Is surgery more about doing than thinking?

ABSTRACT

Detailed thought, knowledge, complex analysis, reasoned judgment and professionalism all fundamentally underpin a surgeon's work and training, yet there is a popularly held view that accomplished surgeons are primarily concerned with performing procedures. A review of pedagogical, social and medical literature, together with personal reflections from the authors, shows that a surgeon's work is multi-faceted. This article discusses the technical skills of operating as a reflection of the 'tip of the iceberg' of a surgeon's cognition, the increasingly multidisciplinary strategic approach of surgeons today, the importance of surgical decision making, the influence of robotics, the role of non-medically trained staff, surgeons' role in postoperative care, adaptive expertise and the formation of professional identity. In so doing, a much wider view of a surgeon than simply 'doing' or 'thinking' is presented with implications for surgical training.

The technical expertise of operating – the 'doing' – has traditionally determined surgeons' most widely held role in performing procedures. Indeed, in the *Charmides*, even Plato described the routine performance of medical procedures on patients by 'slave doctors', implying the reduction of these albeit skilled surgical tasks to well-practiced physical acts without necessarily the involvement of significant cognition.

However, the authors believe that surgery is much more multi-faceted and centred around 'thinking' rather than doing; this draws not only on personal experience but also on evidence from the literature relating to several different perspectives.

1. A surgeon's operative work results from a vast amount of knowledge, analysis, thought and judgment.
2. In today's medical practice, surgeons are increasingly thinking of 'what to do' in terms of best treatment strategies, no longer simply 'how to do it' with respect to performing procedures.
3. The importance of decision making in relation to operating is particularly emphasized in complex and life-threatening cases of patient injury.
4. Doing and thinking frequently overlap for a surgeon in terms of intraoperative decision making, especially during complex operations. The introduction of robotics and the increasing role of non-medically trained staff have also influenced surgeons' practice.

From an educational perspective, preparedness for learning – the ability to continuously improve one's knowledge and skills – may be under-supported in current practice and training schedules, yet is required as a surgeon to develop and maintain up-to-date expertise. Finally, surgeons must 'be' as well as 'do' with regards to developing their professional identity. By assessing each of these components in turn, a balanced analysis can be made as to whether surgery is more about doing than thinking.

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Discussion

Operating is just the tip of the iceberg – the visible face of a surgeon's cognition

Learning to operate takes a significant proportion of a trainee's time (over 3000 hours) (Leung, 2002). Therefore, the technical expertise of surgery has always been a strong focus of surgical training and a dominant part of professional practice. Supporting this focus on doing, Ericsson (2004) advocated deliberate repetitive practice to help achieve task mastery and expert performance in medicine, describing how structured activity with maximal effort and concentration can detect and correct errors, provide feedback and allow repetition, in order to improve critical aspects of performance.

Furthermore, over the last two decades great emphasis has been placed on competency-based surgical training, with a focus on teaching and measuring the ability to perform discrete tasks (Tanner, 2001; Leung, 2002). This is exemplified by the Postgraduate Medical Education Training Board in the UK, who have analysed physicians' professional roles, deconstructed them into measurable competencies, and assessed the progress of trainees toward achieving these competencies (Tanner, 2001; Leung, 2002). In a parallel manner, annual appraisals of fully qualified surgeons increasingly focus on the volume of operations performed and their clinic throughput (i.e. how much they do) as markers of achievement and progress (Cevasco and Ashley, 2011).

Despite the examples above, many would argue that what is most important and more active among surgeons and the actual determining force behind their operative work is their thinking – analysing patients' symptoms and signs, establishing diagnoses through carefully planned and interpreted investigations, and critically judging whether and in what ways patients may benefit from undergoing surgery over the attendant risks. Indeed, evidence demonstrates that if a thorough and complex preoperative work-up of patients is not carried out despite the involvement of competent surgeons, there is high patient anxiety, increased analgesic requirements, increased complications from surgery and longer hospital stay (Ankuda et al, 2014).

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Surgeons are increasingly thinking about 'what to do', no longer simply 'how to do it'

As the proportion of complex multimorbid and often elderly patients increases, decision making regarding the most appropriate treatment options, including surgical intervention, has become increasingly complex (Pearse et al, 2006). In this context, the Royal College of Anaesthetists has highlighted the importance of a multidisciplinary team approach to improve outcomes for such patients (Whiteman et al, 2016), whereby surgeons engage with a range of other experts including radiologists, oncologists, pathologists and specialist nurses, and discuss cases and seek their counsel to plan optimal treatment strategies. Thus, there has been a shift in the expectation of surgeons within the medical profession itself to deciding 'what to do' rather than simply 'how to do it', incorporating complex and thoughtful decision making, and taking into account the patient, the disease and the input of other specialists (Frilling, 2016).

Importance of decision making over operating

From the senior author's experience of working in neurosurgery over the last 30 years, an example of the importance of surgical decision making was the case of a young 40-week pregnant woman who suffered a severe brain haemorrhage with brain swelling during labour. The surgical treatment of her brain condition was simple (insertion of a thin tube to drain away CSF thereby reducing the swelling) and could be performed by a junior trainee. However, complex decision making was involved around the best course of action with respect to general anaesthesia and its effects on the fetus, the need for emergency obstetric team input, the precise timing (simultaneous *vs* sequential) of delivering the baby *vs* treating the brain swelling, and the timing of subsequent procedures to identify the bleeding point in the brain and secure it. Following rapid but thorough planning and multidisciplinary team organization, the patient had emergency neurosurgical CSF drainage surgery and simultaneous delivery of the baby immediately followed by cerebral angiography to identify and secure a ruptured intracranial aneurysm (all performed within 4 hours) with an excellent outcome for mother and baby.

This example illustrates the critical influence of thoughtful decision making and judgement on patient outcomes and this is well supported in the literature (Anderson, 1995; Chapman and Sonnenberg, 2000; Patel et al, 2008; Radosa et al, 2016).

Doing and thinking frequently overlap

Henry Marsh, a British neurosurgeon, explains in his book *Do No Harm* (Marsh, 2015) how he caused a young patient to suffer a devastating stroke during a brain tumour operation that was technically progressing well, as a result of his conscious decision during surgery to remove every particle of brain tumour adjacent to major blood vessels and his own reasoned judgement during the course of the procedure that pursuing dangerous excision was better than the safer option of leaving a small residual lump. The surgeon's doing and thinking overlapped and in this case led to a bad outcome, yet this active weighing up of different courses of action and their risks *vs* benefits during the course of operations is a critical part of a surgeon's work and can profoundly influence patient outcome.

However, despite published anecdotal evidence, and a widely quoted American physician who stated: 'a skillfully performed operation is about 75% decision making and 25% dexterity' (Spencer, 1978), there remains a dearth of research on intraoperative decision making. Emerging models of intraoperative decision making include rapid intuitive and analytic (deliberate comparison of alternative courses of action). In these models, a surgeon's cognition is purported to receive inputs from auditory and visual information, is influenced by the surgeon's own personality, and feeds into a limited working memory. This in turn can render the surgeon susceptible to cognitive overload, hindering his/her ability to process thoughts and make decisions. These models also suggest that intraoperative cognition may be improved by communication, anticipation and situation awareness by team members within the operating environment (Malhotra et al, 2007; Pauley et al, 2011).

Influence of robotics on surgeons' ability to strategize and think

The increasing addition of a wide range of robotics and technological advances to surgery since the turn of the millennium has offered greater precision instruments with a level of automation that removes the inefficiencies of standard human surgical manoeuvres, and has enabled the potential for remotely performed surgery through internet connectivity, simulation training for learner surgeons, and thorough pre- and intraoperative planning and risk calculation through three-dimensional modelling (Aruni et al, 2018). To a large extent these take the technical task-based aspects of surgery away from the forefront of surgeons' minds, allowing them to focus more on the strategic aspects of choosing the safest, most effective surgical approaches, scenario planning, and predicting risks, pitfalls and rates of success from different surgical decisions.

Role of non-medically trained staff in taking over simple task-based activities

There is an emerging trend of non-medically qualified staff, including advanced nurse practitioners and physicians' assistants, who are increasingly performing some of the roles previously carried out by surgeons and physicians. For example, nurse endoscopists, advanced nurse practitioners performing vessel harvesting procedures during cardiac and vascular operations, and advanced nurse practitioners and physicians' assistants performing ward tasks. This frees up trainees' time for other areas of clinical practice (Coombes, 2008).

While the relative merits and faults of this evolution in the workforce can be debated at length and are beyond the scope of this article, there is certainly an argument that more of the doing, especially of simple surgical and ward tasks, has been allocated to these non-medically qualified staff, affording the surgeon more thinking time to focus on the complex, more challenging aspects of surgical practice.

Surgeons' involvement in postoperative care is evolving

There is a widely held perception by the non-surgical medical community, perhaps

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unjustified, that surgeons are more focused on the preoperative and operative phases of patient care (the doing) and tend to lose interest once the patient enters the convalescent or rehabilitation phase. However, surgeons have led research into enhancing postoperative recovery and established input of physicians' expertise to improve postoperative care, for example with the use of orthogeriatricians in orthopaedic surgery and rehabilitation physicians within neurosurgical departments (Bowyer and Royse, 2016).

Although the latter may be seen as further evidence of surgeons' lack of appetite to master postoperative care themselves, it can also be interpreted as surgeons' recognition that the postoperative phase is critical and complex and requires the contribution of other expert physicians to achieve optimal patient outcomes. Certainly for current junior surgical trainees who are learning on the wards and liaising with these expert physicians, their approach and training in postoperative management has greatly progressed in comparison with their predecessors. In recognition of this, several surgical training programmes are now assessing the feasibility of providing rotations in rehabilitation units to improve surgical trainees' understanding and management of postoperative recovery (Intercollegiate Surgical Curriculum Programme, 2017).

Preparedness for learning may be undersupported but is required as a surgeon

From a pedagogical standpoint, De Cossart and Fish (2005), a practising surgeon and an educationalist respectively, explain in their book on cultivating a thinking surgeon that 'having an experience is not the same as understanding its meaning'. They highlight the importance of reflection by surgeons as a means of conceptualising, self-emancipating, and developing propositional, procedural and metacognitive knowledge to enable them to take active and effective control of the lifelong learning that a career in surgery requires. However, there has been concern that surgeons following their recommendations may become 'well-educated and educationally eloquent but poorly trained' (Raftery, 2006). Immersive experiences, reflection, role modelling and mentorship as well as technical skill and knowledge acquisition are all important in achieving technically competent and well-educated thoughtful surgeons (Pauley et al, 2011).

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Today's surgeons must be efficient with the knowledge they have gained previously, and be able to adapt and learn through both formal professional development and informally as part of their daily work. However, there is evidence that doctors, including surgeons, may not incorporate 'novel, conflicting information' as much as needed into their clinical problem solving (Eva, 2002). Furthermore, Asch et al (2014) found that obstetricians' future performance correlated more positively with the initial complication rates straight after graduating from residency, rather than with the volume of experience they had accumulated during their careers. The study suggests that physicians have limited incremental learning from experience, and that the trainee choosing a surgical career may not be fully aware of the extent of cognitive learning required in addition to experiential learning. The role of critical reflection as a tool that can amplify learning in trainees is crucial and supported by a systematic review of the educational literature (Winkel et al, 2017).

Adaptive expertise results from preparedness for learning

Part of the problem in surgeons' training is that assessments of surgeons' preparedness for continued learning – the capacity to learn new information, use resources effectively and innovatively, and invent strategies for learning and problem solving (Mylopoulos et al, 2016) – have always been retrospective.

For example, a large database study by Tamblyn et al (2002) showed that family doctors' medical licensure exam scores associated modestly with primary care outcomes (such as correct prescriptions and blood pressure targets) in the first 7 years out of graduation, but did not correlate with their future clinical performance. Yet for independent and trainee surgeons in a rapidly evolving environment, preparedness for learning and the ability to adapt knowledge and skills flexibly to develop the best solutions for patients (i.e. 'adaptive expertise') is critical (Mylopoulos et al, 2016), and is key to the 'thinking' surgeon.

Adaptive expert surgeons are able to see the 'old in the new' as well as the 'new in the old' (Schwartz et al, 2012). For example, with patients' increasing desire for scar-free procedures, neurosurgeons are increasingly learning minimally invasive procedures, using existing anatomical knowledge (seeing the old in the new) but at the same time learning new technical steps and creating new follow-up and assessment plans for patients (finding the new in the old). This reflects the highest order of Bloom's taxonomy of learning (creating/constructing) (Bloom et al, 1956).

Surgeons must be as well as do – professional identity

As explained by Jarvis-Selinger et al (2012), professional identity encompasses the development of 'thinking', 'feeling' and 'being' resulting from personal reflections and negotiations with self, involving influences from social interactions in the workplace and wider society. Although the initial training years may emphasize competence in basic surgical skills and clinical tasks, there is an ever-increasing role for more holistic development of decision making, accountability, acting as a professional, and learning to think and feel as a surgeon. These aspects are not doing per se but fundamentally underpin a surgeon's daily work and professional interactions.

Doing and thinking are interlinked as immersion in surgical practice and completing tasks can in turn help to shape a surgeon's knowledge and thinking, a concept perhaps understated by Jarvis-Selinger et al (2012). Although the European Working Time Directive with its restriction of trainees' working hours led to an increasing tendency for surgical trainees in the UK to focus on gaining operative skills, new components since introduced into training, such as workplace-based assessments, have empowered trainees to solicit feedback from colleagues, identify learning opportunities, and analyse and incorporate new lessons as

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KEY POINTS

- Detailed thought and knowledge, complex analysis, reasoned judgment and professionalism all underpin a surgeon's work and training.
- A surgeon's operative work results from a vast amount of knowledge and careful analysis – operating is just the tip of the surgeon's iceberg of cognition.
- Surgeons are increasingly thinking of 'what to do' in terms of best treatment strategies, no longer simply 'how to do it'.
- The role of creative thinking, problem-solving and strategizing often dominate preoperative work-up of patients as well as intraoperative decision making during complex procedures, with evidence indicating it can make the difference between good and bad patient outcomes.
- Professional identity is the development of 'thinking', 'feeling' and 'being' that results from personal reflections and negotiations with self and others; this fundamentally underpins a surgeon's daily work and professional interactions.
- Preparedness for learning and adaptive expertise (the ability to continuously improve one's knowledge and skills) may be under-supported in current practice and training schedules, yet is of paramount importance to develop and maintain expertise.

thinking, responsible, accountable surgeons (Wilkinson et al, 2008). This also reflects increasing public expectation that surgeons be no longer the patriarchal 'dictatorial' type of the past but rather be thoughtful, flexible, communicative and empathetic (Tallis, 2006).

Conclusions

Surgery is much more widely encompassing than simply thinking or doing as mutually exclusive domains. Rather, detailed thought, iterative knowledge, complex analysis, reasoned judgment and professionalism as well as technical skills and knowledge, all fundamentally underpin a surgeon's work and training. Indeed, while it has been said that surgeons are 'plungers' and physicians are 'planners' (Harken, 1998), perhaps the surgeon is better defined as per Plato's concept of the 'expert doctor', engaged in 'thoughtful diagnosis and reasoning about treatment and explanation to the patient'. **BJHM**

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