UNDERSTANDING OF INTERPROFESSIONAL COMMUNICATION TO IMPACT

PATIENT SAFETY IN THE OPERATING ROOM: A GROUNDED THEORY STUDY

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Submitted to the faculty of the University Graduate School
in partial fulfillment of the requirements
for the degree
Doctor of Philosophy
in the School of Nursing,
Indiana University

November 2021

Accepted by the Graduate Faculty of Indiana University, in partial
fulfillment of the requirements for the degree of Doctor of Philosophy.

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DEDICATION

I would like to dedicate this dissertation to my parents. I didn't realize they were both the first in their respective families to attend college until later in life, and I didn't understand the significance of that until even later. To my father, many of my earliest memories are of you at the kitchen table before sunrise, studying diligently for whatever was 'next' for you; please know that you were not the only one learning from your persistence and dedication to lifelong learning. And to my mother, who couldn't hold on long enough to see me finish - you were with me every step of the way. You both are directly responsible for anything I ever manage to achieve.

You may have tangible wealth untold;
Caskets of jewels and coffers of gold.
Richer than I you can never be --
I had a mother who read to me.
~ Strickland Gillilan

ACKNOWLEDGEMENTS

who are always willing to speak up and of the physicians who are willing to listen. Thank you for trusting me with your stories.

Kimberly Renee McNealy

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Intraoperative adverse events (IAEs) due to interprofessional miscommunication continue to occur despite implementation of surgical checklists and focused communication trainings. Much of the previous intraoperative communication research has focused on the content and quantity of interprofessional communication instead of its context and quality, and current communication interventions seem to have varying levels of engagement, effectiveness, and persistence. The purpose of this dissertation study was to explore the psychosocial processes involved during the establishment and maintenance of interprofessional communication surrounding IAEs or potential IAEs in the intraoperative environment and to identify the perceived facilitators and barriers to communication. Twenty surgical team members participated in semi-structured interviews and described their experiences with interprofessional communication during IAEs.

Grounded theory methodology was used to identify the central process, Testing the Water, and two subprocesses, Reading the Room and Navigating Hierarchy. Testing the Water describes the situational nature of interprofessional communication as surgical team members navigate factors influencing the context and probable trajectories of surgical cases and the perceptions of professional rights and responsibilities within surgical teams. Participants in this study experienced Testing the Water differently based on their professional roles and tenure; findings were organized around three emerging groups identified as inexperienced nurses, experienced nurses, and surgeons.

Interprofessional communication surrounding IAEs occurred for study participants in fluid, iterative phases identified as 1) Recognition, 2) Reconnaissance, 3) Rallying, 4) Reaction, and 5) Resolution. Participants recognized IAEs or potential IAEs, gathered information through reconnaissance, rallied other team members, reacted to stabilize patients, and resolved IAEs through individual or surgical team reflection.

Study participants reported using strategies during communication to accomplish two psychosocial goals, preserving the flow of surgical cases, and protecting the 'face' of themselves and other surgical team members. Supporting these psychosocial goals through increased psychological safety for all surgical team members potentially leads to more effective, timely surgical team communication. More effective interprofessional communication facilitates the improved situational awareness, collective sensemaking, and integrated team mental models that are critical to coordinated responses to IAEs. The findings of this study suggest practical implications to increase the effectiveness of interprofessional communication in the intraoperative environment.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Term
CHAT	Cultural-Historical Activity Theory
CAS	Complex Adaptive Systems
CATS	Communication and Teamwork Skills Assessment
CPR	Cardiopulmonary Resuscitation
CRM	Crisis Resource Management
EMCRM	Emergency Medicine Crisis Resource Management
IAE	Intraoperative adverse event
IRB	Institutional Review Board
ITEM	Integrated Team Effectiveness Model
ICP	Interprofessional Collaborative Practice
IOM	Institute of Medicine
NAM	National Academy of Medicine
NPSF	National Patient Safety Foundation
OR	Operating Room
SA	Situational Awareness
SBAR	Situation-Background-Assessment-Recommendation
SAT	Structurating Activity Theory
ST	Structuration Theory
SEIP	Systems Engineering Initiative for Patient Safety
Team STEPPS	Strategies and Tools to Enhance Performance and Patient Safety
TMM	Team mental model
WHO	World Health Organization

Chapter1

Introduction

This chapter serves as an introduction to the dissertation research. It begins with a discussion of the background of preventable patient harm, a statement describing the problems preventable patient harm causes in the intraoperative environment, and the significance of those problems. The chapter then identifies the study purpose and the research questions that were addressed by the dissertation research. Finally, the chapter describes the assumptions of this research and provides a brief summary.

Background

Public exposure of the unacceptable incidence of medical error in the Institute of Medicine's (IOM) 2000 report "To Err is Human" led to an increased focus on human error as a direct cause of preventable patient harm (IOM, 2000; Leape & Berwick, 2005; Pronovost et al., 2016). More than twenty years later, the National Academy of Medicine (NAM, formerly known as IOM) and others report that levels of preventable patient harm are still unacceptably high (Gandhi et al., 2018; NAM, 2018; Panagioti et al., 2019). Findings by the National Patient Safety Foundation (NPSF) suggest patient safety initiatives succeed only through continuous systemic changes focusing on patient engagement, culture, and teamwork (NPSF, 2015). Research indicates the reduction of preventable patient harm through changes at both systemic and individual levels is possible through the development of healthcare safety culture based on interprofessional collaborative practice (ICP) through effective interprofessional communication (Browder & Maggio, 2017; Pronovost et al., 2017).

ICP within healthcare delivery is defined as two or more people from different professions actively engaging to coordinate and provide patient care within a practice setting (Morgan et al., 2015). ICP has been identified as critical to healthcare delivery through its influence on increased patient safety, improved patient outcomes, and enhanced patient and provider satisfaction (Gilbert et al., 2010; Manojlovich, 2005; Proudfoot et al., 2007; Welp & Manser, 2016). When healthcare delivery requires a more interdependent team approach, the need for effective ICP is increased and influenced by macro (policy), meso (organizational), micro (primary care team), and individual (health care professional) factors (Mulvale et al., 2016). The primary care team-level micro factors include team attitudes, team structure, formal processes, and social processes; these factors have been indicated to contribute directly to the complexity of healthcare culture (Mulvale et al., 2016). Consciously facilitating the creation and development of patient safety culture through effective ICP requires an understanding of both collaboration and practice (Thomson et al., 2007).

Collaboration is a process in which autonomous or semiautonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions (Thomson et al., 2007, p. 3). The concept of practice in healthcare has been identified as the socially-acceptable and socially-institutionalized enactment of professional roles (Thistlethwaite et al., 2013). The complexity of ICP results from the negotiations performed within the social construction of practice. The social construction of practice is

2

negotiated among professions, exists within and across professional cultures, and is influenced by both current circumstances and historical tensions (McNeil et al., 2013).

Statement of the Problem

One patient care setting where errors are known to occur is the intraoperative environment. More than four thousand malpractice claims resulting from intraoperative adverse events (IAEs) are paid every year in the United States at an estimated cost of over sixty-five million dollars. Root-cause analyses indicate that over half of IAEs were directly preventable through effective interprofessional communication (Hempel et al., 2015; Mehtsun et al., 2013). An IAE is defined as any deviation or injury caused by surgical healthcare delivery rather than underlying disease (Mavros et al., 2014). IAEs include a wide range of deviations of care and vary in severity from those requiring no additional intervention or treatment to those resulting in the death of the patient (Rosenthal et al., 2015).

Examples of IAEs include incidents such as anaphylactic reaction, electrocautery injury, episodes of decreased patient safety, laparoscopic conversion to open procedure, procedural delays, unintended bleeding, unintentional dissection or resection, cardiac arrhythmia, and occurrences classified as surgical 'never' events (Hu, Arriaga, Roth, et al., 2012; Rosenthal et al., 2015). Surgical never events are described as IAEs that should never occur including retained foreign bodies, wrong-site surgeries, wrong-patient surgeries, and wrong-procedure surgeries (Mehtsun et al., 2013; Steelman et al., 2019). Undesirable patient outcomes of IAEs include failure to wean off of the ventilator, perioperative transfusions, pneumonia, return to surgery, surgical site infection, systemic

sepsis, prolonged hospital stay or hospital readmission, and mortality (Mavros et al., 2014; Nandan et al., 2016).

IAEs were determined to be such a pervasive problem that in 2009 the World Health Organization (WHO) devised a global surgical safety checklist to ensure the minimum communication necessary for patient safety occurs immediately before, during, and immediately after surgical procedures (Haynes et al., 2009). Surgical safety checklists facilitate communication among surgical team members by preventing both active and latent process failures and have demonstrated increased safety compliance, improved teamwork behaviors, and reduced morbidity and mortality (Bergs et al., 2014; Collins et al., 2014; Hempel et al., 2015; Lingard et al., 2008; V. E. Lyons & L. L. Popejoy, 2014; Pugel et al., 2015; Russ et al., 2013; Savage, Gaffney, Hussain-Alkhateeb, et al., 2017; Wæhle et al., 2012a; Weiser & Haynes, 2018).

The WHO surgical safety checklist includes pre-procedure verification of patient identity using two identifiers, description of the consented procedure(s), identification of the surgical site with marked laterality (if indicated), disclosure of known patient allergies, description of any anesthesia concerns, confirmation of display of relevant patient images, administration of antibiotics, explanation of expected blood loss, anticipation of any critical events, and introduction of all surgical team members by name and role. The post-procedure checklist confirms consented procedure(s) was/were performed, verifies needle and surgical sponge counts, documents removal of all foreign bodies not intended for implantation, and reports disposition of any surgical specimens (Haynes et al., 2009).

Although surgical safety checklist implementation has reduced reported surgical complications from 11% to 7% and surgical patient mortality from 1.5% to 0.8%, the structure provided by the checklist does not consider the communicative complexity inherent in the delivery of intraoperative care (Haynes et al., 2009; Marlow et al., 2017; Russ et al., 2013; Thiels et al., 2015). The intraoperative environment's unique physical and cultural constraints influence the social construction of interprofessional practice and intraoperative communication. Environmental physical constraints are related to the interdependent and 'overlapping' use of time and space as surgical team members from different professions attempt to simultaneously accomplish tasks within a confined physical space (Morgan et al., 2015). Cultural constraints are reinforced by established professional boundaries that often hinder the establishment and maintenance of the effective interprofessional communication needed to drive successful ICP in the intraoperative environment (Gillespie et al., 2013). Ineffective interprofessional communication has been indicated to directly contribute to the occurrence and severity of intraoperative adverse events (Sun et al., 2018).

Additionally, disengaged or cynical implementation of the surgical safety checklist is frequently reported and is potentially counterproductive to team communication efforts (Anderson et al., 2018; Birnbach et al., 2017; Borchard, 2012; Devcich et al., 2015; Korkiakangas et al., 2016; Rydenfalt et al., 2014; Sendlhofer et al., 2016; Wæhle et al., 2012a; Ziman et al., 2018). And while event-specific critical event checklists have been developed for use during IAEs, they are not widely used and only provide users with relatively basic prompts to assist the surgical team in the navigation of critical events. (Clebone et al., 2017). Some research even suggests the most significant

improvements from surgical safety checklist implementation as occurring primarily in developing countries, with the fairly inconsistent results being reported in developing countries possibly resulting from temporal changes such as improved teamwork attitudes and behaviors instead of from checklist implementation (De Jager et al., 2016).

In spite of the global safeguards put into place to protect patients, preventable patient harm related to human factors continue to result in unacceptable rates of IAEs. An initial exploration of how errors related to human factors continue to result in IAEs can be accomplished using Reason's Swiss Cheese Model (Collins et al., 2014). Reason's Swiss Cheese Model was originally proposed by James Reason to explain system failures (Perneger, 2005). In the model, slices of cheese represent barriers to system failures, and the holes in the cheese represent active failures (unsafe acts) or latent failures (Stein & Heiss, 2015). While active failures are caused by inappropriate behaviors, latent failures are often caused by environmental or system factors (Chrouser et al., 2018). *Ineffective communication has been indicated to be the most common cause of both active and latent failures* (Stein & Heiss, 2015). The cheese slices for the intraoperative environment might be identified as training, technology, policies and procedures, and checklists (Stein & Heiss, 2015). The holes in the cheese slices can be used to represent active failures or latent failures in the patient care process that, if aligned, allow harm to reach the patient (Perneger, 2005). Effective communication can be used to increase the situational awareness needed to prompt the appropriate actions to close the holes (Seshia et al., 2018).

The cheese slices described by Reason represent many of the safeguards currently used in the intraoperative environment. The training slice would include team member

education, repetition, and exposure to components of the situation such as procedure, surgical specialty, surgeon, equipment, and level of patient acuity. Technology could include the electronic medical record and any computer pop-ups or alerts used to promote patient safety (Stein & Heiss, 2015). Policies and procedures include processes such as double-checking patient information, patient handoffs, standardized site marking, positioning standards, prepping and wait time requirements, and blood transfusion protocols. Finally, checklists would include the surgical safety checklist, extended or specialized checklists, and structured briefings or debriefings. The fact IAEs still occur due to human error in spite of deliberate focus on the 'cheese' indicates potential in recognizing and closing the holes. Closing the holes requires an understanding of the types of human error that contribute to IAEs.

Human error has been described as being caused by either schematic or attentional behaviors (Stein & Heiss, 2015). Schematic behaviors are described as reflexive or routine and can be facilitated through the 'cheese' barriers identified above: training, technology, policies and procedures, and checklists. Attentional behaviors are behaviors that contribute to the situational awareness and problem-solving needed during IAEs. Situational awareness (SA) is the shared, dynamic, and evolving understanding of environmental elements that includes the (1) perception of those elements (information), (2) comprehension of their contextual meaning, and (3) projection of their significance to the situation (Endsley, 1995; Stanton et al., 2017). Figure 1.1, Errors Related to Human Factors, identifies the behaviors that have been identified as contributing to error.

Figure 1.1: Errors Related to Human Factors
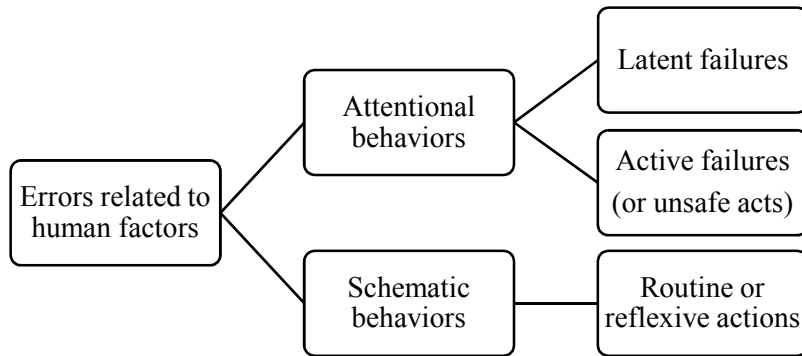
While active failures are often the result of the behavior of an individual (the person approach), latent failures can often be attributed to an unsupportive environment (the system approach) (Reason, 2000; Stein & Heiss, 2015). Some studies identify up to 90% of error as being either 'blameless' or as not being attributable solely to individual behavior; this would suggest future potential gains to be more likely in the research of latent failures (Reason, 2000; Waring et al., 2016).

Research also seems to indicate that most of the benefits available from using the person approach have been realized, and that more durable, resilient improvements would be better achieved by exploring system factors that impact patient safety outcomes (Adams-McGavin et al., 2019; Kolodzey et al., 2019). System factors that impact patient safety in the intraoperative environment have recently been categorized using the Systems Engineering Initiative for Patient Safety (SEIP) work model into safety threats and resilience supports (Kolodzey et al., 2019). Resilience in the intraoperative environment is the ability to respond to unanticipated circumstances and sustain safe practices while avoiding or minimizing patient harm. Examples of safety threats and resilience supports are listed in the following table, Table 1.1: Safety Threats and Resilience Supports. (Kolodzey et al., 2019).

Table 1.1: Safety Threats and Resilience Supports

SEIPS category	Safety threats	Resilience supports
External environment	System-level constraints (such as budget or time)	None listed
Internal environment	1) Inefficient workspace design 2) Inefficient configuration of equipment 3) Distracting work conditions	1) Standardization or optimization of workspace 2) Standardization or customization of equipment setup 3) Reduction of distractions
Organization	1) Inadequate resources 2) Deficiencies in safety culture (e.g., inadequate staffing) 3) Process failures 4) Deficiencies in training	1) Acquisition of needed items or provision of substitutes 2) Location of task support 3) Double-checking of processes 4) Enlisting of knowledge or process support
Person	1) Failures of attention or unsafe acts 2) Deficiencies in experience, knowledge, or skills 3) Failures of leadership 4) Issues related to team effectiveness 5) Failures of communication	1) Recognition and redirection 2) Contingency planning and enlisting of support 3) Coaching and guidance behaviors 4) Modeling/reinforcement of effective team behaviors 5) Effective communication patterns
Task	1) Excessive workload or time pressure 2) Unexpected secondary tasks (e.g., equipment malfunctions) 3) Unanticipated task difficulty	Delegation and enlistment of surgical team support
Tools and technology	1) Unfamiliarity with setup 2) Item malfunctioning or unavailable	1) Enlisting of knowledge or process support 2) Provision of backups or substitutes

One study reported that even though most of the identified safety threats did not originate from the 'person' category of the system, *75% of the resilience supports were obtained through the person category*, suggesting that the majority of system resilience within the intraoperative environment is provided through adaptability and interventions

at the person level (Adams-McGavin et al., 2019; Jung et al., 2019). This further indicates the need to extend the exploration of the influence of systems on IAEs.

Education and reinforcement of schematic behaviors such as the structured communication prompted by the surgical safety checklist have improved patient outcomes, but effectively addressing IAEs such as unanticipated and emerging surgical deviations or changes in patient status during the procedure requires effective *unstructured* intraoperative communication (Berlinger & Dietz, 2016; Nagpal et al., 2012; Nagpal, Vats, Lamb, et al., 2010; Rhee, 2017; Russ et al., 2013; Wangoo et al., 2016a). Unstructured intraoperative communication has been identified as ineffective as often as 30% of the time due to information loss or communication breakdowns (Greenberg et al., 2007). Ineffective communication can result from exclusion of relevant team members, inclusion of inaccurate content, delayed transmission of necessary information, or ambiguity of purpose (Garosi et al., 2019; Lingard et al., 2008). Ineffective communication includes failures of purpose, occasion, content, or audience and often leads to procedural delays or errors, team inefficiency or tension, medication errors, equipment issues, workarounds, and waste of resources (Lingard et al., 2004; Nagpal, Vats, Ahmed, et al., 2010; Tiferes et al., 2015). One study described the most common communication errors as occurring related to surgical progress, equipment issues, medications, procedural changes, policy issues, environmental concerns, and personnel changes (Halverson et al., 2011).

Barriers to effective intraoperative communication can include interruptions, miscommunications, multitasking, and time constraints (Espin & Lingard, 2001; Gillespie et al., 2012b; Gillespie et al., 2017; Göras et al., 2019; Weigl et al., 2018).

Research also identifies ineffective interprofessional communication and organizational structure issues as common factors in IAEs (Hu, Arriaga, Roth, et al., 2012). Improving intraoperative communication potentially requires a deliberate culture change with increased disclosure, transparency, and accountability (Lark et al., 2018). Culture change interventions using focused interprofessional communication training have demonstrated benefits including enhanced organizational outcomes, increased teamwork behaviors, and improved patient outcomes; unfortunately, these improvements tend to deteriorate over time (Hughes et al., 2016; Weller & Boyd, 2014; Weller et al., 2014). More research is needed to better understand how unstructured communication develops between and among surgical team members to develop structures and processes that persist over time.

Significance of the Study

Interprofessional communication in the intraoperative environment has been minimally facilitated through surgical safety checklist implementation and temporarily improved through communication training interventions (Erestam et al., 2017; Kuy & Romero, 2017). Although surgical safety checklists and training interventions often directly address the necessary content of interprofessional communication, they often fail to address the relevant context of healthcare culture. Within interprofessional collaborative practice, the establishment and maintenance of effective communication are often hindered by the professional boundaries and cultural constraints traditionally inherent to healthcare delivery (Pugel et al., 2015; Tiferes et al., 2015; Weiser et al., 2010). These boundaries and constraints are influenced through behavioral expectations, personal demeanor, gender, and professional socialization (Chung et al., 2012; Nembhard & Edmondson, 2006).

11

Professional socialization has been identified as one mediating factor that impacts the motivations, perceptions, and expectations for interprofessional communication within the intraoperative environment; these motivations, perceptions, and expectations are often defined and determined by professional role (Disch, 2012; Finn, 2008; Gillespie et al., 2013; Grade et al., 2019; Makary et al., 2006) Socialization into professional roles is the process by which individuals gain the social knowledge for assuming their roles within organizations. Socialization includes developing relationships with others, learning the profession's values, goals, technical language, and understanding the profession's customs, myths, rituals, and traditions (Hall, 2005; MacArthur et al., 2016; Thistlethwaite et al., 2013). The traditional socialization of surgeons and nurses contributes directly to the identified authority gradient that is present in the intraoperative environment (Elfering et al., 2017; Gardezi et al., 2009; Jayasuriya-Illesinghe et al., 2016; Walrath et al., 2015).

> An authority gradient "is a real or perceived difference in a health care team member's experience level, expertise, status, or authority relative to another member of the team. This difference can prevent the individual from raising a concern about a patient to another health care team member", impacting patient outcomes (Walrath et al., 2015, p. 174).

Recognizing and describing the influence of socialization and the resulting authority gradients on healthcare culture are essential first steps to exploring the communicative contexts involved (Gerardi, 2004). This study fulfills a significant gap in the research by providing the necessary communicative context through a better understanding of the psychosocial processes surrounding interprofessional communication between surgeons and nurses involved in IAEs.

Purpose of the Study

The purpose of this study is to explore the psychosocial processes involved during the establishment and maintenance of interprofessional communication surrounding IAEs or potential IAEs in the operating room. Understanding how communicative patterns and strategies related to IAEs develop between surgeons and nurses in the intraoperative environment would allow for more effective interprofessional communication interventions and focused education, potentially further reducing IAEs and directly impacting patient safety and satisfaction. For the purpose of this research, interprofessional communication within the intraoperative environment was considered as a series of inherently complex social interactions among surgical team members functioning from and within differing perspectives, positions, perceived power, and roles (Foot, 2014). The participant meanings of the social interactions experienced by surgeons and operating room nurses were solicited and explored through the use of grounded theory methods (Charmaz, 2014; Creswell, 2013).

Research Questions

1) How do surgeons and surgical nurses experience the initiation of interprofessional communication in the operating room related to IAEs or potential IAEs?

2) How do surgeons and surgical nurses experience the maintenance of interprofessional communication in the operating room related to IAEs or potential IAEs?

3) What do surgeons and surgical nurses perceive as facilitators to the process of establishing and maintaining effective interprofessional communication?

4) What do surgeons and surgical nurses perceive as barriers to the process of establishing and maintaining effective interprofessional communication?

Assumptions

The interdependence and close physical proximity of the surgical team produce an environment where ICP is even more critical to the effective delivery of patient care (Kirschbaum et al., 2015; Ren et al., 2008). Because of this interdependence, the ICP required for optimal functioning for a surgical team is often studied using the concept of teamwork. ICP was used in this study to refer to the more focused collaboration (or teamwork) required during surgical team functioning.

For the purpose of this research, a surgical team was identified as a group of healthcare workers providing service in the intraoperative environment who 1) share a permanent/dynamic identity during the provision of care, 2) have an awareness of team member roles, tasks, and goals, 3) demonstrate the interdependence of team members, 4) integrate teamwork, 5) share responsibility for outcomes, and 6) experience workflow that is alternately complex, predictable, and urgent (Reeves et al., 2018).

Research indicates that ICP is experienced differently by surgical team members and that perceptions are based on professional discipline (Grade et al., 2019). Interprofessional communication, as a critical consideration of ICP, is also influenced by the socialized professional roles of surgical team members; for example, motivations, perceptions, and expectations for communication in the intraoperative environment vary based on role (Cruz et al., 2019; Finn, 2008; Gillespie et al., 2013; Makary et al., 2006). Finally, because the intraoperative environment requires more extensive interdependent functioning from professions that are traditionally socialized differently, it was assumed

the participant interviews would reflect differences in the motivations, perceptions, and expectations related to interprofessional communication surrounding IAEs or potential IAEs in the intraoperative environment.

Summary

In spite of focused communication improvement initiatives implemented within the intraoperative environment, IAEs with serious complications have been proposed to continue to occur in 4-10% of the fifty million surgical procedures performed annually in the United States (Weaver et al., 2017). While improvement initiatives focused on structured intraoperative communication provide a framework to guide basic communication, they lack a thorough consideration of healthcare culture and of the emerging, dynamic nature of interprofessional communicative relationships (Anderson & Talsma, 2011; Meese & Borkowski, 2017).

Chapter 2

Literature Review

Opinions vary about the appropriate role and timing of reviewing the literature in grounded theory studies (Charmaz, 2014). Initial suggestions by Glaser and Strauss included delaying literature reviews in order to avoid experiencing the data as 'received theory' (Glaser & Strauss, 1967). Many scholars now consider a review of relevant research as critical to an informed qualitative approach by a novice researcher (Charmaz, 2014). Thornberg describes an informed qualitative approach as using existing research to flexibly, creatively, and reflectively locate the phenomenon within existing knowledge and determine any knowledge gaps (Thornberg, 2012). Familiarity with existing research has been identified to enrich data analysis by enhancing sensitivity to nuance, providing a source for data comparison, and improving theoretical sampling methods (Strauss & Corbin, 1990). Critical self-awareness must be used to evaluate existing research and avoid its imposition on the new study data (Charmaz, 2014). A deeper understanding of the competing or conflicting views surrounding the phenomenon also facilitates a more balanced presentation of study results and its place among existing literature (Charmaz, 2014). The review of the literature for this study was conducted to orient the researcher to the existing research of the phenomenon and was revisited and extended after theory generation (Bryant & Charmaz, 2007).

A broad literature review was initially conducted to explore the complexity of interprofessional communication in the intraoperative environment. Effective interprofessional communication in the intraoperative environment has been described as both a facilitating factor and as a result of interprofessional collaborative practice;

therefore, a survey of the research in both areas was indicated. Although the terms

interprofessional collaboration, interprofessional collaborative practice (ICP), and

teamwork are often used interchangeably, there are subtle differences among them

(Morgan et al., 2015; Reeves et al., 2018; Xyrichis & Ream, 2008). These differences are

explored in the following sections.

Interprofessional Collaboration

Interprofessional collaboration occurs when members of different professional

groups use open communication to make decisions, manage conflict, and solve problems

to positively impact patient care (Careau et al., 2015; Nair et al., 2012). This

collaboration is often experienced as a brief 'overlap' of practice such as during

healthcare provider consultations, care conferences, or as a result of handoffs between

specialties or levels of care (Colligan et al., 2015; Rayo et al., 2013). Providers

experiencing this level of collaboration may share time and space only briefly, if at all,

with their primary professional responsibilities being satisfied independently. As the

overlap of collaborative practice is extended due to an increased level of necessary

coordination to provide healthcare delivery or to a more intensely shared practice setting,

interprofessional collaboration is perhaps more accurately described as ICP.

Interprofessional Collaborative Practice

ICP within healthcare delivery is when two or more people from different

professions *actively engage* to coordinate and provide patient care *within a practice*

setting (Morgan et al., 2015). This level of coordination of care often occurs as a series of

related actions and reactions based on each profession's responsibilities and

specialization. Providers may collaborate in person, electronically, or by phone to

17

accomplish complementary, but often profession-specific goals. One example of ICP in

healthcare is when providers from different professions collaborate to provide concurrent

but 'overlapping' care to a trauma patient in the emergency department. A trauma patient

might require services from the nurses, physicians, radiology and laboratory personnel,

and consulting surgeons within the practice environment of the emergency department,

but often these providers accomplish their goals consecutively instead of simultaneously

during non-emergent patient care.

Teamwork

An even more interdependent level of ICP is experienced when teams are required

to function beyond task work as they interact *simultaneously*, dynamically, and

recursively through teamwork toward a valued common goal (Fiscella & McDaniel,

2018; Salas et al., 2005).

> Teamwork has been identified as occurring within "a collection of individuals
> who are *interdependent in their tasks, who share responsibility for outcomes, who
> see themselves and who are seen by others as an intact social entity embedded in
> one or more larger social systems* and who manage their relationships across
> organisational boundaries" (Cohen & Bailey, 1997, p. 239).

These relationships across organizational and professional boundaries are constructed and

managed through interprofessional communication, usually within a shared practice

setting (Morgan et al., 2015).

Culture in Collaboration

The interprofessional collaboration required for healthcare delivery is socially

constructed through negotiation across professional boundaries based on culturally- and

historically-constructed professional identities and norms (Collin et al., 2011; Finn,

2008). Practicing across professional boundaries requires healthcare professionals to

negotiate the contradiction between the specialization of their professions and the integration necessary for effective collaborative practice (Finn, 2008). Successful negotiation and navigation between and among professional boundaries yields increased role awareness, SA, team decision-making, and the distributed or collective cognition required to create the shared mental models necessary for effective ICP (Frasier et al., 2015; Nagpal, Vats, Lamb, et al., 2010; Ren et al., 2008; Sonoda et al., 2017). Establishing the interprofessional communication necessary for successful collaboration is often complicated by the differences in professional socialization experienced by the professional groups. Professional socialization has been identified to influence the perceptions, motivations, and expectations of interprofessional communication. These differences are described as being especially pronounced between the roles of physician and nurse (Carney et al., 2010; Gardezi et al., 2009; Sollami et al., 2015; Wauben et al., 2011).

Physicians identify collaboration as successful when physician instructions are followed and physician needs are anticipated (Carney et al., 2010). This perception often results in the use of pragmatic, utilitarian communication strategies intended to better explain or delegate aspects of patient care (Haddara & Lingard, 2013). In contrast, nurses define collaboration as having their input considered and respected by physicians, which often results in the employment of emancipatory communication strategies designed to ameliorate issues of medical dominance (Carney et al., 2010; Columbus et al., 2018; Haddara & Lingard, 2013). These differences in communication perceptions and motivations likely originate from the professional socialization of the physician and nurse roles and become potentially problematic as the need for collaboration is increased

through the more interdependent practice in the intraoperative environment (James-Scotter et al., 2019; Khalili et al., 2014; Nugus et al., 2010; Sacks et al., 2015; Schmidt et al., 2021; Thomson et al., 2015). Because successful healthcare delivery is increasingly delivered through ICP occurring within healthcare teams, current research has been focused on the desire to better understand the components, characteristics, and processes involved in effective collaborative practice through teamwork.

Collaboration through Teamwork

A review of the current teamwork literature demonstrates conceptual similarities among many of the most widely accepted teamwork models. Nine critical considerations for teamwork have been identified: culture, composition, context, cooperation, coordination, cognition, conflict, coaching, and communication (Salas et al., 2015). Salas et al. make distinctions among the critical considerations through division into two categories: influencing conditions and emergent states. Culture, composition, and context are described as influencing conditions because variability within them can, directly and indirectly, impact outcomes through their influence on the emergent states. The emergent states of cooperation, coordination, cognition, conflict, coaching, and communication are dynamic processes involved in the interdependent accomplishment of team goals (Salas et al., 2015). Emergent states are constructs that demonstrate dynamic properties of teams that vary as a function of inputs, processes, outcomes, and context. Emergent states are demonstrated through the affective, cognitive, and motivational states of teams rather than through the nature of team member interactions (Marks et al., 2001).

The critical considerations described by Salas et al. (2015) demonstrate essential relationships with healthcare teamwork concepts described by Lemieux-Charles and

McGuire in the Integrated Team Effectiveness Model (ITEM) (Lemieux-Charles &

McGuire, 2006). The ITEM similarly identifies team processes (defined as emergent

states by Salas et al. (2015) of communication, coordination, and conflict; the processes

of collaboration (cooperation), decision making (cognition), and leadership (coaching)

represent the critical considerations described by Salas et al. (2015). ITEM also explores

the influencing conditions of culture, composition, and context identified by Salas, et al,

(2015). Minor differences in terminology are explored in the following table, Table 2.1:

Comparison of Teamwork Processes and Factors; any information omitted was not

present in the source research.

Table 2.1: Comparison of Teamwork Processes and Factors

	Critical considerations of teamwork *Salas, et al., 2015*	**ITEM** *Lemieux-Charles & McGuire, 2006*
Emerging Process	Communication	Communication
Emerging Process	Coordination	Coordination
Emerging Process	Conflict	Conflict
Emerging Process	Cooperation Behavioral teamwork actions motivated by the attitudes, feelings, and beliefs of team members	Collaboration
Emerging Process	Cognition Shared team understanding developed from team interactions that includes team norms, member roles and responsibilities, and familiarity with members' skills and abilities	Decision making
Emerging Process	Coaching	Leadership

	Enactment of leadership behaviors to set team direction and establish goals	
Influencing Factor	Culture Group shared assumptions that manifest in member behavior based on their beliefs, values, and perceived norms	Team Psycho-Social Traits Cohesion Norms Efficacy Problem-solving effectiveness
Influencing Factor	Composition Includes team configuration, diversity, and team member knowledge, skills, and attitudes	Composition Size, age, gender, tenure Discipline Diversity
Influencing Factor	Context Characteristics of the situation that influence the meaning and occurrence of behavior	Organizational context Goals/Standards Rewards/supervision Training environment Information system Resources (human, technology) Structure/Characteristics

Compelling components of ITEM not included in the critical considerations by Salas et al. are the influence of task design on the functioning of teams and the subjective and objective outcomes of that functioning (Lemieux-Charles & McGuire, 2006). Features of task design include interdependence, autonomy, specialized knowledge, clarity of rules, work cycle, and the use of quality frameworks. Team effectiveness is demonstrated through the subjective outcome of perceived team effectiveness and the objective outcomes of quality of care, organizational cost-effectiveness, and patient functional status and satisfaction (Lemieux-Charles & McGuire, 2006). These components are critical to a holistic understanding of the level of teamwork necessary for improved healthcare delivery, yet current instruments and interventions primarily focus on the *measurable and observable processes* of teamwork without adequate exploration of the influence of culture and perceived teamwork effectiveness on the interprofessional communication that makes teamwork possible (Feitosa et al., 2018). Interprofessional

22

communication and teamwork in the intraoperative environment have been identified as being particularly influenced by culture, indicating the need for a more focused literature search to understand them within that context (Sacks et al., 2015).

<p align="center">Interprofessional Communication in the Operating Room</p>

A focused literature search was conducted to capture findings from contemporary research surrounding interprofessional communication in the operating room. A systematic search of electronic databases including CINAHL Complete, Academic Search Premier, MEDLINE, MEDLINE with Full Text, PsycARTICLES, PsycINFO, and SocINDEX using the search terms *operat** OR *surg*, communication* and *team* yielded an initial 2,629 articles published between 2012 and 2019 in peer-reviewed journals using English. After duplicate results were eliminated, the provided titles and abbreviated abstracts were reviewed to reduce the number of articles to 265. Full abstracts of the 265 articles were read and compared using inclusion criteria to further reduce the articles to 106. Articles from the search were included if they described research related to communication among surgical team members within the surgical environment; research conducted within simulation was not included. Additional articles were located through ancestry and descendant searches using Google Scholar. Complete text versions of articles meeting the described inclusion criteria were read and the studies were organized according to their identified research focus into four broad categories: structured surgical team communication, communication culture in the operating room, facilitators and barriers for intraoperative communication, and intraoperative communication instruments and interventions.

Structured Surgical Team Communication

Recognition of the parallels between the interdependence found within aviation flight crews and within surgical teams combined with the success of the aviation industry in dramatically reducing safety errors through communication resulted in the adaptation and adoption by healthcare providers of similar forms of structured communication (Kuy & Romero, 2017; Savage, Gaffney, Laith, et al., 2017). Structured communication is any systematic or standardized approach to communication intended to facilitate the ability or opportunity for individuals to communicate effectively (Etherington et al., 2019). Forms of structured communication adapted for use in the surgical environment included the surgical safety checklist, specialized and extended checklists, critical event checklists for unanticipated surgical events, and briefings and debriefings.

Surgical Safety Checklists

Effective and consistent implementation of surgical safety checklists facilitates communication among surgical team members by preventing both latent and active process failures and has demonstrated results including reduced morbidity and mortality, improved teamwork behaviors, increased safety compliance, and improved patient outcomes (Bergs et al., 2014; Collins et al., 2014; Hempel et al., 2015; Lingard et al., 2008; V.E. Lyons & L. L. Popejoy, 2014; Pugel et al., 2015; Russ et al., 2013; Savage, Gaffney, Laith, et al., 2017; Wæhle et al., 2012b; Ziman et al., 2018). Unfortunately, many surgical team members describe the ineffective and inconsistent implementation of the surgical safety checklist due to hierarchal culture, time constraints, asynchronous workflows, lack of clinical champions to support implementation, lack of sufficient implementation training, and disinclination by physicians to openly share case-relevant

information (Braaf et al., 2013; Cullati et al., 2014; Dellinger, 2016; Erestam et al., 2017; Gillespie et al., 2018; Gillespie, Marshall, et al., 2016; Gurses et al., 2012; Melekie & Getahun, 2015; Ragusa et al., 2016; Sendlhofer et al., 2016). Research suggests the disinclination to share relevant information is more likely due to perceived time pressure or failure to realize the necessity of relaying information rather than as a deliberate withholding of information by physicians (Nagpal, Vats, Lamb, et al., 2010).

Other studies indicate partial checklist compliance is common and suggest the components necessary to facilitate fluid interprofessional communication, including the introduction by name and role of all participating team members before the procedure begins, are among those most often neglected during implementation (Biffl et al., 2015; Birnbach et al., 2017; Garland et al., 2017; Rydenfalt et al., 2013; Singer et al., 2016). This partial checklist compliance reduces the effectiveness of implementation through the reduction of 'error trapping' and the resulting time-sensitive modifications needed to adjust for intraoperative deviations (Weiser & Berry, 2013). Error trapping "acknowledges that individuals are prone to errors and that checklists help identify and adjust for these fallibilities before they cause harm" (Weiser & Berry, 2013, p. 138). Additionally, sign-in and sign-out were identified as particularly vulnerable to information loss because of the increased time pressures of their timing in the surgical procedure (Gillespie, Withers, et al., 2016).

In spite of these recognized limitations, the majority of study participants reported perceptions of value in surgical safety checklist implementation and described effective implementation as a "state of mind" that is ideally advocated and coordinated by physicians (Cullati et al., 2014; Gillespie, Withers, et al., 2016; Haugen et al., 2015; V.E.

Lyons & L. L. Popejoy, 2014; Valerio et al., 2017; Willassen et al., 2018). However, the findings identify significant differences among professions regarding perceptions of the value of both the individual components of the checklist and of its social acceptance by all surgical team members (Birnbach et al., 2017; Molina et al., 2017; Norton et al., 2016; Papaconstantinou et al., 2013; Rodrigues et al., 2013; Santana et al., 2016; Wæhle et al., 2012a).

Identified improvements from checklist implementation in patient safety and surgical team communication seem to be dependent upon team flexibility, continued engagement of key stakeholders, and deliberate error detection and recovery during all phases of the surgical procedure (Collins et al., 2014; Fudickar, 2012; McDowell & McComb, 2014; Oak et al., 2015; Russ et al., 2013; Siu et al., 2016; Walker et al., 2012). Unfortunately, research indicates effective implementation of the surgical safety checklist is lowest in countries with the most potential for improvement due to the lack of perception of checklist value, transparency, and accountability within surgical teams (Aveling et al., 2013; De Jager et al., 2016; Vohra et al., 2015).

Specialized and Extended Checklists

Specialized checklists can be customized by the surgical team and implemented to address provider concerns specific to the procedure, such as unusual positioning considerations, potential complications, or nonstandard equipment or medication needs (Soler & Smith, 2012; Song et al., 2013). Specialized checklists have been developed to protect patients during specific procedures such as robotic urologic surgery, endoscopy, management of renal tumors, tumor thrombectomy, and venous thromboembolism (Ahmed et al., 2013; Joshi et al., 2012; Perry et al., 2015; Sommer et al., 2018). Extended

26

versions of surgical checklists include additions such as involvement of the patient or

caregivers in the initial time out, assigned checklist components for specific team

members, briefing and debriefing, and employment of an electronic checklist display that

is visible to all team members (Berrisford et al., 2012; Cabral et al., 2016; Kozusko et al.,

2016; Nelson, 2017; Nissan et al., 2014).

Critical Event Checklists for Unanticipated Surgical Events

While effective implementation of checklists has demonstrated benefits to patient

safety, additional protection is required during unanticipated surgical events that

necessitate deviations from the surgical plan (Gauss et al., 2013; Sanders, 2015). Critical

event checklists for use during intraoperative adverse events have been developed to

protect patients who are experiencing or are in danger of experiencing air embolism,

anaphylaxis, unstable bradycardia, cardiac arrest, failed airway, fire, hemorrhage,

hypotension, hypoxia, malignant hyperthermia, and tachycardia (Clebone et al., 2017;

Subbe et al., 2017; Ziewacz et al., 2011). The display of critical event checklists during

IAEs serves as a cognitive aid to shorten reaction time and reduce critical response

component omissions through improved communication and collaboration (Everett et al.,

2017; Marshall, 2017).

As valuable as safety checklists seem to be, unanticipated intraoperative

deviations occur and require spontaneous, unstructured interprofessional communication

to heighten SA, update the team mental model (TMM), and deliver optimal patient care

(Nakarada-Kordic et al., 2016). Although several instruments have been developed to

potentially evaluate the reactive response to unanticipated deviations in healthcare

provision, only one has been identified to evaluate the *proactive* problem detection

strategies needed to prevent IAEs through the use of cross-monitoring the performance of other healthcare team members to increase SA (Hughes et al., 2014; Marlow et al., 2018). The Emergency Medicine Crisis Resource Management (EMCRM) instrument was adapted from CRM for use in emergency departments. EMCRM emphasizes anticipation and includes unique measures that consider resource awareness, help mobilization, and continual situational monitoring by the team (Reznek et al., 2003). More effective checklist implementation has been found to be supported by factors that facilitate interprofessional communication in the intraoperative environment.

Facilitators for Implementation of Checklists

Facilitating factors for thorough, effective checklist implementation include perceptions of psychological safety, collective responsibility for implementation, presence of an active safety culture, and adequate checklist training (Bergs et al., 2015; Wangoo et al., 2016b). Even when the necessary facilitating factors are present, effective checklist implementation is an inherently complex social intervention that requires consistent, deliberate cooperation and enhanced interactions among surgical team members (Bergs et al., 2015). Some studies suggest implementation is perceived as more critical when the checklist is adapted to be extended or specialized based on the surgical procedure because the included content has 'earned' its way into the process through situational relevance (Burian et al., 2018). Scheduled communication that extends beyond the structured communication provided by checklist implementation is often achieved through the use of briefing and debriefing by the surgical team. Commonly occurring timing for the facilitators of structured communication and scheduled communication is

identified in Figure 2.1, Timing for Facilitators of Structured Intraoperative

Communication.

Figure 2.1: Timing for Facilitators of Structured Intraoperative Communication
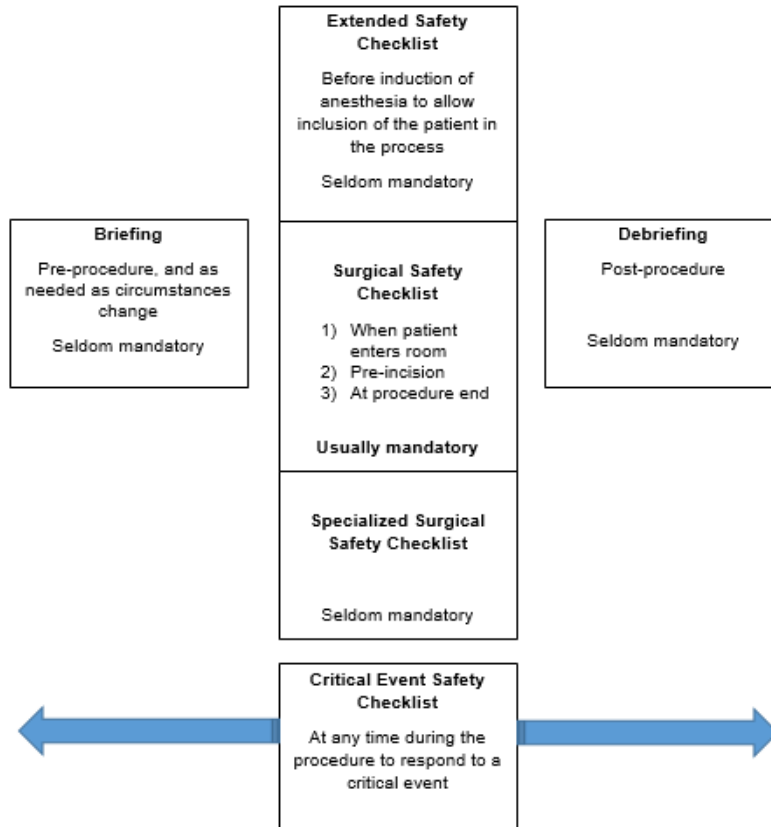
Barriers to Implementation of Checklists

Reported organizational and cultural barriers to successful implementation

included participant perceptions of checklist component ambiguity, inappropriate timing

of implementation, duplication with existing checks, lack of communication by

physicians, time constraints, the unaddressed presence of 'unaccounted-for risks', unclear

expectations, lack of willingness to assume personal responsibility for checklist

implementation, lack of agreement of necessity for particular components, resistance by

senior clinicians, and lack of merging existing workflow with checklist timing (Bergs et al., 2015; Cadman, 2016; Fourcade et al., 2012; Russ, Sevdalis, et al., 2015).

Briefing and Debriefing

Structured extension of surgical communication is often accomplished through the use of formal briefing and debriefing or 'huddles' of the surgical team. Briefing occurs before the surgical procedure to clarify procedural expectations, encourage questions from the surgical team, and clearly define professional roles (Donnelly, 2017). Debriefing occurs after the surgical procedure and allows the surgical team to collectively process events to deliver patient care and identify resources for future cases (Finch et al., 2019; Steelman, 2014). Effective briefing and debriefing have been associated with increased team communication, increased detection of defects or deficiencies in care, decreased surgical workflow disruptions, decreased patient complications, and improvements in perception of surgical safety climate (Bandari et al., 2012; Brindle et al., 2018; Fong et al., 2016; Hicks et al., 2014; Kleiner et al., 2014). Some reported benefits of debriefing include a significant reduction in surgical mortality, substantial gains in surgical team productivity and efficiency, a reduction in the number of surgical procedures with reported IAEs, and a more favorable safety climate (Bartz-Kurycki et al., 2017; Rose & Rose, 2018). Debriefing also offers opportunities for the surgical team to process near-failures when IAEs are 'caught' before they have adverse consequences for patients. Processing near-failures as a team makes recurrence of these incidents less likely (Bohomol & de Abreu Tartali, 2013). Paradoxical effects of surgical team briefing include possible disruption of positive communication, reinforcement of professional

divisions, creation of tension, masking of knowledge gaps, and perpetuation of a problematic communication culture (Whyte et al., 2008).

<p align="center">**Communication Culture**</p>

Effective interprofessional communication beyond the implementation of surgical safety checklists depends upon the establishment and maintenance of a dialogic, participatory communication culture (Bleakley et al., 2013; Stein & Heiss, 2015). Three identified barriers to a participatory communication culture are (1) demonstrations of underlying lack of respect for surgical team members, (2) expressions of the existing surgical team power structure or hierarchy, and (3) stresses caused by time pressure that decrease collaboration (Tanaka et al., 2019). The establishment and maintenance of a communication culture to promote collaboration are inherently complex because of the interprofessional composition of surgical teams and the influence of socialization on the participating professions (Garrett, 2016).

Surgical teams are necessarily composed of several healthcare professions demonstrating responsibility for both independent and interdependent tasks during the surgical process. Surgical teams often experience fluid membership, with team and individual changes related to skill differentiation or specialization, authority differentiation, and temporal stability (Hollenbeck et al., 2012). These dimensions of team composition often translate to a communication culture that is constantly being negotiated among professional roles (if team members are unfamiliar with each other) or among individuals (if team members are familiar with each other) (Tørring et al., 2019).

This ongoing negotiation of communication culture directly impacts patient outcomes. Research identifies that interprofessional communication problems are

<p align="center">31</p>

associated with over 60% of intraoperative adverse events and suggests many of these events as potentially preventable through preoperative briefings, team familiarity and stability, and standardized communication (Bohomol & de Abreu Tartali, 2013; Elbardissi & Sundt, 2012). Interprofessional communication problems are described as being exacerbated by hierarchal factors, with interprofessional communication exchanges in the intraoperative environment failing nearly twice as often as intraprofessional exchanges (Frasier et al., 2019; Hu, Arriaga, Peyre, et al., 2012). Interprofessional communication occurs between and among different professions, while intraprofessional communication takes place between and among providers from the same profession.

Recognition of the potential challenges inherent in interprofessional communication and its importance to healthcare delivery by interprofessional teams prompted attempts to better define and understand its complexity by healthcare leaders. An essential component in many of these initiatives was the shift in focus from the individual healthcare provider to the systems level of care. This shift led to several initiatives that outline specific interprofessional practice competencies (Dolansky & Moore, 2013). The Quality and Safety Education for Nurses (QSEN) initiative developed six competencies based on the IOM reports that included expectations related to evidence-based practice, informatics, patient-centered care, quality improvement, safety, and teamwork and collaboration (Sherwood & Zomorodi, 2014). Examples of the proposed relevance of these competencies in the intraoperative environment are given in the following table, Table 2.2: QSEN in the Intraoperative Environment.

Table 2.2: QSEN in the Intraoperative Environment

Competency	Expectation	Intraoperative environment
Evidence-based practice	Integrate clinical expertise with current evidence and patient preferences	Determine necessary care interventions based on evidence-based standards
Informatics	Use information to manage and communicate knowledge, support decision-making, and mitigate error	Collect, monitor, and record intraoperative patient data in EHR as necessary to provide accurate account of intraoperative events
Patient-centered care	Provide compassionate care based on patient needs, preferences, and values	Advocate for patient based on their stated preferences or evolving care needs
Quality improvement	Use available data to monitor patient care outcomes and to improve processes	Identify and address areas to benefit from process improvement strategies
Safety	Use system and individual performance to minimize risk of patient harm	1) Recognize and report intraoperative errors and near misses 2) Participate in root cause analyses of IAEs
Teamwork and collaboration	Demonstrate mutual respect, effective communication, and shared decision-making within interprofessional teams	Collaborate and communicate effectively with all surgical team members based on their limitations, roles, and strengths

While all of the QSEN competencies are relevant to the intraoperative environment, development of the teamwork and collaboration competency is critical to the functioning of interprofessional teams. Interprofessional teams have been identified as microsystems and as the building blocks within the provision of healthcare (Disch, 2012). To function as microsystems, teams must work across professional boundaries, practice group decision-making, and maintain collective responsibility for outcomes through constant collaboration. Collaboration under these circumstances depends on effective interprofessional communication. This collaboration through communication is

complicated by the fact that nurses and surgeons "come from different cultures, use specialized languages, face different societal expectations, hold differing viewpoints and goals, and often define success very differently" (Disch, 2012, p. 93).

Facilitation and maintenance of effective interprofessional communication during healthcare provision were determined to be of such importance that the Interprofessional Education Collaborative (IPEC) developed eight core interprofessional communication competencies. IPEC competencies state that health care team members should choose effective communication techniques and tools to enhance team function through interactions; organize information so that it is easily understood through the strategic avoidance of discipline-specific terminology; communicate respectfully to ensure common understanding of relevant information; actively listen to all team members, provide instructive, sensitive feedback to team members; initiate respectful communication during crucial conversations; recognize rights and responsibilities for effective communication within team culture; and maintain awareness of the impact of teamwork to patient care (IPEC Panel, 2011) . The focused development of these communication competencies is critical to the reduction of interprofessional communication failures. Communication failures are influenced by systemic, organizational, and interpersonal factors that are perceived and experienced very differently based on professional roles (Collette et al., 2017; Elfering et al., 2017; Wade, 2014).

Perceptions of Communication

The perceptions and experiences of existing intraoperative communication vary most markedly between surgeons and surgical nurses (Bohomol & de Abreu Tartali,

2013; Collette et al., 2017; de Fátima Cordeiro Trajano et al., 2017; Rodrigues et al., 2013). Existing institutional culture often results in surgical nurses feeling intimidated by possible reprehension or retaliation when there is a need to alert the surgical team to patient safety issues (Bohomol & de Abreu Tartali, 2013). Surgical nurses have been described as requiring 'moral courage' to transcend perceptions of repressive institutional culture when advocating for patient safety in the intraoperative environment (Dinndorf-Hogenson, 2015). Surgical nurses are also described as carefully monitoring the timing and tone of their interactions with those at the surgical field to be perceived as 'less intrusive' (Redaelli, 2018). Many surgical nurses report a lack of information reciprocity and the frequent absence of acknowledgment by surgeons of attempts at interprofessional communication (Carrera et al., 2017).

In contrast, surgeons experience interprofessional interactions quite differently and often describe perceptions of both higher levels of collaboration and better interprofessional communication (Prati & Pietrantoni, 2014; Wahr et al., 2013). The different perceptions are potentially due to the role expectations and socialization of surgeons, who are traditionally responsible for the management of surgical resources through informal intraoperative briefing and the effective 'use' or delegation of support staff (Healey et al., 2010). Surgeons also frequently are not present with other surgical team members during the preoperative phase for planning or clarification and may experience intraoperative questions as distractions or disruptions (Collette et al., 2017; Healey et al., 2010). This communication dynamic potentially results in patterns of unasked or unanswered questions by surgical nurses and the use of authoritarian observations, opinions, and statements by surgeons (Kirschbaum et al., 2015). While this

35

adherence to hierarchy is often detrimental to interprofessional communication, it also seems to have been traditionally perceived as necessary to establish and maintain effective surgical team leadership (Kirschbaum, 2012).

Surgical Team Leadership

Leadership behaviors identified as required by the surgeon role include guiding/supporting/directing other team members, managing tasks and resources, making decisions, and maintaining surgical or professional standards; when coupled with the evolving technical demands of the surgical procedure, these required behaviors often lead to inherently unbalanced dialogue (Bleakley et al., 2013; Parker et al., 2012). This unbalanced dialogue can result in tense, non-directed communication that can fail to achieve desired results in a timely manner (Barling et al., 2018; Parker et al., 2012; Rogers et al., 2013).

Unexpected findings by Gostlow et al. (2017) identified observational assessment scores of surgeons as *decreasing* over time from peak scores at the end of surgical fellowships (Gostlow et al., 2017). Surgeon scores on the Non-Technical Skills for Surgeons survey decreased significantly for behaviors such as including others in discussion for alternative courses of action in the surgical plan, informing team members of potential problems, and establishing a shared understanding or TMM. This could be explained as resulting from surgeons assuming more senior roles in the operating room, and therefore having the 'final say' instead of seeking input from others, or by the instrument's reliance on the observable, explicit articulation of the processes involved and evaluated. Additionally, and perhaps more concerning, the findings reported noted a significant decrease over time for all three elements of leadership. The leadership

category includes behaviors such as proper introductions of all team members, appropriately delegating tasks, and tailoring leadership to support other team members (Gostlow et al., 2017). These leadership behaviors are potentially critical to the establishment of psychological safety and a team communication culture.

Unfortunately, research suggests many of the skills required for surgical leadership have traditionally been taught primarily through the 'hidden curriculum' in medical school and residency instead of through deliberate, focused training (Hull & Sevdalis, 2015). And although surgeons initiate intraoperative interprofessional communication approximately 80% of the time, studies show that surgeons could correctly identify team members by name and professional role less than 45% of the time. This lack of name knowledge and use often results in ambiguous communication by the surgeon that is not explicitly directed toward any particular team member or role (Birnbach et al., 2017; Sevdalis, Wong, et al., 2012). The time-sensitive surgical leadership expectation without established communicative relationships potentially reinforces a vertical, role-based hierarchy that may inhibit interprofessional questions or clarifications and result in accommodation or avoidance communication behaviors by nurses and junior team members (Etchegaray et al., 2019; Jayasuriya-Illesinghe et al., 2016; Landgren et al., 2016; Pattni et al., 2018; Skevington et al., 2012; Tsui-Fen et al., 2017).

Reliance on accommodation or avoidance communication behaviors by surgical team members inhibits both the development of a TMM to anticipate needed actions during the surgical procedure and the maintenance of the SA needed to respond to unanticipated intraoperative events (Attree, 2007; Rydenfält et al., 2012). An evolving

TMM and SA contribute to prospective sensemaking by the surgical team (Bleakley et al., 2013; Rosness et al., 2016). Prospective sensemaking occurs when the concern and attention of the surgical team are deliberately directed toward events that may happen in the future, collective expectations are formed, and interrelated team actions are refined to construct a more manageable situation or an optimal outcome (Rosness et al., 2016). Certain types of leadership behaviors support or suppress the communication culture and the types of communication that enable prospective sensemaking (Barling et al., 2018). Leadership behaviors that support effective communication culture include emphasizing the collective mission, motivating through enthusiasm or optimism, soliciting and valuing other provider perspectives, considering the needs and abilities of other team members, and encouraging others to perform beyond expectations based on evolving contextual needs (Hu et al., 2016).

It is important to note that perceptions of operating room leadership often change throughout surgical cases depending on the roles and tenure of the surgical team members who are present. Circulating nurses are considered responsible for many of the initial tasks directly involved with preoperative patient assessments, verifying surgical consents, preparing the operating room for cases, and patient transport. Once the patient arrives in the operating room, there is often a perceived 'shift' of control to the anesthesiologist during patient intubation, anesthesia induction, and patient positioning. When the surgical residents and surgeons arrive in the operating room, many of the necessary decisions become their responsibility as surgical approaches are navigated, equipment needs are finalized, and the procedure begins. IAEs can further complicate who is perceived as 'responsible' for different aspects of surgical patient care, and those

responsibilities often continue to change as patients are stabilized, surgery ends, and the patient is transported to the postoperative care unit.

Unstructured Communication

Timely, optimal responses to intraoperative deviations and unexpected circumstances require surgical teams to move beyond the structured communication prompted through surgical checklists to effective unstructured communication (Garrett, 2016). Unstructured communication strategies discussed in the literature include the implementation of an informal intraoperative briefing by the surgeon and the use of scheduled or unscheduled surgical pauses to encourage evolving TMMs (Erestam et al., 2017; Healey et al., 2010). Unlike surgical checklists, these strategies do not seem to be universally employed, and their use appears to be dependent upon the intraoperative communication culture. The facilitators and barriers that impact interprofessional communication in the intraoperative environment are explored in the next section.

Facilitators and Barriers in Interprofessional Communication

Interprofessional communication facilitators that seem to enable prospective sensemaking through unstructured communication include prompts for structured communication and deliberate surgical pauses. Scheduled and unscheduled surgical pauses contribute to prospective sensemaking by allowing surgical team members time to mentally 'reset' and encouraging team communication. Unscheduled pauses seem especially helpful when in doubt of necessary surgical strategy or after resolution of surgical deviations or intraoperative adverse events (Erestam et al., 2017). Research suggests that even unscheduled pauses due to 'waiting' during the surgical procedure are often used by team members to augment SA and update the team's mental model (Santos

et al., 2012). Characteristics of individual team members that seem to function as facilitators for interprofessional communication include team member age and professional tenure, with communication improvements occurring with increased age, length of professional experience, and time worked on the same unit (Önler et al., 2018).

Current research also identifies many barriers to establishing and maintaining effective interprofessional communication in the intraoperative environment. Barriers include distractions, interruptions, miscommunications, disruptive behavior, and robotic technology (Almeras, 2019; Bellandi et al., 2018; Weber et al., 2018; Weigl et al., 2018). Distractions and interruptions include noise peaks, telephone calls, music, physician pager notifications, door openings, equipment noises or failures, case-irrelevant conversations, and visual disturbances such as obscurement of monitors (Keller et al., 2016; Plaxton, 2017; Seelandt et al., 2014; Weigl et al., 2015; Weldon et al., 2015; Wright, 2016). Although research seems to indicate case-irrelevant conversations as being adapted or reduced based on the difficulty of the procedure, one study linked case-irrelevant communication during incision closure with increased incidence of surgical site infections (Tschan et al., 2015; Widmer et al., 2018). Other studies report significant distractions as occurring as often as every ten minutes intraoperatively and describe 80% of these distractions as leading to at least one member of the surgical team being visibly distracted from his or her task (Sevdalis et al., 2014; Wheelock et al., 2015; Yoong et al., 2015). Distractions are suggested to occur as often as every three minutes in the intraoperative environment and contribute to up to 50% of surgical error (Mentis et al., 2016). Distractions and interruptions have been linked to fewer patient safety checks,

impaired team performance, extended surgical times, more surgical error, and increased surgical site infections (McMullan et al., 2021).

Miscommunications occur as often as every eight minutes in the intraoperative environment (Hu, Arriaga, Peyre, et al., 2012). Intraoperative miscommunications include failures of communication audience, content, purpose, or occasion and are more likely to occur during interprofessional communication (Hu, Arriaga, Peyre, et al., 2012). Miscommunication within the surgical team has been identified as a significant predictor of deviation in the expected length of surgical procedures (Gillespie et al., 2012a). Both miscommunications and interruptions have been identified to negatively impact surgical teams' non-technical skills, including communication (Gillespie et al., 2017). One study identified that as much as 30% percent of case-specific information is lost to miscommunication and revealed a positive correlation between procedure interruptions and miscommunications (Gillespie et al., 2012b).

Another barrier to interprofessional communication in the intraoperative environment is disruptive behavior. Disruptive behavior ranges from dysfunctional behavior that alters clinical care to intimidating behavior that is emotionally or physically abusive (Van Norman, 2015; Villafranca et al., 2018). Disruptive or unprofessional behavior by surgeons, such as bullying, harassment, and undermining behavior, has been linked to adverse patient outcomes (Cochran & Elder, 2014; Cooper et al., 2019; Halim & Riding, 2018; Heslin et al., 2019). Disruptive behavior by surgeons has been identified to lead to increased care errors due to impaired decision-making by the surgical team, heightened surgical team anxiety, and decreased efficacy of communication (Cochran & Elder, 2015). One study reported that some surgeons view intraoperative questions by

interprofessional support staff as disruptive behavior (Bezemer et al., 2016). Finally, while robotic assistance during specific surgical procedures produces clear benefits for patient outcomes, it has also been identified as a barrier that impacts decision-making, teamwork, and communication in the intraoperative environment (Randell et al., 2016). This impact is potentially realized through changes in the physical proximity of team members and the resulting decreased SA because of the surgeon's separation from the sterile field (Gill & Randell, 2016; Randell et al., 2014).

Intraoperative Communication Instruments and Interventions

Identification of the importance of interprofessional communication in the operating room has resulted in focused research to better understand, describe, and quantify its contributing factors in spite of the methodological challenges inherent in the surgical environment (Jones et al., 2016). Access to the surgical environment is limited by its confined and sterile characteristics, and the interdependent, concurrent action makes a comprehensive understanding of communicative interactions potentially elusive (Bonzo et al., 2016). Any attempt at evaluating the quality of intraoperative communication is further complicated by the significance of nonverbal modes of communication such as body positions/movements, facial expressions, visual gaze direction, gestures, and tool manipulations (Tiferes et al., 2019). Additionally, team processes and communication culture are often specific to the surgical teams being studied and therefore are not conducive to standardization or generalization (Tiferes et al., 2015). In an attempt to standardize the study of intraoperative communication, a review of a priori coding schemes by Tiferes et al. identified six dimensions of surgical team interactions. Dimensions described included information flow, information

recipients, surgery phase of occurrence, statement type, topic or theme of statement, and communication breakdown effects (Tiferes et al., 2015). Although Tiferes suggested these dimensions be developed and incorporated into procedure-specific evaluation instruments, as of this writing there is no evidence of that having been accomplished. Recognition of the impact of interprofessional communication and its influence on teamwork has resulted in the development of instruments to measure relevant behaviors (Hasnain et al., 2017; Hill et al., 2015; Hull et al., 2012; Hull et al., 2011; Rubin, 1993; Sevdalis, Hull, et al., 2012; Tan et al., 2017; Thannhauser et al., 2010; Valentine et al., 2015; Wingo et al., 2015). Unfortunately, the reliability, validity, and teamwork content of many existing instruments have been described as 'largely unaddressed' in the current research, with many measures having undergone little or no reliability or validity testing (Li et al., 2018; Marlow et al., 2018). Two of the most widely used instruments to evaluate teamwork behaviors in surgeons are the Oxford Non-Technical Skills and the Non-Technical Skills for Surgeons instruments.

NOTECHS II

The Oxford Non-Technical Skills scale (NOTECHS II) was adapted from evaluations of non-technical skills in the aviation industry, does not seem to be confounded by technical skill assessment, and correlates with other reliable measures of teamwork behaviors (Robertson et al., 2014). Non-technical skills have been identified as the cognitive, personal, and social skills that combine with technical skills to contribute to safe and efficient performance (Hull & Sevdalis, 2015). NOTECHS II scores are based on evaluations of observable teamwork behaviors by trained observers; interprofessional communication is only evaluated *indirectly* through teamwork behaviors. NOTECHS II

evaluates leadership, support and inclusion of other team members, conflict resolution, risk assessment, identification of future/potential problems (briefing), outcome review (debriefing), establishment and maintenance of TMMs, and prioritization of SA (Robertson et al., 2014). Reliability coefficients for the five subscales of NOTECHS range between .77 and .87 (Sevdalis et al., 2008). Inter-rater reliability has been reported as a range of 0.68-0.97 within-group, with totals ranging from 0.95-0.99 (Shoemaker et al., 2015). Another study reported test-retest reliability of ($P > 0\cdot09$) and interobserver reliability of (Rwg = $0\cdot96$) (Li et al., 2018). NOTECHS has been identified to have predictive, concurrent, construct, content, and convergent validity in the operative environment (Mishra et al., 2009; Shoemaker et al., 2015).

Non-technical Skills for Surgeons (NOTSS)

Another instrument, the Non-Technical Skills for Surgeons (NOTSS) behavior rating system, specifically measures the non-technical skills identified for safe surgical practice by surgeons. NOTSS groups surgical leadership behaviors into five categories: communication and teamwork, decision making, leadership, SA, and task management (Yule et al., 2008). These categories consist of observable behaviors that include many previously discussed, such as gathering information, anticipating and projecting procedural needs (SA), selecting and communicating options, flexibility and responding to change, establishing a shared understanding (TMM), and coordinating team activities. Reliability for the NOTSS varies based on the number of cases, number of raters, and the experience level of raters involved in the research. While the Leadership and Communication and Teamwork categories had acceptable within-group agreement with raters of varied experience, the other categories improved to acceptable levels only when

expert raters were used (Jung et al., 2018). Inter-rater reliability has been reported as ICC = 0·12–0·83 (Li et al., 2018). NOTSS has also been identified to demonstrate longitudinal construct validity (Dedy et al., 2016; Jung et al., 2018; Yule et al., 2015).

Observational Teamwork Assessment for Surgery (OTAS)

In contrast to the instruments that focus only on the teamwork and communication behaviors of surgeons, the Observational Teamwork Assessment for Surgery (OTAS) is designed to be a comprehensive measure of the teamwork behaviors of the entire surgical team (Undre et al., 2007). OTAS is based on Dickinson and McIntyre's Model of Teamwork and consists of two sections (Walters et al., 2016). The first section of OTAS is a task checklist to monitor the completion of intraoperative tasks related to the patient, equipment and provisions, and communication. The second section uses a seven-point scale to rate five teamwork behaviors: communication, coordination, cooperation, leadership, and monitoring/awareness. Communication includes the quantity and quality of information exchanged among surgical team members; coordination evaluates the time management of tasks and activities; cooperation measures backup behaviors and support of other team members; and leadership includes team direction, SA/monitoring behaviors, and assertiveness. Trained observers identify and record collaborative behaviors using the checklists (Walters et al., 2016). These collaborative behaviors are then scored using a six-point ordinal summary scale, with unexpected emerging behaviors recorded on a qualitative assessment form (Rehim et al., 2017). Research suggests OTAS is a valid and reliable instrument to assess collaboration within surgical teams and even suggests acceptable interrater reliability (ICCs ≥ 0.68) among novice and expert raters after focused observational training (Walters et al., 2016). Another study

reported significant correlations for reliability for all measured behaviors except communication (r=0.35) (Undre et al., 2007). OTAS has also been reported to demonstrate both content and construct validity (Hull et al., 2011; Sevdalis et al., 2009).

Communication and Teamwork Skills Assessment

Another instrument, the Communication and Teamwork Skills Assessment (CATS), was developed based on principles from crisis resource management (CRM). CRM was initially developed for use in the aviation industry (as Crew Resource Management) and was adapted and medicalized when behavioral parallels were recognized between aviation and healthcare delivery. CRM identifies principles of individual and team behaviors such as SA, decision making, and team management and was designed to quantitatively measure team skills and interprofessional communication (Gaba, 2010). CATS uses trained observers to assess interprofessional responsive communication through direct observation of teamwork behaviors in cooperation, coordination, SA, and communication (Havyer et al., 2016). Cooperation behaviors include requesting help or additional resources, cross-monitoring team member behaviors, and receptivity to assertions or feedback (Frankel et al., 2007). Coordination behaviors include verbalization of the surgical plan and timeframes, briefing, and debriefing. SA behaviors include visually scanning the environment and verbalizing changes in patient condition or the surgical plan. Communication behaviors include using SBAR, performing closed-loop communication, providing verbal updates, and maintaining an appropriate tone of voice (Frankel et al., 2007). Additionally, CRM addresses behaviors needed when crisis situations arise, such as the establishment of an event manager (clear leadership), recognizable escalation of concerns, and the use of

critical event language. Behaviors are rated as 'observed and good', as demonstrating 'variation in quality', or as 'expected but not observed'. Each completed observation results in an overall score, category scores, and specific behavior quality scores (Frankel et al., 2007). Since its initial development, CATS has not been statistically validated and information regarding validity and reliability is negligible (Frankel et al., 2007; Shoemaker et al., 2015).

The following table, Comparison of Intraoperative Teamwork Instruments, illustrates the similarities among the categories measured by the instruments used in the intraoperative environment. While all four instruments measure communication, cooperation, and SA, the instruments designed to evaluate the teamwork behaviors demonstrated by surgeons measure decision making and do not measure coordination with other team members. Table 2.3: Comparison of Intraoperative Teamwork Instruments provides a comparison of the instruments.

Table 2.3: Comparison of Intraoperative Teamwork Instruments

	NO TECHS II (surgeons)	**NOTSS** (surgeons)	**OTAS** (surgical team)	**CATS** (surgical team)
Communication	X	X	X	X
Coordination			X	X
Cooperation	X	X	X	X
Leadership	X	X	X	
SA	X	X	X	X
Decision making	X	X		

Communication Training

Research indicates that surgical teams benefit from interprofessional communication training interventions through increased cognitive and affective learning,

skill-based transfers, and teamwork performance (Kirschbaum et al., 2015; Salas et al., 2018). Two training interventions developed to focus on interprofessional communication are CRM and Team Strategies and Tools to Enhance Performance and Patient Safety (Team STEPPS).

Crew/Crisis Resource Management (CRM)

CRM concepts originated during a 1979 NASA workshop from exploration of the role of human error in aviation incidents (Kuy & Romero, 2017). Similarities between aviation crew performance and the interdependence of surgical teams led to the adaptation of CRM concepts to promote safety culture and improved interprofessional communication in the operating room. CRM concepts focus on advocacy and assertion training, briefings and debriefings, decision-making skills, SA, and team communication (LaPoint, 2012). CRM uses interprofessional role-playing group exercises to teach non-technical skills, including closed-loop communication, creating and sustaining shared mental models, decision making, risk recognition, SA, speaking-up strategies, and team formation (Savage, Gaffney, Laith, et al., 2017). CRM also directly addresses unanticipated surgical deviations through threat and error management (TEM) strategies designed to establish SA and resolve the situation as a team (Gordon et al., 2012). Tailored checklists are provided to support the trained skills and those required for effective crosschecks, debriefings, and standardized time-outs. CRM also describes the development of blame-free culture, maintenance of only case-relevant conversation during critical surgical phases, and acknowledgment of the potential effects of physician fatigue on patient outcomes (Aerden et al., 2014).

Studies have demonstrated that CRM positively influences safety culture, reduces intraoperative adverse events, and improves surgical patient outcomes but suggests periodic reinforcement and retraining to be necessary for continued demonstrated benefits (Ricci & Brumsted, 2012; Savage, Gaffney, Laith, et al., 2017; Wakeman & Langham, 2018). A five-year study of CRM-trained pediatric surgical teams by Savage et al. identified significant, sustained improvement in communication, leadership, mutual support, and situation monitoring (Savage, Gaffney, Laith, et al., 2017). Another study by Kuy et al. described sustained safety climate improvement after CRM training in 24 of 27 surveyed areas; unfortunately, two of the three areas identified with regression to baseline or worse involved "I am frequently unable to express disagreement with staff/attending physician" and "in this clinical area, it is difficult to discuss errors", indicating persisting problematic interprofessional communication patterns (Kuy & Romero, 2017).

Team STEPPS

Team STEPPS was developed in 2006 by the Agency for Healthcare Research and Quality (AHRQ) and the United States Department of Defense (USDOD) based on four teamwork competencies: team leadership, mutual support, situation monitoring, and communication (Rhee et al., 2017). These four teamwork competencies are the foundation for focused training that provides specific performance criteria for both structured communication strategies to improve the implementation of the surgical safety checklist and skills training to facilitate the initiation of unstructured communication when surgical team members experience concerns or perceive deviations or deficiencies in patient care delivery. The structured communication strategies include standardized behavioral expectations for the surgical time out that compel engaged participation and

leadership, mandatory team member introductions, and verbalization of procedural complexity and anticipated events (Rhee et al., 2017).

Performance criteria for unstructured communicative interactions identify skills such as call-out, check-back, and the 2-challenge rule. During call-out, a surgical team member verbalizes changes in patient condition or procedural expectations for all team members to hear, potentially increasing SA and updating the TMM. Check-back is a form of closed-loop communication requiring the recipient of information to repeat it aloud to confirm understanding of the content and the speaker's intention. Finally, the 2-challenge rule offers surgical team members 'challenge' strategies to state or restate concerns regarding patient care; the team member being challenged is expected to verbally acknowledge the information (Rhee et al., 2017).

Additional focused language to be used by team members to 'stop the line' (all team activity) uses the CUS acronym through one of three statements: "I am **C**oncerned", "I am **U**ncomfortable", or "This is a **S**afety issue". Team STEPPS training teaches that when *any* team member uses one of the three CUS statements, the issue should be immediately acknowledged and addressed. This not only empowers surgical team members to make assertive statements when needed, it also provides 'signal phrases' to indicate the perceived magnitude of the situation to the recipients.

Reported barriers to the successful implementation of Team STEPPS include inadequate training, lack of administrative support, failure to address hierarchal differences/incivility in healthcare, and resistance to change from CRM concepts (Clapper & Ng, 2013). In spite of these barriers, research by Weld et al. identified both improvements in patient safety and in operating room efficiency with significantly

shorter anesthesia and case times and significantly higher on-time case starts (Weld et al., 2016). Reported benefits include increased recognition of surgical team members, increased active engagement of surgical team members, increased anticipation of case complexity, and improved discussion of resource status (Rhee et al., 2017).

Lessons from the Cockpit

The need for immediate improvement in intraoperative communication understandably led to the adoption and adaptation of communication interventions and strategies that demonstrated significant safety results within the aviation industry (Davidson & Brennan, 2019). The interventions currently in use do seem to prompt and measure communication that contributes directly to patient safety outcomes, but results are dependent upon surgical team buy-in, persistent and consistent implementation, and the establishment and maintenance of a positive safety culture supported through the organizational structure (Abbott et al., 2018; Cadman, 2016; de Jager et al., 2018; Gillespie et al., 2013; Pugel et al., 2015; Rakoff et al., 2017; Russ, Rout, et al., 2015).

While checklists and structured communication focus on the basic, prescribed information exchange needed to facilitate the prevention of or response to IAEs, they often fail to recognize IAEs as *emergent phenomena that are combinations of unanticipated circumstances or developments* (Karanasios et al., 2017). As such, IAEs require both recognition and articulation of dynamic situations and mutual construction of evolving plans of action (TMMs). This mutual construction and implementation of needed action are accomplished through effective interprofessional communication. While many of the described studies have focused on the content and timing of communication, this study focused on the context and the process.

The similarities identified between the communication cultures of the cockpit and the operating room provided a logical starting point to influence the content and timing of structured team communication, but the inherent cultural differences between the two types of teams indicate the need for more research to realize further communication improvements (Teunissen et al., 2019). Although flight crews enter the cockpit with hierarchal constraints, they enter as professionals socialized through the same culture. In contrast, surgical team composition results in team members from different professional cultures needing to socially negotiate and construct communication culture within the intraoperative practice environment. While research indicates the interventions in use impact the quantity of interprofessional communication, they do not provide an informed understanding of unstructured communication *quality*. Effective unstructured communication patterns and strategies are what are needed to adequately respond to IAEs, and those patterns and strategies are perhaps better understood through familiarity with relevant existing theory and concepts.

Theoretical Constructs

Building grounded theory often requires engaging with existing theory to be able to successfully develop theory to a higher level (Bryant & Charmaz, 2007). Familiarity with existing theory offers the researcher opportunities to experience sensitizing concepts that deepen researcher perceptions and provide a 'starting point for building analysis' (Charmaz, 2003). Sensitizing concepts have been identified as providing a general sense of reference that suggests direction and structure to the researcher with the understanding that they may eventually be displaced or supplemented through the developing theory (Bowen, 2006). One theory potentially useful to the understanding of the interactive

processes involved in establishing effective communication and teamwork behaviors is Structurating Activity Theory (SAT).

Structurating Activity Theory

SAT, a combination of Structuration Theory (ST) and Cultural-Historical Activity Theory (CHAT), identifies mediated activity as both reproducing and transforming social structure over time through system transformations (Seamons & Canary, 2017). ST is an organizational communication theory developed primarily by Anthony Giddens in the late 1970s. Giddens objected to the presentation of social interaction as a 'timeless snapshot' and believed the study of social practices, forms, and processes to only make sense within the context of time and space (Carlstein, 1981). ST focuses on human practice systems and makes the distinction between structure, the resources and rules that drive individual practices, and systems, or observable relationship patterns among individuals (Canary, 2010; McPhee & Canary, 2014). In ST, individuals use resources and rules within systems as they both influence the structures within the system and are influenced by them as the system evolves. This focus on social construction within systems includes the tenet stating, "ongoing action is influenced by structure while at the same time such action produces, reproduces, and transforms structure over time" (Canary, 2010, p. 29). Actions and structures are influenced by norms, codes of meaning, and allocative and authoritative resources.

CHAT is an evolving, third-generation communication theory initially conceived by abbotian psychologist Lev Vygotsky in response to assertions that psychic processes occurred in isolation (Roth, 2007). Instead, Vygotsky proposed social interaction as the origin and context of higher mental functions and identified tools as mediators of

psychological and social processes (Wertsch, 1990). He described cognitive development

as occurring through collaboration with others in a zone of proximal development

(Tudge, 1993). Vygotsky identified a unified framework where a subject interacts with an

object and artifacts or tools in this zone of proximal development (the environment)

(Yamagata-Lynch, 2010). The subject within the framework is the individual or

individuals engaged in activity centered on the activity's object or goal. Tools function to

accumulate and transmit social knowledge and can include prior knowledge and artifacts

that mediate the social interaction (Kaptelinin et al., 1995; Yamagata-Lynch, 2007).

Many of the basic elements described in CHAT are similar to those of ST. There

are rules (norms), tools (resources), and recursive, reciprocal influences between

systems/individuals and structure (Canary, 2010). SAT's integration of ST with CHAT is

useful because it explains relationships between social structure and social action

(Canary, 2010). Heather Canary proposed SAT in 2010 as a theoretical framework better

able to explain the complexity of the social construction of policy knowledge; the social

construction and organization of collective knowledge in public policy are similar to the

social construction of collective practice (teamwork) within healthcare delivery (Seamons

& Canary, 2017). Canary offers six propositions within SAT to explain SAT's four

theoretical constructs. First, social structures both constrain and enable knowledge

construction within the social context. Second, elements of systems shape knowledge

construction through interaction and mediated action. Third, mediated action both

transforms and reproduces structure through system transformations. Fourth, resolution

of contradictions can generate knowledge construction through interaction. Fifth,

constructed knowledge is further mediated by the elements of the intersection of activity

systems (individuals). Sixth, structural features both enable and constrain knowledge construction as it "produces, reproduces, or transforms social structure" (Canary, 2010, p. 37).

Canary describes the four types of knowledge (explicit, tacit, group, and individual) as being dimensions that are interdependent instead of independent types. The assertion is made that since knowledge is open to alteration, knowledge should be considered as a process and not a static possession to be transferred or shared (Canary, 2010). "Knowledge can be a mediating resource of the system, an integral aspect of a subject in the system, or a rule. Knowledge is also an (intended or unintended) outcome of activity as people develop knowledge through their interactions within the activity system" (Canary, 2010, p. 44). The knowledge process is influenced through four types of system-level contradictions. Primary contradictions describe inherent fundamental tensions between or among components of systems. Secondary contradictions become apparent when new elements are introduced that cannot be resolved without transformation of practice or system elements. Tertiary contradictions occur when new motives are introduced into systems. Finally, quaternary contradictions result from tension between or among the central activities of systems. Engeström and Sannino described four possible discursive manifestations of contradictions: dilemmas, conflicts, critical conflicts, and double blinds. Dilemmas are identified as exchanges or expressions caused by incompatible evaluations between individuals. Conflicts are arguments, criticisms, disagreements, or resistance. Critical conflicts are when self-doubt or functional paralysis occur because of contradictory motives. Last, double blinds are described as processes where individuals perceive an inescapable problem because there

are only unacceptable alternatives as solutions (Karanasios et al., 2017). While activity

theorists view contradictions as indicating the developmental capacity of an activity,

perception of contradictions as flaws or malfunctions of the system potentially result in

unfavorable responses. Contradictions can be perceived to destabilize a situation or to

transform it through expansive learning; this distinction is relevant because the

perception often determines the response (Karanasios et al., 2017).

There are individual implications from both ST and CHAT that are potentially

useful in the grounded theory exploration of the motivations and perceptions involved in

intraoperative communication. While implications from both theories are relevant to this

research, considering them in combination more accurately reflects the complexity of the

social processes involved. The following table, Table 2.4: Relevance of Structuration

Theory to Research, identifies implications from each theory that were considered during

the research.

Table 2.4: Relevance of Structuration Theory to Research

Structuration Theory	*Possible relevance to research*
Structure influences - but does not necessarily determine - action.	Are there indications participants believe they are acting within/outside of the bounds of existing structure?
Participant knowledge about the contributions to structure can be discursive or practical knowledge.	Do participants describe 'filtering' or limiting their interactions based on explicit or tacit expectations?
Agentic participants should be considered as active, reflexive contributors to structure.	Do participants describe their actions as proactive or reactive? Do they reflect on the interactions and outcomes?
There are unintended consequences and unacknowledged conditions of actions that contribute to structure.	Do participants reflect on how actions contribute to structure? On how their actions are influenced by structure?
Social interactions are often guided by recurrent practices that constitute structure and influence individual identity.	Do participants describe recursive practices that influence structure? Their contributions to structure?

Structure can be enabling, constraining, or both.	How do participants describe their perceptions of the influence of structure on interaction?
Structure is constantly produced or reproduced through action.	How do participants experience the evolution of structure through their actions?
Cultural-Historical Activity Theory	
Social interaction is a series of processes that is contained within a bounded activity system.	Do participants describe perceived social or professional boundaries? Expectations? As an individual? As a team member?
Participants engage in goal-directed and object-oriented activity using the tools and rules of the activity system.	Do participants describe conflicts between individual goals (professional responsibilities or concerns) and the object (interdependent surgical patient care)?
Tools can be conceptual or material and may include protocols and language specific to the activity system.	Do participants describe perceptions of being influenced by the procedural or language norms of the activity system?
Rules are culturally- and historically-formed behaviors that mediate the object-oriented activity of the subjects.	Do participants describe perceptions of being enabled or constrained by the rules of the activity system?

Although a primary goal of this research is to develop new grounded theory to better understand interprofessional communication in the intraoperative environment, SAT provides a valuable framework to explore the perceptions, expectations, and motivations of surgeons and nurses surrounding the knowledge construction and contradictions that occur during IAEs. This exploration potentially allows a deeper understanding of the possible differences in perceived value and purpose of interprofessional communication when the surgical team is considered as a system.

Systems Thinking

Beginning to understand interprofessional communication within the context of the system in which it occurs can be facilitated through the use of systems thinking. Systems have been described as combinations or groups of interacting, interdependent, and interrelated elements that form collective entities (Arnold & Wade, 2015). These

interrelated elements work together under particular conditions that influence their behavior to perform actions needed to achieve the system's purpose (Plack et al., 2018). While each element of the system is necessary, the elements are individually insufficient to accomplish the aims of the system.

Surgical teams might be even more accurately identified as being complex adaptive systems. Complex adaptive systems (CASs) are groups of independent agents who are free to act in ways that are not necessarily predictable and whose actions are interconnected and interdependent (Holden, 2005). Several assumptions about complex adaptive systems are relevant to surgical teams.

1) CASs are composed of independent agents who operate based on social, psychological, and physical rules that are independent of the system.

2) The rules of the independent agents are not homogeneous. Because of this, their behaviors and goals are likely to contribute to conflict. This conflict leads to adaptive behaviors. These behaviors may be 'positive' or 'negative'.

3) As the independent agents gain experience and experiment within the system, their learning changes the behavior of the system.

4) The adaptive behaviors and learning result in the self-organization of the system. Self-organization results in the emergence of behavior patterns rather than blind conformity to the design of the system.

5) The CAS does not have one single point of control; therefore CAS behaviors are easier to influence than to control (Mahajan et al., 2017).

6) Independent agents interact dynamically and exchange information.

7) These interactions are non-linear and not bound by a framework to control the information flow.

8) CAS interactions have both enhancing (positive) and inhibiting (negative) feedback loops.

9) CASs do not function under equilibrium; there is constant change.

10) CASs are an extension of their histories, and the system's actions and effects are not easily predictable.

11) Complexity within the CAS results from the interaction patterns between and among the independent elements (Holden, 2005).

12) CASs are resilient when functioning effectively. Resilience is demonstrated when CASs "dynamically respond to unanticipated disturbances to sustain safe operation amidst conditions that could lead to failure" (Kolodzey et al., 2019, p. 1).

The processes and structures of CASs form through interactions and relationships that are non-linear, recursive, and systemic (Arrow et al., 2000). It is therefore necessary to avoid exploration of CAS interactions and relationships using consideration of the surgical team as an isolated system without considering the relevant embedding concepts such as other workgroups, patients and families, and the physical environment (Arrow et al., 2000). The functioning of the CAS is constantly influenced through both internal and external two-way exchanges of information, stimulation, and resources. These assumptions about CAS are essential when seeking to understand systems thinking within surgical teams.

Systems thinking gained recognition through efforts by Barry Richmond to distinguish his research from the model- and simulation-based studies of System Dynamics (Richmond, 1994). Richmond described systems thinking as a way to learn to make reliable predictions or inferences about behavior by developing a deep understanding of underlying structure. Richmond identified systems thinking as both a paradigm and a learning method, with the paradigm conditioning the learning method and the learning method supporting the paradigm. Richmond's explanation of systems thinking as a paradigm potentially has interesting applications to the exploration of the surgical team as a system because it addresses vantage point (professional role) and thinking skills as they relate to SA and the assignment of meaning. This is illustrated below in Figure 2.2: Systems Thinking.

Figure 2.2: Systems Thinking
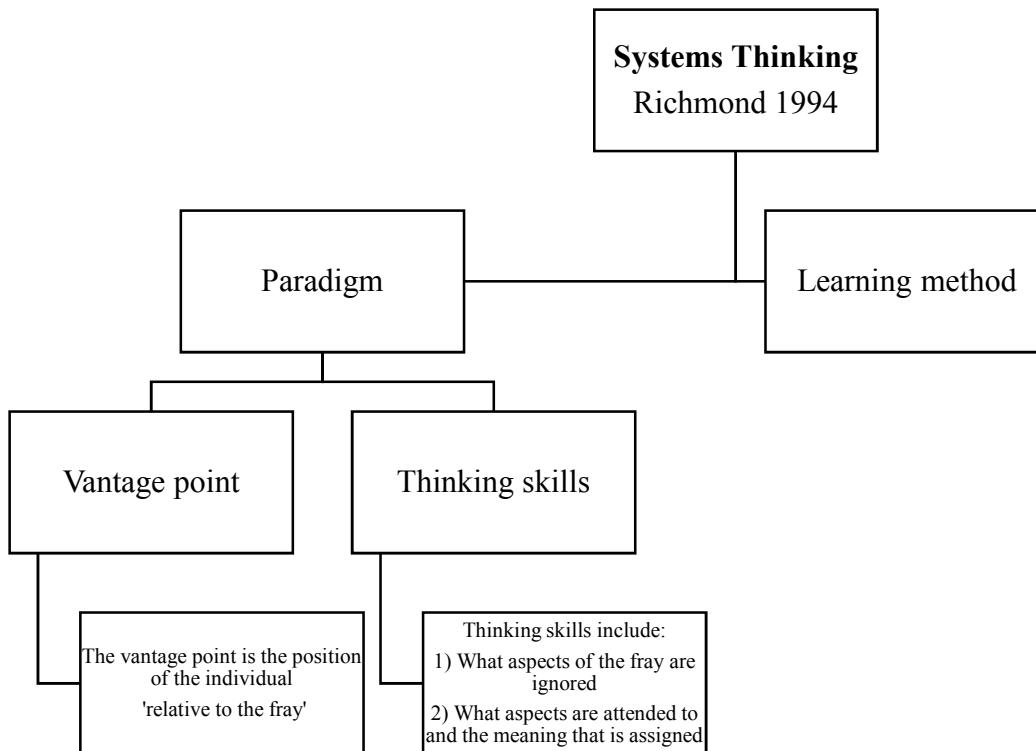
Systems thinking was identified by Peter Senge as the fifth discipline of

disciplines that are consistently exhibited by learning organizations: 1) personal mastery,

2) mental models, 3) shared vision, 4) team learning, and 5) systems thinking (Arnold &

Wade, 2015; Thornton et al., 2004). Senge described systems thinking as "a discipline for

seeing wholes and a framework for seeing interrelationships rather than things, for seeing

patterns of change rather than static snapshots" (Arnold & Wade, 2015, p. 672). Critics

suggested the concept of systems thinking proposed by Senge failed to address the

agency of the individual in practice-based learning (Caldwell, 2012). The agency and

behaviors of the individual were considered by Sweeney & Sterman to result in the

dynamic complexity of systems (Sweeney & Sterman, 2000). Systems thinking was

proposed to represent and assess dynamic complexity, identify and represent positive and

negative feedback processes, identify nonlinearities, and challenge the recognized

boundaries of mental models.

Systems thinking definitions soon evolved to include the interdependent

relationships and patterns among a system's components and link individual behaviors to

the environment (Dolansky & Moore, 2013; Stalter et al., 2017).

> Systems thinking is the ability to recognize, understand, and synthesize the
> interactions and interdependencies in a set of components designed for a specific
> purpose. This strategy includes the ability to recognize patterns and repetitions in
> interactions and an understanding of how actions and components can reinforce or
> counteract each other. These relationships and patterns occur at different
> dimensions: temporal, spatial, social, technical or cultural (Dolansky & Moore,
> 2013, p. 4).

A recent concept analysis of systems thinking extended the definition as "what

occurs when the individual's social, cultural, physical, emotional, and political attributes

change the system but at the same time are changed by the collective nature of the system

(Stalter et al., 2017, p. 326). The analysis identified four defining attributes: a dynamic system, a holistic perspective, attempted identification of patterns, and the potential for transformation. This potential for transformation among teams has been suggested to reduce disempowerment and promote increased collaboration among healthcare providers (Stalter et al., 2017). In addition to systems thinking, this research considered the importance of two key concepts to the interprofessional communication process: situational awareness and proxy efficacy.

Situational Awareness

One key concept that influenced this study of interprofessional communication in the operating room is situational awareness (SA). SA is the shared, dynamic, and evolving understanding of environmental elements that includes the (1) perception of those elements (information), (2) comprehension of their contextual meaning, and (3) projection of their significance to the situation (Endsley, 1995; Stanton et al., 2017). Shared surgical team SA is inextricably related to the dynamic TMM because SA is the basis for understanding *when and how the team mental model must* <u>*adapt*</u> *to respond to IAEs*. A TMM is the team members' mental representation and shared understanding of relevant knowledge to the team's task environment. The TMM includes *shared* team- and task-related knowledge that allows the team to interpret information

similarly, develop shared expectations for the future, and have similar explanations for situations. TMMs also facilitate more accurate direction of resources and anticipation of other team members' needs (Fernandez et al., 2017). TMMs are often initially established during structured forms of communication like the implementation of the surgical safety checklist and might accurately be described as the shared surgical

team plan based on *known* information and *anticipated* developments. When new information and unanticipated developments emerge, SA ideally provides the impetus for appropriate, responsive action by surgical team members.

An understanding of the SA components and their barriers can emphasize its dependence on effective interprofessional communication in the operating room. Any of the three components may be influenced by physical or social psychological stressors common to the operating room environment (Endsley, 1995). Physical stressors include noise, distractions, temperature, lighting, and fatigue. Social psychological stressors include mental load, anxiety, uncertainty, fear, and time pressure. The first component of SA is the perception or recognition of relevant environmental elements or changes. Team members may fail to perceive or recognize relevant information due to limited attention, other-focused attention, or available working memory capacity. The second component of SA is the comprehension of relevant information's contextual meaning. Team members may fail to comprehend or integrate the contextual meaning of information due to limitations in the individual mental model or the use of an incorrect mental model for reference. The third component is the projection of the information's significance to the emerging situation. Team members may not be able to understand the significance of conveyed information due to the lack of an appropriate, highly developed mental model or individual attention and memory limitations. These barriers to SA underline the critical role of effective interprofessional communication to 'bridge the gaps' in shared awareness that may occur during IAEs.

Proxy Efficacy

Responses to IAEs in the operating room environment are often accomplished through increased SA and proxy efficacy. Proxy efficacy is one's belief in the skills, abilities, and willingness of a third party or parties to function effectively on his or her behalf to facilitate desired outcomes (Bandura, 2001). Proxy efficacy evolved from Albert Bandura's Social Cognitive Theory. Bandura initially identified three forms of efficacy: personal, collective, and proxy. He furthered his research through the development of the concepts of personal, collective, and proxy efficacy as *temporal extensions* of agency; people engage in forethought about the accomplishment of tasks in anticipation of events (Bandura, 2001). Personal efficacy is comprised of the beliefs of an individual surrounding his or her competence in a given situation. When people feel deficient in personal efficacy, they will often rely on proxy efficacy to achieve the desired results.

This reliance on proxy efficacy is vital in the intraoperative environment because information is often exchanged with the intention of (1) encouraging others to perform an action on behalf or at the behest of the team member, or (2) seeking approval to perform actions that might be commonly outside of that team member's role and responsibilities. Examples of proxy efficacy in the operating room could occur if there is unexpected bleeding and the surgeon (1) asks the nurse to order blood (since the surgeon is occupied at the sterile field) or (2) the nurse asks permission to order blood (since this is usually accomplished through surgeon orders). Many surgical team member relationships develop to include the assumption of proxy efficacy that works in concert with SA. An example of this could be when the circulating nurse notices evidence of unexpected blood

loss and orders the blood without having either conversation (asking or being asked).

Although ordering blood is usually beyond the nurse's defined role, it often falls within a

previously established role of proxy efficacy or agency.

Summary

An initial review of the literature underlines the importance of advancing a better

understanding of how unstructured interprofessional communication develops in the

intraoperative environment. Effective interprofessional communication has been

indicated as fundamental to interprofessional collaboration, to ICP, and to teamwork, but

has primarily been studied within the intraoperative environment through the

implementation and evaluation of structured surgical communication such as the surgical

safety checklist, specialized checklists, extended checklists, critical event checklists, and

briefing/debriefing strategies. While checklists and communication prompts can improve

interprofessional communication surrounding known information and anticipated

developments, they fail to address the unstructured communication needed for surgical

teams to respond to IAEs (Teunissen et al., 2019). Improvements in unstructured

interprofessional communication are indicated to be established and maintained through

changes in intraoperative communication culture.

Current perceptions of intraoperative communication culture include widely

variable perceptions of both the intent and the success of interprofessional

communication in the operating room, and this variability is most significant between

surgeons and surgical nurses. This variability is often attributed to professional

socialization and its traditional focus on the role of the surgeon as the surgical team

leader. Although this professional hierarchy is necessary to provide the structure to

65

facilitate a successful surgical process, it has also been shown to result in reliance on accommodation or avoidance communication behaviors by other surgical team members (Walrath et al., 2015). The use of accommodation and avoidance communication behaviors by subordinate surgical team members inhibits the evolving SA needed to respond to unanticipated IAEs.

Instruments designed to evaluate interprofessional communication among surgical teams in the intraoperative environment focus on behaviors that demonstrate cooperation, communication, and SA. Communication interventions attempt to encourage and inculcate those behaviors through the use of prescribed prompts and specialized language but often deteriorate over time and through team member resistance. Research suggests that the improvements attained through checklists and interventions are limited and not necessarily lasting.

Significant, lasting changes in interprofessional communication might best be made through gaining a better understanding of how surgeons and surgical nurses perceive the social construction and exchange of knowledge in the intraoperative environment. This understanding of the social construction of knowledge and its influence on the SA needed to respond to IAEs requires 'taking a step back' to explore how the structures and strategies of interprofessional communication are experienced by those involved.

This study focused on surgeons' and surgical nurses' communicative patterns and relationships because of the complexities identified in the literature. A recent ethological study described the intraoperative surgeon-nurse relationship as demonstrating the least cooperation and the most conflict among members of the surgical team (Jones et al.,

2018). Ethological studies focus on behavior from an evolutionary perspective and explore cooperation and conflict as they are influenced by hierarchy and gender (Jones et al., 2018). This study by Jones et al. is valuable to this research because it explored spontaneous behavior and identified trends related to hierarchy, gender, and professional role as they influence cooperation and conflict in the intraoperative environment. Lack of cooperation and the presence of conflict within the surgical team potentially contribute to IAEs and undesirable patient outcomes through ineffective interprofessional communication. Although surgical nurses are almost *twice* as likely as other surgical team members to witness an IAE or near-failure in the operating room, they are often hesitant to report either type of occurrence to the surgical team (Makary & Daniel, 2016; Mariet, 2016; Molina et al., 2017; Norton et al., 2016; Okuyama et al., 2014; Sydor et al., 2013). The perceptions and patterns of interprofessional communication between surgeons and surgical nurses were examined using a grounded theory approach.

Chapter 3

Research Methods

The purpose of this study was to explore the psychosocial processes involved during the establishment and maintenance of interprofessional communication surrounding IAEs or potential IAEs in the operating room. Interprofessional communication is established and maintained between and among individuals and groups through social interactions influenced by the meanings constructed and assigned by the participants. Exploring participant meanings of their experiences through sensitive, deliberate data collection to inductively and deductively establish themes and patterns is often best accomplished through the use of qualitative methods (Creswell, 2013). Grounded theory is a qualitative method designed to explore situated interactions among participants through the collection and iterative analysis of data (Wæhle et al., 2012b). The systematic, concurrent data collection and analysis occur with the intention of moving beyond description of the experiences to formulation of a theory that is grounded in the data (Creswell, 2013; Wæhle et al., 2012b).

Grounded theory is appropriate to the study of interprofessional communication in the intraoperative environment because it considers the assumptions, beliefs, feelings, ideologies, and values of the participants during interactions that are influenced by relational hierarchies (Creswell, 2013). The contextual consideration of these interactions was achieved through deliberate focus on a shared problem, IAEs, and how participants experienced their interactions attempting problem resolution through interprofessional communication (Bryant & Charmaz, 2007; Wæhle et al., 2012b). This contextual consideration included the researcher's perspective and position through the framework of social constructivism (Charmaz, 2014). Social constructivism is an interpretive

68

framework that identifies subjective meanings of experiences as being historically and socially negotiated through interaction (Creswell, 2013). The constructivist approach does not seek a single 'truth'; instead, it acknowledges that the perception of truth is based on perspective (Bryant & Charmaz, 2007). This approach considers and discloses the importance and roles of interactions, interpretive understandings, social contexts, and viewpoints to the conduction of grounded theory research (Charmaz, 2014).

Research Design

Design of a grounded theory study requires researcher responsiveness and vigilance throughout the process to ensure methodological coherence and rigor (Morse et al., 2002). Coherence and rigor were provided through deliberate, consistent consultation with method experts using evaluative criteria addressing credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Design of the study was based on the following assumptions: (a) surgical staff initiating and maintaining interprofessional communication during IAEs share a common experience, (b) interprofessional communication during IAEs is a psychosocial process that evolves over time, and (c) the psychosocial process is influenced by the social context in which the interprofessional communication occurs. The psychosocial processes inherent in involvement with IAEs and their descriptions were potentially sensitive to participants; any resulting reluctance was addressed through transparency, assurance of participant confidentiality, and demonstrated engagement with the existing surgical team culture (Dundon & Ryan, 2010; Råheim et al., 2016). The following sections describe the research methods used for the study through the identification and description of participant and setting selection, relevant tools, data analysis, and data quality.

69

Participants and Setting

Institutional Review Board (IRB) approval was obtained prior to the conduction of this research through the IRB required by the research site. Approval to recruit participants was sought and obtained through the hospital research council and the perioperative unit director. Participation was voluntary, participant risk was minimal, and no adverse events were anticipated or reported from participation. Participants for the study were selected through the use of both purposive and theoretical sampling. Purposive sampling is used initially in grounded theory to recruit participants who are going through or who have been through the relevant psychosocial processes and to more accurately determine the scope of the phenomena (Bryant & Charmaz, 2007). Analysis of initial participant interviews facilitates subsequent theoretical sampling designed to increase understanding of the developing categories and refine their focus (Charmaz, 2014). Theoretical sampling strategies function to explore emerging theory and may include changes in selection of participants, study sites, or interview style to define "pivotal qualities of the studied experience" (Charmaz, 2014; Draucker et al., 2007). Theoretical sampling continues until theoretical saturation is achieved; this saturation determines the adequacy of the final sample size (Charmaz, 2014; Gentles et al., 2015).

Because sample size in grounded theory cannot be determined or anticipated *a priori,* a tentative participant sample of 15-20 surgeons and 15-20 nurses was proposed (Aldiabat & Navenec, 2018). The initial participant sample included men and women (1) of any race or ethnicity (2) functioning within the professional roles of surgeon or nurse within a pediatric setting (3) with varying levels of career experience and (4) team tenure in an effort to illuminate relevant theoretical categories (Charmaz, 2014). Potential

participants were excluded if they expressed reluctance to candidly describe their experiences surrounding communication during IAEs or reported being unable to recall qualifying intraoperative events.

Twenty participants were recruited for study interviews. There were five surgeon participants; two were female and three were male. They ranged in age from thirty-five years old to 'over sixty'. The surgeons had between two and thirty-five years of experience as attending surgeons and indicated they worked with primarily the same surgical team members between 25-50% of the time (one surgeon), approximately 50% of the time (one surgeon) and approximately 75% of the time (three surgeons). The fifteen nurse participants were all female. Nurse participants ranged in age from twenty-three to over sixty-five years of age and had between three months and thirty-six years of intraoperative experience. They reported working with primarily the same surgical team members less than 25% of the time (three nurses), between 50%-75% of the time (five nurses), approximately 75% of the time (six nurses), and approximately 95% of the time (one nurse). Nineteen of the participants were Caucasian and one participant was African American.

Participants were recruited from an urban academic pediatric hospital for in-depth interviews encouraging narrative description of their perspectives and experiences with interprofessional communication surrounding salient events in the operating room. An urban academic pediatric hospital was used for several reasons. First, urban academic hospitals traditionally provide healthcare to higher-acuity patients whose surgical care potentially results in higher complexity and increased likelihood of IAEs.

Second, research suggests a lower incidence of 'speaking up' behaviors in academic hospitals, perhaps due to the fluid, uncertain nature of the medical hierarchy where residents function as both practitioners and as learners (Schwappach & Sendlhofer, 2018). A lower incidence of speaking up behaviors potentially offered more opportunities to explore situations where ineffective communication contributed to IAEs. Third, the unique physiologic challenges of the pediatric patient such as smaller airway, lower blood volume, and tendency toward hypothermia require both more timely recognition and resolution of any developing IAE (Lagoo et al., 2017). Fourth, the reported personal attributes of pediatric surgeons potentially translate to more effective interprofessional communication practices. While surgeons traditionally score higher on extraversion and conscientiousness than other physician specialties, they score lower on agreeableness (Drosdeck et al., 2015; Hoffman et al., 2010; Preece & Cope, 2016; Turska et al., 2016). Pediatric surgeons have similar high scores on extraversion and conscientiousness but score higher on agreeableness, openness, and emotional stability than general (adult) surgeons (Hazboun et al., 2017). Surgeons with tendencies to be more open and agreeable potentially offer candid interviews of more effective, deliberate, and balanced interprofessional communication. Increased emotional stability would likely also be reflected in the leadership communication strategies required for surgical management during IAEs.

After hospital approval, initial recruitment for the study was initiated through contact with the hospital's perioperative unit director to obtain access to work email addresses for potential participants. A recruitment email describing the study, the goals of the research, and the voluntary nature of participation provided initial contact with

participants. Participants who responded to the recruitment email were scheduled for private interviews at their convenience.

Tools

Tools used during data collection and analysis included the initial interview guide, demographic questionnaire, and visual mapping with Venn diagrams. The initial interview guide was composed of data-generating questions designed to elicit an experiential description from the participants (Charmaz, 2014). (Appendix A) Use of the interview guide during the pilot study solicited relevant, expressive narratives from the participants; an in-depth evaluation of the transcripts before the dissertation research begins guided necessary revisions. The interview guide was evaluated throughout data collection and analysis to determine its continued effectiveness in addressing the purpose of the research. Evaluation of the interview guide was accomplished using reflexive questions described by Charmaz and consultation with committee members (Charmaz, 2014). (Appendix B) A brief questionnaire was used to collect relevant demographic information such as participant professional role, age, years of experience, gender, and team experience specifics.

Visual mapping with Venn diagrams allows representation of logical relationships including any overlapping between and among categories (Bryant & Charmaz, 2007). Modified Venn diagrams are also useful to identify and display shared aspects of concepts and processes (Verdinelli & Scagnoli, 2013). This identification and visual representation of the concepts involved in interprofessional communication was used to facilitate a better understanding of the relationships between and among the concepts and clarify their development into categories (Charmaz, 2003).

Procedures

Semi-structured interviews took place over the telephone or via Zoom®. Prior to the interviews, participants in this study were counseled regarding their right to decline to answer any questions or to withdraw from the study at any time without penalty. All study participants were provided with digital copies of the informed consent by electronic mail prior to their interviews, and demographic information was gathered at the beginning of each interview.

Participants were asked data-generating questions during audio-recorded, private in-depth interviews lasting approximately one hour in locations negotiated based on participant comfort. Participant privacy was protected through the interview settings and confidentiality was assured through custody/access to the recordings, use of IRB-approved transcription and password-protected storage, and de-identification of private information within the transcripts. Presentation of results was aggregated and de-identified. The researcher made observational, methodological, and theoretical notes to provide context and to inform and refine the interview process through consultation with the dissertation committee (Bryant & Charmaz, 2007). These field notes were expanded post-interview and incorporated into memos to accompany the transcribed interviews. The researcher reviewed and compared all transcripts with the original audio recordings for accuracy of content and the transcribed and de-identified interviews were imported into the computer program MaxQDA for analysis.

Data Analysis

Audio recordings of participant interviews were uploaded for transcription to a password-protected transcription service approved by Indiana University School of Nursing. Transcripts were checked against audio recordings for accuracy. The transcribed participant narratives were downloaded and imported into the coding software for analysis. Analysis of the transcribed participant narratives during data collection was accomplished through use of an iterative, line-by-line coding process to organize the experiences into initial codes (Charmaz, 2014). Next, constant comparison analysis of the emerging initial codes was used to identify the significance of meanings and actions from the data. This information was then organized through focused coding into conceptually linked categories. Conceptualization of the relationships between and among the categories was accomplished through theoretical coding to begin theory integration and an initial description of the psychosocial processes (Charmaz, 2014). Theoretical coding of the psychosocial processes involved in surgeon-nurse communication is often useful to identify the temporal and structural orderings of the processes and to describe the participants' respective strategies for the establishment and maintenance of interprofessional communication. The theoretical codes were analyzed and organized into categories using the constant comparison method as patterns, relationships, and variations were explored. These categories were then 'unified' around a core category as it emerged and was identified from the data to explain the central phenomenon (Corbin & Strauss, 1990).

Data analysis also included the development and exploration of interview and theoretical notes to ensure the maintenance of conceptual detail and transparent analysis. Interview notes served to identify the context, conditions, and consequences of the

phenomenon (Corbin & Strauss, 1990). Theoretical notes provided a record of the generation of the emerging theory's categories, conceptual relationships, and generative questions (Corbin & Strauss, 1990).

Data Quality

Although evaluation of qualitative findings varies from the evidence of statistical significance available in quantitative research, assuring rigorous methods and adequately acknowledging the influence of the researcher on the analysis and presentation of the data can provide accurate and plausible findings (Levitt et al., 2017). The accepted quantitative concepts of validity and reliability are often identified within qualitative research as 'trustworthiness' and are addressed as credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). (Appendix C - Trustworthiness in Qualitative Research).

Credibility

Credibility in qualitative research has been described as 'truth value' and is related to the quantitative concept of validity (Morse et al., 2002). Credibility is influenced by evidence of a fundamental appreciation of and adherence to the philosophical nature of the chosen qualitative approach, the credibility of the researcher (as an 'instrument' in the process), and by the credibility of the data. Credibility of the researcher is established through evaluation of disclosed 1) experience, 2) training, and 3) perception of self (Patton, 1999). Credibility of the researcher in this dissertation was established through transparency during researcher disclosure and by addressing and adjusting for any perceived researcher bias (Creswell, 2013).

Credibility of the data can be achieved through prolonged researcher engagement, triangulation, and consensual validation (Marshall & Rossman, 2014). Prolonged engagement of the dissertation researcher with the participant culture in the intraoperative environment facilitated collection and analysis of relevant, rich data. This prolonged engagement was accomplished through extended participant interviews to provide adequate opportunities for study participants to reveal how meaning is assigned to interprofessional communication (Charmaz, 2014). Triangulation during data collection and analysis was accomplished through selection of the sample in a manner that ensured the identification and representation of varied participant perspectives and through substantiation with relevant existing literature and theories (Creswell, 2013; Cutcliffe & McKenna, 1999; Fusch & Ness, 2015). Possible negative cases that emerged from the data were analyzed to explore whether the contradictions were related to the individual, the described situation, or the identified themes (Charmaz, 2014). These cases were evaluated to determine if they were outliers or were true negative cases that need to be integrated into the theory (Bryant & Charmaz, 2007). Finally, consensual validation was achieved through solicitation of expert advice and insight by consultation with committee members and through the use of member checks with a diverse group of study participants (Charmaz, 2014; Marshall & Rossman, 2014).

Credibility criteria in qualitative research are influenced by the research purpose and are evaluated by the intended audience (Patton, 1999). Audience evaluation of credibility depends on production of a cohesive, transparent research report that recognizes multiple perspectives and facilitates logical conclusions and inferences (Cohen & Crabtree, 2008; Levitt et al., 2017). Several questions were potentially valuable

to audience evaluation of credibility and were deliberately addressed during the research process and within presentation of the findings. Strategies to address these questions are described in italics below.

1) How well did the described data and research process reflect the stated research focus? *Consistency with the stated research focus was confirmed through consultation with content and methods experts on the research committee.*

2) Were participants with varied perspectives and experiences included? *Inclusion of participants with varied perspectives and experiences was facilitated through deliberate theoretical sampling during participant recruitment and data collection.*

3) Were suitable meaning units chosen for analysis? *Suitable meaning units for analysis were identified by the preservation of both content and context of the narrative within text segments that are narrow enough to isolate meaning, but broad enough to avoid condensation or fragmentation (Graneheim & Lundman, 2004). The suitability of meaning units was periodically verified with members of the research committee.*

4) How well was the data represented? Was the researcher excluding irrelevant data and including all relevant data? *Consultation with members of the research committee members after coding of initial transcripts facilitated the adequate representation of relevant data, with follow-up consultation as needed during data analysis.*

5) Did the audit trail identify how similarities between and among categories are being evaluated? *Transparency regarding evaluation of data categories and relationships was facilitated through the researcher memos.*

6) Were representative quotes included in the analysis to serve as referential adequacy? *Representative quotes identified by participant role and assigned participant number were included in the presentation of the findings (Tong et al., 2007).*

Transferability

While quantitative studies seek generalizability, qualitative research is more often considered to have potential transferability to other settings or groups (Graneheim & Lundman, 2004). Generalizability describes how widely a theory can be used to explain or predict the studied phenomena but grounded theory is often most accurately applicable, or transferable, to specific groups or situations (Walker & Avant, 2011). Since this transferability must be evaluated and determined by the reader, the dissertation findings included thick description of the demographic characteristics and selection of participants; clear identification of the context, setting, and culture; and an extensive audit trail detailing the process of analysis. Transferability was also facilitated through constant, concurrent data analysis to encourage inquiry to guide theoretical sampling and conceptual saturation (Morse et al., 2002).

Dependability

The quantitative concept of reliability is often described within qualitative research as dependability (Lincoln & Guba, 1985). One strategy to develop dependability in qualitative research is by establishing intercoder agreement (Creswell, 2013). Although

coding was the responsibility of the student researcher, dependability was facilitated in the dissertation research through verification of both the codes and of the coding process with committee members during all stages of the study. An audit of dependability has been described as an examination of the *process* of how the data were collected and would include an evaluation of the adequacy of the methodological approach (Lincoln & Guba, 1982). This audit of the approach was facilitated through use of a reflexive researcher journal including a log of daily research activities, methodological research decisions, evolving perceptions, personal introspections, and developing insights to document the research process. A separate audit of the *product*s of the data collection and analysis was performed to evaluate confirmability (Lincoln & Guba, 1982).

Confirmability

Confirmability helps to establish the value of data that has been analyzed and interpreted by the researcher. Confirmability within this study was established through provision of an audit trail that includes the rationale for research decisions (Morse et al., 2002). While this cannot guarantee the analysis is independent of researcher motives or values, it does provide the reader information that can guide evaluation of the method and findings (Bitsch, 2005). Confirmability was also facilitated through researcher reflexivity using memos to address and examine personal assumptions and any epistemological concerns during analysis (Bryant & Charmaz, 2007). These reflective memos became part of the audit trail. An audit of confirmability would also include examination of: (1) the appropriateness of the size of the data units used in the coding process (2) the reasonableness of the categorization of the data (3) the verification that any conclusions drawn from the categorization are documented, and (4) the transparent triangulation of

the conclusions by the researcher (Lincoln & Guba, 1982). The auditor(s) could then evaluate whether the identified conclusions flow logically from the data to form a cohesive, meaningful understanding for the readers.

Summary

This chapter identified the methodology that was used in the dissertation research. It described the grounded theory study design, the purposive and theoretical participant recruitment, the data collection through semi-structured interviews, and the iterative data analysis that was used to answer the identified research questions. Findings from the study potentially contribute to a better understanding of the psychosocial processes involved in the establishment and maintenance of effective interprofessional communication in the intraoperative environment, providing an important step toward establishing a persistent safety culture to directly impact patient outcomes and improve provider satisfaction.

Chapter 4

Chapter four describes the results of a grounded theory study and the development

of a theoretical framework that identifies how surgical team members experience the

initiation and maintenance of interprofessional communication during IAEs.

Introduction

Participants in this grounded theory study shared the common psychosocial

problem of initiating and maintaining interprofessional communication during IAEs.

Twenty surgical team members participated in private interviews that lasted between

thirty-one and seventy-nine minutes. Participants reported having between three months

and thirty-six years of professional experience and provided information freely in

response to the interview questions. Some study participants were prompted during the

interviews to encourage more detailed memories of the communication surrounding

IAEs. Participants described the processes and strategies by which interdisciplinary

surgical teams communicated during IAEs. I have labeled the core process as Testing the

Water. Testing the Water is a common-use metaphor identified as attempting to

determine whether an action is likely to be successful before one attempts the action

(Cambridge, n.d.). This metaphor captured the core process described by study

participants because communication was driven by their perceptions of how the surgical

team would likely respond to their communication attempts.

This metaphor relates to the experiences of the study participants in many ways.

Participants in this study described entering a room and looking around to determine the

'temperature' and 'intensity' of the 'water' they were preparing to swim in as members of

the surgical team. Some participants first warily dipped in a toe, some waded in slowly,

and some jumped in fearlessly. Others entered the water only to extricate themselves as quickly as possible because of hazards they did not anticipate. Were there 'waves' present? Was the water cold, or was it inviting? Were there 'rocks' that could potentially hurt them if they made mistakes choosing where and how they would enter the water? Once in, were they only able to tread water, or could they safely swim? Were there riptides (sensitive topics) that could pull them under water or carry them off in directions they didn't intend? Were there stronger swimmers there who could help them find their way? Some swimmers were so confident that they barely noticed the characteristics of the 'water' as they jumped in and performed the experienced strokes needed to get them where they wanted to go.

Study participants described multiple ways to Test the Water that were determined by professional role, length of professional experience, and the evolving nature of IAEs. Testing the Water is an ongoing process throughout interprofessional communication in the intraoperative environment; it is an attempt at an informed negotiation of coordinated action. The two interdependent subprocesses that comprise Testing the Water were Reading the Room and Navigating Hierarchy, and both of these subprocesses are experienced throughout the phases of communication surrounding IAEs. The phases of communication include the recognition of a problem or potential problem, reconnaissance to gather information, rallying to coordinate action, reaction to the problem(s), and resolution of the problem(s). A conceptual rendering of Testing the Water is provided on the following page in Figure 4.1: Testing the Water.

Overview of Framework

Figure 4.1: Testing the Water

Psychosocial Problem	Establishment and Maintenance of Interprofessional Communication during IAEs

Psychosocial Process	Testing the Water	
Interdependent Subprocesses	Reading the Room	Navigating Hierarchy

Recognition	Reconnaissance	Rallying	Reaction	Resolution
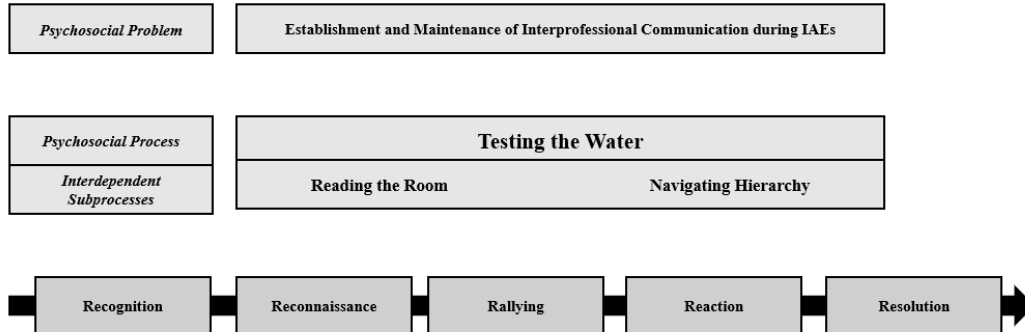
Although the process of interprofessional communication during IAEs is depicted above as a linear process, in practice, the study participants engaged in Testing the Water in a variety of ways, and the process was fluid and often iterative. The study participants' interviews revealed three major topics related to interprofessional communication among surgical team members during IAEs: the essence of communication, Testing the Water, the phases by which communication unfolds (recognition, reconnaissance, rallying, reaction, and resolution), and the facilitators and barriers to effective interprofessional communication. The discussion below addresses each of these major topics using illustrative participant quotes, beginning with a detailed exploration of the two interdependent subprocesses of Reading the Room and Navigating Hierarchy.

Reading the Room

Reading the Room is identified as the awareness and deliberate consideration of the factors influencing the context and probable trajectory of a surgical case. The factors influencing the context and case trajectory include characteristics of the patient, process, practice, procedure, plan, and potential problems. Most study participants identified

Reading the Room as essential to understanding the context that determines expectations

of interprofessional communication within the surgical team. Participants surveyed the

operating room to become familiar with cases and decide how to gather any information

needed to perform their professional roles safely. If study participants became aware they

were unfamiliar with relevant aspects of the case, they recognized the need to obtain

additional information from the surgical team. Reading the Room is an ongoing process

that often begins when surgical team members find out their case assignments. Once in

the operating room, study participants continued to use Reading the Room to remain

aware of any changes during cases, and many participants described intentional,

heightened awareness related to Reading the Room during the recognition of IAEs or

potential IAEs.

Patient. Participants in this study gathered information about patient status and

complexity through written or verbal handoff reports, reading the electronic medical

record, and monitoring patient vital signs. They also sought information from the surgical

team. At times, however, the information they obtained about patients was inadequate.

For example, one participant related the following.

> Another one is kind of the same thing, but this nurse, she came down with the baby. She had (gotten an) absolute horrible handoff because they had just done shift change. And so, she knew nothing about this patient. Anesthesia asked her what lines are going where and what's running. And she was like, I don't even know. I just got this kid five minutes ago and came down, and we were like, okay. And then I was like, do you know if consents are in the chart? And she's like, I don't know, I didn't even look. Or is the baby marked (with the surgical site)? And she's like, I don't know. I didn't look. And we were like, what do you know? So that was horrible. It was the worst handoff I've ever witnessed. (…) I just pass it (the problem communication) off to charge at that point. We took the baby back to the OR and I called charge, and I was like, hey, just so you know, like, this was really horrible. I don't know if you want to tell whoever a manager (for the other unit) was at that time. It wasn't the same one. So, I kind of just moved it up the chain there. (…) She didn't know if they even had any

allergies. My report said no, but I just wanted to verify that. And she was like, I don't think so, but I don't know. So, there wasn't anything that went wrong during the case because of that, but it definitely could have. (…) So that's the only time ever in my career that I've had a nurse, literally not know the answer to anything I asked. (TN9, Pos. 39-45)

Process. Processes are actions performed in a particular order to achieve desired results. Study participants identified understanding the usual processes followed by the surgical team, surgical specialty, perioperative unit, and the hospital as influencing patterns in interprofessional communication. While familiarity with relevant processes reduced the need for communication, increased communication was necessary during unfamiliar processes or when processes were changed unexpectedly. For example, one participant remarked:

> I was in ortho one day, and one of the surgeons, Dr. Vxx, was coming over. He had a case at (another hospital), and then he was gonna come do a case (over here). And he had told our charge nurse that he would be ready. I think it was at like two o'clock, or something and they were an inpatient. So, we went ahead and sent for the patient. But it had been a few hours since he had told her that he would be ready at two o'clock. And I went, I was going to go out and bring the patient back to the room, but then I should have checked with him before we sent for the patient, but I just, I don't (know. I) spaced it and thought he was ready and made that mistake -- until before I brought the patient back to the room, I contacted him and asked him if he was ready to bring back. And he actually was like, actually, we're delayed here. And it'll probably be another one to two hours before I can come over there. So, then we ended up having to send the patient back upstairs, which really was terrible for them. And everyone involved - and it's just a mess. But it definitely could have been prevented had I communicated earlier, or maybe he had communicated to us that they were delayed over at (the other hospital). So, there was just kind of a lapse of people not double-checking things like that (TN10, Pos. 3)

Another participant explained how an unanticipated process deviation led to the surgical team having to scramble to try to keep up with the demands of their case.

> So, normally when we have a vented baby who is an inpatient, charge will (call upstairs to) pack them up. And then, when the OR is ready, we will call the inpatient nurse and have them come down the elevators. I meet them there. Well, this day, a charge called to pack them up. But the nurse took that as 'come down'. So, she came down the elevators, and we were not at all ready (or

finished) turning over the room for that case. We were not at all ready to receive this patient. So, she called me as we're turning over and said, hey, we're down at the elevators. And I said, who told you to come down? And she said, well, the charge nurse just called me and told me to pack them up, so, we came down. And I said, 'pack them up' does not mean the same thing as 'come down'. We're not ready for you. And so, yeah, this kid was vented. Instead of going back up, she just stayed in by the elevators, in that little waiting area for 15 to 20 minutes until we were ready in the OR. And so, then we had to hurry up and try to open as fast as we could and get the (anesthesia) circuit connected as fast as we could so that we could go retrieve this vented, one-week-old baby who was waiting downstairs. So that was not great communication on that floor nurse's part because she didn't understand what 'pack up' versus 'come down' meant. She definitely made anesthesia unhappy, and the charge nurse that day was also extremely unhappy with that. (TN9, Pos. 31)

Practice. Practice is used to identify the usual methods involved in a team member's work activities; it can also describe how a surgical team works together. Participants in this study experienced different interprofessional communication patterns depending on their familiarity with the common practices of other surgical team members or the team as a whole. Team members who worked together infrequently or randomly required increased interprofessional communication compared to team members working in expert teams. One participant working with unfamiliar team members described how a lack of awareness of her team's usual practice led to an IAE.

So, the patient had a ChloraPrep allergy and everyone in the room was told and aware of it. And we have ChloraPrep in the anesthesia IV start kits, as well as that's our primary prep agent. So, we took away the ChloraPrep that came up in the case cart, put it back outside (the operating room) and took out the one that was in the anesthesia IV start kit, put the alcohol (prep) up for them. And we did our time out normally and announced that ChloraPrep was an allergy, but the surgery resident was not in the room when that was done. And anesthesia did their stuff. That part went fine. And we even put a 'do not use' (sign) on the anesthesia ChloraPrep up by the head. So, no one would use that. And we're all done with that part. And then a resident goes to prep. He can't find the ChloraPrep on the bed. So, despite us moving it away, he goes to the cabinet and gets it out, and starts prepping with the ChloraPrep. And I had my back turned to him because I was scrubbed, and when I turned back around, I was like, you can't use ChloraPrep. The patient is allergic to it. And then he proceeded to say that it was

on the bed. He (said he had) found it (on the bed) anyway, even though he didn't. He got it out of the cabinet himself. (TN4, Pos. 3)

Procedure. The word procedure is being used in this study to define the surgical

intervention(s) taking place. Increased communication was required during unfamiliar

procedures, complicated procedures, and procedures involving multiple surgical

specialties or surgeons. Increased communication was also identified to be necessary

when working with unfamiliar equipment or instruments. A study participant explained

her confusion with the following:

> It was probably like my second service, so I was on GU. And was scrubbed into a case. For this particular case, it was a really large kid. Like a seventeen-year-old, football player-sized guy that we were doing a penis case on. And um, so I'm still trying to convert my ways back to the pediatric way of doing things. Like with instruments. Because I'm thinking that he's an adult, so I need to use adult-sized instruments. And so, my preceptor was like, 'no, no, no, still use the same tiny little instruments, blah blah' and honestly, I'm like not really sure what we're doing. We were putting in some kind of suprapubic catheter or something, and I hadn't done that (…) And so I really wasn't quite sure what we were doing. (…) And so, he's asking me for stuff. (…) So, he's having conversations with all these residents. And then, so, we get the catheter in or whatnot, and he asks me for...some water. And I was like, 'okay'. So, in my mind, I'm thinking, 'all right, so we just put a (Foley) catheter in, so this must be for the balloon, right?' (…) So, he's asking me for water, I'm kind of confused, I'm looking over at, you know, the people who are supposed to be watching me, and paying attention, and they're not. And I'm like, 'okay, well...' So, I drew up, like, water-for-irrigation water. And he wanted like, and this is my bad because I should have known when he asked for like a hypo (needle) for it. Um, but I literally as I was handing it to him -- I was like, this is WATER.' And he's like 'kaay', and he's not paying attention because he's having conversations with his residents. And so, I gave it to him, and he starts injecting it into the patient. And so then, the circulating nurse is like, 'whoa whoa whoa -- what are you doing? So, he stops, and she's like, 'what is that?' And I was like, 'he asked for water'? And she was like, 'that's not the kind of water he wants' And I'm like literally, 'I told him this is water'. (…) I haven't put a suprapubic catheter into a person, so, with my line of thinking, he's going to fill a balloon up (for a Foley catheter) (TN2, Pos. 17-19)

Plan. The plan for a case considers the characteristics of the patient, the proposed

process, and the expected procedure(s). Study participants needed increased

communication during situations where plans were evolving, such as during exploratory

procedures or procedures involving patients with traumatic injuries. One participant

described how an IAE occurred even after the surgical team discussed the plan during the

time-out.

> I don't even know if it was a resident or if it was an advanced care provider like a
> CRNA or whatever. But we kind of went through our time out in the usual
> fashion, and we were getting ready to do like a T&A and maybe some other
> things I can't remember. Oh, and like a possible laser and whatnot. And we all just
> sort of, our ENT physician talked about O2 saturation for the laser would be a fire
> risk and also the bovie (electrocautery) and stuff because he does the T&A with
> the bovie and suction instead of a coblator wand. So, he makes sure to sort of
> make a distinction about that the O2 needs to be down to like less than 40 or
> something -- or the CO2, excuse me. So, he kind of rattled all that stuff off, and
> we all kind of went about our business. (…) We started with a bronchoscopy, not
> the T&A, and we were lasering, and I think the anesthesia person, (now) how did
> this happen? Somebody said something about the CO2, and I think maybe it was
> the attending anesthesia person, but at any rate, they came in, and they're like,
> 'hey, uh?' (…) At any rate we had thought that we had communicated what we
> wanted CO2 to be when we were doing the lasering and everybody seemed to be
> listening and understand, but (for) most of us this is what we do all the time.
> (TN12, Pos. 5)

Problems. Problems during a case may be anticipated or unanticipated. Anticipated

problems were often disclosed when surgeons explicitly described their plan for the case.

One participant identified how the advance description of anticipated problems was

critical to ensuring optimal patient outcomes.

> We had a kiddo with a rare skin disorder, I can't remember what it was called. Not
> just skin. It was a disorder where he, like his skin was just like sloughing
> off. Like he didn't have any protection. So, he didn't have thermal regulation. He
> didn't have infection control. His skin was just like - it was blisters. And it was
> like very sensitive. He didn't really have very many layers. And the ones he did
> have, you couldn't shear anything across them, but it happened internally too. I
> think his esophagus did the same thing. And so, they had to be careful with the
> (endotracheal) tube and everything like that. So, it was really interesting. It was
> rare. I'd never seen anything like it. The doctor came in beforehand and had
> talked to a colleague at - there was a specialty clinic for this in another state. And
> he had known the head or one of the docs at that clinic. So, he came in with
> printed protocols and gave them to each of us, the anesthesiologist, the nursing

staff, everybody, and kind of said, okay, here's the plan. This is what we're going to do. Because we couldn't have tape, you had to pick the kid up - you couldn't shear their skin when you're moving them over. The ET-tube had to be certain -- they had to do certain things with that. We had to go over each certain thing to make sure everything was perfect for this kid because he could have really long-term effects from, you know. (…) So, we just had all these extra precautions, and it was sort of stressful, but all the disciplines had to work together for the safety of that kid. And so, we bounced ideas back and forth. 'Hey, do you think…?' We prepared for a long time before we even brought the kid back (to the operating room). And said, 'hey, do you think we should use this Coban instead to wrap the IVs, or is that going to be too much pressure?' You know, and we just kind of all went back and forth and tried to plan the best we could about, what should we do about this? What should he lay on? Is this soft enough? We don't want this pulling. And so, we kind of all sat around and tried to figure out all of those different things so that when he came back, and we were all prepared. We were all on the same page. And everything went really well. (TN13, Pos. 31-35)

Navigating Hierarchy

Navigating Hierarchy is the process by which participants in this study considered the rights and responsibilities of the surgical team members. Although surgical team members have rights and responsibilities during a case, many are not explicit or are inconsistent among surgical teams. Study participants navigated hierarchy by evaluating the timing of communication, maintaining the tone of the room, managing tension within the surgical team, considering the topic of communication, and respecting the tenure of surgical team members. Most participants used these strategies in varying orders and combinations depending on the urgency of the communication.

Evaluating Timing. Participants in this study identified timing as a significant consideration in interprofessional communication, regardless of professional role or tenure. The appropriate timing for communication can depend on the tenure of the team members initiating and receiving the communication, the tone of the room, the tension in the room, and the topic to be discussed. Timing also impacts which surgical team

members are perceived as having a 'right' to speak as the perceptions of hierarchy, control, and responsibility change throughout the surgical process. Study participants reported teaching new nurses how to consider the tone and tension present in the room to evaluate timing when they need to ask important questions. One participant related the following:

> I tell them don't ever be afraid to ask the question that they (the surgeons in that specialty) are very open to questions and being questioned, to read the room if they're trying to ask a question or not. (They need to make sure) that the surgeon or whoever was in the field didn't seem stressed, wasn't being asked a bunch of questions at the same time, or it wasn't really like a tense part of the procedure. I will also tell people if you're not sure, call me and ask me. Ask the person that's scrubbed in do you think this would be a good time for me to ask the question. I tell people to call me, whether I'm on vacation, whether I'm at home, whether I just left. I said it doesn't matter. You can always call me 24/7 for anything. I would rather you ask me the question than spend one minute being uncomfortable or not knowing what the next move you should make is. (TN6, Pos. 65-67)

Maintaining Tone. The tone of the intraoperative environment also influences interprofessional communication patterns. The tone of an operating room might be very focused, collegial, or even chaotic, and the tone may change many times during a surgical procedure. Sometimes the tone in the intraoperative environment can be altered or unusual due to tension; in other situations, the tone might be determined by the preferences or tendencies of the physicians involved. Participants in this study used communication strategies to avoid disrupting tone when the room was focused, such as during difficult parts of the procedure. Participants also were reluctant to alter tone through potentially unsettling communication when the tone was perceived to be collegial. Study participants explained how they enter the room where ongoing cases are taking place:

So, in addition to like body language, current conversations that are happening, if the kid is desatting obviously you don't go into a room making a whole lot of noise. Chit-chatting and trying to start conversations. So yeah, you're going to go off of patient condition, what's currently happening, maybe what portion of the case they're in, um, if it's like a tense portion of the case -- you're not really stirring up a lot of conversation and what-not. Yeah, so those are like your environmental cues. (TN2, Pos. 110)

I would say I look at the scrub nurse to see if she feels chaotic or if she's making any faces, like rolling her eyes about like, what's going on or what the surgeon is asking for because he's asking for a million things kind of thing. You can kind of notice like a good flow between the scrub and like the surgeons, if it's a good case, or if they're having things thrown at them and things aren't going (well), I don't know. You can kind of tell how it's going by looking at their interaction. I would say you can kind of tell how things are going based off of how the anesthesiologist is either sitting back in their chair and nice and relaxed looking or (is standing) up by the patient. If the circulator, her body language, if they're standing up running around or if they're nice and relaxed. So, I think probably body language is what I look at on top of what you said to kind of study how tense people are. If they're relaxed, then things must be going good. (TN15, Pos. 82)

Managing Tension. Tension has been described as both an "inner striving, unrest, or imbalance often with physiological indication of emotion" and as a balance maintained between opposing forces or elements (Merriam-Webster, n.d.). Tension in the intraoperative environment is often attributed to the inherent interdependence of the surgical team while providing care during surgical procedures and is frequently increased during IAEs or potential IAEs. Tension originated both internally and externally and was indicated to impact team members both individually and at the team level. While internal tension was most often exacerbated by performance considerations, sources for external tension included equipment malfunctions, performance lapses by other team members, patient status changes, and other unanticipated events. Participants in this study initiated, avoided, and delayed communication to reduce tension among surgical team members.

One study participant experienced a situation where unacknowledged tension contributed to a delayed response to a potential IAE.

> I don't know what (about the situation) was more tense. There was simply something in there that was more tense. The blood loss didn't seem to be any more extreme at all, but the room just was no longer like, oh, we're getting this, we're chipping away at this. It was tense. And no one communicated to the surgeon that they were uncomfortable with the situation. And that was the near miss. During the operation, I had a little more wherewithal of what was going on with her because I wasn't doing most of the operating. I was assisting, and so my brain was able to process what else was going on. And it sounds as if the anesthesiologist in the room was uncomfortable with the amount of blood loss and the amount of time it was taking to have the tumor taken out. The anesthesiologist at no time communicated that to the surgeon. (TS1, Pos. 5)

Another participant described using humor to alleviate tension in the operating room.

> If I feel like it's appropriate, I'll kind of say like, I'll make it kind of lighthearted and say like please don't kill me, but I don't know how to do this. Or like don't laugh at me, but then I do this right? So, I kind of try to preface it with a statement like that, kind of a little jokey about it, or I don't know. I guess it depends on the situation. If I can, I try to make it a little lighthearted. If it's a pressing urgent or emergent situation where there's like no time to make any kind of jokes, then I'll just straight up ask them, even though I'm scared, but I'll be like I don't know how to do this, or I don't know where this is, or I don't know how to load this stitch. I guess I would just say that. But if I can, I try to soften it a little bit, I guess. (TN8, Pos. 45)

Considering the Topic. Participants in this study considered the proposed topic when initiating interprofessional communication. While some topics were perceived as being 'open' to being introduced for discussion by any member of the surgical team, other topics were identified as being more complicated. More complicated topics included issues related to team member performance, team member error, or to topics that were perceived as another role's responsibility. Some participants in this study with less tenure experienced situations when they lacked enough confidence in their experience and expectations to know if a topic was relevant to the case or to the surgical team. This lack

93

of confidence was also mentioned when introducing a topic could be perceived as challenging another team member's tenure or role. Study participants with less tenure frequently struggled to understand relevant topics well enough to know how to approach asking questions when they were concerned about what was happening in the operating room. "I feel like when you first start somewhere new, at least for most people, they don't feel confident in their abilities or confident in having those conversations. *Because they don't exactly know what to ask*." (TN4, Pos. 63) Many study participants were concerned about reactions of other surgical team members, especially the reactions from surgeons. Two participants related the following experiences:

> Some of the doctors do make it more difficult. You feel like you can't say *anything* because they're so rude or harsh. But no, I can't think of a specific example where I would be like, oh my gosh, that's harming the patient, and I didn't say something. But some surgeons do make it more difficult to point things out, or they might take it the wrong way -- that they're in the wrong, or that kind of thing. (TN13, Pos. 47)

> I do know that like sometimes I am a little bit nervous about like -- say it's something that I might think that a surgeon's going to be annoyed about or like, I dunno, someone might just be frustrated with the situation. They might take it out on me. And sometimes I am like, I don't really want to say this, but I'll still do it. (TN10, Pos. 23)

Respecting Tenure. Tenure has been described as the act, manner, or right of holding something (Merriam Webster, n.d.). While tenure is connected to team member role, it is also determined by team member experience within the surgical team, surgical service, profession, and hospital. Tenure often extends the rights and responsibilities related to team member roles and influences the perceived ability to recognize and respond to IAEs. The ability to recognize and respond to IAEs through tenure was identified as a consideration during interprofessional communication. More experienced study

participants had higher tenure within the surgical team and were more likely to be

directly involved in sustained interprofessional communication during IAEs. Less

experienced study participants, regardless of professional role, were more likely to delay

or avoid interprofessional communication; this was especially true when IAEs were the

result of errors or omissions by higher-tenured team members. Higher-tenured study

participants considered tenure of their audience and whether those team members

possessed the knowledge and experience to complete the required actions and would

often go 'over' or 'around' inexperienced team members to obtain the assistance they

needed. Many participants in this study felt having tenure protected them from unwanted

changes in perception by other team members when they needed to initiate

interprofessional communication. Two participants shared the following experiences:

> I think because I worked here as long as I have, I know that the surgeons know that I'm competent and I feel I've earned a lot of their trust, so if I don't know something (and have to ask a question), I think they'll let it slide, whereas five years ago, I would think they just think I'm a complete idiot that doesn't know anything and is useless to them, basically. (TN8, Pos. 47)

> If I were a few months into it (as a new nurse), I would have still said it, but I definitely would have been more nervous to say something. Or I would have second-guessed myself more and be like, oh, like, do they actually have an allergy? And go look at the chart again. But I knew that they did because I had just received handoff from the pre-op nurse. And so it was fresh in my head. (TN9, Pos. 29)

Testing the Water during IAEs

Communication surrounding IAEs occurred in several phases identified as

recognition, reconnaissance, rallying, reaction, and resolution. Recognition is when

surgical team members become aware of a problem or potential problem. Reconnaissance

is when surgical team members seek more information about the problem. Rallying is

95

when surgical team members attempt to enlist and coordinate others to solve the problem or potential problem. Reaction is the response to the problem in the form of actions by the surgical team members. Finally, Resolution includes focused communication after the problem was solved. These phases of communication were experienced differently by the study participants based on professional role and tenure, and not all participants experienced each phase during IAEs. The length of the phases experienced also varied among participants. A discussion of how participants in this study experienced interprofessional communication during these phases follows.

Communicating during Recognition

Participants in this study often initially became aware of developing or potential IAEs through 'becoming uncomfortable' or 'sensing a change in the room'. At other times, participants noticed situations as they monitored patient status, caught a 'lapse' when checking behind other team members, or realized they had made mistakes when providing care. Changes in patient status were experienced as the least complicated problems to address because indications were usually visible through patient monitors or were recognized by the surgical team at the sterile field. Double-checking behind other team members was more complicated for study participants to address through interprofessional communication because of the hierarchal considerations involved in performance monitoring. Additionally, participants were often hesitant to admit their own mistakes because of perceived potential reactions from the surgical team. Recognizing and addressing problems in the intraoperative environment almost always required coordinated actions from other team members and led to delays in the surgical process.

The two most common communication strategies identified by participants in this study were Making the Case and Saving it for Later.

Making the Case. Although study participants tried to find the best time to communicate with the surgical team, they recognized delaying communication was not always possible when the topic was urgent. Participants who decided to make their case deliberately reduced delays in interprofessional communication because of the urgency of the situation. One participant reported her rationale about appropriate times to address the surgical team:

> I do regularly tell the orientees, never be afraid to ask a question. It's always better to ask than to not. And even if someone does get a little bit upset with you if it's a bad time, try to wait for a better time if possible. *But there's not always going to be a better time.* And it's always better to upset someone a little bit than to risk your patients. (T N14, Pos. 113)

Study participants often considered the perceived hierarchy when Making the Case, and many relied on 'evidence' to convince others when they recognized potential IAEs. One participant described the following:

> So, I had a pretty good relationship with this guy, but he was definitely the attending (surgeon), and I was the resident. And so, when I first brought it up, I said, 'I'm not sure, but I don't think that that looks like the right level to me.' And he was like, 'It's fine. This is the correct level.' Then we were looking around more, and I was like, 'well, there's no disc osteophyte complex here. This looks normal to me.' And he was like, 'I think it's okay. I think this is the right level. Look at the imaging.' And then when he looked back at the imaging, he thought, 'oh, wait, maybe we are off. I'm not a hundred percent sure.' And so because I persisted and said, 'well, I think this looks normal. I think that looks abnormal. You know, I don't think we're in the right spot. Let's just look at it from a different perspective.' Then he sort of agreed and ultimately was very thankful we had diagnosed that. (TS3, Pos. 42)

Some nurse participants were less direct when Making the Case and described 'playing dumb' to Navigate Hierarchy. These participants pointed out potential problems or errors in ways that encouraged others to consider (or reconsider) their actions before problems

97

impacted patient care. This strategy was used to encourage others to rethink planned

actions or to double check behind themselves instead of feeling confronted by another

team member. Several study participants shared their use of this strategy:

> I do think about whether I'm going to say something overtly or whether I'm going to frame it as a question or pretend like I'm being stupid. I'll pretend like hey, why would we do this instead of that, or help me understand why we're doing it this way today or something like that. I decide whether I'm going to just flat out say it or I'm going to 'backhand' say it. I think I know I'm going to get them to the same answer either way, but I kind of just determine the timing of it. I'm just going to say something, but if I have time to tease it out, I'll go that route instead. (TN6, Pos. 59-63)

> I mean, I've done that in some situations. Yeah. Or I'll say, I thought that *this* is what we were doing. Yeah. Kind of the same way because that way you're not just saying, hey, you're wrong. You're kind of just like making them double check themselves. (TN10, Pos. 27)

> Yeah. That's kind of what they taught us to do. Instead of throwing somebody under the bus, making a scene out of it or making it a confrontation, it's just kind of like oh, I've never seen it done that way. You know? And then maybe it makes them think more about, oh, am I doing it right? Just the way you say it, I think can help with the way it comes off, also it's not confrontational then that way. You're sounding more dumb or just curious, oh, how do you (do that), show me how that works, or I have never seen it like that. (TN13, Pos. 77)

Saving it for Later. Study participants with lower tenure often evaluated whether

information exchanges 'could wait' when initiating communication. Reading the Room

to understand how things were going with the procedure and with the patient allowed

participants to delay communication when problems could be solved without assistance

from the surgical team at the sterile field. A participant described her thinking during this

strategy:

> I would just say, I try to think like, is this something that needs to be taken care of immediately? And if not, maybe I can call, say it's like a page or something, call that person back in five minutes. Or I'll just say, hey, I'll call you back whenever they're available. Or like sometimes if I'm in a room and I'm not in those rooms a lot and I don't really know what's going on in that procedure, I'll leave in, like if my scrub nurse is in there a lot, I'll ask them. And sometimes they'll find a better

time for me to be able to tell them. But it is kind of more of a 'is it gonna affect this other person or this other thing if I don't answer the question right now' is kind of what I think. Like, can it wait? And if it can, then I'll kind of feel out the rest of the situation to see when's an easier time to ask. (TN10, Pos. 72)

Inexperienced study participants often asked others to determine if the timing was right and considered the potential impact of the information before initiating communication. Even topics usually dealt with immediately were sometimes delayed through problem solving by the participants. One participant shared the following story.

> Recently actually there was a time where I was scrubbed into a tumor case and we were in the middle of it and I looked down on my, like my big Mayo, the high Mayo and on the corner, there was a hair on the Mayo and I was like, Oh, my gosh. I remember at that moment we were in a very serious part of it, though. There was some bleeding going on and it was just very serious, and I remember calling (a more experienced nurse) over, being like Exx, hey, I'm whispering to her, there's a hair right here. What do you want me to do? What do you think would be best? Because we were just like in a critical situation where Dr. Cxx was actually just like -- I'm trying to control bleeding. She (the other nurse) was like, hey, let's just throw all those instruments right there in that corner. I'll get you an op site, we'll cover the site and then we'll let Dr. Cxx know as soon as it's a good time. So, I was just really nervous, like of course, like dang it, there's a hair and we're in the middle of it and the brain is open and we're also just not in a great situation. I was thankful to have her to help me kind of guide, like let's not tell him now, but we will wait until things calm down and then we'll let them know and so that's exactly what we did as soon as things calmed down. I let them know like, hey, just so you know, about ten minutes ago we found a hair on the corner of the Mayo, I wanted to let you know that we took all the instruments that were in the area off, covered the area, changed gloves, but didn't want to tell you at that time, because it was critical and he just said that he really appreciated it (that we waited). (TN7, Pos. 50)

While some of the developing IAEs were obvious to study participants, at other times the situations were more complex, and participants needed more information to make sense of what was happening. When study participants felt they lacked an understanding of the situation, they searched for more information through reconnaissance.

Communicating during Reconnaissance

Reconnaissance is used to describe the process used by participants in this study

to get information to understand how to respond to IAEs or developing IAEs. Participants

who felt they were being 'left out of the loop' or were 'missing a piece of the puzzle'

sought clarification of their perspectives through Reading the Room or Navigating

Hierarchy to get more information. Study participants looked for environmental clues,

doublechecked behind other team members, and communicated with others to get the

information they needed to understand how best to respond to IAEs. The most common

strategies identified by participants during Reconnaissance were Looking for Clues and

Seeking Clarification.

Looking for Clues. Most study participants looked for clues when they noticed or sensed

something was wrong during a case. Participants paid increased attention to

environmental cues such as patient monitors and to nonverbal behaviors of other team

members to achieve heightened awareness during developing IAEs. Looking for clues

often allowed study participants to discover objective 'proof' of problems or potential

problems that supported their perception of needed interventions. Many participants were

able to troubleshoot problems found through looking for clues and avoid involving team

members at the sterile field. One study participant related the following:

> I think it's more of the tension, you kind of read how the case is going and how
> they're acting. Like when you go into a CV room and there's no music and it's
> quiet and they're on the pump and everybody seems tense. You're not going to go
> in there talking loudly or that kind of thing. It's just, I guess I get the cues from
> body language and how people are talking, how the room feels. I think that's
> about it. I mean, I don't really look at much else for communication. And then
> you can also get it from if you're giving someone a break or that kind of thing,
> when they start to give you a report and how they're talking and if it's more frantic
> or if it's quieter or louder, or that kind of thing, you can kind of get cues there
> also. (…) I usually talk to the circulator. The scrub seems to be busy

usually. Like, especially if you're not sure if something's going wrong, they're probably right in the middle of it. So no, I just usually talk to the circulator and then just try to read out how they're acting. I don't necessarily do anything different. I mean, obviously if they start asking for things or whatever, jump in there and get it. But other than that, I probably just like, stay quiet unless they need help. (TN13, Pos. 53-55)

Seeking Clarification. While Reading the Room often provided the heightened awareness needed to respond to an IAE or potential IAE, study participants frequently needed to obtain additional information from other team members. Some participants were uncomfortable with asking questions they 'thought they should know' and made assumptions to guide their actions. Inexperienced study participants avoided asking particular team members questions directly, and instead chose other team members based on their perceived receptivity or reactions. Two participants related the following stories.

> I definitely would probably stick with asking either circulator or nurse. Even if I didn't know them very well -- just because I knew that they knew I was learning. Not all the time does the surgeon realize who's an orientee and who's not and (it's the) same with anesthesia. So, I would probably feel the most comfortable with sticking to someone who I knew I was learning. And (knew) <u>that's</u> why I was asking them questions. I would probably obviously go to someone who was orienting me that day and who was kind of in charge of me already. But I would feel comfortable probably with asking anyone who was a nurse or scrub. (…) Well, I think one of the things that I've kind of found, I just ask questions about everything, but sometimes the people orienting us don't realize the most basic things might not be something we know. And even like, maybe they just think, because I'm an experienced nurse, I know some things, but you know, it's a different hospital. Things work differently and the OR is like a completely different ball game. (TN15, Pos. 96)

> My feeling on it is I think the surgeon and nurse relationship is really important, because if the nurses feel comfortable around a doctor, they're more likely to speak up or ask a question. But if the nurses are like scared of a doctor, then I think they're less likely to speak up about something or ask a question if they're unsure, because they don't want to get yelled at. (One time) there was a trauma in the ER in the evening. It was a gunshot wound and they had the chest open in the ER, the kid was basically actively dying. They didn't even have time to bring it up to the OR. And the surgeon asked for a sternal retractor, and I didn't know how to assemble one and I was freaking out and I was too scared to tell her that I didn't know how to assemble it. (…) Luckily (another nurse) was there and she

101

saved me. She just kind of figured it out, but I remember freaking out, because I didn't know how to put it together. I asked the resident, or the fellow, and he was kind of busy working and he couldn't really put it, assemble it. Luckily (the other nurse) was there and she was able to do it for me. But if not, I would have either assembled, handed it up to her wrong - assembled wrong, or had just had to tell her, I don't know how to assemble it and she probably would have had to stop what she was doing and do it herself. (TN8, Pos. 27-29)

Communication while Rallying

Rallying is calling upon surgical team members to coordinate the necessary actions to respond to an IAE or potential IAE. Study participants rallied to align team priorities and to delegate important actions during IAEs. When participants rallied the team, they experienced heightened communication and redirected focus to the patient. Because rallying often includes bringing additional team members in to meet the increased task demands during IAEs, some study participants perceived rallying as a lack of ability to handle the situation or even as a failure. Three common strategies during Rallying were Getting Everyone on the Same Page, Giving Everyone their Piece of It and Getting Hands in the Room.

Getting Everyone on the Same Page. Getting everyone on the same page is relating information to align the surgical team's priorities. Aligning priorities to update the team's mental model is often the first step of rallying to respond to IAEs. Participants described their experiences with the following stories.

> And I think sometimes it goes to what I think is the core of most nurse-physician problems, which is the most important thing in one person's head may not be the most important thing in the other person's head and may not be the most important thing in the group of things that needs to happen in the room. Even though it's the most important thing on your list. Like going back to intubating. The most important thing in the room then is when he's putting the tube in. It might be important in my line of stuff that I have to answer this page, but that's probably trumped by what he's doing with listening to the heart rate and sticking the tube in and listening for breath sounds. That probably is more important than

me calling the social worker back on my pager, even though that is the thing that I have to deal with most immediately. (TS2, Pos. 59)

There was good communication because the surgeon team talked to the anesthesia team and said, this is what we're seeing. He stood up, assessed, and just immediately came up with a concrete plan with bite-sized pieces that were integral, but they were stair-stepped and in order of what needed to happen - very clearly with each person directed to a job appropriate to their station and immediately calling for the assistance of another two sets of hands, get the resident in the room, have them immediately mix up the nor-epi. You get me this pentobarb. Get somebody else from out there and start reading in three units of blood. So, he gave everybody concrete things to do. Very calmly, mobilized two extra set of hands into the room. And everybody had a job to do. Everybody knew what they were doing in what order. And it worked out very nicely. (TS2, Pos. 35)

Giving Everyone their Piece of It. Giving each person their piece of it is specific, directed delegation designed to make the best use of team members' skills and abilities. Directed delegation is critical during IAEs because often emergent needs are 'duties' that could be done by many of the people in the room, but if the duties are not specifically assigned, there's a possibility that either many team members or no team members will attempt to do what is needed. One participant described how directed delegation allowed the surgical team to respond rapidly in a critical situation.

We were operating on a very high grade and arteriovenous malformation (AVM) on a patient we all knew pretty well. And the patient had been embolized before the surgery and the first iteration of those embolization materials were very stiff materials. And so sometimes when you came around the bottom of the AVM, as you manipulated it, because the stuff wasn't soft, it would maybe tear through the vein. And when doing an AVM the last thing you come to is the veins because if you clamp the vein off first, the AVM kind of explodes in your face. So, this particular patient, we had come all the way around the AVM. We were working underneath it. And as we were manipulating it, one of those things tore, and I'm not kidding, the brain came puffing out of there like the Jiffy Pop popcorn on TV twenty years ago. And we looked over at anesthesia and the anesthesiologist was an incredible guy, very, very good. And (he was) one of the attendings, he is very skilled, very good, very calm. Had seen everything, done everything, whatever. And we just turned and were like we've got a torn vessel and we've got some bleeding here and the brain swelling. And he just kind of walked up, or he was seated in his chair by the anesthesia machine. He kind of stood up, looked over

103

the thing and then just very calmly looked over at the circulator and said, I need three syringes of pentobarb. And he said, get my resident in here right now. And the resident came in and he said, mixed up a bag of epi right now. He said the blood pressure's going to drop. And he turned to the circulator and said, go grab somebody out front, bring three more bags of blood in. And he said, I'm going to push. And the circulator by then was back with the three syringes of pentathol. And he said, the blood pressure is going to drop. He said, we're going to put the head down, you guys hold the brain. And he said, all right, I'm going to administer the pentathol. He's like one going in, two going in, keep telling me the blood pressure out loud and the resident's reading (those numbers). And he's like, I've got the epi strung or I've got the nor-epi strung up. And he basically shoved in three grams of pentobarb. I'm sorry, three syringes, which was 1500. And we just watched the brain deflate like a soufflé. Blood pressure - absolutely tanked out. And the nor-epi drip was right there ready to go and boom, boom, boom, boom, boom. Up came the blood pressure. And the circulator or the scrub already had the (aneurysm) clips up in that. And we were then -- because there was a blood pressure and we weren't having to worry about doing CPR, we're able to very rapidly come underneath the thing (AVM), get it. We were actually able, we kind of kept working as the blood pressure dropped because when the blood pressure is lower there's less bleeding. And we're able to remove the last of it. And then basically I think everyone stood there for a few minutes and waited for their heart rate to come down. (…) But what was so incredible about that was communication wise is he was very direct. You know, again, it was a bad situation. We communicated to him, he stood up, he looked at it and immediately grasped what was going on. And he did what they always talk about that you're supposed to do in codes. Right? You know, you don't say 'get this' and four people lunge for it. Of course, there aren't that many people in the OR who could do that even if there was. But he was very direct about, I need this many syringes of that. I need a resident. Have him come right here right now. I need you to mix up an epi drip or nor-epi drip, be ready to start this immediately because the blood pressure will drop. You know, you've handed me these syringes. I need you to be reading blood in as we have ongoing blood loss. So, I want you and you to go take care of that for us. And it was very interesting because it was handled so nicely. I mean, it was horrifying. I mean, because you know, it was just watching the brain kind of explode out at you thinking, oh my gosh, she's going to die now. And he took something that was just catastrophic and with very calm, very, very directed and concrete things to do, never missed a beat and said, this is what I need each of you to do. We're going to do these things in this order. You watch for this, you watch for this, you start this if this happens and boom. We were good. So that's my good one. (TS2, Pos. 31)

Getting Hands in the Room. Getting Hands in the Room is the process of getting extra

help in during an urgent or emergent situation. Although all surgical team members have

the responsibility to rally the surgical team during IAEs, not all study participants felt like

they had the right to rally others. Some nurse participants were nervous about calling

codes even when it was obvious to them that anesthesia providers needed help. Having to

call a code can often be experienced by anesthesia residents as a 'failure' because it

means their supervising anesthesiologist and many other providers come into the room to

help. One participant related the following story.

> Yeah, I've been in a couple of cases where it wasn't like the patient's coding. Like we're not having to do compressions, but I have been in a couple of rooms where maybe our patients starting to de-sat really quick in a spinal surgery and our pressures have started to drop. And some people are kind of like unsure when they're in that, should I pull the code button? Should I not? And I've been in the room when there are people with me and they just look and they say, just pull it just in case because that way you do get those other people there. And when they come in it adds hands and they're faster to help. And then it's better safe than sorry. You know, I'd rather pull the button and too many people come in the room rather than to not (call a code) and would have needed it. (TN10, Pos. 11)

Participants in this study who were scrubbed during procedures often relied on those not

working at the sterile field to summon additional staff to help during IAEs. One

participant identified struggling to get the help the surgical team needed into the room.

> So, we were doing the operation and the anesthesiologist was a resident, to be honest with you, that we were a little uncomfortable with. So, all through the case, he kept re-inflating the endotracheal tube. And we were like, what's going on? Well, there was a leak. And we're like, that's a lot of air you keep putting in there. No, it'll be fine. There's a leak. There's a leak. And we had the front bone, which means the spinal cord was exposed, retractors were in place and the patient started moving and desatting. They couldn't ventilate the patient. And so, my staff and I are like - *call anesthesia*. So, my staff is kind of looking at this and I said, call the anesthesia staff and the resident is like, no, no, no, I got it. And I'm looking and the stats are going to sixties, fifties. And the patient is clearly awake. And my attending is laying over the patient to keep him on the table. And he just kind of quietly says, call for a trach tray. And so because we weren't ventilating and wouldn't get, the patient was tanking, patient was moving. Clearly the patient was becoming hypoxic, and it was apparent the patient was awake under there. And so, we said (to the circulating nurse), hey again, <u>call</u>. And so, the resident for anesthesia goes to the nurse, he goes, no, no, no, everything's fine. That's under control. And we're like, no it's not. Basically, our room was across from the anesthesia front desk. And I went over, I was still scrubbed. And I started kicking the door until someone came to the door and I said I need a bunch of people in

here right now. And they came in and basically the patient had to be reintubated. What had happened was that ET tube had been filled with air so many times that the cuff had herniated around and was occluding the bottom of the tube. So, the patient was a gas - or the patient had a gas anesthetic. So that's why the gas wasn't going and that's why the patient was lighter (receiving less anesthetic gas). (…) So, I think again, in that one, it was interesting because, and I don't know if this is the kind of thing you're looking for, but communication wise, we were very clear and very urgent. *You've got to call the anesthesia staff* and then the anesthesia resident was like, 'oh no, everything's fine' to the nurse. And she hung up the phone and then we're like, no, you have to call. And then by then we needed the trach tray. So, like I said, the form of communication was then me kicking the door to get someone's attention while my attending was holding the patient on the table and trying to keep the guy from becoming a quad by moving around with an unstable spine. Because again, the bone was out, and he was trying to sit up and the nurse was running for the trach tray. So that's my bad one. It ended well, that was really pretty horrible at the time. And I think it highlights too, sometimes the conflicting information you get from two different teams with somebody else in the middle. When one person is saying it's an issue and the other one (saying it) isn't, and that leaves the person who's being directed to make a call, which is kind of unique to the OR. Right? Because otherwise I could pick up the phone and say, I want this person in here except (that) I'm scrubbed. And you have to have this proxy communication. Right? So, it is a situation that is unique to proceduralists or the operating room whereby you have to have in something like that, where it's so time sensitive, but yet you're not the one making the call because you can't, you didn't break scrub because you don't know if you're going to have to immediately stick your finger in there and do something. But yet getting that message out is very difficult. You have to get that message out. And like I said, unfortunately I resorted to the lowest possible form of nonverbal communication, which was kicking the door because I couldn't yell loud enough through the door. And there were other things happening in there. So, I just kicked the door and the person sitting at the desk was a couple feet away from me and they immediately jumped up and came in. So yeah, that one was interesting (TS2, Pos. 7)

Communicating while Reacting

Surgical team members rally to coordinate an informed response to IAEs; that response is the team's reaction. Reactions include correcting mistakes, stabilizing the patient, troubleshooting problems, and responding appropriately to the priorities of other team members. Two common strategies used during the reaction phase were Doing the Dance of Surgery and Switching Gears.

Doing the Dance of Surgery. The coordination of purposeful, independent movements within the shared space of the intraoperative environment has led to the surgical process being compared to a dance, and this need for coordination increases during IAEs. Participants in this study increased communication to make their next actions evident to other team members and 'took turns' to allow providers in other professional roles to perform actions to stabilize surgical patients. One surgeon related the following experience.

> We made the final decision to kind of turn her a little bit on the operating room table and do a laparotomy in addition. But when we did that, we found that her left kidney was essentially mangled - it was just busted off from her renal vein. And that was just pumping blood into her abdomen. We got control of that. And then I got my hand in her abdomen and actually to be able to put it up into her chest. She had a traumatic rupture of her diaphragm as well. And once we got control of the kidney bleeding and got that taken care of, we were able to sort out what the problem was with the diaphragm and control that. And all along the communication was great between us and anesthesia because you know, we have to be. You know there's always sort of this dance back and forth about are they doing okay? Right? Because if they are bleeding and the anesthesiologists can't catch up, a lot of times, what we can do is just sort of pack off the area with lap pads and hold pressure there for a little bit of time, until the anesthesiologist can get their blood products and things like that into the patient and get their blood pressure up. And that's where we can go back to work and try to figure out where the source is. So, there was that sort of dance back and forth a little bit during the operation where she would be like, oh, this patient's really hypertensive. And I need a little bit of time to get some blood product in. And so, we would stop and just hold pressure for a while. Let them put some blood and fluids and stuff like that in and the patient's blood pressure would come up and I'd start working again. (TS4, Pos. 24)

Switching Gears. Responding effectively to IAEs often demands a 'refocus' for the surgical team. Surgeons deliberately changed the tone of the intraoperative environment to reflect the need for an increased focus on the patient and performance of any actions that were needed. One study participant described how he changes his tone when he feels it is necessary.

I think the way that I (under normal circumstances) communicate with everybody, everything is calm and very relaxed and understanding. And when things change at the operative field and I have become terse and direct and loud, I say, turn off the music. *Everybody focus*. There's never been a time where people have been like, yeah, whatever, man. So, I think that dichotomy of operative tone is pretty important. I mean, I know there are some surgeons who are constantly upset and like, this is wrong. Everything's going to happen. And they use very jolting, just, tones. And not even that they're mean or anything. It's just that they're very abrupt. The music is off. It's very quiet. And I think that if that's the way you operate, sometimes it might be harder for people to understand that there's a real problem when there is a real problem. (TS3, Pos. 54)

Communicating during Resolution

Resolution includes interactions or actions taken after IAEs have been addressed. Many study participants reflected internally, debriefed with specific team members, and debriefed as a team to understand the trajectory of IAEs. Some IAEs also required disclosure through incident reports and root cause analyses with hospital administration. Most study participants felt these shared explorations of IAEs were beneficial and informative and said they often led to individual or group practice or process changes. One participant identified how miscommunication led to a reportable IAE.

> Yeah. Recently, we were doing a cranial reconstruction. All those kids have to have ultra-fresh blood. There was a, Kxx was circulating, Lxx came in to give her lunch, or break, something somebody did, and she said, the blood is on its way. The blood came while Kxx was gone. (When she came back from her break) the person told Kxx, the blood is here. It's good. It's in the room. They left. We're doing a timeout, Dr. Bxx says, what kind of blood do you have? Kxx say, I have ultra-fresh blood. She said, Great. About an hour later the anesthesiologist wants to just check the blood in to make sure that it's checked in. Opened the cooler - it's not ultra-fresh. The person giving her the break said the blood was here. She heard her say it was okay, but she didn't really double check. Neither one had communicated that. I was in there, and I said, let's make a quick phone call. I said, we also need to tell the surgeons. We tell Dr. Bxx, we tell anesthesia we don't have the right blood. Lxx may tell you about that one because that one was pretty significant. We called the blood bank; we got the right blood. Got it over. I think they waited for a few minutes, but that was a mistake and a communication error, probably. Kxx goes, what do I do? And I'm like, umm. She's like, they told me it was ready, and they told me it was okay, but it wasn't, and I said, Kxx, you have to look at it every single time it comes in

108

here. You can't trust anybody. So, then I said, you have to call blood bank. You have to tell them you have the wrong blood. You have to fill out an incident report, figure out why we have the wrong blood, and send it back and get the right blood. And I said, we also need, I said, Sxx, we need to tell you that we don't have Ultra-fresh blood. And she's like, well, in the timeout you told me we did. I said, I know that we did, but we don't. And there was some miscommunication, big time, there. I think there was a miscommunication and a misinterpretation. You know? I don't know why I think it was Lxx, but I feel like it was. Hey, I just got your blood. It's here. It's good to go. Kxx *interpreted* that as, It's Ultra-fresh. It's what I ordered. It's here. It's good - and didn't look at it. (…) After the case) we talked about it. We went back and talked with the person, I think it might've been Lxx, talked with her, and then it became a big, big deal with our team. Going over it again and how you have to look at it. So now the whole process has changed because of that. Instead of saying, we have two units of blood, during the timeout, the cooler's opened, they take it out, they look at it, they read it, and then they put it back in. Even if they've already done it, they do it again. So, because of that incident, no harm was done, thank goodness, but because of that we do that process now. (TN3, Pos. 37-43)

Another participant described being involved in a sentinel event.

(The attending surgeon) stayed for a while to help with the closing, but the count was just beginning because there was a lot of stuff to count. Anyway, he did ask if we could do final timeout after he broke scrub to go talk to the family. Well, I said to him, I can't do a final timeout because we haven't completed our count. At that time, I think they were done closing fascia. He went and talked to the parents and then the fellow continued to close as the second circulator and the scrub were continuing to count. The sponges and needles had been done first, and the wand, and all that, and that was fine, but the instrument count took much longer than it took to close. They were continuing to close skin, and at that point, the skin was not completely closed. The fellow was notified that there's a missing instrument that we can't account for. (…) The scrub said, we're missing a piece of the Bookwalter (surgical retractor). Then they said, okay, but they continued to close. Then skin was closed and the scrub and the second circulator, and by this time, I'm involved, and we actually had some outside help come in to try to help go through the trash and the linens and make sure, because it wasn't a very big piece. Then she said, the scrub nurse said, we can't find this piece. I don't know where it is. The fellow said, Well, all right. Well, let's get an x-ray., which we did. Nobody was really expecting to find it there, but the x-ray revealed that there was a retained instrument. Then, the pediatric staff surgeon was notified and came back, and the patient was reopened, and the object was retrieved so the count could be reconciled. Then they had to re-close the patient, and by this time, the staff surgeon was back in the room. Actually, he was grateful that it was found in the operating room. (At the root cause analysis) I would say that the core team, the people that were at the root cause analysis, or whatever you call it where you have to map up your plan about how to fix it, were the director, a hospital person, and

they weren't an attorney but some specialist in this sort of thing that kind of ran the meeting, and then the staff surgeon, and then the three core nurses that were in there during the procedure. Then the staff surgeon was very, very, very supportive of the nursing staff, felt they did the right thing, and he was like, I don't even see why this is 'never' incident (sentinel event) because it was resolved before the patient left the room. That was a moot point because apparently, it's considered that anyway, so it met the criteria. No, he was very supportive of the nursing staff, very open with the director and the hospital specialist. I don't know. I felt very supported at that point. (TN1, Pos. 93)

Psychosocial Goals

Two psychosocial goals often achieved by Testing the Water appeared consistently throughout the study participant interviews. Participants in this study used conscious and subconscious communication strategies to preserve the flow of cases and to protect the 'face' of themselves and of other surgical team members. The psychosocial goals of preserving flow and protecting face were indicated to be the underlying motivations for many of the described communication strategies of interprofessional communication during IAEs.

Preserving Flow. There is a rhythm in the operating room when things are going well; it has been described as flow. An exploration of flow began in 1975, when Csikszentmihalyi identified a state of optimal functioning that included intense concentration, a loss of reflective self-consciousness, and a distortion of temporal experience (Nakamura & Csikszentmihalyi, 2014). Participants in this study experienced both intra- and interpersonal flow in the operating room and indicated reluctance to disrupt existing flow states when it could be avoided. This reluctance to disrupt the flow states of surgical team members was often demonstrated through delayed or deliberately timed interprofessional communication, especially when the need for communication conflicted with difficult parts of surgical procedures. Study participants experiencing

intrapersonal flow often indicated their increased focus and distorted temporal experience

as producing decreased awareness and increased response time to developing situations

outside of their immediate tasks. One participant related details of a case where the

attending surgeon appeared to be unaware of what was going on outside of the surgical

field as he was operating.

> And so, this continued, and people are uncomfortable and there's a lot of tension in the room. And I don't know if the surgeon knew about it or if he was so focused on the operation in front of him, that you can be oblivious to it. And that's very easy to be oblivious when you are hyper focused on one thing. That's so easy that I've had days where like I blink after ten minutes and I throw out like, wow, I forgot to blink because I'm so focused on taking out this tumor. (TS1, Pos. 5)

Protecting Face. Participants in this study also navigated interprofessional

communication with the goal of protecting face, both for themselves and for other

members of the surgical team. Face has been described as situational personal standing

that may be achieved or ascribed, and that can be lost when an individual fails to meet the

expectations of his or her position or role (Ho, 1976). Study participants experienced a

continuing awareness of protecting the face of others and of themselves during

interprofessional communication. This awareness resulted in communication that

considered and respected the rights and responsibilities of other members of the surgical

team. Nurse participants often were apprehensive about asking questions because of their

perceptions of potential responses from the surgical team. Many study participants were

wary of asking clarifying questions regarding surgeon preferences or unfamiliar

instruments; this was identified as being particularly true when they felt they 'should

know' the answer. Two participants shared the following stories.

111

I was going to say maybe if people are afraid to ask a surgeon to clarify something, but I don't know how much of a problem that really is. Like a fear of getting yelled at or belittled or whatever. (TN8, Pos. 53)

Depending on the surgeon, I have seen some be a little bit more temperamental than others. So that's always a factor. It's just the surgeon that you're working with, (you) can feel more comfortable asking (questions) with others than with them. It's hard to think just because, I don't know, they have all this additional schooling and you're there to make sure that they have what they need. And sometimes you feel bad if you don't have it, or if there's something that you feel you should know at that point, that you don't. And you have to ask about it and you kind of feel stupid for having to ask that question that you feel you should know. (…) Yeah, but on those (questions) I usually ask the nurse. Just (say to them) -- I know I should know this, but I can't remember. (TN14, Pos. 119)

Other study participants experienced situations where team members provided incorrect information to the surgical team instead of admitting a lack of knowledge in order to save face, as demonstrated with the story below.

I had a case one day where the surgeon wasn't around and anesthesia, it was like an elbow or fracture or something, and anesthesia was wondering whether or not the surgeon needed paralysis. So, they wanted to see whether or not they needed to intubate or just do an LMA (laryngeal mask airway). And so, they ended up asking the resident and he just told them that they didn't need paralysis. So, they just put it in an LMA. And I think he was just kind of guessing -- he wasn't really, he didn't say I don't know, let me ask. He just told them. And then the surgeon came in and they actually ended up needing paralysis. And so, they needed to intubate. So that was a little rough because now they're going to have to switch their airway. They're going to have to change their plan for the anesthetic. And it totally could have been avoided had he just said, I'm not sure. Let me ask or let me verify. You know? I think the surgeon like walked in and noticed and then was like, said something about they need paralysis and I'm pretty sure anesthesia said, we asked the resident. Something, like we asked the resident, but he said he only needed LMA. And they were like, I don't know. It's hard to remember, but you could tell they (the surgeon) were frustrated, but I think he was more frustrated with the resident than the anesthesia obviously, because it wasn't really their fault. Then (the surgeon) just told (the anesthesia provider) that we're going to need to switch it. (Interviewer) Did you see a conversation between the surgeon and the resident about this? Like did they talk about it in the room? (Participant) I didn't hear it, but I saw it and it didn't look pretty. (TN10, Pos. 47-49)

Facilitators and Barriers

Another stated goal of this study was to identify and explore participants'

perceptions of the facilitators and barriers to interprofessional communication during

IAEs. The perceived facilitators and barriers are explored in the following sections

through excerpts from study participant experiences.

Facilitators

Participants in this study identified many facilitators of effective interprofessional

communication during IAEs. Facilitators mentioned by participants included setting the

stage, looking down the field together, using backup behaviors, initiating purposeful

pauses, using directed communication, using closed-loop communication, and

encouraging input from surgical team members.

Setting the Stage. Setting the stage is when a member of the surgical team provides or

updates the TMM to help surgical team members understand what is happening and what

actions are required of each member of the surgical team. Setting the stage is critical in

situations where inexperienced team members might be unsure of what is happening or of

the specific order of actions that are needed to stabilize a surgical patient. Setting the

stage also allows for a more informed inclusion of additional unit staff who come into an

operating room to assist during IAEs. Two study participants described how Setting the

Stage improved communication during their cases.

> The sinus bleeding where you're like, okay, put your finger on this. All right.
> Okay. Situation is controlled. And then again, you set the stage for what happens
> next. All right. Anesthesia do you have blood ready? And again, I need everybody
> paying attention. Okay. I need you to make me a little roll of thrombin gel foam
> powder and load sterile Nurolon sutures. And I need you to stand there in case I
> need anything else. So, let's just all pay attention and do this part here. So yeah, I
> don't know. But yeah, sometimes I think all of us are guilty of tunnel vision.
> Surgeons included. (TS2, Pos. 83)

And then they know that communication has been established. They know, okay, if we're doing an emergent trach and I've never done an airway trach case that my surgeon can shout out what he's going to need next, or she (can) -- before it's needed. So, I have a chance to -- if they know I haven't done it, then they know I'm not gonna have any assumptions on what's next. They need to tell me. So that helps then they can communicate with me better so I can help them. Help me help you. (TN11, Pos. 84)

Looking Down the Field Together. Looking down the field together is when an experienced member of the surgical team provides information surrounding the proposed surgical plan that emphasizes the goal of providing care through coordinated teamwork instead of role-based task work. Looking down the field together also encourages recognizing team member interdependence and the importance of collective focus on delivering safe, efficient patient care. One surgeon reported how he attempts to provide an accurate mental model for even the most inexperienced or peripheral team members.

I would encourage surgeons to break up their procedures into component parts and then write them down and what resources they're going to need. I have anecdotal evidence that that limits the amount of unnecessary things (surgical supplies and instruments) that are opened, decreases cost, and facilitates an understanding among the surgical team that everyone's on board with the procedure. And I would encourage physicians mostly to have more collaborative relationships with everyone in the room, not just the anesthesiologists, but the anesthesiologists, the nurses, the techs, the students, everybody. Everybody needs to be engaged and onboard, and all looking down the proverbial field together to accomplish the most safe surgeries. (…) So, for these big complex cases that have infinite different little steps that nobody knows how to do and everyone's very anxious about, (I) actually send out a Word document the day before, a couple of days before, that has every single step and what we're going to need. And if anyone has any questions about that, I'm available to talk about it at any time. And that actually gets printed out and put on the wall. And then we look at it and refer to it constantly. And then I use an intraoperative whiteboard where I write up all the steps in less detail, but still like a component step of the procedure, like, this is incision, paraspinal muscle dissection, bone removal, dural opening, tumor resection, dermal closure, you know, that sort of thing. And then what we'll need, what resources are we going to need? Are we going to need the CUSA? Are we going to need Tisseel, DuraGen, Surgiflo? What are the specimens? Write the specimens up there. And that way everyone feels like they're part of the procedure. They know what's going on. And when the support nurse comes by to

say, where are we at (in the procedure)? And they say, We're at step six on the board of twelve. And that's how we're moving down (TS3, Pos. 46)

Using Backup Behaviors. Participants in this study identified implementation of backup behaviors as essential in preventing adverse patient outcomes in the intraoperative environment. Backup behaviors included providing relevant information or performing supportive actions that assisted others to perform their professional roles. Backup behaviors were even more critical when less experienced surgical team members needed support during IAEs. One surgeon identified how backup behaviors prevented a potential sentinel event.

> Everything's fine, patient's intubated, and I turned the child's head to start to position him. And so, the (normal sequence of) positioning, as you are well aware, is you position the child, and then I was going to use stealth, so intraoperative navigation to also mark out where this thing was and where I wanted to be and so I knew inside of the child's head where I was. And then (usually) after we do all that, then we clip the hair, mark the skin incision, and finally we do a timeout to confirm the current patient, the operation, the sidedness. And so, after the child's intubated, has the lines in place, I turned the child's head and start to get positioned. And the anesthesia fellow said, are you sure that's the right, like I thought we were doing the other side for the operation. And I stopped, I look at the child, I look at my images and I say, you are absolutely correct. Thank you for pointing that out to me. (…) It has changed the way that I do my timeout in that I do my timeout <u>very</u> early. I don't do it when the drapes are on. I now do a timeout before the child is prepped. Initially I would kind of say yeah, we can agree this is the correct side. Now I will make my scrub, my circulator, and my anesthesiologist all confirm this is the correct side of the child that we are operating on. And so, this event of which I don't know if the terminology is 'near miss' because it *wasn't* a near miss. We had several steps to go before it became a near miss. But this event that was very powerful and it has changed in that I will now <u>over</u> communicate about the sidedness of the children that we are operating on probably for the rest of my career because of this event. That's it. (TS1, Pos. 31)

Another experienced participant described how she used backup behaviors to support an inexperienced surgical team attempting to manage an emergent IAE.

I walk in the room and literally I see blood pouring out of the kid's mouth and running down the side of the table like you've never seen before. And this poor girl (as a new nurse) is there by herself. And the resident had gotten into like a feeder vessel for the carotid on one side, trying to take out the tonsil and in retrospect we found out that it was, what did they call it? Like an aberrant carotid feeder or something that was basically in a place where they didn't suspect that it would be. (…) you know, everybody's running into the room, and it was just like you know, get another suction, hold pressure. And we ended up having to go straight to IR (Interventional Radiology). And I just literally -- and this actually was when one of our surgeons was a little bit newer and I'm going to say it was probably like within his first three months of being here or something, the staff surgeon. And it was later in the evening and probably getting time for me to be going home or whatever, but I just remember thinking I'm not going to leave, especially because this guy is pretty new. A lot of people don't know him here. I want him to feel supported and feel like he has the help that he needs and stuff. (…) And I remember just trying to reassure my (nurse) orientee because she was horrified and didn't know what the hell was going on, you know? And just reassure her that, I mean, clearly it wasn't anything she had done wrong or whatever. And then just paying attention to that that staff surgeon who was fairly new and just trying to support him and get whatever we could. (…) There were a lot of people that were able to come in the room (to help), but you know how you can just tell that somebody is pretty nervous about something, even if you don't know them real well. I could tell that this guy was really probably freaking out and then the resident was almost in tears. He was so, so upset about it because nothing like that had ever happened to him before. I remember like some of the girls hugging him and just while we were in IR kind of like consoling him about the fact that this was even happening (TN12, Pos. 53)

Initiating Purposeful Pauses. Surgical procedures often feel very driven by timing, tension, and tone. The initiation of purposeful pauses allowed study participants to adjust their mental models and better prepare for needed actions during IAEs. Some participants deliberately paused before performing actions that would require increased coordination of the surgical team. One surgeon related the following story.

I was concerned about opening the dura that there would be circulatory collapse, that the heart rate would stop, they would go asystolic. So, with that, the whole room was aware of it because I might need a circulator or someone to do CPR. I needed anesthesia to be aware, so they could have the drugs. So, there was a pause before I did the movement that I thought could stop the heart. So, there was actually a little timeout in the middle of the operation and things were less harrowing. (TS1, Pos. 45)

116

Using Directed Communication. Navigating the arrival of additional team members to assist during IAEs can be problematic due to the duplication of professional roles, lack of clarity about responsibility delegation, and the use of non-directed communication one study participant described as 'yelling into the void'. Yelling into the void is when delegation or requests are non-directed, and the speaker cannot be sure that they were heard or will receive the response they need from the communication. The opposite of yelling into the void is using directed communication. Directed communication is accomplished by using the recipient's name or, when that isn't possible, assigning responsibilities by role. When directed communication was not used, study participants often tried to guess what support was required and needed actions were missed or efforts were duplicated. Many participants related stories where directed communication played a role in the experienced IAEs.

> And I feel like the last time I was in sort of that situation -- that people were more concise with what they need. At least the last time I was in a situation, like the anesthesiologist looked at me and said my name, and then, I need whatever. Not just a general, hey I need this when you only have one other person in the room. And I feel like when we're in trauma situations, people sort of fall into, I'm going to be the runner person, I'm going to be the person that does the charting, I'm going to pay attention to the scrub person. I feel like we have dedicated people to what we're doing and it's not like always people go, I want you to do this, you to do this, and you to do this. People just sort of feel or see that there's a need and then that's what they start doing. (TN4, Pos. 53)

> Honestly, in any kind of trauma, emergency situation, to me, consistently the biggest problem is too many people in the room and I think everybody thinks that they need to be in there to help, but that's like one of the biggest problems I think we have, is having too many people in there and somebody will yell out for something and three people are scrambling to get it, or nobody gets it, because someone thinks somebody else is getting it. So, I think what we really need to work on in our code situation is turning to somebody and say, Johnny, I need three vials of epi. Kelsey. I need four packages of laps. Dr. Anesthesia, I don't know your name, but I need you to hand me that cord behind your back. Like people speaking directly to each other I think, instead of just kind of yelling out loud, like, oh, I need three more packs of sutures or this or that. I think talking

directly to a person, calling that person by name, which obviously that's helpful since we all know each other, but we, in our OR, we have so much turnover. There's a lot of new people, like the doctors don't know the newer people, or if the OR is helping out in cath lab, the general surgery nurses don't know the cath lab nurses by name and so forth. (…) But I think the turnover causes a problem, because people don't know each other and so you can't always call somebody by name. I think the biggest help would be calling somebody by name. (TN8, Pos. 53)

Using Closed-loop Communication. Closed-loop communication was indicated to be critical to effective IAE response by many participants in this study. Closed-loop communication includes a specific message, an acknowledgment by a recipient called a 'check back' that includes relevant details from the original message, and then a verification by the original speaker that the interpretation of the recipient was correct (Davis et al., 2017). Closed-loop communication is important during IAEs because it ensures that the message has been received, understood, and that appropriate actions are being implemented. A participant reported how closed-loop communication improves IAE responses.

> If it's tense case we're not chattering or we're not needlessly conversing. But you know, if they're focused and they're in there (at the sterile field), I'm not going to disrupt them. I want them to be focused on that patient because that's what's best for that patient. (But) when they've got bleeding and then yeah, (the scrub is) yelling out what she wants. (…) But if it's a tense emergent (case), then yes, you're communicating, you're saying it loud and proud. So, people hear you and I'm repeating it back to them. So, it's clear who in the room is getting that. You know? So (the scrub) asks for laps, okay, I'll get them. I'm communicating back. So, she knows I heard her, and I'm focused on her and everyone else in the room knows not to waste their time getting laps because I'm doing that. But if it's a very delicate thing and then if she needs suture, then she might hold her packet up to me without saying anything and I'll know she needs her suture. And so, I'll grab that for her, and you know how it is. (TN11, Pos. 80)

Closed-loop, directed communication was identified as being especially important when less experienced team members were recruited to assist during IAEs because it facilitates

a better understanding of the TMM and allows even inexperienced team members to accept responsibility during unfamiliar situations. One study participant described being able to fulfill responsibilities based on her abilities specifically assigned to her by an experienced team.

> I don't remember why the kid coded, I think it was a pulmonary embolism or something (like) that, but I remember the code being successful and going very well because of the communication that I witnessed. And even though I wasn't an experienced nurse and I felt I wasn't -- I didn't have a lot of help to offer -- it ended up being that I *was* able to help a lot due to the correct people being in that situation. So, what I witnessed that went really well was that everyone was communicating very clearly and efficiently and making eye contact and pointing to people and saying, you go get this, you go get this. Anytime I heard anesthesia talking to the doctors, they would say, how much volume have we given? They would reply with, I have given this much volume. This is what we gave. Very concise, to-the-point closed loop communication, which was wonderful to see (TN9, Pos. 5)

Encouraging Input from the Team. Another facilitator to interprofessional communication described by participants in this study was when surgeons actively encourage input from surgical team members, including questions. One participant identified how communication culture in the intraoperative environment can impact newer team members' ability and willingness to ask questions.

> I just feel like I wish that some people wouldn't be so afraid to ask questions, but I think it's also kind of like a culture thing with the way that some surgeons or residents kind of address people when they do ask questions. I just sometimes wish that people would be a little friendlier and more welcoming to questions. (TN10, Pos. 39)

Another nurse described how a surgeon she works with deliberately builds a culture of communication safety through an introduction of all surgical team members at the beginning of the case that includes a reminder he is receptive to team member input.

> I think being able to feel like you can communicate with someone I think is really key here. Making it an environment where it's safe. In our timeouts with (this

119

particular surgeon) at the end of every timeout he goes, *this is a team*. If you see something, say something. Speak up now, or even throughout the case. Say something. Oh, my gosh. Talk about a transformation (of the culture), in my opinion. (…) He just does a nice job. He asks for help. (TN3, Pos. 158)

Barriers

Participants in this study experienced many barriers to interprofessional communication during IAEs or potential IAEs. Reported barriers to effective communication included having unclear roles, having unclear responsibilities, having tunnel vision, receiving incomplete or incorrect information, being 'overridden', experiencing distractions and interruptions, delaying or avoiding confrontation, and 'throwing people under the bus'.

Having Unclear Roles. Surgical team member roles during IAEs are often unclear because additional team members often come in to provide support, which can result in confusion regarding responsibilities. A study participant described having too many providers in the room for a patient who was being coded. Since many of the usual roles present had more than one provider representing that professional role in the room, it became increasingly unclear whether important things were being done and by whom.

> That was a code in the cath lab. I think they were there were cathing, I don't know what happened, I don't know if they tore something. The kid was bleeding. I think that kid ended up passing away too, but this happened at like five o'clock in the afternoon, so there were probably thirty people in the OR, and it was really hectic because there was probably five or six cath lab nurses, probably four or five anesthesiologists and then two or three residents or fellows. There was a cath lab doctor and then the CV surgery doctors came over, so there were probably two of them in there. The CV nurses came over, probably two of them in there. The charge nurse came in there. The general surgery nurses came because they were going to try to put the kid on ECMO, so there's two or three more of them, then the general surgeon. I ended up leaving the room because I realized there's too many people in here. I think they're getting -- people are having to yell over each other. Maybe I think the side conversations going on. Number two, somebody asks for blood, to get blood from the blood bank. I called up the blood bank and then like five minutes later, somebody was

like is the blood here? And they're like yeah, it's already in the room, so between the cath lab nurses, the OR nurses, OR assistants -- and some of them don't know each other very well and they weren't communicating with each other about what was being done, so extra phone calls were being made and there was confusion of where the blood is and so things like that. (TN8, Pos. 19)

Newer surgical team members entering an operating room to assist during IAEs often struggle to determine their role; that struggle can be further complicated by their limited experience. One inexperienced nurse participant was asked to assist in an unfamiliar specialty during an IAE.

And things (situations) that where that's not my room, it's not my area. It was in (another surgical specialty). I'm not familiar with what's in those rooms and where to get it. And I'm not familiar with the nurses who work there or the doctors who work in (Interventional Radiology) IR. *So, I was only a body.* I felt very out of my element, but because I was communicating mostly with the anesthesia nurses and with the coordinators the OR people who are scrubbed in, I mostly just hung around them and got things for them because I knew where they were and I was able to help more. But I feel like in those situations where it's very high stress everything's on the line and I didn't really have a part because no one there knew my name besides a handful of people that were in that room. So, in that scenario, yeah, I definitely feel I don't really have a role until someone directs something at me like that. (TN9, Pos. 65)

Having Unclear Responsibilities. While many of the responsibilities in the intraoperative environment are understood to belong to specific roles, other tasks are performed as part of the process and are not assigned to a specific team member. One surgeon participant related an incident when he was almost finished operating before he realized that no one had prepped the patient.

I think the one downside to doing prep is that there's no check on the prep. Not a responsibility, per se, of someone in the room. So, in other words it's not the necessarily the resident's job to the prep, and not necessarily the scrub's job to prep. At a lot of other hospitals that we go to, the circulator basically preps the patient and maybe the surgeon, I'm not sure. But so, there's no defined person that does the prep. And I think that's what happened in this particular situation, I thought the resident did the prep, I guess the resident thought the circulator was going to do the prep. And as it turns out, nobody did the prep. So basically, it was a patient who had leukemia was getting a central line in place. (…) And

essentially what had happened was that we were moving along with the operation. We had already done the needle stick. We had already fed the wire and created the tunnel for the line. And it was sort of the process of doing that when I kind of looked down and saw the skin didn't have the sort of normal blue color like I would expect for a ChloraPrep prep, which is blue for central lines here. And I said, did anybody prep this patient? And everybody kind of looked at each other and was like no, no, nobody prepped the patient. And I kind of looked further. I kind of lifted up the drapes. No, there's no blue or anything on the patient. (TS4, Pos. 16)

Another study participant was repeatedly ignored when she told the surgical team she had an incorrect count.

So, we were doing a large reconstructive case with an adult-sized patient and there were lots and lots of instrumentation that needed to be counted and lots and lots of what we call soft stuff (surgical sponges) to be counted. We were closing and it was the staff (surgeon) and a fellow. They were closing rather fast. I let them know that I was not finished counting. I was not even close to finished counting and I would appreciate it if they would hold on a minute and *let me finish the count.* There was a piece of a retractor set that I don't know if it was never there or if it was missing. So, we were like well, let's go ahead and get an x-ray. While they were doing the x-ray, anesthesia said it looks like there are sponges in there. I said, of course there are sponges in there. I told you guys I was not done counting yet. So, we were looking for the metal piece of the retractor and obviously the piece of the retractor was not on the x-ray. We decided that that was okay, that we were going to proceed because it would have been a fairly large piece that would have been seen and they got right back to closing. I was like, *excuse me. I'm still not done counting.* I would really appreciate if you guys would stop what you are doing and let me finish before we go any further and they did not. They were asking me if I would give them the surgical glue to close before I was still even done and I thought they were absolutely insane. (TN6, Pos. 3)

Having Tunnel Vision. Participants in this study experienced tunnel vision in situations where their immediate task required a level of focus that resulted in reduced SA during IAEs. Sometimes participants became so involved in their personal task work that processes that require teamwork were done independently. One participant described the following situation:

We went and looked in the cooler and there was only one unit of blood in the cooler and (the other nurse) was like, wait, I didn't know that a bag of blood got

hung already. So, then we looked, and I looked in the cooler and the unit that was still sitting in the cooler was the one that was checked in. Then I asked her, I said did you check in that blood that was hung? And we looked up and the blood had already gone through, like the whole bag had gone and you could see the slip, still hanging on the bag of blood, so it wasn't even checked in. At this point we both kind of freaked out for a second and went right over to anesthesia and the resident and she asked him, she said, hey, when did you even grab those? (…) The resident ended up, he voiced that he thought they were both checked in and so he didn't even consider checking or even telling the circulator that he was going to grab a unit of blood. So, the anesthesia resident came over, just opened the cooler while the circulator was busy doing something else and grabbed a unit and hung it. We finally, all three of us just checked in that bag that was already hung and everything thankfully was correct, and it matched for the patient, but that was just something that was super scary, and it really could have led to something really bad. Obviously, the patient could have died or had an adverse reaction or anything with that unit of blood. It was just a huge, we had to fill out an incident report and everything, just because obviously the resident was super-sorry, but still like we just voiced that we really needed the communication of, hey, can I hang this unit of blood? Just making sure, because everyone knew that only one was checked in, but instead the resident just went in and grabbed a unit without even telling the circulator that they were going to do that and the circulator was so busy at the time that she didn't even realize it was being hung or else she would have stopped and been like, hey, like is that the one that's checked in? But instead, the wrong unit was hung. (TN7, Pos. 4-5)

Other study participants experienced tunnel vision at a sensory level because of the

narrowed attention at the surgical field. One surgeon related the following story.

I was assisting, and so my brain was able to process what else was going on. And it sounds as if the anesthesiologist in the room was uncomfortable with the amount of blood loss and the amount of time it was taking to have the tumor taken out. The anesthesiologist at no time communicated that (directly) to the surgeon. And it was a junior surgeon, and it was a big case for a junior surgeon. But this (being uncomfortable) is communicated to our circulator, and our circulator is also the charge nurse at the time, who still is. And so, this is communicated to the circulator, and she was visibly uncomfortable and walking around the room while this is going on. And what my perception of the situation was, was that no one wanted to offend this junior surgeon doing a very difficult case and tell them that they were getting uncomfortable with it. And so, it was clear that the anesthesiologist was communicating with nursing. Nursing was communicating with other neurosurgeons who were in (another) operating room, but not actually in our room and telling them that they were uncomfortable with the situation. (…) And I don't know if the surgeon knew about it or if he was so focused on the operation in front of him, that you can be oblivious to it. And that's very easy to be oblivious when you are hyper focused on one thing. That's

so easy that I've had days where like I blink after ten minutes and I throw out like, wow, I forgot to blink because I'm so focused on taking out this tumor. (TS1, Pos. 5)

Receiving Incomplete or Inaccurate Information. Many participants in this study received incomplete or inaccurate information that led to IAEs or potential IAEs. One participant described an inexperienced nurse bringing a surgical patient back to the operating room and realizing she did not have the information she needed to safely catheterize her patient for surgery.

> I came into the room kind of to the same sort of, I could tell from my circulator who has only been a nurse a couple years and been on my team for a couple years, and she was just like, I don't know what to do. I don't know how to cath this person. I don't know what's going on, and there's no note on the chart. There's nothing anywhere. (…) She was trying to call the nurse in day surgery to say, you didn't put what size catheter. You didn't put which one was the Monti. You didn't put which one was the MACE. (…) So, I helped her guide her through that. We could definitely call the pre-op nurse, but at this point we're probably just better off just to own it and call the mom and find out what we need to know. So that was again another possible problem that could've happened because communication was not written down, because this nurse didn't communicate with the mom before she came back. Just teaching her to go directly to the parent, as hard as that is, to admit that you didn't get all the information. We were able to kind of stop that from being a big problem. (TN3, Pos. 4)

Another study participant experienced how ambiguous communication led to their team not receiving the assistance they needed to stabilize a patient.

> And so, at this point, communication went from being wishy-washy to everyone in the room, to (a situation where) we were directly communicating with anesthesia telling them that things are <u>bad</u>. We need you to do several measures to try and decrease the pressure inside of the child's head. And a second call was made to said surgeon of saying, we don't need your advice. We need your hands. We need your help. We need you right now. We have concerns. This child's life is in danger. And at that point, said surgeon came into the room, and instead of helping, and instead of guiding, took over the operation, whatever that means. That doesn't matter much, but it took two calls and unfortunately, poor communication to eventually get what we wanted, which was help. And after this, the child did great. (TS1, Pos. 5)

Surgeon participants were most likely to identify anesthesia providers as the source of incomplete or inaccurate information that impacted their practice in the intraoperative environment. Anesthesia providers have the responsibility of monitoring vital signs throughout surgical procedures and the monitors are not easily visualized by surgeons from the sterile field. Often the first indication for them that patient status is deteriorating is an awareness that the associated monitor noises are changing, which causes them to disrupt their focus in order to check on the patient. One surgeon related the following story.

> There are definitely days I wish that anesthesia would communicate more vital signs. I wish I knew more about cold patients. Sometimes for our patients, it gets really cold, and I don't know until I look up and I see that the kids like 34 degrees. Because I can operate in a room with 100 degrees. Everyone can, no one's going to pass out. So just little things that probably aren't going to change the outcome of the case, but could, so being cold we think can cause increased wound infections, bleeding problems, et cetera, et cetera. So, I wish I would know about that. And there's other times where you always hear the heart rate monitor in the background, and it's dropping or it's getting quick, and you don't know what's going on. (TS1, Pos. 51)

Not Going Directly to the Source. Less-experienced study participants often solicited advice from peers when they needed clarification in the intraoperative environment. Although this strategy allows them to avoid potential discomfort caused by revealing a knowledge deficit to other members of the surgical team, it can also result in receiving inaccurate or incomplete information. Specialty coordinators are nurses who are chosen to oversee surgical services based on their experience and expertise. One study participant who functions as a specialty coordinator on her unit expressed her frustration at having people 'go around her' when they need timely, accurate information about her surgical service.

125

Oh, like even here, we as coordinators, literally we'll have people asking like their little friends for help on how to do whatever this neurosurgery case is that comes into their room instead of asking Exx (an experienced specialty coordinator) or me. I don't understand why they don't immediately seek out the expert. But they instead ask their buddies. I want to talk about it at one of our staff meetings. It's that bothersome to most of us in the OR. And it ends up wasting time. And if you're in a case and the surgeon's waiting on something that nobody understands what to do or where to get it from -- why would you not immediately just ask the person who is paid to know these things? (TN12, Pos. 85)

Being Overridden. Many participants in this study felt their communication was overridden when they expressed concerns during developing IAEs. One surgical team realized a small piece of an instrument was not accounted for, but when they repeatedly notified the surgical fellow who was closing the incision, she continued to close instead of pausing until the piece could be found. This ultimately resulted in a sentinel event.

Then they (the surgical fellow) said, okay, but they continued to close. Then skin was closed and the scrub and the second circulator, and by this time, I'm involved, and we actually had some outside help come in to try to help go through the trash and the linens and make sure, because it wasn't a very big piece. Then she said, the scrub nurse said, we can't find this piece. I don't know where it is. The fellow said, Well, all right. Well, let's get an x-ray., which we did. Nobody was really expecting to find it there, but the x-ray revealed that there was a retained instrument. Then, the pediatric staff surgeon was notified and came back, and the patient was reopened and the object was retrieved, so the count could be reconciled. Then they had to re-close the patient, and by this time, the staff surgeon was back in the room. Actually, he was grateful that it was found in the operating room (TN1, Pos. 33)

Experiencing Distractions and Interruptions. Many participants in this study were distracted or interrupted during cases and reported actively 'tuning out' other conversations to try to maintain their focus. One participant related the following story.

I think something that is, unfortunately, I think something that is not helpful in our rooms and it's just all the chit chat. Like there's just a lot more banter and sarcasm and just talking than I was raised with when I first worked in the OR and I think unfortunately, it's just sort of a, I don't I don't want to say it's a generational thing necessarily, but it is just something that I'm uncomfortable with a lot anymore. And it's probably not just my service, but it's definitely a problem

in (my service). There's just a lot of, yeah, just a lot of chitchat that doesn't really need to be happening. (TN12, Pos. 75)

One surgeon participant identified how the timing of questions from surgical team members can disrupt focus within the surgical team.

> Because think about this for a second. Would you ever ask the pilot of a 747 flying from JFK to Singapore to weigh in on the flight path of a plane that's flying from Los Angeles to Houston? Would that ever happen? (…) It would be inconceivable that you would ask a pilot to weigh in about another flight. You know, particularly in a time that as we are driving down the road, we're not supposed to be texting or surfing or fiddling with all of these things in our cars. But yet what is asked of the anesthesiologist and the surgeon to a degree is to do six things at once and manage a whole bunch of other things. While you could argue that doing an operation or providing anesthesia has every bit as many intensity and concentration requirements specific as driving a vehicle would have. And some people might argue even more so. (TS2, Pos. 67)

Operating on Autopilot. Many participants in this study were involved in IAEs where assumptions were made based on what the surgical team 'does all the time'. Study participants relied on a shared understanding of common practice and missed opportunities to share knowledge, to communicate about the team's plan for the case, and to perform backup behaviors with inexperienced team members. A participant identified her experience with a surgical team running on autopilot in the following story.

> I'm just thinking about the other day we did a time-out. And it was a bunch of us that are used to working together, aside from like the anesthesia (provider). (…) At any rate, we had thought that we had communicated what we wanted CO_2 to be when we were doing the lasering, and everybody seemed to be listening and understand, but (for) most of us, this is what we do all the time. That was, so it was a little rote, but either the person - I think the person running the laser was not like a person that does it very regularly. And for some reason, somebody brought it to our attention that the anesthesia people had not reduced the CO_2 to what the surgeon had recommended. And I remember us all being like, 'oh, my gosh, I thought we talked about that.' And the laser nurse was like, 'oh my God.' Maybe it was that she didn't understand how important it was or whatever, but anyway, we all kind of stopped what we were doing and made sure that the change was (made and) then noted. And they waited and got everything to where it should have been as far as that (CO_2 level) using the laser in the airway. But I don't know. (…) Basically, what I'm trying to say is that everybody in the room thought

we all understood what we're supposed to be doing. And yet what we had talked about did not actually happen. I mean, we all had gone through and did what we just sort of rotely do without having actually paid attention to that one detail that was sort of important, especially in a risky airway kind of a kid. (…) And I think it's just a little bit indicative of how we can be sort of lax about our timeouts and just each of us saying our own little spiel and not really paying attention that putting that into practice. (TN12, Pos. 17)

Delaying or Avoiding Confrontation. Participants in this study delayed or avoided confrontation in the intraoperative environment to prevent conflict from impacting patient care. One participant observed a circulating nurse ignoring a sterility issue because of the response she expected if she confronted a nurse she found intimidating.

> I'm amazed sometimes that the people that I think would say something, don't. I came in the room last fall and (a nurse) had draped a prep stand with, almost like, a towel. Like a hand towel thing. It came in a disposable gown thing, and I go, Ixx, what's going on there? What are you doing? And, anyway, she had some reason or excuse why she did it and I gave her a back table cover or something and said, you have to use something else. You can't use that. (Another experienced nurse) Hxx was in the room, and I'm like, Hxx, why did you not say anything? And she said, well, I just figured she would just have some excuse and it would be uncomfortable, which really surprised me, because Hxx's pretty strong. So, I think when you have people that are very intimidating - it silences people, too. Even what's right. Had you prepped with that prep stand it would've not been sterile. And Hxx knew that. It was hard for her to stand up to Ixx and say, this isn't right. You've got to do something else. I think that's a big problem. if you don't intervene and stop that kind of behavior. You know? (TN3, Pos. 172)

Throwing People Under the Bus. Throwing someone under the bus is commonly used to describe sacrificing the interests of someone to preserve one's own interests (Merriam-Webster, n.d.). This expression is used in the intraoperative environment to identify when a team member or members speak or act in a way that results in another team member losing face. Participants in this study felt they were thrown under the bus when they were publicly ridiculed for asking questions or were left out of important conversations that result in them being less prepared than other team members. Nurses in the intraoperative

128

environment frequently alternate between functioning as the circulating nurse or the

scrub nurse for procedures. One participant described having roles in the room changed at

the last minute, without her knowledge, which impacted her readiness to begin the case.

> And then another thing is just kind of like last minute schedule changes where they're not communicated to you. I had a coworker that was complaining to me about this today, that she got switched at the last minute and she was going to scrub, and they didn't tell her. And she had all of her stuff set up to scrub and everything. And then the other nurse came in like fifteen minutes before the kid was supposed to come back and said, oh, hey, I'm scrubbing and you're circulating. So, she didn't have any of her circulating stuff done beforehand. And I guess it was like a double case where two different specialties were doing the case and they didn't have consent for one of them. And so, I mean, it was partially her fault because she didn't make sure they had both consents before they brought her back. But she was so flustered because she just got thrown in and had to go out and get the kid and didn't have time to look in the chart or do anything. And so that was just like a last-minute schedule changes and things like that, where they just throw you in a room and you have to, oh, hurry and get the kid and be on time to the room and make sure the kid is safe, but you don't have time to prepare anything to make that kid safe. And so that's another definitely breakdown. (...) But this nurse just felt like she wasn't prepared for any of that, because she just got a last-minute schedule change, and nobody told her until right before and she was preparing for this other role and then she didn't have time to set up her role. And the other nurse that came in to scrub, she had all of her stuff ready for her, obviously all of her surgical and everything set up. And then that nurse didn't help her in turn, like get her stuff ready. So, she just felt very stressed and not ready for the kid. (TN13, Pos. 15)

Another study participant was accused of not giving her relief nurse important

information after being rushed during handoff.

> But there are a couple of nurses in particular that they, if they come in to relieve you and you're trying to give report, that they try to hurry you out the door. And there was one instance where, you know, I told the nurse what I needed to tell him, but I think he missed it. I think I was in ENT, and it was something about where the position of the bed needed to be, or something like that. And then when I got back, he was like, I got hosed because it wasn't set up the way they wanted it. But I told him it needed to be a certain way. But he was rushing me, and he wasn't paying attention. But, again, no harm to the patient or anything. Oftentimes when people try to rush, either they're not listening or you don't tell them everything that you need to tell them, because they're rushing you. (TN2, Pos. 81)

Disruptive Behavior. Participants in this study sometimes experienced disruptive

behavior by other surgical team members. Disruptive behaviors experienced included

verbal abuse, intimidating physical actions such as throwing or grabbing instruments or

supplies, and physical abuse. One nurse related the following experience.

> So, I was scrubbed helping (another surgeon) and we took the bone off, and he
> (the second surgeon) came over, he was scrubbed in, and he said to me, I want
> you to help me scrape the bone off with this SafeScraper. And I go, oh, I've never
> done that. I don't know how to do that. (He said) Well, come over here. I can
> show you how to do it, I can show you how to do it. It was not in my scope of
> practice nor was I doing it the way he wanted me to do it. I said, I can't. (He said)
> You're not trying. You're not even trying. He began to yell at me that I wasn't
> trying, that I wasn't paying attention, that I just couldn't get it. He grabbed the
> bone from me, and he grabbed the scraper, he said, I'll just do it myself. I'll do it
> myself. You can't do it. And then that was at the back table, then we were back
> at the field, and I was just completely quiet just waiting for (the other scrub nurse)
> to come back, because I'm like, I've got to get out of here. That's when he began
> questioning me again, you're mad at me, aren't you? You're mad at me. And I'm
> like, I'm not mad at you. I'm not talking to you about this right now. We're
> taking care of this patient. (He said) You just don't pay attention to what I tell
> you to do. And I'm like, *we're not talking about this right now.* It was so
> humiliating, and the room was full of people. It took every tiny bit of my
> emotional energy to provide safe care to that patient, and to make sure I didn't
> hurt that patient. So, it's kind of like you have a certain amount of reserve of
> emotional intellect at a time like that, I think. It was like a flight or fight. I just
> put everything of what I had into making sure I didn't hurt the patient until I got
> out of there. I don't know, I think it totally compromised my ability to do the best
> job I could do, again, for that patient, because I couldn't think as clearly, I couldn't
> respond as quickly because I was paralyzed that somebody would actually talk to
> another human being like that. (TN3, Pos. 75)

Study participants did not have to be the target of disruptive behavior to feel that

communication within the surgical team was negatively impacted. One participant

witnessed a prolonged argument between surgeons that made the surgical team members

hesitant to initiate communication throughout the rest of the case.

> Because it was two different specialties. So then both docs were in there and they
> were arguing, yelling at each other, asking who was going to go first. Then the
> one doctor was like, well, I've got my consent, I'm going. And the other doctor
> was like, I was out there. But she was not out there, she had not gotten consent

130

yet. And I guess it was just a big, very blown-up situation. (…) I don't know how they ended up picking who went first, but both doctors were very upset. The rest of the case was very tense. It was not good. You know, they should have probably had that planned ahead of time who was going to go first and not left that til the last minute. They shouldn't have left consents till the last minute, obviously. (TN13, Pos. 19-21)

Conclusion

The findings from this research study include a framework that identifies and explores the psychosocial process of Testing the Water used by participants to initiate and maintain interprofessional communication during IAEs. Most participants in this study experienced interprofessional communication during IAEs as a situational, iterative process where communication strategies were used to influence responses of the surgical team. Because the study participants varied in professional role and tenure, the application of the strategies and their consequences were experienced differently. Nurse participants with less experience were more likely to see something and not recognize or understand its importance, not know what to ask, or to be afraid to ask other team members questions to clarify their understanding. Nurse participants with more experience were quicker to recognize and clarify problems, used strategies to avoid seeming confrontational, and used patient advocacy to override their concerns about using speaking up behaviors. Surgeon participants experienced interprofessional communication very differently than nurses because of the professional rights ascribed to their role. Surgeon participant stories detailing problems with upward communication were primarily from situations where they were junior members of the team during residency or fellowship, or during times when they were working with other physicians and hierarchy was unclear. As attending surgeons, interprofessional communication

concerns were most likely to be caused by not receiving information in a timely matter and by surgical team members not understanding the communication used for delegation.

The differences identified among participants in this study reveal opportunities to improve interprofessional communication through increased perceptions of psychological safety. Increased perceptions of psychological safety are indicated to reduce the time needed to recognize and respond to IAEs. Future research including the other professional roles constituting the surgical team would be valuable to further develop the framework and explore its potential application to intraoperative communication training, interventions, and evaluations. The findings also identified facilitators and barriers to effective interprofessional communication that were consistent with current communication literature that are discussed in the following chapter.

Chapter 5

The purpose of this study was to explore the psychosocial processes involved during the establishment and maintenance of interprofessional communication surrounding IAEs or potential IAEs in the operating room. This qualitative exploration was guided through the use of grounded theory to answer four related research questions. 1) How do surgeons and surgical nurses experience the initiation of interprofessional communication in the operating room related to IAEs or potential IAEs? 2) How do surgeons and surgical nurses experience the maintenance of interprofessional communication in the operating room related to IAEs or potential IAEs? 3) What do study participants perceive as facilitators to the process of initiating and maintaining interprofessional communication? 4) What do study participants perceive as barriers to the process of initiating and maintaining interprofessional communication? Answers to these questions were largely satisfied by the findings presented in the previous chapter.

An overarching finding of the study was the perception that interprofessional communication during IAEs is largely situational as surgical team members navigate care provision through action teams within an interdependent, evolving practice environment. This situational approach to interprofessional communication was titled Testing the Water and was experienced through subprocesses identified as Reading the Room and Navigating Hierarchy. Another important finding was that study participants experienced the initiation and maintenance of interprofessional communication differently based on their tenure and professional roles. These differences in participant experience extended to the perceived facilitators and barriers to interprofessional communication. This chapter

contains analysis, interpretation, and synthesis of the findings and relates them to relevant concepts in current surgical team communication literature.

Discussion

Study participants described their experiences during semi-structured, private interviews that were recorded, transcribed, and imported into MaxQDA software for analysis. These experiences were analyzed through the constant comparison method to identify patterns between and among participating individuals and professional groups. Patterns indicated the tenure and professional roles of the study participants significantly influenced their communication experiences. The described experiences also suggest the existence of common phases of interprofessional communication during IAEs. These phases are recognition, reconnaissance, rallying, reaction, and resolution. Not all study participants experienced each phase during IAEs, and the phases were often recursive and repeated throughout the surgical team's coordinated response.

The identified communication phases have been used to organize an exploration of the findings. These communication phases also relate directly to concepts frequently described within interprofessional healthcare communication research. A comprehensive review of teamwork and communication literature preceded this study to allow the researcher to identify knowledge gaps and to situate this study within current interprofessional communication research. This chapter will focus on connecting the study findings to concepts that directly impact the surgical team's response to IAEs. The concepts that are most critical to a surgical team's response to IAEs include SA, sensemaking, and TMMs. This chapter will explore these concepts as they are interwoven

into the discussion of the communication phases of recognition, reconnaissance, rallying, reaction, and resolution.

Initiation of Interprofessional Communication During IAEs

Initiation of Communication During Recognition

The first research question sought to answer how study participants experienced the initiation of interprofessional communication. Many participants in this study had to initiate interprofessional communication during the recognition phase of developing or potential IAEs. Their experiences initiating communication were influenced by their role, tenure, and the need for the involvement of other surgical team members to assist in their responses to IAEs.

Identified patterns suggest the existence of three groups that were represented during all phases: inexperienced nurses, experienced nurses, and surgeons. Inexperienced nurse participants were often confused and anxious during the initiation of communication during IAEs. Inexperienced nurse participants also often doubted they had the experience or knowledge to identify and evaluate potential problems and risks during IAEs. Inexperienced nurses were more likely to double check relevant information before initiating communication with other surgical team members. Many inexperienced nurses also initiated communication with peers to confirm their perceptions before addressing or alerting the surgical team. Some inexperienced nurses relied on others to communicate concerns to the surgical team for them. Inexperienced nurses were most apprehensive about initiating communication about IAEs resulting from team member error or performance issues.

Experienced nurse participants were more likely to understand potential problems and risks during IAEs. They were also more likely to troubleshoot problems and to know when (or if) communication with the surgical team could be safely delayed. Experienced nurses relied on prior knowledge to know how to phrase and direct their requests for information; because of their prior knowledge, they frequently were able to shorten or skip the reconnaissance phase for familiar problems. Many experienced nurses also tailored their communication to the recipients and often used strategies to avoid seeming confrontational or embarrassing other surgical team members.

Surgeons often experienced the recognition of IAEs based on their level of involvement at the sterile field. Many surgeons were not involved in the recognition phase if problems originated outside of their immediate focus. Some surgeons recognized changes in the room that indicated problems but relied on team members with a broader perspective of events to provide information about developing situations. Most surgeons who recognized problems felt they had the experience and knowledge to intervene in IAEs. Surgeons often required supplementary situational information to rally the surgical team to appropriate responses to IAEs. All groups desired increased information exchange during the recognition phase to more effectively perform their professional roles. All groups also felt the initiation of communication was more complicated during IAEs resulting from team member performance and were more likely to describe communication as problematic when the performance belonged to an 'equal' or 'higher' ranking surgical team member. Findings related to interprofessional communication during the recognition phase were consistent with current team communication literature.

Situational Awareness. The concept of situational awareness (SA), sometimes identified

as situation awareness, is critical to the understanding of interprofessional

communication during the recognition of IAEs or potential IAEs (Green et al., 2017).

Accurate SA within individuals occurs at three levels; having SA includes perceiving

elements of the environment, comprehending meaning, and then projecting that meaning

to the situation (Endsley, 1995, 2004). "SA can also be described as a person's ability to

maintain an adequate internal representation of the status of the environment in complex

and dynamic domains where there are sudden fluctuations in conditions" (Green, 2017,

p.721). Accurate SA occurs when team members correctly perceive what is happening,

what the observed event does or could mean, and what needs to happen next to respond

effectively. The following table, Levels of SA, depicts how surgical team members might

experience the levels of SA described by Endsley. It is important to note that an accurate

perception of the elements in the environment requires the ability to sift out what is

relevant, to understand the significance of the elements, and to integrate that significance

with the individual's existing or developing goals and mental model. This is explained

below, in the table titled Table 5.1: Levels of SA.

Table 5.1: Levels of SA

Level One		Level Two	Level Three
Perception of the attributes, dynamics, and status of **relevant** elements in the environment	Synthesis to understand significance and integration with goals	Comprehension of relevant elements	Projection of future status to develop plan/update mental model
Study participants asked themselves: What is happening?	Study participants attempted to 'link' their observations to indicated responses.	Study participants asked themselves: What does this mean? What could it mean?	Study participants asked themselves: What might happen next? What should we do?

In this study, many participants perceived elements or changes in the environment but were not able to comprehend their meaning or potential importance. This lack of comprehension often meant that inexperienced surgical team members had 'information' but did not possess the experience-based knowledge to discern its importance, and there were frequent delays as they tried to make sense of evolving situations. Other study participants who had the experience to comprehend and project the meaning of environmental elements or patient status changes often did not perceive relevant information when they were focused on the sterile field or other tasks. These differences in SA during IAE recognition often resulted in experienced surgical team members not having the information that was necessary to guide critical decision-making processes during procedures (Brennan, Holden, Shaw, Morris, & Oeppen, 2020; Madani et al., 2017).

Inexperienced surgical team members potentially find themselves 'stuck' at the perception level of SA because making sense of evolving situations requires the "effortful processes of gathering and synthesizing information, using story building and mental models to find some representation that accounts for and explains the disparate data" (Endsley, 2004, p. 324). Making sense of many developing situations requires prior experience with similar or comparable situations; the absence of those experiences necessitates bringing relevant observations to the attention of other, more experienced surgical team members.

> The overall SA of the team is only as good as the lowest SA of any of its members, and this should be remembered. It is sometimes the least qualified person who realises that something is wrong, again highlighting the importance of the team briefing to empower everyone to speak up. A useful practice that can be discussed at the briefing is to stop when something does not seem quite right. (Brennan et al., 2020, p. 406).

This 'permission' to speak up when something does not *seem* right, without requiring the 'justification' possible through the synthesis of prior knowledge or perceived risks, potentially brings developing IAEs to the attention of the surgical team more rapidly, which can facilitate faster, more informed responses to IAEs.

The importance of SA in the intraoperative environment has resulted in role-specific measures being developed for surgeons, anesthesia providers, and scrub staff (Geraghty & Paterson-Brown, 2020; Kang, Gillespie, & Massey, 2014; Lee et al., 2021; Mitchell et al., 2013). SA can also be measured at the team level with the Observational Teamwork Assessment for Surgery (Hull, Arora, Kassab, Kneebone, & Sevdalis, 2011). Decreased SA has been linked to nontechnical surgical error, and increased SA has been indicated to reduce the impact of preventable IAEs (Doumouras et al., 2017; Siu, Maran, & Paterson-Brown, 2016).

Obstacles to Situational Awareness. Researchers have identified several obstacles to or 'enemies' of SA that were also described by study participants (Endsley & Jones, 2016). These identified factors that directly impact SA include attentional tunneling, complexity creep, data overload, errant mental models, misplaced salience, out-of-the-loop syndrome, requisite memory trap, and workload, anxiety, fatigue, and other stressors (WAFOS).

Attentional tunneling. Participants in this study described attentional tunneling as 'having tunnel vision'. Many participants became so involved in performing the taskwork connected to their professional roles that they became less aware of changes in the intraoperative environment. When attentional tunneling or tunnel vision occurs, individuals "lock in on certain aspects or features of the environment they are trying to

process and will intentionally or inadvertently drop their scanning behavior" (Endsley & Jones, 2016 p. 32). This reduced scanning behavior contributed to delays in participant recognition of IAEs. Some study participants became so involved with the factors within their immediate focus that they then described 'turning around' or 'finally blinking' to discover they had not attended to important environmental information. Attentional tunneling is likely unavoidably inherent to the surgical process because of the focus required by surgical team members, making the scanning behaviors of other team members even more important to the early recognition of IAEs.

Complexity creep. Complexity creep is another identified factor that contributes to reduced SA. Complexity creep occurs in complicated, dynamic situations where there are so many variables that it becomes difficult for individuals to "form sufficient representations of how these systems work" (Endsley & Jones, 2016 p. 38). The participant narratives from this study of IAEs or developing IAEs often included descriptions of rapidly changing patient status, unclear surgical team goals, and lack of team member engagement that made it difficult to communicate effectively to coordinate team member actions. In addition, many participants in this study described being in situations using unfamiliar equipment or instruments, working with unfamiliar team members with unknown knowledge or abilities, and emergently caring for patients without opportunities to assess and understand factors related to patient status. Complexity creep makes responding to IAEs more difficult because of its influence on the development of an accurate mental model.

Data overload. Data overload is a factor that contributes to complexity creep in the intraoperative environment. During dynamic situations, "the rapid rate at which data

140

changes creates a need for information intake that quickly outpaces the ability of a

person's sensory and cognitive system to supply that need" (Endsley & Jones, 2016 p.

35). Many participants in this study experienced IAEs where they felt bombarded by the

constant influx of information as situations changed, and some participants had trouble

determining which changes were relevant to the situation and what actions were indicated

to respond effectively. Data overload also was identified as contributing to confusion

when surgical team members indiscriminately communicated about needed actions

without designating intended recipients. Failing to designate recipients often meant that

study participants struggled to process unclear requests for assistance during IAEs.

Errant mental models. Errant mental models also impact SA in the intraoperative

environment. Mental models are the basis for interpretation of situations that "tell a

person how to combine disparate pieces of information, how to interpret the significance

of that information, and how to develop reasonable projections of what will happen in the

future" (Endsley & Jones, 2016 p. 39). Some participants in this study experienced

inaccuracies in their individual mental models which led to them delaying or avoiding

relevant communication with the surgical team. Some study participants also relied on

other team members to 'bridge the gap' between what they were observing and what it

might mean. Errant mental models are potentially unavoidable within action teams

because the trajectory of many situations is dependent on variables like changing patient

status, staff composition, and the proposed interventions.

Misplaced salience. SA is also influenced by misplaced salience. The salience of

information has been described as the "compellingness of certain forms of information"

which has been linked to the information's physical characteristics (Endsley & Jones,

2016 p. 36). In the intraoperative environment, the physical characteristics of incoming information can be both misleading and distracting. Participants in this study identified having their SA impacted by equipment alarms, case-irrelevant conversations, and movement in their peripheral vision. Attempts to remain focused during such distractions often cause individuals to use significant mental energy to "block out all the competing signals to attend to desired information" (Endsley & Jones, 2016 p. 38). This intermittent attention to environmental factors led to diminished SA and distracted focus for many participants in this study.

Out-of-the-loop syndrome. Out-of-the-loop syndrome can be another obstacle to SA in the intraoperative environment. Originally used to indicate how automation influences SA, it also applies to situations where providers depend on electronic alerts from patient monitors to make them aware of changes in patient status. In many situations, patients are surgically draped, and awareness of patient status changes is dependent on equipment alarms instead of assessment of the patients. Some study participants also reported feeling disengaged from both the patient and the surgical team during robotic surgeries because of the size and configuration of surgical equipment.

Requisite memory trap. Another factor that can impact SA is called the requisite memory trap. The phrase requisite memory trap describes the limitations of working memory. Working memory is used to process situational information; this is especially true of inexperienced surgical team members. Some participants in this study experienced situations where they felt they 'should know' what to say or do but reported they could not 'retrieve' the needed information. Research suggests that, unlike inexperienced team members, experienced team members do not seem to be constrained by the limitations of

working memory to synthesize information during SA (Endsley, 2015). Experienced team members have another advantage because "the development of rich mental models of the environment over time contributes significantly to people's ability to form meaningful chunks of information for more efficient storage" and more rapid retrieval during IAEs (Endsley & Jones, 2016 p. 33).

Environmental stressors. The final factor influencing SA as described by Endsley addresses the stressors experienced in a complex environment: task workload, anxiety, fatigue, and other stressors (WAFOS) (Endsley & Jones, 2016). The other stressors identified include mental workload, time pressure, uncertainty, career advancement, self-esteem, and participating in high-consequence events - such as when lives are at stake (Endsley & Jones, 2016). All of the identified WAFOS stressors are relevant to the intraoperative environment. Most participants in this study described being under varying levels of stress during surgical procedures, and this stress often increased significantly during IAEs. Study participants identified feeling 'being up against' factors related to time, problems, 'the system', the personalities or practices of other surgical team members, and perceived performance or knowledge deficits within themselves. Working under these stressors has been identified to decrease both the availability of working memory and the ability to gather information as individuals tend to "pay less attention to peripheral information, become more disorganized in scanning information, and be more likely to succumb to attentional tunneling" (Endsley & Jones, 2016 p. 35). Individuals working under stress are also more likely to experience premature closure during IAEs and tend to arrive at decisions without understanding or thoroughly considering all of the available information. (Endsley & Jones, 2016).

These obstacles to effective SA at the individual level indicate the need to communicate earlier during developing IAEs to 'shift' the SA to a team or shared level to make sure the entire surgical team perceives, comprehends, and projects the meaning of events. Although the specific aspects of the situation that are relevant to each team member's SA may be different in that they are determined by the unique goals of each role, there also seems to be a subset of information requirements that is common among all surgical team members. It is this overlap in SA requirements that defines the need for distributed SA or team SA (Gillespie, Gwinner, Chaboyer, et al., 2013). Researchers suggest the most accurate SA within teams is when surgical team members communicate deliberately to develop team or distributed SA (Sorensen & Stanton, 2013). Deliberate communication includes communicating clearly, checking for understanding of the current situation, and developing a shared projection of what is likely to happen next to create distributed SA (Gillespie, Gwinner, Fairweather, et al., 2013). This team or distributed SA raises the understanding of situations from the individual to the team level and makes better use of the knowledge and experience of all surgical team members.

Bringing potential or developing IAEs to the SA of the surgical team allows an 'accessing' of the cognitive capability of the entire team, and "occurs as a consequence of an interaction of an individual's pre-existing relevant knowledge and expectations; the information available from the environment; and cognitive processing skills that include attention allocation, perception, data extraction, comprehension and projection" (Salas, 1995, p. 125). This aligned, distributed SA heightens awareness for the entire surgical team, facilitates informed decision-making, and increases responsiveness to IAEs. Moving through the levels of SA as a team to make sense of developing situations is

necessary to respond more effectively to IAEs. One common pathway from perception to projection using SA is shown in the following table titled Table 5.2: Situational Awareness.

Table 5.2: Situational Awareness

Level One Perception	Level Two Comprehension	Level Three Projection
	Sensemaking ➡	Mental Model
		Communication ⬇
		Team Mental Model

Speaking Up Behavior. Accurate team SA surrounding developing IAEs often depends on the ability and willingness of less experienced or less tenured members to 'speak up' or 'stop the line', even if they are not sure of the importance of what they are witnessing. Speaking up has been defined as the explicit communication of doubts, opinions, problems, or suggestions that seem to challenge the status quo (Weiss et al., 2014). Speaking up can include raising concerns about performance errors, rule breaking, mistakes in clinical judgment, or failure to follow protocols (Okuyama et al., 2014). The importance of speaking up behaviors has been identified in healthcare, but in practice speaking up behaviors have been described as 'unsafe and ineffective' and as being impeded by power dynamics and hierarchies (Morrow et al., 2016; Okuyama et al., 2014; Pattni et al., 2018). Speaking up to prevent harm to others in the workplace has also been identified as 'safety voice' and has been described as being influenced by shared safety knowledge, norms, work configuration, and psychological safety (Noort et al., 2019). Psychological safety has also been shown to enhance communication, increase

interprofessional partnerships, increase accountability, improve conflict resolution, and increase recognition and reporting of adverse events and near misses (Fencl et al., 2021). "Psychological safety reflects the belief among team members that it is safe to take risks, voice dissent and make errors" (Barling et al., 2018, p. 15). Several studies show that safety culture and the related concept of safety climate are related to such clinician behaviors as error reporting (3), reductions in adverse events (4, 5), and reduced mortality (Barling et al., 2018; Rosen & Kelz, 2021; Weaver et al., 2013).

Many studies in the literature contain findings that are consistent with the strategies and goals identified during the psychological process of Testing the Water. One compelling study emphasized that team members using safety voice or speaking 'up' across a power gradient often base subsequent speaking up behaviors on *how those in power receive the initial communication attempts* (Noort et al., 2021). These findings are consistent with a narrative synthesis study identifying the barriers to speaking up behaviors or safety voice as "hierarchical climate, a superior's interpersonal communication skill, gender differences, and a lack of adequate training in voicing concerns" (Pattni et al., 2018, p. 234). Other reported barriers to speaking up include feelings of intimidation, fear of embarrassing oneself or other team members, and fear of consequences (Hurley & Hutchinson, 2020).

Even with these barriers, many study participants described situations when they risked negative responses to assertively advocate for their patients, which is similar to findings reported in the literature. One study reported that experienced nurses feel compelled to speak up when adjustments are needed to respond to evolving patient needs or team member performance, even if their suggestions might not be well received

(Ingvarsdottir & Halldorsdottir, 2018). Another study found that centralized leadership and a robust hierarchy 'delay' speaking up behaviors but do not affect nurse voice frequency (Krenz et al., 2020). Surgeons who perceive themselves to have lower ranking in the medical hierarchy seem to experience many of the same barriers as nurses. A study focused on the speaking up behaviors of young surgeons identified similar struggles for physicians when faced with upward communication they thought might be perceived as challenging to those above them in the hierarchy (Bould et al., 2015; Sur et al., 2016). Strategies described by participants in this study were similar to those identified in the Bould et al. study, with a reliance on framing concerns as questions in the attempt appear non-confrontational. In another study, the willingness of junior surgeons to speak up a second time was determined by the response to their first attempt (Pattni et al., 2018). Besides teaching surgical team members to speak up, it has been suggested that there also needs to be an effort to teach those higher in the hierarchy to 'listen down' to increase psychological safety for all team members (Hurley & Hutchinson, 2020). After the recognition of developing or potential IAEs, participants in this study moved into the reconnaissance phase, where they gathered information to try to make sense of what they were observing.

Initiation of Communication During Reconnaissance

Most participants in this study used reconnaissance strategies to obtain additional information to understand developing or potential IAEs. These reconnaissance strategies varied by tenure and professional role. Most study participants not actively involved at the sterile field tried to evaluate the situation through environmental clues before initiating communication with the surgical team. Some study participants relied on their

interpretation of environmental clues to make assumptions that ultimately delayed communication with the surgical team. Many inexperienced nurse participants struggled during the reconnaissance phase when they lacked the knowledge and context for understanding potential problems. Some inexperienced nurses were faced not only with not knowing how or when to ask questions, but often they were unsure of what to ask or even if what they were seeing was important to the surgical team. Inexperienced nurses were apprehensive about disrupting the surgical team with questions that might be perceived as irrelevant or that concerned something they felt they 'should know'. Inexperienced nurses also sometimes felt their concerns were minimized or overridden by other surgical team members. Experienced nurse participants were often able to use their prior knowledge to evaluate what might be important to the surgical team and were able to more easily navigate obtaining the information they needed to make decisions. They were also more likely to know 'what' to ask, be aware of who might have the information they needed and feel more entitled to seek that information. Surgeons were rarely reluctant to solicit information from the surgical team. Many surgeons relied on team members to provide information they could not readily access from the sterile field and experienced frustration when relevant communication did not occur in a timely manner. Conversely, they sometimes perceived 'upward' communication by other team members as distracting or confrontational. When initiating communication during reconnaissance, all participants in this study maintained an awareness of communication timing when that consideration was possible to avoid disrupting the flow of the surgical team. Most study participants felt they frequently did not have access to relevant information that would allow them to anticipate needed actions or make informed decisions.

148

Participants in this study used the reconnaissance phase to make sense of events

and changes in the intraoperative environment. Sensemaking began to be explored in the

late 1960s and is said to consist of seven interrelated properties. Sensemaking is

described as social, driven by plausibility rather than accuracy, ongoing, grounded in

identity construction, extracted by cues, enactive of sensible environments, and

retrospective (Kilskar et al., 2020).

> Sensemaking can thus be described as consisting of three interrelated processes:
> creation, interpretation, and enactment. For issues, events, or situations to become
> triggers for sensemaking, there must be a discrepancy between expectations and
> reality, either in form of an unexpected event or the nonoccurrence of an expected
> event. There are many factors that influence whether violated expectations or cues
> trigger sensemaking, e.g., individual or organizational identity, cognitive frames,
> personal or strategic goals, and technology (Kilskar et al., 2020, p. 2).

An intriguing aspect of sensemaking is that it is identified as originating in

'disruptive ambiguity'; it requires the violation of expectations. When processed

individually, this ambiguity is noticed, bracketed, and responded to through connections

with past experience. A problem with individual processing of intraoperative ambiguity is

that reliance on connections with past experience can result in assumptions that lead to

incorrect or delayed responses (Weick, Sutcliffe, & Obstfeld, 2005). Sensemaking by an

inexperienced team member is potentially problematic because individuals tend to try to

make sense of situations based on their experiences, which might be limited or not

applicable to current circumstances (Weick et al., 2005).

Sensemaking by inexperienced team members also tends to be more retrospective

than prospective, and research indicates the successful completion of surgical procedures

requires the surgical team to engage in prospective sensemaking. (Rosness, Evjemo,

Haavik, & Wærø, 2016). When collective, prospective sensemaking is socially supported

149

and deliberately constructed, surgical team members benefit from the experiences of others and are more prepared to respond to IAEs (Siegel & Schraagen, 2017). Collective sensemaking includes deliberate behaviors "such as questioning, analysis, making use of knowledge explicitly, reviewing past events with self-awareness and coming to terms over time with a new awareness" that allows surgical team members to better respond to IAEs (Siegel, 2017, p. 128). These improved responses through distributed sensemaking can be at least partially attributed to an evolving, explicit TMM. TMMs are discussed in more detail during the exploration of the rallying phase.

Initiation of Communication During Rallying

Surgical teams rally to coordinate their response to IAEs. Rallying often includes recruiting additional team members from the surgical unit and dividing responsibilities during increased work demands. Because some team members consider needing outside help as a 'failure' of the existing surgical team, not all study participants felt they had the right to rally others to respond to IAEs. Inexperienced nurse participants were the most reluctant to rally others. Some inexperienced nurses felt they were overstepping the boundaries of their role and lacked the judgment to know when additional providers were necessary to respond to IAEs. They also worried about offending senior surgical team members if they asked to bring in additional help. Inexperienced nurses felt they were most helpful during the rallying phase when they received explicit, directed delegation based on their abilities. Experienced nurse participants were quicker to initiate rallying others, both from the original surgical team and from the perioperative unit. Because many of them had experience with emergent IAEs, they felt justified in bringing in others to divide the increased responsibilities for a more effective response. Experienced nurses

often assigned relevant duties to themselves and other team members during IAEs. Surgeons were the most comfortable with rallying other team members and used informed delegation to support the stabilization of their patients. Many surgeons described needing to understand the abilities of others to delegate tasks successfully and felt less comfortable delegating in situations with unfamiliar team members. All groups felt that an understanding of hierarchy and professional roles was essential to successful, timely delegation. All groups experienced situations where rallying without clear delegation resulted in delayed or duplicated efforts by the surgical team.

Clear delegation with appropriate explanation during IAEs was described as vital to developing a dynamic TMM. At its most basic, a TMM is a shared understanding that enables purposeful, coordinated actions (Gardner, Scott, & AbdelFattah, 2017). TMMs reflect the extent to which surgical team members similarly categorize information that impacts the execution of interdependent team processes. When teams are "on the same page" and interpret incoming information and activities in a similar or compatible manner, research suggests that the team will engage in more effective and efficient team behaviors. Accurate TMMs are essential to interdependent adaptations to evolving IAEs because they allow the team to make the best use of all surgical team members' collective abilities and knowledge (Fernandez et al., 2017). The most accurate TMMs are often developed through the integration of individual mental models, which can vary widely among surgical team members based on professional roles and tenure.

> Theories of expertise suggest that experts have mental models that differ in measurable ways from those of novices, consisting of a vast and organized amount of declarative and tacit knowledge, gained through accumulated experiences. Furthermore, expert knowledge is highly structured so that relevant information can be retrieved efficiently, thereby accelerating performance and reducing cognitive workload for a given task (Madani et al., 2017, p. 262).

151

Retrieval and sharing of relevant expert knowledge facilitate similar interpretations and expectations of events through the TMM, which ultimately enables the surgical team to rally for the most effective, focused reactions to IAEs.

Maintenance of Interprofessional Communication During IAEs

Maintenance of Communication During Reaction

The second research question addressed the maintenance of communication during IAEs or potential IAEs. Although maintenance of communication is evident during many of the described phases, sustained maintenance of communication is most focused and critical during the reaction phase. The surgical team's reaction is their coordinated response to the IAE. Reactions to IAEs were often experienced as cycles of recognizing and responding to emerging problems as situations evolved. Inexperienced nurse participants were often unsure how to perform their roles during emergent IAEs, and they experienced issues similar to the challenges of the previous phases. Their confusion often led to a reluctance to participate in problem solving as a team and in sustained interprofessional communication during IAEs; instead, they often relied on direct delegation to guide their participation. Once they completed an assigned task, they often waited to be directed about the next best action. Inexperienced nurses were also more likely to be left out of active participation in sustained communication. Some study participants felt ignored or overridden when they attempted to contribute to communication within the surgical team during the reaction phase. Experienced nurse participants were more likely to self-delegate, participate in sustained communication and group problem solving, and make suggestions to the surgical team during IAEs. Experienced nurses were also more likely to stay actively engaged with the surgical team

152

and to be able to anticipate the supportive actions needed to respond to IAEs. Surgeons most often communicated through delegation during IAEs and frequently shared delegation responsibilities with anesthesia providers. Surgeons felt responsible for managing tension and for providing updated, specific information during IAEs. Most participants in this study felt less ambiguity about interprofessional communication during this phase of responding to IAEs because the delegation strategies used relied primarily on the existing professional hierarchy and communication culture. Study participants also valued deliberate, directed communication such as closed-loop communication to establish and maintain SA and evolving TMMs.

Closed-loop communication occurs when a message is transmitted, the recipient acknowledges the message and repeats it to verify understanding, and the original sender verifies the interpretation is correct (Härgestam, Lindkvist, Brulin, Jacobsson, & Hultin, 2013). This deliberate focus on transmitting and verifying the interpretation of information is critical during reactions to IAEs. Closed-loop communication minimizes misunderstandings, encourages active listening, and helps to develop an explicit consensus about the next best actions for the surgical team (Jacobsson, Hargestam, Hultin, & Brulin, 2012). One study identified that when team delegation occurred through closed-loop communication that orders were completed 3.6 times sooner than those that didn't use closed-loop communication (Abd El-Shafy et al., 2018). Another study reported that the initiation of closed-loop communication resulted in increased communication for both high- and low-performing teams (Kolbe et al., 2014). In another study, closed-loop communication training reduced medical errors by almost fifty percent in high-acuity pediatric patients (Diaz & Dawson, 2020). Closed-loop communication

can be implemented immediately and requires minimal training (Etherington et al., 2019).

Most study participants who experienced closed-loop communication during IAEs

described it as valuable to effective team reactions to IAEs.

Maintenance of Communication During Resolution

Many participants in this study did not experience any form of resolution after

IAEs. Some study participants were required to immediately progress throughout their

scheduled cases without opportunities to process even severe IAEs. Inexperienced nurse

participants often sought the opinions and advice of others to make sense of IAEs when

there was no debrief with other surgical team members. Because the communication that

occurred during IAEs was often focused only on needed actions during the adverse event,

debriefing with others offered opportunities to examine the 'why' of factors contributing

to IAEs. Many experienced nurse participants examined their performance after IAEs to

develop ways to better recognize and respond to future events. Surgeons were often

absent during informal resolution after IAEs but described processing adverse events

individually through self-reflection. All study participants used resolution as a chance to

make sense of what happened during IAEs. Resolution was also used to make informed

decisions about practice or policy changes to prevent future IAEs. Most participants who

did experience resolution through debriefing with other team members considered those

experiences valuable and often changed their individual or group practices as a result.

Debriefing has been indicated to improve surgical team perceptions of patient

safety and to reduce the mental workload of surgical team members when they

experience future IAEs (Boet et al., 2017; Magill et al., 2017). Training surgeons to

initiate structured debriefs has been linked with improved perceptions of team

154

communication and surgical leadership (Bui et al., 2021). The benefits of debriefing seem to be significantly increased when senior team members are in attendance and are actively engaged during briefings (Phadnis & Templeton-Ward, 2018). Implementation of debriefs is critical to sensemaking. The connection of past events to future situations links retrospective sensemaking to prospective sensemaking and allows surgical team members to actively learn from IAEs, especially if team members with less experience can benefit from the knowledge, experience, and interpretation of more experienced team members (Rosness et al., 2016). Deliberate collective sensemaking through debriefing offers an enhanced perspective of IAEs that might be unavailable when processed individually or informally by those with less experience.

Facilitators to Interprofessional Communication During IAEs

The third research question sought to identify facilitators of interprofessional communication among surgical team members. These facilitators are discussed using the three groups that emerged from the narratives: inexperienced nurses, experienced nurses, and surgeons. Inexperienced nurses identified facilitators for interprofessional communication that were influenced by their level of experience in the intraoperative environment. Many of these facilitators were related to their perceptions of support or psychological safety in the operating room, with inexperienced nurses feeling communication was most effective when they had a trusted team member to ask questions. When faced with unfamiliar situations, inexperienced nurses often turned to their peers, preceptors, charge nurses, or medical residents to gather information instead of going directly 'to the source' by communicating with the involved attending physicians. Most inexperienced nurses identified more frequent and effective

155

communication when they were working with more experienced team members, with familiar team members, or in familiar surgical specialties. Inexperienced nurses were encouraged and empowered by positive feedback related to speaking up. They identified being compelled to 'speak up' when they were advocating for their patients, but this process was sometimes delayed as they tried to navigate timing or communication recipients. Inexperienced nurses often read nonverbal cues or sought the advice or followed the examples of others to navigate communication timing, including critical procedural times when silence was expected. Inexperienced nurses also benefited from having an explicit surgical plan, and many tried to develop this understanding through consultation with more experienced surgical team members if the plan was not provided by the leaders of the surgical team. Inexperienced nurses valued direct, closed-loop, delegation that was based on their abilities during IAEs.

Experienced nurses also identified familiarity as a facilitator for communication. Experienced nurses felt communication was more effective when working with teams where there was a reduced 'authority gradient' because of experience levels, in services or situations that were 'predictable', and when team members understood professional roles well enough to 'overlap' duties or anticipate what other team members needed. Experienced nurses felt their knowledge was a facilitator when they needed to be able to 'tease out' information, 'fill in the gaps', or to 'be a chameleon' when it came to communication with other team members. They benefited from being able to 'read surgeons' and from knowing how to 'soften' communication when monitoring the performance of other team members. Experienced nurses felt communication was more effective when they understood other team members' abilities and were able to tailor

their communication or provide support during IAEs. Although experienced nurses were able to accurately anticipate needed actions in many situations, they preferred working with explicit, expressed plans for procedures and valued direct communication through an accepted leader during IAEs. Surgeons also appreciated the advantages team familiarity provides to interprofessional communication, and many study participants described using very deliberate strategies to engage and include other surgical team members. Surgeons identified value in outlining the surgical plan with the team, communicating to 'prevent panic', and giving team members time to 'prepare internally' when possible during IAEs. Surgeons felt they had more effective communication when they had working knowledge of team member abilities, available operating room supplies and equipment, and unit resources. Surgeons valued timely, direct, unambiguous communication during IAEs or potential IAEs.

The study participants identified facilitators that were consistent with the perioperative communication literature. Participants in this study perceived value in practices such as setting the stage, looking down the field together, using backup behaviors, initiating purposeful pauses, using directed communication, using closed-loop communication, and encouraging team member questions. As discussed in chapter four, these practices allow teams to take advantage of all surgical team members' collective knowledge and experience to form an accurate and evolving TMM during IAEs (Davis et al., 2017).

Barriers to Interprofessional Communication During IAEs

The fourth research question addressed the identification of barriers to interprofessional communication. The barriers experienced by participants in this study

often varied based on role and professional tenure. Inexperienced nurses described many barriers to communication that were related to their level of experience in the intraoperative environment and their communication was more impacted by unfamiliarity than the communication of experienced nurses or surgeons. They described communication difficulties resulting from 'not knowing the little things' that other surgical team members seemed know but that weren't passed on to them (tacit knowledge). Inexperienced nurses often felt they were 'thrown into' situations where they were outside of their 'normal zone' and were not aware of the practices of surgical specialties or unfamiliar surgical teams. When this happened, they often were not aware of available resources, such as phone numbers to call to rally 'outside' help. Inexperienced nurses also felt vulnerable to mistakes due to miscommunication when they were suddenly reassigned to different rooms, roles, or were made 'responsible' for learners. They struggled with navigating communication during inconsistency, including working with multiple specialties, feeling there were 'different rules' for communication among surgical teams, and working with surgical team members who had volatile personalities. Inexperienced nurses were more likely to have their communication be affected by time pressure, distractions, tension, and 'pushback' from other team members. While they often felt more comfortable asking surgical residents questions, this strategy often resulted in receiving incomplete or inaccurate information that led to delays or mistakes. Inexperienced nurses also seemed to be more impacted by the perceived social consequences of upward communication. They felt stupid, like they were 'disappointing the surgeon', or like the surgeon might 'take communication the wrong way'. Inexperienced nurses also often did not get opportunities to debrief with

more experienced surgical team members, which resulted in them often not understanding where the 'ball was dropped' or what went wrong during cases.

Experienced nurses seemed to be impacted by unfamiliarity in different ways, possibly because unfamiliarity made them less able to anticipate what was needed from their professional role. Experienced nurses struggled to navigate interprofessional communication when people ignored the 'usual' communication channels or processes. They often felt they were 'put in the middle' during situations where responsibilities, roles, or 'rank' was not clear. Their communication was often influenced by being asked to perform tasks outside of their scope of practice, work with unfamiliar equipment, or being expected to 'read minds'. Experienced nurses were concerned about revealing their knowledge gaps about what they felt they were expected to know. Experienced nurses sometimes feared being belittled or intimidated and often felt their suggestions were rebuffed or ignored. They sometimes felt left out of communication that directly impacted decision-making related to their responsibilities, that their professional experience was invalidated, and that they might not be supported by hospital administration in situations when they had to speak up. Experienced nurses identified inattention, side 'banter', and sarcasm as significant barriers to effective interprofessional communication. Some experienced nurses worked with surgical residents who tried to 'take charge' of the operating room without the necessary experience and knowledge to successfully lead the surgical team.

Surgeons identified many communication barriers that were unique to their role. Surgeons often experienced narrowed awareness of communication that was outside of their current focus. They often missed communication or didn't communicate with others

because they were internally developing the surgical plan, were 'hyper-focused' on stabilizing the patient, or felt 'compressed' while working in a high-stress, time-sensitive situation. In spite of this focus, they often sensed uncommunicated tension in the room and were frustrated when important information was not related to them. Some of the information communicated felt ambiguous, was unclear, or was not communicated early enough to guide their decisions. Surgeons felt 'dependent' on others to communicate effectively while they were at the sterile field, and often had to use proxy communication to obtain the help they needed. Surgeons often experienced the need for increased communication as 'overload' based on their responsibilities, such as when they were responsible for communicating with anesthesia providers, teaching medical students, and coaching inexperienced surgical team members; this overload was increased when working with unfamiliar team members.

The barriers commonly experienced by all study participants were consistent with the perioperative communication literature and included having unclear roles, having unclear responsibilities, having tunnel vision, receiving incomplete or incorrect information, being 'overridden', experiencing distractions and interruptions, delaying or avoiding confrontation, and 'throwing people under the bus' (Aouicha et al., 2021; Ford & Fencl, 2020; Healey et al., 2006; Jung et al., 2020; Keller et al., 2018; Mackenzie & Foran, 2020; Murji et al., 2016; Pasarakonda et al., 2020; Roberts et al., 2021). Cognitive distractions identified by surgeons included those described in the reviewed literature, such as teaching while operating, preplanning for the next case, equipment or device malfunctions, time pressure, and case-irrelevant conversations (Jung et al., 2020; Widmer et al., 2018).

Psychosocial Goals

A compelling finding of this research was the identification of two psychosocial goals that influenced interprofessional communication; most participants in this study described using strategies intended to preserve the flow of cases and protect the face of surgical team members. Developing a better understanding of these underlying psychosocial goals is essential to improving the persistence of interprofessional communication training and interventions. Unfortunately, interprofessional communication training and interventions tend to 'decay' over time (Weller & Boyd, 2014). This decay of communication improvements could be at least partially attributed to the influence of preserving flow and protecting face to prevent the perception of boatrocking by surgical team members when they need to speak up during IAEs. The concept of boatrocking explores how the successful navigation of hierarchy in organizations is often internalized as 'go along to get along', or that expressing dissent or asking questions can be perceived as not being a 'good' team member (Redding, 1985).

Even effective communication training is likely to deteriorate when it is not socially supported through communication culture (Long et al., 2020; Weller et al., 2014). The support of speaking up behaviors through culture is critical, and nurses are particularly vulnerable to pressures to conform to the traditional perception of being a 'good nurse' by avoiding conflict and maintaining the status quo in the intraoperative environment (Chard & Tovin, 2018; Garon, 2012). When questions or speaking up behaviors are perceived as conflict, that perception potentially reduces interprofessional communication and delays the timely response to IAEs. Many study participants also experienced situations where communication was tailored to avoid embarrassing

161

themselves or others. Tailoring communication to protect 'face' through impression management can lead to communication that is ambiguous or protracted and can ultimately delay effective reactions to IAEs.

Surgical team members describe flow as occurring when team members demonstrate the accountability, adaptability, and consistency required to make teamwork feel like a "well-oiled machine" (Paige et al., 2021). The importance of surgical flow has been recognized in the literature and disrupting surgical flow has been shown to significantly increase surgical error (Wiegmann et al., 2007; Wiegmann & Sundt, 2019). The accumulation of even minor flow disruptions has been suggested to "diminish the compensatory resources of the surgical team, increasing their vulnerability and susceptibility to committing errors" (Wiegmann, 2019, p. 260). Flow disruptions have been indicated to result in surgical team distractions, changes in strategy to address problems, and elongated surgical pauses; these disruptions often lead to surgical error or combine to contribute to major disruptive events (Joseph et al., 2019). Disruptions in flow have also been identified to distract surgical team members from their intended tasks, significantly increase cognitive workload, and potentially create even more severe IAEs (Koch et al., 2020). Surgical team members experiencing flow disruptions have also reported increased fatigue, higher stress levels, and longer operative times (Koch et al., 2020). One study focused on the experiences of circulating nurses found that flow disruptions can cause patient care to be compromised when nurses have reduced SA as they attend to flow disruptions (Cohen & Boquet, 2021).

A recommendation to address the psychosocial goal of preserving flow would be to implement planned surgical pauses before and during procedures to allow time for

team member questions or updates to the surgical team. One study identified surgical team perceptions of improved team communication and increased patient safety after the implementation of planned pauses (Erestam et al., 2016). A study by Guidolin et al. identified using structured pauses to establish and reinforce the TMM through five distinct strategies. The first suggested phase includes listing the indications, risks, and potential complications of the procedure. The second phase consists of explaining the plan, goals, and critical steps of the procedure. The third phase is identifying the proposed surgical approach and critical anatomy. The fourth phase includes identifying which surgical team members are responsible for important needed actions during the procedure. Finally, the fifth phase consists of explicitly identifying any new aspects related to the case, such as unusual approaches or related research (Guidolin et al., 2020). Pausing to exchange information and allow for questions allows the surgical team to preserve the surgical flow, answer relevant questions, and facilitate more rapid recognition and response to IAEs.

Implications of this Research

This research identified many practical implications to improve the effectiveness of interprofessional communication during IAEs. These implications are explored below through the described communication phases. A relevant observation from the literature is that much of 'operative training has moved rapidly from problem recognition to solution implementation, for the most part failing to explore how operative teams actually communicate' (Davis et al., 2017, p. 1349). The findings from this study were an important first step to understanding how surgical team members currently communicate

and how interprofessional communication can be improved to facilitate the performance

of highly functioning teams.

> Highly functioning teams are described with the following attributes: situational awareness by team members; effective leadership; empowerment of nonleader members of the team; closed loop communication; critical language and standardized procedures; assertive communication; adaptive and supportive behavior by team members; and follow-up with a reflective debriefing process (Hughes et al., 2014, p. 549).

This research also begins to explain why many trainings and interventions lack

persistence and suggests the implementation of cultural communication support strategies

to improve the surgical team's response to IAEs.

Practical Implications

There were several indicated practical implications for changes that potentially

improve the surgical team's response to IAEs. These implications are explored in the

following sections through the identified phases of communication during IAEs.

Implications for the Recognition Phase. A developing or potential IAE must first be

recognized. Earlier and more consistent recognition of IAEs could be accomplished

through deliberate training of SA. SA is dependent on attention and working memory to

guide decisions about goal-directed behavior (Endsley, 1995). An obstacle to SA in the

intraoperative environment is that often the surgical team members with more

opportunities to notice issues might have less experience interpreting the available

information. This discrepancy could be ameliorated through efforts to shift SA from the

individual to the team (or distributed) level through focused training (Graafland,

Schraagen, Boermeester, Bemelman, & Schijven, 2015). Focused SA training has been

shown to produce team-level improvements, but the results are still considered difficult to

measure (Gardner, Kosemund, & Martinez, 2017). Research by Rosenman et al.,

identified a positive correlation between team SA agreement and surgical team clinical performance (Rosenman et al., 2018).

SA could also be improved through the deliberate use of 'call out' communication by all surgical team members. Call out communication is intentionally verbalizing the initial observation of changes in the intraoperative environment (Härgestam et al., 2013). The use of call out communication could be refined through efforts to make the surgical plan explicit, which would guide team members related to specific issues of concern to be alert for and to notify the surgical team about during procedures. Surgical teams could also deliberately train and reinforce performance monitoring as one of their expected backup behaviors (Johnsen, Westli, Espevik, Wisborg, & Brattebø, 2017). Many participants in this study indicated reluctance to initiate interprofessional communication related to surgical team member lapses or errors; training performance monitoring as a team expectation could potentially promote earlier communication through speaking up behaviors and reduce the time to effectively respond to these issues (Salas, Grossman, Hughes, & Coultas, 2015).

One recommended practice that has been shown to increase both SA and speaking up behaviors while decreasing IAEs is the preoperative briefing (Phadnis & Templeton-Ward, 2018). Implementation of a preoperative briefing with surgical team member introductions, a specific outline of the surgical plan, and anticipated problems has been shown to significantly reduce preventable IAEs and reduce the likelihood that smaller issues develop into IAEs. Briefing before cases start also allows surgical team members to explicitly share their individual mental models and facilitates developing a cohesive, shared TMM (Rutherford, 2017; Salas et al., 2019). Other identified benefits of team

165

briefings include improved patient outcomes, reduced hierarchical communication barriers, and improved team member coordination during increased workload (Pimentel et al., 2021; Stout et al., 1999)(Magill et al., 2017).

Another recommended strategy to increase the recognition of developing or potential IAEs through SA is to define specific surgical phases to be navigated through the use of the 'sterile cockpit' rule. The surgical phases would be defined from an interprofessional perspective and recognized as critical surgical phases when all non-essential behaviors are prohibited (Boet et al., 2020; Keller et al., 2020). Suggested critical phases include the preoperative team briefing, the time out process, induction of anesthesia, surgical counts, specimen handling, and the emergence from anesthesia (Ford & Fencl, 2020). Prohibiting non-essential behaviors during critical phases can increase SA, redirect surgical team focus, and encourage effective performance monitoring.

Implications for the Reconnaissance Phase. When an IAE or potential IAE is recognized, members of the surgical team frequently need to gather more information to determine the needed actions to intervene. The requirement for more information to decide on appropriate interventions suggests the need to normalize questions in the intraoperative environment. The normalization of questions is one of the most critical, immediate facilitators to timely interprofessional communication. Asking questions relevant to patient care should be the expectation of surgical team members; this might best be accomplished by linking this expectation to the concept of surgical conscience. Even study participants who were inexperienced and anxious about speaking up in the intraoperative environment identified specific issues they would 'always speak up about'. If the concept of surgical conscience could be expanded to that of a 'safety conscience'

and taught as a professional imperative, the time necessary for reconnaissance could often be reduced. Implementation of these changes could ultimately reduce the time to appropriate IAE reactions by the surgical team.

Reconnaissance could also be significantly improved through the use of deliberate, ordered communication by experienced surgical team members (White et al., 2018). Ordered communication, such as what is used with the SBAR technique, includes "selecting terminology that facilitates sharing major chunks of information quickly, minimizing unnecessary communication, ensuring that team members share clear and audible information, and sharing information in a predictable order" (White et al., 2018, p. 380). This approach 'filters' information for relevance, groups information for easier synthesis, and creates a communication cadence that can make information easier to understand and act upon by surgical team members. Several participants in this study experienced situations where inexperienced team members were able to increase or accelerate their participation during IAE responses because of the deliberate, ordered manner used to present relevant information during IAEs.

Implications for the Rallying Phase. Rallying in the intraoperative environment can be improved through the use of directed communication, an expectation to rally when necessary, and encouragement of collective agency (Diaz & Dawson, 2020; Lahno, 2017). Directed communication is when specific instructions or requests are made to a particular person or group of people. Directed, specific communication makes it more likely that needed actions will be understood and performed; the use of directed call out communication has been reported to increase the likelihood of 'check back' (response and performance of indicated action) by 50% (Davis et al., 2017). Directed

communication is essential during IAEs because of the increased workload and

mobilization of additional team members.

> Messages or orders of "can someone get me . . ." may go unheard if not directed
> to a specific person or role, or multiple people may attempt to perform the same
> task simultaneously if there is no clarity about who will or should perform the
> task. This leads to unnecessary redundancy and ineffective use of resources (Diaz
> & Dawson, 2020, p. 474).

Surgical team members also need to understand the expectation, regardless of

their role or tenure, to rally others for help when assistance is needed. This expectation is

more likely to be met when all team members, even those with less experience, feel they

have collective agency. In collective agency, "the individual mode of cooperation is

transcended. People take on the goals and values of a group and submit their decisions to

a scheme of actions that is collectively held to be best in view of these goals" (Lahno,

2017, p. 129). Surgical team members who perform their duties using the 'umbrella' of

collective agency feel entitled and even compelled, to make higher-level decisions that

are in the best interest of the patient and the surgical team. These decisions can include

determining the necessity to bring in additional healthcare providers during IAEs without

waiting for permission from higher-ranking surgical team members.

Implications for the Reaction Phase. The use of closed-loop communication has been

shown to reduce medical error significantly and to increase the efficiency and speed of

responses to pediatric emergencies (Abd El-Shafy et al., 2018; Diaz & Dawson, 2020;

Etherington et al., 2019). Closed-loop communication's importance has resulted in its

inclusion in both Team STEPPS and CRM training (Cooke, 2016; Wakeman &

Langham, 2018). Although many study participants described using closed-loop

communication during IAEs, even non-emergent communication could be improved

significantly through verification of instructions within the surgical team. Suggestions for the most effective closed-loop communication include providing complete answers (instead of replying yes or no), repeating the understood information (instead of replying 'understood' or 'okay'), articulating one thought or direction per sentence, and using message markers (like 'instruction' or 'warning' to identify the nature of the direction (Boström, 2020).

Implications for the Resolution Phase. For many participants in this study, the resolution phase of communication related to IAEs was limited to debriefing with peers or even to self-reflection. Debriefing as an interprofessional team could contribute directly to both retrospective and prospective sensemaking. Debriefing as a team also allows surgical team members to identify what parts of surgical procedures went well and any areas of improvement (Neily et al., 2010). Successful debriefing factors include the early engagement of team members, a persistent safety culture, a visible commitment to ongoing debrief practice, and focused feedback (Brindle et al., 2018). Debriefs should include focused discussion of the event, inclusion of developmental intent, exploration of multiple team member perspectives, and the expectation of active learning (Twigg, 2020). The most effective debriefs have been identified as being based on critical performance issues, specific teamwork interactions, and focused feedback at both the individual and team levels held in a psychologically safe learning environment (Allen et al., 2018). Psychological safety has been identified as both a desired outcome of the process and an indicator of the 'success' of debriefs (Keiser & Arthur Jr, 2020). Other reported benefits of debriefing include increased team member agency, increased speaking up behaviors, increased perceptions of emotional support and teamwork, and

169

focused process improvements (Rock et al., 2020). Recommendations from this study are summarized in the following table, Table 5.3: Strategies to Improve IAE Response.

Table 5.3: Strategies to Improve IAE Response

Recognition	Reconnaissance	Rallying	Reaction	Resolution
Strategies to increase SA	*Strategies to improve sensemaking*	*Strategies to influence TMM*	*Strategy to increase team engagement*	*Strategy to improve retrospective and prospective sensemaking*
Focused SA training	Normalization of questions	Directed communication	Use of closed-loop communication	Guided team debriefs after IAEs
Use of call out communication	Use of deliberate, ordered communication	Expectation to rally		
Preoperative briefings				
'Sterile cockpit' implementation				

Theoretical Implications

The findings from this research add to the understanding of how surgical team members currently experience interprofessional communication during IAEs or potential IAEs with a grounded theory that proposes that interprofessional communication within surgical teams is largely situational. The developed grounded theory of Testing the Water demonstrated connections with the ST, CHAT, and SAT theories presented previously in chapter two. Questions were posed at the beginning of this research to guide an exploration to determine if the motivations and perceptions involved in interprofessional communication during IAEs or potential IAEs demonstrated potential relationships with

the identified implications of ST, CHAT, and SAT. Participant narratives did identify

perceptions of existing rules, norms, tools, and recursive, reciprocal influences among

individuals, systems, and structures (Canary, 2010). Participants in this study also

described working within systems including structures that involved meaning

(signification), norms (legitimation), and power and authority (domination). (Seamons &

Canary, 2017). The following table, Table 5.4: Connections to Theory, includes answers

to the questions posed in the second chapter as they relate to the participants in this study.

Table 5.4: Connections to Theory

Structuration Theory	*Impressions from Participant Narratives*
Are there indications participants believe they are acting within/outside of the bounds of existing structure?	Yes. Many participants described being aware of things they felt they could/couldn't say or should/shouldn't say because of their perceptions of existing structure (communication culture). Other participants were willing to 'go around' the existing structure to ensure the performance of needed actions.
Do participants describe 'filtering' or limiting their interactions based on explicit or tacit expectations?	Yes. Participants felt there were certain accepted actions or conversations and would often 'filter' what they needed to convey through humor, 'acting dumb', and the use of proxy communicators. Some participants also 'opted out' or 'dropped it' if the surgical team did not seem to agree with their opinions or suggestions.
Do participants describe their actions as proactive or reactive? Do they reflect on the interactions and outcomes?	This seemed to be closely related to participant tenure and professional role. Participants with less tenure seemed to be more reactive, while participants with more tenure were often proactive. Many participants described reflecting on the responses to their attempts to communicate with the surgical team.
Do participants reflect on how actions contribute to structure? On how their actions are influenced by structure?	Participants with more tenure seemed to be more likely to reflect on how actions contribute to structure; they were also

	more likely to feel they could influence the existing structure. Participants with less tenure seemed more likely to feel their actions were influenced by structure.
Do participants describe recursive practices that influence structure? Their contributions to structure?	Many participants related experiences that demonstrated this. The contributions of recursive practice to structure were often demonstrated through practice changes.
How do participants describe their perceptions of the influence of structure on interaction?	This varied by the tenure and professional roles of the participants. Some participants felt the existing structure was enabling, while others found it constricting.
How do participants experience the evolution of structure through their actions?	Many participants were less likely to repeat actions or suggestions that seemed unacceptable to the surgical team, which tended to reinforce the existing structure. Other participants were deliberate in their efforts to 'go around' existing structure to accomplish actions they perceived as necessary to protect their patients.
Cultural-Historical Activity Theory	***Impressions from Participant Narratives***
Do participants describe perceived social or professional boundaries? Expectations? As an individual? As a team member?	Yes. Almost all participants described being influenced by social and professional boundaries based on perceived expectations of their professional role and their 'status' as a team member.
Do participants describe conflicts between individual goals (professional responsibilities or concerns) and the object (interdependent surgical patient care)?	Yes. Participants identified both internal and external conflicts related to the rights and responsibilities of surgical team member roles. IAEs often seemed to increase these conflicts.
Do participants describe perceptions of being influenced by the procedural or language norms of the activity system?	Yes. Most participants seemed to be deliberately conscious of how they thought things were 'supposed to be' and the things they were 'allowed to do' based on their professional role and tenure.
Do participants describe perceptions of being enabled or constrained by the rules of the activity system?	Yes, there were situations when participants felt enabled and others where they felt constrained. Again, this seemed to be related to professional roles and tenure. Some participants with more experience were likely to ignore perceived 'rules' of communication when the need

	for compliance with existing rules/norms was overridden by the need to respond to IAEs.

Methodological Implications

Using grounded theory to identify patterns of behavior among surgical team members allowed a deeper understanding of how participants in this study experienced the psychosocial process involved in establishing and maintaining communication during IAEs. Identification of common communication strategies and behaviors revealed the common psychosocial goals of protecting the flow of surgical cases and protecting the face of surgical team members. Supporting these psychosocial goals through the development of a communication culture that promotes psychological safety should improve and extend the results of communication training and interventions.

Strengths of the Research

This grounded theory study had several strengths. Although there is a large body of quantitative research related to interprofessional communication in the intraoperative environment, much of that research focuses on the content and quantity of communication. Using qualitative research allowed the researcher to 'take a step back' and focus, instead, on the context and quality of interprofessional communication surrounding IAEs. Performing in-depth interviews with a smaller number of participants also allowed for a deeper exploration of each participant's experiences through guided and flexible questioning. Another strength was that study participants were very willing to communicate openly with the researcher due to the depth of the researcher's subject familiarity with the intraoperative environment and the perception of the researcher as an 'insider'. The researcher's subject familiarity allowed for an informed, thoughtful

interpretation of the participant narratives. Another strength of this study was the wide range of professional experience or tenure among the participants in this study. This range facilitated an understanding of how tenure can influence perceptions and motivations during interprofessional communication, regardless of the participant's professional role.

Limitations

There were recognized limitations to the completed dissertation research. First, the purposive, convenience, and theoretical sampling strategies indicated for use with grounded theory had the potential to produce a biased sample (Kolb, 2012). Second, since the primary researcher for the study practiced as a nurse within the intraoperative environment, it was essential to recognize, address, and adjust for possible researcher bias during data collection and analysis to ensure the researcher's perspective and experience allowed for clarity in the interpretation and representation of the results (Levitt, Motulsky, Wertz, Morrow, & Ponterotto, 2017). Third, even when study participants honestly and completely related their experiences of interprofessional communication, the narrative accounts described only their perspective of the communicative interactions as well as their selection of the communicative interactions they choose to share; a more balanced view of the communication involved could perhaps be realized if participants were interviewed regarding the same interactions. Fourth, the understanding of interprofessional communication gained from the research is potentially only generalizable to participants from the specific operative units or their surgical teams because of the complexity of team communication culture. Fifth, because there was little diversity in the participants who volunteered to participate in the study,

174

their experiences might not represent the experiences of surgical team members of other genders, races, ethnicities, or those who speak English as a second language. Finally, because the study focused only on the experiences of surgeons and surgical nurses, the experiences of other professional roles such as anesthesia providers and surgical techs were not considered.

Recommendations for Future Research

There are several ways future research could address the identified limitations of this study. Future research could include multiple recruitment sites, represent more professional roles from the surgical team, recruit more diverse participants, and interview multiple participants involved in the same IAEs to better understand the different perspectives. Another compelling area for research is an in-depth exploration of the language surgical team members use when describing their perspectives and motivations during interprofessional communication. Many participants in this study used language that suggested emotional responses to ineffective communication interactions, such as feeling 'stupid' or incompetent, even when dealing with entirely unfamiliar situations.

Conclusion

Interprofessional communication during IAEs is a complex psychosocial process that is profoundly impacted by professional socialization and existing communication culture. Efforts to influence this psychosocial process through communication trainings and interventions have resulted in varying levels of effectiveness and persistence. The purpose of this grounded theory study was to provide an initial exploration of the psychosocial processes experienced by surgeons and surgical nurses during the establishment and maintenance of interprofessional communication during IAEs. This

175

study provided insight into those experiences through the development of a grounded theory framework entitled Testing the Water. Testing the Water identifies the strategies and psychosocial goals involved in the situational negotiation of interprofessional communication as experienced by surgeons and surgical nurses.

The identification of underlying psychosocial goals potentially explains why the effectiveness of communication training and interventions varies widely in the intraoperative environment. Support of the psychosocial goals of preserving flow and protecting face can be accomplished using practical strategies such as pausing to allow 'safe times' to exchange information without disrupting the surgical process and normalizing questions and backup behaviors within the surgical team. These simple communication changes potentially allow the surgical team to recognize minor errors earlier and prevent error escalation into more severe IAEs.

There are many aspects of the intraoperative environment that are unlikely to change. Surgical teams will continue to be composed of multiple professions shaped by socializing factors that contribute to perceptions of hierarchy. Surgical teams will also often, out of necessity, continue to function as dynamic, ad hoc action teams that must navigate the complexities of interprofessional communication that are unique to each iteration of providing surgical care. Research has suggested that the influence of human factors during the surgical process is inescapable but that the influence of these factors *can* be mediated by developing and supporting psychological safety. Supporting psychological safety addresses both IAEs that occur because of error and those that result from complexity. Recognition and response to the complexity of the intraoperative environment support the need to explore the surgical team as an interdependent, complex

adaptive system instead of reducing the perception of the functioning of the surgical team to the individual roles performed by surgical team members. Surgical team members are inherently social creatures, and as such, are likely to continue to Test the Water to socially integrate themselves into high-functioning surgical teams. The challenge is to provide opportunities to shift our communication expectations during interdependent surgical care provision from our social voice to our safety voice - and to the collective voice that endeavors to speak, ultimately, for our patients.

Appendices

Appendix A - Interview Guide

Sample initial data-generating questions include:

You indicated that you experienced an event in the operating in which interprofessional communication led to an IAE or a potential IAE.

1) Tell me about the event. *Researcher will encourage participant to give a 'play-by-play' description of the event – to describe as closely as possible the actual conversations and interactions that took place. Possible prompts include: "Take me back to the time when…" and "Help me understand what really happened."*
2) Tell me who was in the operating room at the time - you don't need to refer to team members by their names, but it would be helpful for me to know their roles - such as the nurse or the anesthesiologist.
3) Tell me all you can remember about the communication that surrounded the event.
4) How did the communication start? What happened next?
5) How would the discussion unfold?
6) In that situation, what were the barriers to communication?
7) In that situation, what were the facilitators for the communication?
8) Did anyone in the room not participate in the communication? Why do you think they weren't a part of the conversation?
9) How did the event end? Was there any discussion about the event after it occurred (was resolved?)
10) Do you think what happened was due to the behavior of an individual who was involved, or could it have been something else? Some people I've talked to have mentioned things like distractions, time pressure, process failures, equipment malfunctions, or inadequate resources as contributing to their IAE. Do you think anything like that contributed to this event?

You have told me about an instance in which interprofessional communication in the operating room led to an IAE or potential IAE; conversely, could you give me an example of when communication led to a *good* outcome, such as a near-miss or an 'averted' IAE?

1) Tell me about the event. *Researcher will encourage participant to give a 'play-by-play' description of the event – to describe as closely as possible the actual conversations and interactions that took place. Possible prompts include: "Take me back to the time when…" and "Help me understand what really happened."*
2) Tell me who was in the operating room at the time - you don't need to refer to team members by their names, but it would be helpful for me to know their roles - such as the nurse or the anesthesiologist.
3) Tell me all you can remember about the communication that surrounded the event.

4) How did the communication start? What happened next?
5) How would the discussion unfold?
6) In that situation, what were the barriers to communication?
7) In that situation, what were the facilitators for the communication?
8) Did anyone in the room not participate in the communication? Why do you think they weren't a part of the conversation?
9) How did the event end? Was there any discussion about the event after it occurred (was resolved)?

Demographic information:

Professional role:

Time in current role:

Time on current specialty team (if applicable):

I work with many of the same team members:

Less than 25% of the time   Between 25% and 50% of the time

Between 50% and 75% of the time   More than 75% of the time

Length of employment in facility:

Gender:

Age:

Appendix B - Reflexive questions suggested by Charmaz

1) Does the researcher adequately prepare participants for what to expect during the interview process?

2) Do the questions in the interview guide reflect researcher interests and views or the participant experience?

3) Are researcher assumptions shaping the content or focus of the interview?

4) Has appropriate background information been collected to allow understanding of the participant experience?

5) Are the interview questions clear and concise?

6) How would the interview questions sound to participants who have had these experiences? Is the language appropriate?

7) Do the interview questions adequately elicit participant accounts of the experience, including their concerns, and views?

8) Are the questions open-ended?

9) Are the follow-up questions being used suitable to probe for more information? Are they too intrusive?

10) Is researcher pacing appropriate?

(Charmaz, 2014)

Appendix C -Trustworthiness in Qualitative Research

Trustworthiness

	Considerations	Strategies
Credibility *(validity)*		
	Prolonged engagement in the field	Building rapport with participants and understanding their culture
	Triangulation	Using different methods, investigators, and theories to provide corroborating evidence
	Structural corroboration	Using multiple types of data to support or contradict the interpretations
	Consensual validation (peer review)	Seeking the advice of experts through consultation with committee members
	Clarifying researcher bias	Addressing and possibly adjusting for researcher bias based on experience and position
		Showing representative quotations
Dependability *(reliability)*		
	Intercoder agreement	Seeking the advice of experts through consultation with committee members
Transferability		
	Thick description	Providing details that allow the reader to determine shared characteristics (and determine transferability)
	Purposive sampling	Performing ongoing analysis to encourage lines of inquiry that drive sampling
Confirmability		
	Establishment of value of data	Providing an audit trail including memos, decisions and their rationale

(Creswell, 2013; Morse, 2007)

181

Appendix D – Definitions of Terms

Action teams	Action teams are teams are teams "in which expertise, information, and tasks are distributed across specialized individuals, where team effectiveness depends on rapid, complex, and coordinated task behavior, and the ability to dynamically adapt to the shifting demands of the situation" (Kozlowski et al., 1996, p. 254)
Briefing	Briefing describes surgical team communication that occurs *before* the surgical procedure to clarify procedural expectations, encourage questions from team members, and clearly define professional roles and responsibilities (Donnelly, 2017).
Closed-loop communication	Closed-loop communication is a three-step communication model where the sender transmits a message, the recipient acknowledges the message with a 'checkback' that verbalizes their understanding of the message, and the sender verbally verifies the receipt of the message and its interpretation; this is described as 'closing the loop' (Härgestam et al., 2013).
Collaboration	Collaboration has been described as a "process in which autonomous or semiautonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions" (Thomson, et al., 2007, p. 25).
Collaborative practice	Collaborative practice is coordination of independent actions to accomplish shared objectives
Debriefing	Debriefing describes surgical team communication that takes place *after* the surgical procedure and allows the surgical team to collectively process events to better deliver care and identify resources for future cases (Steelman, 2014).
Emergent states	Emergent states are constructs that demonstrate dynamic properties of teams that vary as a function of inputs, processes, outcomes, and context. Emergent states are demonstrated through the affective, cognitive, and motivational states of teams rather than through the nature of team member interactions (Marks et al., 2001).

Influencing conditions	Influencing conditions are described as factors such as composition, culture, and context that influence how teams operate (Salas et al., 2015).
Interprofessional collaboration	Interprofessional collaboration has been identified as "an active and ongoing partnership often between people from diverse backgrounds with distinctive professional cultures and possibly representing different organisations or sectors, who work together to solve problems or provide services" (Morgan, et al., 2015, p. 1218). Interprofessional collaboration occurs when members of different professional groups use open communication to make decisions, manage conflict, and solve problems to positively impact patient care (Careau et al., 2015; Nair et al., 2012).
Interprofessional collaborative practice (ICP)	ICP within healthcare delivery is when two or more people from different professions *actively engage* to coordinate and provide patient care *within a practice setting* (Morgan et al., 2015). ICP is a process in which autonomous or semiautonomous participants interact through formal and informal negotiation using socially-acceptable and socially-institutionalized enactment of professional roles as they jointly create rules, norms, and structures governing their relationships, goal-directed activities, and decision making. (Thistlethwaite et al., 2013; Thomson et al., 2007).
Interprofessional communication	Interprofessional communication is the exchange of information between and among surgical team members performing different professional roles that includes verbal, para-verbal, and non-verbal elements (Etherington et al., 2019).
Intraoperative adverse event (IAE)	An IAE is any intraoperative deviation or injury caused by healthcare delivery rather than underlying disease (Mavros et al., 2014).
Practice	The concept of practice in healthcare has been identified as the socially-acceptable and socially-institutionalized enactment of professional roles (Thistlethwaite et al., 2013).
Prospective sensemaking	Prospective sensemaking occurs when the concern and attention of the surgical team is deliberately directed toward events that may happen in the future, collective expectations are formed, and interrelated team actions are refined to construct a more manageable situation or an optimal outcome. Prospective sensemaking

	contributes to the formation of a dynamic team mental model.
Proxy efficacy	Proxy efficacy is one's belief in the skills, abilities, and willingness of a third party or parties to function effectively on his or her behalf to facilitate desired outcomes (Bandura, 1995)
SBAR	SBAR is an acronym for the Situation, Background, Assessment, and Recommendation technique designed to facilitate interprofessional communication. The speaker describes the situation that prompted initiation of the communication, relays the background or history of the patient, reports his or her assessment of what is happening, and makes a recommendation for treatment or problem correction (Shahid & Thomas, 2018).
Silence	Silence is "the conscious withholding of information, suggestions, ideas, questions, or concerns about potentially important work- or organization-related issues from persons who might be able to take action to address those issues". Silence often occurs because of because of "fear, concerns about negative repercussions, or feelings of futility". It can be silence can be "an automatic withdrawal response, a habituated behavior, or a deep state of resignation (Morrison, 2011).
Situational awareness (SA)	Situational awareness is the shared, dynamic, and evolving understanding of environmental elements that includes the (1) perception of those elements, (2) comprehension of their contextual meaning, and (3) projection of their significance to the situation (Endsley, 1995).
Socialization	Socialization into professional roles is the process by which individuals gain the social knowledge for assuming their roles within organizations. Socialization includes developing relationships with others; learning the values, goals, and technical language of the profession; and understanding the profession's customs, myths, rituals, and traditions (Hall, 2005; MacArthur et al., 2016; Thistlethwaite et al., 2013).
Surgical never events	Surgical never events are defined as events that should never occur, and include retained foreign bodies, wrong-site surgeries, wrong-patient surgeries, and wrong-procedure surgeries (Mehtsun et al., 2013).
Team mental model (TMM)	A team mental model is the team members' mental representation and shared understanding of relevant knowledge to the team's task environment. The TMM includes *shared* team- and task-related knowledge that

184

	allows the team to similarly interpret the information, develop shared expectations for the future, and have similar explanations for situations. TMMs also facilitate more accurate direction of resources and anticipation of other team members' needs (Fernandez et al., 2017).
Teamwork	Teamwork has been identified as occurring among "a collection of individuals who are *interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems* and who manage their relationships across organisational boundaries" (Cohen & Bailey, 1997, p. 239). Teamwork is the interdependent coordination of activities and decisions through deliberate sharing of resources and information to attain shared goals (Dickinson & McIntyre, 1997).
Traits	Traits are processes that are internalized by the team and stabilized over time. Traits include positive behavior norms, cohesion, and cooperation, and have been associated with perceived team effectiveness and team member satisfaction(Lemieux-Charles & McGuire, 2006).
Voice	Voice has been defined as upward discretionary verbal expression with constructive intent (Morrison, 2011)

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194

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Curriculum Vitae

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Education

- Doctor of Philosophy in Clinical Nursing Science (Minor-Health Communication), Indiana University, earned at IUPUI, Indianapolis, IN (2014-2021)

- Bachelor of Science in Nursing, Indiana University, earned at IUPUI, Indianapolis, IN (2008-2009)

- Bachelor of Science in Elementary Education, Auburn University, earned at AUM, Montgomery, AL (1995)

Fellowships and Grants

- 100th Anniversary Scholars Fellowship, IUSON

- Indiana Nurses Foundation (research grant)

- Sigma Theta Tau International, Alpha Chapter (research grant)

Professional Memberships

- AORN

- Sigma Theta Tau

Certifications and Licenses

- Registered Nurse, state of Arizona (2018-present)

- Registered Nurse, state of Indiana (2010-present)

- CNOR (2013-present)

- Team STEPPS Master Trainer (2014)

- Quality Assessor Training for International Missions (Operation Smile – 2019)

- **Volunteer Service – International Surgical Missions**

  - Cambodia 2015

  - Peru 2015

  - Vietnam 2016

  - Malawi 2016

  - Philippines 2016

  - Ghana 2017 (nurse educator)

  - Madagascar 2018 (nurse educator)

  - Kenya 2019

Publications

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