EVALUATION OF A SCIENTIFICALLY DEVELOPED ANESTHESIOLOGY HANDOFF PROTOCOL

by

Kristen Lise Welsh Webster

A Thesis Submitted to the Department of Human Factors in the College of Arts and Science in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy.

Embry-Riddle Aeronautical University
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This dissertation was prepared under the direction of the candidate's Dissertation Committee Chair, Dr. Joseph R. Keebler, Professor, Daytona Beach Campus, and Dissertation Committee Members Dr. Elizabeth H. Lazzara, Professor, Daytona Beach Campus, and Dr. Scott A. Shappell, Professor, Daytona Beach Campus, and Dr. Laura L. Roberts, Professor, Medical University of South Carolina and has been approved by the Dissertation Committee. It was submitted to the Department of Human Factors in partial fulfillment of the requirements for the degree of Doctor of Philosophy

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Abstract

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Institution: Embry-Riddle Aeronautical University

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Communication failures have been cited as the leading cause of avoidable adverse events in healthcare. Specifically, within handoffs, these communication failures can cause error in the transfer of patient information. A multitude of factors can affect the transmission of patient information between providers including transactive memory, power distance, and conversational noise; however, literature suggests that the use of handoff protocols assist in improving communication and efficiency during handoffs. Studies regarding handoffs have typically centered on the content or delivery of the information during the handoff. To date, none have targeted the underlying mechanisms of the communication and their effects on the handoff conversation between providers. Furthermore, protocol creation is commonly accomplished using Delphi methods, rather than empirical methods. This dissertation aims to implement an empirically derived handoff protocol and to test variables grounded in the communication mechanisms of the handoff conversation, which are associated with handoff efficiency.

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“Where the greatest successes of one's life are charted ... Where fortunes are won and lost... Where characters are forged. If you never venture beyond what you know... You've spawned your own limitations.”
– Sumner Redstone

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TERMS AND DEFINITIONS

Term	Definition
Handoff (transition of care)	Conversations between providers when transitioning patient care
Handoff protocol	An organized structure for delivery of information during the handoff
Handoff efficiency	The ability to pass the necessary information needed during a handoff without an extraneous waste of time
Transactive memory	The ability for group members to rely on others for information according to the individual's specialty
Turn-taking	The "give and take" in a conversation where individuals each speak
Conversational noise	Any barrier that causes the clarity of the message to be distorted
Power distance	The perception that some individuals are of higher status than other in the hierarchy

LIST OF ABBREVIATIONS

1. Operating room (OR)
2. Post Anesthesia Care Unit (PACU)
3. Certified Registered Nurse Anesthetist (CRNA)

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CHAPTER I: INTRODUCTION

Statement of the Problem

Since the release of the U.S. Institute of Medicine's 1999 report, "To Err is Human: Building a Safer Health System," adverse events have continued to plague the healthcare system. Current data suggests that more than 400,000 patients die due to preventable error (Aspden et al., 2007; James, 2013; Makary & Daniel, 2016). In fact, medical errors have been determined to be the third leading cause of death in the United States (Makary & Daniel, 2016). Approximately 80% of these errors could be attributed to communication failures (Joint Commission, 2012). Specifically, handoffs (also known as handovers, transitions of care, sign-outs, etc.) were recognized as being susceptible to poor communication that could lead to errors in patient care (Maughan, Lei, & Cydulka, 2011). Handoffs are defined as the "real-time process of passing patient-specific information from one caregiver to another or from one team of caregivers to another for the purpose of ensuring the continuity and safety of the patient's care" (Joint Commission, 2008 p. 65).

Although handoffs allow an opportunity for healthcare providers to communicate patient details, issues, and possible treatments, they are vulnerable to problems. In an attempt to lower the communication failures during handoffs, the Joint Commission (2007) mandated the process of handoffs be standardized and include opportunities for participants to ask and answer questions. While the Joint Commission assessed a 94% compliance with the rule the following year, communication errors continued. Despite movement to improve the handoff process and documented compliance with the new mandate, morbidity and mortality increased (Greenberg et al., 2007; Mueller et al., 2012).

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Intuitively, it would seem that the best decision would be to make handoffs as thorough as possible, transferring every detail about a patient's care from one provider to the next. However, due to time demands of providers, handoffs must be efficient, succinct, and purposeful in order to accomplish the goal of transitioning care and responsibility without keeping the provider from other responsibilities for too long. This means that providers must prioritize what information is deemed most important when transitioning patient care.

Since the Joint Commission's mandate lacked specificity as to what should be included in a standardized protocol, it left the rule open to interpretation by individual facilities. Consequently, healthcare professionals began creating handoff protocols on their own (Riesenberg, Leitzsch & Little, 2009; Riesenberg, Leitzsch, & Cunningham, 2010). While literature suggests that any protocol is better than no protocol, it is not clear which protocol is ideal (Keebler et al., 2016). Additionally, professionals focused most frequently on the content of the handoffs, questioning what information should or should not be presented and less so on the structure of the conversation, the process of communication, and the social interaction that takes place during the conversation (Johnson, Sanchez & Cheng, 2016; Cohen & Hilligoss, 2009). Since literature lacks a significant amount of evidence discussing handoffs as a conversation, it seems prudent to contribute to the literature by studying handoffs from a social technical perspective including factors such as teamwork, shared memory, and expertise-based hierarchies, (one based in social interactions and implicit conversational skills). As a handoff is "more than just information transfer" (Manser, Foster, Gisin, Jaeckel, & Ummenhoffer, 2010, p. 1), studying the underlying constructs of communication present in the handoff can

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possibly create clarity to how and why handoff protocols improve efficiency and potentially patient safety. To achieve this goal, this study has selected variables that correspond with the “ABCs” of teamwork: attitudes, behaviors, and cognitions (Refer to Table 1).

Table 1. *Construct and variables measured*

Construct	**Variable Measured**
Attitudes	Power distance
	Transactive memory perceptions
	Perceptions of handoff efficiency
Behaviors	Turn-taking
	Handoff efficiency
Cognitions	Transactive memory

Purpose of the Current Study

The targeted handoffs consistently occurred between anesthesia providers and registered nurses in the Post Anesthesia Care Unit (PACU). Consequently, this study did not include any of the other roles that are commonly present in the unit (i.e., surgeons, perfusionists, circulating nurses, etc). Additionally, observations were limited to general surgery due to time constraint and patient status. Limiting the status of patients being handed off assisted in eliminating confounds since patients from different surgeries present with a multitude of differing complications possibly requiring different amounts of time for information relay in the handoff.

With these patients and corresponding handoffs in mind, the purpose of this study was twofold. First, this study analyzed the effects of implementing an empirically derived handoff protocol in the perioperative setting with the goal of improving handoff efficiency. Second, this study analyzed numerous variables that affect communication during handoff protocols.

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This study specifically contributes to the communication theory and handoff literature by analyzing the use of a scientifically derived protocol at an academic institution. Additionally, this study used conversational process variables and, in doing so, expands understanding into the underlying themes of communication in regard to the handoff process by considering the handoff as a conversation, rather than a protocol.

Conversations are built on predetermined and often taken-for-granted rules that are taught by the society in which an individual is raised. These rules influence the ways in which individuals converse with each other, including medical professionals. In turn, medical professionals bring these conversational rules into their jobs, even during handoffs. These rules influence when the conversational floor changes between individuals, in other words, when a person speaks and when a person listens, known as turn-taking. This turn-taking can be altered based on the power distance between those participating in the conversation. For example, when an anesthesiologist and a nurse talk about a patient's status, the nurse may feel that she/he does not have the authority to interrupt while the anesthesiologist is speaking. This power distance is created by individual factors such as gender, experience, and role. When there is a difference in these individual factors, those that have a perceived lower status choose not to take turns, or those with perceived higher status do not let others speak.

Conversational noise is any barrier that causes a hindrance in the effective transmission of information. For instance, a loud noise that is distracting to the participants in the handoff can hinder transfer of information during the handoff. Transactive memory, or a provider's awareness of his/her coworker's expertise, can aid in the effective and efficient transmission of information. By way of illustration, a

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physician may skip over certain parts of the treatment plan because (s)he is aware that the receiving nurse has a history of caring for such patients and will already be familiar with the related medications. Rather than listing and explaining the medication and doses of each, the physician may say, "Medications are the usual." These variables will be further discussed in the literature review. Figure 1 presents a graphical representation of the proposed model depicting the relationships between these constructs.

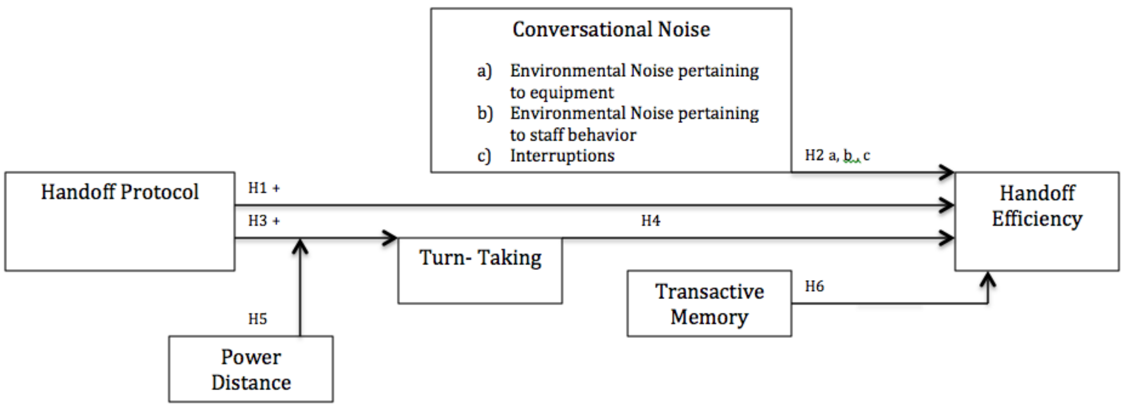

Figure 1. *Handoff Model*

Hypotheses Overview

H1: Handoff Protocol to Handoff Efficiency. **H2**: Conversational Noise to Handoff Efficiency. **H3:** Handoff Protocol to Turn-taking. **H4:** Turn-taking mediates the relationship between Handoff Protocol and Handoff Efficiency. **H5:** Power distance moderates the relationship between handoff protocol and handoff efficiency **H6:** Transactive memory to Handoff Efficiency.

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CHAPTER TWO: LITERATURE REVIEW

Conversations are common in everyday life. While all conversations transfer information, not all conversations include information that specifically deal with the health and well-being of an individual. Handoffs are conversations between providers when transitioning care of a patient and, therefore, include pertinent information needed for continuing care of the patient in a timely and effective manner. Like any other conversation, a handoff can be affected by a multitude of factors. This section will offer insights as to what handoffs are, why handoffs were implemented within the healthcare industry, what factors influence handoff efficiency, and how handoffs are affected by a multitude of variables including conversational noise, turn-taking, power distance, and transactive memory.

Handoffs

Definition of Handoffs. The definition of a handoff varies between facilities and organizations, sometimes not even being called by the term "handoff" (Runny, 2008). Synonyms for handoffs include sign-out, rotations, sign-offs, shift report, sign over, cross-coverage, and transitions in care (Cohen & Hilligoss, 2009; Friesen, White, & Byers, 2008). Each of these terms can carry a different connotation. While some focus on the content of the conversation (patient information), others focus on the exchange of responsibility (legal responsibility) (Cohen & Hilligoss, 2009). According to the Joint Commission (2008), a handoff is "a contemporaneous, interactive process of passing patient-specific information from one caregiver to another for the purpose of ensuring the continuity and safety of patient care." The Medical Dictionary (2016) defines a handoff as "the transfer of patient care from one healthcare provider to another or from one healthcare facility to another," while a handover is "the passing of care of one or more patients to the doctors and nurses working on the next shift, informing them of tests

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ordered, management issues, and evolving and resolving problems." The underlying theme of all these definitions can be reduced to "the transfer of patient care." This creates a foundational definition of a handoff from which an incredible amount of detail may be added. What information is included and who must be present for the handoff varies between institutions, units, and patient cases. With a lack of a standardized definition and/or detail of what should be included in a handoff as mandated by a governing body, healthcare professionals use existing handoff protocols or create their own.

Types of handoffs. Standardization of handoffs is difficult because they vary drastically based not only upon the needs of the physicians, staff, and patient but also the area in which they are taking place. They fluctuate based upon who is involved in the handoff, oftentimes conforming to the needs of the expertise present. Handoffs can be further delineated to new patient transfers, continuing patient transfers, and cross boundary transfers. New patient transfers are limited to personnel having similar expertise, such as a day shift nurse handing off to the night shift nurse. Continuing patient transfers develop when similar expertise and a mutual knowledge of the case takes place. An example would be when a patient is handed off from the night nurse back to the nurse who admitted the patient the previous day. Lastly, cross-boundary transfers occur between personnel of differing/distinct expertise, like an Emergency Room physician handing off to a floor nurse. These handoffs commonly occur between departments and are limited to one patient at a time whereas other forms of handoffs can sometimes include multiple patients. Providers can tailor handoffs based upon the type of format/media used. Traditionally, handoffs have been conducted orally with face-to-face interactions or over the phone, but busy schedules sometimes force handoffs to take place through texts, email, or paper. Additionally, "recorded components of a handoff include informal notes, audio recordings,

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formal documents, entry into the electronic medical record (EMR) and computerized handoff systems" (Cohen & Hilligoss, 2009, p. 13-14). Furthermore, while it is possible for a hospital to standardize within its own facility, protocols can vary drastically between institutions, hospitals, departments, and available technology.

Handoff Protocols. Literature has shown that handoff protocols have helped alleviate communication failures (Wayne, et al., 2008) and increased the amount of information passed between providers while decreasing the amount of time taken in the handoff thereby, increasing handoff efficiency (Burton, Kashiwagi, Kirkland, Manning, & Varkey, 2010; Lazzara et al., 2016). Due to the limited guidance as to how a handoff protocol should be constructed, the market has been flooded with a multitude of different protocols including mnemonics. Some well-known protocols use mnemonics to capture required information and assist in increasing memory retention during handoffs (e.g., SBAR, IPASS). Mnemonics assist the provider by arranging information according to the letters in the word, which is usually an acronym. More than a memory aid, the mnemonics provide a structure for communication. Currently, there are more than 35 different mnemonic devices used to create a handoff protocol (Riesenberg, Leitzsch, & Little, 2009; see Table 2 for a list of various handoff protocol mnemonics). Of the many that have been created, only one presented compelling evidence to suggest that a mnemonic protocol increases consistency and confidence (not efficiency) when compared to an informally structured process, (Horwitz, Moin, & Green, 2007; Starmer et al., 2012). Although mnemonics are popular, there are a multitude of protocols outside of those listed in Table 2 that do not include mnemonics.

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Table 2. *List of mnemonics-based protocols and concepts*

Mnemonic	General Concepts	Article/Creator
SBAR	Situation, Background, Assessment, Recommendation	
IPASS	Illness Severity, Patient Summary, Action List, Situation Awareness and Contingency Planning, Synthesis by Receiver	Starmer et al., 2012
Flex 11	Access, Current Issues, Demographics, FEN/GI, Labs/Tests, Medication, Patient Summary, Plan, Respiratory, Social, Surgery, Information to be given if needed	Lazzara et al., 2016
AIDET	Acknowledge the patient, Introduce yourself, Duration of the procedure, Explanation of process and what happens next, Thank you for choosing our hospital	Mathias, 2006
ANTICpate	Administrative data, New information, Tasks, Illness, Contingency	Vidyarthi, Arora, Schnipper, Wall, & Wacher, 2006
ASHICE	Age, Sex, history, Injuries, Condition, Expected time of arrival	Budd, Almond, & Porter, 2007
CUBAN	Confidential, Uninterrupted, Brief, Accurate	OR Manager, 2006; Currie, 2002
DeMIST	Patient Demographics, Mechanism of injury, Injuries sustained, Symptoms and signs, Treatment given	Talbot & Bleetman, 2007
GRRRR	Greeting, Respectful listening, Review, Recommend or request more information , Reward	Boynton, 2007
HANDOFFS	Hospital location, Reward, Allergies/adverse reactions/medications, Name/number, Do not attempt resuscitation, Ongoing medical/surgical problems, Facts about this hospitalization, Follow up	Brownstein & Schleyer, 2007
I PASS the BATON	Introduction, Patient, Assessment, Situation, Safety concerns, Background, Actions, Timing, Ownership, Next	Sandlin, 2007; Improve handoffs, 2006
Just Go Nuts	Name, Unusual/Unique, Tubes, Safety concerns,, Safety concerns	A nutty idea, 2006; Pass the baton, 2007

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MIST	Mechanism of injury, Injuries sustained, Signs, Treatment initiated	Budd, Almond, & Porter, 2007; Sandlin, 2007
PACE	Patient/problem, Assessment/actions, Continuing/changes, Evaluation	Schroeder, 2006
PEDIATRIC	Problem list, Expected tasks to be done, Diagnostic one-liner, If/then, Administrative data, Therapeutics, Results, IV access, Custody and current issues	Arora & Johnson, 2006
I-SBAR	Introduction, Situation, Background, Assessment, Recommendation	Improve handoffs, 2006; Q&A, 2006
SBARR	Situation, Background, Assessment, Recommendation, Response or Readback	Guise & Lowe, 2006
SBAR-T	Situation, Background, Assessment, Recommendation, Response or Readback, Thank patient	Federwisch, 2007
SHARED	Situation, History, Assessment, Request, Evaluate, Document	Sharing information, 2005; Mathias, 2006
SHARQ	Situation, History, Assessment, Recommendations, Questions	Sandlin, 2007
SIGNOUT	Sick or DNR, Identify data, General hospital course, New events, Overall health status, Upcoming possibilities, Task to complete overnight,	Horwitz, Moin, & Green, 2007
SOAP	Subjective information, Objective information, Assessment of the patients conditions, Plan	Kilpack & Dobson-Brassard, 1987.
STICC	Situation, Task, Intent, Concern, Calibrate	Boynton, 2007; Sutcliff, Lewton & Rosenthal, 2004
4 P's	Purpose, Picture, Plan, Part	Hansten, 2003
5 P's v.1	Patient Identity, Plan of care, Purpose, Problems, Precaution,	Sandlin, 2007; Ellis, Mullenhof, & Ong, 2007
5 P's v.2	Patient, Precautions, Plan of care, Problems, Purpose	Sandlin, 2007

In summary, it is challenging for providers to carry out an appropriate handoff in light of the risk of error or communication failures. Mnemonics and protocols were created with the goal

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of limiting problems associated with handoffs through creating a structure for communicating, and in so doing improve handoff efficiency and safety (Riesenberg, Leitzsch, & Little, 2009). Regardless of the protocol utilized, handoff protocols have been shown to reduce error and improve communication (Keebler, et al. 2016).

Handoffs as conversations. Since handoffs are conversations between providers, it is appropriate to examine handoffs as a communication process using applicable communication theories. There are unspoken rules in conversation within our society that are often taken for granted. Yet, these rules govern when and how a person should speak (Saks & Jefferson, 1992), and in the case of a handoff conversation, can greatly affect how well communication is transmitted. Within this section, I will discuss the *cooperative principle* which identifies the guidelines for a conversation to be efficient and social dynamics that affect turn-taking and silence in the handoff. Finally, due to its potentially devastating effects during handoffs, I will discuss the way environmental noise can potentially affect the communication process.

The cooperative principle and handoff efficiency. In the early 20th century, H.P. Grice aided in the establishment of the first mechanical view of language. He postulated that conversations followed a specific set of guidelines which assumed efficiency and effectiveness. These rules were universal, meaning that every conversation conformed to these guidelines. His theory, the *cooperative principle*, stated that individuals should "make their conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which they are engaged" (Coiera, 2009, pp. 182; Grice, 1974). In other words, a person must add truthful information to a conversation only when it is on topic and without extra details. Grice asserted successful and efficient conversations followed these guidelines. *The cooperative principle* was further expanded into a set of four maxims: Manner,

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Quality, Quantity, and Relation. While all the maxims support the reasoning for the use of a handoff protocol, the last two (Quantity and Relation) can be used to operationalize handoff efficiency as relevant and unique information over time.

Maxim of Manner. The first of Grice's maxims requires that the speaker deliver his/her thoughts in an organized and logical fashion (Grice, 1974). For handoffs, presenting facts in a logical progression allows the receiver to understand, assess, and inquire if needed for clarification (Arora & Johnson, 2006). This logical progression supports the use of a protocol during handovers. A protocol will create the logical order for the presentation of the information rather than the providers having the ability to construct an order for information delivery. Because the providers will receive the information in a logical progression, it will be easier for the receiver to understand the information, thus creating a more efficient handoff.

Maxim of Quality. The second of Grice's maxims requires that information presented be based in fact, not conjecture. Grice posited that speakers should only present information that can be supported by evidence (Grice, 1974). Within handoffs, accuracy and truth are assumed since at no point would it be expected for a provider to lie. However, it is possible to report out-of-date information, so the quality of information within handoffs pertains specifically to the most up to date and timely information available. Additionally, it is possible for others to incorrectly write down information, mishear a detail, etc.

Maxim of Quantity. The third of Grice's maxims requires that information added to the conversation be as precise and exacting as possible without addition of extra details (Grice, 1974). This type of formatting in conversations encourages the transmission of appropriate information without the waste of time for useless information. Additionally, providing only necessary information reduces the risk of overloading the listener with unnecessary information

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that may hinder comprehension (Cruse, 2006). Within handoffs, providers share valuable information without offering every detail of the patient history. Therefore, efficiency can be partly measured as pieces of unique information passed during the handover process.

Maxim of Relation. The fourth and final of Grice's maxims requires that any contribution to the conversation be relevant to the topic at hand (Grice, 1974). During conversations, speakers must seek to keep the transition between topics smooth and related to the subject/task at hand. For handoffs, all participants in the conversation must work together to transfer all patient information in order to create a plan of care (Cruse, 2006). To measure relation, information and comments will be classified according to subject. See Table 3 for a description of each category.

Table 3. *Table of relation categories*

Information Subjects	Description	Example
Patient-centered	Information which is strictly about the patient and is directly related to treatment of the patient.	Age, weight, blood pressure, etc.
Educationally-centered	Information that is mean to correct or update another provider.	An attending instructing a resident
Organization-centered	Information about the status of the organization that could potentially affect performance of the providers.	The pharmacy being closed
Personally-centered	Information about the individual provider which are related to the providers ability to perform.	Lunch schedules, meetings, sickness, etc.
Trivial	Information that is not in any way relevant to patient care, the organization, the education of others, or the providers ability to perform.	Stories about their dog, kids, jokes, etc.

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To summarize, *the cooperative principle* and the subsequent maxims detail the rules that govern successful conversations and how the use of a protocol reinforces conversational success. These maxims describe what information should be said, when it should be said, and how it should be said. During a handoff between two providers, if information is presented in a clear, concise, and orderly manner, there is less risk for the receiver to confuse the information being processed. This should allow for focus, questions, and memorization of the material by the receiver. Grice's maxims provide a framework for effective, concise, and precise information sharing in conversations. Since handoffs are conversations, the maxims provide a framework for effective, concise, and precise information sharing in handoffs. In other words, the maxims evince that conversations should be limited to what a participant has to say, and if it is relevant to the conversation. In terms of a handoff, this would suggest that an effective and efficient handoff conversation would be regulated to ensure that only information pertaining to patient care is permitted. As described earlier, a protocol would create a structure for the handoff conversation and as such would tailor the handoff conversation. The introduction of an empirically-derived handoff protocol should increase handoff efficiency (Hypothesis 1) by creating a structured style of conversation, making communication more effective, displayed in Figure 2.

H1: The handoff protocol will have a positive effect on handoff efficiency.

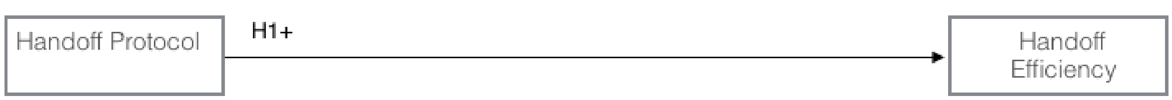

Figure 2. *Hypothesis 1*

Communication Process

The communication process was originally thought to be as simple as the relationship between sender and receiver. One person sends information to another person using a medium of

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some kind: spoken words, a written message, a gesture, an expression, etc. This model (Figure 3) has evolved and become more complex to include eight key parts: the sender, encoding, the message, the channel, decoding, the receiver, noise, and feedback (Communication, 2013).

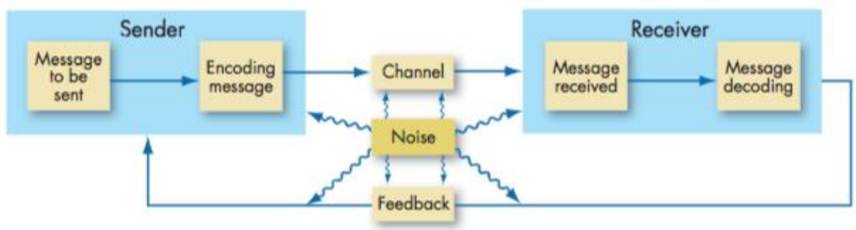

Figure 3. *The communication process model shows the many steps involved in proper communication. (Adapted from "Communication Process Model," by S.P. Robbins & T. A. Judge, 2012, Organizational Behavior, p. 338. Copyright 2013 by Pearson Education, Inc.)*

Within the handoff communication process, the sender creates a message by encoding a piece of information or thought, which then becomes the message (usually vocal during handoffs). The message is directed at a specific target; this person or group is known as the receiver. The receiver then decodes the message to translate the message into something of meaning or value. The final step in the communication process is the feedback portion in which the receiver checks back with the sender to verify that the decoding was successful and that the information is verified. In medicine, this is called a "callback," "feedback loop," or "closed-loop communication." Types of conversational noise will now be presented to highlight their effect on the handoff conversation.

Conversational Noise. Difficulty in this process arises because of noise. *Conversational noise* is any "barrier that can distort the clarity of the message" (Robbins & Judge, 2013, p.338). Noise is difficult to define due to its subjective nature. What is determined as noise can be influenced by social and/or cultural factors, individual sensitivities, etc. (Kam, Kam, &

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Thompson, 1994). Additionally, how noise is studied in the literature can vary. Background noise and interruptions were identified as some of the top ten barriers to effective handoffs (Runy, 2012). Literature demonstrates many purposes for which noise can be studied, but this study will focus on how conversational noise affects the verbal communication between the providers. Within the communication process, noise can pertain to anything that punctuates the flow of information in a conversation and can be present in different forms, not necessarily a sound. Noise can be psychological, physiological, semantic and/or of a physical nature (Wood, 2010/2016). Psychological noise includes any preconceived information that is brought into the conversation by the sender or receiver. This can include stereotypes, reputations, and other mental distractions that can prevent the receiver from receiving the correct message. Physiological noise pertains to the body's distractions including hunger, tiredness, aches, pains, and sickness. Semantic noise, produced by the sender, is caused when grammar or language is difficult to understand. This can be due to accents, use of inappropriate jargon, speaking too quickly, slurring of words, or using unknown jargon. Finally, physical noise is created by environmental stimulus, like background music, other individuals speaking, or pausing the conversation to acknowledge something in the environment, like an alarm (Wood, 2010/2016). This is a very broad definition and includes a multitude of different facets that can otherwise be described in more detail using the human factors literature. It is important to note that the term "noise" is commonly associated with environmental factors within the human factors literature. In this study, conversational noise is more encompassing because it contains "any barrier that can distort transmission of the message." As such, environmental factors will be categorized under environmental noise and will be further distinguished as noise related to equipment and noise related to staff behavior. Furthermore, interruptions will also be classified

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under conversational noise because interruptions by others can create a barrier for an effective handoff, potentially causing it to pause or slow. Further explanation of each variable will be given in the following subsections.

Environmental Noise. Environmental noise is divided into two groups: noise related to equipment and noise related to staff behavior (Hasfeldt, Laerkner, & Birkelund, 2010). Noise related to equipment will be defined as any sound that was made by a piece of equipment or machine present in the environment. This includes alarms, codes, music, the air conditioning unit, etc. Noise related to staff behavior could be defined as any type of sound that was made by a person but not related to verbal/written communication. For example, the sound made by a person typing or clicking a pen repetitively is noise related to staff. As the communication process shows, noise can create a barrier to the sharing of information. In handoffs, noise has been shown to affect the communication between providers and decrease patient safety by creating distractions and barriers to communication (Hasfeld, Laerkner, & Birkelund, 2010;Healey, Primus & Koutantji, 2007; Lewis, Staniland, & Davies, 1990;Stinger, Haines, & Oudyk, 2008; Tsiou, Efthymiatos, & Outantji, 2008). These noises may be present in the environment but may not necessarily visibly affect the performance of the providers during the handoff. A provider may be able to ignore a sound or audible distraction but in doing so creates a greater mental burden. Therefore, any audible noise that takes place during the handoff will be recorded for frequency and duration.

Interruptions. Interruptions are defined as a break in task activity, evidenced by observed cessation of a task (Healey, Primus, & Koutantji, 2007) caused by a person purposefully and intentionally seeking the attention of one of the handoff participants through verbal and/or written communication. For example, this could include the following: someone

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who verbally requests the attention of a handoff participant in order to ask a question, someone who walks by and greets the handoff participants distracting them away from the handoff, or a page/text message/email that causes a handoff participant to act or be visibly distracted. These interruptions are marked by a participant's behavior that shows visible signs of distraction away from the handoff conversation.

During a handoff, conversational noise, including environmental noise and interruptions, take attention away from the task at hand that can potentially add to the length of the handoff. For every second that is not dedicated to the sharing of patient information, the time lost must be recovered by extending the length of the handoff to accommodate required information. Information should not be forfeited in order to accommodate a time demand because participants are distracted or the handoff is interrupted. Furthermore, interruptions and environmental noise have been shown to negatively impact the ability to concentrate which can reduce a person's ability to focus (Okamoto, Rashotte, & Smith-Lovin, 2002). As a result of this lack of focus, information can be lost, repeated or slowed as the speaker mentally struggles to keep the conversation focused on patient information (Sensation and Perception, 2014).

Certain kinds of conversational noise can be more time costly and have different social implications if ignored. While noise related to equipment and staff behavior can be distracting, providers have learned how to filter these noises and ignore those that do not need attention. For example, a provider may be able to distinguish between different kinds of alarms and pay attention to those that demand action, like a low oxygen alarm, while ignoring an alarm for a low battery alert. Additionally, if the environmental noise is so loud or startling that it demands the provider's attention, it can directly influence the length of the handoff.

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While environmental noise can be filtered by the provider based upon priority and importance, interruptions are more difficult to ignore and filter due to the active nature of the distraction (Fritsch, Chacko, & Patterson, 2010). For instance, it is difficult for an individual to simply ignore a person who has sought them out for information or has communicated with them purposefully. Social implications of ignoring another person dramatically increase the pressure to react to the interruptions and pause the handoff, or break the conversation, especially if the social hierarchy of the organization demands attention be paid to those of higher status.

Regardless of type, conversational noise can create a break in the focus and concentration of the providers as well as cause a break or pause in the entire handoff conversation. Because the information must still be provided, the handoff must compensate for the laggard pace of delivery caused by a lack of focus or the pause. Compensation is accomplished by extending the length of the handoff which decreases the handoff efficiency. Therefore, conversational noise can negatively impact handoff efficiency (Hypothesis 2), displayed in Figure 4. The more conversational noise that is present during a handoff, the longer the handoff will likely take to accomplish. Furthermore, noise related to equipment will negatively impact the handoff efficiency (Hypothesis 2A), noise related to staff behavior will negatively impact the handoff efficiency (Hypothesis 2B) and interruptions will negatively impact the handoff efficiency (Hypothesis 2C).

H2: Conversational Noise will negatively affect handoff efficiency.

H2A: Environmental Noise related to equipment will negatively impact handoff efficiency.

H2B: Environmental Noise related to staff behavior will negatively impact handoff efficiency.

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H2C: Interruptions will negatively impact the handoff efficiency.

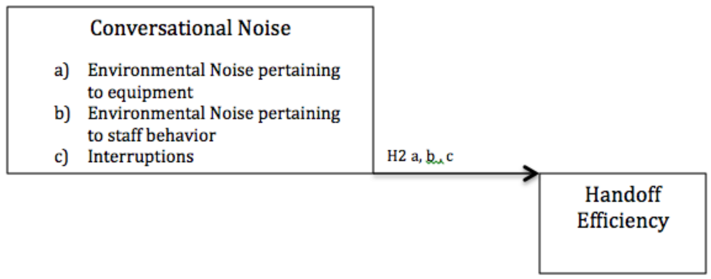

Figure 4. *Hypothesis 2*

Speech Exchange Systems

Conversations take two primary forms: mundane and speech exchange systems. Mundane conversations are more common, unorganized, and generally spontaneous. Most of our daily interactions with others are mundane conversations (Schegloff, 1999). During a mundane conversation, participants may freely step in and out of the speaking position so long as everyone in the conversational group is participating. However, participation in this manner does not necessarily mandate a speaking turn and can simply be relegated to listening. Mundane conversations are conducted with a 'laissez-faire' system, without order or guidelines. Speech exchange systems are the patterns in which we communicate based upon the environment and context of the conversation (Levinson, 2015). These conversations follow strict patterns of "detailed order," only functioning because it is inherently part of the day-to-day routine. Common examples of speech exchange systems include the dialogue used in courtrooms, classrooms, and therapy sessions, where each person fulfills a certain speaking part with all participants recognizing a common goal (Dingwall, 1980). These conversations avoid common chit-chat (Schegloff, 1999) and have a standardized and expected order to the conversation (Dingwall, 1980). This strict detail and order of turn-taking within the conversation is generally taken for granted and so recognized that it becomes implicit in nature (Sharrock and Anderson,

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1987). Currently, handoffs exist in a gray area between the mundane and speech exchange system. They are not mundane because they exist for the purpose of organizing a workflow, creating organization of a plethora of facts, and for creating a uniformed and guided passing of information from one party to another. Handoffs do not quite reach the level of speech exchange systems because there is no standardized or expected order to the conversation. Handoff protocols attempt to elevate the conversation from mundane speech to a speech exchange system but lack some of the key requirements, like turn taking.

In the following section, I will discuss the role of turn-taking and power distance in speech exchange systems as applied to handoffs. Additionally, I will review the supporting theories for the relationships between these factors and speech exchange systems.

Turn-taking. Turn-taking refers to the natural give and take of speech during a conversation. This "rapid exchange of short turns" (Levinson, 2015) requires that individuals in the conversation speak and then relinquish speaking power to another person so that only one person is speaking at a time. The process through which participants interject into a conversation is dependent upon many factors including gender, power distance, context, and culture (Sacks & Jefferson, 1992). Speakers naturally know that there are pauses and gaps in the flow of the conversation and "jump" in when appropriate. These gaps last between 7-460 milliseconds depending on the culture, with the average gap lasting only 200 milliseconds (Stivers et al., 2009). During these tiny gaps, an individual can take the conversational floor and in doing so, the attention of the group.

Within a conversation, a transition between speakers can be achieved in three manners: a new speaker is directly addressed by the current speaker, another speaker enters the conversation, or the current speaker continues the conversation currently in progress (Okamoto,

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Rashotte, Smith-Lovin, 2002). Usually, the transitions between speaker turns are fluid and easy, without a discernable pause. But, as we have all encountered, a speaker may be cut off or spoken-over before his/her speaking turn is complete. This “takeover” of the speaking floor can be described using the following terms: overlaps, butting in, and interruptions (Li, 2015). An overlap is when two people speak at the same time and continue to do so, much like finishing someone's sentence with them. Overlaps also contain minimal responses, such as “yeah,” or “uh huh.” This type of conversational turn-taking is not seen as intrusive but instead reiterates that the listener is engaged in the conversation (Tannen, 1986, 1994; West & Zimmerman, 1983). Minimal responses also show attention and interest in the conversation and can assist in creating trust (Lisitsa, 2012). Butting-in is when a speaker chooses to talk over another person in the attempt to take the conversational floor but is unsuccessful at keeping or maintaining it (Benus, Gravano, & Hirschberg, 2002). And finally, an interruption is when a person stops the conversation and takes the floor of the conversation successfully while speaking, consequently expecting the original speaker to cease speaking (Li, 2015). Now that I have discussed the different types of turn-taking, I will discuss how turn-taking can be used to influence the handoff protocol in order to elevate a handoff from the mundane to the speech exchange system.

Despite the mandate for a standardized protocol and question/answer section, many handoffs take place unidirectionally, with the sender providing most of the information and the receiver listening. In this manner, the handoff is conducted as a mundane conversation, where a participant speaks freely. This freedom in the conversation trends toward the sender being the primary speaker. The newly derived protocol will require the providers to take turns speaking, rather than the sender spending a large amount of time speaking while the receiver listens. Rather than information flowing in one direction, the protocol will elicit an exchange in the speaking

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floor. Handoffs, with the use of a structured protocol, are highly detailed, ordered, and are a required daily activity within medicine. The protocol creates guidelines and rules where previously none have existed including the turns that the sender and receiver should take (Hypothesis 3). Figure 5 displays the proposed relationship between handoff protocol and turn-taking.

H3: The handoff protocol will positively affect turn-taking during the handoff.

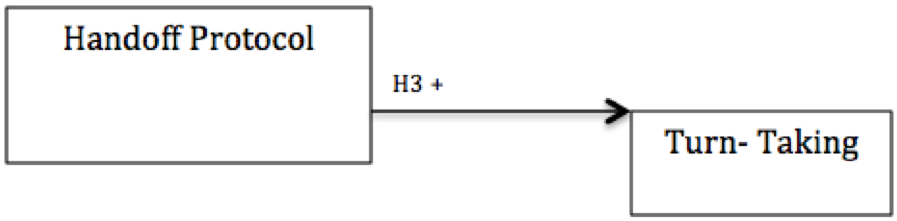

Figure 5. *Hypothesis 3*

Building upon the previous hypothesis, an increase in turn-taking has the potential to increase handoff efficiency. By creating a strict outline for turn-taking, the protocol elevates the handoff conversation from the mundane to a speech exchange system. Creation of this order in the conversation eliminates the overall dawdling that can take place in mundane conversations, creates a more positive reaction amongst the participants, and increases interest of the participants who are gaining a speaking turn (Ford & Stickle, 2012). The study suggested that the expectation of turn-taking was coordinated with displays of recipiency of the targeted participants. In other words, participants in the meeting were more invested in the conversation and more open to receiving information. During handoffs, the receiving team needs to be invested and open to receiving information during the conversation. The expectation of becoming a speaker during the conversation rather than passively listening may increase the efficiency since the receiver will be more attuned and invested in the handoff.

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The use of protocol-induced turn-taking will elevate the mundane conversation into speech exchange system, and in so doing, will mediate the relationship between the handoff protocol and handoff efficiency (Hypothesis 4). Refer to Figure 6 for the mediated relationship.

H4: Turn-taking will mediate the relationship between the handoff protocol and handoff efficiency.

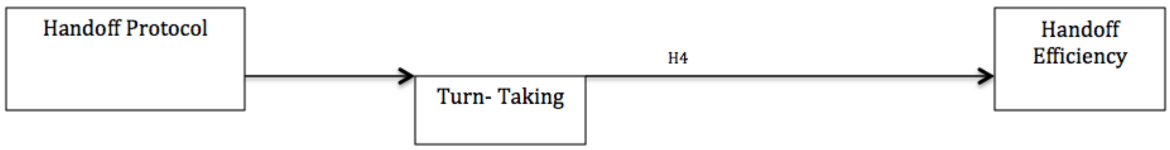

Figure 6. *Hypothesis 4*

While turn-taking within a speech exchange system has the benefits of creating interest and openness between the speakers, it can also be used to create power distance between the speakers. Consider the manner in which a courtroom conversation unfolds. Trial is conducted as a conversation between the prosecuting and defending lawyers with the judge as overseer of this conversation, making rulings as to what can and cannot be said in the trial. During trial it is expected that a judge may speak over and interrupt an attorney, but an attorney speaking over a judge would be insulting and can even result in the attorney being held in contempt of court. In the simplest way, the judge's power is manifested in the conversation by his/her ability to control the conversation by starting his/her own turn and ending another's at his/her own discretion. There is no disagreement on the power distance between the judge and attorneys. This same kind of power distance can be witnessed within the medical industry. While the power distance between the judge and attorney help facilitate the trial, power distance between providers can cause silence during the handoff conversation.

Power Distance.

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The medical industry is based in a hierarchy with certain positions and differing levels of experience holding more status over others. This difference in status facilitates power distance between the providers. Hofstede (1980) defines power distance as the way in which unequal status differences are treated by the people experiencing them. These power distances are caused by a person perceiving a difference in status between themselves and another individual. Individuals who rate high on power distance commonly expect those of higher status to demonstrate the status over them and, in turn, will accept that their own status is lower in the hierarchy (Adler, 1991).

Behaviors that can demonstrate power over another can include subtle cues within a conversation. Turn-taking is a natural part of a conversation but can be used as a tool in order to influence others in the conversation and exert power over the other participants in the conversation. Speakers can place themselves at a higher status in the conversation by speaking over others or prohibiting others from speaking (Okamoto, Rashotte & Smith-Lovin, 2002). Additionally, individuals who perceive themselves to be lower than others in the hierarchy will be more hesitant to take a turn speaking in a conversation. In this manner, silence becomes the more prevalent form of communication for those with lower status (Gardezi, et al. 2009). The medical field is trying to even the social status between doctors, nurses, and other medical professionals, but as a publication by Webster, Keebler, Lazzara, Lew, & Fagerlund (2017) points out, the final authority for treatment decisions lies with the attending creating an implicit reminder of the hierarchy for all involved. The Joint Commissions' mandate to provide a section for questions during the handoff may go unutilized if the social context of the conversational space limits the ability of the participants to speak. As Liu, Mania, and Gerdtz (2011) reiterate, nurses rarely interrupt a superior or ask questions. Further, body language suggested that the

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nurses were there to listen only, not to speak. However, in this same study, it was shown that more experienced nurses were more privileged in these handoffs, displaying a give and take of power based on an inherently understood ranking system. This study speaks to the implicit interconnected organizational and social blend of factors that impacts the handoff conversation. Furthermore, power distance has been shown to be one of the barriers to communication (Halm, 2013), limiting direct communication between providers (McMullan, Parush, & Momtahan, 2015). Unfortunately, medical professionals are not instructed on how to navigate the medical hierarchy or told where their position is within the assumed hierarchy. These individuals simply assert themselves where they belong and act accordingly, knowing when to speak and when to remain silent during the handoff conversations. To better understand the manifestation of power distance within medical handoff conversations, I will next review implicit voice theory, which grounds this phenomenon in social norms and explains how these individuals learn their place and expected behaviors within the hierarchy.

Power distance describes the degree to which people accept that power within institutions and organizations is distributed unequally (Robbins & Judge, 2016). A high-power distance indicates inequalities based in power are tolerated; while, low power distance indicates social norms reinforce equality regardless of title or class (Robbins & Judge, 2016). Within the context of this dissertation this phenomenon might manifest as lower status employees being submissive or not to higher status employees. In the case of the former, this would lead to issues with communication and likely affect those in lower power position to not speak up (Ghosh, 2011). Musson (2008) maintains that these learned experiences from childhood, later termed conversational guidelines, continue through an individual's lifetime including their profession. Healthcare professionals will obey the guidelines of the *implicit voice theory* and will apply these

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previously learned guidelines to the existing hierarchy within medicine. This is reflected in the observation that medical students quickly adapt to the medical hierarchy and are rewarded for falling into their correct place in that hierarchy (Savic & Pagon, 2008). *Implicit voice theory* proposes that children are introduced to the societal rules of conversation early in life, learn how to speak within hierarchies, and transition those rules from one hierarchy to the next as he/she moves from childhood to medical school to the hospital.

Implicit voice theory posits that hesitation to speak is taught through social norms and is sometimes defined as a person's confidence to speak (Benus, Gravano, & Hirschberg, 2002). While this seems like a personal decision most commonly based on extraversion or introversion,society creates rules that are understood and act as unspoken guidelines that continue from childhood into adulthood and the job world (Sutcliffe, 2007). The theory assumes that the rules learned by children are based on experiences of "punishment and reward." During conversations, children will try to gain the conversational floor (i.e., take over the speaking position) and will either be successful or unsuccessful (Dingwall, 1980). Children will test when it is appropriate to speak by listening and watching their parents/guardians converse. Through these experiences, children learn when it is appropriate to speak based on who else is in the conversation, the environment, and the content of the conversation. Children implicitly learn the concepts of status and hierarchy from their parents speaking over the child, ignoring when the child speaks, or not allowing a child to speak at all. Thus, children learn that parents have a superior status while he/she has a subordinate status creating a social power distance (Hilbrink, Gattis, & Levinson, 2015). This ability to learn status and hierarchy remains into adulthood and can be seen within relationships in the workplace (Musson, 2008).

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Individuals learn from these rules and begin to self-monitor. When a person self-monitors, he/she adjusts their individual behaviors based on external factors (Robbins & Judge, 2016). These traits have both pros and cons. Those that censor their negative comments in the workplace and do not "attack" the organization or others around them tend to have better experiences at work and are perceived by others as more positive. This in itself provides positive returns like praise and promotions. However, this also means that people may feel that they are personally at risk if they speak up during a situation that would be inappropriate. For example, a resident might not feel comfortable speaking up in disagreement with an attending. The resident will self-monitor and will censor him/herself from speaking.

Furthermore, to compound the power of *implicit voice theory* in regards to hierarchy, the power distance can become more convoluted when interjecting gender inequalities. Commonly within medicine, men more often hold higher positions in the medical hierarchy since the occupation of surgeon is often male dominated and the role of nurse is often female dominated. Literature suggests that men and women participate differently in conversations. Males more often "take" the conversational floor while females wait to be "given" the conversational floor. It is also more common for boys to talk simultaneously with those higher in status than themselves (Aukrust, 2008). Furthermore, Zimmerman & West (1975) studied conversations between the genders and discovered that men overwhelmingly interrupt or speak over women in conversations. Despite the recognition and efforts within society to equalize men and women**,** Hancock & Rubin (2014) discovered that women were interrupted more often than men during conversations.

Interruption in a conversation can alter the power distance between those involved in the conversation (Fisher & Ury, 1992). The power distance is created by the ability to speak and the

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mandate of others to listen. When perceived power distance is present, it can cause those with higher status to control the conversation by speaking more or interrupting others who are of lower status. It can also cause those with lower status to remain silent. In this manner, the power distance creates the context for how the participants in a conversation interact. However, participants in a conversation can create the perception of power distance by interrupting others or not allowing another to speak. Because of this, it is often said that the conversation creates the power distance and the power distance creates the rules of the conversation (Kollock et al. 1985; Octigan and Niederman 1979; West 1979; West and Zimmerman, 1983). In a handoff, one person/group can create a power distance by interrupting or actively silencing the other group. In turn, the silenced group learns to not speak up but instead remains in the "listening" only part of the communication process, without providing any feedback - the last part of the communication process model.

High power distance can cause turn-taking in the handoff to decrease. The power distance can be caused by a multitude of individual factors, like gender and position in the medical hierarchy. Therefore, if there is a large difference between position, years of experience or a difference in genders in the participants of the handoffs, it will cause those of lower status to not take turns speaking. Because anesthesiologists "out rank" nurses, the more experienced "out rank" the less experienced, and men "out rank" women, it is expected that within the conversations those with these perceived lower ranks will not speak as frequently or for as long. For this reasoning, I predict that power distance will moderate the relationship between the handoff protocol and turn-taking, such that a high power distance between providers will negatively impact turn-taking. Refer to Figure 7 for the proposed moderated relationship.

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H5: Power distance will moderate the relationship between the handoff protocol and turn-taking in the handoff conversation.

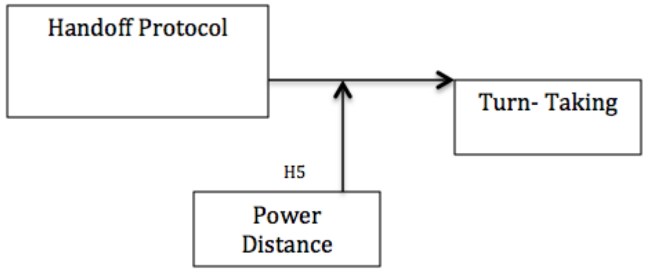

Figure 7. *Hypothesis 5*

Transactive Memory. When people work together frequently or are around each other for a significant amount of time, they begin to learn what one another knows. This does not mean that one person knows all the information the other person knows, but rather that each person will recognize that the other person has a certain boundary of information due to past experiences, education, etc (Lewis, 2004). This phenomenon is called *transactive memory*. Transactive memory systems are "knowledge about who knows what" (Lazzara, 2013). Wegner (1985) proposed that a person could create a "human storage unit" of memory by using the people in his/her team. Rather than having to know all the possible information, a team can act as a whole by drawing upon each other's knowledge and memory.

Work on transactive memory began with married couples. Oftentimes, these couples will have a shared understanding of what knowledge the other has. One spouse may be a historian while the other is an astronomer. If I asked the historian about Saturn, he/she would defer the question to the spouse. Vice versa, the astronomer would defer my questions about the U.S. Civil War to the historian. One spouse may not be able to answer the question him or herself, but knows that their spouse has the knowledge to answer the question.

Similar to a married couple, each person within a team must unite expertise, specific sets of knowledge, credibility, and cooperation in order to have team efficiency (Huan, Liu, &

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Zhong, 2013). Transactive memory systems expand our understanding of how an individual encodes, stores, and retrieves information. Rather than analyzing the individual memory, a group of individuals could be used together to form a larger aggregate memory. While there is some shared knowledge, there is a greater amount of knowledge available in the team as a whole. A person might not know everything but must know his/her own expertise and be willing to share that knowledge with a teammate when called upon to do so.

Transactive memory is built by learning what each other knows. However, if one never speaks or demonstrates his/her expertise, then it cannot be expected for the rest of the team to know what that person knows (Lewis, 2003). Each person receives information, stores it, processes it and retrieves it from memory when needed. When multiple people are together, the capacity to store information increases. During the handoff conversation, a group of people can act as a collective memory bank because the information passed during handoffs is stored, processed, and retrieved through the same manner as personal memory (Hinsz, Tindatl, & Vollrath, 1997). Within a medical team, there are multiple areas of expertise, so transactive memory systems describe how each person might remember different information that relates to his or her specific area of expertise as well as have knowledge of what the other team members know, which can be called upon as needed (Hinsz, Tindatl, & Vollrath, 1997). In this manner, a member of a group only stores information pertinent to his/her job and the information that is needed to be regularly accessed.

Additionally, Nemeth, Mayseless, Sherman, & Brown (1990) suggested that transactive memory within groups can cause a better recall of information because each member's perspective and information stored for their expertise was organized in a more efficient manner. For example, handoff teams are commonly composed of doctors and nurses. Rather than each

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team member knowing everything pertaining to a particular procedure, each member would only know what is needed for their expertise for that procedure. This can be seen when doctors are unaware of the location of a piece of equipment while a nurse can find it quite easily, or conversely, a nurse may not know proper dosage of a medication but can ask the attending/resident for this information.

According to theories of transactive memory systems, in order to retrieve the information, one must simply know who has it and then ask that member of the team. Hinsz (1990) suggested that group transactive memory might be superior to individual memory due to the ability of the group members to correct one another if information is remembered incorrectly. Because there is some shared memory, a team member may recognize or challenge incorrect information and draw the group's attention to the inconsistency. This would require the whole group to collectively search their memories for the correct information and produce it.

Within a handoff, if incorrect information is shared, a teammate will seek to correct that information (if it is recognized as incorrect) and either call attention to the issue during his/her turn or interrupt the conversation to correct the issue. Furthermore, knowing each other's area of expertise will limit the amount of information needed to be shared in the conversation. Because the sender understands the receiver's expertise and knowledge, the need to explain all information is decreased and redundant information is eliminated. Therefore, transactive memory will positively influence handoff efficiency (Hypothesis 6). Refer to Figure 8 displaying the proposed relationship between transactive memory and handoff efficiency.

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H6: Transactive memory will positively affect handoff efficiency

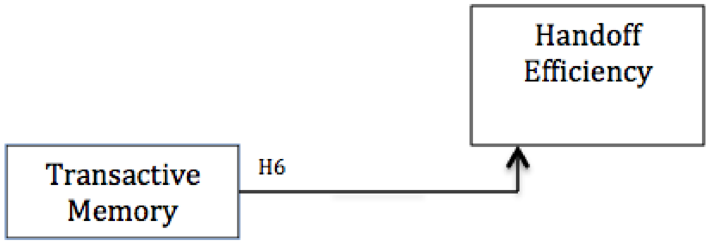

Figure 8. *Hypothesis 6*

In summary, this section has reviewed multiple variables that can affect handoff efficiency. First, I discussed how an empirically derived handoff protocol will increase handoff efficiency. Next, borrowing from the communication literature, I hypothesized that the handoff conversation will be subjective to the implicit guidelines of communication, and conversational noise will cause the handoff efficiency to decrease. Turn-taking will be increased by the handoff protocol but will be moderated by power distance in the conversation. Finally, I discuss how the presence of transactive memory will increase handoff efficiency. For a depiction of these relationships refer to Figure 9. For a summary of the hypotheses, refer to Table 4. Also, refer to Table 5 for the constructs that were chosen for this study as well as confounding variables that could influence handoff efficiency but were not chosen for this project.

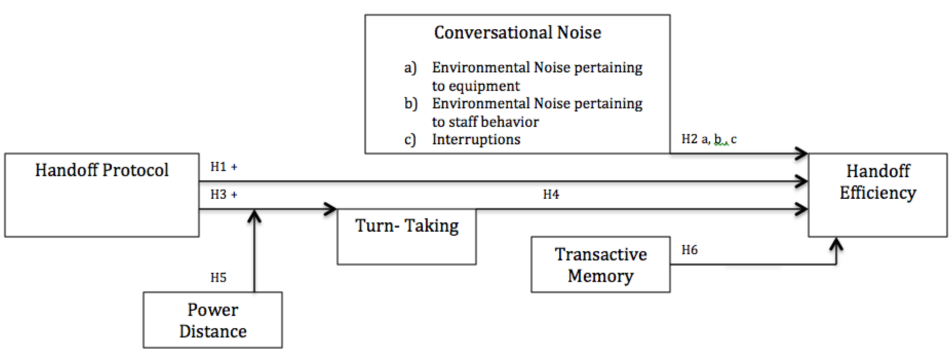

Figure 9. *Hypothesized relationships between variables*

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Table 4. *List of proposed hypotheses*

H1: Using an empirically-derived handoff protocol will lead to an increase in handoff efficiency.

H2: Conversational noise will lead to a decrease in handoff efficiency.

> H2A: Environmental noise related to equipment will lead to a decrease in handoff efficiency.
>
> H2B: Environmental noise related to staff behavior will lead to a decrease in handoff efficiency.
>
> H2C: Interruptions will lead to a decrease in handoff efficiency.

H3: Use of an empirical handoff protocol will lead to an increase in turn-taking during the handoff conversation when compared to the general handoff protocol.

H4: Turn-taking will mediate the effect of the handoff protocol on handoff efficiency, such that more turn-taking will lead to a more efficient handoff.

H5: Power distance between handoff participants will moderate the effect of the handoff protocol on turn-taking during the handoff conversation, such that when power distance is high, there will be less turn-taking between handoff participants.

H6: Transactive memory will lead to an increase in handoff efficiency such that the higher the level of transactive memory between the providers the more efficient the handoff will be.

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Table 5. *Constructs*

Constructs	Variable Type	Definition	Measurement
Handoff Protocol	Independent	Scientifically developed handoff tool	N/A
Handoff efficiency	Mediator	The amount of unique relevant information passed over time	$\frac{\text{Pieces of Unique, Relevant Information}}{\text{Time}}$
Conversational Noise	Moderator	Any noise that creates a barrier in the effective transmission of information	Frequency and duration
Transactive memory	Independent	The use of the group for cognitive encoding, storage, and retrieval.	Austin (2003)
Turn-taking	Dependent	The transition of speakers taking the conversational floor or attempts to take the conversational floor	Frequency and duration as measured by West & Zimmerman's Syntactic measurement of Interruption (1975)
Power distance	Independent	The perceived inferiority or superiority of a participant in a conversation	Maznevski, DiStefano, Gomez, Nooderhaven, & Wu (1997)
Individual Factors	Independent	Facts about the participants that are uncontrolled: age, gender, role, years of experience	Demographic Survey
Time	Dependent		seconds
Patient complication	Independent	A more complex patient would require more time to discuss	
Personality	Independent	Extraverts tend to talk more during conversations and interrupt more	Communication, 2013
Knowledge	Independent		Not measured

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Familiarity with the patient	Independent	Not measured
Cognitive Fatigue	Independent	Not measured
Team cohesiveness	Independent	Not measured
Time handoff was conducted	Independent	Not measured
Other conversational noise: fatigue, pain, hunger, need to urinate, etc.	Independent	Not measured

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CHAPTER THREE: METHODS AND MATERIALS

This section includes the design of the proposed study and identifies the participants, method, metrics, and operationalized descriptions of each construct presented in the literature review. This research proposal is part of a larger project that was conducted in two stages, with this dissertation focusing on the evaluation of effectiveness during the protocol implementation. During the first stage, interviews, surveys, and card-sorting activities were conducted to develop a scientifically-grounded protocol. Once the protocol was developed, data collection began in order to test the effectiveness of the protocol implementation.

Participants

Participants included anesthesia providers (anesthesiologists, nurse anesthetists, anesthesia residents, student nurse anesthetists) and registered nurses in the PACU at a public teaching hospital in the Southeastern United States. The anesthesia provider, designated as the "sender," handed patients off to a registered nurse, designated as the "receiver." All participants were over the age of 18 and work directly with the patients in the operating room and in the post anesthesia care unit. Anesthesiologists and nurses that have not been employed at the hospital more than a month were excluded. This ensured that each participant had been sufficiently exposed to the hospital and department culture, procedures, and handoff training. Study participants were observed during handoffs of patients between general surgery and the PACU.

A total of 170 individualized handoff performances were recorded during 85 handoffs. Thirteen PACU nurses, 19 Certified Registered Nurse Anesthetists (CRNA), 6 residents, and 1 student Registered Nurse Anesthetist (sCRNA) participated in the handoff observations. Each participant provided an informed consent and completed a short survey addressing background

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and demographic information before being observed. Twelve PACU nurses, 9 CRNAs, 4 residents, and 1 student RNA completed the demographics packet.

Design

This field study employed a quasi-experimental within-groups design with multiple post treatment measurements:

Design: Pre ->Treatment -> Post 1 -> Post 2

Though it can be argued that the handoff process starts with the receipt of documents, this project focused on the oral communication between the sender and receiver in a handoff, specifically the conversation that took place during the handoff. The study site requires face-to-face handoffs; therefore, this project focused on the face-to-face handoff process instead of other routes of communication such as phone call, electronic medical record, or email. Due to the fact that all participants have received previous training on handoff process in some way, it is not feasible or practical to measure against a control group (i.e., a group that has not been trained on any protocol whatsoever). To compensate, this study collected pre- and post- intervention measurements before and after the empirically derived protocol was implemented. Consequently, this study executed a mixed-method design utilizing a within-groups factor.

The sender to receiver dyad consistency is never insured, meaning there is no way to insure that the same providers are working together throughout the shift or week. Due to this and the small sample size available, it was determined that the best option was to use a within subjects design. However, unpredictable provider schedules prevent the ability to maintain a true within groups study as providers who were in the baseline observations may not be present during the treatment observations and vice versa.

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Procedure

It was a goal of the study to collect a total of 75 handoffs during data collection, with 25 handoffs per each period: pre, post, and retention. Due to time constraints, the procedure was adapted to accommodate funding deadlines. The study utilized a pre- and post-test design but was unable to collect a retention period. A total of 96 handoffs (50 pre, 46 post) were observed over a three week period. The pretest handoffs were observed during week one. A one-hour training program was conducted on Tuesday of week two, and the providers were given the rest of the week to practice use of the protocol. The posttest handoffs were observed during week three. The handoffs were video recorded, unitized, transcribed, and analyzed afterward. While the original proposal for this study required two tripod supported cameras in order to capture the faces of each member of the handoff dyad, creating this arrangement would have placed patients and providers in harm's way by obstructing the walking path of the providers. Instead, an observer operated a hand-held camera and moved from bay to bay to capture handoffs.

During the pre-intervention observation period, 50 handoffs were observed. These observations acted as a baseline for comparison to the post-treatment handoffs. The post intervention observation period included 46 handoffs.

At the very beginning of the study, all participants were asked to complete a packet of surveys about themselves and the unit. The first part of the packet inquired about personal information such as role/profession, gender, race, and years of experience as well as the Ten Item Personality Measure (TIPI). The second part of the packet included surveys about power distance. After each handoff, participants in that handoff were asked to complete a form that included a transactive memory survey assessing their partner and themselves in that handoff and a question rating the efficiency of the handoff just preformed.

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Observations and recordings of the handoffs were conducted based upon convenience, were determined in advance, and were appointed in accordance with the complex scheduling of the hospital. All handoff observations and recordings were conducted during the weekday (Monday through Friday) and between the hours of 0800 and 1700. This eliminated the possibility of the weekend or night shift from being included in the study.

Recordings were started when the patient bed entered the PACU bay and the handoff conversation start was coded from the first indication of conversation initiation by either the sender or receiver. This type of initiation commonly included the question “Are you ready for me?” or phrases like “This is what we got.” The handoff conversation ended when either the sender walked away from the conversation or a concluding remark was made such as “I’m good” or “That’s it.”

Operational Definitions

Handoff efficiency. Handoff efficiency was measured according to the two maxims of Quantity and Relations, amount and relevance. To measure quantity, unique bits of information were tallied. For example, “Ms. Smith is 43 years old, is allergic to penicillin and is currently on 30 mg of Dilaudid,” would provide 5 unique pieces of information: name, age, allergy, medication and dose. Once each observation was unitized, frequency counts were calculated. Redundant pieces of information were ignored so as to not artificially inflate the frequency counts.

To account for relations (i.e., the relevance), it was important to consider the relevance of the information provided. Because unique information does not necessarily pertain to the patient, it is important to appropriately categorize each piece of information. For example, “Chicken is being served today” is a unique piece of information but has nothing to do with the

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care or treatment of the patient. Because relevance can be subjective based upon the provider, information included in the frequency count was strictly limited to information that was needed for the purpose of patient care, education of a student present, or scheduling related. The count of unique and relevant information was then divided by time to create a ratio: $\frac{number\ of\ bits\ of\ unique, relevant\ information}{duration\ of\ handoff\ in\ seconds}$. By measuring efficiency in this way, we were able to determine the relevant, unique information compared to the amount of time it took to convey this information.

Handoff efficiency perceptions. In addition to measuring handoff efficiency, perceptions about handoff efficiency were also measured. Each participant was asked to rate the efficiency of the handoff using a 7- point Likert based scale with ratings from “not efficient at all” to “extremely efficient.” This question was asked as part of the survey that was present after every handoff.

Conversational noise. As discussed earlier, conversational noise which acts as a barrier to the transmission of information was analyzed using the following variables: interruptions and environmental noise (noise related to equipment and noise related to staff behavior). Using observational behaviors, these variables were counted for frequency as well as duration of the event.

Environmental noise was assessed using two variables: environmental noise related to equipment and environmental noise related to staff behavior (Hasfeldt, Laerkner, & Birkelund, 2010). Environmental noise related to equipment was defined as any type of sound that was made by a piece of equipment or machine. This includes alarms, codes, music, the air conditioning unit, etc. Environmental noise related to staff behavior is defined as any type of sound that is made by a person but not related to verbal/written communication. These behaviors

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were not limited to those within the handoff conversation. For example, the sound made by a person typing, clicking a pen repetitively, humming, etc were included. These two sub-variables were counted by the observer based on behavior of the participants who visibly acknowledge the noise in some way. An example of this would be a nurse entering medical information into a computer near handoff conversation participants. This noise was only counted and timed if one of the participants asked her to stop, paused the conversation, looked at the nurse, made a comment about the typing, or demonstrated some other behavior which indicated distraction. Environmental noise events were counted and the duration was timed when a participant exhibited an action which alluded to distraction or disruption of the handoff due to noise.

Interruptions were defined as a break in task activity, evidenced by observed cessation of a task (Healey, Primus, & Koutantji, 2007) caused by a non-participant in the handoff purposefully seeking the attention of someone participating in the handoff through verbal/written communication. Examples of interruptions include the following: someone who purposefully requested the attention of one of the handoff participants to ask a question about another patient, someone who walked by the handoff and the handoff participants paused to acknowledge that person, a page over the intercom required a handoff participant to act, a text message, an email, etc. Frequency and duration of interruptions were counted.

Individual factors. Individual factors were identified using a brief demographic survey before the project began. The questionnaire consisted of multiple choice questions regarding age, gender, profession/role, and years of experience.

Power distance. Power distance was measured using a seven-question survey originally used by Maznevski, DiStefano, Gomez, Nooderhaven, and Wu (1997). This survey employed a 7-point Likert scale with ratings from “strongly disagree” to “strongly agree”. This survey was

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given to each participant in the study before data collection began. The scale was changed slightly to accommodate appropriate terminology for the Anesthesia/PACU environment. For a copy of the power distance index, see Appendix A.

Turn-taking. Turn-taking was broken into multiple levels including overlaps, butting in, minimal responses, and interruption. To measure turn-taking, West and Zimmerman's Syntactic Measurement of Interruption (1975) was employed to analyze the handoff conversation. This is the most universally used Syntactic Measurement in group processes (Okamoto, Rashotte & Smith-Lovin, 2002). This measurement tool allowed for adherence to rigid and strict definitions for turn-taking and subsequent types of turns. Each type of turn was measured and counted for a total number of turns taken. Refer to Table 6 for the definitions of each type of conversational turn.

Table 6. *Classification of turns*

Type of Turn	**Definition**	**Reference**
Turn-taking	Count of the number of times turns are taken between handover sender and receiver	West & Zimmerman (1975)
Overlap	The frequency of a new speaker starting to speak during the last syllable of the first speaker's utterance.	West & Zimmerman (1975)
Minimal Response	The frequency of a new speaker to use filler phrases, commonly placed during the speaker's breath, rarely overlapping with the progressing utterance.	West & Zimmerman (1975)
Interruption	The frequency of a new speaker starting to speak more than two syllables before a possible turn-transition space and gains the speaking floor	Okamoto, Rashotte & Smith-Lovin, (2002)
Butting in	The frequency of a new speaker starts speaking more than two syllables before a possible turn-transition space, but does not gain the floor	West and Zimmerman (1975) and Benus, Gravano, & Hirschberg (2002)

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Transactive memory systems. Transactive memory systems were measured using Lazzara's Transactive Memory System Scale (2013) (Refer to Appendix B), which was based upon the Austin metric (2003). This survey asked participants to provide a rating of 1-7 of "very low ability" to "very high ability" about their own ability and their teammate's ability on multiple skill topics. Skill topics included development of a treatment plan, evaluation of treatment, patient management, education of junior clinicians, and leadership in the handoff discussions. In effect, each participant rated their own level of transactive memory and their team member's level of transactive memory. Throughout the remainder of this document, transactive memory will be denoted as "transactive memory self" or "transactive memory other." The transactive memory survey was presented after every handoff to both sender and receiver who participated in the handoff.

Transactive memory systems perceptions. In addition to measuring transactive memory systems between the providers who participated in the handoff, perceptions of transactive memory were also collected. The transactive memory systems perceptions were measured using Lewis' Transactive Memory System (TMS) Scale Items (2003) which utilizes a 7-point Likert scale with ratings from "strongly agree" to "strongly disagree." For a copy of the Transactive Memory System Scale Items, refer to Appendix C. The survey was presented to all participants at the beginning of the study. This measure contains three sections, each containing 5 questions. The specialization section includes statements like "I have knowledge about an aspect of the patient that no other team member has." The credibility section contains statements like "I was confident relying on the information that other team members brought to the discussion," and the coordination section contains statements like "Our team have very few

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misunderstanding about what to do.” Throughout the remainder of this document, the individual sections of transactive memory perceptions will be referred to as “TMS specialization,” “TMS credibility,” and “TMS coordination.”

In summary, this section has discussed the experiment in detail. It has outlined the participants, method, operational definitions, and metrics. The next section will provide information about tests of the variables outlined in this section and purposed analyses.

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CHAPTER FOUR: RESULTS

All analyses for this study were conducted using IBM SPSS 22 for Mac and Windows. As detailed in the methods section, metrics were completed by the participants in the study as well as coded from the video recordings from the handoffs. Because participants remained anonymous, some of the survey-based variables could not be directly linked to participant behaviors. This section will present the sample population, results of the proposed hypotheses, and results of exploratory hypotheses.

Sample

The final number of handoff events observed for the data collection included 50 handoffs during the pre-implementation phase and 46 during the post-implementation phase for a total of 96 handoffs. Because the video recording was vulnerable to environmental constraints, a total of 11 handoff events were deleted from the data base, leaving 44 pre-implementation handoffs and 41 post-implementation handoffs for a total of 85 handoff events. A total of 42 healthcare providers participated in the handoff observations: 23 CRNAS, 5 residents, 1 Student CRNA, and 13 PACU nurses. Due to scheduling in the OR and PACU, providers participated in one or multiple handoffs. Refer to Table 7 for a summary of participant roles in the handoff dyads.

Table 7. *Summary of descriptives for participant's professional roles in handoff dyads*

	Participation Frequency	Percent	Cumulative Percent
PACU Nurse	85	49.7	50
CRNA	73	42.7	92.6
Anesthesia Resident	7	4.1	97.1
CRNA Student	4	2.3	99.4
Other	1	.6	100.00
Total	170	100.00	

Of the 42 providers that participated in the study, only 26 completed the demographics survey. Refer to Table 8 for a summary of the demographics information.

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Table 8. *Summary of demographics from surveys*

	Residents	CRNA	PACU Nurses	Student CRNA	Total
Participant role	4	9	12	1	26
Male	4	2	1	1	8
Female	0	7	11	0	18
Years in Field	6	20	18	3	16.42
Years in Role	2.8	12	6.9	1.5	4.92
Years in Department	2.5	8.4	3.5	0	4.92

In addition to measuring handoff efficiency, it was possible to capture participant's perception of handoff efficiency. Provided with this new dependent variable, a new set of hypotheses can be proposed in addition to the original hypotheses. This section will provide results for both the originally proposed hypotheses as well as the newly established hypotheses. For convenience, the proposed model is reprinted here as Figure 10. Table 9 provides a summary of intercorrelations, means, and standard deviations of the independent variables. Refer to Appendix D for the Normal Probability Plots (P-P) of the Regression Standardized Residual and Scatterplots for each hypothesis.

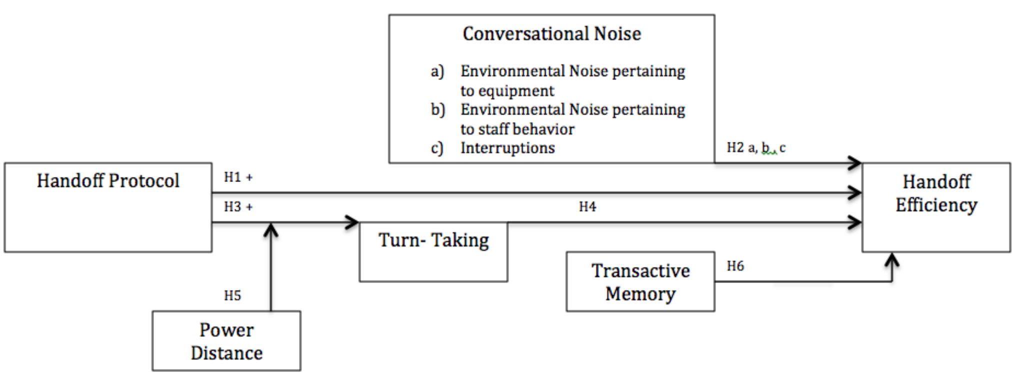

Figure 10. *Hypothesized relationships between variables*

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Table 9. *Summary of Intercorrelations, Means, and Standard Deviations of Independent Variables and Handoff Efficiency*

	1	2	3	4	5	6	7	8	9	10	11	12
1. Handoff efficiency	(n/a)											
2. Handoff efficiency perception	.084	(n/a)										
3. Protocol use	-.167	.203	(n/a)									
4. Conversational noise frequency	-.282	-.072	-.211	(n/a)								
5. Conversational noise duration	-.267	-.075	-.277	.629	(n/a)							
6. Turn-taking	-.422	.054	-.047	.322	.230	(n/a)						
7. Power distance	.094	-.077	-.275	.011	.133	.126	(.738)					
8. Transactive memory self	.018	.281	-.003	-.059	.027	.025	-.440	(.993)				
9. Transactive memory other	.061	.266	-.039	-.043	.037	-.020	-.494	.966	(.995)			
10. TMS specialization	.142	.108	-.173	-.018	.172	-.230	.173	.062	.102	(-.080)		
11. TMS credibility	.047	.210	.039	-.291	-.238	-.027	-.183	.165	.176	.032	(.528)	
12. TMS coordination	.014	-.281	.006	-.066	-.008	-.298	-.131	.187	.242	.031	.243	(.827)
M	.361	5.614	.316	3.281	35.544	3.333	3.003	5.389	5.925	5.077	5.340	5.793
SD	.120	1.677	.470	2.351	41.400	2.445	.876	1.537	1.600	.701	.664	.741

Note: The diagonal contains reliability estimates (*Cronbach's Alpha)*.

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Results

As previously stated, this section will discuss the results of each hypothesis individually. It will begin by presenting the originally proposed hypotheses and conclude with presenting exploratory hypotheses and an omnibus test using all relationships that were found to be significant.

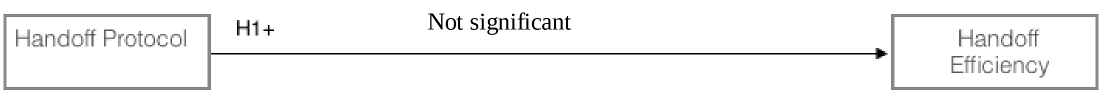

Figure 11. *Hypothesis 1 findings*

H1: Handoff protocol will significantly affect handoff efficiency.

Linear regression was used to determine the relationship between the handoff protocol and handoff efficiency. Analysis demonstrated that there was no correlation between the IV and DV, F (1,171) = .709, p = .401, R^2 = .004, R^2 *adjusted* = -.002. Refer to Figure 11 for the modeled relationship.

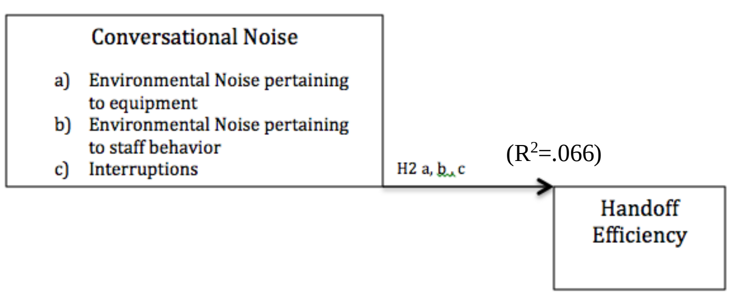

Figure 12. *Hypothesis 2 findings*

H2: Conversational noise affected handoff efficiency such that an increase in frequency/duration of conversational noise will predict a decrease in handoff efficiency.

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H2A: Environmental noise related to equipment will affect handoff efficiency such that an increase in frequency/duration of noise will predict a decrease in handoff efficiency.

H2B: Environmental noise related to staff behavior will affect handoff efficiency such that an increase in frequency/duration of noise will predict a decrease in handoff efficiency.

H2C: Interruptions will affect handoff efficiency such that an increase in frequency/duration of noise will predict a decrease in handoff efficiency.

Linear regression was used to determine the relationship between conversational noise frequency and handoff efficiency. Conversational noise frequency and duration contributed to 6.3% (R^2 *adjusted* = .051) of the variance in the dependent variable, handoff efficiency, F (2, 166) = 5.579, $p < .005$. Conversational noise frequency recorded a higher beta value (*beta* = -0.210, p = 0.034) than conversational noise duration (*beta* = -0.056, p = .570).

Conversational noise was also analyzed using the three constructs: noise due to environment, noise due to staff behavior, and interruptions. Frequency and duration of the noise event were included in this analysis. When analyzing all constructs using multiple regression, it was determined that conversational noise frequency and duration significantly affected handoff efficiency such that when more noise was present, the less efficient the handoff would be, F (6,162) = 4.123, $p< 0.001$, R^2 = .127, R^2 *adjusted* = .095. Environmental noise due to equipment frequency recorded the highest beta weight (*beta* = -0.165, p = .061), followed by interruption duration (*beta* = -0.151, p = .220), noise due to equipment duration (*beta* = -0.134, p = 0.123), interruption frequency (*beta* = -0.120, p = .335), noise due to staff behavior duration (*beta* = -0.068, p = .497) and noise due to staff behavior frequency (*beta* = 0.039, p = 0.699). Refer to Figure 12 for the modeled relationship and R^2 value.

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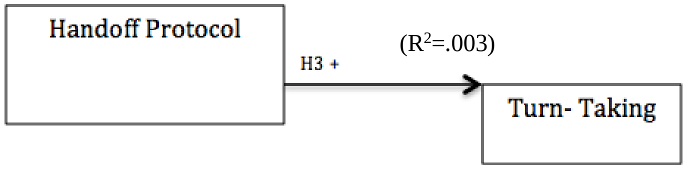

Figure 13. *Hypothesis 3 findings*

H3: Handoff protocol will significantly affect turn-taking within the handoff conversation.

Linear regression was used to analyze the use of the handoff protocol on turn-taking. Analysis did not support a relationship between the handoff protocol and turn-taking, F (1,168) = .490, p = .485, R^2 = .003, R^2 *adjusted* = -.003. Refer to Figure 13 for the modeled relationship and R^2 value.

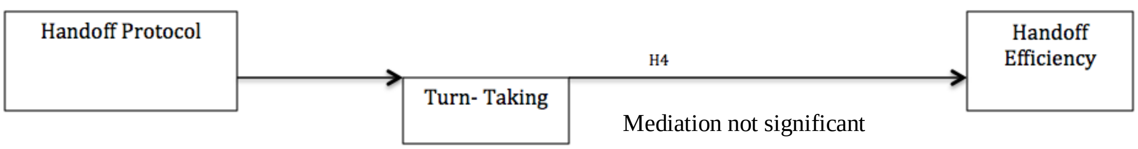

Figure 14. *Hypothesis 4 findings*

H4: Turn-taking will mediate the effect of the handoff protocol on handoff efficiency, such that more turn-taking will lead to a more efficient handoff.

Linear regression was used to determine the relationship between use of the handoff protocol and turn-taking. Analysis demonstrated that there was no relationship between the IV and DV, F (1, 168) = .490, p = .485, R^2=.003, R^2 *adjusted* = -.003. Linear regression was used to determine the relationship between turn-taking and handoff efficiency, F (4, 162) = 7.550, $p<$ 0.001. Turn-taking accounted for 15.6% (R^2 *adjusted* = .136) of variance in the DV. It was determined that more turns taken within the handoff led to lower handoff efficiency. Specifically, interruptions recorded higher (*beta* = -.278, p = 0.001) than butting in (*beta* = -.248,

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p = 0.001), minimal response (*beta* = -.191, *p* = .011), and overlap (*beta* = 0.048, *p* = .522). This suggests that turn-taking and handoff efficiency are inversely related such that an increase in turn-taking predicts a decrease in handoff efficiency. However, because handoff protocol was not significantly related to turn-taking or handoff efficiency, this study does not provide evidence that turn-taking mediates the effect of the handoff protocol on handoff efficiency. Refer to Figure 14 for the modeled relationship.

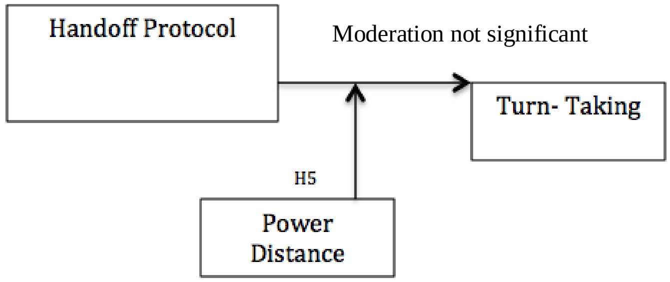

Figure 15. *Hypothesis 5 findings*

H5: Power distance will moderate the relationship between the handoff protocol and turn-taking in the handoff conversation.

Linear regression was used to determine the effect of the handoff protocol on power distance. Handoff protocol use accounted for 4.7% (R^2 *adjusted* = .036) of the variance power distance, F (1, 131) = 6.413, $p < 0.05$. Linear regression was used to determine the effect of power distance on turn-taking. Analysis demonstrated that there was no correlation between power distance and turn-taking, F (1, 116) = .453, p = .502, R^2 = .004, R^2 *adjusted* =-.005. Therefore, this study provides no evidence that power distance moderates the relationship between the handoff protocol and turn-taking. Refer to Figure 15 for the modeled relationship.

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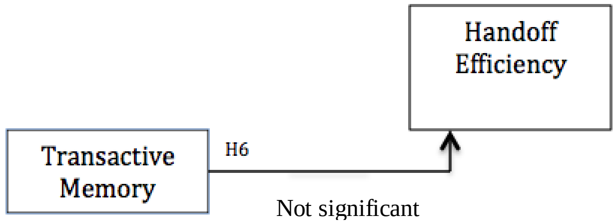

Figure 16. *Hypothesis 6 findings*

H6: Transactive memory significantly affect handoff efficiency.

Linear regression was used to analyze the relationship between transactive memory and handoff efficiency. Analysis demonstrated that there was no significant relationship between the IV and DV, F (2,152) = .563, p = .570, R^2 = .007, R^2 *adjusted* = -.006. Refer to Figure 16 for the modeled relationship.

The next hypotheses were not originally proposed when the study began. However, as previously stated, transactive memory perceptions and handoff efficiency perceptions were also collected. Therefore, the following exploratory hypotheses were proposed after data collection was completed.

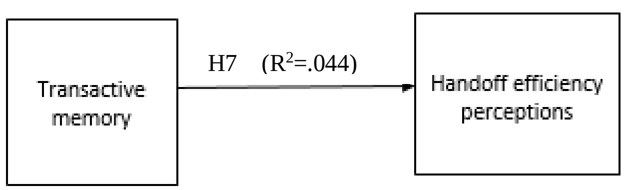

Figure 17. *Hypothesis 7 findings*

H7: Transactive memory will significantly affect handoff efficiency perceptions.

Linear regression was used to analyze the relationship between transactive memory and handoff efficiency perceptions. Analysis demonstrated that transactive memory accounted for 4.4% (R^2 *adjusted* = .027) of variance in handoff efficiency perceptions, F (1, 113) = 2.589, p<

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0.05, such that the lower transactive memory, the lower handoff efficiency perceptions. Refer to Figure 17 for the modeled relationship and R^2 value.

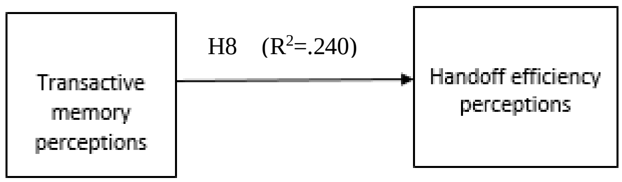

Figure 18. *Hypothesis 8 findings*

H8: Transactive memory perceptions will significantly affect handoff efficiency perceptions.

Transactive memory perceptions were significantly correlated with handoff efficiency perceptions F (3, 65) = 4.613, p < 0.05, accounting for 17.6% (R^2*adjusted* = .137) of the variance in handoff efficiency perceptions. High perceptions of transactive memory indicated higher perceptions of handoff efficiency. Each construct scale was significant with specialization recording the highest of the three constructs: specialization (*beta* =.473, p< 0.001), credibility (*beta* = .347, p< 0.05), and coordination (*beta* = -.448, p< 0.001). Refer to Figure 18 for the modeled relationship and R^2 value.

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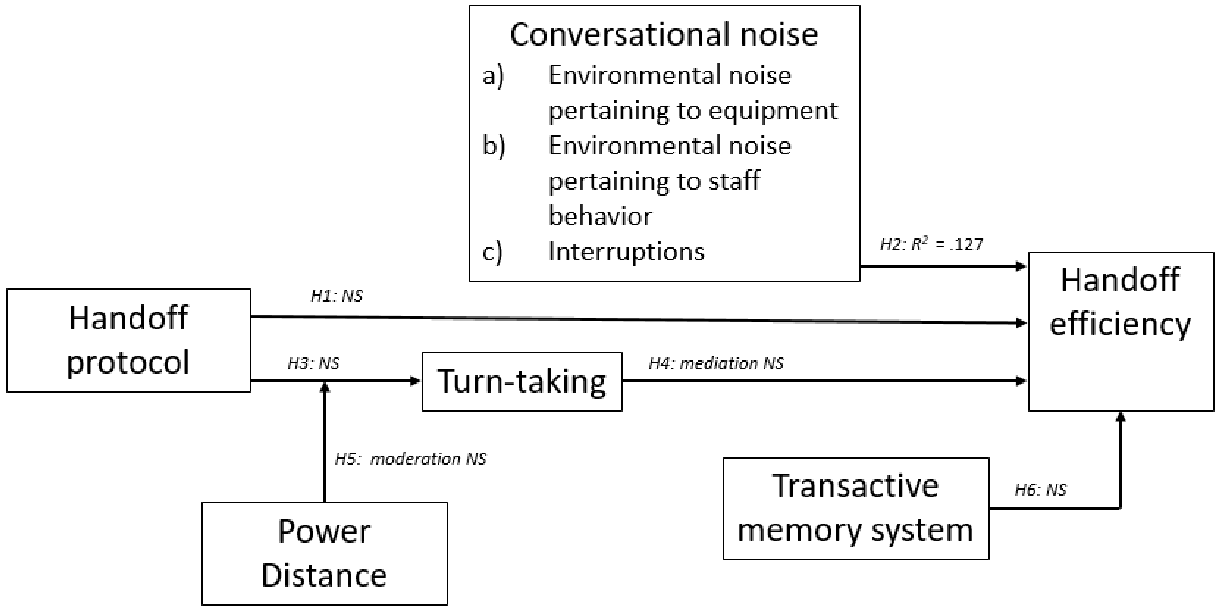

Figure 19. *Total model findings*

Total model testing: All significant variables from the original model

When all variables proposed in the model were tested for their effect on handoff efficiency, analysis demonstrated there was no significant relationship between the IVs and DV. However, if mediation and moderation are ignored and all independent variables are regressed onto handoff efficiency, these variables account for 37.7% of variance in handoff efficiency, F (9, 81) = 5.444, $p < .001$, R^2 *adjusted* = .308. For beta weights, refer to Table 10. Refer to Figure 19 for complete model of variables and respective statistical results of significance (displaying R^2 value) or non-significance (NS).

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Table 10. *Beta weights and significance values of variables included in omnibus test*

Variable	***β weight***	***p* value**
Turn-taking	-.449	.000
Protocol use	-.233	.018
Conversational noise frequency	-.158	.162
TMS credibility	-.140	.147
Conversational noise duration	-.112	.310
Power distance	.042	.671
Transactive memory	-.017	.850
TMS specialization	.010	.915
TMS coordination	.004	.970

To summarize, the total model was not supported. Individual relationships within the model were significant. These variables combined with the variables that were tested in the exploratory analyses were found to predict more than a third of variance in handoff efficiency. For a list of all hypotheses and findings, refer to Table 11.

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Table 11. *Hypotheses and outcomes*

Proposed Hypothesis	Outcome
H1: Using an empirically-derived handoff protocol leads to an increase in handoff efficiency.	Not Significant
H2: Conversational noise leads to a decrease in handoff efficiency.	**Significant**
H2A: Environmental noise related to equipment leads to a decrease in handoff efficiency.	**Significant**
H2B: Environmental noise related to staff behavior leads to a decrease in handoff efficiency.	Not Significant
H2C: Interruptions leads to a decrease in handoff efficiency.	**Significant**
H3: Use of an empirical handoff protocol leads to an increase in turn-taking during the handoff conversation when compared to the general handoff protocol.	Not Significant
H4: Turn-taking will mediate the effect of the handoff protocol on handoff efficiency, such that more turn-taking leads to a more efficient handoff.	**Partially Significant**
H5: Power distance between handoff participants moderates the effect of the handoff protocol on turn-taking during the handoff conversation, such that when power distance is high, there is less turn-taking between handoff participants.	Not Significant
H6: Transactive memory leads to an increase in handoff efficiency such that the higher the level of transactive memory between the providers the more efficient the handoff.	Not Significant
H7: Transactive memory systems significantly affects handoff efficiency perceptions	**Significant**
H8: Transactive memory perceptions significantly affects handoff efficiency perceptions.	**Significant**

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CHAPTER FIVE: DISCUSSION

This study was not able to add evidence to the overwhelming literature suggesting handoff protocols increase handoff efficiency; however, it does present precursors for achieving handoff efficiency. By addressing just a few of the attitudes, behaviors, and cognitions present during handoff conversations, a clearer understanding of the conditions needed to improve handoff efficiency exists. Further, this study presents evidence for the need to further explore the underlying communication constructs and theories that influence handoffs. While the previous section presented the statistical results of the study, this section will discuss the results, offer possible explanations to the significant or non-significant findings, and identify limitations of the study.

Hypothesis 1 posited that handoff efficiency is positively related to handoff protocol use because the protocols have been demonstrated to alleviate communication failures (Wayne et al., 2008) and increase information passed between providers while decreasing length of the handoff (Burton, Kashiwagi, Kirkland, Manning, & Varkey, 2010; Lazzara et al., 2016). While the findings of this study did not support previous literature suggesting that protocols increase handoff efficiency, it does not discredit previous research. Instead it spurs the need for further research regarding the implementation of handoff protocols. Plausible explanation to this non-significant result may stem from the lack of protocol adoption. During the post-intervention observations, only 21 out of 47 observed cases used the protocol thereby decreasing the power of the manipulation in the study. Furthermore, it was made known during the observation periods that the unit had previously been using a form known as “the purple sheet.” A member of the anesthesia team was required to complete and deliver this form to the receiving PACU nurse during each and every handoff. This form potentially created a patterned handoff that was still

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being used despite the sheet itself no longer being present during handoffs. Lastly, some of the CRNAs commented that they had received training in handoff protocols during nursing school and followed the systems or head to toe approach for the handoff. This meant that the CRNA habitually handed off patients by addressing each health system from head to toe starting with neurological, then cardiac, pulmonary, gastrointestinal, renal and etc. Other limitations to the efficacy of the handoff protocol will be discussed in the limitations section.

Hypothesis 2 suggested that conversational noise taking place during the handoff decreases the efficiency. The findings of this study support that conversational noise causes a decrease in handoff efficiency and indicates that as conversational noise increases efficiency of the handoff decreases. Because a handoff is a conversation, it is accurate to model the conversation based on the communication process model with a sender, receiver, the channel, and possible noise. Due to the difficulty in defining conversational noise, this variable was further subdivided into three variables: environmental noise due to equipment, environmental noise related to staff behavior (Hasfeld, Laerkner, & Birkelund, 2010), and interruption. The first two categories of noise are made by a piece of equipment or are unintentional and are not purposefully seeking the attention of the individual involved in the handoff. The last category, interruption, does include a person purposefully and intentionally seeking the attention of one or more of the handoff participants. Hypothesis 2 posited that each of these types of conversational noise would decrease the efficiency of the handoff. Conversational noise frequency and duration was measured during the handoffs. As expected, the frequency and duration were highly correlated with each other, but only two of the three categories were significant: environmental noise due to equipment and interruptions. This was true for both frequency and duration of the noise. Because environmental noise made by equipment consisted primarily of alarms indicating

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a change in patient status, providers commonly acted in order to accommodate the patient or turn off the alarm. Since both the alarms and the interruptions included a need for action, the handoff would pause or slow in order to compensate for the action being performed. Due to this finding, it is recommended to focus on action performed in response to conversational noise for future analysis. To explain the lack of significance in regard to conversational noise due to staff behavior, it is plausible that the staff have learned to ignore the noise that does not strictly pertain to the patient care, habituating to the environment and only focusing on pertinent environmental stimulation and sensation.

Hypothesis 3 posited that the introduction of a handoff protocol affects turn-taking between the participants in the handoff. Conversations are commonly mundane meaning that the participants lack a rigid structure in turn-taking. Handoffs are commonly unidirectional with the sender, in this case the anesthesia provider, imparting information to the receiver, the PACU nurse. These conversations tend to lack turns because the receiver is expected to listen for the information and then proceed with providing care for the patient. Handoff protocols have the potential of creating a speech exchange system by providing a strict pattern of detailed order within the conversation (Dingwall, 1980). By providing a uniformed and guided passing of information from one party to another, the protocol can cause the order of the conversation to become implicit and expected. When analyzed, this hypothesis was not significant the handoff protocol did not impact turn-taking. Possible reasons this was not significant include that the protocol was not used long enough to become implicit or second nature to the providers, and therefore the handoff conversation was not elevated to a speech exchange system. Perhaps the results of this test would be different with prolonged use of the protocol. It is also possible that the previously mentioned purple sheet has already begun cultivating a speech exchange system

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that the participants follow implicitly. Further research into the speech exchange system and its application to handoffs is needed to understand the relationship of implicit speech on turn-taking.

Hypothesis 4 posited that turn-taking mediates the relationship between the handoff protocol and handoff efficiency. Because the nurses were encouraged to speak during the handoff protocol by asking questions and helping to remind/guide the anesthesia provider of the order of information to be delivered; it was expected that turn-taking would increase. The fact that nurses would be expected to speak and actively contribute to the handoff conversation would create a more positive reaction (Ford & Stickle, 2012). While the relationship between turn-taking and handoff efficiency was significant, it suggested that less turns increased handoff efficiency. This suggests that when the nurse took a turn to speak, it slowed down the information. However, this is not a negative result. It was common that when the nurses took a turn speaking, it was to clarify or ask a question, rather than to contribute new information. This suggests that a “goldilocks zone” of turn taking may exist; too few or too many turns can decrease handoff efficiency. Turns are needed to clarify and retrieve information not previously presented and to improve retention of information. Too many turns reduces handoff efficiency while too few possibly prevents information from being included in the handoff, for example, a nurse not asking about a missing piece of information. Because literature suggests that people pay closer attention to the presented information when they expect to take a turn speak, further studies should analyze information retention in regards to turns taken. If the receiving nurse took a turn, is that information more often remembered than other pieces of information?

Hypothesis 5 posited that power distance moderates the relationship between the handoff protocol and turn-taking in the handoff conversation. Because the handoff protocol to turn-taking relationship was insignificant, it is not possible to determine if power distance would moderate

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the relationship. However, it is interesting to note that the relation between the handoff protocol and power distance was significant, even though power distance was not significantly related with handoff efficiency or handoff efficiency perceptions. Because power distance and turn-taking are linked, manipulating the handoff conversation by introducing a rigid structure decreases the power distance between the individuals participating in the handoff protocol. By providing a framework for the conversation, it “democratizes” the environment (Raghunathan, 2012). Rather than passively listening to the anesthesia provider for information, the receiver has the ability to anticipate/expect the next piece of information and even ask for it when skipped. This ability to anticipate and request information based upon a pre-established protocol acts as support to the “lower” nursing staff thereby encouraging their equal participation in the handoff.

Hypothesis 6 posited that transactive memory positively affects handoff efficiency. Because the anesthesia providers and PACU nursing teams are fairly consistent, it was expected that transactive memory would exist between the individuals. Another possible explanation for this finding may be the small sample size or possible biased responses on the surveys. Providers may have felt uncomfortable “rating” other individuals with whom they work closely or have over-estimated their own performance when rating themselves. Though the findings of this study do not support the proposed hypothesis for this population sample, more research is needed to identify the effect of transactive memory on handoffs and the communication within handoffs including the transactive memory of the person providing the handoff protocol and associated training.

Hypothesis 7 posited that transactive memory affected handoff efficiency perceptions. It is interesting to note that transactive memory does not affect handoff efficiency but it does affect handoff efficiency perceptions. It is possible that the providers who have well established

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transactive memory systems perceive handoff to be more efficient because they expect there to be a reduction in the amount of information needed to be passed. Language in the handoff can be shortened to phrases like “the usual” which implies a plethora of meaning for members who are experienced, competent, and familiar with the procedures. However, when transactive memory is low between providers, there may be a hesitation to assume that the other person knows all the information inherent to the patient’s care and therefore must be given or asked about all possible pertinent information. Furthermore, due to transactive memory systems being assessed at the dyad level, participants were more likely to rate their handoff partner while in close proximity to him/her. The ratings provided by the participants could have been biased as it is common for people to rate their own performances higher.

Hypothesis 8 posited that transactive memory perceptions would significantly affect handoff efficiency perceptions. During the transactive memory perceptions survey, participants were asked to relate their answers to the unit, rating the group rather than the individual. If a participant rated the unit high on specialization, coordination, and credibility, it is logical that the handoff efficiency perceptions would be significantly related. Providers who would rate their colleagues highly in specialization, coordination, and credibility would perceive handoff efficiency to also be high. The more a provider is aware of other’s knowledge, the more he/she can predict the information needed and actions that will be taken by the other team member. So if a participant perceived that this understanding of knowledge was higher, he/she would also perceive that the capability of the providers engaged in the handoff would also be higher resulting in an efficient handoff. It is possible that because transactive memory perceptions were rated at the unit level, participants were more comfortable relating their assessment of the group, rather than the individual.

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Finally, even though the model as presented is not supported, when using the individually tested variables to create an altered model, 27.1% of the variance in handoff efficiency can be accounted for using conversational noise due to equipment frequency, conversational noise interruption frequency, turn-taking, and transactive memory perceptions factors specialization and coordination. While the largest component in handoff efficiency is arguably the complexity of the patient (DeReinzo, Lenfestery, Horvath, Goldberg, & Ferranti, 2014), being able to account for more than a quarter of the variance in handoff efficiency is a positive step toward understanding handoff communication.

Limitations and Validity

Limitations

Like any other study, adaption was needed in order to complete the study. Due to unforeseeable circumstances, I was unable to collect a third round of observations for analysis. As discussed previously, the handoff protocol was not effectively adopted by all participants in the study. Senders in the handoff did not always use the protocol, and receivers did not always assist in reminding the providers that use of the handoff protocol was necessary.

While investigating the implementation of handoff protocols in the PACU, it was discovered that the PACU was not completely handoff protocol free. Because the unit had previously used what they called the “purple sheet” (see attached), it is possible that the effects of a new protocol were limited. The purple sheet provided a structure for the delivering of information during the patient transfer to the PACU staff. This could have potentially weakened the effects of the newly implemented handoff protocol. Additionally, the EPIC electronic medical record tool was arranged in such a way to assist in facilitating a quick and highly informational handoff. Notably, the providers and the creator of the EMR tool commented that the tool was not fully supported by the providers and was never “truly adopted.” This behavior

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was mimicked in the current study as implementation of the handoff protocol was not readily adopted by the providers since only half of the post-intervention handoffs utilized the new handoff protocol. A possible explanation for this could be the cultural concern for implementation of a new handoff protocol. Comments from some of the providers included that "Protocols don't work in general," "We've done this before; it didn't work," "Doing this just ruins my normal flow," and other similar comments suggesting that the environment was not receptive to a behavioral change.

Lastly, the Hawthorne effect may have affected the environment in which the study was conducted. During the study, a provider commented that typically handoffs were very short and a lot of information was left for the nurses to look up in the EMR. While this was only one comment, it does raise the question of whether or not the providers were adapting their performance in response to the presence of the study/camera/observer. If this behavior adaption was taking place, it is possible that when providers conducted handoffs they were delivering more information in a more succinct manner regardless of the intervention. Given the short period of time in which data was collected, it was difficult to circumnavigate the possibility of the Hawthorne effect, despite staying as unobtrusive as possible.

Time restricted limitations (longitudinal limitation): In the time between applying for Institutional Review Board (IRB) approval and the beginning of baseline intervention, the surgery team had begun handing off patients to the PACU nurses. Because of this, the PACU nurses now receive two handoffs about a single patient: one from the surgery resident and one from an anesthesia provider. Because the surgery resident passes off so much information, it limits the amount of information needed from the anesthesia provider. Some information passed by the surgery resident and the anesthesia provider is redundant. With this in mind, the efficiency

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of the handoff from the perspective of the anesthesia provider has increased while the efficiency of the handoff from perspective of the nursing staff is debatable. Further study is needed to address the efficacy and efficiency of separating the surgical and anesthesia handoffs versus delivering all pertinent information at once.

Validity

Internal validity. While the study properly demonstrates a relationship between variables, it does not entirely account for all causal relationships between handoff protocols and handoff efficiency. Other plausible and possible explanations exist for the observed effect between the tested variables, such as participant familiarity, illness complexity, patient load, time of day/day of week, familiarity with the patient, etc. Further, this study was not conducted as a true within subjects test due to the inherent nature of field studies. Especially within the medical field, schedule, availability, and caseload dictates the provider participation, so little control exists when determining the sample population. Therefore, a convenience sample of handoffs was used for analysis. The study did insure inclusivity for all medical provider roles and did not exclude participation because of role. The study was designed to limit the type of surgery that the patient had undergone to limit drastic differences in patient complexity. Additionally, the study was strict in regards to the observation time. This was accomplished by limiting the hours and days of the week included so other confounding issues would not be present such as the effect of night shift or weekend shift.

External validity. Because this field study was conducted within a PACU, it is possible that the results and protocol created could be effectively applied within other PACU environments. However, based upon the literature (Riesenberg, Leitzsch & Little, 2009; Risenberg, Leitzsch, & Cunningham, 2010), we know that handoffs cannot always be translated

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from one environment to another. This does not reduce validity of the study's findings related to the tested variables. Results regarding the effects of conversational noise, turn-taking, power distance, psychological safety, transactive memory, transactive memory perceptions and handoff efficiency could help bring insight on the underlying communication and sociotechnical aspects of handoffs, regardless of the environment in which the handoff is being conducted.

Construct validity. While not every aspect of a social technical interaction like a handoff can be measured through one study or even through one model, this study endeavored to select variables for testing that were supported by the literature and represented attitudes (perceptions of transactive memory, perceptions of handoff efficiency), behaviors (turn-taking, handoff efficiency), and cognitions (transactive memory, power distance, psychological safety) of the handoff teams being observed as well as taking into consideration the environment (conversational noise).

Statistical Validity. Survey scales in this study were selected for use due to their previous validation and consent among the literature to appropriately measure the stated construct. The measures were tested for reliability and all were determined to hold a Cronbach's Alpha score of .73 or higher. Refer to Table 9 for a list of all scale assessment scores.

Conclusion

Medical errors, especially regarding communication, will continue to pervade due to the high amount of communication mandatory to facilitate effective care. Communication and coordination among team members will remain a focal point of study as researchers and clinicians undertake the arduous task of linking behavior to outcomes. Little research has been completed to assess the underlying communication principles that affect handoff protocols. Though more research is needed, this study has provided insight into how handoff efficiency can

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be affected. By implementing an empirically based handoff protocol and testing influencing variables on handoff efficiency, this study was able to identify 15 variables which together can predict more than a third of variance in handoff efficiency. Perceptions of transactive memory systems (specialization, credibility, and coordination), turn-taking (interruptions, minimal response, and butting in), conversational noise frequency and duration (due to equipment, due to staff behavior, and interruptions), power distance, and psychological safety can be used to predict handoff efficiency. Increasing and maintaining patient safety while balancing the demand on the provider's time is a difficult task. Understanding and implementing practices that increase handoff efficiency saves provider's valuable time while delivering quality care.

This work seeks to improve and add to the existing literature regarding communication within handoffs. It is my sincere belief that by continuing to understand the implicit communication theories that persist in society, the communication between providers can be further studied and improved upon. It is my hope to continue this research and that others will also seek to explain the underlying principles of communication inherent within patient care.

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APPENDIX A

Variations in cultural orientations:
Power Distance Scale

Scale: 1 = strongly disagree 7 = strongly agree

Items:
1. Organizations should have separate facilities, such as eating areas, for higher-level managers
2. A hierarchy of authority is the best form of organization.
3. People at higher levels in organizations have a responsibility to make important decisions for people below them.
4. The highest-ranking manager in a team should take the lead.
5. Employees should be rewarded based on their level in the organization.
6. People at lower levels in organizations should carry out the requests of people at higher levels without question.
7. People at lower levels in the organization should not have much power in organization.

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APPENDIX B

Transactive Memory Scale Survey

Below is a list of skills that have been identified as being relevant to your work environment. Now, think about your interactions with your team mates during handoffs between the OR and PACU. For each skill on the list, please rate your own level of ability for each particular skill area. Next, for each skill on the list, please rate your teammate's level of ability for each particular skill area. Use the following scale:

1= very low ability -> 7=very high ability

Skills list:

Skill/Knowledge Area	Your ability (self)	Teammate's ability (other)
1. Knowledge of patient background (past/history)		
2. Knowledge of patient's affliction (current status)		
3. Monitoring vital signs (current status)		
4. Developing treatment for patient		
5. Evaluation of treatment (treatment quality)		
6. Patient management (caring for the		

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patient/administering treatment)		
7. Leading discussion during handoffs (team coordination)		

APPENDIX C

Transactive Memory Systems

Scale: 1 = strongly disagree 7 = strongly agree

Specialization
1. Each team member has specialized knowledge of some aspect of our project.
2. I have knowledge about an aspect of the project that no other team member has.
3. Different team members are responsible for expertise in different areas.
4. The specialized knowledge of several different team members was needed to complete the project deliverables.
5. I know which team members have expertise in specific areas.

Credibility
1. I was comfortable accepting procedural suggestions from other team members.
2. I trusted that other members' knowledge about the project was credible.
3. I was confident relying on the information that other team members brought to the discussion.
4. When other members gave information, I wanted to double-check it for myself. (R)
5. I did not have much faith in other members' "expertise." (R)

Coordination
1. Our team worked together in a well-coordinated fashion.
2. Our team had very few misunderstandings about what to do.
3. Our team needed to backtrack and start over a lot. (R)
4. We accomplished the task smoothly and efficiently.
5. There was much confusion about how we would accomplish the task. (R)

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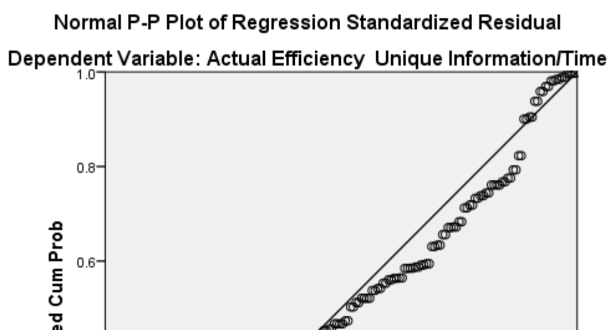
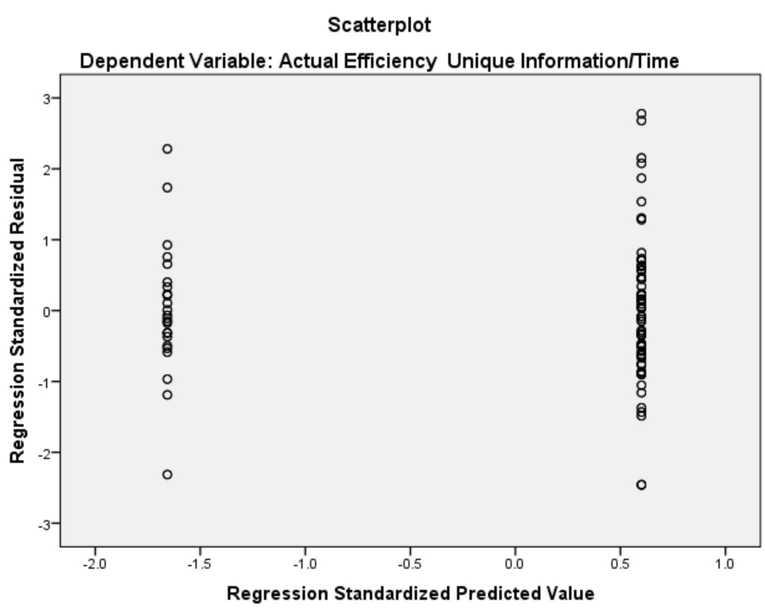
APPENDIX D

Normal P-P plots and scatter plots for each analysis are displayed in this appendix

Hypothesis 1: Using an empirically-derived handoff protocol will lead to an increase in handoff efficiency.





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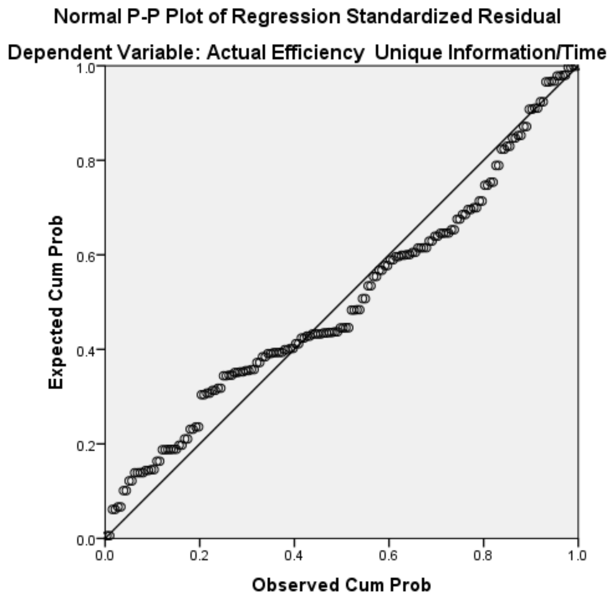
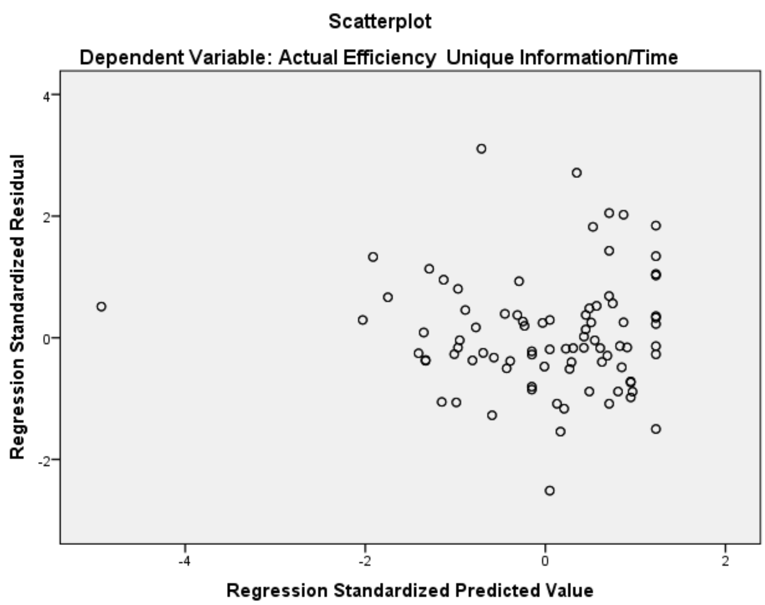
Hypothesis 2: Conversational noise will lead to a decrease in handoff efficiency.





H2A: Environmental noise related to equipment will lead to a decrease in handoff efficiency.
H2B: Environmental noise related to staff behavior will lead to a decrease in handoff efficiency.
H2C: Interruptions will lead to a decrease in handoff efficiency.

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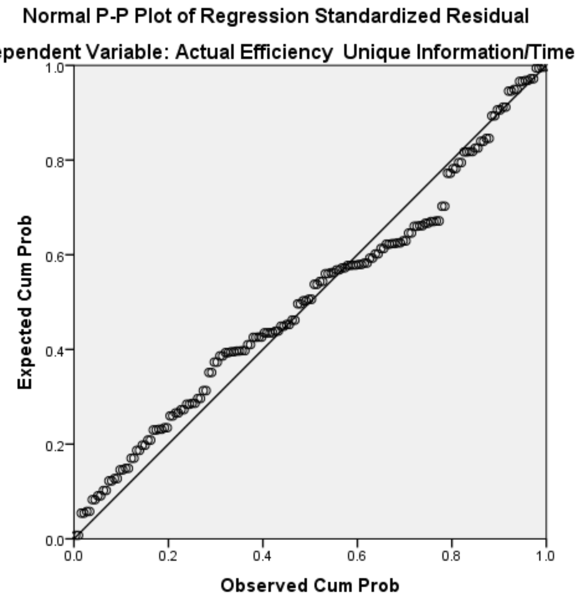
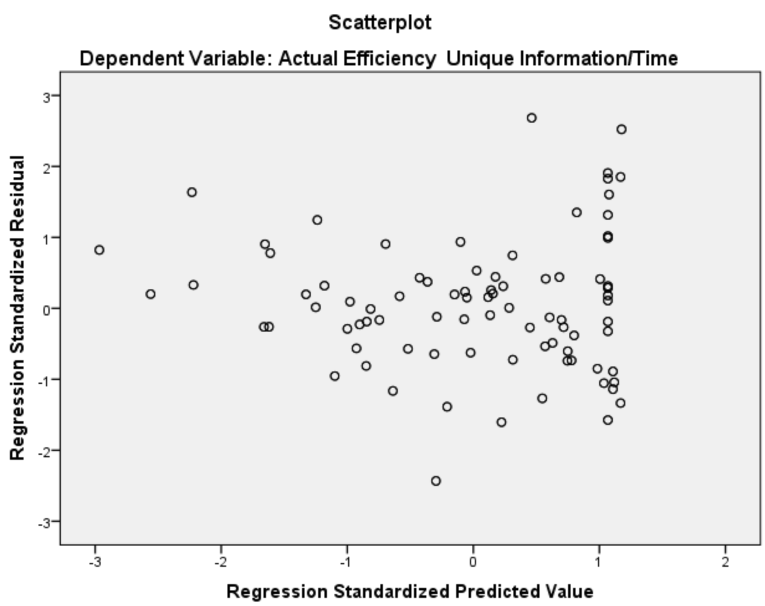


H3: Use of empirical handoff protocol will lead to an increase in turn-taking during the handoff



conversation when compared to the general handoff protocol.

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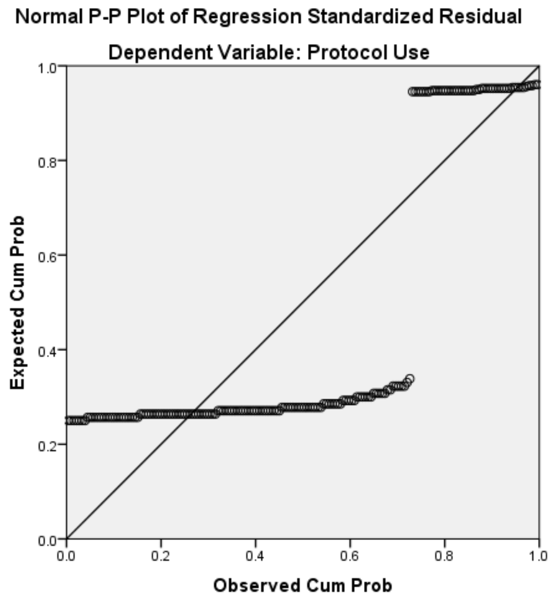

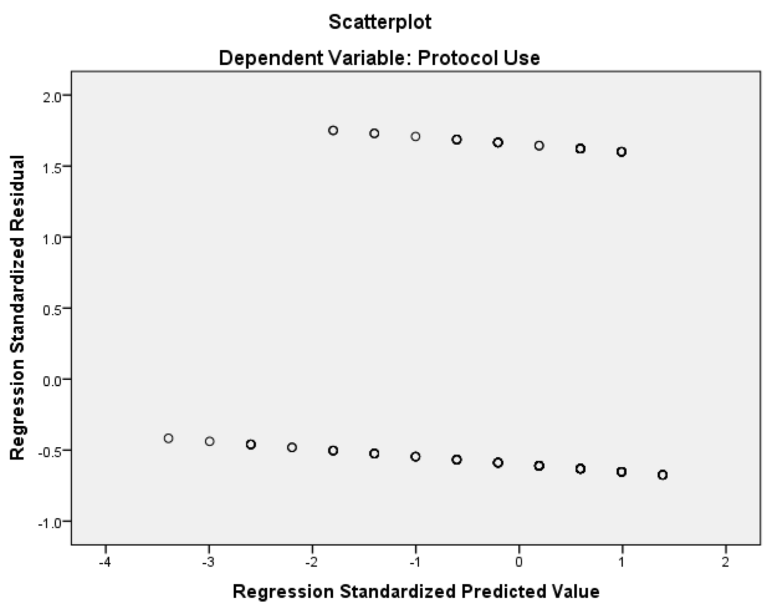

H4: Turn-taking will mediate the effect of the handoff protocol on handoff efficiency, such that more turn-taking will lead to a more efficient handoff.

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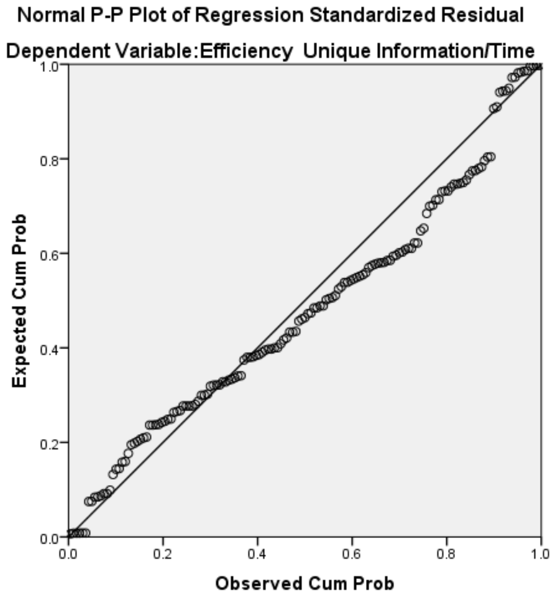

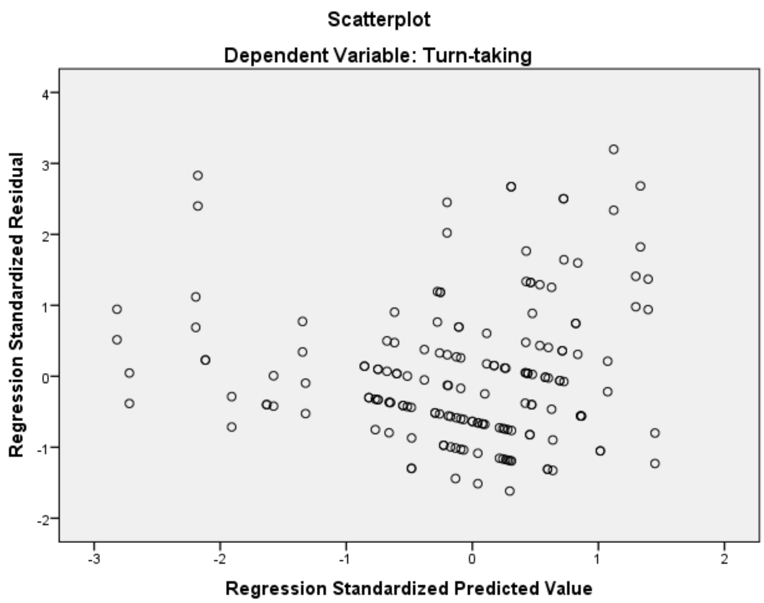

H5: Power distance between handoff participants will moderate the effect of the handoff protocol on turn-taking during the handoff conversation, such that when power distance is high, there will be less turn-taking between handoff participants.

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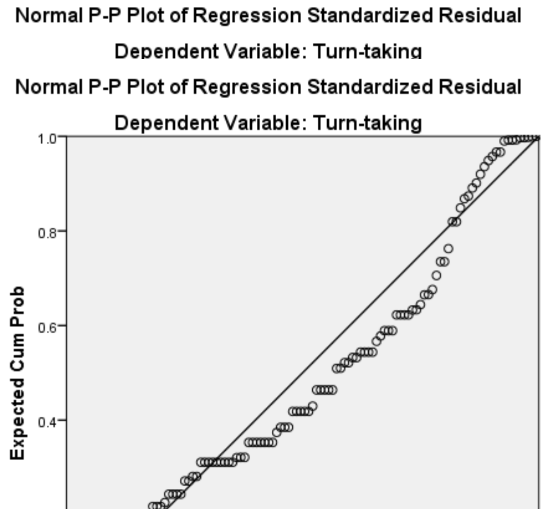

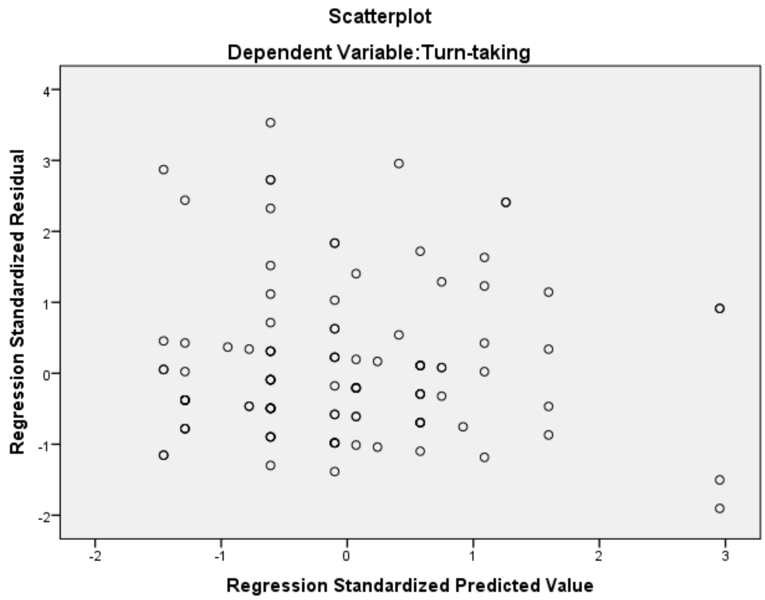

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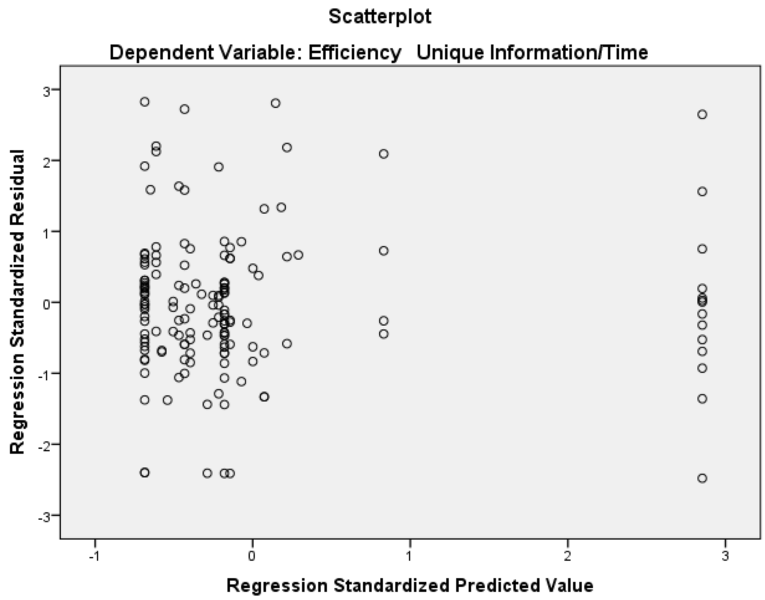
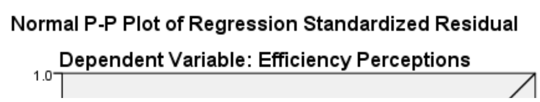
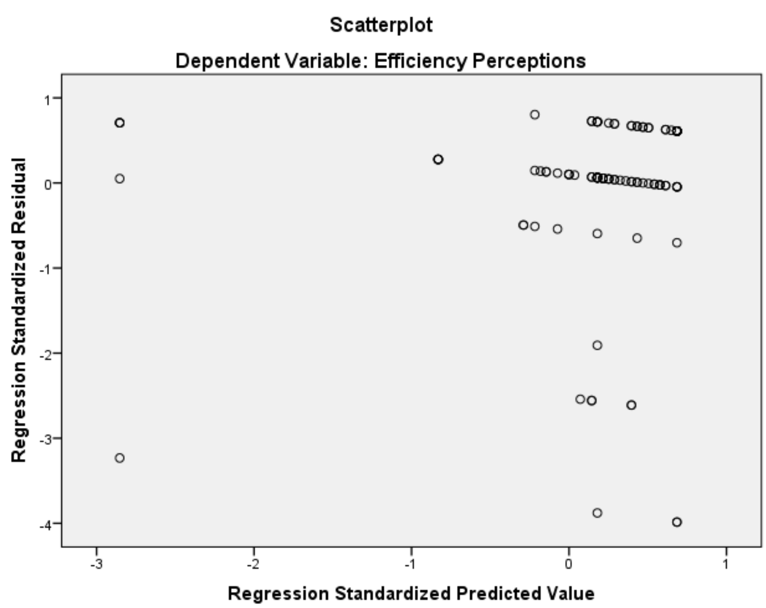


H6: Transactive memory will lead to an increase in handoff efficiency such that the higher the level of transactive memory between the providers, the more efficient the handoff will be.





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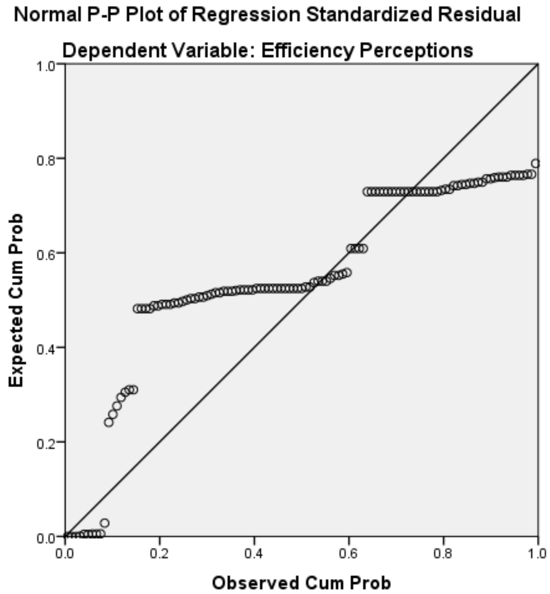
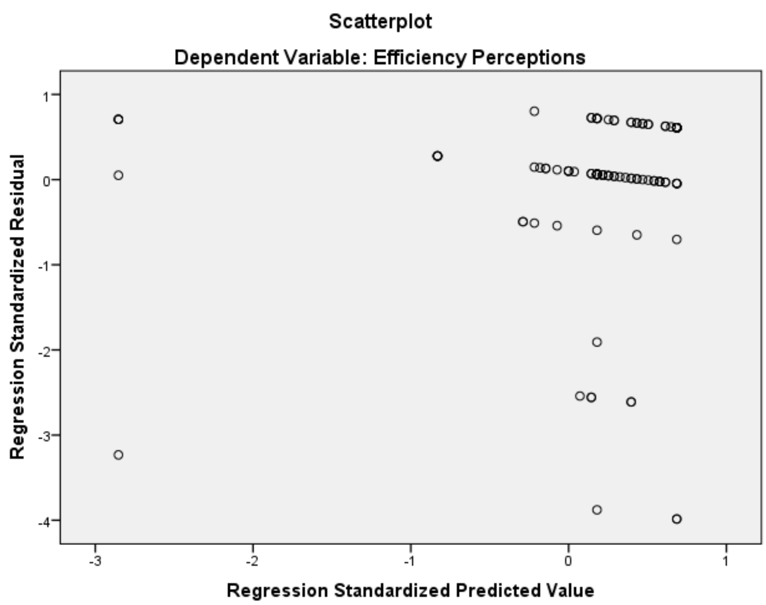
H7: Transactive memory significantly affects handoff efficiency perceptions.





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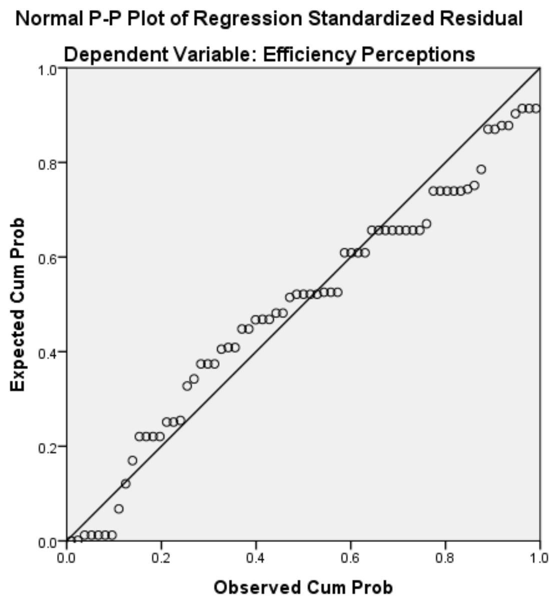
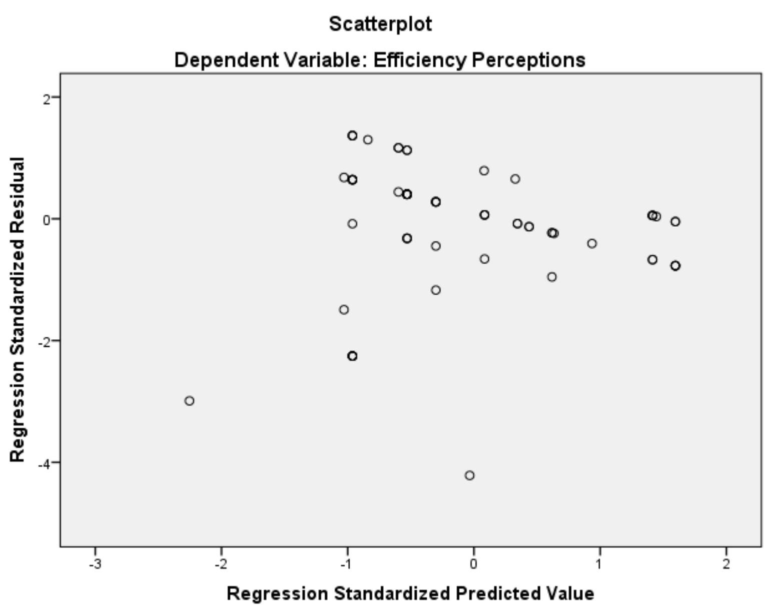
H8: Transactive memory perceptions significantly affects handoff efficiency perceptions.





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APPENDIX E

Table 12. *Hypotheses, Constructs, and Statistical Findings*

Hypothesis	Constructs	*F*	*R*	R^2	R^2 *adjusted*	*B*	Sig	*SE*
1	Handoff Protocol to Handoff Efficiency	.709	.064	.004	-.002	-.020	.421	.140
2*	Conversational noise (frequency and duration) to handoff efficiency	5.579	.250	.063	.051	-.011 .000	.005	.128
2A*	Conversational noise made by equipment (frequency and duration) to handoff efficiency	5.820	.256	.066	.054	-.019 -.001	.004	.129
2B	Conversational noise my by staff behavior (frequency and duration)to handoff efficiency	.695	.091	.008	-.004	.000 -.001	.501	.131
2C*	Conversational noise: Interruptions (frequency and duration) to handoff efficiency	5.525	.250	.062	.051	-.014 -.003	.005	.128
3	Handoff protocol to turn taking	.490	.054	.003	-.003	-.304	.485	2.513
	Protocol use to turn taking	.490	054.	.003	-.003	-.304	.485	2.513
	Turn taking to handoff efficiency	7.550	.395	.156	.136	-.012 -.035 .002 -.029	.000	.118
	Protocol use to power distance	6.413	.216	.047	.036	-.482	.013	.966
	Power distance to turn taking	.453	.062	.004	-.005	-.170	.502	2.682
6	Transactive memory on handoff efficiency	.563	.086	.007	-.006	-.023	.570	.140

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7*	Transactive memory perceptions (specialization, credibility, coordination) on handoff efficiency	2.589	.210	.044	.027	.030 .194 -.813	.04	1.504
8*	TMS (specialization, credibility, coordination) on handoff efficiency perceptions	4.613	.419	.176	.137	.353 .674 -.820	.005	1.504
Total*	Total model: protocol use, turn-taking, conversational noise frequency, conversational noise duration, power distance, transactive memory, TMS specialization, TMS credibility, TMS coordination	5.444	.614	.377	.308	-.070 -.023 -.010 .000 .006 .002 -.029 .001 -.001	.000	.113

Note: Statistical findings are denoted by an asterisk.

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