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Information transfer in multidisciplinary operating room teams: a simulation-based observational study

David Cumin,[1] Carmen Skilton,[2] Jennifer Weller[2,3]

[1]Department of Anaesthesiology, University of Auckland, Auckland, New Zealand
[2]Centre for Medical and Health Sciences Education, University of Auckland, Auckland, New Zealand
[3]Department of Anaesthesia, Auckland City Hospital, Auckland, New Zealand

Correspondence to
Dr David Cumin, Department of Anaesthesiology, University of Auckland, Private Bag 92019, Auckland 1142, New Zealand; d.cumin@auckland.ac.nz

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ABSTRACT

Background Communication of clinically relevant information between members of the operating room (OR) team is critical for safe patient care. Formal communication processes, such as briefing, sign in and time out, are designed to promote this.

Aims We investigated patterns of communication of clinically relevant information between OR staff in simulated surgical scenarios, to identify factors associated with effective information sharing. We focused on the influence of precase briefing, sign in and time out, which we defined as formal team communications.

Method Twenty teams of six participated in two scenarios during a day-long course. Participants each received unique, clinically relevant items of information (information probes) prior to simulations and were tested postscenario on recall of the information in the probe. Using videos of the simulations, we coded each time an information probe was mentioned against a structured framework.

Results Of the 145 instances where a probe was mentioned at least once, 75 (51.7%) were mentioned during a formal team communication. However, there were 89 instances of a possible 234 (38%) where a probe was never mentioned. Some team members were more likely to mention the information than others. When probes were mentioned during formal team communications, significantly more team members were attentive (1.4 vs 2.3; p<0.001), the information was significantly more likely to be recalled and the team was five times more likely (p=0.01) to recall the information than if the information was only mentioned outside of a formal communication.

Conclusions While our study supports the value of formal team communications during precase briefing, sign in and time out in the Surgical Safety Checklist, our findings suggest suboptimal transmission of information between team members and unequal contributions of information by different professional groups.

Good communication is an essential part of teamwork and safety in the operating room (OR).[1 2] However, failures in OR team communication throughout the perioperative period are common.[3–7] Recently, Thiels and colleagues identified inadequate communication in the OR to be the most common behavioural factor that contributed to 'never events' such as retained foreign object, wrong site/side procedure, wrong implant or wrong procedure.[8]

While there are many definitions, we will consider effective communication as a two-way process in which one party sends information that is heard and understood by the receiving party or parties. The transfer of information between OR team members aids the development of shared mental models[9] so that team members have a common understanding of the situation, the treatment plan and the roles of each member of the team.[10] In the time-pressured OR, this shared mental model enables individuals to identify when the situation deviates from the plan, predict the information and resources needed by other team members, adapt quickly to changes in the situation and reprioritise tasks and contribute more to decision-making.[11] Several studies have shown that high-performing OR teams exchange more information than low-performing teams.[12–14] Previous observational research by Lingard *et al* found

inconsistent or inaccurate information transfer in OR teams. It was identified that the OR teams rarely gathered to discuss issues, and when they did, key individuals were often absent, leaving the transmission of information to chance.[3]

Perceived status asymmetry between OR team members also contributes to communication breakdowns, as some health professionals are reluctant to speak up or challenge decisions of more senior colleagues.[15–19] An 'open-culture' that facilitates communication is exemplified by a flat hierarchy, where the power distance between individual team members is low.[20–22] Recommendations have therefore been made for communication processes to be standardised and structured through the use of checklists, including opportunities for team members to ask and respond to questions, in an effort to reduce communication errors, flatten hierarchies and unify the OR team.[23–25]

The use of checklists to guide formal team communication has become widespread following the introduction of the WHO Surgical Safety Checklist (SSC).[26] In a recent systematic review, Glymph *et al*[27] highlight the advantages of including a preoperative briefing, referred to as a 'huddle moment'. A preoperative briefing may encourage the team to assemble and share the information that they have about the ensuing procedure, allowing the whole team to be 'on the same page'.[28–30] Evidence for the effectiveness of the SSC in reducing patient morbidity and mortality is generally very positive[31 32] and the three phases of the SSC: sign in, time out and sign out are well established in many hospitals. More recently, the Patient Safety First Campaign in the UK recommended that preoperative briefings and postoperative debriefings should be included in the SSC to form the Five Steps to Safer Surgery (5SSS),[33] to further improve communication between the OR team.[34 35] Hill and colleagues also found significant improvements in safety culture attitudes after the implementation of the 5SSS, specifically highlighting the importance that the OR staff attached to the formal prelist briefings.[36] However, the uptake of these additional steps seems to be lagging.[37] The implementation of the SSC is also variable and this hampers research in the area.[38–40] Checklists themselves are clearly valuable tools, but not sufficient on their own. The way in which they are administered by staff may lead to an effective communication between team members or an unhelpful exercise in compliance.[41 42]

Formal team communication practices, as in the SSC, are designed to improve OR teamwork by encouraging open discussion and providing a systematic process to ensure that critical information and concerns are revealed and shared with the entire team. While research suggests that communication failures can decline by two thirds with the use of checklists,[28 43] there is still relatively little research that explores how these formal team communication practices influence the transfer of information between members of OR teams.

Our research group previously developed and administered an immersive multidisciplinary operating room simulation (MORSim) course at the Simulation Centre for Patient Safety, University of Auckland.[44] During the course, 20 OR teams participated in three challenging simulations of emergency surgical scenarios. Prior to each scenario, participants were provided with a briefing of the case. Each briefing sheet for participants also contained a piece of information that no other participant had. These pieces of information were clinically relevant and important to the particular case and we refer to them as 'information probes', a term coined by Blum *et al*[45] in their study tracking the transfer of information between participants in a simulated clinical case. Previous research has also used the information probe technique to identify specific behaviours that are important for effective communication.[46]

In this exploratory study, we investigated patterns of communication of clinically relevant information between members of the OR team with the aim of identifying factors that promoted effective information sharing. In particular, we were interested in the influence of a precase briefing, sign in and time out.
Our specific research questions were:

- To what extent is clinically relevant information about a case effectively communicated within an OR team?
- Is information more effectively communicated during formal team communications than at any other time during the case?
- Does information sharing depend on role of transmitter and receiver?

METHODS

Twenty OR teams comprising a consultant surgeon, surgical registrar, anaesthetist, anaesthetic technician, circulating nurse and scrub nurse took part in three simulated scenarios during the day-long MORSim course.[42] Participants were from two different hospitals but on any given day the team was from one site and so were more likely to have worked together before and work together again soon after the course. The scenarios were recorded using audio–visual equipment and StudioCode V.4.5.1 software (StudioCode Business Group, Sydney, Australia). Ethical approval was obtained from the Central Regional Ethics Committee (CEN/12/03/002) and informed consent was gained from all simulation participants. This work, focusing on the sharing of information, is part of a larger study of teamwork in the OR.[44]

Simulation scenarios

The three scenarios were each approximately 40 min in duration. The first and third scenarios were an emergency laparotomy with an intraoperative emergency (a perforated viscus with developing anaphylaxis and a

stab wound to the inferior vena cava with profound intraoperative hypotension). These were presented to participants in random order on the course day. We made an a priori decision not to analyse the middle case as it included a 10 min pause in the simulation, between initial patient assessment and commencement of surgery, which was specifically designed to promote precase information sharing.

Information probes

OR team members were provided with individualised case briefing notes prior to each of the scenarios. The briefing notes contained the same description of the clinical details for the case, as well as an item of information that no other participant received (information probe). This generated six potential items of information that could be transferred to other members of the team in each of the 40 study scenarios (240 probes). Each information probe was designed to be clinically important, relevant to other members of the OR team and plausible for the team member to have sole knowledge of the information.

Postscenario test for information probes

We tested participants on knowledge of all six information probes using a multiple choice question (MCQ) format. MCQs were completed independently by all OR team members directly after each scenario. The information probes and MCQ assessment are described in table 1.

Formal team communications

There were three potential instances during the simulated scenario which could involve formal team communications. The first was a precase briefing, which occurred as soon as the team members entered the OR and before they started their own preparations for the case. At this time, the clinician and nurse who had transferred the patient to theatre (played by faculty) provided a handover of the case, and the participants had the opportunity to pause for a precase briefing to discuss the plan for the case. The faculty clinician and nurse followed a script to ensure that their communication was consistent. The second formal communication opportunity was the sign in, which usually occurred before induction of anaesthesia and involved the administration of the SSC 'sign in'. The third was the time out; this usually occurred before skin incision and involved the administration of the SSC 'time out'. The scenarios ended before SSC 'sign out' could occur.

The coding method

We used the Vianto software programme (V.5.0, http://sourceforge.net/projects/vianto/) for coding the data. We identified all instances in scenarios when an information probe was mentioned and coded probes against the following framework: timing (during precase briefing, sign in, time out or other); if it was mentioned in response to an invitation to share information; who mentioned it; who was attentive (defined as looking at the person mentioning the probe or verbally responding to the information); if the probe was articulated clearly and if it was correct. Two researchers (DC and CS) independently coded the videos and then reviewed the codes together to reach an agreement on the final set of data. Where there was disagreement, a third researcher (JW) was consulted.

Statistics/analysis

At each administration of the postscenario MCQ test, the total number of correct responses to questions about the information probes from all team members was counted and a percentage score calculated from the total number of possible correct responses.

We used logistic regression to determine the relationship between correct answers to the postscenario MCQ test and the factors in the coding framework. We controlled for the potential confounding effects of specific information probes.

RESULTS

Of the 40 videoed case scenarios, 39 were suitable for analysis. One was excluded due to technical difficulties with the recording.

We identified a total of 302 instances where an information probe was mentioned by a participant during the scenario. Of the 302 instances, 157 were repeated mentions of the same information probe within a scenario. Thus, over the 39 scenarios, there were 145 instances (of a possible 234; 62.0%) of the different information probe mentions and 89 instances (38.0%) across the 39 scenarios where an information probe was never mentioned.

Of the 145 instances where an information probe was mentioned one or more times, there were 18 instances (12.4%) where the probe was never mentioned correctly and 39 instances (26.9%) where it was never mentioned clearly. Thus, only 88 of a possible 234 (37.6%) of the probes were mentioned correctly and/or clearly at least once.

In the postscenario questionnaire, testing recall of the information probes, our results showed that participants correctly answered 38.9% of the questions. For questions on the probes that were actually mentioned in the scenario by one of the participants, 56.8% were answered correctly. For those probes that were never mentioned at all by any participant during the scenario, 11.5% of the questions were answered correctly.

Of the total 302 instances of probe mentions, which included repeat mentions, the majority (64.9%) were outside of a formal team communication. Most mentions within formal team communications were during the precase briefing (58.5%). If the probe mention occurred during a formal team communication,

Table 1 Information probes and relevant question on the postscenario questionnaire

	Perforated viscus scenario		Stab wound scenario	
OR team member	**Information probe**	**Postscenario question**	**Information probe**	**Postscenario question**
Surgeon	The patient has been complaining of a sore leg after arriving in New Zealand from London.	What risk factors did this patient have for pulmonary embolus from deep vein thrombosis? (select all that apply) ☐ Malignancy ☐ Long distance travel ☐ Inflammatory bowel disease ☐ Diabetes ☐ Not aware that he had any of these risk factors	The patient is on a methadone programme.	Which substances/medications were you aware the patient may have been taking prior to arriving in the ED? (select all that apply) ☐ Metformin ☐ Salbutamol ☐ Aspirin ☐ Warfarin ☐ Methamphetamine ☐ Methadone ☐ Not aware he was taking any of these
Surgical trainee	A second group and screen sample are needed as the first was labelled incorrectly.	What problems were there before the patient arrived to the operating theatre? (select all that apply) ☐ Another sample requested for group and screen ☐ Hepatitis C carrier ☐ Patient is Jehovah's witness ☐ Methicillin-resistant *Staphylococcus aureus* precautions required ☐ Not aware of any of these problems	The patient was at a 'P' (methamphetamine) party.	
Anaesthetist	The patient is taking gingko and garlic which may affect coagulation.	Which medications were you aware the patient may have been taking prior to arriving in ED? (select all that apply) ☐ Metformin ☐ Salbutamol ☐ Aspirin ☐ Warfarin ☐ Herbal medicines with anticoagulant effects ☐ Not aware he was taking any of these	The patient may be on warfarin.	
Anaesthetic technician	The ICU rang to say they do not have a bed for this patient.	Which of these difficulties in the hospital experiencing? (select all that apply) ☐ Steam down in the CSSD ☐ Critical availability of platelets in blood bank ☐ No ICU beds available ☐ Air conditioning failure in acute theatre ☐ Staff shortage in the postanaesthesia care unit ☐ Not aware of any of these difficulties	The group and screen are being processed and the MTP has not been activated.	The MTP was: ☐ Activated prior to arrival in theatre ☐ Activated following arrival in theatre ☐ Not activated at any time ☐ I do not know
Circulating nurse	CSSD rang to say that there's a problem with the steam.		The police have asked to cover and preserve fingerprints on the knife.	What were the specific instructions regarding the knife? ☐ Send to hospital lab ☐ Dispose off safely in sharps bin ☐ Preserve fingerprints for the police ☐ Not aware of any specific instructions
Scrub nurse	The patient has not had a metronidazole infusion.	Which antibiotics had the patient received in ED? (select all that apply) ☐ Amoxicillin ☐ Gentamicin ☐ Metronidazole ☐ Vancomycin ☐ Co-trimoxazole ☐ Not aware he had any antibiotics in ED ☐ None of these	The patient has hepatitis C.	Which medical conditions do this patient have? (Select all that apply) ☐ Paroxysmal atrial fibrillation ☐ Hypertension ☐ Diabetes ☐ Hepatitis C ☐ HIV ☐ Not aware he had any of these conditions

CSSD, central sterilisation supply division; ED, emergency department; ICU, intensive care unit; MTP, massive transfusion protocol; OR, operating room.

Table 2 The number of information probe mentions during formal team communication and at any other time during the scenario, and the number of team members attentive at the time the probe was mentioned (N=number of OR team participants. (%)=% of all probe mentions)

When	Precase briefing	Sign in	Time out	Other times	Overall total
Count (%) of information mentions	62 (20.5%) Total 106 (35.1%)	11 (3.6%)	33 (10.9%)	196 (64.9%)	302 (100%)
Mean (SD) number of team members attentive (N=six)	2.3 (1.4) Total 2.3 (1.4)	2.0 (1.7)	2.5 (1.3)	1.4 (1.1)	1.7 (1.3)

OR, operating room.

significantly more team members (2.3 vs 1.4 people, t test $p<0.001$) were attentive at the time, compared with information probe mentions at any other time during the scenario (table 2).

In the logistic regression, the whole team was 5.0 times more likely (95% CI 1.5 to 18.4, $p=0.01$) to correctly answer the MCQ if a probe was mentioned as part of a formal team communication than if it was not. The whole team was also 4.1 times more likely (95% CI 1.3 to 14.1, $p=0.02$) to correctly recall the probe if it was mentioned in response to a question during the scenario. There were no other significant effects on whether the questions were answered correctly.

Of the 302 probe mentions, 99 mentions were not directed at anyone. Of the 203 probe mentions that were directed at another person, anaesthetists and surgeons were more likely to mention information probes to each other than any other pair of team members. Furthermore, scrub nurses and surgeons were generally more likely to mention information probes during a formal team communication than at any other time (table 3).

DISCUSSION

We tracked transmission of clinically relevant information between participants in simulated surgical cases and found that information was five times more likely to be effectively communicated if it was mentioned during a formal team communication, that is, precase briefing, sign in. However, most information was mentioned outside of formal team communications (table 3), and we found many instances (48%) when information was never shared. While each OR team member had a unique and important piece of patient information, some team members were more likely to volunteer information than others. In particular, consultant surgeons, anaesthetists and circulating nurses were more likely to volunteer their information than scrub nurses, anaesthetic technicians or surgical trainees (table 3).

Value of formal team communications

The formal team communications during the precase briefing, sign in and time out represented only a fraction of the total scenario time, but our results demonstrate that these represented key opportunities for sharing information. Furthermore, information shared during these formal team communications was more likely to be picked up by other team members. This could be due to the increased number of people who are attentive during that time (table 2). This lends support to including a briefing prior to the three steps of the SSC.

Unequal contributions between team members

There was also a clear pattern of communication, with anaesthetists and the senior surgeons mentioning probes most often. It is interesting to note that the anaesthetic technician never spoke up with information during the formal team communications.

In our scenarios, probes were designed to all be important, so the finding that some team members do not volunteer clinically relevant information has

Table 3 Direction and timing of communication for the information probe mentions between team members

	To						
From	Anaesthetist	Anaesthetic technician	Circulating nurse	Scrub nurse	Surgeon	Surgical registrar	Total
Anaesthetist	–	16 (0%)	10 (10%)	0 (–)	56 (25%)	4 (0%)	86 (17%)
Anaesthetic technician	10 (0%)	–	1 (0%)	0 (–)	2 (0%)	0 (–)	13 (0%)
Circulating nurse	7 (28.6%)	1 (0%)	–	7 (28.7%)	18 (27.8%)	3 (0%)	36 (25%)
Scrub nurse	3 (66.7%)	0 (–)	2 (50%)	–	2 (50%)	2 (0%)	9 (44%)
Surgeon	24 (25%)	2 (100%)	7 (57.1%)	3 (100%)	–	6 (66.7%)	42 (45%)
Surgical registrar	7 (0%)	0 (–)	1 (100%)	1 (0%)	8 (25%)	–	17 (18%)

Numbers are probe mentions by each team member, to each other team member. The column labelled Total is the sum of all the probe mentions that particular team member addressed to any other team member. (%)=% of these probes that were mentioned during formal team communication.

patient safety implications.[47] One explanation could be the potential for 'tribalism' in the OR,[20] where OR staff view themselves as belonging to the surgical, anaesthetic and nursing subteams rather than the larger OR team. Thus, they may feel responsible for their own subteams' roles and tasks but do not feel responsible for or able to contribute to tasks that normally reside with other professional groups.

Another possible reason for the lack of probe mentions could be that some participants did not fully understand the importance or relevance of the information they were given. Speaking up with information requires confidence that your contribution is relevant and accurate, and that your contribution will be valued.[19 48 49] A prelist briefing where the whole team is informed about the cases on the list, what to expect and what to look out for, may encourage information sharing as staff have more confidence in the relevance of their contribution. Our findings may also represent the influence of a hierarchical culture, with some team members dominating the flow of information around the team and other subordinate team members holding back.[15 16 50–52] This suggests that specific strategies designed to promote a more democratic environment,[53] or to facilitate speaking up, are needed to mobilise the full resources of the team.[54–57]

Communication failures

Failures in effective sharing of information were very common in our study. An individual team member failed to share an important piece of information relevant to clinical care on over one third of occasions. There were no teams where all team members correctly answered all questions about the information probes and average test scores for knowledge of the information were under 50%. This was a concern as the probes were designed to be important enough to share with the team. Even incorporation of formal team communications such as precase briefing, sign in and time out, while promoting information sharing, failed to overcome failures in communication of key items of information. Our findings build on other evidence from observational studies of communication failures in the OR[3 46 52 58 59] and support the need for interventions to improve the reliability of information sharing between OR team members.

Furthermore, our results suggest that more explicit and directed approaches to drawing out information from all team members may be required. The information probe methodology used here could well be an effective evaluation tool for such interventions.

Strengths and limitations

A strength of our study was the ability to track the same pieces of information across two standardised scenarios, across 39 full OR teams. Simulation allows for a controlled setting in which the scenario, individuals present, and information provided can all be standardised. However, it is possible that being in a simulated rather than clinical environment affected participants' likelihood of sharing information probes with the rest of the team.

The study was undertaken with staff from two hospitals. The extent to which our findings are generalisable to other hospitals remains to be tested.

The method for determining postscenario knowledge of the probe was a cued response (MCQ), so there was a possibility that participants could correctly guess the answer, thus inflating scores. The 11.5% correct answers for probes that were not mentioned at all by participants during the scenario support this possibility.

The relatively large spread in CIs for the logistic regression suggests that a larger sample size could provide a better estimate of effect size. However, the results are still highly significant.

CONCLUSIONS

A shared mental model is fundamental to effective team performance and depends on effective communication of information between members of the team. While our study supports the value of formal team communications as promoted in the WHO SSC, our findings suggest suboptimal transmission of information between team members and unequal contributions by different professional groups. Interventions to ensure that all relevant information is shared between members of the OR team are likely to include educational interventions, specific communication strategies, organisational change and potentially a cultural shift towards more a democratic team environment.

Contributors All listed authors have contributed to the design of the study, data collection, data analysis and interpretation, and drafting and critically revising the content of the manuscript. All authors have approved the final version of the manuscript.

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Competing interests None declared.

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Notes