Characterization of non-technical skills in paediatric cardiac surgery: communication patterns†

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INTRODUCTION

There is a lack of information on non-technical skills in health care teams, and very little is known about the management of these variables in the operating theatre. These cognitive (situation awareness and decision-making) and social (communication, teamwork and leadership) non-technical skills complement a worker’s technical skills and contribute to safe and efficient task performance [1].

Following the aviation sector, high-risk industries, emergency services and military organizations began to realize that they could not manage to address their safety problems by attending only to technology or to technical skills. Nowadays, we know that human error is inevitable and cannot be completely eliminated, but efforts can be made to minimize, catch and mitigate errors by ensuring that people have the appropriate non-technical skills to cope with the risks and demands of their work [1]. Consequently, organizations must now search for the ability to adapt in order to meet changes. “It’s not enough that they are reliable so that the failure probability is acceptably low. They must also be resilient and have the ability to recover from irregular variations, disruptions and a degradation of expected working conditions” [2]. In effect, the frontline personnel represent the last line of protection of a system’s defences, and much of the resilience that has been demonstrated by health care systems has been initiated by clinicians. Not only are they responsible for the active failures that can contribute to losses and injuries, but more importantly, they also regularly catch and correct their own and others’ errors [1]. In spite of this evidence, non-technical skills are not yet a part of a physician’s training.

Regarding non-technical skills, communication plays probably the most important role in patient safety. Ineffective and inefficient team communication is frequently the cause of medical

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errors [3, 4], and according to the Joint Commission of Hospital Organizations, communication failures are even the leading cause of inadvertent patient harm.

Compared with other hospital settings, medical errors in the operating room (OR) can have catastrophic consequences for people’s lives. There is widespread recognition and evidence of the association between human communication breakdown and OR adverse events. According to Healey et al. [5], communication failures are the leading cause of surgical errors. Their study is characteristic of the major research approaches related to communication in health care. They characterize communication failures and relate them to errors and the negative impact on patient care [3, 6–8]. Particularly, in the case of cardiac surgery, significant work has been done by Catchpole et al. [9–11]. Despite the importance of these studies, focusing on failure does not allow us to learn about the adaptive strategies which individuals, teams and organizations use to create success [12]. In this regard, structured observation of communication interactions in the OR would help to identify not only deficiencies, but also successful practices in the system.

Therefore, ergonomic/human factors, characterized by its human-centred approach which aims to understand the interactions among humans and other elements of a system, can contribute greatly to the safe design of health care systems by considering the various needs, abilities and limitations of people. These interactions occur between staff and elements of socio-technical systems that could be other individuals, tasks, tools and technologies, physical environment or organizational conditions [13]. Several studies have already applied the human-factor approach to cardiac surgery [14–18].

So the aim of this study was to analyse and characterise cross-professional communication flow patterns in paediatric cardiac surgery using a human-factor approach, in order to improve the system’s safety and efficiency.

MATERIALS AND METHODS

During a pre-investigation period, a paediatric cardiac surgical team was observed for 20 h in order to capture the nature of their activities. This observation was complemented with informal questions to the clinicians in order to better understand cardiac surgical care.

Next, through observation and video recording, the same human-factor specialist analysed the intraoperative phase of 10 paediatric cardiac procedures (Ventricular Septal Defect = 4, Arterial Switch Operation = 2, Tetralogy of Fallot = 1, Reop Tetralogy of Fallot = 1, Sub Ao Membrane = 1, Mitral Valvuloplasty = 1) performed by informal and variable teams on children aged from 5 days to 12 years. The surgeries occurred between November 2010 and February 2011 and the first procedure of the day was always elected to limit professional fatigue. The video camera (Sony DCR-SR58) was placed on the feet of the patient, and the tape recorder (Philips Digital Voice Tracer 7675) was placed on the right-hand side of the anaesthetist to amplify the communication capture area. Moreover, the observer registered on paper all events that in some way could influence communication flow.

This complex kind of surgery demands a broad team of eight elements interacting: three surgeons—S1 (main surgeon), S2 (first surgical assistant) and S3 (second surgical assistant, usually a resident); one anaesthetist—A; one perfusionist—P; one scrub nurse—SN; one circulating nurse—CN; and one anaesthetist nurse—AN, distributed in the OR as shown in Fig. 1.

Despite the existence of broad non-verbal communications, only the content of verbal exchange events in surgery were systematically described, that is, any communication relevant to the surgical procedure itself, excluding social conversations and other discourse not related to a teams’ procedural tasks. Utterances were chosen as the unit of analysis, classified by the speaker and the receiver, and analysed relative to the total communication number in order to assess its distribution among the team. Tape analysis complemented video data, allowing for the detection or clarification of communication content not well understood.

Patients’ guardians gave specific consent for the study which was permitted by the hospital’s ethical board.

RESULTS

Various staff members (n = 21) participated in these 10 surgeries: seven surgeons (the main surgeon always being the same), three anaesthetists, three perfusionists and eight nurses.

The results of the communication analysis were separated into two main points: characterization of communication flow patterns (comprising communication frequency, direction, type, content and pattern) and factors influencing communication (comprising disturbing elements and interdependency with other non-technical social skills).

Characterization of communication flow patterns

Communication frequency. The 10 surgeries produced a total of 10 167 communications, with an average of 1017 ± 170.9 per procedure that lasted on average 136.2 ± 19.5 min (intraoperative phase only).

Almost all communications were directed to a specific element of the team. Only 0.7% were directed to all team members, sent mainly by S1. The frequency of communication between the different elements is shown in Table 1 and the
main channels are represented in Fig. 2. It was maximal between S1–SN, followed by S1–S2, S1–P and S2–SN. These four channels represented 52.7% of all communications. However, communication between S1 and A was not more than 5%. Communications between S3–A, S3–P, CN–AN, S3–team, CN–team and AN–team were residual with no attributed percentage. These results raise the passive role of S3 in team communication in accordance with its learning role. The results in Fig. 3 demonstrate that S1 was involved in the highest proportion of communication. The surgical staff consistently initiated and received most of the communications and next to them, SN and P were also very intervening elements.

The frequency of communications (related and not related to surgery) increased during waiting periods. These moments had technical causes (waiting for the patient’s body to be the right temperature) or non-technical causes (waiting for the arrival of S1). At first glance, these moments may seem to have only harmful consequences for the patient, but instead they were used with some frequency to augment team situation awareness with conversations between all team members. The more silent or quiet moments happened with S1 often asking for silence to improve concentration as S1 was engaged in more complex and technical actions. In contrast, the final part of the intraoperative phase was always agitated, with a large quantity of communications not related to surgery. It was clearly a phase of relaxation after the S1 tension and focus in the most complex technical actions.

Communication direction. Table 1 also reveals that the participation of each element on communication channels had
different characteristics. S1 and S2 were mainly senders to SN, S1 was mainly sender to S2 and, of the main channels, only the relation between S1 and P was more balanced in communication direction. Furthermore, Fig. 3 shows the kind of participation of all team members in communication. It is obvious the tendency of surgeons and anaesthetists to be mainly senders, and perfusionists and nurses to be mainly receivers. The exceptions are the above-mentioned passive role of S3 and the balanced communication direction of CN.

Communication type. The data obtained in the preliminary observation permitted us to categorize the variety of conversations registered into six major types of utterances: request, question, answer, statement, information and explanation. In this way, it was verified that the types of communication were very different for distinct staff roles as Table 2 demonstrates (higher values in bold). S1–SN's communications involved mainly requests and SN–S1 mainly questions; between S1 and S2, in the two senses, statements prevailed; S1–P involved mainly requests and P–S1 mainly answers; S2–SN involved mainly requests and SN–S2 mainly questions, as verified for S1–SN relation. Finally, for SN–CN requests prevailed and in contrary, explanations were the leading type of communication. The relatively high percentage obtained (30%) was due to the fact that three of the surgeries were training exercises for the inexperienced SN and that CN, experienced in that role, provided a great amount of information to his colleague.

Communication content. Regarding the content of the main channels of communication, it was observed that between surgeons and SN instrument request dominated. In spite of the variable SN situation, awareness often permitted the anticipation of needs and consequently made the verbal request by the surgeon unnecessary. Between surgeons, speech was dominated by the technical aspects of the procedure, and between S1 and P the content was about bypass and cardioplegia management. Finally, between SN and CN, communication was about the material and the equipment used.

The content analysis has also permitted us to analyse the critical degree of the messages. Clearly, if a misunderstanding occurs, the timely communication between S1 and P in bypass entry and cleaning is much more critical than an instrument request among S1–SN or SN–CN. Also, in spite of the fact that communication between S1 and A was only seventh in terms of frequency, we considered their content the second most critical due to the timely management of the administration of certain medicines, like heparin and protamine. Thus, although the most frequent communications occurred between S1–SN and S1–S2, the most critical communications occurred between S1–P and S1–A.

Communication pattern. There was an evident lack of systematization and homogeneity of communication between different team members in terms of time and in form of content. The same information was given in different ways at different times, even by the same person. A good example was the surgery briefing done in the OR that sometimes occurred in the preoperative phase and sometimes was already accomplished in the observed intraoperative phase.

Communication patterns varied between different professionals, being closed-loop only between S1 and P, and mostly open among other team members. Closed-loop communication involves the following sequence of actions: sender initiates the message; receiver accepts the message and provides feedback which is received; and sender double checks to ensure that the message was received as intended.

The mostly open pattern that was verified between all other team professionals can be considered more susceptible to information loss because there was no confirmation that the information had been well understood. Moreover, team members repeatedly began their utterances with the name of the colleague. Finally, communication between team members was unnecessarily interrupted, with some frequency, by questions from others, potentiating also information losses.

Factors influencing communication

Disturbing elements. There were several factors that disturbed communication. First of all, the high noise level registered due to three main sources: teamwork-, material or equipment- or environment-related. Team communications themselves, sometimes in the form of cross-conversations, were one of the most perturbing factors for communication failure and noise increment. Equipment, material or device unpacking, mainly done by nurses, saw and suction equipment used by surgeons, the strokes on the heart-lung machine at the beginning of surgery and bypass cleaning performed by P, and equipment alarms mainly derived from anaesthetic workstation (sometimes disconnected due to the unbearable disturbance) are examples

Table 2: Team members' type of communication (five main channels)

<table>
<thead>
<tr>
<th></th>
<th>Request</th>
<th>Question</th>
<th>Answer</th>
<th>Statement</th>
<th>Information</th>
<th>Explanation</th>
<th>Main type</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1–SN</td>
<td>84.2</td>
<td>2.4</td>
<td>5.4</td>
<td>6.5</td>
<td>0.8</td>
<td>0.7</td>
<td>Request</td>
</tr>
<tr>
<td>SN–S1</td>
<td>1.2</td>
<td>40.7</td>
<td>27.5</td>
<td>26.7</td>
<td>3.1</td>
<td>0.8</td>
<td>Question</td>
</tr>
<tr>
<td>S1–S2</td>
<td>4.5</td>
<td>4.5</td>
<td>2.6</td>
<td>59.9</td>
<td>3.2</td>
<td>25.2</td>
<td>Statement</td>
</tr>
<tr>
<td>S2–S1</td>
<td>0.3</td>
<td>3.6</td>
<td>27.6</td>
<td>55.6</td>
<td>3.0</td>
<td>9.9</td>
<td>Statement</td>
</tr>
<tr>
<td>S1–P</td>
<td>30.0</td>
<td>24.0</td>
<td>12.0</td>
<td>12.6</td>
<td>20.0</td>
<td>0.7</td>
<td>Request</td>
</tr>
<tr>
<td>P–S1</td>
<td>0.5</td>
<td>12.0</td>
<td>65.4</td>
<td>6.9</td>
<td>15.0</td>
<td>0.2</td>
<td>Answer</td>
</tr>
<tr>
<td>S2–SN</td>
<td>76.4</td>
<td>2.7</td>
<td>6.5</td>
<td>12.0</td>
<td>1.4</td>
<td>0.9</td>
<td>Request</td>
</tr>
<tr>
<td>SN–S2</td>
<td>0.9</td>
<td>38.7</td>
<td>17.9</td>
<td>36.3</td>
<td>1.9</td>
<td>4.2</td>
<td>Question</td>
</tr>
<tr>
<td>SN–CN</td>
<td>35.6</td>
<td>12.2</td>
<td>25.9</td>
<td>21.3</td>
<td>5.0</td>
<td>0.0</td>
<td>Request</td>
</tr>
<tr>
<td>CN–SN</td>
<td>1.9</td>
<td>20.8</td>
<td>18.3</td>
<td>23.6</td>
<td>4.7</td>
<td>30.6</td>
<td>Explanation</td>
</tr>
</tbody>
</table>

Note: The highest values in each row are highlighted in bold.
of significant noise sources during the intraoperative phase of the procedure. Other equipment, not related to surgery, were also noise producers. The leadership positions at the hospital level, occupied by some elements of the team, make them likely to receive urgent and important calls with some frequency.

The noises caused by environmental factors were led by the opening and closing of doors of OR. The OR used in these 10 surgeries was always the same and it had two doors. Lengthy journeys to make blood tests or to get equipment and provisions located outside were needed, but a mean frequency of 102.5 ± 22.7 entrances/exits registered per surgery seems enormous and even excessive. Also, although not frequently and at a very low volume, some background music was added by clinicians. All these noise producers were potentiated by the bad acoustics of the room.

Other factors also caused some distractions and interruptions which disturbed communication; for instance, technology-related events with technical problems occurring in the equipment that interrupted normal work activity. This was the case in two distinct situations, one with the anaesthetist's equipment and an other with a camera placement to film the surgery for a class. Resource-based issues, such as the lack of material with the desired characteristics, supervisory or training-related issues due to external students, the entry of external team members into the room to ask questions, besides the already referred to calls that sometimes demanded the recipient left OR, were also causes of frequent interruptions and distractions.

**Interdependency with other non-technical social skills.**

The communication analysis also permitted and supported a general assessment of other non-technical social skills, teamwork and leadership that influence and are greatly influenced by communication.

Despite the existence of some examples in our study, real signs of teamwork were rare between different disciplines. The feeling that emerges is that each one is there to do his/her work, but teamwork is much more than the sum of all the team members’ work. Regarding the factors defined by Salas et al. [19] for teamwork, the signs of monitoring each other’s work (mutual performance monitoring) were low. Sometimes it happened, above all with the perfusionists and circulating nurses who, in some phases of surgery, had more time without action and were more available to monitor their colleagues. Also present, even in a more reduced percentage, were behaviours of providing feedback to improve performance or to assist in performing a task and to complete the task for a colleague (back-up behaviour). However, there were more signs of the adaptability of individual team members based on information gathered from the task environment with compensatory behaviours and reallocation of resources (mainly in nurses).

Concerning leadership behaviour, it was clearly noted that the situation awareness essential to effective teamwork was deficient (mainly in nurses and especially in perfusionists), due also to the lack of information about surgical developments provided by S1.

**DISCUSSION**

Non-technical skills can be very important to improve resilience in a complex system and, until now, they have not received the proper attention. The characterization carried out in this research aims to contribute to the understanding of what can be done to improve communication in particular. This discussion is divided into four parts. The first part regards the characterization that was developed, the second covers the factors influencing communication, the third points out the lessons learned and some strategies for communication improvement and, finally, the fourth part presents the concluding remarks.

**Characterization of communication flow patterns**

The characterization of communication has permitted us to understand the information flows and patterns and also to identify some weaknesses and a clinician’s adaptation strategies in the surgery room.

**Communication frequency and content.** The leading communication frequency of S1 is in agreement with the results obtained by Parush et al. [20]. This fact could be explained by its leading role and because S1’s attention is directed primarily to the surgical site and so relies almost exclusively on human communication to receive situation-related information, with much of it—especially while the patient is on bypass—coming from P. Yet, the high communications percentage of SN and S2 are different from those obtained by Parush et al. [20], but can be explained due to the variation of other factors. In some surgeries, S1 was only present for the most complex technical actions of the intraoperative phase and it was S2 who led the surgery at the beginning and at the end of this phase, which augmented his participation. SN’s values could also have a great variation depending on their experience, situation awareness and consequent anticipatory ability, which avoids a great amount of requests and questions.

The most critical communications occur between S1 and P and S1 and A as verified by Parush et al. [20] which means that, when needed, the prioritization of improvement initiatives must take into account both quantitative and qualitative data.

**Communication pattern.** The lack of systematization and homogeneity of the communication between different team members in time and in form of content is consistent with the conclusions obtained by Lingard et al. [3], who found that communication between professionals was highly variable in time and clarity.

The evidence of a more patterned and structured communication between S1 and P was also verified by Hazlehurst et al. [21]. Each one of these professionals has access to information that the other does not. S1 has visual access to the surgical field, whereas P has visual access to the various displays and controls of the heart-lung machine and other equipment not visible or accessible to S1. The successful execution of cardioplegia management and defibrillation tasks requires the effective integration of this information, and P is the element that has less access to live information because he is placed behind S1. The synchronization of their critical actions lies exclusively in the verbal communication established and that explains the strategy of more systematic and structured exchanges being developed by these professionals. The discomfort with this constraint was physically expressed by P in that, when possible, he stood up next to S1 to see the procedure develop. Likewise, S1 turned back to talk to P when the task permitted.

Another detected communication strategy was calling the receiver’s name at the beginning of an utterance to avoid doubts about the audience. This was usually the case with surgeons who
usually did not stop looking at the patient chest when talking to their colleagues, or P who had the heart-lung machine in front of him and so was not able to look directly at his team mates.

Factors influencing communication

As stressed by Healey et al. [5, 22], the causes of communication failures are not limited to interpersonal exchanges alone. They are derived from a whole range of systemic factors, such as the design of team processes and procedures, the media employed for communication or the working environment. This fact was also verified in this study, with the same disturbing elements registered. The most annoying were those related to noise and especially the high personnel flow, suggesting a general lack of control over different zones of activity which must urgently be avoided.

Concerning other non-technical skills, efforts must be made to improve teamwork weakness in order to improve the resilience of the system. Leadership behaviour must be approached with caution. The lack of situation awareness previously noted may be due to the lack of information about surgical development provided by S1, but he probably cannot be the only one responsible for that update. S1 was already present in 50% of all communications that along with the high cognitive charge demanded by his task renders the addition of another load difficult.

Lessons learned and strategies for improvement

A simple observational study like this raises important issues that must be addressed. According to the results obtained, some behavioural, technological and organizational tracks are proposed.

Training. Communication patterns have shown a lack of systematization, which in some way is comprehensible. Non-technical skills are neither formally taught nor included in competence assessments. Effective communication is situation- or personality-dependent and it is the experience of clinicians that moulds their behaviour. There is evidence that communication can be improved in the operating theatre and that training would be crucial moments to render clinicians more aware of those matters and problems that are usually muffled by technical issues. Furthermore, some communication tools like, for instance, SBAR [24] which involves clarifying the problem (situation), then giving pertinent background information, followed by an assessment of the situation and a recommendation, must be used to provide a common predictable structure to the messages. Therefore, the cardiothoracic unit should soon start a training programme that aims to establish more structured communication patterns.

Technology. Although the most frequent communications occurred between S1 and SN, the most critical occurred between S1 and P. The study of Hazlehurst et al. [21] described and enhanced P’s activity which, until then, had not been emphasized in the literature. However, there is no other layer of defence for this interaction if anything goes wrong and a misunderstanding occurs. Furthermore, if P had a better situation awareness of the surgery progress, he could anticipate some of its actions and contribute to decrease bypass time which is very harmful to the patient.

These findings stress the need to look for the means or the equipment to mitigate the potential of information loss and cognitive charge and to improve situation awareness, in order to augment the systems’ resilience. In this specific communication channel, information technology (IT), namely a screen monitor, could play a major role in showing images of the procedure’s progression and any additional information which needed to be shared (for instance, the main patient characteristics such as age and weight), providing redundancy to a possible communication failure. That is indeed a solution to be tested. Regarding improvements through IT, and particularly screen monitors, some studies have highlighted its importance to improve team situation awareness. Parush et al. [20] have developed an augmentative information display and Hazlehurst et al. [21] enhanced the importance of information technologies to improve distributed cognition in the heart room. In this way, besides supporting technical skills, IT can also have an important role in supporting non-technical skills.

Research into actual practice at the sharp end of health care will provide the basis of understanding how IT can support clinical practice, answering the organization and users’ needs, and avoiding another source of error that arises when the main preoccupation is only its technological power. The study of Parush et al. [20] where technology was adopted according to communication needs is a good example.

Meanwhile, management staff must also be aware that the present rhythm of new technologies introduced (e.g. information systems or medical devices) influences communication characteristics and needs and, consequently, demands a continuous evaluation to update the system’s new variables.

Health care, as with other sectors, and regarding specifically technology, must be aware of its real needs in order to assist
developers to design ongoing adaptation and be more demanding with manufacturers to fulfil their real needs.

Organizational level. Regarding the above-cited questionable positioning of perfusionists and the constraints it places, an added organizational physical measure, besides the introduction of technology, is going to be tested by putting the peerperfusionist in front of S1. However, this disposition implies the positioning change of SN to the right-hand side of S1, breaking well-established activity routines. In addition, other variables such as the (possibly diminished) viewing angle of SN regarding S1’s technical actions and the increase in movement paths to provide devices to S1 (raising physical fatigue in SN) must be tested, and other positive and negative consequences should also be analysed and simulated regarding their effects on teamwork.

Furthermore, the disturbing factors detected were almost totally dependent on organizational parameters that can be enormously improved. As a first step, the high frequency of doors opening during surgery must be reduced through new rules for non-technical factors and better organization for technical issues. Nevertheless, the attention dedicated to these variables cannot be resumed only to those registered in the sharp end of the system (OR) but must also be to those at the blunt end, at higher levels of management. A critically important element will be to dissociate the inevitable errors and communication failures associated with human performance from the issue of clinical competency as defended by Leonard et al. [24], touching the old problem of culture blame in health care.

Concluding remarks

This study has analysed the human–human interaction in the OR, and the approach was limited mainly to communication flow patterns. Other non-technical skills must also be systematically approached following the system perspective defended by human factors. The next obvious step should be the follow-up of the measures that are going to be implemented in order to compare the results before and after its implementation. In addition, further studies must be developed to evaluate the impact of the measures, namely focusing on performance and performance outcomes. This cyclic process should be integrated in a more comprehensive quality improvement programme will feed the system with continuous information that should be integrated to provide increased efficiency and safety.

Surgery is a complex and high-risk activity. Therefore, it should be expected that there would be a high level of control in the operating theatre environment, a high level of reliability in the equipment and low interference overall [15]. But the feeling that remains after a detailed observation is that this scenario has still huge room for improvement. The solution to attain this purpose is to implement a systems approach to safety that is only possible with a continuous and structured strategy of research.

Health care must understand its specificities more profoundly and, when required, call on other disciplines to support its progress in a more sustainable and efficient way. As socio-technical systems become more complex, a greater range of expertise is necessary to obtain a well-grounded understanding in order to improve the various interactions between people and those systems. Ergonomics/human factors can also be an essential addition to health care, building bridges to enable an effective interaction of the major complex socio-technical system components. In effect, being the first step in identifying the human, team and organizational factors that support safe and high-quality surgical outcomes, understanding human factors can accomplish an important role in cardiac surgery. The challenge is launched.

Conflict of interest: none declared.

REFERENCES

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I will also address the variable informal teams. Variable informal
tems disrupt standardization and communications. Performing particular
procedures over and over increases learning opportunities and
improves anticipations. Conversely, having to think about everything every
time leads to imperfections. A checklist can facilitate systematization and
avoid errors.

My question is simple. Did you discuss the findings with the administration and the team in order to produce a plan of action to address these issues?
This is an interesting issue; non-technical issues play an important role in
the reason that people fail in life.

Dr Fragata: I have always had big concerns about non-technical skills, I
Teach them at university and I have introduced checklists and briefings in my
operating theatre. Although that continues, I recently hired a psychological
observer, Santos, a non-medical person, to observe our behaviours in the op-
erating room. She then produced the results. I was somewhat concerned
about presenting them, but they represent the reality in my theatre; until
then, I would have thought that we were reasonably safe. Considering the
issue of informal teams, teams comprising the same people all the time, it is
known from civil aviation that this is a dangerous way to manage teams, and
cockpit personnel are very seldom the same, they change constantly.

Regarding the organizational issues, I believe that adequate institutional
support and proper planning can avoid delays in arriving in the OR, calls un-
related to the procedure, as well as preventing unnecessary entrances and
exits by providing a dedicated operating room with a core team whose needs
are met. A camera in your headlight and two screens in the right spots can
keep the team informed about the development and progression of the
surgery. In addition, changing the position of the scrub nurse and the second
surgical assistant would also help. As a chief, it is within your power to reduce
cross-conversation and disruptive interruptions of communications.

Concerning the non-technical issues, you would agree that more than
1000 communications per case is far too many. Suboptimal teamwork and
and collaboration among disciplines can be improved by removing barriers to the
exchange of knowledge and promoting bottom-up participation to find solu-
tions in the collective intelligence of people at all levels. Ideally, in complex
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issue of informal teams, teams comprising the same people all the time, it is
known from civil aviation that this is a dangerous way to manage teams, and
cockpit personnel are very seldom the same, they change constantly.

Concerning the non-technical issues, you would agree that more than
1000 communications per case is far too many. Suboptimal teamwork and
and collaboration among disciplines can be improved by removing barriers to the
exchange of knowledge and promoting bottom-up participation to find solu-
tions in the collective intelligence of people at all levels. Ideally, in complex
systems, all members contribute to the quality of outcomes with an inte-
grated approach in which communication, organization, interdependence and mutual supervision are crucial. However, as in an orchestra, a conductor
is still needed.

I will also address the variable informal teams. Variable informal
team disrupt standardization and communications. Performing particular
procedures over and over increases learning opportunities and
improves anticipations. Conversely, having to think about everything every
time leads to imperfections. A checklist can facilitate systematization and
avoid errors.

My question is simple. Did you discuss the findings with the administration and the team in order to produce a plan of action to address these issues?
This is an interesting issue; non-technical issues play an important role in
the reason that people fail in life.