary care, where clinical intervention largely occurs within 1:1 patient-physician consultations, in secondary care most of the clinical interventions for a patient are performed by several teams of healthcare professionals. This 'shared decision making' within and across teams can lead to gaps in practice and expose areas of weakness in communication [13]. Surgical checklists such as the World Health Organization's Surgical Safety Checklist, have been introduced to make sure key elements of care, including prescribing antibiotic prophylaxis, are not missed [14]. However, recent studies on the implementation of the WHO checklist have demonstrated suboptimal use of this simple intervention [14–16]. Though interventions have been developed to improve effectiveness of surgical teams and their use of quality and safety improvement tools [14,17,18], there remains a gap in research. The published studies often neglect the contextual and cultural factors that underpin behaviours in general and antibiotic prescribing behaviours in particular [19,20]. Implementing interventions that attempt to change the behaviours of healthcare professionals with no knowledge of the factors that actually influence practice, including its context, is ineffective[21].

The surgical ward round (WR) is a key component of the care of the surgical inpatient. Critical decisions regarding the clinical management of the patient, e.g. treatment of infections, are made on the WR and it provides a regular opportunity for the team responsible for the care of the patient to come together to discuss the patient [22,23]. One recent qualitative study performed in surgical WRs investigated the key challenges, including the variability in WR practice, faced by patients and healthcare professionals [24]. The evidence suggests there are

problems in surgical WRs and recommendations have been made to improve them – including WR standardization[24]. To date, antibiotic decision making on the WR has not been investigated – this is what this study sets out to address.

We report here on an ethnographic study of the surgical WR. Ethnography was selected as it describes culture and context [25]. Understanding and addressing culture will help develop theories which inform interventions that are tailored to the context in which they are expected to be implemented. The aim of the study was to investigate the impact of culture and team dynamics of the surgical WR on antibiotic decision making.

Methods

The setting

This study was conducted at Imperial College Healthcare National Health Service hospitals. The hospitals operate across a 1300 bed multisite healthcare organisation. The same organisational structure and antibiotic stewardship programme, including specialist pharmacists, bespoke guidelines and microbiology services are implemented across all the hospitals[26].

Inclusion and exclusion criteria

Using purposive sampling methods, surgical teams were selected for inclusion in the study. All healthcare professionals who attended the WRs were eligible to participate in the study. Full ethical approval was obtained from the North Yorkshire and the Humber Research Ethics Committee prior to data collection. Full informed consent was obtained from all study participants prior to inclusion in the study.

Ethnographic observation and semi-structured interview methodology

An ethnographic study design was applied which included non-participant observations, interviews and documentary analysis. One researcher with background in pharmacy and training in ethnography (EC) conducted all the fieldwork, including non-participant observations on the wards, and face-to-face interviews with key informants. Field notes were typed by the researcher on the day of the observation to enable a rich and accurate

documentation of the data. Interviews were conducted with a purposive sample of key informants who participated in the decision making on the ward. The interviews were semi-structured with an interview guide, developed through review of literature and built upon previous work of the research team [19]. Open ended questions were used as prompts to explore the participants' views, perceptions and experiences of antibiotic decision making in surgery and the behavioural determinants that motivated the participants as individuals and as members of a team. The interviews were performed after the observations were completed and the interview guide was modified to include any key points from the observations that required further investigation. Interviews were recorded and transcribed verbatim. The transcripts and the field notes were anonymised. Handover sheets, multidisciplinary team meeting notes and the policy and guidelines on antibiotic prescribing were collected to provide contextual knowledge of the processes. These different methods enabled cross-validation and triangulation of the findings.

Analysis

A constant comparative method was used for the analysis of the emerging themes[27] aided by Nvivo 11 software. The field notes from the WR observation, the data from the documentary analysis, and the transcripts from the interviews were openly coded to identify key concepts, which were developed into themes. The analysis was conducted using an iterative and recursive process of moving between the coded data and the higher level themes, until the themes, and the relationship between the themes, reached saturation (i.e. no new themes or inter-relationships between them were identified). Coding and analysis was conducted by EC, with the coding and the interpretation checked and reviewed by CT and AH.

Results

Ward round participants and demographics

Thirty WRs, over 100 hours, were observed, involving six surgeons and their teams (Table 1). Acute surgical and elective WRs were observed. All adult patients admitted to the team for emergency and elective surgery, and for non-surgical care e.g. cholangitis, cholecystitis etc. were included in the study. Over 50 hours of observation was conducted on the ward and in

handover and team meetings. Thirteen key informants were interviewed, including five consultant surgeons, three registrars, two nurses, two junior doctors, and the ward pharmacist. In the UK, doctor training includes, 2 years of foundation training (junior doctor), and six years of specialist training (registrar), before qualification as a consultant.

Describing the surgical ward practices

The surgical pathway is complex and includes many actors and actions along the patient pathway that are directly related to infection management. The multidisciplinary input into the care of the surgical patient though missing from the ward rounds, cannot be ignored. The pharmacy, microbiology laboratory, anaesthesiology, and nursing staff provide input into patient care in course of the patient's stay. Mapping a causal diagram for infection as an outcome in surgical patients highlights the key variables that must be included in antibiotic decision making (Figure 1).

The acute surgical ward round started at 7.30 each morning, at the same time as the ward nursing handover. The surgical WR varied in the number of people attending, the number of wards visited, and its duration (Table 1). The WR team consistently comprised doctors in substantive posts within the surgical team, locum doctors and medical students. The nurses that attended most frequently were the advanced practitioner nurses (APN) attached to the surgical teams and occasionally the ward matron. The APN model is adopted by the UK healthcare system to meet its increasing demands. It refers to nurses, with additional qualifications and training who can take some of the responsibilities of junior doctors. No other healthcare professionals were present on the WRs. At the time of this study, the organization had electronic medical records and prescribing. The analysis identified four key themes in relation to antibiotic management in surgery: 1) working in a constant state of flux; 2) communication jigsaw; 3) delegating antibiotic management; and 4) the need for an intervention.

Working in a constant state of flux

There is a hierarchy as to who leads the WR, but this is a shifting hierarchy whereby people are promoted or demoted from their position based on who is present on the WR. For

example, if the recently appointed surgeon is leading the WR, and then a more senior surgeon joins, the line of authority is shifted upwards to the more senior surgeon. Likewise, if the surgeon leading the WR is called away e.g. to the OR, the line of authority shifts downwards and people must act up, e.g. the registrar takes on the role of the surgeon, the junior doctor 'becomes' the registrar and the medical student 'becomes' the junior doctor. The roles and responsibilities thus constantly shift. What does not stop or change is the work, the patients must be seen and decisions made regardless of who is on the round (Table 2, T1a).

The frequent use of locums also means that often the teams are working with gaps in care, as the locum doctors are often not familiar with patients or with local working practices (Table2, T1 b & T1c). The senior team presence is vital to effective direction (Table2, T1d), but often this is not possible (Table 2, T1e).

Communication jigsaw

Most of the time one or more members of the surgical team are unable to participate in ward rounds as they are busy performing surgery. WRs are often rushed, interrupted, and dispersed and reconvened because of demands for the senior team to be in the OR (Table 2, T2a). The constant disruption and people leaving and joining the WR means that members of staff will rarely be present for the entire WR. Junior doctors often shoulder the responsibility for keeping track of and actioning decisions made, but they are commonly sent from the WR to chase different tasks, or are omitted from critical conversations, and the thread of continuity in the WR is lost (Table 2, T2b &T2c).

Because of being constantly split between the OR and the ward, communication within the surgical team occurs across different platforms. Key decisions are made, recorded, and communicated not necessarily in medical health records but on handover sheets, text messaging, and applications on smartphones. Throughout the WR one or more of the team will access their mobile telephones to look up information, receive and make phone calls, send text and WhatsApp messages (a smart phone app for instant messaging) to keep each other informed about decisions made for individual patients and about the team's impending tasks and whereabouts of individual team members (Table 2, T2d &T2e). Key decisions

about what medical tests the patient needs, what the results are and what procedures have been performed on a patient in the OR are similarly communicated via WhatsApp and text messaging. The study was conducted on wards that had recently adopted electronic medical records and prescribing and computers on wheels were used as part of the WR to access the necessary information and to document the WR. However, on numerous occasions, the computers failed to work, or were unavailable, and the teams had no means of accessing information or documenting decisions other than their own memory and written hand over sheets. (Table 2, T2f). These technological advances have the potential to facilitate information sharing, but to get a full picture of the clinical story for each patient one must put together all the communication pieces from this jigsaw of platforms (T2g & T2h). Information about the infection management of the patient is recorded on multiple communication platforms, and the context specific knowledge about the specific steps that have been taken in managing the infection in the patient is spread amongst the team. This knowledge is often not shared effectively (T2, i).

On many occasions a patient was thought to be on antibiotics by the team, and after further queries in notes and charts was found not to be on them, and vice versa. In relation to antibiotic prescribing the conversation that was heard most often was: '*Continue antibiotics… [after a pause] is she on them now…?'* (surgeon to the team) (see also T2j). This gap in communication sometimes means that the patient, if they are cognisant, can become the vital source of information about their own care (Table 2, T2k).

<u>Delegating antibiotic management</u>

Surgeons tended to see the core elements of their role as relating to the surgical management of their patients, a role that is performed in the OR. Antibiotic management is peripheral to this role (Table 2, T3 a).

The surgeons' accounts demonstrate that antibiotic decisions come second to decisions directly relating to surgical practice. The lack of priority given to antibiotic decision making is compounded by a lack of expertise, resulting in responsibility for antibiotic decisions being

commonly delegated to others (Table 2, T3b). In the hospital we studied, the delegation of responsibility for medical management for patients has been formalised through the appointment of medical consultant who conducts twice weekly WRs of patients referred to him by the surgical team for medical care. This consultant has become an additional source of support for antibiotic management of the patients (Table 2, T3c and d).

The consultant surgeon may be the person who decides whether a patient needs an antibiotic or not, but the drug choice, the route, timing etc. is not consistently discussed on the WR. That decision is left to the junior doctors (Table 2, T3e). In the OR too the surgeons rely on the anaesthetist to support them (Table 2, T3f). Due to the competing priorities in surgery, management of the antibiotic prescribing is low on the priority list of the surgical team (Table 2, T3g).

<u>The need for intervention</u>

The need and expectation to intervene means that often antibiotics are initiated for patients with no or little evidence of infection, but a high plausibility of infection in the minds of the surgeons. This process is rationalised by the surgeons as being an extension of their roles as 'interventionists' (Table 2, T4a). In the absence of evidence of infection what drives antibiotic decision making is a risk of failure, and a risk of blame (Table 2, T4b-T4d). What is considered unique in surgery is that a patient has to be well enough to be able to undergo an operation, therefore any deterioration post-operatively is assumed to be a consequence of the surgery, and the decisions of the surgeon, and not the patient's underlying illness (Table 2, T4d). These concerns drive a more conservative approach to antibiotic decision making leading to unnecessary and prolonged courses of antibiotics (Table 2, T4e).

Discussion

This study found inconsistencies in the approach to antibiotic decision making in surgery, often with the key identified variables (Figure 1) not discussed as part of the WR. Some of this is due to the practicalities of the the WR in surgery and can be overcome through simple solutions (Box 1). The principal purpose of the surgical teams' contribution to the patient

pathway is a surgical intervention. The surgical team is constantly split between the OR, clinics and the ward. Thus, there is a lack of clarity about the responsibility for antibiotic management of patients, and antibiotic prescribing takes place in the context of disjointed information. This leads to poor continuity of care and sub-optimal antibiotic management. The use of WhatsApp and other smartphone apps amongst surgical teams has been reported [28,29].The multitude of communication pathways though essential to a team that is constantly split up, introduces gaps in communication that can impede effective coordination and thus patient care[30]. One of the drawbacks of electronic prescribing systems is that they do not offer handover or messaging tools, especially on mobile devices. This leaves healthcare professionals with no recourse other than using paper handover sheets and their smartphones. In electronic health records, all entries are made on a single computer screen, making it easy to overlook checking the electronic medication chart on the WR, and miss reviewing the antibiotics prescribed. There were several occasions where decisions about antibiotic courses for the patients were made without referring to the prescription screen to see what medication the patient was on. This can result in patients not receiving appropriate antibiotic management.

The overwhelming responsibility for the patient remains with the surgeons. However, the surgeons identify their main role to be addressing the surgical problems of the patient. All other tasks, including antibiotic management, are peripheral to this and may be missed in the WR. The expectation placed on surgical teams to optimise antibiotics needs to be managed in the context of the way that the teams work how they prioritise the patient needs. Antibiotic decision making is often seen as a necessary, conservative intervention, even where there is no evidence of an infection. This perception is driven by a fear of the risk of possible infections and risk of blame rather than an active exercise of managing infections. This practice drives inappropriate antibiotic use, particularly in the post-operative phase. The surgeons demonstrate a willingness to delegate the leadership of antibiotic management to other colleagues. As surgeons are required to increasingly specialize in technical procedures, there is a need to explicitly assign the responsibility for antibiotic management of the surgical patient to a responsible, individual(s) with necessary expertise. This will help bring together

the different threads of information that are required in order to optimise antibiotic use in surgery (Figure 2). Diagnosis and treatment of infections is a specialty that requires expertise and training, therefore this is an opportunity to develop, with support from specialist microbiology laboratory and staff, a role for a clinician(s) responsible for perioperative antibiotic management. This will help strengthen the antibiotic management for surgical patients and has the potential to facilitate continuity of care and to help overcome the substantial gaps in communication that have been identified in this study. In a previous paper we described the influence of 'prescribing etiquette' on antibiotic decision making in hospitals, recommending that leadership within existing clinical teams should be used to wield influence [19]. The time is right to question whether we need to address the gap in antibiotic prescribing for surgical patients by developing this specific perioperative clinician role to manage infections. This is of critical importance considering the rising challenge of antibiotic resistance in post-operative patients.

This is a single centre, qualitative study, and we did aim not develop and test solutions. The study's strengths are that it provides a detailed qualitative exploration, appropriate for describing how and why antibiotic decision making takes place within the complex sociotechnical system that is the surgical specialty. The findings are strengthened by triangulation through the use of three data sources.

Conclusion

Antibiotic management is peripheral to the role of surgeons, is not prioritised, and is commonly delegated to other healthcare professionals. Achieving effective antibiotic management is frustrated by diffusion of responsibility, lack of continuity, and disjointed information. Antibiotic management of the surgical patient could be potentially improved through assigning explicit responsibility for it to clinicians who could address perioperative medical care, working within, or closely with the surgical team.

Transparency declaration

Conflicts of Interest and declare: Charani, Tarrant, Moorthy, Brennan and Holmes none to declare. Sevdalis is the Director of London Safety & Training Solutions Ltd, which provides

team skills training and advice on a consultancy basis in hospitals and training programs in the UK and internationally.

Acknowledgements

The authors would also like to acknowledge the National Institute of Health Research Imperial Biomedical Research Centre and the National Institute for Health Research Health Protection Research Unit (NIHR HPRU) in Healthcare Associated Infection and Antimicrobial Resistance at Imperial College London in partnership with Public Health England and the NIHR Imperial Patient Safety Translational Research Centre. NS research was supported by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care South London at King's College Hospital NHS Foundation Trust. NS is a member of King's Improvement Science, which is part of the NIHR CLAHRC South London and comprises a specialist team of improvement scientists and senior researchers based at King's College London. Its work is funded by King's Health Partners (Guy's and St Thomas' NHS Foundation Trust, King's College Hospital NHS Foundation Trust, King's College London and South London and Maudsley NHS Foundation Trust), Guy's and St Thomas' Charity, the Maudsley Charity and the Health Foundation. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the National Institute for Health Research or the UK Department of Health. The authors wish to thank Enrique Castro-Sánchez, Timothy Rawson, Sanjay Guatama, Nebil Behar and Mark Gilchrist for their contribution to the discussions and to the development of the manuscript.

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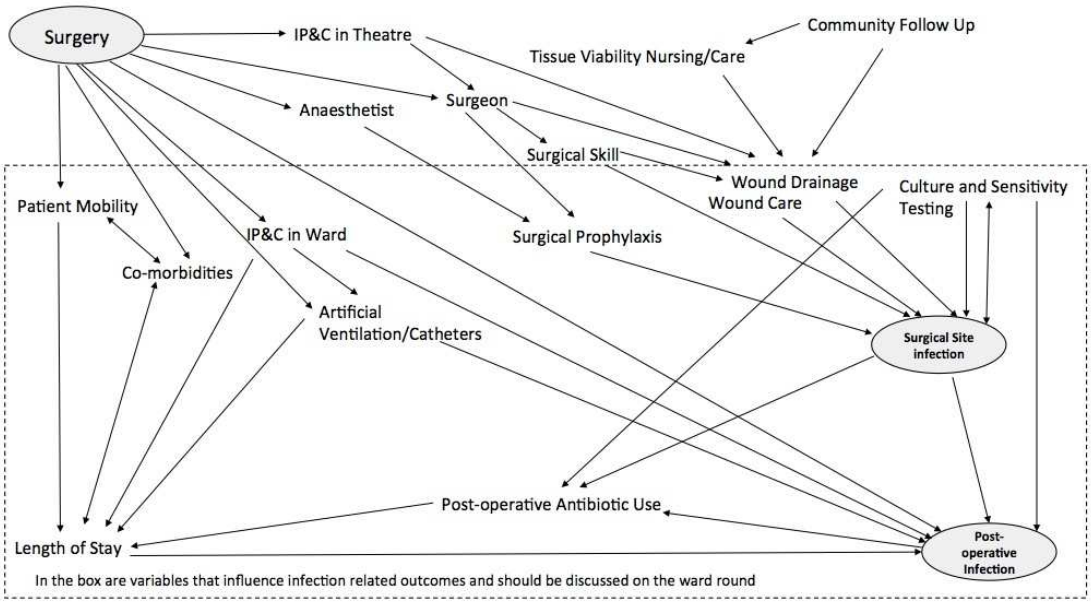
Table 1 Summarising the ward round demographics

Ward round number	Duration (hours)	Number of patients	Number of wards visited	Ward round type	Lead by	Number of participants on ward round	Participants
1	2 ½	7	2	Non-Acute	Surgeon A	5	Surgeon, Registrar, Junior Doctor, Medical Students
2	2	7	3	Non-Acute	Reg A	5	Registrar, Junior Doctor, Medical Student
3	3	10	4	Non-Acute	Surgeon B	8	Surgeon, Registrar, Junior Doctor, Medical Student, Summer Placement Students
4	3	8	5	Acute	Surgeon A	8	Surgeon, Registrar, Junior Doctor, Medical Students
5	5	12	3	Acute	Surgeon A	8	Surgeon, Registrar, Junior Doctor, Advanced Practice Nurse
6	3	11	3	Acute	Surgeon A&C	13	Surgeon, Registrar, Junior Doctor, Advanced Practice Nurse, Electronic Medical Records Team
7	2	15	5	Acute	Surgeon B&C	7	Surgeon, Registrar, Junior Doctor, Medical Student, Advanced Practice Nurse,
8	2 ½	16	8	Acute	Surgeon D&C	6	Surgeon, Registrar, Junior Doctors, Locum Registrar
9	4 ½	15	10	Acute	Surgeon C	7	Surgeon, Junior Doctors, Locum Registrar, Advanced Practice Nurse
10	3	14	4	Acute	Surgeon C	9	Surgeon, Registrar, Junior Doctors, Medical Students, Advanced Practice Nurse
11	4 ½	16	9	Acute	Surgeon C	8	Surgeon, Registrar, Interns, Medical Students, Advanced Practice Nurse
12	1 ¾	9	4	Non-Acute	Reg B	2	Registrar, Junior Doctor
13	1 ½	7	3	Acute	Surgeon A	11	Surgeon, Registrar, Junior Doctors, Locum Junior Doctor, Medical Students
14	2 ½	13	8	Acute	Surgeon E	7	Surgeon, Registrar, Junior Doctors, Locum Junior Doctor, Medical Students, Advanced Practice Nurses
15	6	22	11	Acute	Surgeon C	7	Surgeon, Registrar, Junior Doctors, Medical Students, Advanced Practice Nurses
16	5	20	10	Acute	Surgeon C	6	Surgeon, Registrar, Junior Doctors , Advanced Practice Nurse
17	2	10	4	Non-Acute	Surgeon F	4	Surgeon, Registrar, Junior Doctors, Locum Junior Doctor, Medical Student
18	1 ½	7	2	Non-Acute	Reg B	2	Registrar, Junior Doctor
19	¾ Hour	4	1	Non-Acute	Reg C	2	Registrar, Junior Doctor
20	5	15	3	Acute	Surgeon A	5	Surgeon, Registrar, Junior Doctor
21	3	20	4	Acute	Surgeon B	5	Surgeon, Registrar, Junior Doctor, Locum Junior Doctor, Advanced Practice Nurse
22	4 ½	28	5	Acute	Surgeon B	5	Surgeon, Registrar, Junior Doctor, Locum Junior Doctor, Advanced Practice Nurse
23	1	17	4	Acute	Surgeon B	5	Surgeon, Registrar, Junior Doctor, Locum Junior Doctor, Advanced Practice Nurse
24	3	19	2	Acute	Surgeon A	6	Surgeon, Registrar, Junior Doctor, Locum Junior Doctor, Advanced Practice Nurses,
25	2	18	3	Acute	Surgeon G	5	Surgeon, Registrar, Junior Doctor, Advanced Practice Nurse
26	2	14	3	Acute	Surgeon G	6	Surgeon, Registrar, Junior Doctor, Locum Junior Doctors, Advanced Practice Nurse, Medical Students
27	2	19	4	Acute	Surgeon C	9	Surgeon, Registrar, Junior Doctor, Locum Junior Doctors, Advanced Practice Nurse, Visiting Surgeon

Ward round number	Duration (hours)	Number of patients	Number of wards visited	Ward round type	Lead by	Number of participants on ward round	Participants
28	5	20	4	Acute	Surgeon F	5	Surgeon, Registrar, Junior Doctors, Locum Junior Doctors, Advanced Practice Nurse
29	4	27	7	Acute	Surgeon F	6	Surgeon, Registrar, Junior Doctors, Locum Junior Doctor, Advanced Practice Nurse
30	3 ½	20	5	Acute	Surgeon F	7	Surgeon, Registrar, Junior Doctors, Locum Junior Doctor, Advanced Practice Nurse

Figure 1 Causal diagram mapping the relationship between surgery and infection, and the variables that should be considered as part of antibiotic decision making



Box 1 Oportunities in antibiotic management in surgery

Observed practice	Opportunities
• **Senior surgeons are not actively engaged in antibiotic decision making**	• The surgeons are the leaders in their specialty, engaging with a surgeon is tantamount to engaging with their entire team • Colleagues with expertise in antibiotics (microbiology/infectious disease and pharmacy) should engage and communicate with surgeons in a consistent and sustainable way, this includes accommodating the different working patterns of surgeons, e.g. in this study an ideal point of daily intervention and engagement is the 7.30 ward round, where the team spends the first 30 minutes to discuss and present every patient to the lead surgeon
• **Incoherent communication about antibiotic management of surgical patients**	• It is critical to engage with the surgical teams on the communication platforms most frequently used by them, this may be via phone, text-messaging etc.
• **Unco-ordinated antibiotic management**	• Define a dedicated clinical role for antimicrobial stewardship within the surgical team, this can be context specific whether it is a pharmacist or a nurse or surgical trainees who have responsibility for ensuring appropriate antimicrobial management for patients in their team

Table 2 Continued Key emerging themes from the study, normal text denotes observation notes, italics denotes quotes from participants

Theme	Example
Theme 1 Working in a state of flux	T1 a A registrar is called from the OR to conduct a WR. The junior doctor has gone to look for a senior doctor to help her with the WR. The registrar texts her to return as she is now here, and without waiting for the junior doctor she starts the WR asking the medical student who is present– 'You have to step up, you are now the junior doctor, do you know the patients? **Field notes**
	T1 b The locum surgeon on call over the weekend is not present for the handover – the surgeon tells me later that is because he was a locum and they don't care, cannot expect them to be there. **Field notes**
	T1 c The junior doctor comes back and the registrar leaves to go back to theatre. The locum registrar tells the junior doctor – '*I've no idea about the patients. I'm new, I have never done a ward round before..'* I ask him later how long he has been here, and he says he has just started a 6 month contract, and he has trained here in the UK. Field notes
	T1 d *'In terms of locums, some of them are fantastic, some of them are not fantastic, and it means, so some of the junior locums, not, it feels harsh saying, but some of them are not as good as they could be so it makes our life harder because we're having to check, double check things. And in terms of registrars, …if I do not trust that registrar, I just won't go to them and that makes me vulnerable in a way because then I have to make more decisions on my own and also it means that I'll have to bother the surgeon more.'* **Interview, junior doctor**

	T1 e *'…what you see at the week, so we have our individual teams, so the four or five specialities are covered by different surgeons, and at the weekend we cover, only one team covers everyone.'* **Interview, Advanced Practice Nurse**

Table 2 Continued Key emerging themes from the study, normal text denotes observation notes, italics denotes quotes from participants

Theme	Example
	T2 a The surgeon gets a call that he is needed in the OR to help with an operation. The round continues with the registrar, junior doctor and advanced practice nurse. The locum is still running around finishing tasks for other patients. **Field notes**
Theme 2 Communication jigsaw	T2 b *'Some people don't tell me stuff that is vital and between us and nurses, the nurses to us, and between doctors. If you don't tell anyone anything they're not going to know and things don't get done. So, some people are not very good at communicating.'* **Interview, junior doctor**
	T2 c Whilst waiting for the round to start, the surgeon came on the ward and went to see his patients. He saw the patients alone, and then told a registrar who was on the ward: '*I've seen all the patients, tell the junior doctor what I told you.'* **Field notes**
	T2 d On the way back to the ward I ask them if they can access the entry they just made into the intensive care unit electronic notes. They respond: *'No it is an absolute waste of time. It's a farce.'* I ask them how they communicate the recommendations made for the patient by the surgeons and they explain that *'The surgeons expect us to update them on the patients constantly via email or texting or calling. If they don't hear anything it means all is well with the patient.'* The registrar adds: *'I don't call or text about*

Theme	Example
	every little detail, but for important things. ' Field notes
	T2 e *'…it's a very good general surgery hospital, it's renowned for research and surgeries, etc, so the registrars and the surgeons are very high up in their fields, and very dedicated, so they spend far more hours here than they should taking care of their patients, and because we communicate on the phone rather than bleep system, which I know some of my other colleagues in other hospitals, they can only bleep their seniors, I feel like that improves communications, and they're always, the vast majority of them anyway, are always at the end of the phone if they're not operating or, and they're always going to text back within half an hour. There's a WhatsApp group, just for the juniors, we have our own WhatsApp group. The emergency junior doctors who are on post-take that day have their own WhatsApp group too, just because they're the ones posting the most.'* **Interview, junior doctor**
	T2 f A junior doctor goes to find a computer on wheel (COW) that works. His card is not working in any of the COWS that are free on the ward. He goes to check his card on a PC and finds the fault is in the COWs and not his card. The surgeon goes to find him and says he has to hurry and asks him to come on the round and take notes instead of using the COW. **Field notes**
	T2 g The first patient they see on the ward has been transferred from the clinical decisions unit. The team ask the patient if he is on any medications. The patient replies he is on painkillers and antibiotics – he looks bewildered at the question. The junior doctor explains to the patient the clinical decisions unit have their records on paper, whilst this ward is electronic records. The pharmacy technician stops the advanced practice nurse to explain the team have written up 30gram of morphine for the patient instead of 30mg. A nurse walking by says that the patient is on augmentin and metronidazole. The nurse returns with the medication chart and says the patient is on 'cef&met'. **Field notes**
	T2 h The junior doctor remarks that '*I don't like it when it's mixed (medical records on paper and electronic) as you can miss things*.' Leaving the ward the she continues: '*What I hate about surgery is that the ward rounds are done in such a rush, we never get to delve into the patient history, in medicine there is more delving into the detail…. he has been in our care for three days and we didn't know he has bronchiectasis*.'

Theme	Example
	Field notes
	T2 i A patient has severe sepsis post-operatively. The team go through the patient results and the junior doctor explains to the surgeon – 'we put her on meropenem..' The surgeon wants to know whose decision that was. The junior doctor confirms it was the registrar who decided that. The surgeon wants to check the bloods and culture results for the patient, but the results are from the day before. The advanced practice nurse replies that they should have taken culture yesterday. The nurse looking after the patient joins the WR. The patient, the nurse confirms, missed her dose of meropenem, as the electronic medical record system was down and the team were using paper charts and the meropenem was written on the paper chart. **Field notes**
	T2 j The surgeon sees the patients. He asks team to *'continue on antibiotics'* for one patient, the junior doctor explains the patient is not on antibiotics. *'Put her on some, put her on cef*. **Field notes**
	T2 k The patient asks the surgeon – "*what about antibiotics and my scan"*. The surgeon replies that according to the handover if the patient was considered to be well she could go home. He then looks at the results and confirms – "*your inflammatory markers are normal, no antibiotics…"* The patient explains that because she has lupos she was told by the registrar on the weekend that she "*was going to need antibiotics"*. He then tells the team to give the patient seven-day course of co-amoxiclav. And to the patient he reiterates – "*we'll give you some antibiotics since my colleague told you, you will get it."* **Field notes**

Table 2 Key emerging themes from the study, normal text denotes observation notes, italics denotes quotes from participants

Theme	Example
Theme 3 Delegating antimicrobial management	T3 a *I think, it's [antibiotic management] quite a long way away from what a surgeon's primary interest is. Surgeons basically like to operate, and if you're dragging them away from the operating room or distracting them from what they're really interested in, it's quite hard to motivate them.* **Interview, surgeon F**
	T3 b M*ost surgeons don't have expert knowledge of microbiology. Most surgeons basically are dogmatic in their prescribing practices. They prescribe the handful of antibiotics that they know, and they don't understand the fundamental clinical science in what they're doing. So, asking a surgeon to go onto an antibiotic ward round, it's a bit like, you might as well be asking them to go onto, I don't know, a cardiology ward round. They just don't have any working knowledge of it. Surgeons have quite significantly advocated responsibility to microbiologists, so on my ward round I no longer prescribe, we have hospital guidance, which says … but basically if I've got a patient with a complex wound infection, I will culture whatever I can, and get them whatever fluid or tissue that I can get them, and then I just let them make the choice, because, this is the world we live in, they are the experts, they know what specific bacteria are doing and which drugs will work, so I just let them make a call. So, for garden variety wound infections, I will go with hospital guidance, but if it's a bit more complicated, I abdicate responsibility to microbiologists.* **Interview, surgeon F**
	T3 c *'So if the infection is related to their abdomen basically we are responsible but we need the support from microbiology, sometimes if there's a collection we need the support from the interventional radiology. If it's chest infection then probably we need the support from the medical team sometimes, although we, ourselves we just give them antibiotics for chest infections. But when something is complicated obviously, we need some other specialties to get involved. We sometimes get involved the medics, the medical consultant who's working very hard…. he is very approachable usually and the juniors very often, and even me, we often talk to him even if it's not the day of the meeting to get some advice and he very kindly comes and sees the patients.*' **Interview, surgeon C**
	T3 d

	'I don't think they think there's a gap in antibiotics but I think they realised there was a gap in the medical knowledge and that's why a medical physician was employed…which is completely invaluable, and I would, I hope every surgical team have that, because I literally go to him for everything and…. It means that, in a way, that surgeons don't even try because they're like, he will review it, for anything from delirium…they rarely listen to the chest if they've got a wheeze or a cough. So, in that way it's bad because it makes them not take responsibility for that, but in the same way the surgeon is incredible at what he does and he will deal with any problem from heart failure, chest infection, anticoagulation, antibiotics, so I would ask him about, anything, so I think they recognised that gap in the sort of medical infectious issues and that's why he was designated …' **Interview, junior doctor**
	T3 e *They* [the surgeon's team members] *think, you told them, sometimes they ask you, what dose, and if you know the dose you let them know. If you don't know the dose you just say, please call pharmacy or call microbiology. To be honest I don't double check, I don't have the time to double check whether they prescribe correctly or not.* **Interview, surgeon C**
	T3 f *I think that most of the surgeons don't follow the guidelines a lot. They are based more on the practice and the experience…. because sometimes they don't have time to look at the guidelines and we just… work on, OK, chest infection, give tazocin [piperacillin and tazobactam]. I do that as well sometimes…. Surgeons don't think about antibiotic resistance. To be honest I don't think about antibiotic resistance. This [surgical prophylaxis] is something that most of the time the anaesthetist will remind us because we are very focussed on the operation and it's something that we usually forget.* **Interview, Surgeon C** T3 g *It's not that I don't think, it's not that surgeons don't think antibiotics are important, it's just not high on their priorities. And sometimes it drops off their priority list.* **Interview, surgeon F**

Theme	Example
The me	T4 a *I think a lot of it is about personality, because we go into surgery because we are interventionalists. We go into surgery because our mechanism of making people better is to do something to them that makes them better. And I think that we do that surgically,*

but I think that we have a habit of doing it pharmacologically as well. We, we are not as good at riding things out, we get impatient, we want to do something, and I think we therefore probably trigger interventions more quickly maybe, than other specialities. **Interview, surgeon G** T4 b *A lot of it comes down to consensus of opinion. That what none of us want to be is vulnerable, and that's the danger that, that doing something like not treating the patient, not treating your patients. But for me to change what the unit do in that is going to be difficult, because you have one complication and then suddenly you're isolated because you've done something different to how Prof X does how Consultant Z does and there's been an issue. So, there's, a lot of it is about the consensus.* **Interview, surgeon G**
T4 c *I think it's just because you don't want that patient to end up with a complication that has been caused by you, so if you thought, or not that it was caused by you but if it was say for example a difficult appendix, really infected and loads of pus everywhere, if you know that it was nasty and you tried your best to get it all clean, but you don't know you're going to be able to prevent an infection, then the best thing that you can do to prevent that is to start them on antibiotics. So, if you've tried your best but you still think, you're worried they're going to develop something, and I think because if you tried your best but you're still concerned, and then on top of that because, I guess it's partly to do with being accountable because in an operation, you put your name on it and then surgeons are very quick to point their finger.* **Interview, registrar**
T4 d *The major challenge is this, is that, there is a fundamental difference in medicine and surgery, which is if someone comes in with a pneumonia, so you try and treat it, but that person with pneumonia dies. Well you tried and that's OK. If someone comes in to hospital for an elective operation, and they die from sepsis or infection, that death was preventable and it's your fault. And therefore, surgeons practise an incredibly defensive brand of medicine, and if there is even a small chance that me giving a dose of prophylactic antibiotics or keeping my patients on ten days instead of seven, and it means that my patient's outcome will be better, and my outcome data will be better, because I get judged, then I'm going to give that patient antibiotics. I'm going to do it, and so I think what you see is a lot of surgeons prescribe defensively, and they don't really care what the evidence is, and they don't really care what the problems antibiotic resistance are. So I think that's the major hurdle you've got to get over. And that's a real challenge, because it's not just providing an evidence base, you're changing the entire culture.* **Interview, surgeon F**

T4 e T*here's too much Tazocin prescribed, everyone seems to have a hospital acquired pneumonia, anyone who's got any crackles on their chest, hospital acquired pneumonia, they start Taz, but have they though? It's the culture, it's cultural, it's easy, it's too easy to say oh put them on Taz because I don't want my operation screwed up. I get really upset when I find two days after I've done a laparoscopic operation they've put them on Tazocin, why?* *I'm not always the one making that decision, the registrar will do it, you know. And then I stop it, or by the time I've realised they've already had three doses, I go can you just stop it which makes complete nonsense because they haven't even had a full course either so it's a stupid thing but I'm not going to keep someone on Tazocin just because someone's started it. So, if I don't think there's a good clinical reason I'm going to stop it anyway.* **Interview, surgeon B**

Figure 3 The multidisciplinary elements of antibiotic prescribing in surgery