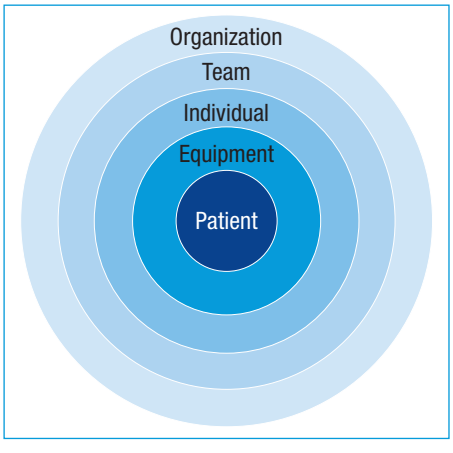
Human factor skills in the surgical environment

It is estimated that 16% of surgical patients in UK hospitals have an adverse event, with half deemed preventable (Vincent et al, 2001). Serious adverse events continue to occur regularly; with 83 cases of wrong site surgery, 42 cases of the wrong implant or prosthesis being used and 130 cases of a retained foreign object post operation in NHS England 2012–13 (NHS England Patient Safety Domain, 2014). The majority of these adverse events are not a result of failures in the technical skill of the surgeon but of so-called human factors (Shouhed et al, 2012).

The term 'human factors' describes the influences of humans and their behaviour within a work system. In surgery it encompasses everything from the culture within the workplace, to rotas and workload, how people work within the surgical team, how well-rested the surgeon is, down to the design of the equipment used (*Figure 1*) (Moray, 2000).

Figure 1. Human factors in a health-care system. Adapted from Moray (2000).



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It has been advocated (Vincent et al, 2004) that all these factors need to be considered when working to improve surgical outcomes; a so-called systems approach. Such an approach espouses the 'Swiss cheese' model of error development developed by Professor James Reason (2008). This model (*Figure 2*) identifies that for an adverse event to occur there is usually an accumulation of minor errors, propagated through multiple levels (often bypassing checks that would usually catch them) that ultimately result in the major adverse event. This model of error development is supported by the surgical safety literature, with Catchpole et al (2006, 2007) identifying that even in successful operations increasing numbers of minor errors are associated with major errors.

There is a danger that the human factors approach can appear defeatist at an individual level – 'to err is human' – the individual appears lost as a product of the system, damned to commit error as victims of circumstance. However, individuals within a system are also perfectly placed to capture and recover errors (Reason, 2008). This may be in the form of a 'heroic recovery' from an adverse event but much more frequently it is in mitigating the many minor errors we encounter on a daily basis. Human factors should not be considered theoretical but instead permeate and influence working practice through practical application of skills. These individual human factor skills are known as non-technical skills.

Non-technical skills for surgeons

Non-technical skills are 'the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance' (Flin et al, 2011). In surgery these have been defined through the NOTSS (non-technical skills for surgeons) taxonomy (*Table 1*).

Non-technical skills are not new skills; they are intrinsic to everyday work. They are related to how we do everyday things – reach diagnoses, make decisions, interact with colleagues, deal with stress – to maximize safety and efficiency. You will have encountered consultants who are very

Figure 2. The Swiss cheese model applied to a case of wrong site surgery. The 'slices of cheese' are defensive layers within the health-care system, the 'holes' are transient or permanent gaps in these defences. When the holes align a significant adverse event occurs.

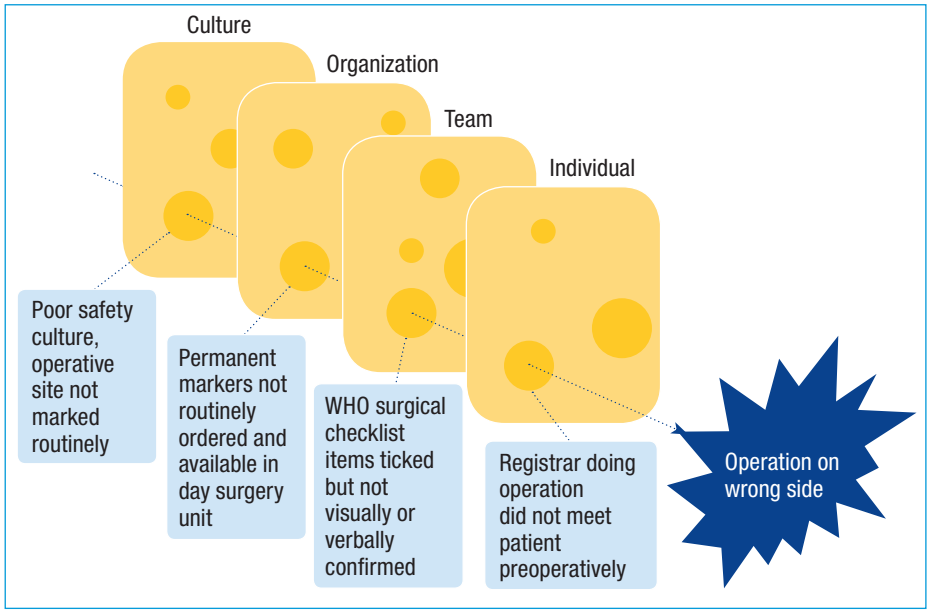

Table 1. The NOTSS taxonomy

Category	Element
Situation awareness	Gathering information Understanding information Projecting and anticipating future states
Decision making	Considering options Selecting and communicating option Implementing and reviewing decision
Leadership	Setting and maintaining standards Supporting others Coping with pressure
Communication and teamwork	Exchanging information Establishing a shared understanding Coordinating team

From Yule et al (2006)

good at anticipating and managing problems; they share the plan with the team and always seem in control. You may also have encountered others who always seem to run into difficulties, lose their temper, and expect things to be done without having asked. These scenarios reflect good and poor non-technical skills respectively. More usually people display a mix of non-technical aptitude. This article reviews each of the NOTSS skill categories below, with pointers on how to improve your own surgical performance in each area.

Situation awareness

Situation awareness can be thought of simply as 'knowing what is going on around you' (Flin et al, 2011) and is a necessary step before making decisions. In practical terms this involves consciously considering the information you have gathered and identifying any information that could be missing before developing understanding. For example a young female patient with right iliac fossa pain and raised inflammatory markers may appear to have appendicitis if a pregnancy test is missed. On the ward round, a patient may appear to be doing very well if we fail to notice a falling urine output and rising creatinine level. Similarly, it is very easy to overlook one of the new oral anticoagulants scribbled on a drug chart while obtaining consent for theatre.

Having gathered information and used it to form an understanding of the problem or diagnosis we need also to think about the patient trajectory. For example, the above patient with falling urine output needs additional fluid but may also need a time point in the future identified for re-evaluation and referral to critical care if no improvement has been made.

All these scenarios could be written off as poor care, symptomatic of a 'bad' doctor, and could lead to a poor outcome. However, with an understanding of the human factors involved in such cases we have to recognize that everybody can make similar mistakes given the correct circumstances – perhaps just a busy day at the end of a busy week. If we are to prevent ourselves making these mistakes we need to build resilience into our practice.

We can improve our situation awareness by using checklists (including mental checklists) to ensure we do not miss vital information. We can also build in checking behaviours at specific time points, i.e. reviewing the drug chart for anticoagulants before consenting.

In every patient encounter a three-stage cognitive approach can be consciously taken:

1. What information have I gathered or missed?
2. What does this mean?
3. What might happen next?

This forces us to maintain a more rounded picture of the situation and patient trajectory – vital for decision making and planning.

Finally, writing information down will improve situation awareness when we need to recall details. Consider a morning handover of 15 new admissions – can you really remember the combination of history, clinical exam and previous investigations for each of the five patients with right upper quadrant pain?

Decision making

Decision making is intrinsically linked to situation awareness – without the correct mental picture of the situation it is very difficult to make a good decision. Humans have two main pathways by which we can make decisions – either automatically or analytically (Kahneman, 2011). Automatic decision making (often referred to as intuition) involves subconsciously pattern matching against previous experience – it is very fast and requires little mental effort. This automatic system is entirely dependent on previous experience so is very accurate in experts but highly inaccurate and prone to error in novices (Reason, 2008; Kahneman, 2011). The analytical approach requires consciously considering options and selecting the best one – this is slow and requires lots of attention and mental effort. This pathway is much slower than the automatic pathway but is more likely to give the correct answer, particularly if you have limited experience (Kahneman, 2011).

Consider one of the classic mistakes in surgery – an elderly man with loin to groin pain and tachycardia diagnosed with renal colic who subsequently dies of a ruptured abdominal aortic aneurysm. Was the original diagnosis reached intuitively or analytically?

In recognizing the two systems you can develop strategies to bring yourself back to an objective, analytical style of decision making and avoid cognitive traps such as the classic abdominal aortic aneurysm misdiagnosis. This can be very difficult; even asking 'is there anything else this could be?' invites us to reinforce our intuitive decision by taking the simplest answer – 'no'. Far better is to force the analysis: 'what are the alternative causes of loin to groin pain and tachycardia?'. This forces us to develop a list we can objectively consider and helps identify any further information we need to gather to confirm.

Leadership

Leadership can be a daunting concept and is commonly misunderstood as a 'quality' you are either born with or not. This is not the case. It is far more useful to concentrate on the skills essential to leadership which, vitally, can be taught, practised and improved at any level.

A leader must be available and responsive to colleagues – ensuring your team know how to contact you and, when contacted, listening and responding appropriately is a simple yet fundamental skill. Any member of the team may hold vital information or alert you to important problems. In one famous case of wrong side nephrectomy the operating team were informed by a medical student preoperatively that they were about to operate on the wrong side but this was ignored (Coxon et al, 2003). Consider how you respond to junior or nursing colleagues – are you demonstrating good leadership skills?

Being able to draw up a task list, prioritize and delegate tasks to appropriate team members are essential leadership skills (Flin et al, 2011) and can be practiced at any level. Diligence is also needed to ensure these tasks are completed and results checked. Consider a ward round where the senior asks for certain tasks to be performed but does not remember to ask for results later. Over time the value attached to jobs will diminish, they are seen

KEY POINTS

- Non-technical skills are practical skills that need to permeate your practice.
- Use checklists and build in checking behaviours.
- Always consider – what information have I gathered/is missing? What does this mean? What will happen next?
- Write important information down.
- In reaching a diagnosis consider 'what are the alternative causes of ...'.
- Construct job lists, prioritize tasks and share with colleagues.
- Maintain standards – chase results, observe infection control measures, complete notes fully.
- Adopt a transmitter-orientated approach to communication.
- Maintain awareness of team tasks – support and back-fill tasks as necessary.

as pointless and start to be missed; over time patient care deteriorates. Following up and checking tasks is part of standard setting within the team (Flin et al, 2011). Similarly the apparent value placed on activities such as hand-washing, infection control measures and note taking is imparted to the team through role-modelling – if you do not do it properly your junior colleagues are unlikely to either.

Dealing with pressure involves recognizing the source of this pressure then developing strategies to remain objective, rational and organized in your response. If the stress is related to workload or an overwhelming task – construct your task list, prioritize and recruit others to help, in clinical scenarios stick to established ABCDE (airway, breathing, circulation, disability, exposure) and ATLS (Advanced Trauma Life Support) principles.

Communication and teamwork

Communication and teamwork involve many of the skills already addressed but relate to how you share these skills with colleagues. When the team has the same understanding of the situation, the same plan and knows the priority of the tasks they will be performing this is known as having a 'shared mental model' (Flin et al, 2011). It follows that the team can function effectively and efficiently.

A good general approach to communication is to adopt a transmitter-orientated approach (Brindley and Reynolds, 2011), i.e. it is the transmitter's responsibility to ensure that the receiver understands the message. A number of tools can assist with this.

SBAR (situation, background, assessment, recommendation) is a structured handover tool that has been adopted widely within health care (Leonard et al, 2004; Haig et al, 2006; Brindley and Reynolds, 2011). It forces the user to select the relevant information for handover, reducing the signal-to-noise ratio. The user has to decide what they want their colleague to do with the information. This recommendation is vital to make the exchange effective – without it information can be exchanged but nothing happens.

Closed loop communication can also be used to ensure the receiver understands the message or plan (Brindley and Reynolds, 2011; Flin et al, 2011). Following the exchange the receiver recites the information back to the transmitter to ensure it is correct. This can be initiated as transmitter ('Can you read that back to me?') or receiver ('Can I just read that back to you to make sure I've got it correct?').

In all teams there is a common goal, and although tasks are allocated to different team members there is interdependence to these tasks (Agency for Healthcare Research and Quality, 2005). Consider a patient with a peritonitic abdomen and the task of obtaining intravenous access delegated to the most junior member. If no intravenous access is obtained the patient does not receive fluid resuscitation or antibiotics and the computed tomography scan may be delayed or performed sub-optimally – patient outcome is affected. In high performing teams individuals are aware of their own tasks but also of the overall progress of the team tasks. If a key task is missed or delayed then any competent member of the team will step in to address it – the overarching team goal is more important than individual tasks with no task considered too menial. This mutual performance monitoring (Agency for Healthcare Research and Quality, 2005) at a practical level involves being aware of other members' task lists with a willingness to support and back-fill any tasks as necessary.

Conclusions

Surgeons in training frequently equate their competency to pure technical skills but it is increasingly clear that non-technical skills are also major determinants of surgical outcome. Non-technical skills can appear inherently obvious and simple and so we are at risk of neglecting them. Elite athletes commonly talk about 'marginal gains' – tiny adjustments to day-to-day practice (e.g. sleep, nutrition, training, preparation) that collectively improve performance. Non-technical skills are the same; small incremental adjustments to our day-to-day practice that improve performance, allowing us to anticipate and mitigate problems more effectively and improve surgical outcomes. So, if you plan to be a surgeon and you have not been consciously working on how you assimilate information and reach diagnoses, how you make decisions, how you communicate and how you interact with colleagues… you need to start now. **BJHM**

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