

Chapter 5

Scrub Practitioners' List of Intra-Operative Non-Technical Skills – SPLINTS

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Modern surgery requires a group of people with a variety of skills to work together effectively to deliver patient care. In addition to their technical expertise, members of an operating theatre (OT) team will utilize a range of 'non-technical' skills. These are the cognitive and social skills that complement technical skills to achieve safe and efficient practice. Taxonomies of these non-technical skills have already been identified for anaesthetists' (see Glavin and Patey, Chapter 11 in this volume, Fletcher et al. 2004) and surgeons' performance (see Yule et al., Chapter 2 in this volume, Yule et al. 2006b) in the intra-operative phase of surgical procedures. Another key member of the theatre team is the scrub (or instrument) nurse, practitioner or technician,¹ who works directly with one or more surgeons while they are operating on the patient. As there was no taxonomy of non-technical skills for this member of the scrub team, a research project (funded 2007–2009 by NHS Education Scotland) was established to identify these skills and this chapter will describe the findings of the SPLINTS project to date.

Background

The aviation industry lead the way in the non-technical skills approach by developing special research programmes to identify pilots' cognitive and interpersonal skills that influenced flight safety. These skills are trained in special courses called Crew Resource Management (CRM) with the aim of reducing human error and improving the performance of flight crews (see Musson in Chapter 25, Wiener et al. 1993). The effectiveness of CRM training can be evaluated by using attitude surveys or observing and rating individuals' performance during task execution to establish whether training has resulted in knowledge transfer and improved skill execution (O'Connor et al. 2008). To increase the reliability and objectivity of these observations, behavioural assessment tools have been developed by listing the observable non-technical skills taught in these courses and devising a rating system to assess them. Other high risk work settings such as nuclear power, shipping and military have also accepted that human factors impact on safety and production and have also developed

¹ Although this project focussed on scrub nurses, the resulting skills taxonomy will be relevant to the scrub role whether that is performed by a nurse, practitioner or technician.

this type of training and assessment method (Flin et al. 2008). In recent years, there have been efforts to extend the research and training in non-technical skills into areas of acute healthcare services, such as surgery, trauma centres and intensive care units (ICUs) (Baker et al. 2007). A recommended tool for rating individual airline pilots' behaviour called NOTECHS was developed by European pilots and psychologists (see O'Connor et al. 2002) and it has been adapted to rate teamwork in the operating theatre (see Catchpole et al. in Chapter 7, Undre and Sevdalis in Chapter 6). Rather than adapt tools designed for airline pilots, some other research teams have taken a task analysis approach to identify non-technical skills, e.g., in anaesthesia (Fletcher et al. 2004), surgery (Yule et al. 2006a; 2006b), ICU (Reader et al. 2006) and neonatal resuscitation (Thomas et al. 2004). These investigators have then devised behavioural rating systems, to evaluate the identified skills and these are now being used in professional training and formative assessment (see for example, Yule et al. in Chapter 2). Some of the team-based tools include behavioural ratings of nurses (e.g., Catchpole et al. 2008, Undre et al. 2006a) but, despite nurses being a key member of the operating theatre team, their particular non-technical skills have not been formally identified. The first task of our research project was to search the nursing and psychology literature for any studies of nurses' non-technical skills.

Literature Review

We searched electronic databases including BioMed Central, NHS e-library, Web-of-Science; publications from the Association for Perioperative Practice (AfPP), Association of peri-Operative Registered Nurses (AORN) and university library catalogues and bibliographies from related research papers. The skill categories searched for included communication, teamwork, situation awareness, leadership, decision-making and additional search terms such as *lead*, *trust*, *discussion* and *relationships* were included to keep the search as broad as possible.

The literature search identified very few studies, in fact from an initial total of 424 publications identified, only 13 papers had data pertaining to non-technical skills of scrub nurses (for full details see Mitchell and Flin 2008). Those papers only discussed the skills relating to scrub nurses' communication, teamwork and situation awareness (see Table 5.1).

There were no behaviours identified from this literature which could be classified as scrub nurses' leadership or decision-making although these may be skills which scrub nurses also require. Leadership might be displayed when assisting/advising junior team members and decisions could be made in relation to timing requests. For example, deciding when to ask the circulating nurse to bring warm saline to the table because if it is brought too soon, it will be cooled by the time the surgeon requires it and if this request is made too late, the surgeon will have to wait. The identified studies of scrub nurses' communication, teamwork and situation awareness are now briefly summarized in order to illustrate the types of behaviours which have received research attention.

Table 5.1 Non-technical skill categories examined in the 13 included papers

Paper	Non-technical skill				
	Communication	Teamwork	Situation Awareness	Leadership	Decision-making
Awad et al. (2005)	X	X			
Baylis et al. (2006)		X			
Edmondson (2003)	X	X			
Flin et al. (2006)	X	X			
Nestel and Kidd (2006)	X	X			
Riley and Manias (2006)	X	X	X		
Saunders (2004)	X				
Sevdalis et al. (2007)	X				
Sexton et al. (2000)	X	X			
Silen-Lipponen (2005)	X	X			
Tanner and Timmons (2000)		X			
Timmons and Reynolds (2005)		X			
Undre et al. (2006b)	X	X			

Categories of Scrub Nurses' Non-technical Skills

Communication

Communication is seen as fundamental to all types of nursing but the focus has mainly been on communicating with the patient as opposed to with colleagues. Despite the recognition that all members of a team require effective communication skills to enable the smooth running of the operating theatre (OT) (Taylor and Campbell 2000), insufficient or ineffective communication between team members in the OT setting has been recognized as a contributing factor to some adverse events (Helmreich and Schaefer 1994). This has led to the development of

checklists to promote team communication between the disciplines in the OT (see Lingard et al. 2005). Studies of nurses have shown general dissatisfaction with communication in the OT (Nestel and Kidd 2006). Case-irrelevant communications for example, questions about a previous patient, telephone calls or bleeps within the OT, particularly those which are intended for the nurse or anaesthetist were also found to be distracting to the OT team (Sevdalis et al. 2007).

In the USA, CRM principles were used in an attempt to improve communication through medical team training which included didactic instruction, interactive participation, training films, role-play and team briefings. After this intervention surgeons and anaesthetists reported that communication had improved although there was no significant improvement in nurses' perception of team communication (Awad et al. 2005). In another study (Edmondson 2003), the ability of team members to voice concerns or speak up within the hierarchical structure of the OT was examined during implementation of new technology in cardiac surgery. Since use of the new equipment required interdisciplinary communication, difficulties staff reported were more behavioural than technical. Nurses reported that nursing staff in the team had not been accustomed to speaking up in the past, they would not have dared do so – but that surgeons had become more amenable to being questioned and team members listened more to others despite this being contrary to the previous power-based communication norms. Studies such as these illustrate that nurses' communication is obviously a key component of effective teamwork in this domain.

Teamwork

The composition of perioperative teams can vary, for example, the number of personnel, individual levels of experience, competence and familiarity of working together. We identified teamwork papers that mentioned nurse behaviours intended to aid teamwork such as memorizing surgeons' preferences and sharing information. There was also research on the effect on performance of stable versus flexible theatre teams. Attitudes to teamwork and hierarchy were also common themes discussed in these nursing articles.

Researchers have examined teamwork in the field of medicine to try to develop ways to enhance patient safety and increase team cohesion to reduce error. Perceptions of teamwork have been found to differ between disciplines. Nurses largely felt that the theatre team was a single unit, in contrast with surgeons' impressions of being a member of a team which comprised several highly specialized sub-teams (Undre et al. 2006b). Sexton et al. (2000) found low ratings of teamwork by surgical nurses in the USA and Europe when they rated interactions with consultant surgeons. In a Scottish study, surgeons rated their quality of relationships with other consultants and nurses equally, whereas nurses rated teamwork and communication with other nurses higher than between themselves and surgeons (Flin et al. 2006). Since Stein's classic paper (Stein 1967), in which the working relationship between doctor and nurse was described

as a 'game' which involved nurses learning the art of making suggestions to doctors without appearing to do so, several researchers have considered how this relationship has evolved (e.g., Hughes 1988, Mackay 1993, Porter 1991, Stein et al. 1990, Svensson 1996). They have offered differing views as to why the relationship has changed, but the general consensus is that the relationship has become more informal over time. Still, ten years later, scrub nurses perceived their main responsibility as 'not upsetting' the surgeon or 'keeping the surgeons happy' (Timmons and Reynolds 2005).

Teams in the OT can either be flexible, where personnel are rotated, or stable, where members become used to working together as a unit. However, even within stable theatre nurse teams, members may alternate between scrub and circulating roles if they are multi-skilled. A study in Finland, UK and the USA by Silen-Lipponen et al. (2005) found stable OT teams helped combine team members' skills, enabled advance planning and promoted safety. When interviewed, less experienced nurses admitted that in a strange team they felt unable to prepare or participate in the planning of the surgery. There was also frustration from nurses towards the attitude of some surgeons, who seemed unaware that their operating style differed from that of their colleagues when they assumed that nurses would automatically know what equipment they required, resulting in the nurses becoming flustered and liable to make errors, causing concern for patient safety. Baylis et al. (2006) concluded that staff on unplanned leave being replaced in the team by temporary staff resulted in a higher incidence of complications. Familiarity with a surgeon's way of working helps the scrub nurse to anticipate what the surgeon will need and in what order. This cognitive skill, called 'situation awareness', was considered from the scrub nurses' perspective in only one paper.

Situation Awareness

Situation awareness is defined as 'the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future' (Endsley 1995, p. 36). The term was initially coined in military aviation, but is now being adopted by many other professions. Perceptual and anticipatory cognitive skills are clearly critical for scrub nurses as an element of their expertise is to 'think ahead of the surgeon'. The scrub nurse uses situation awareness, in addition to technical knowledge, to assess the stages of the surgical task correctly in order to select the appropriate instrument for the next phase of the operation. Situation awareness is not a term which has been used in the nursing literature, although an Australian study observing theatre nurses used the term 'judicial wisdom' to describe the way nurses combine their personal expertise, ability to read surgeons' demeanour and knowledge of surgical procedures to make sense of situations rather than interrupting surgery by asking questions. This unobtrusive manner of assessing the situation without interrupting was labelled 'prudent silence' (Riley and Manias 2006, p. 1548).

Surgeons' preference cards are used as an aide memoire for theatre nurses to gather the instrumentation the surgeon has indicated in the past that s/he prefers to use while performing the different procedures within his or her surgical speciality. In one study, the cards were often altered or unclear and sometimes included a choice of instruments for a single procedural element (Riley and Manias 2006). This was taken as indicative of the changeable nature of surgeons' requirements, making anticipating their needs much more difficult. That paper was the only one found directly studying scrub nurse situation awareness but since situation awareness has only recently been investigated in relation to surgeons (Way et al. 2003) this is not surprising. There have, however, been studies of situation awareness in other areas of nursing such as neonatal intensive care (Militello and Lim 2006). Scrub nurses were also interviewed about surgeons' non-technical skills during non-routine procedures and they referred more often to surgeons' interpersonal skills than cognitive skills as being important to the success of the procedure. Nurses said they were able to judge the mood and concentration level of the operating surgeon by observing and understanding their behaviour, and nurses also demonstrated situation awareness by reporting that they were able to comprehend that a patient's state was deteriorating by perceiving changes on physiological readouts (Yule et al. in preparation).

Decision-making and Leadership

The literature review did not uncover any papers specifically related to decision-making by scrub nurses during operations although they are obviously required to make decisions during interactions with surgeons and other team members whilst engaged in intra-operative problem-solving. Similarly, nurses' leadership was a skill which although studied in other areas of the hospital; for example, emergency departments and critical care (Nembhard and Edmondson 2006) did not appear to have been examined for scrub nurses. It is possible that leadership is not required by scrub nurses, yet this would be a skill displayed in a situation where an experienced scrub nurse is working with a less experienced or trainee circulating nurse or with an inexperienced surgeon.

So, from the literature we could see that although there was some evidence of the non-technical skills of scrub nurses having been examined, they were usually extracted where nurses had been interviewed or observed with regard to the theatre team as a whole or as a consequence of investigating surgeons' skills, improving safety or reducing error within the OT. Since such a small number of papers identified scrub nurses' non-technical skills in the course of the literature review, the next step in the project, to provide more examples, was to use a different method of task analysis (see Flin et al. 2008). Observing task execution and semi-structured interviews with experienced scrub nurses were two of the methods available. The project team consisting of experienced theatre nurse practitioners, a consultant surgeon and research psychologists chose the latter. Interviews with 25 scrub nurses and 9 consultant surgeons, to obtain a surgical perspective, were

conducted. Ethics approval was granted from both UK National Health Service and University School of Psychology Ethics Committees.

Scrub Nurse Interviews

Semi-structured interviews with scrub nurses (n = 25) (mean scrub nurse experience of 15 years; range 2–33 years) were conducted at three Scottish hospitals to extract the non-technical skills required to do their job effectively. The interview protocol consisted of general questions designed to elicit responses which would provide details of non-technical skills used in general, day-to-day working as a scrub nurse during surgery. These questions were designed by drawing on knowledge of the generic non-technical skill categories (e.g., communication, decision-making, leadership, situation awareness) which had emerged from previous skill taxonomy development (Flin et al. 2008). Table 5.2 gives a sample of the questions asked in the interviews. For example, question 4 asks about what decisions the scrub nurse thinks s/he makes, questions 6 and 7 are designed to tease out situation awareness skills and question 8 elicited responses about teamwork and communication.

There were also questions where the interviewee was asked to recall a challenging case, to extract skills necessary to facilitate bringing a case to its conclusion on occasions where a diversion from the original plan is necessary. The interviews were conducted during the nurses' working shift in a quiet area and were digitally recorded before being transcribed and coded independently by LM and a psychology PhD student using QSR International's NVivo 8 software (NVivo 2008).

Table 5.2 Examples of scrub nurse interview questions

No.	General questions
4	What sort of decisions do you have to make during surgery?
6	How do you keep track of the status of an operation?
7	What factors affect the working atmosphere in the operating theatre?
8	What do you do to keep others in the team informed of what you are doing or requiring?
No.	Case-related questions
10	What did you contribute to making that operation end successfully?
11	Describe how your relationship with the circulating nurse helped you perform your role.

Results and Discussion

It quickly became apparent that the nurses were very keen to talk about their work and the interviews produced extremely rich data. At the time of writing, analyses of the data were ongoing but examples are now given of some coded segments in the identified non-technical skill categories. During coding, phrases fitting several different skill categories were regularly coded in answer to a question designed to capture one skill.

Communication

For example question 4, designed to elicit decision-making data, elicited a response coded as communication:

If I hand over a suture which is short, maybe because the surgeon has already used it, I would say to him 'that's a short length' to make him aware of it otherwise he could get half way through using it before realising.

The reasoning behind this type of communication is so the nurse feels she has given the surgeon enough information for him/her to decide whether this will be a long enough suture for the immediate task. If it is not, she expects that the surgeon will tell her so that she can mount a full-length suture instead. This is to minimize the chance of causing the surgeon to become frustrated were s/he to discover, during the task, that the suture is shorter than expected and to prevent a confrontation with that surgeon, or delay in the procedure, while that is rectified. A number of items were coded referring to the different manner in which nurses speak to or communicate with different surgeons. For example:

There are certain surgeons that if certain things happened, I feel able to say, 'Would this [piece of equipment] help?' and there are also surgeons who I would never suggest anything to.

The scrub nurse regularly communicates with all members of the theatre team; examples of communication items between the nurse and surgeon, circulating nurse and anaesthetist are shown in Table 5.3.

Teamwork

The data produced by the questions relating to teamwork were interesting. Generally, when asked to 'Describe the team that you work in when in theatre', the nurses named the other nursing team members, for example, team leader and circulating nurse, rather than describing members of the whole theatre team. Further questioning by the interviewer resulted in the surgical and anaesthetic team members also being described indicating that, in this sample of nurses, they

Table 5.3 Interviewee responses categorized as communication**Communication**

If you can't see it [swab], you have to ask [the surgeon] what they've done with it. Sometimes they'll say, 'there's one inside' but they don't always.

If there are specimens to go off, I might say to the circulating nurse, 'go and get the registrar, he's [in another room], so that he can take these away in a minute'.

If there's a lot of blood loss, especially if that wasn't expected, I'll ask them [anaesthetist] if they want them [swabs] weighed because he's the one who'll be replacing the fluid.

did not automatically associate themselves as members of the whole theatre team, but rather as belonging to the nursing subteam. This contrasts with the majority view of nurses in the Undre (2006b) study who thought that OT professionals all belong to a single team whereas surgeons and anaesthetists perceived the OT as comprising multiple highly specialized teams. However, in our study, the nurses were advised that the interview was about their duties and skills as a scrub nurse which may have suggested that their role within the nurse subteam was under scrutiny. Additionally, they are very conscious that their ability to do their job efficiently depends largely on the working relationship with their circulating nurse.

It is unsurprising that a common theme to emerge was their relationship with the circulating nurse. The scrub nurse is the member of the team who is responsible for providing the surgeon with the equipment necessary for the procedure and once scrubbed can not leave the table. So, for the partnership between scrub and circulating nurse to work, the circulating nurse must be attentive and also follow the procedure. S/he must be able to anticipate the scrub nurses' needs so that s/he, in turn, is able to provide the surgeon with the equipment in a timely fashion.

You are ultimately dependent on them [circulating nurse] because you are stuck at the table and can't get anything.

I like to think we [scrub nurses] really do make a contribution to the end result. The people who are scrubbed at the table are useless without everybody else [in the team].

One underlying element of teamwork from the nurses' perspective appears to be coordination, i.e., that exchanges of information and equipment or instruments passing between team members must be smoothly executed, for example:

I am really pleased if I have been able to make everything flow in a challenging case.

...so that they're [surgeon] not having to wait when they ask for something.

This means that if the scrub nurse is 'one step ahead' of the surgeon then the circulating nurse has to be two steps ahead in order to enable this information/system to flow smoothly.

Situation Awareness

Situation awareness is most certainly a non-technical skill required by scrub nurses for effective performance. Available clues in the environment include listening to conversation exchanges between other team members, listening to and understanding changes in patient monitors, as well as observing changes in other team members' tone of voice, body language or demeanour:

Listening, being aware of the other stuff round about you. I am always tuned into the pulse sats or the ECG or something so I'm instantly aware of the changes because I might have to stop ...

You just know when something is going wrong, it's either ... you can physically see that something's happened but sometimes you can't see. You can just recognize the surgeon's body language, or see them clenching their jaw, that things are not going well.

These are skills which develop with experience and anticipation is an underlying element of situation awareness which one nurse enunciated:

The longer you are a scrub nurse, the more you are able to not just react to what the surgeon does, you can anticipate what the surgeon is going to do.

Decision-making and Leadership

As was found in the literature review, there were minimal data in the interviews coded as decision-making or leadership skills. Some phrases coded as decision-making included those relating to choosing which instrument to hand to the surgeon, the quantity of supplies (e.g., swabs) or when to ask for things to be taken onto the trolley. However, most of these items are driven by the nurses' knowledge of the surgeons' preferences or stages of the procedure.

Leadership was not seen as a role which the scrub nurse felt they had in the theatre team. The question 'who do you see as the leader in the team?' was answered with a mixture of responses but the senior nursing team leader on duty or a fluctuating leadership role between consultant anaesthetist and consultant surgeon as the procedure progresses were responses.

Consultant surgeon interviews In order to obtain a surgical perspective on what scrub nurse behaviours assist or hinder the surgeon to perform his/her task, interviews were conducted with nine consultant surgeons from four Scottish hospitals. The nurses' ability to anticipate and hand the surgeon instrumentation in a timely fashion were skills they appreciated:

She should watch me and be ahead of me, a step ahead ... when I say knife she will hand me the knife and she should know what I'm going to ask next ...

A lot of what you need arrives in your hand without you actually having got as far as asking for it, it's almost telepathy, it's smooth, it runs.

The scrub nurses' knowledge of surgical procedures and instrumentation were also skills which emerged as being important in the surgeons' view:

They [scrub nurse] don't ask if I'm going to need a mounted suture or a mounted tie – it will come mounted because they know I'm working deep and they know I'll not be able to reach. They don't hand me short scissors when I'm in the pelvis, they're going to give me long scissors.

One behaviour identified as negatively affecting the surgeons was when the scrub nurse is distracted by other people or issues in the theatre:

They need to have the ability to be quite focused on the procedure and not be distracted by what else is going on.

Although this was a common complaint from the surgeons, it should be acknowledged that the ability of the scrub nurse to assist the surgeon effectively seems largely as a consequence of their ability to absorb the conversations and cues in the rest of the theatre whilst still maintaining concentration on the procedure and the likely requirements of the surgeon. One surgeon acknowledged this point:

It requires the female thing, the multi-tasking, able to do all of those things simultaneously and still give you what you need.

A communication issue which emerged in interviews with both nurses and surgeons was on occasions where the surgeon can not bring to mind the name of the instrument that s/he requires the scrub nurse to hand over:

I find particularly when I am deeply concentrating and stressed out I can't find the names of the instruments.

One nurse explained how she compensates for that:

When they ask for something and you give them what you think it is that they need and it's not the thing they said but you know it is what they actually want.

Surgeons do seem to prefer scrub nurses to possess a certain degree of 'mind reading' ability although this skill appears to be a combination of knowledge of the procedure, familiarity with surgeons and their preferred methods and use of instrumentation. This knowledge, combined with the ability to listen and process sources of available information, for example, conversations and monitors in the operating theatre environment, enables them to assist the surgeon efficiently and seemingly effortlessly. These skills also appear to contribute to the satisfaction derived by experienced scrub nurses when a procedure 'flows', particularly when they have planned well, have all possible equipment available and have anticipated his/her requirements so that the surgeon does not have to wait for anything.

Future Direction for Project

The next step in the project is for expert panels comprising three to four theatre nurse team leaders to review the data segments (example described in Table 5.3). These panels will be tasked with labelling the skill categories and also with providing labels for the underlying categories within those skills. In previous taxonomies, for example, within the 'Situation Awareness' category of the behavioural rating system for surgeons' non-technical skills (NOTSS) (see <www.abdn.ac.uk/iprc/notss>), the three elements are

- gathering information;
- understanding information;
- projecting and anticipating future states.

Although the component elements of these skill categories remain to be determined for scrub nurses, it is likely that they will be similar to those previously identified for anaesthetists and surgeons however, it is critical that they are identified and labelled in terminology recognizable to scrub nurses if the rating system is to be valid for use by individuals in that domain.

Conclusion

There are a number of key non-technical skills required for effective and safe task performance by scrub nurses. One of the most important skills of the scrub nurse is situation awareness, that is, to monitor the actions of the surgeon, anticipate the surgeon's technical requirements and using coordination skills to enable the

smooth flow of the operative procedure. In addition, scrub nurses' ability to identify and cope with different surgeons' personalities and changing preferences is a skill which enables them to assess surgical situations, particularly when a procedure is not going according to the original plan. They appear able to identify the changing behaviour of surgeons as well as absorbing audible and visual clues in the theatre environment, so that they can adjust their own performance to assist surgeons effectively. This project will produce a prototype rating tool for use by nurses to rate observations of performance by them in the operating theatre. Currently, training and assessment of trainee nurses is by subjective assessment and a formal rating tool, such as SPLINTS, would be of benefit to both trainees and trainers as well as for ongoing training and assessment for scrub nurses, practitioners or technicians.

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