Learning New Skills in Practice:

Surgeons Adopting and Integrating New Procedures

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in Education

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RESEARCHER'S ROLE

This research study, which explores the experience of surgeons learning and integrating new skills into practice, serves as my thesis for partial fulfillment of the requirements for the degree of Master of Arts in Education. As the Masters candidate, I served as the primary investigator and was responsible for initiating and conducting each phase of the project. This includes taking primary responsibility for project conception, data collection, data analysis and write-up.

However, the scope and methodology of the work undertaken necessitated that I recruit a team of researchers to provide me with supervision, guidance and expertise, as needed throughout the course of the study. This team included my primary supervisor, who has a background in psychology and medical education; two co-supervisors, who are practicing surgeons with expertise in medical education and grounded theory research; research assistants with training in medical anthropology and political science; and a transcriptionist. This group was augmented by my Thesis Advisory Committee, which was comprised of professors with expertise in educational theory and qualitative research methodology. As the leader of the team, my responsibilities included ensuring that all team members were working towards achieving my stated research goals, acknowledging and processing the varied perspectives of the group members and encouraging the use of a reflexive approach to data collection and analysis. The primary responsibilities of the research team were to ensure that I was achieving my research goals by imparting their methodological expertise, challenging my analysis, ensuring that I maintained a reflexive approach, and serving as an external audit at each step of the project.

The final product presented in this thesis is my own work, which has been augmented by the involvement of a team of colleagues and supervisors. I am eternally grateful for their contributions.

ABSTRACT

Surgeons regularly make changes in their practice to ensure they are providing high quality patient care. This includes the process of learning and safely integrating new skills, techniques and technologies into practice. When faced with the challenge of integrating a new surgical procedure into practice, surgeons must determine when they are ready to overcome the associated risks. This study sought to understand how surgeons experience risk when learning and integrating a new procedure into practice.

A modified constructivist, grounded theory approach was utilized. Eighteen surgeons were purposively sampled from two Canadian academic medical institutions. Semi-structured interviews were conducted and interpreted through constant comparative analysis. Emergent themes were identified and a conceptual framework was developed for understanding the surgeon experience associated with adopting and integrating a new procedure into practice.

Regardless of personal risk tolerance, surgeons described a similar approach to learning and implementing new skills. The experience of risk was one of several factors that affected their adoption of new techniques. They also described being influenced by individual, personality-driven factors, logistical considerations and the culture inherent to their departmental, institutional, professional and societal contexts.

A framework for understanding the surgeon experience when adopting and integrating new skills was constructed. The complex, nuanced multifactorial interplay between a surgeon's individual willingness to engage risk, his/her motivations and the systemic and cultural factors that serve to facilitate or hinder the implementation of a new surgical skill is at the core of this experience. An increased awareness of these factors highlights the challenges that surgeon face in adopting new procedures and may lead to the development of policies which support surgeons learning and implementing new skills, techniques and technologies while maximizing patient safety.

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LIST OF ACRONYMS

ABMS	American Board of Medical Specialties
ACGME	Accreditation Council for Graduate Medical Education
ACS	American College of Surgeons
CME	Continuing medical education
CPD	Continuing professional development
CMPA	Canadian Medical Protective Association
CPSO	College of Physicians and Surgeons of Ontario
OR	Operating room
PBLI	Practice-based learning and improvement
RA	Research assistant
RCPSC	Royal College of Physicians and Surgeons of Canada
REB	Research ethics board
TAC	Thesis advisory committee

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CHAPTER 1: INTRODUCTION

Overview

Growth of medical knowledge and evolution of surgical technologies require surgeons to regularly update the skills and techniques used in their practice. Making a change in practice by adopting and integrating a new procedure is associated with risks, which surgeons are responsible for identifying and mitigating. The literature investigating surgeon learning, learning curves and perceptions of risk in surgery are reviewed in this chapter. Gaps in the literature are described and the purpose and rationale for this study are established.

Context and Purpose

The current practice of medicine is characterized by exponential knowledge growth and unparalleled opportunities for innovation. The doubling time for medical data is estimated to be only 73 days by 2020 (Densen, 2011). Advances in medical imaging, technology, surgical techniques and their application to human anatomy have opened doors for pursuing novel therapeutic options (Riskin, Longaker, & Krummel, 2006). As a result, physicians face the challenge of regularly changing their practice to ensure provision of high quality, up-to-date, patient care. As members of a self-regulated profession, all physicians are responsible for recognizing when they need to make changes to their practice and determining how to go about making those changes. For surgeons, this means monitoring for gaps in their skills, identifying techniques that will help their patients, assessing the risks of introducing new procedures and effectively mitigating those risks. At present, there is no formalized or standardized process to support practicing surgeons in the process of learning and implementing a new skill. This differs from other professions, such as aviation and physiotherapy, where policies have been implemented in an attempt to minimize the risks associated with making changes in practice. The aviation profession requires that commercial airline pilots go through a structured process of training,

oversight and certification when moving to a new type of aircraft (Canadian Aviation Regulations, 2015). Physiotherapists in Ontario who want to perform specific high risk procedures, such as acupuncture or pelvic floor assessment, must participate in training that includes theoretical, practical and evaluation components before they can "roster" with their regulatory college and be qualified to perform those procedures (College of Physiotherapists of Ontario, 2016). In contrast, surgeons are solely responsible for guiding their own learning, evaluating the risks associated with incorporating a new technique into practice and taking steps to mitigate these risks(Gates, 1997; Hasan, Pozzi, & Hamilton, 2000).

In the realm of patient safety, the ideal of self-regulation is limited by an individual surgeon's ability to effectively identify and minimize potential risks. As a result, hospital-based protocols have been devised to systematically assess and combat risks that arise in many areas of medicine and surgery. However, systemic protocols do not address the risks associated with surgeons introducing new skills into their practice. Previous failures to acknowledge and manage these risks have led to high-profile cases of patient harm (Learning from Bristol, 2001; Pradarelli, Campbell, & Dimick, 2015). Currently, our knowledge of a surgeon's experience of risk is limited to intraoperative moment-to-moment decision making (Moulton, Regehr, Lingard, Merritt, & MacRae, 2010; Zilbert, Murnaghan, Gallinger, Regehr, & Moulton, 2015).

The purpose of this qualitative study is to explore how surgeons experience and evaluate risk when adopting and integrating a new surgical procedure into practice. Specifically, the primary objective is to develop a conceptual framework for understanding the surgeon experience when learning and implementing new skills. Secondary objectives include gaining a better understanding of how surgeons identify, perceive, accept and mitigate risk during this process; exploring surgeons' perceptions of risk in the context of the 'learning curve'; and gaining a better understanding of how surgeons with differing levels of risk tolerance experience risk when performing a new procedure. The framework that is

conceived from this study may lead to the future development of guidelines that would help surgeons learn and implement new skills, techniques, and technologies all while maximizing patient safety.

Surgeon Skill Development and Surgical Learning Curves

How Surgeons Learn

Surgeons have classically learned their craft through an apprenticeship model. Most North American surgeons train in a residency program, where they learn the required procedures of their specialty by working with an accredited surgeon. With continued exposure, trainees gain skills and are afforded a graded level of responsibility and decision-making during the procedures, and ideally progressive independence towards autonomous practice. At the end of training it is a program's responsibility to attest to a trainee's ability to perform the required procedures safely, and they are generally certified to perform the procedures of their profession if they pass their knowledge-based certification examination. Some graduates will pursue specialised fellowship training in their field. This is usually a closer, preceptor-based experience, where the trainee gains increased surgical independence in preparation for a practice that may include patients with more complex surgical requirements.

Once in practice, internal and external pressures motivate surgeons to continue to hone and modify their skills (Gates, 1997; Sachdeva & Russell, 2007). Surgeons wishing to provide new approaches or less invasive techniques to their patients must acquire and integrate new skill sets into their established practice. Ideally, surgeon learning in the unstructured practice environment should be guided by the cycle of practice-based learning and improvement (PBLI) (Sachdeva, 2005b). This framework for professional development is embedded within the core competencies of the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties (ABMS) in the United States. The Royal College of Physicians and Surgeons of Canada (RCPSC) similarly values practice-based learning and has established the Centre for Learning in Practice to

conduct research focused on physician practice interventions and continuing professional development (CPD) to improve physician practice and education (Royal College of Physicians and Surgeons of Canada, n.d.-b). The four steps of the PBLI cycle include identifying areas for improvement, engaging in learning, applying new knowledge and skills to practice and checking for improvement (Sachdeva, 2005b). The PBLI cycle provides the most comprehensive framework available to ensure surgeons learning new skills access the best available resources to improve their practice. However, to achieve the ideal state of learning, surgeons require the availability of data to conduct needs assessments, high-quality educational opportunities, opportunities for deliberate practice in a safe environment, assessment of their skills with valid results, access to preceptors and mentors, the support of their colleagues and institutions and constructive feedback from all of the stakeholders involved in their learning (Ericsson, 2004; Sachdeva, 2005a, 2005b; Sachdeva, Blair, & Lupi, 2016; Sachdeva & Russell, 2007; See, Cooper, & Fisher, 1993). Many of these resources remain lacking in the current training environment.

In the absence of the systemic structures needed to engage in optimal PBLI, practicing surgeons receive limited guidance on how to best improve their skills or how to learn new skills. The Maintenance of Certification programs that are overseen by the ABMS and the RCPSC currently serve as the best resources available to surgeons. The ABMS program includes four parts: Professionalism and Professional Standing; Lifelong learning and Self-Assessment; Assessment of Knowledge, Judgement and Skills; Improvement in Medical Practice (American Board of Medical Specialties, n.d.). The RCPSC program is divided into 3 learning sections: Group Learning; Self-learning; Assessment (Royal College of Physicians and Surgeons of Canada, n.d.-a). The achievement of the standards required for both programs is largely dependent on the accumulation of learning hours or the completion of courses. Specific to surgeons, the American College of Surgeons (ACS) introduced the Program for Validation and Verification of Surgical Knowledge and Skills in 2005 (American College of Surgeons, n.d.). The program provides a framework for the design and implementation of continuing medical education courses and

includes a 5-level model for verifying and documenting surgeon participation in CPD (referred to as continuing medical education, or CME, in the USA). The levels are progressive and include the verification of attendance, course objectives, knowledge and skills, preceptorial experience and satisfactory patient outcomes. To further support the integration of simulation into surgeon CPD the ACS established a network of accredited education (skills) centres to serve as a home for high quality training programs (Sachdeva, 2010).

Despite the significant efforts of the licensing, certification and regulation bodies to provide structures for optimal surgeon learning, the learning opportunities available to surgeons remain largely ad hoc with no formal method for ensuring that CPD courses follow established educational principles (Dunkin, 2015). As a result, individual surgeons largely rely on their discipline's respective associations (or academies/societies/organizations) or industry to provide high quality educational opportunities (Adkinson & Chung, 2015; Dunkin, 2015). Many of these opportunities take the form of courses offered at a discipline's annual meeting. The course structure usually involves lectures by expert faculty and hands-on learning using a variety of models (i.e. artificial, cadaver or virtual). However, due to the brevity of the instruction, the ability for any level of surgeon to enroll and the high learner to faculty ratios, these courses are best suited as an introduction to new procedures as they do not provide the thorough understanding and skill development necessary for safe integration in to practice (Dunkin, 2015). For courses that are industry-sponsored, there are added concerns of bias, a focus on a single technique or technology and a lack of skill assessment (Dunkin, 2015). Evaluation of performance during the learning and implementation of the skill is most often through self-assessments (Rizan, Ansell, Tilston, Warren, & Torkington, 2015).

As a result of the fragmented CPD environment that is available to surgeons, there is a lack of systemic accountability to ensure that surgeons adopting and integrating new procedures into practice are doing so in a safe manner. Thus, individual surgeons are responsible for ensuring that the associated

risks are mitigated throughout the process. However, the risks inherent to the learning process pose a challenge that has yet to be adequately addressed.

Surgeon Learning Curves

While surgeons may use a variety of resources to learn the basics of a new technique, mastery of the skill is done in practice. As surgeons gain expertise in a new skill, their performance improves and the risks to patient safety decrease – a phenomenon that has been extensively described in the literature as the 'learning curve' for a given procedure. Especially during the early phases of learning, poorer patient-centred outcomes, longer surgical times, increased blood loss, increased transfusion rates and complication rates have been reported (Arora et al., 2015; Hasan et al., 2000; Khan, Abboudi, Khan, Dasgupta, & Ahmed, 2014; Rogers, Elstein, & Bordage, 2001; Schmidt et al., 2010; Shahidi, Ou, Telford, & Enns, 2014). There have been several high-profile instances where patients were harmed due to risks imposed during a surgeon's learning curves. The most widely-cited example is associated with general surgeons transitioning from open cholecystectomies (gallbladder removal) to laparoscopic cholecystectomies in the early 1990s (Gates, 1997; Rogers et al., 2001). During the early phases of a surgeon's implementation of the minimally invasive laparoscopic technique, the risk of bile duct injury was significantly increased. This risk decreased as surgeons gained more experience with the technique. A similar but more tragic example comes from Bristol, England where 29 babies undergoing cardiac surgery died between 1984 and 1995. A thorough investigation by the United Kingdom's National Health Service identified, among many systemic issues, that surgeon learning curves were a central issue leading to patient harm (*Learning from Bristol*, 2001). Several of the recommendations stemming from that investigation resulted in policy changes to improve patient safety.

Despite the growing body of literature and increased understanding of the importance of surgeon learning curves, the risks associated with learning a new procedure in practice remain under-

reported (Ramsay et al., 2000; Sclafani & Kim, 2014). As a result, surgeons do not have reliable reported learning curves to guide their decisions when overcoming the challenges of integrating a new skill into practice. Previous authors have outlined the need for a formal training and credentialing process for learning and implementing surgical skills (Gates, 1997; Hasan et al., 2000; Sachdeva, 2005a; Sachdeva & Russell, 2007). However, until such a system is in place and widely available, decisions about how and when to integrate new procedures are largely dependent on a surgeon's self-assessment of the learning challenge and the associated risk to patients.

Risk in the Surgical Culture

Individually, physicians monitor and regulate their own performance while continuously assessing the limits of their own competence (Epstein, Siegel, & Silberman, 2008). For a surgeon, part of this assessment is done pre-operatively and includes a judgment of his or her personal contribution to the overall risk of any given procedure (Moulton et al., 2010; Zilbert et al., 2015). A similar thought process must take place when considering the integration of a new procedure into practice (Zilbert et al., 2015). However, the ability to reliably assess risk is coloured by a surgeon's personality and his or her appreciation for the risks associated with a given procedure (Contessa, Suarez, Kyriakides, & Nadzam, 2013; Massarweh, Devlin, Gaston Symons, Broeckel Elrod, & Flum, 2009; Pauley, Flin, Yule, & Youngson, 2011). These factors likely impact a surgeon's perceived need for training or support when integrating a new skill into practice.

In the culture of surgery, a variety of terms have been used to describe surgeons who are perceived to have various risk-taking behaviours: the "too timid surgeon" who perhaps "backs out" too quickly, the "cowboy" or "cavalier" who takes too many risks, and the "pioneer" who is well regarded as expanding his or her field in a thoughtful and safe manner (Cassell, 1991). While such terms are stereotypes rather than fundamental risk behaviours, there is little doubt that there exists a spectrum of

risk-taking behaviour across individuals in surgery (Zilbert et al., 2015). Moreover, these terms may also apply to surgeons with respect to their attitude toward integrating new procedures into their practice, despite potential risks associated with the learning curve. Given the increasing emphasis on patient safety in medical practice, it is important to assess what impact a surgeon's individual assessment of a new procedure's learning challenge may have on patient safety.

A qualitative study by Zilbert *et al.* (2015) explored surgeons' perceptions of their risk taking behavior and the risk taking behavior of their colleagues. Zilbert *et al*. (2015) argued that an individual surgeon`s risk profile was likely a product of both psychological and sociological factors, and that both play an important role in clinical judgment and decision-making. When surgeons reflected on their own risk-taking behaviour, they focused predominantly on whether they felt secure with their own competence and abilities to manage risk rather than on the risk profile of the surgical procedure being considered. Zilbert *et al.* (2015) demonstrated that when surgeons perceived cases to be at the boundary of their own capabilities, their decision making was modulated by both patient and environmental factors. Surgeons often reacted by modifying the environment with the goal of bringing the case back within their comfort zone. Examples of these modifications included requesting specific operating room (OR) personnel or equipment that was felt to reduce potential risks. Surgeons can learn and adopt strategies that modulate the boundaries of their comfort zones to make procedures that initially were considered undoable in their hands ultimately achievable.

At this point, it is not known whether a surgeon's risk profile affects decisions about when and how to integrate a new procedure into practice. However, given that a surgeon's risk profile influences their intra-operative thought processes, it is reasonable to expect that a surgeon's perceptions of risk may also affect their experience when learning and implementing a new skill. How a surgeon perceives risk may be reflected in their beliefs about the significance of learning curves and the best strategies for minimizing the risk to patients associated with a new procedure. This may manifest as a willingness to

be early adopters of a new procedure or, conversely, a desire to seek out further training and support prior to implementation. As we seek to understand how surgeons experience risk during the process of learning and implementing a new skill, an appreciation for how surgeon risk profiles impact their approach will be essential to managing their learning curves when integrating new procedures into their surgical practices.

CHAPTER 2: METHODOLOGY

Overview

This study uses a modified constructivist grounded theory approach to explore the surgeon experience of risk while adopting and integrating new surgical procedures into practice. Semi-structured interviews were conducted with surgeons from two academic health centres. Iterative data collection and analysis was performed. Emergent themes were identified and discussed with the larger research team to guide theoretical sampling and the development of a preliminary theoretical framework. Member checking interviews were used to test for resonance of the theoretical framework, which served as the foundation for the generation of a conceptual framework for understanding the surgeon experience of learning new skills. Throughout the research process, various methods were employed to ensure the trustworthiness of the study findings.

Researcher's Positionality

As the principal investigator for this study, I must acknowledge my personal assumptions and be aware of the biases that may be present amongst members of the research team. As a third year orthopaedic surgery resident, my position is that of an insider-outsider relative to the study participants. Due to my training, I am partially socialized within the culture of surgery and, specifically, orthopaedic surgery. My experience with learning new skills involves didactic teaching and supervised practice, prioritizing patient safety over learning. My clinical supervisors are practicing surgeons who, I believe, go through a similar process when learning new skills themselves. This provides me with a lens that is likely similar to that of the participants. However, as practicing surgeons, the participants are fully socialized within both the culture of surgery and their particular subspecialty. Thus, they may present perspectives that are foreign to my understanding. My ontologic assumption is one of multiple realities and my epistemological assumption is congruent with social constructivism. My positionality

has been influenced by Jean Piaget but is most closely aligned with Lev Vygotsky's view of knowledge being socially generated and situated (Davydov & Kerr, 1995; Proulx, 2006). As such, I accept the fundamental tenet of constructivism that there is no objective truth, but instead multiple perspectives that are shaped by individual, social, cultural and institutional factors.

Grounded Theory

Constructivist Grounded Theory

Grounded theory provides a method for studying and explaining a process, action or interaction that is shared by a group of people (Creswell, 2013). The explanation takes the form of a theory that is developed through systematic qualitative data collection and analysis (Kennedy & Lingard, 2006). The development of a theory is the characteristic that differentiates grounded theory research from other descriptive forms of qualitative study (Creswell, 2013). Since the focus of this study was to understand how surgeons experience and evaluate risk during the process of adopting and integrating new surgical skills, a grounded theory approach was employed

Early grounded theory, as developed by Glaser and Strauss, presented a methodology for studying phenomena that could not be effectively examined through the prevailing scientific paradigm of positivism (Charmaz, 2006; Glaser & Strauss, 1967; Kennedy & Lingard, 2006). While their model for grounded theory aligned with the positivist values of rigour and objectivity, it rejected the positivist research goal of identifying a single, verifiable truth. Instead, Glaser and Strauss developed grounded theory within a post-positivist paradigm to approach an unreachable truth through a systematic methodology that included iterative data collection and analysis, developing analytic codes from data, using constant comparative methods, memo-writing and theoretical sampling (Charmaz, 2006; Glaser & Strauss, 1967; Kennedy & Lingard, 2006).

Since the introduction of grounded theory methodology, contemporary researchers have adapted the initial grounded theory model to reflect numerous theoretical approaches (e.g. Charmaz, 2006; Clarke, 2003; Kennedy & Lingard, 2006). This study draws from Charmaz's constructivist grounded theory approach. The rationale behind the use of this approach is both philosophical and methodological.

From a philosophical perspective, I acknowledge my personal biases, which include a belief that there are multiple perspectives of the world which are shaped by social, cultural and institutional factors. This is consistent with the constructivist works of Piaget and Vygotsky (Davydov & Kerr, 1995; Proulx, 2006). Charmaz's constructivist grounded theory approach is compatible with this belief and makes the assumption that data and analyses are constructed by the interaction between participants and researchers, each of whom are influenced by their own contextual factors (Charmaz, 2006, 2008b). As such, I recognize that any conclusions reached in this study are a product of how I, along with the research team, interpret the data and are coloured by our positions and perspectives. This differs from other approaches to grounded theory, including classical objectivist grounded theory models which view the data as containing truth waiting to be methodically discovered by the researcher (Charmaz, 2006; Glaser & Strauss, 1967; Strauss & Corbin, 1990).

With respect to methodology, Charmaz's constructivist grounded theory approach encourages more flexibility than classical grounded theory. While it is an approach that is consistent with basic grounded theory strategies, constructivist grounded theory views those strategies as guidelines instead of rules and uses interpretive inquiry to guide methodology (Charmaz, 2008b). As such, researchers determine their next steps based on what is required to further their understanding of the phenomenon being studied, rather than adhering to a recipe-like framework. Constructivist grounded theory also encourages the initial use of "what?" and "how?" questions to understand action and context so that the answers to the "why?" questions can be interpreted (Charmaz, 2012). This differs

from classical grounded theory approaches which rely on explanatory "why?" questions without seeking to position reasoning with respect to history, culture or situation.

While the methodology used for this study reflects Charmaz's constructivist grounded theory approach, I acknowledge that there are elements to our process that do not adhere strictly to Charmaz's methodology. For example, explanatory "why?" questions were likely asked sooner than Charmaz would advocate and our findings are presented as a conceptual framework, rather than a standalone theory. The reasons for these deviations include having limited time and opportunity to engage individual participants and the need to communicate our findings in a form that can be easily understood by our predominantly positivist medical community. As such, this study employs a modified constructivist grounded theory approach, which draws heavily from Charmaz, but is also influenced by other approaches to account for the context in which the study is being completed.

Grounded Theory in Medical Education

Studies in medical education bridge two epistemologies which are often at odds with one another. Balancing the objective lens of the medical community and the subjective beliefs of the education community presents challenges in conducting and presenting medical education research. Grounded theory serves to satisfy both perspectives through the systematic investigation of social phenomena (Kennedy & Lingard, 2006). The methodological underpinnings of grounded theory reflect rigour and objectivity, which satisfy the positivist, objective world of medicine. However, that same methodology provides the freedom to explore the experiences of participants and acknowledge the influence of history, culture, society, institutions, context, relativity and bias, which are important to the study of education. Thus, it is no surprise that grounded theory is gaining popularity in health care fields such as nursing and medicine (Creswell, 2013).

Specific to this study, grounded theory methodology provided an avenue for exploring a subjective topic with a group of participants who think predominantly in terms of positivism and objectivity. Investigating the experience of risk required an awareness of the myriad of factors that impact how individuals are influenced by their environment and how they, in turn, influence their environments. The use of a constructivist paradigm ensured that I questioned my own beliefs and those of the participants on an ongoing basis. However, I was aware that the surgeons who were sharing their experiences may be skeptical of the value or validity of qualitative research. The analytic process inherent to grounded theory research provided a shared language that I could use to alleviate their concerns. Furthermore, the development of a theory speaks to the positivist medical community which values research that is able to make generalizable conclusions (Kennedy & Lingard, 2006). Being aware that our specific audience includes surgeons and administrators who appreciate research that provides actionable findings, we have taken the leap of translating the emergent theory into a conceptual framework which can more easily lead to the development of education and practice interventions.

Process

Through discussions with my research supervisors, study conception was initiated in April 2015 and proceeded through July 2015, at which point the phenomenon that we wished to study was identified. We identified a surgeon's experience of learning and incorporating new surgical skills as a phenomenon that was poorly understood. While surgeon learning curves and educational interventions have been published in the literature, the surgeon experience had not been previously studied from an educational perspective. Based on a preliminary literature review and research team expertise in the area of risk-taking and surgical decision making, I chose to explore the phenomenon through the lens of surgeon risk-taking.

Course work focused on qualitative research methods served to develop my understanding of qualitative research and my skills as a researcher and interviewer. I was also introduced to the multiple methodologies that are the foundation of qualitative research. Given that I was interested in exploring the experience of risk as it relates to a surgeon's process of learning and incorporating new skills, it was determined that a grounded theory approach with data collection through interviews was the optimal study design.

The initial thesis proposal was reviewed with my Thesis Advisory Committee (TAC) in March 2016. While the basic structure of the study was satisfactory, it took time to clarify the constructivist approach that I would use in conducting the research. The final thesis proposal was approved by my TAC in July 2016.

Ethics approval was sought and obtained from the Ottawa Health Science Network Research Ethics Board (REB), the University of Toronto Health Sciences REB and the University of Ottawa Health Sciences and Science REB. Grant funding was obtained through the University of Ottawa Postgraduate Medical Education Educational Initiatives in Residency Education (EIRE) Award and the Royal College of Physicians and Surgeons of Canada Medical Education Research Grant (MERG).

Data collection was initiated in August 2016 and completed in April 2017. Iterative data analysis occurred throughout the study and regular research team meetings were held to discuss analytic findings and the ongoing participant sampling strategy. A preliminary theory was developed from emergent themes in the data and refined through member checking interviews. The conceptual framework was finalized in June 2017 with input from all research team members.

Participants and Sampling

The participant population and sampling strategy used in this study were purposefully selected to overcome challenges posed by engaging surgeons in educational research. Based on the research

team's familiarity with the surgeon community, these challenges were expected to include the size of the potential participant pool and the ability to identify individuals who could contribute to the study. To overcome the limitation presented by the relatively small number of surgeons at any single institution, surgeons from different specialties at two academic health centres - The University of Ottawa/The Ottawa Hospital and The University of Toronto/University Health Network - were invited to participate. To find a sample of participants that would accurately represent the depth and breadth of experience amongst surgeons, a purposeful mixed sampling approach was used over the course of the study.

In the first phase of data collection, maximal variation sampling was used to purposefully explore a wide variety of perspectives (Patton, 2015). During this initial phase, a representative sample of surgeons who had integrated a new skill into their practice within the past five years was invited to participate. A new surgical skill was defined as a technique or technology that a surgeon implemented to perform a new procedure or improve upon an existing procedure. This initial group of surgeons varied with respect to surgical subspecialty, number of years in practice and risk tolerance, as perceived by their peers. At this point, the participants were limited to those who had learned a new skill within the past five years to ensure that surgeons could accurately remember details of the learning experiences. However, it quickly became apparent that the time limitation was not necessary as the participants could recall both recent and remote experiences with satisfactory detail. As such, there was no time limitation considered when recruiting participants beyond the first phase of the study.

Given the small community of surgeons being recruited for the study, snowball sampling was then used to identify surgeons who could provide unique perspectives (Patton, 2015). Each participant was asked to recommend other surgeons who they felt could share an experience relevant to the phenomenon being investigated. During the second phase of the study, these referrals were reviewed

with the research team to identify potential participants who could provide views that were unique or could build upon concepts identified through analysis of the initial interviews.

The third phase of the study involved grounded theoretical sampling based on the needs of the emergent theory (Charmaz, 2012; Creswell, 2013; Patton, 2015). As themes emerged from the data and a preliminary theory was developing, further participants were selected on the basis of their potential to assist in bringing the theory into focus. Surgeons with confirming experiences were interviewed to augment developing ideas and surgeons with disconfirming views were interviewed to sharpen the clarity of those concepts.

The fourth phase of the study included 'member checking' interviews to evaluate the resonance of our findings (Crabtree & Miller, 1999). Four surgeons who had previously participated in the study were purposefully selected to participate in these interviews on the basis of their ability to engage in active reflection, as demonstrated through their initial interviews.

The sample size of eighteen surgeons was ultimately determined by 'saturation' – the point at which no new emergent themes were found in the data (Charmaz, 2006; Morse, 1995). The point of saturation was discussed with all of the members of the research team and consensus was reached that further sampling was unlikely to add to the conceptual framework.

Data Collection via Semi-Structured Interviews

Semi-Structured Interview Guide

Among the options available to explore the experience of risk as it relates to learning a new surgical procedure, it was felt that interviews were the optimal method for data collection. Other options, including surveys, field observations and focus groups would not provide adequate opportunities to probe surgeons' experiences in a manner that promoted the depth of reflection necessary to explore the phenomenon of interest. As such, a semi-structured interview guide was

developed to assist in the active, formal reflection required for this study. In designing the interview guide, we drew from Donald Schön's theory of the "reflective practitioner" and Graham Gibbs' "reflective cycle". Both theories have been widely and successfully applied in health professions education to investigate clinician learning (Gibbs, 1988; Mann, Gordon, & MacLeod, 2009; Schön, 1983). The interview guide design is consistent with Schön and Gibbs' shared view of reflection as an iterative process which includes a triggering incident, an evaluation and analysis of the situation, taking (or planning) action and further reflection. The interview script guides surgeons through a reflective process that includes thinking about a specific event (the learning and implementation of a new procedure), appraising the process used and considering how the experience may influence future behaviour. Surgeons are encouraged to explicitly and critically explore the beliefs, attitudes, values, thoughts and actions involved in their learning processes. The prompts are specifically worded as "what?" and "how?" questions, which reflect the constructivist grounded theory approach to understanding experiences through actions and their context. Thus, the use of constructivism is synergistic with the reflection theories employed because the objective of the interviews was to cue the surgeons to speak about their actions and factors that influenced their behaviours.

The interview guide was developed with the assistance of research assistants (RAs) from both study sites. The questions were generated through the adaptation of probes used in previous similar studies and by constructing queries that addressed the specific objectives of this study (Moulton et al., 2010; Zilbert et al., 2015). Preliminary versions of the interview guide were tested in practice interviews with the RAs and a practice interview with one of the surgeon research supervisors not directly involved in the development of the questions. These practice interviews served as opportunities to refine the interview guide and to sharpen my own interview skills in preparation for the study. Refining the interview guide ultimately included reducing the number of questions from 14 over-arching questions (See Appendix A) to 9 questions (See Appendix B) that explored how surgeons identify, assess

and mitigate the risks associated with learning a new procedure and how these surgeons eventually incorporate the skill into practice within their comfort zone.

During the actual interviews, the guide was used as an outline rather than a strict set of questions to be asked. This semi-structured nature of the interviews allowed for deeper probing of participant thoughts and feelings. Furthermore, as preliminary themes were identified through iterative data analysis, the questions were regularly modified to better our understanding of concepts that may later serve as the foundation for the developing theory and conceptual framework.

Recruitment and Interviews

All potential participants were contacted via email. This initial message included details regarding the purpose for the study and the extent of involvement required (See Appendix C). Surgeons who were interested in participating were then sent an electronic copy of the consent form and an interview time was arranged (See Appendix D). The consent form was reviewed and a hard copy was signed by the participant prior to the start of each interview.

Interviews were scheduled for 60 minutes and ranged from 30 to 90 minutes in duration. Shorter interviews were limited by participant availability and, in those cases, the questions asked were focused to account for time limitations. The interviews which ran longer than 60 minutes were with participants who were particularly engaged in the discussion and were willing to extend their participation. I conducted all interviews in person, at the location of the participant's choice. The interviews were audio-recorded on dedicated voice recorders.

Immediately following each interview, I wrote a memo outlining the context of the interview, my immediate emotional and analytic response to the interaction and points for attention during formal analysis. The audio files were sent to a third-party for verbatim transcription. I reviewed all

returned transcripts for accuracy and completeness before distributing them to the research team for analysis.

Data Analysis

Data analysis was guided by Charmaz's constructivist grounded theory approach (Charmaz, 2006). All of the interview transcripts were read and coded by me and two RAs. Select transcripts were also read by research supervisors. The initial open coding of the transcript data was done using a line-by-line approach, followed by focused coding to categorize the data and initiate the development of theoretical concepts. The memos that were taken immediately following the interviews served to supplement the data and guide the development of tentative ideas about categories and relationships. Analysis was further facilitated by ongoing memo-writing to document decision points during analysis, to further explain relationships between emerging themes and to develop theoretical constructs.

Data analysis occurred in an iterative and constant comparative process. I met regularly with the RAs and my research supervisors to discuss our analytic findings. Early meetings involved the development of a coding structure and the identification of emergent themes. Codes were regularly negotiated and the coding structure was updated accordingly. NVivo 11 Software was used for data management and to facilitate data analysis and cross-referencing in the large data set.

As themes became apparent in the data, the research team meetings focused on which themes were best supported by the data and how to most effectively collect further data through theoretical sampling. This process allowed for emerging theoretical constructs to be refined and elaborated through comparisons with 'fresh' examples from ongoing data collection. My TAC was also kept apprised of emergent themes and the sampling strategies being used to ensure that the study remained true to its objectives.

As the identified themes were being augmented by iterative data collection and analysis, an emergent theory was being developed and negotiated on an ongoing basis. As the data approached saturation, each of the transcripts was reviewed again to ensure that all confirming and disconfirming views were considered in the development of the theory. At this point, the theory, along with all supporting and opposing data was reviewed with the entire research team. We all agreed that the proposed theory provided a reasonable explanation for the phenomenon being studied and was soundly grounded in the data collected.

While theories of reflective practice and constructivism were used in the design of the study, we recognized the need to analyze the data without preconceptions and the importance of being aware of other learning theories that may help to better interpret and understand the results. The iterative nature of the study allowed for ongoing re-evaluation of the theoretical framework to ensure that fixation errors were avoided and that theoretical constructs that emerged from the data were constantly compared against established learning theories.

To further verify our findings, 'member checking' interviews were conducted to assist in ensuring resonance of the proposed framework (Crabtree & Miller, 1999). These interviews were conducted with a purposefully selected group of surgeons who had previously participated in the study. Once we were satisfied with the final theory, we set out to translate the theory into a conceptual framework that could be used by surgeons and administrators to effect change in their local environments.

Mechanisms for Research Rigour

To ensure the rigour of our analysis, we used methods to ensure quality in Lincoln and Guba's four criteria for trustworthiness – credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985). To achieve credibility, we used triangulation of sources (surgeons from multiple sites and

subspecialties) and analysts (multiple data analysts with different perspectives). We also performed member checking interviews for verification of the emergent theory. To achieve transferability, we recorded and have provided descriptions of our research settings and participants with sufficient detail such that readers may evaluate the extent to which the studied context resonates with their own. Dependability was established through audits by external researchers who had the opportunity to evaluate and challenge our findings and conclusions. The members of my TAC served as external auditors throughout the research process. The final criteria, confirmability, was achieved through triangulation of sources and analysts (as described above), the use of an audit trail to document analytic decisions, and the adoption of a reflexive process. This process included individual introspection of personal biases (i.e. through journaling), mutual collaboration to acknowledge multiple perspectives (i.e. through discussion) and social critique to position our analysis within the surgical culture and society as a whole (i.e. through discussion and member checking) (Finlay, 2002).

CHAPTER 3: RESULTS

Overview

In exploring how surgeons adopt and integrate new skills into practice it became apparent that their perception of risk was one of several factors that shaped their experiences. In early interviews, multiple themes emerged as being critical to surgeons engaging in the process of learning and implementing new skills. Thus, the exploration was expanded to capture their perceptions of the various factors that influenced their experiences. These factors developed from themes in the data and are presented as such in this chapter. The relationship between these factors ultimately led to the development of a conceptual framework to aid in understanding the surgeon experience when adopting and integrating new skills into practice, which is presented in the next chapter.

Participants

The eighteen participant surgeons were recruited from two academic health centres and included fifteen males and three females. The surgeons represented eight surgical specialties and twelve subspecialties. These include thoracic surgery, plastic and reconstructive surgery, vascular surgery, gynecology oncology, orthopaedic surgery (spine, arthroplasty and upper limb), ophthalmology, cardiac surgery and general surgery (bariatric, colorectal and minimally invasive). The practice experience of the participating surgeons ranged from three years to thirty-eight years. Their views are represented here through quotations used to illustrate their experiences. The data presented has been anonymized but descriptions of the surgeons' personal contexts have been provided where it contributes to an understanding of their perspectives.

Theme 1: Description of Process

At the outset of this project it was unclear whether surgeons shared a similar approach to adopting and integrating new skills or if they took a variety of paths to make changes to their practices. Given the autonomy that surgeons enjoy in determining their own learning and practice needs, I had expected, as one surgeon described a "*grab bag"* (P1) of approaches to be described by the participants. Some surgeons did, in fact, express confidence that a variety of approaches were used to implement new skills. However, these comments were grounded in the belief that other surgeons were more cavalier in their approach because their tolerance for risk was higher. In discussing the process used by themselves and others, surgeons would often rationalize their own process as being safe and justified. For example, a surgeon who described himself as risk averse explained his own process by saying:

> *"I think I try to avoid the risks as much as possible. I try to avoid complications, but it doesn't mean that I would, you know, not do anything new or do something more than I would do. I always try to find a balance."* – P3

But when asked whether other surgeons follow a similarly cautious approach, he responded:

> *"I don't think some of the surgeons may plan it appropriately. Not prepared."* – P3

When probed further on what aspects surgeons are not prepared for, the surgeon expanded:

> *"Well, entire learning process I think sometimes. That's what I think. Not certain for my colleagues, but you know, in general, surgeons…"* – P3

Similarly, another surgeon described his approach to mitigating risks:

> *"I'm looking at all the angles. I'm looking at the cons more so than the pros. And then when it makes sense, then we go for it. And the majority of the things that we've tried have done really well. So we really filtered out a lot of things that seem like great ideas or it seems like, on paper, to be really amazing or it seems to be, on a video presentation at a conference, really amazing. But when you kind of get into more the analysis of it and more of the trying out process in the*

wetlab or amongst the group, you realize, "You know what? It really isn't what it's supposed to be."" – P10

When asked whether his approach differs from his more risk tolerant colleagues, he answered:

"I think so. . . . So this is what I've seen in the community internationally with real disregard to what happens afterwards. It's more for, "I've done this many cases," or, "I was the first to do this and that." And it's almost like a badge of like bragging rights almost, that this is what was done. And so I really want to distinguish the way we work from that kind of attitude. You know, we see videos and we sometimes laugh amongst ourselves about the certain surgeons who are just out there just to show things, you know." – P10

However, not all surgeons agreed. Several surgeons felt that their colleagues followed a similar process to learning and implementing new skills, with minor variations, regardless of personal tolerance for risk. One risk-averse, detail-oriented, surgeon responded in the following way when asked whether other surgeons would take a similar process-driven approach to integrating a new skill:

"I like to think they would. I hope they would. I mean I just think that means planning and preparing. I think most surgeons would certainly take a course or at least work through a model and then introduce it. I think most surgeons would also pair and do them in teams. Would they mentally rehearse and physically rehearse? I don't know." – P4

Another risk-averse surgeon agreed that colleagues who are more risk-tolerant would likely go through a similar process:

"Ideally I think they would probably go through a similar procedure. They may feel comfortable doing the procedure after the course, without bringing in a surgeon [to serve as a mentor], right? So I can see that for sure." – P7

In the population of surgeons interviewed for this study, the process described to learn and implement a new surgical skill was remarkably similar among all participants, whether they described themselves as risk tolerant or risk averse. One risk-tolerant surgeon summed up the process by saying:

> *". . . I would think any surgeon would do exactly what I did. You know, see what's out there in the literature, make sure they're familiar with the anatomy, make sure that they understand like what the technique is and that they're technically able to do it, make sure that they pick their patient correctly, make sure that their team is on board, and then just dive in and do it."* – P2

This description of the approach used to adopt and integrate new surgical skills is representative of the process used by all of the participants. While there were minor differences in the steps taken or justification used, all surgeons described a process of ensuring they were comfortable with the anatomy and understood the details of the technique, employed some version of practice (e.g. simulation, cadaver or mental rehearsal), chose an appropriate patient and prepared their team. This is indicative that the process used to learn and implement new skills is independent of a surgeon's self-described tolerance to risk.

Theme 2: Individual Risk Engagement

While the process used to integrate a new skill was not tied to an individual surgeon's tolerance for risk, a surgeon's relationship with risk does appear to play a role in the experience. A surgeon's willingness to engage risk may influence whether a surgeon chooses to take part in the process of learning and implementing a new skill. Several participants felt that a surgeon's experience of adopting a new skill was not related to whether they were tolerant or averse to risk, but rather whether they were willing to confront the risks associated with going through the process. As one surgeon deliberated:

> *"I'm kind of conflicted in my mind thinking about it but they're not necessarily related, right? Because you can be risk tolerant and still be very, very meticulous in your implementation, right? You can be risk tolerant and say, "I'm going to do something new and crazy but I'm going to take a six month sabbatical to learn it and set up a formal protocol." And then do it because it's crazy but, you know, you've prepared very, very well. So, you know, I'm not sure they're related."* – P6

Building on this participant's thoughts, surgeon's can also be risk tolerant but choose not to learn a new procedure because they do not have, for example, the time or desire to go through the necessary process of mitigating the identified risks. Conversely, a surgeon who is risk averse may be eager to go through the process of methodically identifying and mitigating the risks associated with a particularly challenging procedure. The distinction between risk engagement and risk tolerance is certainly subtle. However, the differentiation becomes increasingly clear as early career surgeons explain how they expect their eagerness to adopt new skills to change throughout the various stages of their career. The same surgeon who provided the above quote explains how increased practice experience will likely lead to more tolerance for risk, but not necessarily lead to an increased willingness to engage in risk:

> *"I anticipate I will be more risk tolerant as times goes on for a couple of reasons. One is that you kind of have that experience that comforts you in doing bigger and harder things. And the second . . . you have a reputation to support it. . . . So I think that changes how, as time goes on, you may be more tolerant of taking risks. That being said, I also see how comfort is very dangerous. You know, when you're comfortable doing something and it's easy, it's very hard to make that change sometimes. . . . And I can see how people, over time in their career, get into a comfort zone that may be hard to crawl out of."* - P6

Similarly, another early career surgeon, who expected that tolerance to risk would come with experience, described the challenges that are expected to arise from continuing to embrace innovation:

> *". . . to me it seems like that you sort of reach a point in your practice where you have a couple of different routes to take. One is you just either stay with the things you know, or you continue to try and innovate. And I mean the fork may come in different places, and I think a lot of it depends on if you're an early adopter or a late adopter and things like that, but to consistently be an early adopter of new technologies is difficult and you have to actively kind of pursue these things through your practice."* – P11

The surgeon goes on to say that he hopes that an increased tolerance for risk will allow him to follow his mentor's path as an innovator, but acknowledges that other factors may not allow him to engage the risks associated with implementing new procedures:

> *"I'm very early in my career so, you know, I'm not… I don't know where things are going to head, but I mean if I could model myself after somebody like him, sort of his entire career kind of was right on the cutting edge, then I mean that's sort of my dream. But I can always see how, you know, there's lots of pressures to… not outside pressures, but it's almost like self-inflicted pressure to kind of stay along the path and do things that you're comfortable with."* – P11

The early career surgeons are describing a nuanced relationship between the context of a surgeon's career and their willingness to engage in risk. This is further elucidated by experienced surgeons who describe their struggles in continuing to learn new procedures, despite accomplished careers. An experienced participant, praised by peers as an expert technical surgeon, described the challenge of engaging in the process of integrating a new skill into practice and the associated risks:

> *"I think an impediment to introducing new stuff, to me, has been… I've always been very busy, more busy than I want to be and so the idea of going out to introduce new stuff has just never been all that attractive, more stuff that I can't do. . . . I'd have to go away and learn how to do the technique. I'd have to get funding for the equipment. I'd have to develop the infrastructure to provide it. And I said who's got time for this?"* – P17

Another senior surgeon, who has won awards for innovation throughout his career, explained why he no longer actively seeks out new procedures, despite no change in his personal risk tolerance:

> *"Well, I think innovation's for the young man. I think it's… as you get older, because the amount of knowledge you have is so much greater, you become much more aware of the potential harm you can cause by change. When you're younger, much naïver, and being naïve sometimes is good. Let your mind, you know, move and going to areas that as you mature, as you become more experienced, you're more reluctant."* – P9

The surgeon expanded on his reluctance to integrate new skills at this stage of his career:

> *"I'm horrified of complication...To be quite honest, I'm going to retire one day, not because I'm inept or becoming incompetent due to age. I'm going to retire because my level of tolerance to mediocrity is increasing to a level that is painful. I lost a patient about five weeks ago and I just mentioned to you three or four times today. It bothered me deeply. My complications tear me apart now. They didn't when I was young. So although, yes, I'm risk averse, before I cared. Now I suffer. And perhaps because you become progressively more and more perfectionist. More perfectionist you become, less creative you are because you're afraid to take a chance. If I have something that I know it's going to be a 99.9% sure is going to work, I want to risk 1%? No. I'll take one in a thousand."* - P9

In this surgeon's case, he explicitly stated that his aversion to risk was unchanged compared to the more innovative stages of his career. He had always meticulously mitigated the identifiable risks but recognized that unforeseen complications were part of the learning process associated with advancing his field. The difference is that, with experience, his priorities have shifted towards patient well-being and personal comfort.

However, not all surgeons shared the same perspective as they gained more experience. A senior surgeon who recently learned and implemented a new procedure explained why it is important to continue to push personal boundaries through integrating new skills:

> *"If you're constantly pushing to improve and to be better, you're going to be in the top 50th percentile. Now if...let's say I'm 64 and along comes the medial approach for [procedure X], and I've got a year to go, am I going to do it? Probably not. Right. I don't know. . . . I think where the problem occurs is some surgeons get older. They narrow the scope of their practice and they eliminate things. And they make themselves obsolete. That's a problem. That people look at them, residents may look at them, and go, phft, I'm not going to that clinic. That person doesn't really have anything to offer me. That's a danger if you restrict your practice."* – P13

A surgeon's willingness to go through the process of adopting and integrating a new skill involves more than simply accounting for their personal tolerance for risk. Surgeons consider multiple factors when deciding whether to engage the risks associated with learning a new procedure, including their technical expertise, their reputation, their willingness to step out of their comfort zone, their inclination for overcoming logistical hurdles, their ability to endure complications and the context of their career.

Theme 3: Motivations

To understand why surgeons decide to engage with the risks associated with adopting and integrating new skills, it is necessary to better appreciate the forces that drive them to make changes to their practice. The surgeons in this sample cited various motivations for learning new skills. These motivations can be categorized as being internal or external. Frequently, surgeons described multiple motivations for learning a new skill.

Internal Motivators

Many surgeons indicated that the desire to engage in lifelong learning and to continuously improve their skills plays a key role in changing their practice through learning new procedures. A senior surgeon shared this perspective:

> *"I think that one of the best sayings in medicine is what Atul Gawande has said in his book, Better. He says as long as you're learning, you`re green. When you think you're ripe, you're almost rotten. And so you have to keep moving forward. We all have to keep moving forward."* – P13

A surgeon who is in the final years of his career discussed lifelong learning as building on what he had been taught by mentors:

> *"My [motivation] was scientific curiosity. . . . You learn that what you do, what you learn from your mentors is not the answer particularly if you have a bit of inquiring mind. And you try to either develop yourself, if you have the tools to go to a lab or accumulate a lot experience to modify things, or go elsewhere where other leaders develop new approach to treat the thing that you're familiar with and introduce in your practice."* – P9

Several other surgeons similarly described a desire to continue to build on their knowledge and skill set so that they could continue to provide safe, high level care to their patients. As another surgeon put it, *"I think that it's incumbent upon us as surgeons to continue to adapt and to evolve in our surgical skill set . . ."* (P4). However, as the quotations from the above surgeons illustrate, lifelong learning was often cited as a general motivation for learning new skills. The driving force behind adopting a particular skill was frequently more specific, such as the personal desire to be an early adopter of technology. A senior surgeon described how a personal enthusiasm for being on the cutting edge of technological advancements played a key role in changing his practice:

> *". . . this platform was very exciting, number one. So it appealed to me in terms of the elegance of its solution to a problem that we have. And the problem we have is that doing minimally*

> *invasive surgery in very complex cancer surgeries and in very difficult patients is just not on, biomechanically, mentally, physically, whatever. And this platform actually transcended that, plus the platform was really one of the future. And robotics will be a major part of surgery, you know, in the years to come. So that, I think, was the drive to take it on."* – P8

A more junior surgeon expressed a similar sentiment regarding the early adoption of a new procedure but framed it as a concern for ensuring career longevity:

> *"I mean I would say that there is a feeling of obsolescence and I kind of look at senior surgeons that are excellent at their craft, but have made a deliberate choice over their practice not to adopt new technologies. And then I look at that as a means to reflect on my own potential career trajectory and my own longevity as a surgeon and, you know, I don't want to be someone that's not able to learn and adapt to new opportunities and new technologies."* – P4

Other surgeons described how integrating new procedures aligned with their personal goals of being leaders in their subspecialty. One surgeon simply stated, "*So I think largely the drive is internal to try to be as good as you can be in your field*" (P14). A surgeon who is described as an "innovator" by colleagues explained how making frequent changes to his practice aligns with his goal of adding to his field:

> *"So I think when I was in fellowship, I knew that I was going to hopefully have a career in which things would be moving fast and changing and I wanted to be kind of contributing to the changes in my subspecialty, especially in Canada. . . . And then so we have like a thing in my clinic . . . our saying is, "if I'm doing the same thing as I did six months ago, I'm not moving with the times."* – P10

The fact that surgeons draw on internal motivations to improve their own skills is consistent with how the participants see surgeons as a group. Collectively, surgeons were described as "being driven by a kind of fire" (P1) and being "driven to innovate" (P8). Pushing the boundaries of the profession was

credited to the "ingenuity of surgeons" (P5). Clearly, there are numerous factors inherent to surgeons that serve as drivers to improving their practice through learning and implementing new procedures.

External Motivators

While internal drivers served to motivate many of the participants, they were also inspired by external factors. All of the surgeons cited, to some extent, improvements to patient care as being a reason to learn a new skill. Improving patient care was frequently mentioned as a general driving force behind making practice changes. As one surgeon stated succinctly, "*But I mean, for us, I think we're pushed by our patient outcomes to strive to do better*" (P14). In many cases, the process of adopting and implementing a new skill was initiated by a specific aspect of patient care that needed improvement. For one surgeon, poor patient outcomes resulted in pushing for a change in surgical technique:

> *"We realized, over time, that we had a wound infection problem. . . . So we took a number of, you know, [safety] measures. It didn't decrease our infection rate. And looking in the literature to see what else we could do. This was basically the only thing that kept coming up is that this type of technique has a very low wound infection rate. So I brought it to my colleagues as a kind of idea. "Would we consider changing this?""* – P6

Several surgeons were driven to learn new procedures because they did not feel that adequate treatment options were available to specific subsets of patients:

> *". . . part of the motivation behind pursuing learning a new technique, well, one was driven in how can I offer my patients the best possible care and this new modality seemed to be something that would play a role in helping a select group of patients…the appropriately selected patients in offering them oncologic and cancer care while preserving function and performance."* – P4

> *"So it came about partly because we were consistently having patients seeking any possible treatment to get back some function for them following their injury. . . . I think it was a need that needed to be served in a patient population that's very connected . . ."* – P2

> *"I mean mainly, you know, at least the new procedures that I've started are for patients that don't have a whole lot of good options, so either patients that people have sort of given up on, I guess, or that the options that are available are significantly more morbid and they're seeking to see if there's a less invasive approach. So most of the things have been sort of in response to specific patients that are coming in seeking a less invasive approach or patients that have been sent by other physicians looking for is there anything that can be done."* – P11

In other cases, implementing a new procedure was a last resort to save a patient's life. As one surgeon described:

> *"Now we had lost patients like that before. And we had thought about it. We had said, you know, geez, next time we should just take [the organ] out, like that would make most sense and everyone kind of laughed, yeah, right, right. And then, this Sunday afternoon we're faced with this [patient] and we said, if ever it's going to work, this is one who's going to benefit because she's going to die this afternoon, right."* - P5

While patient factors were the most common external driver that pushed surgeons to learn new skills, a few surgeons described other influencing forces. For one senior surgeon, the primary motivation came from administration and competition. The surgeon credited *"the pressure to decrease length of stay"* (P13) as the reason for changing practice and went on to explain:

> *"It's competition. Competition within academic centres in Ontario. Financial pressures. To be seen to be cooperating with senior management. You know, we want to do what's best fiscally for the hospital as well and for patient care."* – P13

Other surgeons also cited pressure to keep up with peers as being a motivator to learn a new technique. One surgeon, who had been reluctant to introduce a new procedure, described being motivated by the success of his colleagues:

> *"And I would say I was fairly late to the game, because that evidence evolved over a long time. It was becoming increasingly clear for years. But the equipment was expensive and, you know, if it ain't broke, don't fix it at least that was my naïve notion. I felt like my [patient] selection and technique were good but it was becoming irrefutable. Clearly, whatever I thought about my own abilities, they were not as good as what others were achieving."* – P17

It is evident that surgeons draw from multiple sources to find the motivation to engage in the risks associated with adopting and integrating a new skill. The primary source of inspiration may be internal or external, but both types of drivers often play a role in influencing a surgeon's willingness to engage the risks associated with learning a new procedure.

Theme 4: Facilitators and Barriers

None of the participants characterized the learning and implementation of a new skill as a straightforward, linear process that progressed precisely as expected. All of the surgeons described factors that either supported or hindered their efforts to adopt a new procedure. These factors can be categorized as technical, administrative, financial and collaboration/mentorship.

Technical

Surgeons cited technical issues as a facilitator or barrier based on the challenge of actually learning the procedure and the availability of equipment that was needed for learning, practice and implementation. For some surgeons integrating skills that were similar to those already used in their

practice, their pre-existing technical expertise acted as a facilitator. For example, a surgeon who was learning a new approach to a well-established laparoscopic technique said:

> *"I mean essentially in this case the anatomy's the same, it's just simply looking at it from a different angle. . . . So I think, in this particular example, because the planes are exactly the same and the structures that you are having to be careful of are exactly the same, that there's a degree of comfort."* – P16

Conversely, another surgeon's comfort level with an old skill made it more challenging to learn a new skill:

> *". . . I found it super frustrating. In part because I was so used to the other technique which was easy and I was comfortable with and I was like, "Wow, why are we doing this? This is terrible.""* – P6

Access to equipment for training and implementation was a commonly mentioned barrier to adopting a new skill. This appears to be a more significant issue for procedures requiring specialized and expensive instruments, such as robotic surgery, where the equipment is often shared amongst several surgical divisions. As one surgeon stated, *"I mean one of the challenges with robotics is that we have limited access to it*" (P16). The surgeon explains that he performs 50-60 robotic procedures per year, which is the highest volume among his colleagues. However, he expressed concern that the lack of availability of the necessary equipment makes it difficult for surgeons to achieve and maintain competency:

> *". . . you're having to manage what I could call a minimum number and in robotics that hasn't really been defined. There's different standards. I think the European standard was 20 cases. I think the US standard was 40 cases or something per year to maintain a level of competence, if you will."* – P16

Another surgeon adopting robotic surgery further explained how a lack of access to equipment and not having the right equipment for teaching limits opportunities for other surgeons to learn and practice robotic procedures:

> *". . . you need to do cases in order to be competent and even if we increase [the number of] robotic surgeons it's not going to… it just dilutes the experience. So we have not brought in new surgeons. What would really help with the robotic platform is that if you have a dual console it's easier to teach. That's a challenge because we had the old robotic system and it's a [solo] system. We don't have a teaching console. So if we did have a teaching console, it'd be much easier I think to actually have them do a little bit."* – P3

The availability of specialized and expensive equipment, such as that needed in robotic surgery, is intrinsically tied to the financial realities of the health care system. The surgeon perception of the financial barriers and facilitators is explored later in this chapter.

Administrative

All surgeons discussed navigating administrators and administrative requirements as part of the process of integrating a new procedure into practice. While a few surgeons felt that the administrative requirements helped the process, most surgeons perceived them to be a hindrance.

When discussing how administration facilitated the adoption of a new procedure, surgeons most frequently identified specific administrators who provided support. Examples of administrators cited as being facilitators included the "division head" (P2, P3, P11), the "VP Surgery" (P8), the "surgeon-in-chief" (P4), and the "OR nurse manager" (P2). Some surgeons also felt that going through the steps required to satisfy administrative requirements increased their confidence in implementing the new skill. As one surgeon explained about getting special permissions for the use of new technologies:

"When I identify a new technology or a new concept, we go through a special access program through Health Canada . . . And we go on a case-by-case scenario and do it that way. And that is a lot faster and it's done in, I think, a safe way because Health Canada's got their stamp of approval on it. You have gone through your sniff test in terms of making sure it makes sense. You've run it by your colleagues to see, you know, it makes sense from their point of view. And then once it's made your check, your colleagues check, Health Canada, you have like okay. And we have the patients for it and let's go ahead and try and get it done." – P10

While there were a few examples of administration being described as helpful, surgeons generally shared the perspective that administrative requirements were a barrier to innovation and learning new skills. Surgeons felt that the process required to satisfy administrative requirements took excessive time and effort. Several surgeons described the multiple levels of approvals that needed to be obtained:

"So the way it works is we… I applied for special equipment… and the way that goes through a number of channels. Firstly the division chair has to approve it, followed by various people within the hospital have to approve it." – P7

"It was not an easy process to…it was not a terrible process but it wasn't a totally straightforward process to actually get access to the [equipment]. Because it's not . . . it's not licensed in Canada. So you need a special exemption to be able to access it. So we get to kind of go back and forth with Health Canada and answer a series of questions about its efficacy and kind of proof of efficacy and explain what the salvage options would be if the thing kind of, you know, went wrong." – P14

One surgeon described the various requirements that had to be satisfied so that two colleagues from the USA could assist with implementation of a new procedure:

> *". . . there were surprising hurdles within our hospital and our administration that were not as supportive as I would have liked to see. It was incredibly difficult to bring them up here. It was incredibly difficult to get them privileges, insurance . . . [Surgeon 1] couldn't scrub at all because she doesn't have a valid Ontario licence, even as an observer. She wouldn't be allowed to scrub. So she could only observe and then [Surgeon 2], who does have a Canadian licence would have needed CMPA coverage and that was going to be several thousand dollars at my own cost … so it was actually really difficult. . . . So some it was just really fighting administrative battles to even make this happen in the first place. I found this showed me there's a lot of resistance to doing something new when you would think that people would be so excited about it. You know, our hospital's doing something brand new. It wasn't like that. It was a lot more resistance."* – P2

Another surgeon explained that obtaining the necessary approvals involved going beyond the medical role of a surgeon and becoming an advocate for change:

> *"I think where you work might be different. . . . You know, here it was about is the world flat or round kind of conversation. And so I think it depends on where the innovation is you're bringing in. I made a formal business case, did the whole nine yards. And I think if you're trying to bring in a new surgical platform and a skill, because a platform will have a skill, it does require some attributes that are beyond I'm a surgeon. Attributes of, you know, most of us have the business models, advocacy, even patient… advocating for the patient. . . . So we had to use a lot of those areas to even get us to the game where we could learn.* – P8

Some of the participants were concerned that the effort needed to overcome perceived administrative hurdles could deter surgeons from engaging in the process of integrating new procedures. As one participant commented:

> *"So I'm not saying you should go out there and do crazy things, but sometimes you know, innovation can get stifled by sort of complacency and then sort of engrained methods of doing things and going through, you know, a million hoops to get… because, you know, a busy surgeon, if you have to go through a million hoops and committees and this and that to do something new, it's very easy to say forget about it, you know. I'll just keep doing whatever I've done always."* – P11

A more concerning response from surgeons was consideration of going around established administrative requirements that they found to be obstructive. A surgeon who encountered numerous administrative delays commented on how the process may be approached the next time:

> *"I think that I probably would be a bit less naïve the next time about administrative stuff and I think I probably a bit… maybe I shouldn't say this, but I probably would have a bit more tendency to ask for forgiveness than permission, because I think I tried to do everything through the proper channels, and then the ten million barriers, when I probably should have just said oh, I didn't know whatever, you know. I don't think that any of the stuff that held us back made any improvement to how things got done. So I think it was only barriers that were unnecessary."* – P2

Some of the concerns that surgeons expressed regarding administrative requirements are associated with the professional, workplace and societal cultures that surgeons must navigate. These issues are explored in depth later in this chapter.

Financial

Balancing the costs associated with integrating new procedures and the financial realities of the health care system was a challenge for many of surgeons interviewed. While a few of the surgeons did receive some form of financial support to facilitate the process of learning a new skill, all of the surgeons discussed financial resources as being a barrier to innovation and the adoption of new procedures.

For several surgeons, overcoming financial hurdles was necessary before even attempting to implement a new procedure:

> *"But I did have a few conversations with people in the OR with respect to the cost of this procedure, that it was very costly and they would be monitoring it closely and also questioning about how many I was planning to do per year."* – P7

> *". . . it has been a challenge, a tremendous physical challenge to get hospital buy-in, to secure the funding, all the logistic pieces, to have people who did not understand robotics try to take it down because a hospital lives in sort of a zero sum atmosphere. If one person got an extra cherry, that means somebody didn't get a cherry . . ."* - P8

For some surgeons, financial barriers prevented them from taking on procedures they wished to learn. A surgeon commented generally on the decision making associated with learning a new skill:

> *"Is it cost prohibitive to get it done here or not? There are some technologies that are great but it just won't work here because it's too much money."* – P16

Another surgeon outlined how factoring in lost income and OR time costs played a role in deciding not to adopt a new procedure:

> *"And I think I made the right decision at the time. Like I did what was right for my patients. And to some extent, for me too, because, I mean, to start clogging up the little OR time I had with four hour cases that could take me an hour and a half the way I'm used to doing them, so I don't want to sound falsely altruistic, I mean it was about me too."* – P17

As suggested by the above surgeon, performing a new skill takes more time than techniques surgeons use on a regular basis. Several surgeons acknowledged that increased operating time influenced how they chose to implement a new procedure. As one surgeon explained:

> *"So what I decided to do for the first couple of months, actually, it took me a few months to transition, was I would only do one of the three cases per day with the new technique. . . . And the first couple of ones I did, I found very, very challenging which was why, after I did the first one, I kind of made that 'I'll only do one per day' rule. Because it took me a long time so OR time is part of the issue."* – P6

Once surgeons were able to learn and integrate a new procedure, finances continued to serve as an obstacle to expanding the usage of the procedure:

> *". . . I'm confident that I could do the procedure again. I wouldn't take the most challenging levels to do it in but I would pick a patient that I thought was, you know, a good candidate for it and relatively low risk of complications from doing it. But, again, probably internally weighing, you know, what the traditional procedure is with some risk of the new procedure and the potential benefit for it. And cost and so that's probably what's keeping me, personally, from doing more."* – P7

> *"We haven't been able to grow as a robotics program. We are pretty much stymied from a cost perspective, so that really truncated how much we could grow."* – P8

> *"It largely just comes down to funding...even now there's lot of things that I would like to be able to try out that I think there's going to potentially be a role for, but we're going to be limited because of funding. I'd like to try to ramp up the clinical use of our 3D printers and start doing some…jig-based navigation for complex [procedures]. But I can see already that funding is going to be an issue there . . ."* – P14

Surgeons lamented the lack of financial resources to facilitate the implementation of new surgical procedures as part of the constraints of our healthcare system. As one surgeon stated, *"I think it's a real*

challenge in the Canadian healthcare system as a matter of fact. I think innovation is very much stifled because the money for innovation is drying up" (P16). Just as the administrative facilitators and barriers are tied to a surgeon's environment, the financial realities of implementing a new procedure are influenced by the role that innovation plays in a surgeon's cultural context. These issues are further explored in the final theme in this chapter.

Collaboration/Mentorship

Surgeons felt that learning a new procedure with their colleagues or team and learning from a mentor was beneficial to their experience. However, the process of arranging collaboration and mentorship was cited as a hindrance to the process of integrating a new skill.

Surgeons who were able to arrange to learn with a colleague, team or mentor repeatedly pointed to having direct support during the learning process and in the operating room as a factor that increased their comfort level while implementing a new procedure. Some examples from several surgeons include:

> *"So we brought together all nurses to help give me comfort, because it was more like comfort that was required, to know that the multi-components of this system were being dealt with by people who were interested in being part of the team. . . . this perspective of having to engage a team that would look after different parts of the process, especially a technology based surgery, being comfortable that they had your back and you had their back was essential part of the comfort because I think whatever you do in surgery that's new you can take risk, but you got to be comfortable. Nobody wants to be uncomfortable taking risk. . . . And where does comfort come from? Comfort really comes from having a team that's not only watching your back but you feel you're in it together, like so to speak."* – P8

"I think, you know, we see it so often, we have two surgeons. There's a level of comfort, you know, and when you have another surgeon with you, it really makes you feel, to be honest with you, less stressed. . . . Just having somebody of your knowledge and training with you and that goes for almost any procedure. But here, again, it made it much more comfortable . . ." - P7

"And, you know, I did the first two with [a senior colleague] there so that gave me some confidence too because he watched me do it, everything went fine. It was like well, you know, having that person over your shoulder, stopping you if it's crazy, makes you a little more comfortable. . . . You know, I had my safety blanket which was I had my colleague watching." – P6

"And we decided for the first… I think we said five cases, that both surgeons would be in the room, so if one surgeon was on the console, the other surgeon would be assisting, which is unusual to have two surgeons in one room, and that's how we started, and after, you know, five cases or so, as we got comfortable, then we started doing it ourselves." – P3

"I mean [my colleague] is a part of our program and so we proctored each other, if you will, in this. So having a partner there really eased the stress associated with doing an intervention that I hadn't previously done." – P4

"So we work really closely as a team and I think that what has been tremendously important to me in doing something that's new and a little bit out of my comfort zone has been me surrounding myself with the right people and making sure that I have sort of the multidisciplinary team to help me through it." – P2

Despite surgeons feeling that learning with a colleague, team or mentor was beneficial, arranging such a collaboration proved difficult for many of the participants. One surgeon's experience in arranging for colleagues from the USA to assist in implementation was outlined in the 'Administrative' section above. The surgeon highlighted the administrative and financial barriers to collaborating with colleagues:

> *"It was incredibly difficult to bring them up here. It was incredibly difficult to get them privileges, insurance . . . [Surgeon 1] couldn't scrub at all because she doesn't have a valid Ontario licence, even as an observer. She wouldn't be allowed to scrub. So she could only observe and then [Surgeon 2], who does have a Canadian licence would have needed CMPA coverage and that was going to be several thousand dollars at my own cost … so it was actually really difficult. . . ."* – P2

Other surgeons shared similar frustrations with the barriers that had to be overcome to arrange to work with a colleague or mentor. One surgeon described the challenges associated with going to another province to spend time learning with a colleague and then having a mentor visit his home hospital:

> *"Difficult both ways. Difficult both ways. Going there I had to get, you know, I was in [another province] so I had to get my licence done and all that sort of schmazz and that was just like a bit of a headache. That's fine. That's what we had to do. You know, when I got there, it was pretty easy, to be honest. Mentor coming here was difficult for them. They had to get a preceptorship . . . their credentials and so on and that made it very, you know, it was just a lot of work for them. People are busy, right. These people are busy. They don't really have time to apply for a licence in another province, for instance. I think an intra-provincial mentorship program is very easy to do but inter – or even if it's away, it's in another country, then very difficult. And I think*

> *it's bringing up a good point. I think it's one of the barriers to really international knowledge exchange and I understand there are medical legal reasons why, but…"* - P8

Another surgeon, speaking more generally about the process, also shared concerns about how the challenges encountered when arranging collaborations hinder knowledge translation and innovation:

> *"We are suffocatingly bad when it comes to accommodating proctors. You know, again, this comes to the philosophy of the hospital, right. On the one hand you could say hey, we want to be bold and innovative but we want to do it in a safe way. So let's have these experienced experts come in and proctor our own people so that we can have outstanding clinicians in that area. But that's not what we do. Let's say someone from Texas is the expert in something that you want to bring. That person has to get an Ontario licence and then they have to be credentialed by the hospital to operate. . . . [G]etting an Ontario licence for some American, like you know what it takes to get that provincial or state medical licence. It's hell. It takes months. And so, you know, it's a very… I won't say obstructionary but it's an awfully awkward and difficult impediment to getting people credentialed to come in and proctor. . . . I'm just saying when we've become so suffocating that our people can't import new techniques I think that's a concern."* – P1

When both of these surgeons were asked what supports are available to help surgeons navigate the process, they provided effectively the same answer: *"Zero"* (P1) and *"None"* (P8).

As outlined, surgeons encounter numerous facilitators and barriers as they go through the process of adopting and implementing new procedures. Some of these factors are relationship-based, such as identifying specific supportive administrators or relying on a mentor. The remainder of these factors are logistical, including accessing necessary equipment, satisfying administrative requirements, and procuring financial resources. It appears that surgeons must employ a variety of strategies to overcome these hurdles, which are intrinsically tied to the system in which they operate.

Theme 5: Culture

The environment in which surgeons live and work influenced their experience of learning and integrating new procedures. The participants discussed the various cultures that affected their adoption of a new skill, including those of their division, hospital, profession and society. Depending on each surgeon's context, culture could serve as a facilitator or constraint to the adoption of new skills.

Several of the participants described how a surgeon's multiple environments influence their willingness to engage in the risks associated with learning a new skill:

> *"So I think a hundred percent of workplace matters, but I think there are a number of different workplace environments, right. I think there's you yourself, your immediate colleagues, probably your division as a whole and then, you know, probably the Department of Surgery and then the actual [hospital] and the rehab group and the therapists and everything. I think you can overcome resistance in some areas if you have support in other areas."* – P2

> *"Like I talk about comfort of a team in taking on risk. So if your culture in your division is zero risk, if I don't try anything new, very hard to step outside because if you step outside and you err, I think the social implications are huge. And similarly with the actual… the actual, you know, societal culture. So I think the external forces do play a lot in how you actualize your risk tolerance for sure."* – P8

> *"Well some environments are more conducive to it because you probably have more infrastructure support, more colleague support, etc. Like I had to say, here if you wanted to learn a new procedure, you've got people around that you could ask to proctor you, you've got easy access to simulation centres, easy access to a course. I mean ideally I think with new*

> *technology or with innovations, new types of surgery, two surgeons in a centre should learn together so that they're doubling their [input] and they're helping each other and they're less likely to make mistakes. And so in a bigger centre you've got that. So I think it's a lot harder for certainly a small group in a smaller centre to be able to say safely bring innovation to their community."* – P18

Speaking more specifically about their own experiences in adopting new procedures, surgeons commented on the elements within their hospital environment that facilitated the process:

> *"I think the hospital's acceptable to doing new things. We have a [committee] that reviews new procedures and surgeons need to present and, you know, having committees like that is helpful. It's in a way saying that the hospital is open to this but you need to make sure that we know about it and that we clarify it."* – P3

> *"So I think if you're not innovating, you can't be a world class institution and I think it's just not on. It doesn't mean everybody has to be innovating, but everybody has to be supporting innovation, and I think that's what we're trying to do in a new hospital logo [and vision statement]. Basically what that's saying. So I think we're getting there."* – P8

Other surgeons discussed how their department, division or immediate colleagues provided the supportive environment needed for learning new skills:

> *"So I'm very lucky to be in a very supportive immediate group, right. Like the group of [subspecialty] surgeons that are at my campus are tremendously supportive of one another. We collaborate all the time. We try and make things easier for each other and so I don't know if I was in an unsupportive group if I would have pushed to do this, you know. I think I would have wanted to do it, but I think I would have maybe gotten exhausted with trying were it not to have the support from the people and the push from other people."* – P2

> *"And there's a real spirit of learning and innovation in our centre so when you describe to our partners and to our division chief that you want to learn a new technique that has all these purported advantages, there's a real sense of supporting that. And that comes from our surgeon-in-chief and from our division head and in our culture we're really wanting to push the frontier of technology."* – P4

The broader societal environment and its associated factors, such as economics or patient desires, also played a role in facilitating innovation:

> *"We had rounds, multidisciplinary rounds, you know, the Wednesday morning things where the people from finance showed a case cost average for [our hospital] versus other centres in Ontario and it's like okay, this is obviously important to them. The writing's on the wall. And people are asking for it. Why not. Right. So that was kind of the tipping point. Where patients were not asking for it in 08, 05 or 06 or 08. They weren't asking for it. Now they were." – P13*

> *"I think it is multifactorial. I think in some environments market driven factors push technological innovation. So like in the U.S. I would say . . . in a market driven environment or market driven economy, everything is now being done robotic, even though it perhaps does not need to be done that way, and a lot of that is based on patient demand … and the consumer base in those environments are different than they are here and I think in Canada… and I don't know if it's because of the single care health environment, but the consumerism is different. We're seeing more and more of it being where the consumer, if you will, the patient, or even the consumer as the referring physician, is requesting a particular approach. But it's not quite to the level that I think we see it other market driven economies."* – P4

In some cases, being innovative and introducing new procedures aligned with the identity of a surgical team, division or hospital:

> *"I don't think you could think we're untouchable or things like that. Like we're not unique in that we can do anything we want. But I think it's unique in that it's part of our fabric. . . . like we thrive on this."* – P5

> *"That's our blood. That's our genes. What's next is our genes."* – P3

While surgeons drew on their environment for support when going through the process of learning and integrating a new skill, they also provided many examples of how they were hindered by the cultures of their OR, division, department, hospital or society. Some surgeons pointed to their hospital climate as being a barrier to change, frequently referring to other institutions where they perceived the culture to be different:

> *"I think a culture of innovation as a culture in health care is so important for forward-looking institutions or divisions or departments. . . . And as an institution, we have it isolated. It's not in the culture. I mean we're trying and if I look at the evolution of [our hospital], we're trying to stabilize the base, so to speak, you know, get the quality down. Get, just get the knitting and the shoes and the clothes in the right place before we think about building a rocket to the moon kind of thing. So the evolution of this institution it's in a different place. Whereas in a place like [Hospital A], my God. Like I know if you're not inventing some gizmo X, probably won't have a job next year."* – P8

> *"I will tell you that I think different institutions have different levels of tolerance of the risky intervention. Like, for example, [Institution A] is … how do I say this? You know, they have excellent faculty and they're a highly regarded Department of Surgery and an institution in*

> *general, nationally and internationally. I'm not sure that the faculty there are inherently better than anywhere else, but what they have is a heck of a lot of money that rolls in from their foundation. So that if some surgeon wants to implement some wild new thing . . . they basically have carte blanche to go ahead and do things. So I think that's an institution where there's a very kind of far-reaching vision of let's try new things and let's be as bold and as innovative as we can be. . . . Here in [our institution] I think there's a great emphasis on, you know, sort of safety and sort of playing within the rules and stuff like that. So that's not to say it stifles innovation, but it's definitely a balancing force . . ."* – P1

Other surgeons also specifically identified their institution's financial environment and approach to resource allocation as being constraints to the introduction of new procedures:

> *"Politics are involved with perception and the board of directors has to do what they think is best for the hospital. And now in days of tight financial scrutiny for everything that's being done, they have to be careful of that because… I'm sure the board of directors has to answer to something, someone, some group … and public funds are being really watched these days. So it sucks but it makes sense. I understand it."* – P10

> *"People were not happy about us bringing robotics to [our hospital]. . . .Because it threatened the status quo a lot. And it's complex. I mean I understand that now in retrospect. . . . Because the environment somehow still struggles with the idea that this platform exists because again, it's the… I think the zero sum game again. If we do robotics, we're not doing something else."* – P8

For some surgeons, implementing a new procedure meant having to overcome the environmental inertia that existed within their contexts:

> *"Like anything else you're sort of getting institutionalized a little bit where things have to be done a certain way and, you know, so I remember the first time in [the procedure suite] when I brought an endoscope down there, like the response from the nurses and the managers were like well, in 20 years we've never had an endoscope here. Why do you need an endoscope? We've always done this, you know, the other way. . . . So there's a lot of resistance. Like it's not a call out, but there's a certain kind of momentum that builds in departments and in… not necessarily departments but with people where it's things get engrained and that's how it's been done. That's the way they've always done it and to try and change course can be a bit challenging."* – P11

> *"I'm not going to say it's easy to implement changes but the culture is there to kind of go with the changes and, OR nurses, to the staff, they know that I'm coming in every second and third OR with something new to try out. So there was a little bit of resistance at first but now they know this is how I work. . . . I think [the resistance is] from everything. Just because change is change. And I think it's not so much resistance to new ideas . . . but more how it's going to change or disrupt the way things are being done."* – P10

In addition to speaking about the need to manage change, both of the above quotations allude to the culture of the OR as being a barrier to introducing new procedures. As one surgeon described, the influence of the OR culture can be subtle, yet impactful:

> *"But it was made very clear by, you know, senior nursing staff in the OR that, "Okay. That's great, you're doing a new thing but get out of here by three thirty, right?" Like they don't say it that way. Nobody ever comes to you and threatens you but it's an implied kind of current that's always in the culture. It's always kind of under people's breaths but it's… it's not overt though.*

You know, nobody walks in and is like, "You're running late again because you're doing this new thing."" – P6

Surgeons who felt that they had to overcome institutional cultural barriers to successfully implement a new skill were particularly irritated when their institutions subsequently celebrated their achievements:

"But I certainly was very disappointed in the way that our institution approached trying to bring something innovative, and then I was quite frustrated afterwards to see them take a lot of credit and now like invite [Patient A] to be at the President's fundraising breakfast like as if, you know, what a great thing [our hospital's] done. I'm a little bit frustrated to say like it's annoying to see a bunch of credit when it almost didn't happen and it wouldn't have happened were it not for me, just pushing and persevering to get it done." – P2

"I think the current environment is anti-innovation. I think our colleagues are supportive and it's funny because… so we've had a lot of praise and recognition from the administration, for the OR for this change, because of the cost savings and whatnot and the wound infection rate. At the same time, the bottom line of the OR is they want you to be done quickly and out on time and not bring your patients back. So I feel like as much as we all kind of pay lip service to innovation, doing everything for the patients, at the end of the day, it's those details that matter the most, right? Are you running over time on your day? And that's where I felt a lot of the pressure." – P6

While surgeons did not always specifically identify their workplace and societal environments as being a critical factor in determining whether they went through the process of adopting and integrating a new skill, it is evident that culture affected all aspects of the experience. As illustrated, culture played a role in influencing their motivations for learning new skills, their willingness to engage the associated risks, and the facilitators and barriers they encountered throughout the process.

CHAPTER 4: CONCEPTUAL FRAMEWORK

Overview

A surgeon's experience of adopting and integrating a new procedure into practice is complex. While surgeons appear to go through a similar process when learning and implementing new skills, each surgeon's experience of going through that process is unique. Individual surgeons must decide whether they are willing to engage the risks associated with the learning and implementation process. They have to be motivated to take on the challenge of learning a new procedure. There are multiple facilitators to seek out and barriers to overcome. And they have to navigate the institutional and social cultures in which they work and live. There is no one element that drives the surgeon experience. Rather, the experience is characterized by a tangled web of factors that are specific to each surgeon's context. In the previous chapter, the experiences of the surgeon participants were presented collectively such that the factors that were most common and influential to the experience could be identified. In this chapter, a conceptual framework for understanding the individual surgeon's experience is presented, with examples of how it applies to the participants in this study.

Conceptual Framework

The experience of learning and implementing a new skill is influenced by the factors highlighted in the previous chapter:

- An surgeon's willingness to engage risk
- A surgeon's motivations to adopt and integrate the procedure
- Facilitators and barriers encountered throughout the process
- Cultural elements associated with institutions/society

However, these elements do not exist in isolation. As illustrated by the surgeons' thoughts on their experiences, the factors are related to one another. The relationships are occasionally obvious but they

are often subtle. In Figure 1, a conceptual framework is presented for understanding the individual surgeon experience when adopting and integrating new procedures into practice. This framework represents the nuanced, multifactorial interplay between the various influences that play a role in the experience.

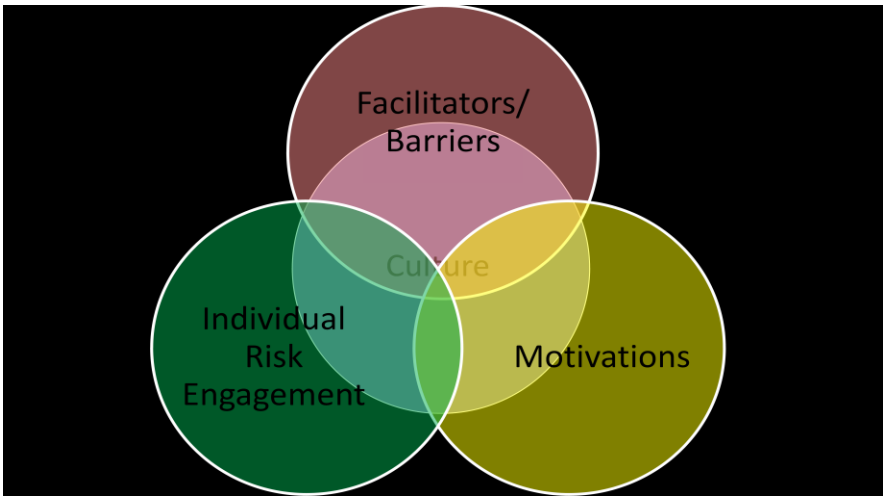

Figure 1. Conceptual framework for understanding the individual surgeon experience when adopting and integrating new procedures into practice.

The framework is structured such that the individual risk engagement, motivations and facilitators/barriers factors appear to be at the forefront of the experience. This reflects how surgeons primarily focused on the personal and tangible elements that influenced their experiences. Culture, as an influencing factor, appears to be hidden behind the others. Again, this is representative of how the surgeons collectively spoke about their environment being a background component of their experiences. However, analysis of the data reveals that a surgeon's work and social culture influence all aspects of the experience of adopting and integrating new procedures. Thus, despite being in the background, the culture of a surgeon's work and social environment overlaps significantly with each of the other factors.

The four components of the conceptual framework are drawn directly from the themes that were described in the previous chapter. Figure 2 provides a visual representation of each factor and its underlying elements.

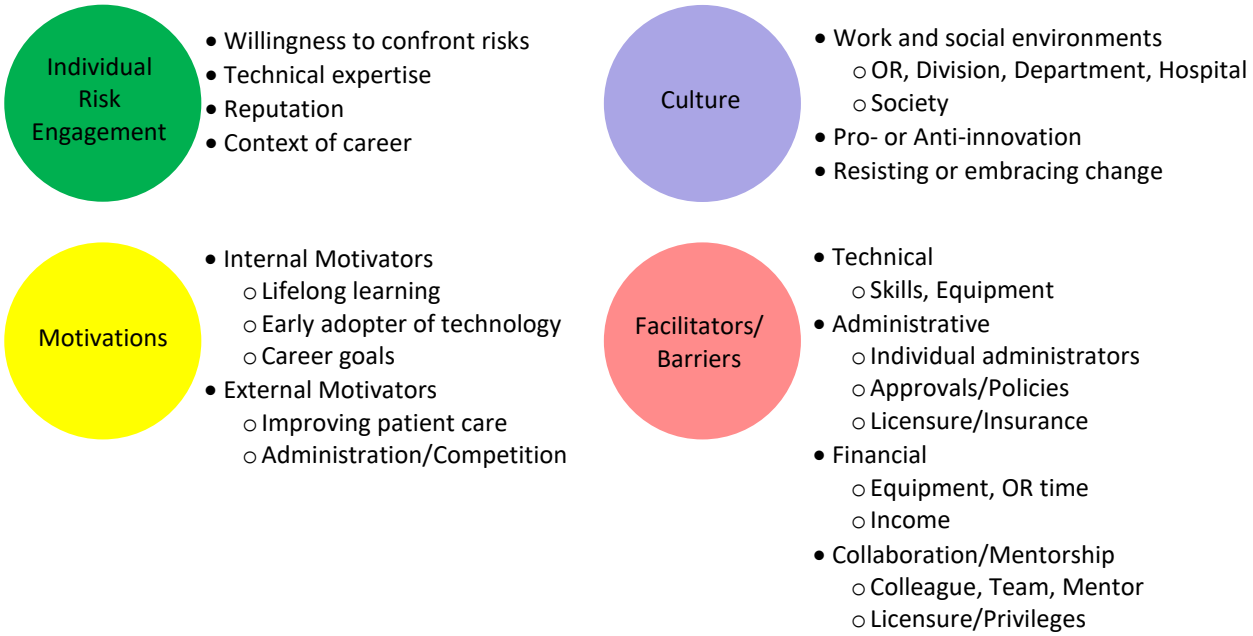

Figure 2. The components of the conceptual framework and their underlying elements

Clearly, there are a substantial number of disparate elements that constitute the factors that influence a surgeon's experience of adopting and integrating new procedures. However, not all of these elements and factors influence each surgeon's experience to the same degree. Each surgeon's experience is unique and the role that each factor plays varies according to each individual's context. The framework, as shown in Figure 1, does not account for differences among individual experiences and, rather, serves as a snapshot of an experience that is equally influenced by all factors. In reality, the weight that each factor carries differs among surgeons and in one surgeon over time. To account for this, the conceptual framework has been designed as a dynamic model that allows for an understanding of how the experience of learning and implementing new skills varies across and within surgeons. In fact, each experience a surgeon has with adopting and integrating a new procedure may be represented

by different depiction of the conceptual framework. The dynamic nature of the model is illustrated by the following two examples.

Example 1

The first example comes from the experience of a surgeon (P2) who is five years into practice. This surgeon introduced a new procedure to Canada and recruited two colleagues from the USA to assist with implementation. The conceptual framework representation of the surgeon's experience is shown in Figure 3.

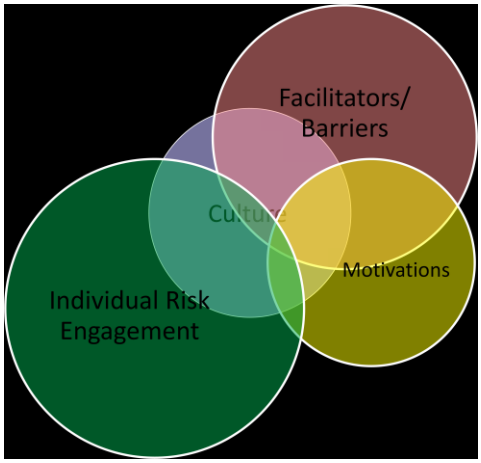

Figure 3. The conceptual framework representation of surgeon P2's experience.

This surgeon's personal willingness to engage risk and the facilitators and barriers encountered were the driving factors behind the experience of introducing a new procedure. The motivation and culture factors were present but were less influential components. With respect to individual risk engagement, the surgeon initially stated:

> *"I think that a hundred percent the person that you are outside of medicine is the way you are as a surgeon in every aspect. I think I'm that classic Type A. I am bossy. I am ambitious. I like to take risks. I like to be challenged. I like to debate and I think I live my life like that and I live my work like that . . ."* – P2

The surgeon went on to further explain how that attitude influenced the experience of adopting a new procedure:

> *"I mean I think it probably had to do with me like doing it at all, right. Like, why do something that you don't know how to do when you can... God knows there's no shortage of things that you can do to fill your OR time that are within your comfort zone."* – P2

This surgeon's willingness to take on challenges and confront the associated risks was one of the key factors that drove the experience and provided the impetus for overcoming the barriers that were encountered. The surgeon outlines the barriers related to arranging for two colleagues to assist with implementation of the procedure:

> *". . . there were surprising hurdles within our hospital and our administration that were not as supportive as I would have liked to see. It was incredibly difficult to bring them up here. It was incredibly difficult to get them privileges, insurance . . . [Surgeon 1] couldn't scrub at all because she doesn't have a valid Ontario licence, even as an observer. She wouldn't be allowed to scrub. So she could only observe and then [Surgeon 2], who does have a Canadian licence would have needed CMPA coverage and that was going to be several thousand dollars at my own cost … so it was actually really difficult. . . . [Surgeon 2] got all her own accommodations and [Surgeon 1] stayed at my house."* – P2

This surgeon spoke extensively about the barriers encountered and the individuals who helped to overcome those challenges. The heavy weight that these barriers added to the experience were crystallized by the surgeon's response when considering what could be changed to improve the experience the next time a new procedure were to be adopted and integrated into practice:

> *"I think that I probably would be a bit less naïve the next time about administrative stuff and I think I probably a bit… maybe I shouldn't say this, but I probably would have a bit more tendency to ask for forgiveness than permission, because I think I tried to do everything through*

> *the proper channels, and then the ten million barriers, when I probably should have just said oh, I didn't know whatever, you know. I don't think that any of the stuff that held us back made any improvement to how things got done. So I think it was only barriers that were unnecessary."* – P2

In this surgeon's case, the motivation and cultural factors were not described as being key components of the experience. However, that does not mean they were not present in any form. For example, while the surgeon cited "*a need that needed to be served in a patient population"* (P2) as being a motivator, the analysis suggests that the surgeon's willingness to confront risk and the desire for a career challenge were, in fact, the primary reasons for learning the new skill. This is consistent with the relationship that exists between each of the factors and is illustrated by the conceptual framework representation of this surgeon's experience.

Example 2

The second example represents the experience of a more senior surgeon (P13) who is 25 years into practice. This surgeon tried a new procedure approximately 10 years ago but found it too difficult and abandoned the learning and implementation process. The procedure had since become a well-established technique and, two years ago, the surgeon decided to learn the procedure again and integrated it into practice. The conceptual framework representation of this surgeon's experience is shown in Figure 4.

Figure 4. The conceptual framework representation of surgeon P13's experience.

The conceptual framework representation of this surgeon's experience is different than that of the previously discussed surgeon. This reflects the reality of different factors being the primary drivers of the experience. In this case, the surgeon's motivations and cultural factors were most influential. Individual risk engagement and the facilitators and barriers were less prominent.

This surgeon's primary motivations came from administration and competition. The surgeon cited the principal motivation as *"the pressure to decrease length of stay"* (P13). The surgeon then proceeded to explain:

> *"It's competition. Competition within academic centres in Ontario. Financial pressures. To be seen to be cooperating with senior management. You know, we want to do what's best fiscally for the hospital as well and for patient care."* – P13

This statement illustrates that the surgeon was influenced by external pressures to take on the challenge of learning a new procedure and that those motivations were related to the surgeon's work environment. With respect to the cultural factors involved, the surgeon said:

> *"We had rounds, multidisciplinary rounds, you know, the Wednesday morning things where the people from finance showed a case cost average for [our hospital] versus other centres in Ontario and it's like okay, this is obviously important to them. The writing's on the wall. And*

people are asking for it. Why not. Right. So that was kind of the tipping point. Where patients were not asking for it in 08, 05 or 06 or 08. They weren't asking for it. Now they were." – P13

This surgeon was attuned to both the cost-cutting work environment within the hospital and the greater social environment in which patients were becoming increasingly empowered to ask for specific procedures. This is an example of a situation where the surgeon's work and social culture interacted to influence a surgeon to change practice and played a significant role in the experience of learning and implementing a new skill.

Similar to the previous example, while two components of the framework had less of an impact on this surgeon's experience, they were present in some form. For example, the surgeon cited having a clinical fellow to collaborate with in learning the new procedure as being a facilitator to the process:

"It's like having a new staff on, right, who's keen and eager and learning and looking. I mean I don't have the time to be sitting around watching [skills videos] but he does. So that's been good. It's helped me on my learning curve, helped him on his learning curve." – P13

But when asked, in follow up, whether having a fellow serves as an encouragement to take on the challenge of learning new procedures, the surgeon responded "*No. I don't think so"* (P13), indicating that the presence of the fellow, while helpful, was not a major aspect of the experience.

Interpreting the Conceptual Framework

The conceptual framework presented above serves to help understand the experience of the individual surgeon going through the process of adopting and integrating a new procedure into practice. However, there are three important considerations to make when interpreting the framework representations of individual surgeon experiences.

First, there is no 'correct' way to adapt the conceptual framework to fit an individual surgeon's experience. The two examples provided were created based on analysis of each surgeon's experience as

shared through interviews. A different interpretation of each experience could reasonably result in models that appear dissimilar to those which have been presented. Fortunately, both of the surgeons represented by the above examples agreed with the key components of the models that were created for them when they were discussed during member-checking interviews.

Second, the examples provided show imbalanced models of the framework, each with two highly influential factors and two less prominent components. That just happened to be the most accurate representation of the experiences of these two surgeons. For different surgeons, the model may show greater or less imbalance. Their models may have three highly influential factors, only one prominent factor or have components that are equally balanced. If models were to be shown for each of the surgeons participating in this study, all of these variations would be represented.

Third, the size of one component's circle relative to another is not meant to illustrate absolute differences in the influence of each factor. There is no objective, accurate way to measure the impact that any specific factor had on a surgeon's experience and the framework was not designed as a representation of measured quantities. Rather, the relationship between the various factors is meant to convey their relative importance within each surgeon's context.

CHAPTER 5: DISCUSSION

Overview

This chapter explores the relationship between the conceptual framework introduced in the previous chapter and educational theory. Practical implications of the findings as they relate to surgeon education and practice will be examined. Limitations of this study and potential future research will also be discussed.

Alignment with Learning Theories

The design and implementation of this study have been guided by constructivist learning theories, specifically those of Piaget and Vygotsky. However, consistent with grounded theory methodology, the data analysis was conducted with an open mind to other frameworks that could serve to explain the experiences of the participants. In exploring the complex nature of the surgeon experience of learning and implementing new procedures, it became clear that the emerging conceptual framework aligned, in part, with multiple learning theories. This includes the constructivism of Piaget and Vygotsky, Kumagai's ways of knowing framework, and complexity theory as described by Davis and Sumara.

Constructivism

Among the more intriguing aspects of the surgeon experience revealed through the conceptual framework is the balance between the surgeon as an autonomous individual and the surgeon as part of a system. Throughout the interviews, surgeons spoke about their perspectives on their own development and their position relative to their environments. They also described the intrinsic beliefs that informed their experiences and how their perspectives evolved as a result of those experiences.

This is evident in the examination of how a surgeon's willingness to engage risk changes with the context of their career.

Early career surgeons felt that it was important to learn and implement new procedures throughout their career. One surgeon even described being on the cutting edge as "*sort of my dream*" (P11). After going through the experience of adopting and integrating new skills, these surgeons still hoped to incorporate innovations into their practice, but also recognized that the experience had impacted the value they assigned to being on the forefront of change. They now acknowledged finding a "*comfort zone*" (P6) and wanting to "*stay along the path*" (P11) of comfort as justifiable career choices.

For these early career surgeons, reflecting on the experience of learning and implementing new skills led to a dissonance in their personal belief systems as they questioned their convictions around adopting new surgical techniques. This is consistent with the cognitive constructivism of Jean Piaget and his contemporary, William Perry (Proulx, 2006; Taylor & Hamdy, 2013; Torre, Daley, Sebastian, & Elnicki, 2006). One of the fundamental tenets of cognitive constructivism is that learners engaged in active discovery will encounter perturbations to their existing cognitive structures. Learners must adapt to the new experiences through self-organization of their cognitive structures to achieve internal equilibrium (Proulx, 2006). This re-organization and adaptation is a process that may occur over a long period of time. While the early career surgeons may be just starting down that path of discovery, two more experienced senior surgeons described differing results of the process. One senior surgeon explained that a fear of complications and becoming increasingly perfectionist has led to reluctance to learn new procedures. The surgeon said that "*innovation's for the young man*" (P9). Conversely, another senior surgeon, who also cited a fear of complications, maintained that *"constantly pushing to improve and to be better"* was necessary to avoid becoming "*obsolete"* (P13). These senior surgeons appear to have adapted differently to the perturbations (i.e. complications) they experienced.

The experiences described by the participants suggest that by going through the process of adopting and integrating new skills, surgeons are learning and restructuring their personal beliefs about the relationships between the concepts of surgery, innovation, learning, risk and career. This personal element of the experience is reflected in the individual risk engagement and motivations components of the conceptual framework. However, cognitive constructivist theories do not account for the environmental context that impacted surgeon learning and was identified as being critical to the surgeon experience. Instead, Lev Vygotsky's theory of social constructivism serves as a better tool for understanding the role that a surgeon's social context played in their learning (Davydov & Kerr, 1995; Taylor & Hamdy, 2013).

As illustrated by the conceptual framework, the social context in which surgeons work and live has wide-ranging effects on their experiences of adopting and integrating new procedures. Surgeons regularly referenced their relationships with individuals and their environments as being influential. In some cases, these relationships played a role in shaping the surgeon's understanding of how innovation is valued in their workplace. For example, one surgeon explained that while OR nurses did not explicitly complain about a new procedure taking longer to complete, their questioning of whether the surgeon would be "*done on time"* (P6) implicitly informed the surgeon of the team's attitude toward innovation. This message played a role in the surgeon developing an understanding that "*the current environment is anti-innovation"* (P6). Another participant's experiences with navigating the systemic challenges to arranging collaborations and introducing innovation led the surgeon to express concerns about the workplace and social environment becoming *"so suffocating that our people can't import new techniques"* (P1). This influenced the surgeon to believe that the institution prioritized collective "*safety and sort of playing within the rules"* (P1) over the development of individual surgeons or techniques. These are just two examples of the many interactions that participants described with co-workers, administrators, mentors, patients, institutions, rules and policies that resulted in the surgeons adapting

their internal schema of learning and implementing new procedures. This process of interacting with one's environment and then assimilating that experience into their mental schema aligns with Vygotsky's belief that learning involves two stages, first social (or external) and then psychological (or internal) (Davydov & Kerr, 1995; Kay & Kibble, 2016). The connection between the external and internal levels is mediated through the use of cultural tools (Kay & Kibble, 2016). In the case of these two surgeons, those cultural tools included language and policy.

The two above examples illustrate experiences which resulted in surgeons adapting in relation their social contexts by forming an understanding of their environment as being negatively oriented towards innovation. However, many surgeons also described social interactions that shaped an understanding of a more positively oriented environment-innovation relationship. An example includes surgeons' descriptions of their experiences learning with a colleague, team or mentor. The way that surgeons described learning with others is consistent with Vygotsky's concept of the Zone of Proximal Development (ZPD) (Davydov & Kerr, 1995; Kay & Kibble, 2016; Taylor & Hamdy, 2013). The ZPD describes knowledge, or in this case skills, that learners require guidance to understand or perform. The support often takes the form of 'scaffolding' from a more knowledgeable source (Kay & Kibble, 2016). As the surgeons in this study described, their peers, teams and mentors played a significant role in providing the support that they required to feel comfortable to implement new procedures. With increased experience, the surgeons no longer needed scaffolding from their colleagues and were able to perform the skills independently.

Cognitive and social constructivism theories serve as lenses that help to understand how surgeons adopting new procedures learn, through self-organization and adaptation, as individuals and as members of a social environment. The conceptual framework that has emerged from this study is congruent with both theories as it recognizes both individual and social factors as being foundational to the experience.

Ways of Knowing

Analysing the experiences of the participants through the lens of constructivism highlights that the participants developed knowledge that goes beyond the expertise needed to perform a new surgical technique. Through reflecting on and discussing the various components of their experiences, surgeons revealed learning that influenced their beliefs, understanding of their worlds and appreciation for a surgeon's role. To explore the various levels of learning demonstrated by the surgeons, Arno Kumagai's adaptation of Jurgen Habermas's classification for ways of knowing serves as an effective framework (Kumagai, 2013, 2014). Habermas classified knowledge according to cognitive interests – instrumental interests generate technical knowledge, communicative interests generate practical knowledge and emancipatory interests result in critical knowledge (Kumagai, 2013, 2014). In adapting the classification for medical education, Kumagai associated each type of knowledge with relevant areas of study. Technical knowledge includes biomedical and clinical sciences, practical knowledge includes clinical skills and standards of practice, and critical knowledge includes humanistic topics such as professionalism, ethics and relationships (Kumagai, 2014).

In applying Kumagai's framework to the experience of surgeons learning new skills, each of the three ways of knowing can be identified. Instrumental and communicative interests were fostered through learning how to perform a new procedure. In learning how to perform a new procedure, instrumental interests were fostered and technical knowledge was generated through studying the relevant anatomy and physiology. Similarly, communicative interests led to the development of practical knowledge through making the correct diagnosis, choosing proper instrumentation, ensuring appropriate patient selection and using accepted surgical technique. All of the surgeons in this study were able to discuss, in detail, how they went about developing technical and practical knowledge and expertise. The process that was described was similar across the study population. The surgeons

demonstrated their technical and practical knowledge by performing the new procedures in practice without significant complications.

Emancipatory interests and the associated critical knowledge developed were more challenging to elicit during interviews and difficult for surgeons to discuss in detail. Critical knowledge is fostered through reflection and one's interactions with the environment, which leads to a fundamental understanding of an individual's place with respect to themselves and others in the world (Kumagai, 2013, 2014; Kumagai & Lypson, 2009). The knowledge that is gained is tacit in nature and inherently more problematic to demonstrate than technical or practical learning. Kumagai references the 'hidden curriculum' experienced by medical trainees as an example of critical knowledge that is problematic to demonstrate but is enduringly powerful (Kumagai, 2014). For the surgeons in this study, critical knowledge was developed from the experience of integrating new procedures into their practice (as opposed to the process of learning the technique), which required navigation of their professional, political and social worlds. Through reflection and discussion in the interviews, some of the surgeons were able to provide insights on the critical knowledge gained through the process. One example is the surgeon who considered bypassing administrative requirements the next time a new procedure was to be implemented. The surgeon cited having "*a bit more tendency to ask for forgiveness than permission*" (P2) during the next attempt to implement a new technique due to the numerous barriers encountered. The frustration that is evident from this response provides insight into the surgeon's orientation towards herself and the world. The surgeon clearly feels that there are enough benefits from introducing a new procedure that it is reasonable to stray from the cultural norms of abiding by rules and policies. Thus, the surgeon views herself as an agent serving to benefit patients in an environment which acts to oppose, or at least obstruct, such beneficial acts. The critical knowledge generated through this experience impacts the surgeon's identity and relationship with the environment, which has the potential to impact the surgeon's future actions.

The conceptual framework that has emerged from this study exposes the components of the surgeon experience that lead to the generation of critical knowledge. While the technical and practical knowledge gained from adopting a new procedure is important and critical to the success of surgeons and their patients, surgeons do not discuss these types of learning as profound elements of the experience. Rather, it is the critical knowledge that is developed from individuals engaging themselves and their environments to put those procedures into practice that leads to lasting change in surgeons' beliefs, their roles and understanding of their environment.

Complexity Theory

Constructivism and Kumagai's ways of knowing framework serve as useful tools for understanding how and what surgeons learn individually and through their social interactions. They acknowledge the role of the environment in individual learning but do not address learning of the environment itself. Consideration of the multiple levels of learning that occur in a social ecosystem aligns with complexity science. Complexity theory, as explained by Davis and Sumara, provides a framework for understanding learning by drawing from Warren Weaver's classification of phenomena (Sumara & Davis, 2006). This classification includes descriptions of simple, complicated and complex systems.

Simple systems have few components which interact on a predictable cause-effect basis. They can be analysed and measured using Newton's laws (McMurtry, 2008; Sumara & Davis, 2006). In complicated systems, there are more components but the interactions remain grounded in linear cause and effect, despite becoming increasingly difficult to predict. Statistics and probability are the preferred tools for analysis and measurement (McMurtry, 2008; Sumara & Davis, 2006). In both simple and complicated systems, the result of interactions between objects remains stable over time. This means

that the systems do not adapt or learn and the systems remain a sum of their parts (McMurtry, 2008; Sumara & Davis, 2006).

Complex systems differ in that their components do not react in a way that is always predictable or easily measured. Rather, the behaviours of the components change as the system self-organizes and adapts to internal and external pressures (McMurtry, 2008; Sumara & Davis, 2006). These adaptations are structural changes in response to and in relation to a learner's environment. While this is a subtle difference from Kumagai's belief that learners adapt their orientation towards self and the environment, complexity theory does not reject other learning theories (Kumagai, 2014; Sumara & Davis, 2006). Rather, it acknowledges that a variety of explanations are required to understand different environments and learners within a system (McMurtry, 2008). So it allows for theories such as cognitive and social constructivism to co-exist but recognizes that the two levels of learner – the individual and the social – cannot be separated because they are interconnected. To understand one level requires being attentive to adjacent levels (McMurtry, 2008).

Surgeons and the environment in which they learn and implement new procedures can be seen as complex systems, albeit at different levels or scales. How complexity theory applies to the surgeons in this study and their experiences is illustrated through the following example. Consider the surgeon who was motivated to change practice due to pressures from the hospital to "*decrease length of stay"* in an effort to "*do what's best fiscally for the hospital as well as patient care"* (P13). To understand the surgeon's experience of learning, it is important to first examine the larger ecosystem in which the learning occurred. The hospital itself is a complex system that demonstrates learning. The hospital interacts outwardly with its own environment, specifically the government and society. Economic and social pressures from these sources caused the hospital to adapt in an effort to balance the competing needs to cut costs and improve patient care. To achieve this adaptation the hospital turned inward to make a structural change. The hospital encouraged its surgeons to look for ways to provide more cost-

efficient patient care and, as a result, a bottom up self-organization occurred with surgeons being motivated to learn new procedures. The complex nature of the system at this level is exhibited by the hospital, which is an environment itself. The institution interacted with internal and external pressures, chose one of many possible responses to those pressures and adapted through structural change.

The next level is that of surgeons collectively learning new procedures. The surgeon who was motivated to change practice due to hospital pressures described a process for learning a new skill that was similar across all of the surgeons in the study population. The similarity in approach is interesting because the individual surgeons have unique backgrounds, varying motivations and act independently. This suggests that surgeons learn the process through a common response to shared environmental influences, such as educational systems and professional expectations and standards. This adaptation exhibited by the community of surgeons is also consistent with social constructivism.

At the individual level, surgeons represent complex systems themselves as they self-organize and adapt in response to their experiences. However, their individual adaptations may differ, as was discussed in the above analysis of how a surgeon's willingness to engage risk may change over their career. The surgeon in this example, despite expressing concerns about experiencing complications, felt that it was important for senior surgeons to strive to "*improve and to be better"* by learning new skills to prevent becoming "*obsolete"* (P13). Other surgeons adapted to similar concerns by choosing not to engage the risks of learning new procedures. These adaptations are both consistent with cognitive constructivism and demonstrative of how complexity theory allows for the application of different learning theories at different levels of a system.

While the conceptual framework introduced in this study is designed to help understand the individual surgeon experience of adopting and integrating a new procedure, complexity theory enriches the understanding that none of the components are static or stand alone. Rather, each component acts

on the others such that individual surgeon experience cannot be wholly appreciated without an exploration of their environment.

Implications for Practice

While alignment of the introduced conceptual framework with educational theory underscores its theoretical grounding, the findings of this study have real world significance. Application of the framework has implications for individual surgeons and the system in which they practice. It brings to light factors surgeons should consider when going through the process of adopting and integrating new procedures, including systemic structural and cultural elements that facilitate or obstruct the process.

Implications for Individual Surgeons

The experience of learning and implementing new skills is unique to each surgeon. The dynamic nature of the conceptual framework represents how the various components carry different weights in each individual's experience. The framework serves to inform surgeons taking on the challenge of adopting a new procedure of the factors that may play a role in their personal context, some of which are more easily controlled than others. This study may also serve to encourage surgeons to view the experience as a learning opportunity, through which they will gain a deeper understanding of themselves and their environment.

The factors that are under a surgeon's control include motivations for adopting a new procedure and a personal willingness to engage risk. The participants in this study cited multiple common catalysts for learning a new skill. These included internal motivators, such as lifelong learning, and external motivators associated with improving patient care. However, surgeons should remain open to other factors that may serve as impetus to change practice. This is especially important when conducting the needs assessment which acts as a trigger to the PBLI cycle (Sachdeva, 2005b). The needs assessment

serves as an opportunity to identify potential areas of improvement in a surgeon's practice. Application of the conceptual framework can guide surgeons to expand their assessment beyond areas of familiarity and be open to other sources of motivation for learning a new procedure. This may include exploring techniques that allow for career advancement, satisfying administrative goals or building on the success of colleagues. By maintaining a wide scope when performing the needs assessment, surgeons can identify motivations for changing practice that might otherwise be overlooked.

The other component of the experience that is under a surgeon's direct control is the willingness to engage the risks associated with learning and implementing a new procedure. Each surgeon's willingness to engage the risks varies. When deciding whether to confront the risks, individual surgeons should reflect on the potential positive and negative outcomes for their patients, their technical competence relative to the expertise needed to safely perform the new procedure, the impact of success or failure on their reputation and whether the context of their career and practice is conducive to taking on the challenge. Building on the comfort zone framework described by Zilbert *et* al. (2015), a surgeon who is motivated to adopt a new procedure but unwilling to engage the risks may consider modifying the learning or implementation environment such that the risks are satisfactorily mitigated. Mechanisms for modifying the environment that were identified in this study include collaborating with colleagues and mentors or attending to the aspects of the surgeon's culture which are resistant to change.

While surgeons have direct control over their motivations and willingness to engage risk, there are numerous factors over which surgeons have little or no influence. These factors generally arise from their work and social environments and require a surgeon to take on different roles in order to engage facilitators and overcome barriers. For example, the economic realities of the healthcare system can create financial barriers to learning and implementing new skills. Surgeons adopting new procedures cannot expect to change the economics of their hospital or community but participants in this study

described multiple ways of acquiring the necessary funds. Doing so often means stepping out of the medical expert role in which surgeons are most comfortable and taking on the roles of leader and advocate to ensure the mobilization of resources (Frank, Snell, & Sherbino, 2015). Procuring funding requires that surgeons be knowledgeable about institutional resource allocation, the resources needed to learn and implement the procedure and alternative sources of funding. The alternative sources described by surgeons in this study included hospital foundations, departmental/divisional funds, industry partners, external (i.e. grant) funding agencies and self-funding. If the conceptual framework generated from this study alerts surgeons to the potential financial barriers that may be encountered, they may be better prepared to overcome this hurdle when adopting and integrating a new procedure.

Another area where surgeons have little control is in the time and effort needed to satisfy administrative requirements. However, as the participants in this study identified, there are mechanisms for alleviating some of the perceived burdens of these requirements. For example, the participants found that engaging an administrator to serve as a champion for their cause facilitated navigation of the administrative system. Administrators that were cited as helpful included division heads, chief surgeons, nurse managers and the vice-president of surgery. By collaborating with an administrator, surgeons may learn to view satisfying administrative requirements as a step in the process that increases their confidence in implementing the new skill, rather than an obstacle to be overcome.

The workplace and social cultures may be the areas where an individual surgeon has the least control. As the participants in this study explained, the cultural stance towards innovation and change can play a significant role in a surgeon's experience of adopting a new procedure. In an environment that embraces change, surgeons will likely find many facilitators to overcome barriers to the process. In an anti-innovation environment, surgeons should be prepared to act as advocates for change. The participants described the challenge of being a lone voice attempting to alter institutional inertia. Similar to the collaboration that helped surgeons navigate administrative requirements, effecting change

requires recruiting other actors in the environment to build a support network that acts towards a common goal. This requires the engagement of patients, nurses, support staff, peers and administrators. Becoming an agent of change means utilizing multiple CanMEDS competencies, including communicator, collaborator, leader, health advocate and professional, to encourage others in the surgeon's environment to facilitate the process of implementing a new procedure (Frank et al., 2015).

Application of the conceptual framework can serve to prepare surgeons who are adopting and integrating new techniques for an experience that goes beyond learning the technical elements of the procedure. From a clinical practice perspective, the framework exposes the various components that impact the surgeon experience of learning new skills. It can help make surgeons aware of the factors that will be influential in their context, identify the elements which they can control and formulate plans for those that will require further engagement. From the perspective of surgeons learning in practice, the framework connects surgeons with peers who have gone through similar experiences and provides a foundation for understanding how surgeons adapt to the experience of implementing a new procedure. For example, the way that surgeons learn to control their motivations and willingness to engage risk highlights the interaction between cognitive and social constructivism in surgeon learning. In the previous discussion on learning theories, motivations and willingness to engage risk were highlighted as areas where surgeons learned through making adaptations to their cognitive structures, which is consistent with cognitive constructivism. However, in cases where a surgeon is unable make effective adaptations the conceptual framework may serve as a tool that provides access to shared collective knowledge. By drawing on the experience of others, surgeons can find new drivers to change practice or mechanisms for modifying their environment that may facilitate their experience of learning a new skill. Using the conceptual framework in this manner would be congruent with social constructivism.

With respect to the factors that surgeons do not directly control, application of the conceptual framework can play a role in fostering emancipatory interests and generating critical knowledge. The

framework underscores the need for surgeons to take on multiple roles to overcome systemic challenges such as economics, administrative requirements and cultural inertia. Embracing roles other than that of medical expert may encourage a surgeon to reflect on his or her interactions with the environment and lead to the development of critical knowledge that impacts a surgeon's orientation towards him or herself and the world.

System Level Implications

From a practical perspective, the primary actors at the system level are institutions and organizations that oversee the healthcare system and the practice of surgeons on behalf of the government. This includes, but is not limited to, hospitals, licensing bodies (i.e. College of Physicians and Surgeons of Ontario or CPSO) and insurance providers (i.e. Canadian Medical Protective Association or CMPA). These groups control the policies and impact the culture influencing the surgeon experience of adopting and integrating new procedures. This study helps to identify systemic elements that facilitate the process and call attention to areas where surgeons need increased supports to adopt new procedures safely and effectively.

The policies relevant to surgeons learning and implementing new skills can facilitate and hinder the process. Policies governing professionalism and education entrust surgeons with the responsibility of identifying areas of their practice that require improvement and the autonomy to make changes to address those deficiencies (College of Physicians and Surgeons of Ontario, 2007). A confluence of systemic factors, including policy, case law and aggressive defense against malpractice claims, have also created a legal environment that insulates surgeons from litigation tied to the risks associated with making changes in practice (Flood & Thomas, 2011). These policies influencing surgeon autonomy, responsibility and protection are foundational in allowing surgeons to adopt new procedures that fulfill the needs of their practice, patients and healthcare systems.

However, some policies designed to protect patient safety have the unintended consequence of obstructing surgeon learning, innovation and knowledge translation. In the context of arranging collaborations, policies regarding licensure, insurance and hospital privileges serve as barriers for surgeons looking to implement skills with the assistance of others. The participants in this study cited collaborating with colleagues and mentors as an important factor in increasing their comfort with learning and integrating a new procedure in a safe manner. They also described the difficulty of arranging on-site visitations with those colleagues and mentors from other hospitals, provinces and countries. For example, a surgeon from another province or the USA visiting Ontario for the purposes of acting as a surgeon mentor must apply separately to the CPSO for a Supervised Short Duration Certificate of Registration, the CMPA for insurance coverage, and the host hospital for obtaining privileges to perform specific procedures. This process can be expected to take at least three months and cost $3,000 to $17,000 depending on the surgical subspecialty (Canadian Medical Protective Association, 2016, 2017; College of Physicians and Surgeons of Ontario, 2017). The process for obtaining licensure, insurance and privileges is even more onerous for surgeons visiting from outside Canada and the USA. These policies and processes are in place to protect patient safety by ensuring that visiting surgeons are appropriately credentialed, licensed and insured. Yet, it is clear that the time and costs associated with the process can hinder surgeons' attempts to reduce the risks of integrating new procedures by collaborating with peers and mentors. Finding a solution to the challenges that these policies pose to surgeons learning new skills is beyond the scope of this study but exposing the unintended consequences of these policies may lead to surgeons and policy makers working together to find a resolution.

Aside from influencing policy, hospitals control information and resources that can be used to engage physicians in making practice changes that are beneficial to their careers, their patients and the healthcare system. For example, for the participant in this study who was motivated to learn a new skill

due to pressures from the hospital to "*decrease length of stay"*, part of being convinced to adopt the new procedure was a session *"where the people from finance showed a case cost average for [our hospital] versus other centres in Ontario"* (P13). Engaging surgeons by providing them with system-level information can make them aware of areas of practice that can be improved and encourage surgeons to embrace positive change. Institutions can prioritize innovation through allocation of resources that facilitate surgeon learning. This could address the commonly cited issue of a lack of OR time needed for implementing a new procedure. If creating new OR time is too costly, ORs with extended working hours (which are already utilized in many hospitals) can be re-assigned to surgeons navigating the learning curve for a new skill. By working together with the goal of improving patient care and healthcare delivery through surgeon development, surgeons and institutions can overcome some of the systemic barriers that currently obstruct surgeons from adopting new procedures.

Finally, this study draws attention to the importance of fostering a healthcare culture where surgeons feel supported to learn and implement new skills. The conceptual framework highlights the crucial role that a surgeon's work and social environments can play in the experience of adopting a new procedure. Establishing a supportive environment can be partially accomplished through addressing some of the issues previously discussed. However, not all of the environmental restraints that frustrate surgeons can or should be changed. Instead, system-level actors should work to educate surgeons of the importance and need for policies and administrative requirements that are necessary for patient safety. Nonetheless, removing redundant barriers or streamlining the processes that hinder surgeons would reflect a shift towards embracing change. Doing so would show a willingness to make adaptations that respect the need for patient safety but also facilitate surgeons in safely and effectively making changes to their practice through learning and implementing new skills.

In addition to influencing clinical practice, collaboration between surgeons and institutions to overcome systemic barriers to surgeon learning may serve to emphasize the inter-related nature of

learning at different levels of a complex system, such as the healthcare environment. As per complexity theory, adaptations made at the institution level have the potential to impact individual surgeons, and vice-versa. Through working together, surgeons and system-level actors may become increasingly aware of the consequences that changes made at one level have on other aspects of the healthcare system.

Limitations

Through the use of rigorous methodology and transparent analysis, the research team sought to conduct as strong a study as possible. However, there remain perceived and actual limitations to the methodology used for the study and the resulting product.

The first perceived limitation to this study relates to the participant-researcher relationship during the semi-structured interviews that formed the basis for data collection. The principal investigator, who is a surgical resident being trained at one of the study sites, conducted all of the interviews. Thus, there existed both a teacher-student relationship and a power imbalance between the interviewees and the interviewer. Several of the participants were surgeons who the principal investigator had either worked with previously or will work with in the future. And as per the social hierarchy that exists within the culture of medical training, all of the participants were in a position of power over the researcher. In some ways, these dynamics were beneficial to the interview process. The pre-existing relationship allowed for easy rapport to be established and the shared socialization within the surgical culture allowed for the use of a common language and experience base. However, those same dynamics may raise concern regarding the trustworthiness of the data collected (McDermid, Peters, Jackson, & Daly, 2014). Specifically, there is the possibility that the participants were not completely honest in their responses to interview questions due to concerns regarding sharing personal beliefs, thoughts or experiences. Given the social constructivist grounding of this study, the research team acknowledged throughout the analysis that the data generated from the interviews was co-

constructed by the interviewer and interviewee. The pre-existing relationship between the parties is one factor that influences the data that is generated in any interview (Garton & Copland, 2010). Similarly, a power relationship exists in all qualitative interviews with control shifting regularly between the interviewer and interviewee, which affects the resulting data generated (Anyan, 2013; Garton & Copland, 2010). Thus, the participant-researcher relationship that existed in this study should be considered a factor that shaped the data, rather than a limitation of the methodology. Nonetheless, awareness of the interviewer-interviewee relationship prompted reflexivity on behalf of the research team. All interview transcripts were reviewed for purposes of data analysis and ongoing refinement of interviewer technique to minimize any detrimental effects of the interviewer-interviewee relationship on the data quality.

The second perceived limitation is the lack of generalizability of the findings to surgeons outside of the participants sampled in this study. The foundation for this perception is the positivist view that the value of study findings lies in their ability to explain and predict (Charmaz, 2008a; Watling & Lingard, 2012). This represents a misunderstanding of the nature of constructivist grounded theory research. The broad goal of this type of study is to deeply explore the experiences of one group of people to better understand the meaning derived from those experiences within context (Charmaz, 2008a; Watling & Lingard, 2012). Generalizing those meanings and experiences would involve stripping away their context (Charmaz, 2008a). Rather, the aim is to achieve resonance and transferability. Through the development of a theory that is grounded in the studied context, participant and non-participant surgeons can determine whether the findings resonate within their personal circumstances. Transferability is achieved through the translation of the theory into a dynamic conceptual framework which can help surgeons apply the meanings derived from the study to their own personal contexts. Thus, while the study findings are not generalizable, they may be applicable to surgeons outside the study sample.

The third perceived limitation relates to the design of conceptual framework. The visual representation of the conceptual framework is a set of interconnected circles that change in size and relation depending on the weight of the influences that shape a surgeon's experience. The specific limitation of this model is that the size of a given circle/factor does not account for whether the influence is positive or negative. Thus, all else being equal, a surgeon with an experience that is greatly influenced by an anti-innovation environment may have a model that looks the same as surgeon influenced by a pro-innovation environment. The conceptual framework representation for each surgeon would not depict the differences in their experiences. The issue lies in the fact the conceptual framework is not an attempt to characterize individual factors as positive or negative. Rather, the framework simply serves to identify the factors that are relevant in each surgeon's context. The individual surgeon assigns meaning and value to each influencing factor. Future work in this area may lead to refinements of the conceptual framework which better represent the meaning that each surgeon assigns to an individual factor in their experience.

Future Research

This study opens multiple avenues for future research exploring the areas of surgeon learning, innovation, risk and culture. The first area of consideration is whether surgeons in different environments share similar experiences to this sample of surgeons. The participants in this study were all surgeons working in large, urban, academic health science institutions with university appointments. As such, the findings are built upon a shared context that is unique to their environment. It is not clear whether surgeons in other environments, such as non-academic, rural or urban community practices would describe similar experiences in learning and implementing new skills. Investigations employing a similar methodology with different samples of participants are warranted to determine if surgeons describe similar influencing factors in a variety of contexts. Understanding the experiences of surgeons

in different practice environments is important in crafting policy that ensures all surgeons receive the support needed to safely and effectively adopt new procedures.

Another area that warrants further study is the process that surgeons use to learn new skills. All of the surgeons in this study described using a similar process for learning new techniques. However, it remains unclear how these surgeons with unique backgrounds and varying motivations came to employ a similar approach. Investigating the underlying factors of this common approach would involve further exploration of the education and professional environments that shape a surgeon's perspective on learning. This may entail discussions with residency program directors, fellowship program directors, leaders of surgical associations/societies and regulatory body administrators. Understanding the factors that influenced the surgeons in this study to use a similar approach may provide insight into how surgeons are taught to identify, assess and mitigate risk when learning new skills.

Finally, future research will be needed to build upon the conceptual framework that was constructed from this study. While the framework identifies the important factors in the surgeon experience of learning and implementing a new technique, each component represents an area of study that deserves to be explored to greater depth. For example, the participants cited various motivations for adopting new procedures but there remain numerous other motivations that did not arise in the interviews. These may include financial incentives, a change in equipment vendors at an institution or medical-legal pressures. It is possible that further study of these motivations may impact the conceptual framework and our understanding of the surgeon experience of adopting new skills.

The relationship between each of the components that constitute the conceptual framework also warrants further investigation. The connections between the factors are represented by points of intersection and areas overlap in the framework. For example, further exploration of the relationship between OR time (i.e. facilitators/barriers) and the attitudes of OR staff toward innovation (i.e. culture) may generate new insights into how a pro- or anti-innovation environment impacts a surgeon's access

to OR time when learning new skills. Studies that extend our understanding of each factor and the relationship between factors may lead to modifications of the conceptual framework. As the framework evolves, it may present a more refined depiction of a surgeon's experience of adopting and integrating new procedures.

Conclusion

This modified grounded theory set out to explore how surgeons experience and evaluate risk when adopting and integrating a new surgical procedure into practice. However, it became clear that the initial focus for the study was too narrow as the surgeon participants discussed risk as only one of several factors that played a role in shaping their experience of learning and implementing new skills. They described being influenced by their willingness to engage risk, numerous motivations for learning new techniques, facilitators and barriers to the process, and hidden but pervasive cultural factors. There was no one factor that drove the experience. Rather, a nuanced, multifactorial interplay between these various influences resulted in experiences that were unique to each surgeon's individual context. The conceptual framework generated from this study serves to aid our understanding of the surgeon experience by visually representing the interplay between the influential components. The conceptual framework is a dynamic model that allows for individualization as the weight and relationship of the factors is adjusted to represent each surgeon's unique experience.

The findings of this study have theoretical implications for understanding surgeon learning and practical implications that could impact surgeons and the healthcare system. The conceptual framework aligns with multiple learning theories, including constructivism, ways of knowing and complexity theory. Piaget's cognitive constructivism, Vygotsky's social constructivism and Kumagai's ways of knowing theories serve as lenses that provide insight into how surgeons construct knowledge, in multiple forms, as they go through the process of adopting a new procedure. Complexity theory, as described by Davis

and Sumara, enriches that understanding through consideration of the roles of the surgeon and the environment as part of a complex learning system. From a practical perspective, the study and emergent conceptual framework provide surgeons with guidance on managing factors, over which they have varying levels of control, that impact their experience of learning a new skill. With respect to surgeons learning in practice, the framework functions as an educational tool that connects surgeons to each other through the sharing of collective knowledge and to their environments through fostering the generation of critical knowledge that can impact a surgeon's identity and orientation towards their environments. At the system level, the study exposes policies that facilitate and hinder surgeon learning, with particular emphasis on policies that act as barriers through unintended consequences. The role of the surgeon environment in promoting or obstructing innovation is highlighted, as is the need for surgeons and system-level actors (i.e. hospitals, licensing bodies and insurance providers) to form partnerships to address the issues which prevent surgeons from safely and effectively adopting new procedures. These partnerships may serve to draw attention to how adaptations made at one level of a complex learning system, such as the healthcare environment, can influence learning throughout the system.

As the first study to explore the surgeon experience of adopting and integrating new procedures into practice, this work lays the foundation for acknowledging and understanding the various factors that impact the experience. It may also serve as a catalyst for further research investigating how surgeons learn, innovate, evaluate risk, and perceive their environments.

Researcher's Final Thoughts

This final section is an opportunity for me to share a few reflections on the impact that this study has had on me, in my various roles. As a learner and future educator, I have gained an understanding of how subtle internal and external triggers can lead to the construction of knowledge

and can shape an individual's orientation towards him or herself and the environment. Perhaps more importantly, I also now have a deeper appreciation for the importance of taking the time to reflect so that those triggers can be identified and the adaptations be questioned and evaluated in my personal context.

As a future surgeon, this study will inform decisions that I make throughout my practice and career. The experiences shared by the participants have already impacted my perception of the factors that I consider important when choosing a workplace. Based on my personal orientation towards risk and patient safety, I doubt that I will be a surgeon who is considered a technical innovator or on the cutting edge of technology. However, I now recognize that surgeons regularly make changes to their practice for numerous, often unpredictable, reasons and the factors that influenced the surgeons in this study will likely impact me throughout my career. Having little control over some of these factors has led to an adjustment in how I think about my optimal workplace. While priorities such as daily work satisfaction and family life remain top priorities, the importance of being in an environment that supports learning new skills and making changes to practice holds greater sway than it did previously.

As a researcher, I have two main takeaways from this study. The first is the importance of allowing discovery to guide research. This project started with a narrow focus, which quickly became untenable. Continuing down that narrow path would have led to a frustrating and unsatisfying experience. With the guidance of my advisors, I widened my scope to explore the more interesting and challenging concepts that were emerging from the data. The result was an opportunity to become engrossed in a topic that was novel, complex and personally enriching. The second takeaway is the challenge and the reward of pursuing an underappreciated research paradigm. Conducting qualitative research from a social constructivist perspective in the positivist, quantitatively-focused world of surgery has proven daunting. Despite presenting this study at several medical education and surgery conferences over the past year, I continue to struggle with understanding how the work is valued. The

qualitative nature of the work sticks out at conferences and rarely prompts audience questions to the same extent as quantitative studies. As a result, I find myself internally questioning whether the work is relevant. However, after each presentation an audience member has approached me to privately say something that has validated my efforts. After one presentation, an anaesthesiologist encouraged me to "keep pushing" because "nobody else is doing work like this". In another case, a surgeon asked for a copy of my presentation because it resonated with his recent experience of adopting a new skill. I am learning to accept that qualitative research is not yet perceived to be as impactful as quantitative research in surgery and medical education. Nonetheless, being given multiple opportunities to present this study and hearing that it is resonating with surgeons and medical educators gives me hope that the value of grounded theory research is becoming increasingly appreciated.

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APPENDICES

Appendix A: Initial Semi-Structured Interview Guide

Date:
Time:
Location:
Interviewer:

Participant ID#:
Participant Surgical Field:
Participant Years in Practice:
Procedure:

Risk Perception Questions/Prompts:

1. Tell me about your experience of learning and implementing a new procedure?
- a. What was your motivation?
- b. What were the internal and external factors?

2. What were the challenges to learning and implementing the new procedure?
- a. What were the internal and external barriers?

3. How did you learn the skill?
- a. How did you decide on the best resource?

4. How did you assess the risk associated with the procedure you were learning and integrating into practice?
- a. How was your perception of risk different when introducing a new skill compared to day-to-day practice?
- b. What role did your comfort zone play during the process?

5. What factors did you consider in deciding whether you were ready to implement the procedure?
- a. Were there factors that held you back from implementing the procedure?
- b. How did you decide you were ready?
- c. How did you decide your team was ready?
- d. How did you choose the first and subsequent patients?
- e. How was the experience doing the procedure for the first time?

6. How did you manage the risk during your learning curve?
- a. Did you use any people (mentors), tools or resources?
- b. During your learning curve, did you have an experience where you were out of your comfort zone and what did you do about it?

7. Looking back on your experience, was your initial perception of the risks accurate?
- a. If yes, what were the most important factors that allowed you to assess the risks accurately at the outset?
- b. If no, can you identify when you realized that your perception of the risks was inaccurate? How did that change your implementation of the procedure?

8. If you were to go through the process again, is there anything you would change?

9. Is there anything else you would like to add about the process of learning and implementing a new procedure?

Risk Tolerance Questions/Prompts:

10. How do you define 'risk' in your practice?

11. How would you describe your own risk tolerance level?
    a. Rank your own risk tolerance on a scale from 1-10
    b. How do you think other perceive your risk tolerance?

12. How does your personal tolerance for risk affect how you approach learning new procedures?
    a. How do you think surgeons with a different tolerance for risk may approach learning new procedures?

13. How do you think our work culture influence's a surgeon's risk taking when introducing a new skill?
    a. What influence do colleagues, OR team, subspecialty culture and hospital environment play in a surgeon's willingness to take on risk?
    b. What are the social, cultural or institutional factors that come into play?

14. Can you think of a colleague who has recently introduced a new skill into their practice?
    a. Do you consider them to be risk-averse or risk-tolerant? (Offer to turn off mic)

Appendix B: Condensed Semi-Structured Interview Guide

Date:
Time:
Location:
Interviewer:

Participant ID#:
Participant Surgical Field:
Participant Years in Practice:
Procedure:

Risk Perception Questions/Prompts:

1. Tell me about your experience of learning and implementing a new procedure?
- a. What was your motivation?
- b. What were the internal and external factors?

4. How did you assess the risk associated with the procedure you were learning and integrating into practice?
- a. How was your perception of risk different when introducing a new skill compared to day-to-day practice?
- b. What role did your comfort zone play during the process?

5. What factors did you consider in deciding whether you were ready to implement the procedure?
- a. Were there factors that held you back from implementing the procedure?
- b. How did you decide you were ready?
- c. How did you decide your team was ready?
- d. How did you choose the first and subsequent patients?
- e. How was the experience doing the procedure for the first time?

6. How did you manage the risk during your learning curve?
- a. Did you use any people (mentors), tools or resources?
- a. During your learning curve, did you have an experience where you were out of your comfort zone and what did you do about it?

7. Looking back on your experience, was your initial perception of the risks accurate?
- a. If yes, what were the most important factors that allowed you to assess the risks accurately at the outset?
- b. If no, can you identify when you realized that your perception of the risks was inaccurate? How did that change your implementation of the procedure?

8. If you were to go through the process again, is there anything you would change?

Risk Tolerance Questions/Prompts:

12. How does your personal tolerance for risk affect how you approach learning new procedures?
- a. How do you think surgeons with a different tolerance for risk may approach learning new procedures?

13. How do you think our work culture influence's a surgeon's risk taking when introducing a new skill?

a. What influence do colleagues, OR team, subspecialty culture and hospital environment play in a surgeon's willingness to take on risk?
b. What are the social, cultural or institutional factors that come into play?

14. Can you think of a colleague who has recently introduced a new skill into their practice?
    a. Do you consider them to be risk-averse or risk-tolerant? (Offer to turn off mic)

Appendix C: Email Recruitment Script

Dear Dr.,

You are being asked to participate in a research project intended to explore how surgeons perceive risk when learning and integrating a new skill in to practice. Your participation is being requested because you have been identified as having recently learned and integrated a new skill, technology or procedure into practice.

We are interested in understanding how surgeons learn new skills, implement those skills in practice and overcome the challenges of the associated learning curve. If you are interested in participating in this study, your involvement would be one interview of approximately 45-60 minutes duration at a time and location of your convenience. You may also be asked to participate in one future interview for validation of the study findings.

Participation in this study is voluntary, and choosing not to participate will not impact your status as a staff surgeon at The Ottawa Hospital. All information you contribute will be kept confidential and you will not be identified in any publications or presentations that result from this study.

Please read the attached information letter and informed consent form for further details.

Please feel free to ask any questions you may have about this study. Thank you.

Appendix D: Information Letter and Informed Consent Form

Participant ID # (Last 4 digits of phone #): _ _ _ _

PARTICIPANT INFORMED CONSENT FORM

Title of Study: Learning New Skills in Practice – How Surgeons Make a Risk Assessment and Know When and How to Safely Integrate New Procedures

Local Site Principal Investigator (PI): Dr. Shay Seth

Participation in this study is voluntary. Please read this Participant Informed Consent Form carefully before you decide if you would like to participate. Ask the study team as many questions as you like.

Why am I being given this form?
You are being asked to participate in this research study because you have recently learned and integrated a new surgical skill, procedure or technology into your established surgical practice.

Why is this study being done?
Surgeons regularly make changes in their practice to ensure they are providing high quality care to their patients. This includes the process of safely integrating new skills, techniques and technologies into practice. While many hospital-based systems help to keep patients safe by identifying and minimizing potential risks, there are no suggested protocols in place to support a surgeon in safely introducing a new procedure into an established surgical practice. Despite evidence that introducing a new surgical technique is associated with a learning curve during which there are reduced surgical and patient outcomes, surgeons receive little guidance or support to best manage patient safety during this period. The goal of this study is to investigate how surgeons perceive the risk associated with integrating a new procedure into practice.

This study is taking place at a number of sites across Canada. We estimate that 24 participants will be enrolled in the study, including 12 participants from The Ottawa Hospital.

How is the study designed?
This is a qualitative study where an investigator and/or a research assistant will conduct interviews with expert surgeons working within The Ottawa Hospital and hospitals affiliated with the University of Toronto..

What is expected of me?
You will be asked to participate in one interview of approximately 45-60 minutes duration at a time and location of your convenience. The interviews are to discuss your experience learning and integrating a new skill, technique or technology into your surgical practice. The session will be audio-taped and data

will then be transcribed, de-identified and analyzed for emergent themes. You may opt-out of the recording and still participate in this study. You may skip any questions that make you uncomfortable or that you do not wish to answer. Additionally, you may be asked to participate in one future interview for validation of the study findings.

Will my research data be used in future research?
Your research data, in the form of de-identified interview transcripts, may be used to guide future research investigating surgeon learning and patient safety.

How long will I be involved in the study?
The entire study will last approximately 6 months. Your participation in the study will last approximately one hour. You may be asked to participate in a 1 hour follow-up interview towards the end of the study period; however, the requirement to do so is not mandatory.

What are the potential risks I may experience?
It is possible that recalling stressful events may be upsetting or distressing. You do not have to answer any questions that make you uncomfortable and you may stop your participation at any time.

Can I expect to benefit from participating in this research study?
You may not receive any direct benefit from your participation in this study. Your participation may allow the researchers to understand how surgeons perceive risk when learning and implementing a new procedure. This may benefit future surgeons and patients.

Do I have to participate? What alternatives do I have? If I agree now, can I change my mind and withdraw later?
Your participation in this study is voluntary. The alternative to this study is not to participate.

You may decide not to be in this study, or to be in the study now, and then change your mind later without affecting the employment or other services to which you are entitled or are presently receiving at this institution.

Will I be paid for my participation or will there be any additional costs to me?
As a token of appreciation for your participation in the study, you will be offered a gift card valued at $75. You will have the opportunity to choose a gift card from a selection of various stores.

How is my personal information being protected?

- All information collected during your participation in this study will be identified with a unique study number, and will not contain information that identifies you, such as your name, address, etc.
- The link between your unique study number and your name and contact information will be stored securely and separate from your study records, and will not leave this site.
- Any documents leaving TOH will contain only your unique study number. This includes publications or presentations resulting from this study.
- Published or presented quotations will never reveal your identity.
- Information that identifies you will be released only if it is required by law.

- The recording device used during the interview will be for study specific use and not a personal cell phone. The recordings will be password protected and will be permanently transferred to a secure network drive within no more than a few hours of the recording being completed.
- For audit purposes only, your original study records may be reviewed under the supervision of Dr. Wade Gofton's staff by representatives from:
    - the Ottawa Health Science Network Research Ethics Board (OHSN-REB),
    - the Ottawa Hospital Research Institute
- Research records will be kept for 10 years, after this time they will be destroyed.

Will I be informed about any new information that might affect my decision to continue participating?

You will be told in a timely fashion of any new findings during the study that could affect your willingness to continue in the study. You may be asked to sign a new consent form.

Who do I contact if I have any further questions?

If you have any questions about this study, please contact the principal investigator, Dr. Shay Seth at 613-xxx-xxxx or the research supervisor, Dr. Wade Gofton at 613-798-5555 x1xxxx.

The Ottawa Health Science Network Research Ethics Board (OHSN-REB) has reviewed the plans for this research study. The Board considers the ethical aspects of all research studies involving human participants at The Ottawa Hospital. If you have any questions about your rights as a study participant, you may contact the Chairperson at 613-798-5555, extension 16719.

Learning New Skills in Practice – How Surgeons Make a Risk Assessment and Know When and How to Safely Integrate New Procedures

Consent to Participate in Research

- I understand that I am being asked to participate in a research study about how surgeons perceive risk when integrating a new procedure into practice.
- This study was explained to me by _____.
- I have read, or someone has read to me, each page of this Participant Informed Consent Form.
- All of my questions have been answered to my satisfaction.
- If I decide later that I would like to withdraw my participation and/or consent from the study, I can do so at any time.
- I voluntarily agree to participate in this study.
- I will be given a copy of this signed Participant Informed Consent Form.

I agree to be audio taped. Yes ☐ No ☐ Initials ___

_____	_____	_____
Participant's Printed Name	Participant's Signature	Date

Investigator or Delegate Statement

I have carefully explained the study to the study participant. To the best of my knowledge, the participant understands the nature, demands, risks and benefits involved in taking part in this study.

_____	_____	_____
Investigator/Delegate's Printed Name	Investigator/Delegate's Signature	Date