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Review

The role of non-technical skills in surgery

Riaz A. Agha [a], Alexander J. Fowler [b, *], Nick Sevdalis [c]

[a] Department of Plastic Surgery, Guys and St Thomas' NHS Foundation Trust, London
[b] Department of Medicine, Guys and St Thomas' NHS Foundation Trust, London, UK
[c] Centre for Implementation Science, King's College London, UK

HIGHLIGHTS

- The volume of surgical procedures is increasing.
- Technical skills have come under increased scrutiny, alongside a realisation of the importance of non-technical skills.
- Non-technical skills include situational awareness, decision making, communication, teamwork and leadership.
- Further research is required to demonstrate the mechanism linking impaired non-technical skills and patient harm.

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ABSTRACT

Non-technical skills are of increasing importance in surgery and surgical training. A traditional focus on technical skills acquisition and competence is no longer enough for the delivery of a modern, safe surgical practice. This review discusses the importance of non-technical skills and the values that underpin successful modern surgical practice.

This narrative review used a number of sources including written and online, there was no specific search strategy of defined databases. Modern surgical practice requires; technical and non-technical skills, evidence-based practice, an emphasis on lifelong learning, monitoring of outcomes and a supportive institutional and health service framework. Finally these requirements need to be combined with a number of personal and professional values including integrity, professionalism and compassionate, patient-centred care.

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* Corresponding author.
E-mail address: alexjfowler@gmail.com (A.J. Fowler).

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1. Introduction

Globally an estimated 234 million major surgical operations occur annually [1]. This volume of procedures is thought to result in seven million complications and one million deaths - double the number of annual maternal deaths [1]. Modern surgery now includes; transplantation, joint replacement, free tissue transfer and advanced multidisciplinary trauma management, as well as minimally-invasive, endoscopic, laparoscopic, robotic and microsurgical techniques.

So what is the *key* to delivering safe, high quality and reliable surgical practice? In this article, we discuss the importance of technical skills, non-technical skills, evidence-based medicine, monitoring outcomes, the wider hospital culture context for surgical practice and the professionalism and values that underpin successful surgical practice.

2. The importance of technical skills

It is clear since the very first recorded surgical operation in India circa 600BC by Sushruta [2], that technical skills are important. A technical skill refers to any psychomotor action or related mental faculty acquired through practice and learning pertaining to a particular craft or profession [3]. Much has been written about the importance of developing good hand-eye co-ordination, manual dexterity and focused psychomotor skills in a 'craft' specialty like surgery [4]. The focus on technical skills development has led to the creation of standard assessments for technical skills, such as the Objective Structured Assessment of Technical Skills (OSATS) [5].

2.1. A lesson from history – laparoscopic cholecystectomy

History has shown that the importance of good technical skills should not be underestimated. A powerful example from history is laparoscopic cholecystectomy. The first reported laparoscopic cholecystectomy was done by Phillipe Mouret in France in 1987 [6]. Within five years it was established as a feasible alternative to the open approach [7]. However, doubts were soon raised about its safety and the technical skills credentials of those performing them [8,9]. Professional societies began to emphasize training both inside and outside the operating room (OR) and stipulated minimum requirements for those performing laparoscopic surgery [10]. Skills courses were introduced to teach basic psychomotor skills and to get surgeons accustomed to the fulcrum effect, viewing two-dimensional images on a screen two meters away and limited tactile feedback.

Gradually laparoscopic cholecystectomy became safer and a viable alternative to the open technique. Residents today can gain significant skills and experience in simulated environments, prior to performing the procedure on patients in the OR. Examples include virtual laparoscopic simulators, cadaveric porcine models and even simulated procedures using anaesthetised pigs [11]. This is in addition to observing and assisting senior surgeons during clinical training. Today laparoscopic surgery is considered 'safe' and is more widely used than the open technique [12]. The debate has now moved onto the number of ports one should use [13].

2.2. Rising scrutiny of surgical technical skills

Technical skills performance in surgery has come under increased scrutiny in recent years, with several highly publicized cases linking poor outcomes with skill deficiency [14–16]. Concerns over technical skills are often acted on swiftly. For example, excess mortality and concerns voiced by staff at the Pediatric Cardiac Surgery Unit at the Bristol Royal Infirmary in the UK resulted in a public inquiry [17]. In addition, three surgeons were found guilty of serious professional misconduct by the UK's General Medical Council (GMC) in connection with the deaths of 29 babies between 1988 and 1995 [18]. More recently, similar concerns raised about pediatric cardiac surgery at another UK hospital (Oxford Radcliffe Hospital) led to its closure in 2010 [19]. In this case low case volumes were blamed in part for the poor outcomes with the Oxford Radcliffe unit being the smallest in the region and doing half as many cases as the next smallest unit.

These are just two illustrative examples to demonstrate the consequences of the now evidence-based and deeply held belief of the importance of technical skills for safe surgery. We know that technical skills tend to improve with experience and this is evidenced by the volume-outcome relationship in much of surgery, especially complex operations like abdominal aortic aneurysm repair [20] and colorectal cancer surgery [21].

3. Is technical competence enough for modern safe surgical practice?

The preceding section makes it clear that technical skills are important for successful surgical practice. Here, however, we argue that they are not enough in isolation.

In 1999, the Institute of Medicine published the report *To Err is Human* [22] and stated that between 44,000–98,000 people die in US hospitals each year from medical errors that could have been prevented. This was followed in the UK by the Chief Medical Officer's report "*An organisation with a memory*" [23], which summarized a very similar problem in the UK. A retrospective patient record review study by Vincent and his colleagues found that adverse events in which harm is caused occur in 10% of hospital admissions in the UK, or >850,000 a year [24]. This costs the UK's National Health Service (NHS) an estimated £2bn a year in additional hospitals stays alone and £400m a year settling clinical negligence claims, without considering the wider human, economic and societal costs. Publications such as these sparked a worldwide interest in patient safety research and interventions.

In surgery, there is increasing evidence that such harm is not due to deficient technical skills alone. The 2010 Scottish Audit of Surgical Mortality found that technical errors during the surgery itself constituted just 4.3% of the operative areas of concern identified, with far more errors stemming from poor decision-making [25]. Further, numerous studies have shown that deficiencies in teamwork in the OR, are significant contributors to adverse events and patient harm reaching surgical patients [26–29]. Taken together, this evidence has led to an increasing focus on non-technical skills, systemic issues and values for the surgical profession.

4. The importance of non-technical skills

The Royal College of Surgeons of Edinburgh defines non-technical skills as a collective term used to describe the skills and behaviors encompassing; situational awareness, decision making, communication, teamwork and leadership [30]. Others have defined non-technical skills along three dimensions, including; the interpersonal (e.g. communication, teamwork), cognitive (e.g. decision-making, situational awareness) and personal resource skills (e.g. coping with stress and fatigue) [31].

4.1. Communication and teamwork skills

In a retrospective review of 258 closed malpractice claims, systems factors contributed to error in 82% of cases and communication breakdown was responsible for 24% of these [32]. Communication failures have been cited in several studies looking at causation of near misses [33,34]. Indeed part of the benefit in performance/outcomes that comes with higher case volumes may reflect a 'well-oiled' multidisciplinary OR team that works together more often and where there are clear pathways for patients, good handoffs (e.g. from OR to the recovery suite), and communication practices.

One of the key points at which communication occurs is handoff. Clinical handoff is defined as the "transfer of professional responsibility and accountability for some or all aspects of care for a patient, or groups of patients, to another person or professional group on a temporary or permanent basis" [35]. Handoffs permeate healthcare delivery systems and occur at multiple points including; shift changes, transfer of patients within hospitals (e.g. from OR to recovery, and from there to a ward), patient transfer between hospitals and from the community to the emergency department. Handoffs are critical for patient safety and continuity of care but also for logistics and clinical efficiency [36]. Poor handoffs can cause a range of problems from reducing efficiency, delays in discharge or time to operation and even contribute to patient harm as highlighted by the National Patient Safety Agency (NPSA):

> *"Handover of care is one of the most perilous procedures in medicine, and when carried out improperly can be a major contributory factor to subsequent error and harm to patients"* [1]

From the perspective of non-technical skills, handoffs are an exercise in communication with good handoffs consisting of effective communication between people and teams. This is acknowledged in the GMC's 'Good Medical Practice', in which doctors are to *'keep colleagues well informed when sharing the care of patients'* [37]. The Institute of Medicine's seminal reports To *Err is Human* and *Crossing the Quality Chiasm* [38] both emphasized the importance of continuity of care, robust information exchange between clinicians and teamwork for safer surgical care. Existing studies examining handoffs in Medicine, Trauma and Orthopedics and General Surgery [39–41] have shown that current arrangements fall short of the ideal – with handoffs often unstructured, rushed, not attended by senior clinicians or simply not taking place. Accuracy and completeness of information transferred between clinicians and teams at handoffs can be improved with some standardization and improved communication skills [42,43].

4.2. Leadership and management skills

In 2012, the GMC published the report *Leadership and management for all doctors* [44], in which it stated:

> *"Being a good doctor means more than simply being a good clinician. Every day, doctors provide leadership to their colleagues, and vision for the organisations in which they work and to the profession as a whole."*

In 2010, the Academy of Medical Royal Colleges and the NHS Institute for Innovation and Improvement in the UK published the Medical Leadership Competency Framework (MLCF) [45]. The MLCF describes the leadership competencies doctors need in order to become more actively involved in the planning, delivery and transformation of health services. In sync with these developments are the launch of the NHS leadership Academy and the Faculty of Medical Leadership and Management. Leadership is now recognized as being fundamental for successful surgical practice, including by the Royal College of Surgeons of England [46].

This interest in leadership and managerial skills is reflected in the relevant evidence base, where leadership features amongst other key non-technical skills in most if not all assessment and improvement instruments – including the revised NOTECHS [47], the Non-Technical Skills for Surgeons (NOTSS) [48], and the Observational Teamwork Assessment for Surgery (OTAS) [49]. Further, research groups have started to investigate specific leadership behaviors that are expected of surgeons in the OR [50,51] – these are now systematically described in relevant leadership taxonomies, which can be used for formative assessment and training [52].

5. Evidence-based surgery and lifelong learning

Clinical performance has been shown to deteriorate over time [53]. A commitment to lifelong learning and keeping up to date must be integral to the foundations of ethical professional surgical practice. However, medical knowledge is growing at a phenomenal rate, estimated to double in volume every 18 months [54]. At any given moment there are 55 new clinical trials taking place, 800 new primary (community) care guidelines added each year and more than 2000 new research papers added to Medline each day. This pace of progress may be welcome – yet it poses a considerable challenge [55]. Paul Glasziou argues that:

> *"the search engine is now as essential as the stethoscope … …a 21st century clinician who cannot critically read a study is as unprepared as one who cannot take a blood pressure or examine the cardiovascular system"* [56].

Surgeons need to stay up to date and adopt the principles of evidence-based surgery and lifelong learning. Many surgeons will contribute to local outcome monitoring processes such as Morbidity and Mortality meetings, adding to local evidence around practice. Similarly, all juniors are expected to take part in quality improvement projects during their training and many continue these into their consultancy. A key aspect of developing these skills is the mentoring offered by seniors, and this represents a central part of leadership. Critical appraisal skills are paramount when much of the surgical literature is based on lower level studies or on studies of low quality, including some underfunded and underpowered RCTs [57,58]. Knowing the evidence not only gives an appropriate rationale for clinical decision making but also allows surgeons to consult with, counsel, and consent patients in a more informed way that takes into account true befits and costs of treatment options.

6. The cultural context of surgical practice

Increased spending alone does not lead to improvements in

healthcare and surgical practice – and in the current financial climate it is likely not feasible. For instance, the US spending on health per capita and as a percentage of Gross Domestic Product is more than double that of France or the UK [59], yet performs worse for mortality amenable to healthcare. Indeed, up to 84,000 lives annually could be saved if the US lowered its preventable death rate to that of the top three performing nations [60].

The Bristol Inquiry in the UK showed with clarity that poor performance was related to the prevailing cultural and institutional practices at the hospital with many failures stemming poor quality assurance and clinical governance processes [61]. Two recent National Confidential Enquiry into Patient Outcome and Death (NCEPOD) reports showed significant deficiencies in the active care of patients who died [62,63]. Delays in assessment, decision-making and treatment/time to surgery were highlighted. The reports outlined shortfalls in access to critical care, radiology and the OR with suboptimal supervision of residents in 30% of cases and a failure of residents' to seek help in 21% of cases. Similar 'systemic' concerns were again raised from national audit data included in the recent Royal College of Surgeons of England report 'The Higher Risk General Surgical Patient' [64].

Culture has often been mentioned and implicated in adverse events, or major failures that have led to patients' deaths. However it is hard to measure, or define – with many available definitions and variable use across studies. For our purposes, we take a pragmatic view of culture: we stress the importance of a team-based and learning culture within a surgical service, and also the wider hospital organization. On the one hand, open communication and teamworking (as described in preceding sections) can only occur within teams where the residents can speak up to their senior, and where interprofessional hierarchies do not obstruct communication. On the other hand, surgical units should be able to review their performance regularly and learn from errors and lapses in care [65].Well run mortality and morbidity conferences can contribute to learning and practice improvements [66].

7. Professionalism and personal values of the surgeon

Whilst technical and non-technical skills are important, good surgical practice requires certain personal and professional values like integrity, professionalism, respect for patient autonomy and choice, and patient-centered and compassionate care. Such aspects of surgical practice are largely value-based – and reflect the core values of being a healthcare professional acting in the interest of the patient and with the patient's needs in mind.

The relationships surgeons have with their patients deserve special mention. Hamelin et al. studied factors which influence confidence and trust in the patient-physician relationship in a hand clinic [67]. They found that patients viewed respect for autonomy and verbal communication skills as more important than technical proficiency. This is perhaps expected – as the patient has a better perspective on the quality of their interaction with their surgeon than of the surgeon's other skills. Nonetheless, the advent of an increasingly elderly population means that surgeons will be increasingly interacting with patient who have chronic conditions, and are therefore 'experts' in them. Such 'expert patients' can and should be partners in their own care, as they have the capacity to monitor the disease and its functional impact, as well as the impact of treatment [68].

Skills training to allow effective and compassionate communication with patients is now routinely offered from the Medical School years and throughout surgical training. Here we stress that, although such training is certainly needed, it should be underpinned by the core values mentioned above: surgeons should offer care that is patient-centered and takes a holistic view of the patient, without being solely disease-focused. The chronic conditions that surgeons are increasingly faced with (e.g. cancer) and the resulting complex decision making (to include disease stage, treatment option, and the patient's psychosocial circumstances) make this is a necessary element of surgical care.

8. Conclusions and future directions

Modern surgical practice requires; technical and non-technical skills, evidence-based practice, an emphasis on lifelong learning, monitoring of outcomes and a supportive institutional and health service framework. Finally these requirements need to be combined with a number of personal and professional values including integrity, professionalism and compassionate, patient-centred care.

Research is now focusing on the mechanism by which a lack of non-technical skills causes patient harm, the prevailing thinking being that it impairs technical performance. Hull et al., performed a systematic review of 28 articles which looked at the impact of non-technical skills on surgical performance [69]. They found that receiving feedback and effectively coping with stressful events in the operating theatre had a beneficial impact on technical performance. Conversely, high levels of fatigue and teamwork failure were strongly associated with technical error.

Being a good surgeon is more than just being a good "pair of hands", it's about being a good team player, who listens and communicates well with patients and colleagues and empowers them to reach their full potential.

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Author contribution

RAA – concept, drafting, approval of final version.
AJF – drafting, critical appraisal, approval of final version.
NS- concept, critical appraisal, approval of final version.

Conflicts of interest

Sevdalis is the director of London Safety and training Solutions Ltd, which delivers team, skills and safety training and advisory services on a consultancy basis to hospitals in the UK and internationally.

Guarantor

RAA.

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