Surgical Education and Training in Pakistan:

Creating a Model

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Edited by

Masood Umer, M. Hammad Ather
and Syed Ather Enam

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It gives us immense pleasure to share the book *Surgical Education and Training in Pakistan: Creating a Model* with our readers, published as an appurtenance of the Department of Surgery of Aga Khan University, Karachi, Pakistan.

This is the first book published by the Department. Our objective for this book is focused on improving surgery training Programmes in developing countries. Over the last 35 years we have strived to establish a surgical training Programme within our university that provides a balance between education and service. We have for the first time in Pakistan developed a residency structure with a fixed weekly, monthly and annual academic schedule across all surgical disciplines. Starting from induction to assessment and evaluation, imparting skills and evaluations, we have set very high standards in our country for others to follow and replicate within their own resources. This book will be a narrative of how we achieved all this and what the way forward is considering the resource constraints that we have in our lower-middle-income countries as compared to Western countries.

We would also like to take this opportunity to thank to all the contributors / authors of this book. We would like to appreciate Dr M. Shahzad Shamim, Neurosurgeon and Associate Professor in the Department of Surgery at Aga Khan University for the organizational structure of this book. We are also thankful to our university's departments: the President's Office, the Dean's Office, and the Legal, Communications, and Finance Departments. Front cover has been designed by Dr Rehan Nasir Khan. In the end we would also like to thank Ms Ayesha Jazib, Content Writer, and Mr Shariff Charania, Specialist in the Department of Surgery at Aga Khan University. They both worked tirelessly day and night and made this herculean task possible. We hope you will appreciate the quality of chapters in this book.

Happy reading,

Editorial Committee,

Surgical Education and Training in Pakistan: Creating a Model

CHAPTER 1

THE SURGICAL CLERKSHIP: THEORY AND PRACTICE OF SURGICAL EDUCATION IN MEDICAL SCHOOL

SADAF KHAN AND AMN SIDDIQI

The word surgery originates from the Latin word *chirurgia*, itself derived from the Greek words *cheiros* (meaning hand) and *ergon* (meaning work) (Haeger 1988). Since the beginning of time, man has had to deal with injuries, deformities, and pathologies requiring physical intervention, and these treatments have been undertaken by healers across the ages. Unfortunately, as our understanding of the human body and its afflictions advanced, surgery began to be regarded as a necessary evil in contrast to the more philosophical discipline of internal medicine. This resulted in the attitude that surgeons were a lesser caste of doctors, and stunted the development of surgical methods and philosophy. Out of Cordoba came the surgeon-educator Abul Qasim (936–1013), also known as Albucasis, and his book *Altasrif* ("Collection"). He provided detailed illustrations of surgical instruments and thorough descriptions of their use. The scope of the surgical chapters was vast, and ranged from the care of wounds to management of bladder stones. This text has been commonly cited in the Western world, where the evolution of the modern surgeon began.

Modern medical curricula are composed of basic sciences followed by the clinical sciences. For most programmes, the third year of instruction is a landmark in every aspiring doctor's career, as they transition from theoretical learning to clinical practice. The challenge is to develop the ability to apply fundamental principles of human biology to understand normal human function and behaviour across age and gender, and diagnose and manage a wide range of pathologies. At the same time, they practise the professional attitudes and behaviour required to become competent and empathetic healthcare providers. This initial clinical

experience is vital in shaping a well-rounded doctor and is pivotal in the student's decision regarding future specialization. Practitioners of the primary clinical disciplines are tasked with the education of these novice learners. The hidden agenda in this process is the search for a learner who shows a passion and aptitude for that branch of medicine. Students on the postgraduate training programmes in North America depend on these initial exposures to select an area of interest for advanced training, thus necessitating high quality experiences as part of the curriculum. In Europe and Asia, the internship (or house job) year is an additional opportunity for exposure to varied clinical disciplines, prior to declaring a speciality of interest.

The surgical clerkship provides a glimpse into a variety of healthcare environments. Students participate in outpatient clinics, follow patients in the ward, contribute in the operating room, assess patients in the emergency room, and attend academic sessions and multidisciplinary meetings. This allows them to follow patients and the disease process over a period of time, while participating in care and decision making. Students also observe the mechanics of communication and team dynamics in high- and low-pressure scenarios. Traditionally, attributes of professionalism are imbibed through role-modelling, but there is a need to include instruction in the formal curriculum. Additionally, the surgical rotation allows medical students to learn and practise many basic technical skills required by a graduating doctor.

For students who wish to pursue surgery, a high-quality clerkship gives insight into the expectations and demands of a surgical career, allowing students to assess their fit for it and help tailor their course as they prepare for a surgical career. For the non-surgically inclined student, the surgical rotation has the enormous responsibility of providing a comprehensive and lasting understanding of surgical disease and its myriad presentations. An increasing volume of surgical care frequently necessitates participation from non-surgical physicians in some way, either when they consult surgeons, or when they are consulted by surgeons (McKinley et al. 2020). The surgical clerkship may be the only time in their career where they will have a meaningful exposure to this group of patients. Finally, the way students remember their surgical rotation can shape how they counsel future generations of students, either perpetuating or combatting misconceptions regarding a career in surgery.

The challenges of undergraduate surgical education

The purpose of undergraduate medical education has been redefined over the years. Traditionally, graduating doctors were expected to have sound medical knowledge and the expertise to perform all tasks relevant to medical practice, including basic surgeries (Agha et al. 2005). With an ever-increasing body of knowledge, development of sub-specialties, and recognition of the importance of professionalism, there has been a reduction in curricular time devoted to technical subjects such as anatomy and surgery (Agha et al. 2005). This time has since been utilized for the instruction of essential generic skills and knowledge, such as communication skills, practice-based learning, system-based practice, and the medical humanities. The emphasis of teaching is now to produce a "pluripotent" doctor with the skill of self-directed learning, who can then dedicate a further six or seven years to becoming a specialist.

A new challenge presented itself with the institution of work-hour restrictions for postgraduate trainees (Acton 2015). These restrictions changed the structure of traditional surgical teams and altered the way in which teaching occurs. For almost a century, William Halsted's model of "see one, do one, teach one" formed the basic framework of surgical education. This relied on teaching the surgical team as a single cohesive unit consisting of medical students, interns, junior residents, and a chief resident. Each team spent a substantial (sometimes unreasonable) amount of time in the hospital and attended calls together. A significant portion of education took place in these ready-made groups during "down time," in which senior residents would teach junior residents and students. This, along with active participation in the operating room and ward, was considered sufficient for students to imbibe the knowledge, skills, and attitudes required for effective patient care. As resident work hour restrictions were implemented, teams became smaller as night floats and shifts were introduced to ensure uninterrupted patient care. Residents were responsible for more patients at a time, which left less time available for formal teaching within the team. To meet this challenge, programs have become more creative and specific about how and when to teach residents, and educating medical students is often relegated to a secondary level.

All academic clinicians balance four core activities: research, clinical practice, training residents, and teaching students (Agha et al. 2005). Academic institutions are perpetually on a quest for high-quality research output, translating to higher academic and clinical ratings, and subsequently greater funding opportunities. For the individual surgeon, research of an

international calibre leads to professional recognition, larger grants, and career advancement. As a result, the academic surgeon spends more time and energy in the laboratory or designing and implementing clinical research, while clinical practice and teaching often become necessary distractions. Additionally, the demand to provide a high-quality patient experience and the intense competition between healthcare entities have led to a manifold increase in pressure on healthcare providers to reduce waiting times and provide rapid service for non-urgent service commitments. Since the consequences of not teaching medical students are less immediate than those of not fulfilling service requirements, training residents, research, and undergraduate education are often put at risk. In view of these realities, the need for physicians to become selective and develop a focus (clinical practice/research/teaching, alone or in combination) is advocated.

Finally, as the healthcare system is modernized, and as patients become more aware of quality and safety, students are becoming increasingly marginalized from active participation during surgical clerkships (Scally and Minter 2016). For example, while using an electronic medical record is undeniably advantageous for patient care, its implementation has limited students' opportunities to participate in clinical documentation. The loss of this active experience has a negative impact on their skill and efficiency, on documenting history and examination findings, procedure notes, and discharge summaries – skills that are essential as they enter residency. Similarly, a shift towards minimally invasive and laparoscopic procedures has reduced students' opportunities to "scrub in" and actively participate in surgical procedures. As a result, the surgical clerkship is increasingly resembling an "observership" with a less active role for medical students (Agha et al. 2005).

These challenges have resulted in an overall dissatisfaction amongst medical students regarding the quantity and quality of teaching within the surgical clerkship (ASiT Medical Student and Foundation Doctor Consensus Group 2020; Lee et al. 2016). Interest in surgical careers has been steadily declining, resulting in an impending shortage of general surgeons (Abbas et al. 2015; Peel, Schlachta and Alkhamesi 2018). Furthermore, graduating doctors have expressed under-confidence in their abilities, and concerns have been raised regarding their readiness to take on basic tasks expected of a surgical intern. This may cause potential safety issues and an increased reliance on senior members of the surgical team (Lee et al. 2016). This shortfall in training has resulted in programmes being obligated to spend a variable amount of time during the initial period of residency to prepare new interns for safely entering the workforce as healthcare providers (Scally and Minter 2016).

Surgical education for contemporary medical students

The limitations discussed above highlight the need to create an environment that facilitates relevant, effective, and efficient teaching/learning. While developing a clear core curriculum and providing infrastructure and opportunity are essential interventions to improve education, the success of the education process is ultimately determined by the efforts of the two main parties involved: the surgeon and the student.

The modern medical student needs to be recognised as an adult learner (Agha et al. 2005). The commitment with which adult learners engage in education depends heavily on their own motivation. Factors that are associated with greater motivation include problem-based learning; learning content that is perceived to be relevant and applicable to practice; learning that can be tailored by the student; receiving regular feedback; and participating in an educational process that is founded on mutual respect. Surgeons need to take into account the characteristics of adult learning (Table 1-1) and adapt their teaching methods accordingly (Table 1-2). Fostering this modified role of the surgeon-teacher will take time and training to develop. Ideally, the shift must be nurtured and enabled at the level of the medical school.

Table 1-1: The characteristics of adult learning (Hamdorf and Hall 2001)

Characteristics of adult learning
Clearly defined objectives Voluntary participation An active process A desire for feedback A need for reflection

Table 1-2: The shifting role of teachers (Hamdorf and Hall 2001)

Traditional	Future
Focus on teachers Students subservient Didactic teaching Emphasis on what is taught	Focus on students and teachers A partnership Facilitator of learning Emphasis on what is learned

In 2019, a study conducted amongst medical students at three large academic hospitals assessed students' perceptions of what makes the surgical rotation a meaningful experience (McKinley et al. 2020). Positive predictors of a meaningful clerkship included active participation, such as closing skin with a stapler and performing electrocautery, receiving feedback and mentoring, establishing relationships with patients, and making a "real difference" in their health. These findings align with the characteristics of adult learning and the new role of a surgeon-teacher. Any interventions that enhance the frequency of these activities may result in better learning within the surgical clerkship.

Objectives of the Surgical Clerkship

There is a perceived inconsistency in the terminal skills of medical graduates, a sentiment that is echoed across many governing medical bodies (Association of American Medical Colleges 2014; The Royal College of Surgeons of England 2015). To some extent, this is due to a varied exposure to the surgical specialty in terms of time and content of teaching (Lee et al. 2016). Further heterogeneity in the experience stems from clerkships being conducted in different hospital settings, and varying degrees of student involvement in patient care and decision making (Scally and Minter 2016). Utilizing a uniform surgical curriculum with clearly defined terminal objectives is a possible strategy to ensure appropriate baseline surgical knowledge and skills that are transferable to other interventional and non-interventional specialties.

The three domains that must be addressed by a medical curriculum (and that can be extrapolated to each discipline) are knowledge, skills, and attitude. Appropriate objectives for each domain must be formulated for the overall programme and each module. Each domain warrants the use of relevant teaching/learning and assessment methods. For instance, procedural skills cannot be assessed in a written format, and knowledge is poorly assessed by observation. Integrated novel teaching/learning modalities, such as simulation, have the added benefit of allowing learning and/or assessment across more than one domain.

The surgical curriculum consists of two components. The first component is the core curriculum which includes basic principles of surgery and common/essential surgical presentations. Students must have an understanding of the anatomy, physiology, pathology, investigations, differential diagnoses, management, and operative care relevant to each topic. For example, in 2015 the Royal College of Surgeons of England

released a national undergraduate curriculum in surgery which covers the core surgical curriculum (Table 1-3) and defines the learning objectives for each topic. These topics are shared across other surgical national curricula (Association of American Medical Colleges 2014; Higher Education Commission, and Pakistan Medical & Dental Council 2011; Medical Council of India 2018). The second component of the surgical curriculum involves the necessary skills in which students must achieve a defined level of proficiency (Table 1-4). These include technical skills, such as basic suturing and catheterization of patients, as well as generic skills that all students must continue to develop, such as history taking and physical examinations.

Table 1-3: Core topics to be covered in the surgery clerkship (adapted from the National Undergraduate Curriculum in Surgery by The Royal College of Surgeons of England 2015)

Surgical Syllabus (General Surgery)
Abdominal pain
Abdominal swelling
Change in bowel habit/rectal bleeding
Vomiting blood
Difficulty swallowing/dyspepsia/dysphagia
Jaundice
Lumps in groin
Breast lumps and nipple discharge
Consent for surgery including mental capacity
Caring for the postoperative patient, including nutrition, enhanced recovery, and the critically ill patient
Understanding wound healing
Trauma
Sepsis and infection
Surgical safety (WHO checklist, minimising complications, errors, communication and teamwork)
Caring for the patient before and after surgery, including fitness

Table 1-4: Skills emphasized in the surgical rotation

Skills emphasized in the surgical rotation
History taking, physical examination and case presentation
Interpreting labs and imaging
Performing nutritional assessments
Writing admission orders
Sterile technique - gowning and gloving, maintaining a sterile field
Basic knot tying
Basic suturing
Nasogastric tubes - placement and care
Foley catheterization
Surgical drains - care and removal
Basic airway management
Wound care and basic wound dressing
Venepuncture and peripheral IV

Teaching opportunities

"What the eye doesn't see, and the mind doesn't know, doesn't exist"
—D. H. Lawrence

Medical education requires that students have a basic understanding of the principles (knowledge) and practice (skills and attitudes) of the primary disciplines. The ideal clinical clerkship is one that provides relevant experiences and quality teaching, with efficiency of time and cost. Traditionally, clinical experience supplemented with didactic lectures was deemed sufficient for student education. With technological advancements and a better understanding of surgical pedagogy, surgical educators have developed teaching methods which align with the characteristics of adult learning (Table 1-1). Based on these principles, teaching opportunities are categorized as classroom based/didactic, inpatient and outpatient patient interactions, teaching/learning in the operating room, and simulation. Together these varied integrated exposures create the optimal student learning experience.

"Classroom" teaching

While patient interactions are essential for the training of a medical professional, formal instruction remains an essential part of the curriculum. This prepares students for clinical experiences and for the

development of clinical reasoning skills. This mode of instruction has multiple formats, ranging from the large class format or LCF (traditional lecture) to problem-based learning, with varying levels of interaction and collaboration between the facilitator and learner, and between the learners themselves. LCFs for large groups have traditionally been used as a method of medical content delivery. The ease of delivery, familiarity, and minimal resources required in terms of space, human resource, and technical support make it a popular method that is employed globally. Despite the popularity of this mode of instruction, it presents certain challenges. Within the classroom, traditional lectures and "death by bullet point" – as dubbed by Levinson (2010) – presents a teacher centred model which undermines an active role for students (Levinson 2010; Reis et al. 2015). Additionally, organizing LCFs is often made difficult due to faculty commitments and emergencies which lead to abrupt changes in scheduling, and medical students rotating at geographically distant sites (Cendan, Silver and Ben-David 2011). Further barriers to the use of didactic lectures include opportunity costs for faculty participation, and lack of consistency in the presented content and its applicability to learners (Lindeman et al. 2015).

Advances in medical education have introduced methods to circumvent the shortcomings of traditional lecture-based education. By using small group formats, online learning, workplace-based assessment and feedback techniques, and fostering environments that promote two-way communication between teaching faculty and students, the focus is shifting from "knowledge transmission to knowledge application."

A study at the University of Florida School of Medicine assessed the effectiveness of small group case-based teaching during the surgical clerkship (Cendan, Silver and Ben-David 2011). The didactic content was restructured from 33 large one-hour lectures to eight small group sessions consisting of four to five students, which would meet for two hours every week. Students reported spending more time preparing for these small group sessions compared to lectures. This was reflected in improved surgery examination scores. Faculty reported taking an hour or more to prepare for each session and the majority felt that such sessions were not disruptive to their workload. Additionally, faculty commented that it encouraged a two-way communication with the learner and created an environment which was ideal to assess student knowledge, judgement and reasoning.

Kaminski and colleagues (2019) assessed team based learning (TBL) strategies during an eight-week surgical clerkship. A class of 16 to 18 students was divided into smaller groups, each with a faculty leader. Students were to complete assigned readings prior to class. Sessions began with readiness tests followed by small group discussions on relevant clinical cases, guided by the faculty leaders. Finally, a faculty "topic-expert" would lead a large group discussion, further solidifying critical content. Students found that the anticipated discussions provided motivation to prepare in advance, which helped them stay on track for examination preparation. Overall, the TBL format was "educationally effective," "informative" and viewed as an "opportunity for interactive learning." Concerns were raised about the increased time students spent studying material that poorly correlated with the quizzes, and instructions and learning objectives were deemed as "unorganised." Furthermore, the extensive group work and interaction required all team members to participate, meaning that unprepared students placed the group dynamics and subsequent learning in jeopardy. They concluded that to ensure effective TBL, relevant learning material must be provided, and faculty should focus on clear communication, effective directions, and building diverse teams where all students are encouraged to be active participants.

Given the aptitude for technology of today's medical students and an increasing accessibility to the Internet, medical educators are harnessing technological resources to create online learning platforms. Lindeman and colleagues (2015) hypothesized that using a less faculty intense, blended online curriculum in the surgery rotation could provide a similar or improved academic experience as compared to curricula delivered via in person lectures. Blended learning combines online delivery of content at a time suitable to the student with formal supervised instruction in a scheduled face-to-face interaction. This allows students to have control over the time, place, and pace of their individual learning. In this study, lectures that were consistently given poor ratings were chosen to be delivered as online modules. Analysis of feedback suggested that the blended online curriculum improved students' academic performance and student satisfaction with the surgery clerkship, without any differences in students' rating of faculty clerkship involvement or teaching quality.

Moodle (Modular Object-Oriented Dynamic Learning Environment) is an online learning resource commonly used by medical schools. Leonardo Oliveira Reis and colleagues (2015) studied the use of Moodle to teach students, rotating through urology, two topics: haematuria and urological emergencies. The Moodle module was set up to provide an online

interface with continuous access to audio lectures with slides, videos of operations, and electronic urology clinical cases. They observed a strong level of student engagement, with about 50% of students accessing the platform on weekends and holidays. By allowing online chat and open discussion, students were encouraged to interact with each other and with supervising faculty. Compared to traditional didactic lectures, faculty received more student inquiries, suggesting in-depth learning.

The flipped classroom paradigm has been proposed as an alternative educational approach. This approach combines blended online learning with interactive small group discussions, skills sessions, and continuous assessment and feedback. Its effectiveness in the surgery clerkship has been studied at Stanford University School of Medicine with promising results (Liebert et al. 2016). The shift to the flipped classroom was made to create a standardized curriculum that could be repeated in every clerkship block, to minimize the students' time away from clinical activities, to increase time spent using active learning strategies, and to allow more time for surgical skills training. Students reviewed material and watched online lectures asynchronously before class. Each session was conducted in a small group setting, and consisted of a pre-test, interactive case-based clinical reasoning discussion, skills session, and a post-test. A faculty member and surgical education fellow supervised each class. Students perceived that their time commitment remained the same as during lectures, with a larger proportion dedicated to active learning. A significant increase in the mean rating of career interest in surgery was also noted. Furthermore, faculty time dedicated to teaching decreased by 43%. The flipped classroom paradigm is flexible and can be applied to a variety of teaching environments. Its use in simulation labs for medical students has been shown to facilitate the acquisition of surgical skills such as laparoscopic suturing and knot tying (Chiu et al. 2018).

Clinical teaching

Surgery is a high-volume service that offers a rich milieu of clinical learning opportunities. Active student participation in the outpatient, inpatient, operative, and emergency settings within the surgery clerkship cater to developing the knowledge, skills, and attitudes that are required of graduating medical students. Studies have shown that the time spent on activities involving direct patient contact is positively related to students' perceptions of the quality of their learning environment (Hinojosa-Gonzalez et al. 2020; McKinley et al. 2020).

A patient's first encounter with a member of the surgical team is often in the out-patient clinic, where an eager medical student waits, ready to take a thorough history and perform a detailed examination. Surgical patients frequently present with clear histories and prominent physical signs, which makes them suitable for developing these skills in novice medical practitioners (Agha et al. 2005). This first patient encounter initiates a doctor (medical student)-patient relationship which solidifies the student's role as a professional and active member of the surgery team. Furthermore, students are introduced to surgical pathology at its initial presentation and are given the chance to develop assessment and management plans and follow the disease process in detail during the course of their clerkship. The clinic also allows students to develop confidence in undertaking low-risk technical activities such as removing staples and sutures, simple wound dressings, drain management, and drain removal.

While an effective surgery clerkship is highly dependent on a cohesive team of students, residents and surgeons, it is ultimately supervising faculty that is responsible for overall student learning and evaluation. The relatively low-pressure environment and fewer number of team members in the clinic allow better student-faculty interaction in outpatient clinics than in the inpatient areas and operating room. There are several well-described strategies for efficient, patient-based teaching. These include the one-minute preceptor which is an easy to learn set of 5 "microskills" (Table 1-5) that can be utilized by busy faculty to teach students and trainees during the workday (Neher et al. 1992). The SNAPPS model is a student-centred model that encourages students and faculty to work together to achieve learning objectives (Wolpaw, Wolpaw and Papp 2003). Clinical faculty are able to provide students with immediate feedback after every patient presentation, identifying areas that need improvement and setting learning objectives for individual students to focus on. Subjective faculty evaluations, which make a significant portion of students' final surgery grade, typically reflect recollections of case presentations, write-ups, and observations of brief patient encounters (Butler et al. 2017). Hence, out-patient clinics are a valuable resource for monitoring student progress and informing final evaluations.

Table 1-5: The five-step "microskills" model (Neher et al. 1992)

Five-step "microskills" model
Microskill 1: Get a commitment Microskill 2: Probe for supporting evidence Microskill 3: Teach general rules Microskill 4: Reinforce what was done right Microskill 5: Correct mistakes

Ideally, the duration of the surgical clerkship allows students to cover the entire spectrum of care from admission and first clinical encounter to long term follow up. A significant portion of this takes place in the inpatient setting, where students follow the progress of two to four patients at a time. In the ward, students learn about post-operative complications, the need for regular observation, contingency planning, and discharge criteria (Agha et al. 2005).

Including students as active members of the surgery service is necessary for their training. Cortez and colleagues (2019) studied predictors of medical students' success on the surgery clerkship and found that according to students, the most highly rated active learning opportunities are presenting patients on rounds, developing assessment/plans, seeing individual consults, and answering directed questions. Passive learning activities that make a positive impact include bedside "on the fly" teaching (during rounds, in-between patients) and listening to patient care discussions.

Students as part of the surgical team do not necessarily guarantee that their involvement in patient care will allow them to practise clinical reasoning, patient management skills and procedural tasks. Programmes often depend on simulation strategies for the acquisition of these skills. However, Marie Catherine Morris and colleagues (2015) noted that medical students who have acquired a skill in a simulated setting often find it challenging to transfer this skill to the workplace. They hypothesized that a fully immersive experience requiring actual performance of an intern role (what is often referred to as a "subintern") would benefit students by allowing them to learn "on the job". They assigned fifth year students to surgical teams as subinterns for two weeks, and compared their learning experience with students who were shadowing interns. The subinterns were given clearly defined roles on the surgery team by senior residents. It is important to note that every subintern was supervised and empowered to

not accept any responsibilities he/she felt incapable of handling. Each subintern was assigned to an intern as an apprentice and was provided a designated pager. Results showed that students who undertook the subinternship had a more valuable learning experience than those who just observed interns. The subintern role was an opportunity for student centred learning. The students were able to identify gaps in knowledge and skills in a safe, supervised setting, prompting them to seek remediation and practise. In the subintern group, students managed complete cases and entire patient episodes. Taking the roles of communicator, professional, and patient advocate proved a rewarding experience for the subinterns. This was in contrast to the "intern-shadow" group that reported a more fragmented experience. Furthermore, the subinterns identified their supervising interns and residents as good role models and valued the teaching they provided.

The in-house call is an essential component of training in many medical disciplines. For trainees, this is the setting where they develop many of the skills necessary for the discipline. For students, the purpose is slightly different. Most clinical rotations have students assigned to "elective" interactions (outpatient clinic, scheduled procedures) during the course of the workday. The surgery call experience exposes students to the care of patients presenting with acute pathology, allows them to assist in the on-going management of admitted patients, and provides exposure to high-stakes situations. They have a chance to experience the nuances of inpatient care, and the impact that attention to detail (or lack thereof) in this setting has on patient outcomes.

The traditional surgery clerkship call lasts 24-hours and occurs at least once a week. However, the ideal frequency of calls for medical students has not yet been established. Too few, and medical students will have limited exposure to the rigors of call and acute emergencies that arise on a surgery service. Too many, and students experience a decline in cognitive function which negatively impacts other vital academic and clinical requirements (Halbach, Spann and Egan 2003; Perez-Olmos and Ibáñez-Pinilla 2014). A study performed at a medical school in Mexico compared students taking surgical calls every three days to students taking calls every four days (Hinojosa-Gonzalez et al. 2020). They found that students who took call every third day had a higher prevalence of burnout syndrome than those who took call every fourth day. Meanwhile, students who took call every fourth day had a higher lecture attendance and academic performance than students who took call every third day. Therefore, student calls should be established in a manner that gives them

the necessary on-call experience but has minimal impact on other clerkship commitments. This decision can vary from service to service and be informed by the level of on-call activity, patient acuity, length of work days, and patient load.

In 2020, the Association of Program Directors in Surgery released a consensus statement regarding the ideal senior medical student preparedness for general surgery internship (LaFemina et al. 2021). They concluded that the general surgery rotation should mirror the working environment of a surgical intern and strongly encouraged surgery clerkships to require a night, holiday and/or weekend shift experience for medical students. In addition to the obvious learning related to the discipline, such experiences encourage students to develop strategies for durability, resilience, fatigue mitigation, and burnout. This gives them insight into the requirements of a surgical career and empowers them to make an informed decision about their choice to pursue it.

Concerns regarding the value of student calls have also emerged in programs where students do 24 hour calls while residents follow a night float set up (Connelly et al. 2016). Different call schedules prevent team cohesion and result in a disconnect between students and residents on both the primary "day" team and night float. Residents play an important part in mentoring medical students. Disconnect between the two dilutes the overall educational value of the student rotation. One proposed solution is to eliminate calls for students to ensure that they remain on the same schedule as the primary team. However, this may lead to a gap in the student learning experience despite fostering team cohesion. Alternatively, students could be assigned to the night float for a period of time during which they would focus solely on call related activities. The remaining time within the clerkship would be spent on the primary surgical service, without any post-call day interruptions. Connelly and colleagues (2016) explored the effect of a night float week for students in a surgical clerkship and found that it led to improved morale, a better sense of belonging, and overall cohesion with the surgery team, without negatively impacting academic performance.

Teaching in the operating room

The primary workplace of a surgeon is the operating room (OR). While a crucial part of every hospital, medical students often perceive the OR as a remote, somewhat daunting, separate entity. Behind those doors lies a new world with its own set of rules, code of conduct, and etiquette. In most

programmes, students are introduced to the OR during their third year, and this experience is perhaps the hallmark of their surgical clerkship.

The OR presents a chance for students to observe the operative management of common and uncommon surgical diseases. They learn to appreciate the physical and emotional implications of surgery (Lyon 2003). Integrating tactile sensations of normal versus abnormal tissue and visualising real anatomy, aids students in creating a long term "clinical memory." For many, the OR also presents the chance to gain some technical surgical skill (O'Neill, Shapiro and Merchant 2018). Furthermore, the social environment of the OR allows students to develop insight into the importance of a well-functioning multidisciplinary team (Zundel et al. 2015).

Jennifer L. Irani and colleagues (2010) evaluated the quantity, quality, strategies, and content of OR teaching during the surgical clerkship at Brigham and Women's Hospital. They found that teaching residents technical aspects of the operation consumed a mean 55% of total case time, while only 9.8% of time was directed towards addressing the objectives of the surgery clerkship for students. Content that was addressed frequently was anatomy, communication skills, pathophysiology, professionalism, disease management, and post-operative care. The teaching and learning strategies most commonly employed were active student participation (e.g., placing a Foley catheter, cutting sutures), giving/following commands (e.g., "come in with the camera so you can see") and lectures (e.g., "the stenosis rate is 5-15%"). Results showed that surgeons perceive the educational value of the OR for students to be much higher than students do, a finding which mirrors other literature (McKinley et al. 2020; O'Neill, Shapiro and Merchant 2018). A better understanding of this discrepancy will allow surgical educators to improve the OR learning experience in the surgical clerkship.

In any hospital, the OR is a place of work which functions irrespective of the presence or absence of medical students. All operations are a serious matter and include an element of risk. Any education that occurs in the OR depends on the individual efforts of the surgeon and student. Lyon concluded that in order for students to have a truly effective educational experience, they must manage their learning across three related domains: managing the demands of the work environment and emotional aspects of surgery; managing educational tasks; and managing the social relations of work in the OR (Lyon 2003).

The first domain involves learning to navigate the physical environment of the OR. Students must familiarize themselves with OR protocols and the working culture, while coping with tensions that may arise during complications or during long procedures that require intense concentration (Lyon 2004). Feelings of intimidation and anxiety regarding the appropriate behaviour in the OR have been reported across the literature (O'Neill, Shapiro and Merchant 2018; Zundel et al. 2015). These feelings stem from fear of making a mistake that may cause harm to the patient, as well as fear of appearing foolish and being humiliated in the workplace. A proposed solution is to include an interactive orientation for all new students, which teaches OR protocols, hand washing, gowning and gloving, and an introduction to commonly used instruments and equipment. Studies have shown that an OR orientation has favourable results on the knowledge, skills and attitudes needed by the students (Patel et al. 2012). This also allows the surgeon a degree of comfort in knowing that they can trust students to competently play an active role during the operation, and more importantly, cause no harm.

Lyon's second domain of managing educational tasks, involves setting clear learning objectives and goals to be achieved in the OR (Lyon 2003). The lack of clear objectives, especially in a setting where there is no defined role for the student, reduces the ability of using the OR as an effective educational setting. Students with a keen interest in surgery are motivated to develop their own goals in the OR, which largely involve gaining technical skills and procedural experience (O'Neill, Shapiro and Merchant 2018). However, these do not align with the expectations of the surgeons, who believe that learning the principles associated with surgical disease is more relevant to the students' level than details of the operative procedure itself. Both students and surgeons agree that basic suturing and working under sterile conditions are objectives all students should achieve (Zundel et al. 2015). A proposed mechanism to ensure that students learn and participate in the OR is for programmes to develop log books or checklists that outline technical skills and procedures students must participate in (McKinley et al. 2020). Furthermore, faculty and students should share their expectations at the beginning of the clerkship, in order to develop goals that are agreed upon by both parties. Often students assigned to be in the operating room feel that unless they are part of the operating team, the experience is a poor use of their time. In a procedure where active teaching is not anticipated (usually due to the complexity of the procedure or the acuity of the patient), the surgeon should discuss this with the student beforehand. In these situations, if the student chooses to scrub in, it is understood that they are willing to maintain a strictly

observational role. With the increasing utilization of laparoscopic and robotic surgery, students can be immersed in the surgical procedure without being scrubbed in, and indeed where the technology is available, they may observe the procedure remotely.

Negotiating the social relations of work and finding a legitimate role to play is Lyon's third and perhaps most important domain in determining a student's motivation to be an active participant (Lyon 2003). Medical students are at the end of the training queue, behind fellows, residents and interns. While there is no denying that students are legitimate learners in the OR and as such, they have a right to participate, many students believe they must promote themselves in the training queue to earn this right. They "size up" the OR environment (the surgeon's willingness to teach, number of people involved, responsiveness of the team, nurses' attitudes and the emotional climate) and reflect on these cues to determine the safety of initiating interaction with the team and asking for responsibility. Students who see an environment that is not fruitful to learning prefer to play the observer. Once scrubbed in, students report feeling pressured and rushed to keep up with the OR team, which hampers their engagement with the task at hand, and any learning that results from it (Zundel et al. 2015). One solution is to brief the OR team in advance regarding the time and importance of a teaching episode so as to encourage the learning process and not rush and pressure students as they perform tasks. In a study that evaluated student experience during a surgical clerkship, Berman and colleagues (2008) proved that students who are given the opportunity to actively participate in the operating room are much likelier to opt for surgical careers.

Simulation-based teaching

The earliest use of simulation-based training in medicine can be traced back to approximately the sixth century BC. *The Sushruta Samhita*, a Sanskrit textbook written by Indian physician and surgeon Sushruta, was translated to English in 1907 (Acton 2015; Owen 2012). In it, he described lessons for students to develop their skills using natural objects that mimicked body parts, for example, making excisions on leather pouches and animal bladders filled with fluid, suturing on pieces of cloth and hides, and cauterizing pieces of meat. Between the 14th and 17th centuries, Chinese physicians employed bronze and clay dolls to teach students acupuncture points and meridians. Similarly, in Europe, life-size human wax models were used to teach anatomy. In response to a rising incidence of birth mortality, 18th century Italy saw Giovanno Antonio Galli develop

a birthing simulator using a glass uterus and flexible foetus to educate midwives and surgeons. Students were required to deliver the foetus blindfolded. This illustrates the key principles of effective simulation curricula: a needs assessment, an appropriate training method to teach the desired skill, and an assessment to verify learning.

Simulation-based training is a valuable tool in medical education. It allows users of all levels, from novice to expert, to practise and develop skills in a safe, supportive, educational environment, with comfort in the knowledge that mistakes will not cause harm to an actual patient (Acton 2015; Bradley 2006). By creating a realistic situation and contextual environment, simulation encourages the acquisition of skill through actual experience, thus facilitating skill transferral to the real clinical setting. Creating a standardized simulation-based training method also allows for effective assessment of skills to ensure that students have reached the desired proficiency level, before being allowed to actively participate in patient care. Simulation-based training can be applied to a number of scenarios in medicine and surgery. It is commonly employed to teach basic clinical and communication skills, simple technical skills and procedures, and teamwork and interprofessional learning.

Simulators can be divided into four broad categories: part-task trainers, simulated patients, computer-based systems, and integrated procedure simulators (Bradley 2006; Michael et al. 2014). Other characteristics used to classify simulators include animate/inanimate, virtual/real, and partial task trainer/procedural (Acton 2015).

Medical schools must consider a number of factors to conclude whether investing in a simulator is educationally worthwhile (Michael et al. 2014). Michael and colleagues summarize these key factors to include feasibility (degree of practicality of the task being performed), face validity (similarity between simulation and reality), content validity (assessment of the simulated task), construct validity (the ability to differentiate between levels of expertise), concurrent validity (similarity in outcomes between the simulation task and gold standard task), predictive validity (degree to which the task can indicate future performance in a specific skill), educational impact (degree to which the task improves performance), reliability (ability to reproduce results regardless of alteration in the subjects), acceptability (degree to which the subjects are accepting of the task), and cost effectiveness.

Part-task trainers are typically benchtop models that represent only a part of human anatomy. These trainers are often used to assist in the acquisition of technical, procedural or psychomotor skills (Bradley 2006). Abstract part-task trainers, such as knot tying boards, foam suture models, or simple laparoscopic box trainers, are reusable simulators that aid in teaching repetitive, simple tasks and are relatively inexpensive (Acton 2015). Physical anatomic trainers such as silicone, plastic, or foam replicas of human body parts are beneficial in teaching procedures with multiple steps. These include simulators for venepuncture and catheterization. Part-task trainers are very useful for teaching skills and techniques to novices, i.e., medical students. By using a simple representation of one body part to learn an isolated skill, students are able to compartmentalize the information and practise it repeatedly, without worrying about the other cognitive and procedural skills that may be required to conduct the task in reality. This allows for a better understanding of the task at hand and an improved retention of skill.

Simulated Patients (SPs) are used extensively in medical education, particularly to teach history taking, physical examinations and communication skills. A trained SP can realistically mimic clinical scenarios in a standardized, reliable manner (Bradley 2006). Furthermore, SPs can make valuable contributions to the assessment and feedback of the practised clinical encounter (Acton 2015). The departments of surgery at two large academic centres evaluated the impact of using simulated patients to teach and evaluate abdominal examinations and breast examinations to medical students during their surgical clerkship (Sachdeva et al. 1997). All medical students were shown a short instructional video developed by faculty experts demonstrating various components of each examination. They were given relevant textbook information and checklists to study from. The students in the intervention group attended a 70-minute teaching programme, conducted solely by trained SPs, who served as subject, instructor and evaluator. At the end of the clerkship, all students participated in a post-test and were assessed in four areas: breast examination skills, professionalism during the breast examination, abdominal examination skills, and professionalism during the abdominal examination. The intervention group performed better than the control group in all four categories. Furthermore, students in the intervention group also had higher scores on specific tasks such as palpation of the axillary tail, palpation of the axillary lymph nodes, and palpation of the liver and spleen, tasks that the authors believe are not performed well by most students.