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Deconstructing Anesthesia Handoffs During Simulated Intraoperative Anesthesia Care

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Intraoperative Anesthesia Care

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

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INTRAOPERATIVE ANESTHESIA CARE

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Anesthesia patient handoffs are a vulnerable time for patient care and handoffs occur

frequently during anesthesia care. Communication failures contribute to patient harm

during anesthesia patient handoffs.   The Joint Commission has recognized the

potential for communication failure during patient handoffs and has recommended

processes to improve handoff safety. Handoffs are made more difficult by latent

conditions such as time constraints, pressure and distractions, which often result in

incomplete or inaccurate handoff reports. This nonexperimental, correlation study

identified the latent conditions that occur during the handoff process and their

relationship to the quality of the handoff. This research shows an inverse relationship

between latent conditions and anesthesia patient handoff scores. The number of latent

conditions and the types of latent conditions affected handoff scores. Handoffs that were not interactive or handoffs with unsafe timing predictably resulted in poor handoff communication. Clinicians must acknowledge that handoffs are a high-risk event that can result in patient harm. Clear and effective communication is key to safe, quality care and this includes being aware of and minimizing the impact of latent conditions during the anesthesia patient handoff.

Chapter One: Introduction

Hospitals are institutions that provide medical and surgical treatment and nursing care for sick or injured people. People go to hospitals for care to improve or at least maintain their health. Unfortunately, every day patients are harmed by medical errors in these same hospitals. Despite the goals of providing safe and effective patient care, hospitals are not as safe as they should be. In fact, healthcare is considered unsafe (Leape et al, 2009).

Medical errors are an ongoing problem in health care. Medical errors are defined as "the failure of a planned action to be completed as intended (i.e. error of execution) or the use of a wrong plan to achieve an aim (error of planning)" (Kohn et al, 2000). One noted patient safety expert likened the problem of medical errors to a public health epidemic (Eisenberg et al, 2000). Health care organizations, government, professional associations and others have come together to create a patient safety movement to improve healthcare and decrease medical errors (Clancy, 2009).

The National Patient Safety Foundation (NPSF) identifies some of the most common and worrisome sources of medical errors as: wrong-site surgery, medication errors, health-care acquired infections, falls, readmissions and diagnostic errors. The causes of medical errors are complex. One thought is that humans are prone to error. This is the human component, which acknowledges that even intelligent, well-intention healthcare providers make mistakes. A systems centered approach to error is a

different way of thinking about errors. Systems approach assumes that humans are fallible and that systems must be designed that prevents humans from making errors (van Beuzekom, 2010). In the enlightened age of error theory, theorists are focusing their attention on system engineering, shifting the focus from the individual blame to system improvement.

Many healthcare systems fit Reason's description of "sick system syndrome." These "sick" healthcare systems are hierarchical and lack mutual respect, teamwork and transparency (Leape et al, 2009). Solutions that create a safer healthcare system and decrease medical errors are centered around system fixes. The Agency for Healthcare Research and Quality (AHRQ) is a government supported agency whose mission is to produce evidence to make health care safer, higher quality, more accessible, equitable, and affordable. The AHRQ recommends the following to prevent and reduce medical errors: creating a culture of safety, encouraging teamwork, reducing healthcare-associated infections, advances in event reporting, supporting patient safety training and understanding resident fatigue.

All patient care areas are at risk of causing harm to patients. The operating room has been identified as a particularly dangerous area of the hospital. Kohn (2000) stated that high error rates with serious consequences are more likely in intensive care units, operating rooms, and emergency departments. More than half of the medical errors occurring in the hospital are attributed to the operating room (de Vries et al, 2008). Effective communication in this environment is identified as essential to ensure the safe delivery of surgical care (Hu et al, 2012).

When medical errors occur, a common cause is communication breakdown between members of the healthcare team (Gawande et al, 2003). Communication breakdown or failure occurs in the care of patients when relevant patient information is not transferred to other health care providers or when incorrect patient information is transferred. Communication failures can occur during any point in the continuum of patient care. One of the most vulnerable times for communication failure is when the patient care is transferred from one provider to another.

A patient "handoff" is a term used to describe the transfer of role and responsibility from one person to another. The handoff has been defined as "the transfer of professional responsibility and accountability for some or all aspects of care for a patient, or group of patients, to another person, or professional group on a temporary or permanent basis (Salzwedel et al, 2013). During patient care, handoffs occur when one person providing patient care transfers their responsibility to another provider who is assuming that role. The primary objective of a patient handoff is the accurate transfer of vital information and the anticipated plan of care.

Patient handoffs occur frequently among anesthesia providers during the patient's perioperative experience. Handoffs occur for meal breaks, bathroom breaks, at the change of shifts or when a patient is transferred to the post anesthesia care unit (PACU) or intensive care unit (ICU) for recovery. The more frequently handoffs occur, the greater the risk of miscommunication and subsequent patient care errors (Solet et al, 2005).

Patient handoffs are recognized as a vulnerable point for communication failure in the process of patient care (Dracup & Morris, 2008; Nagpul et al, 2010; Kalkman, 2010,

Kitch et al, 2008). This vulnerability is due to the potential for relevant patient

information to be omitted or incorrectly reported, undermining subsequent patient care.

Clancy (2008) stated that the failures associated with handoffs might be among the

most important contributors to preventable adverse events in healthcare. Handoff

failures are common and can lead to diagnostic and therapeutic delays and precipitate

adverse events (Segall et al, 2012). The precise quantification of the number and type

of errors that occur during the anesthesia handoff process is not known. The

assumption is made, that due to the high volume of handoffs in anesthesia and the

vulnerability of the handoff process that potentially many instances of error occur.

Background

Data from the late 1990's led the Institute of Medicine to estimate that at least

44,000 and as many as 98,000 patients die in hospitals in the U.S. each year from

medical errors (Kohn et al 2000). At the time, this study's results were alarming and

provided for the "modern patient safety movement." A decade later, it was reported that

much progress had been made in building a foundation to address patient safety

(Clancy, 2009). However, a more recent study reveals that the rate of preventable harm

may be up to ten times higher than the IOM estimates (Classen et al, 2011). James

(2013) provided an updated estimate and states that 400,000 unnecessary deaths, due

to medical errors, occur in hospitals alone. This study also reports that serious harm is

10 to 20 times more prevalent than patient death, indicating between 4 million and 8

million people seriously harmed from medical errors in hospitals.

Medical errors continue to cause disability and death to patients every day in our

health care system. The IOM publication, To Err is Human, was a landmark report

calling patient safety to the forefront (Classen et al, 2011). Despite patient safety

initiatives and increased awareness from patient safety organizations since the IOM

report, medical errors continue to be a major concern. The Institute for Healthcare

Improvement estimates that nearly 15 million instances of medical harm occur in the

United States each year that equals a rate of over 40,000 instances of medical harm

each day in the US (McCannon et al, 2007).

The responsibility of health care providers is to first, do no harm. Patients expect

to receive safe care delivered by safe practitioners, however they are sometimes let

down.

> "We in medicine have discovered how discouragingly often we turn out to do
> wrong by patients. For one thing, where the knowledge of what the right
> thing to do exists, we still too frequently fail to do it. Plain old mistakes of
> execution are not uncommon, and we have only begun to recognize the
> systemic frailties, technological faults, and human inadequacies that cause
> them, let alone how to reduce them" (Gawande, 2002).

Medical errors are costly in terms of patient deaths as well as disability, health care

costs, and lost income. The total national cost of adverse events was estimated to be

37.6 billion dollars with 17 billion attributable to preventable adverse events. The total

costs of adverse events were nearly four percent of national health care expenditures

for 1996 (Kohn et al, 2000). These figures are modest though as only hospital patients

are represented. Andel et al (2012) report that costs of medical errors could approach

one trillion dollars per year if current estimates of medical harm are accurate. The IOM

states "It is impossible for the nation to achieve the greatest value possible from the

billions of dollars spent on medical care if the care contains errors" (Kohn et al 2000).

Indirect costs of medical errors include lost productivity, disability costs and the

personal expenses of care. In addition, patients, and their family and friends, lose trust

in the health care system as they are left to deal with physical and emotional scars. Health care providers are also affected by medical errors. Practitioners may experience guilt, shame, and self doubt when a patient suffers disability or death due to a medical error made by the health care provider or the health care team (Elder & Dovey, 2002).

Patient Safety

Patient safety is the "freedom from accidental injury" (Kohn et al, 2000). Patient safety has long been a concern in healthcare. One of the earliest references to patient safety was from the Greek physician Hippocrates in the 4th century B.C. The Hippocratic Oath states "primum non nocere" or "the first thing is do no harm."

The modern patient safety movement is attributed to the IOM report, To Err Is Human. It was a government-supported report, which sought to identify the scope of the patient safety problem. Since the IOM report, To Err is Human, healthcare has seen modest improvements. Wachter (2010), a noted patient safety expert, graded healthcare giving it a B-. He states that healthcare is not safe enough from the patient perspective but that research is providing opportunities for improvements in patient safety.

Anesthesia Patient Safety

The very first provider-led patient safety organization, the Anesthesia Patient Safety Foundation (APSF), was created by the anesthesia profession in 1985 (Eichhorn, 2012). Their vision is "that no patient shall be harmed by anesthesia." The APSF is credited with a reduction in catastrophic accidents and a reduced number and severity of liability claims (Eichhorn, 2012). The anesthesia profession is identified as a model in health care for prioritizing patient safety. The APSF was cited by the IOM

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report "To Err is Human" for making a demonstrable positive impact on patient safety (Kohn et al, 2000).

Despite these advances in anesthesia patient safety, the operating room is still considered to be a high-risk environment. The operating room is noted for its complexity and chaotic environment (Schimpff, 2007). Control of this environment can be challenging as there are many disciplines coming together to form the operating room team. The operating room team consists of an anesthesia provider(s), surgeon(s), circulating nurse and scrub nurse. Each of these team members is well trained in their separate disciplines and is well trained to perform specific duties, yet they often do not work in a true team fashion (Schimpff, 2007). In a complex environment, teams must rely heavily on interdependence and team coordination, yet these skills are lacking in the OR (Entin et al, 2006). Improved communication is essential to reducing errors (Schimpff, 2007).

The Joint Commission states that safety and quality of patient care depends on teamwork, communication and a collaborative work environment. If these are impaired then the ability of the health care team to function well is at risk (Joint Commission, 2004). Yet the OR is labeled as a unique cultural environment with system factors marked by production pressure, cost-containment and hierarchies (Schimpff, 2007).

Patient Handoffs

Providing care to patients has become increasingly complex (Hunt et al, 2007). No one person can be expected to provide care for a patient on his or her own. Patient care generally involves multiple providers (physicians, nurses, therapists) and different specialties (emergency medicine, internal medicine, surgery). Additionally, care

providers are not present around the clock (Solet et al, 2005). Therefore patients see

multiple providers throughout a 24-hour period due to shift changes and breaks. The

"patient handoff" is a term used to describe the transfer of role and responsibility from

one person to another in a physical or mental process (Solet et al, 2005). When a

patient handoff occurs, the primary objective is the accurate transfer of information

about the patient and the care plan (Patterson et al, 2004).

   During the handoff, valuable information can be omitted or misinterpreted leaving

the patient at risk for errors. Patient handoffs may occur many times during a patient's

care. Patient handoffs occur frequently in the perioperative setting. Nurse Anesthetists

may perform patient handoffs for bathroom breaks, meal breaks and shift changes.

Handoffs also occur when patients are received in the operating room from the intensive

care unit (ICU) and postoperatively when patient care is transferred to the ICU or post-

anesthesia recovery unit. Due to the number of patient handoffs that occur in the

operative setting, there is considerable risk to the patient from communication failure.

   The Joint Commission recognized the inherent risks of patient handoffs and in

2007 created national safety goal 2E (Figure 1). This goal states that a standardized

approach to handoff communication must be implemented (Joint Commission, 2007).

This standardized approach to handoffs include interactive communications, accurate

information, limited interruptions, a verification process and the opportunity for questions

and review.

Communication Failures

   Communication failures are the leading cause of inadvertent patient harm (Leonard

et al, 2004). Various reasons for communication breakdown have been identified. The

increased utilization of hospitalists have shifted the focus from a primary care physician who used to see his or her patients in the hospital, to multiple physician specialists who share in the care of a patient. Also, the reduction in resident physician hours has increased the number of times a patient's care is transferred (Solet et al, 2005). The discontinuity of care is unavoidable, as the same person does not provide patient care 24 hours a day. In fact, patient care has the potential to be transferred several times in a 24-hour period (Solet et al, 2005).

Sidebar 1. Joint Commission National Patient Safety Goal 2: Improve the Effectiveness of Communication Among Caregivers

Requirement 2E

Implement a standardized approach to "hand-off" communications, including an opportunity to ask and respond to questions.

Rationale for Requirement 2E

The primary objective of a "hand off" is to provide accurate information about a patient's care, treatment, and services, current condition and any recent or anticipated changes. The information communicated during a hand off must be accurate in order to meet patient safety goals. In health care there are numerous types of patient hand offs, including but not limited to nursing shift changes, physicians transferring complete responsibility for a patient, physicians transferring on-call responsibility, temporary responsibility for staff leaving the unit for a short time, anesthesiologist report to post-anesthesia recovery room nurse, nursing and physician hand off from the emergency department to inpatient units, different hospitals, nursing homes and home health care, critical laboratory and radiology results sent to physician offices.

Implementation Expectations for Requirement 2E

1. The organization's process for effective "hand off" communication includes: Interactive communications allowing for the opportunity for questioning between the giver and receiver of patient information.
2. The organization's process for effective "hand off" communication includes: Up-to-date information regarding the patient's care, treatment and services, condition and any recent or anticipated changes.
3. The organization's process for effective "hand off" communication includes: A process for verification of the received information, including repeat-back or read-back, as appropriate.
4. The organization's process for effective "hand off" communication includes: An opportunity for the receiver of the hand off information to review relevant patient historical data, which may include previous care, treatment and services.
5. Interruptions during hand offs are limited to minimize the possibility that information would fail to be conveyed or would be forgotten

Source: Joint Commission on Accreditation of Healthcare Organizations: *2007 National Patient Safety Goals Hospital Version Manual Chapter, including Implementation Expectations.* http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/07_hap_cah_npsgs.htm (last accessed Sep. 5, 2006).

Figure 1. Joint Commission National Patient Safety Goal 2E

Despite the high potential for communication breakdown, little to no attention is given to communication or patient handoffs during medical or nursing education. Instead, handoffs are taught by apprenticeship as students watch their preceptors give and receive handoffs. The result is caregivers who learn to give hurried reports in noisy

settings (Dracup & Morris, 2008). At this time little evidence exists to demonstrate that this Joint Commission goal is being met as most anesthesia handoffs lack a standardized approach.

Problem Statement

Medical errors are a serious threat to patients. The most common root cause of medical errors is communication failure. Research has demonstrated that communications failures occur frequently during the handoff process. Handoffs are common in anesthesia. No research has been conducted that correlates system failures (latent conditions) with human failures (low quality handoffs) during the anesthesia patient handoff process.

During the patient handoff, valuable information can be omitted or misinterpreted leaving the patient at risk for errors due to communication failures. Due to the large volume of patient handoffs by anesthetists, research is needed to determine the scope of problem.

Purpose

The purpose of this study is to:

1- Identify latent conditions that are present during the handoff.

2- Identify handoff failures during anesthesia patient handoffs performed in a simulated OR environment.

3- Correlate the latent conditions to handoff failures during the simulated anesthesia patient handoff.

Research Question

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1-What are the frequencies of latent conditions that occur during the anesthesia

patient handoff?

2- Is there an association between latent conditions and handoff scores?

Hypothesis

1- There is no difference in handoff scores related to latency scores. (null)

2- Handoff scores are inversely related to latency scores. (alternative)

Errors during the handoff process frequently result from communication failure and can result in death or disability (Kitch et al, 2008). This research will identify the latent conditions that are present and their effect on handoff quality during anesthesia patient handoffs. A pilot study will be conducted to evaluate the use the VCU anesthesia handoff coding tool and to determine the interrater reliability.

Conceptual Framework

Error is defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim (Kohn et al, 2000). Freud believed error was the result of an unconscious drive. He assumed those who committed error were deficient and error prone (Strauch, 2002). Assigning blame or considering one error prone is considered the old view or "the bad apple theory" (Dekker, 2006). This view sees humans as the cause of trouble.

The new view sees human error as a symptom of deeper trouble; not that humans are the cause for failure, but that systems are inherently not safe. Dekker states that systems exist to make money, render service, and provide products but not necessarily to be safe (Dekker, 2006). An example of the new view of error follows. A patient receives morphine after surgery despite having an allergy to it. It is hard to imagine how

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that happens. Is the surgeon at fault? How about the anesthetist or recovery nurse?

According to the new view of error, the system is at fault. Improvements in the system

to prevent this type of error include better communication through patient handoffs and

team briefings before and after surgery. The new view of human errors sees the

complexity in which people work and views errors as structurally related, not personal.

(Dekker, 2006)

An interesting error concept is Reason's (1990) description of two kinds of errors,

active errors and latent errors. Active errors have effects that are felt almost

instantaneously and are associated with front-line operators such as pilots, air traffic

controllers and officers. Latent errors lie dormant within a system for a length of time

and their consequences become evident only when other factors combine to cause a

breakdown in the system. Latent errors are present within a system long before an

error is committed. Latent errors are errors in waiting and growing evidence shows that

discovering and neutralizing these errors will have a much greater effect on system

safety than efforts to minimize active errors (Reason, 1990). "Thus systems that rely on

human perfection present what Reason calls "latent errors"-errors waiting to

happen…You can also make the case that onerous workloads, chaotic environments,

and inadequate team communication all represent latent errors in the system"

(Gawande 2002, p. 63).

Latent errors may be the result of production pressure, distractions and the OR

environment. This research is designed to examine patient handoffs in anesthesia.

Handoffs are made more difficult by the latent conditions of time constraints, pressure

and distractions, which often result in incomplete or inaccurate handoff reports. This

study will identify the latent conditions that occur during the handoff process and how the latent conditions affect the quality of the handoff.

Justification

Patient handoffs may occur many times during an anesthetists shift. CRNAs perform patient handoffs for bathroom breaks, meal breaks and shift changes. Handoffs also occur when patients are received in the operating room from the intensive care unit (ICU) and postoperatively when patient care is transferred to the ICU or post-anesthesia recovery unit. The more frequently handoffs occur, the greater the risk of miscommunication and patient care errors (Solet et al, 2005). Due to the number of patient handoffs that occur in the operative setting, there is considerable risk to the patient from communication failure. There are no studies however, of the handoff process among certified registered nurse anesthetists (CRNAs). This is a timely and important research topic that will seek to improve the anesthesia patient handoff process by identifying latent conditions and classifying errors that occur during the handoff.

Significance

Communication failure is the leading cause of patient harm due to errors (Leonard et al, 2004). The Joint Commission reviewed 2455 sentinel events and found that 70% resulted from communication failure.   Sentinel events are unexpected occurrences involving death or serious physical injury or the risk of death or serious injury. In 2006, communication failure was a cause in 65% of 516 sentinel events (Joint Commission, 2006). The Joint Commission, recognizing the inherent risks of patient handoffs, created national safety goal 2E. This safety goal states that a

standardized approach to handoff communication must be implemented (Joint Commission, 2007). Recommendations from the Joint Commission for standardizing handoffs include:

- Interactive communications allowing opportunity for questions

- A process for verification including repeat-back or read-back

- An opportunity for the receiver to review the patient's history

- Interruptions are limited

There are few examples in the literature of standardized handoffs being performed by anesthetists.

Handoff strategies from other industries including a NASA space center, a nuclear power plant, a railroad dispatch center and an ambulance dispatch center demonstrated how handoffs could be modified to improve safety. Handoffs from these organizations use strategies including face-to-face updates with interactive questioning, limited interruptions during the update, and the use of handwritten annotations such as a checklist (Patterson et al, 2004). This study will evaluate the number of errors and the type of errors that occur during the anesthesia handoff process. The goal is to better understand the reasons for failure during the anesthesia handoff.

The setting for this research will be The Center for Research in Human Simulation (CRHS) at the Virginia Commonwealth University Nurse Anesthesia Program (Figure 2). The Center was established in 1998 and supports research in the areas of human simulation, education, human error and patient safety. The CRHS is

located on the 2nd floor of West Hospital on the MCV campus of Virginia

Commonwealth University.

Figure 2. The Center for Research in Human Simulation

The facility occupies over 1500 square feet of space in the Department of Nurse

Anesthesia within the School of Allied Health Professions. State-of-the-art audiovisual

equipment enables instructors to record training activities and provide detailed and

subsequent debriefings for simulation participants.

Simulation is utilized by many industries to promote team communication,

procedural skill training, and educational evaluations (Hunt et al, 2007). Medical

simulation provides an immersive and interactive clinical experience for the learner.

Simulation offers realistic, experiential learning without risk to the patient. Simulation is

now considered a key technique for decreasing error, increasing patient safety and

identifying and correcting the human factors that affect clinical outcome (Brindley &

Dunn, 2009).

       The simulation setting provides for the evaluation of patient handoffs without risk

to the patient. This environment allows the anesthetist to make mistakes which can be

identified and corrected during the debrief period. The experience of simulation also

allows the researchers to observe patient handoffs without risk to patient safety yet the

realism of high-fidelity simulation allows the study results to be generalized to the target

population.

       For this study, a convenience sample of 60 anesthesia crisis resource

management scenarios will be selected from the CRHS video library. Videos from 2006

to the present are available for study. The participants in the simulation scenarios

included anesthesiologists, certified registered nurse anesthetists (CRNAs) and student

registered nurse anesthetists (SRNAs). Simulation videos will be evaluated and coded

by five researchers from the study team.

Chapter Two: Literature Review

This chapter will provide an overview of patient safety including history and the

emergence of the modern patient safety movement. Patient safety is defined as "the

freedom from injury" (Kohn et al, 2000). Another, more detailed, definition of patient

safety is "a discipline in the health care sector that applies safety science methods

toward the goal of achieving a trustworthy system of health care delivery. Patient safety

is also an attribute of health care systems; it minimizes the incidence and impact of, and

maximizes recovery from, adverse events" (Emanuel et al, 2008).

The potential for medical care to cause harm, has been appreciated throughout

the history of caregiving. One of the earliest references to patient safety was the

Hippocratic Oath, credited to Hippocrates in the 4th century B.C (Heard, 2001). The

Hippocratic Oath states, "primim non nocere" implying that the first thing is, "do no

harm." This ethical principle has been repeated consistently as it remains as part of

several medical oaths. Florence Nightingale (1860) acknowledged the principle of "do

no harm" when stating, "It may seem a strange principle to enunciate as the very first

requirement in a hospital that it should do the sick no harm."

It was not until the landmark publication by Beecher and Todd that anesthesia

patient safety received much deserved, systematic attention. Beecher and Todd (1954)

reported that anesthesia mortality was high with a mortality rate of one death for every

1,580 anesthetics. They stated that death from anesthesia was of sufficient magnitude

to constitute a public health problem; noting that anesthesia, at that time, was killing more people each year than the prominent disease polio. The authors anticipated that their research would stimulate renewed interest of other groups in patient mortality.

Their reporting of mortality statistics ignited research identifying the harm that was occurring for some patients. "The Hazards of Modern Diagnosis and Therapy – The Price We Pay" by Barr (1955) was one of the original publications to identify that patients are harmed by diagnostic and therapeutic procedures. It was reported that incalculable benefits have come to mankind with newer procedures but the cost was hazards that have subsequently increased enormously.   Barr wrote, "these accidents, risks and dangers may be regarded as the price we, as responsible physicians, must pay for the inestimable benefits of modern diagnosis and therapy. They are the hazards to which, with best intent and most correct practice, me must occasionally subject our patients." Barr was the first to quantify the risk, reporting that 5% of patients admitted to the medical ward were victims of "unfortunate sequelae and accidents." He concluded that iatrogenic disease could be one of the commonest conditions encountered during hospitalization. Although his work focused on physician providers, this message resonated through the healthcare community of providers.

Schimmel (1964) published "The Hazards of Hospitalization" reporting that 20% of patients admitted to their medical ward experienced one or more untoward events. Of those patients that experienced untoward episodes, 10% had a prolonged or unresolved episode and 5% were considered serious or fatal. Schimmel noted that the economic and emotional impact suffered by many patients could not be considered insignificant complications of their medical care. This is considered a landmark paper in

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the measurement of quality of care, credited with acknowledging that patients were often harmed in hospitals (Burke, 2003). Schimmel suggested that the risk of having an untoward episode was directly related to the length of time spent in the hospital.

Anesthesia, as a medical and nursing specialty, continued to struggle with unacceptably high rates of morbidity and mortality. Cooper (1978) acknowledged anesthesia safety issues and addressed them with a novel approach. He believed that in order to decrease the frequency of error, a clearer understanding of the circumstances that surrounded that error was needed. Cooper, an engineer, brought safety science to health care. Using a methodology known as critical-incident analysis, useful in the aviation industry, he applied it to the study preventable anesthetic mishaps. This technique allowed for discovery of the etiology of anesthetic errors and provided for the application of human-factors principles, which was again successful in the field of aviation (Cooper, 1978).

In 1981, Steele et al, studied iatrogenic illness or "the disease that would not have occurred if medical therapy had not been employed." They found that at least a third of all patients had some ill effect during hospitalization that was not related to any pathologic process. Their results showed that 9% of patients had a major untoward event during their hospitalization. Clearly the risks incurred during hospitalization are not trivial. Steele concluded, regardless of how ill patients might be and regardless of what benefits hospitalization provide; mechanisms must be developed to assess the hazards of hospitalization.

1995 was a pivotal year for patient safety (Leape, 2008). A series of medical errors put hospitals in the headlines. Two massive overdoses of chemotherapy

medications occurred at the Dana-Farber Cancer Institute within two days of each other. One patient, Betsy Lehman, age 39, was killed by a four-fold overdose and another patient sustained permanent heart damage (Altman, 1995). Betsy Lehman was an award-winning health columnist for the *Boston Globe*. The *Boston Globe* published the news of the medical mistakes and it made National headlines. The *Globe* reported, "it was a blunder compounded or overlooked by at least a dozen physicians, nurses and pharmacists, including some of the institution's senior staff."

The "modern patient safety movement" began with the publication of the Harvard Medical Practice Study in the *New England Journal of Medicine* in 1991 (Leape, 2008). The Harvard Medical Practice Study retrospectively examined 30,121 patients who were hospitalized in acute care hospitals in New York State during 1984. The study revealed that 3.7% of hospitalized patients suffered an adverse event (Brennan et al, 1991). An adverse event was considered as all injury caused by medical treatment, which either resulted in a longer hospital stay or caused disability or death. Most of the adverse events (69%) were considered to be preventable. The largest number of adverse events, 41%, resulted from treatment provided in the operating room (Leape, 1991). The study was published in the *New England Journal of Medicine* and the findings were a front-page article in the *New York Times* but little attention was paid to these landmark findings (Leape, 2008).

Despite the described incidents and publications, patient safety still was not a major concern for most hospitals or the public. That changed in November of 1999, when the Institutes of Medicine (IOM) released its report on patient safety, "To Err is Human." The IOM report used the data from the Harvard Medical Practice Study and a

later study conducted in Colorado and Utah to conclude that medical errors caused 44,000 to 98,000 preventable deaths each year in US hospitals (Kohn et al, 2000). In addition to lives lost, preventable medical errors were estimated to cost between 17 billion and 29 billion dollars per year in direct health care costs, lost income, lost household productivity and disability (Kohn et al, 2000). This report garnered substantial media attention and caught the eye of the public. Overnight, attention to the seriousness of the medical error problem spread from hundreds to millions (Leape, 2008). President Clinton appointed a government task force to review the IOM report and make recommendations for action. Within days of the IOM report, President Clinton signed into law the Healthcare Research and Quality Act of 1999. In 2005, Congress enacted the Patient Safety and Quality Improvement Act of 2005.

The IOM report produced three important effects. First, it gained the attention of hospitals, health-care workers, administrators, regulators and payors, so the patient safety problem could no longer be ignored. Second, it led to the creation of the Agency for Healthcare Research and Quality (AHRQ) and provided funding that attracted hundreds of new investigators into patient safety research. And finally, *To Err is Human* motivated health care facilities to make changes needed to improve patient safety (Leape, 2008).

Since the IOM report, many patient safety initiatives were started. Many specialty societies have incorporated safety topics into meetings, education and research (Leape, 2008). The Centers for Disease Control (CDC) and Centers for Medicare and Medicaid Services partnered with more than 20 surgical organizations producing a program to reduce surgical complications. The National Quality Forum

(NQF) created standards for mandatory reporting of adverse events and created a list of

30 evidence-based safe practices for implementation by hospitals. The Joint

Commission (JC) has led many initiatives to improve patient safety. The JC requires

hospitals to implement new safe practices. Starting in 2003, the JC implemented

National Patient Safety Goals (NPSGs). For 2014, the JC has 16 NPSGs that are

based on emerging patient safety issues as identified by key stakeholders including

practitioners and provider organizations. The NPSGs were established to help

accredited organizations address specific areas of concern in regard to patient safety

(Joint Commission, 2014).

The National Patient Safety Foundation (NPSF) is another nongovernmental

organization with a patient safety mission. The NPSF was created and funded by the

American Medical Association with support from several medical industry businesses.

The NPSF is now an independent organization that partners with patients and families,

the health care community, and key stakeholders to advance patient safety and health

care workforce safety and disseminate strategies to prevent harm (NPSF, 2014). The

NPSF is a leader in patient safety advocacy, patient safety research and provides

regional and national conferences to instruct patient safety leaders.

The Institute for Healthcare Improvement (IHI) is a powerful force for patient

safety (Leape, 2008). The IHI focuses on medication safety, intensive care, cardiac

care and other areas. They have developed many system changes and measures

including the IHI "global trigger tool" for measuring adverse events. The IHI conducted

the "100,000 lives" campaign, where over 3000 hospitals participated in implementing

one or more of six proven practices with the goal of preventing over 100,000 deaths

related to adverse events (Berwick et al, 2006). The campaign ended in 2006 and observed a reduction in mortality of 122,300 patients.

An organization with a long history of improving patient safety is the Anesthesia Patient Safety Foundation (APSF). The APSF was formed in 1985 and was the first independent, multi-disciplinary organization created expressly to help avoid preventable adverse clinical outcomes, especially those related to human error (APSF, 2014). The APSF states that it is the first organization to recognize the patient safety problem, which was driven by the earliest research into human error in medicine. The APSF's mission is to improve continually the safety of patients during anesthesia care by encouraging and conducting: safety research and education, patient safety programs and campaigns, and National and International exchange of information and ideas.

Despite the efforts of safety organizations to increase awareness, provide training, and fund research, patient safety still remains a serious problem for the healthcare industry. The AHRQ released a report that noted that patient safety was actually getting worse instead of better. The director of the AHRQ, Carolyn Clancy (2009), wrote, "considerable work remains to ensure that patients are safe…all would agree that far more work needs to be done." Noted patient safety expert, Wachter (2010) reported that on the ten-year anniversary of the IOM report, our safety efforts earned a grade of "B minus" writing that although we have made progress, incremental progress is probably the best we can hope for. Leape, at al (2009) wrote, "Healthcare is unsafe….progress has fallen far short. Many patients continue to fear, justifiably, that they may be harmed when they enter a hospital."

Recently, an estimate of patient harm by James (2013) reports a minimum lower limit of 210,000 deaths per year from preventable harm in US hospitals. James used the IHI's Global Trigger Tool to flag medical records. He stated that given the incompleteness of the medical records that the trigger tool depends on, deaths from preventable harm was estimated to be more than 400,000 per year. Noted patient safety experts Lucian Leape, David Classen and Marty Makary reported that the estimate from James is accurate and that it is time to stop citing the 98,000 number (Allen, 2013).

One of the key findings of the IOM report was that most of the preventable medical errors were not caused by careless providers but were the result of defective systems (Levy, et al, 2010). This started a new way of thinking about errors that shifted the focus from the provider to remedying systemic defects. The IOM report (2000) indicated that patient safety might benefit from systems-level error analysis that has been successful in aviation. Voluntary error reporting was suggested to allow for the review of errors and to provide for system corrections. The systems-based approach shifted the focus to prospective systemic safety remedies and prophylaxis, rather than on assessment of blame (Levy et al, 2010).

In order to make patient safety improvements, it is critical to understand how systems work, what factors allow them work well and why adverse events occur. In complex, high-risk systems (nuclear power, aviation, healthcare) it is obviously not wise to wait for a serious accident in order to evaluate the system's safety attributes. Aviation and nuclear power have employed human factors techniques to learn about system performance and safety risks (Weinger et al, 2002).

Error and Error Theory

Error is defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim (Kohn et al, 2000). Freud believed error was the result of an unconscious drive. He assumed those who committed error were deficient and error prone (Strauch, 2002). Assigning blame or considering one error prone is considered the old view or "the bad apple theory" (Dekker, 2006). This view sees humans as the cause of trouble. With this view, the system is considered safe but a few "bad apples" do not follow the rules. Using the bad apple theory, errors can be reduced by adding or enforcing procedures, adding more technology or simply by removing the bad apples. A major flaw of this view is its assumption that people can choose between making errors and not making them.

For a long time, patient safety analysis has been person-centered rather than system-centered. With the person-centered approach, the focus is on the "human factor" and is concentrated on the individual responsible for the error. Human error implies a deficit in an individual's knowledge or technical skill or carelessness (van Beuzekom et al, 2010). Solutions for this type of human error typically include retraining, extra supervision or even disciplinary action.

An alternative to this punitive approach is the systems approach. The systems approach pays attention to organizational factors that are precursors to those individual errors. The systems approach assumes that humans are fallible and that systems need to be designed to prevent and absorb human error (van Beuzekom et al, 2010). This more enlightened view sees human error as a symptom of deeper trouble; not that humans are the cause for failure, but that certain systems are inherently unsafe.

Dekker (2006) explains that systems are set up to make money, render service, and provide products but not necessarily to be safe. This view of human errors sees the complexity in which people work and views errors as structurally related, not personal.

Human performance is a complex interaction of factors including the relationship between individuals and their general working environment (see Figure 3). When the environment allows for errors by individuals, the environment can be searched for underlying conditions that have been recognized or tolerated. The embedded factors making errors more likely are called latent risk factors (van Beuzekom et al, 2010).

FIGURE 1.
Human Factors Considerations

Figure 3. Human Factors Considerations

Reason (1990) described the "Swiss cheese model" that was originally developed for accident investigations in industry such as oil and gas, aviation, railways and nuclear power generation (van Beuzekom et al, 2010). This model is useful for explaining why rare accidents occur in high-risk activities. Systems have developed defensive layers (alarms, physical barriers, automatic shutdowns) and rely on skilled

individuals (anesthetists, pilots, control room operators) to prevent errors or alert to

errors before harm occurs. With this model, serious adverse events are usually

preceded by a chain of individually unimportant errors, influenced by a variety of factors.

The Swiss cheese model identifies two kinds of errors, active errors and latent

errors (Figure 4). Active errors have effects that are felt almost instantaneously and are

associated with front-line operators such as pilots, air traffic controllers and military

officers. Latent errors lie dormant within a system for a length of time and their

consequences become evident only when other factors combine to cause a breakdown

in the system. Latent errors are present within a system long before an error is

committed. Evidence shows that discovering and neutralizing latent conditions will have

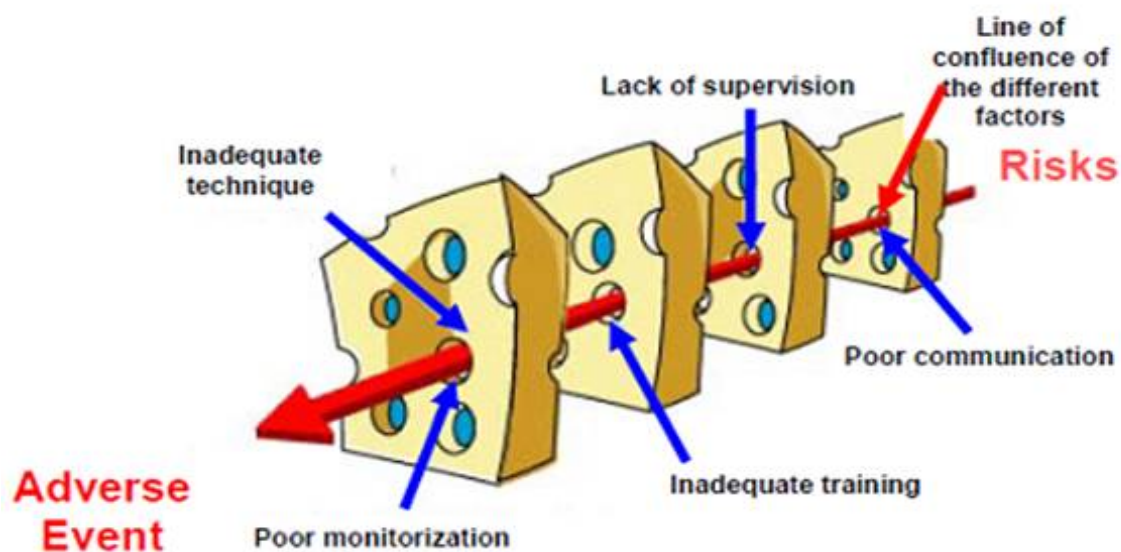a much greater effect on system safety than efforts to minimize active errors (Reason,

1990).

Figure 4. Reason's Swiss Cheese Model

Reason's Swiss cheese model directs attention to system issues during error investigations. The model proposes that latent conditions allow an error to proceed through the system defense (holes of the cheese) and cause harm. Reason believed that situations rather than individuals are error prone. His system approach shifts the blame from the individual towards an acceptance of the inevitability of error. This approach moves from disciplinary actions towards learning from accidents.

Latent factors including communication, teamwork difficulties and lack of training are commonly documented in many investigations. Systems-based latent conditions are usually persistent but not obvious. Gawande (2002) stated "systems that rely on human perfection present what Reason calls 'latent errors'-errors waiting to happen…a case can also be made that onerous workloads, chaotic environments, and inadequate team communication all represent latent errors in the system."

Communication Failure

Communication is foundational to safe, high quality patient care (Clancy, 2008). Communication failures are a leading cause of adverse events and inadvertent patient harm (Leonard et al, 2004; Hu et al, 2012; Lingard et al, 2004)).   Clancy (2008) stated that communication failures are one of the most important contributors to preventable adverse events in health care. Wilson et al (1995) conducted a large study of 28 hospitals and found that communication errors were the leading cause of adverse events. Their results showed that communication errors caused twice as many deaths as incompetence. Lingard et al, (2004) studied communication events in the operating room and found a failure rate of 30.6% during room setup and induction of anesthesia. A similar study by Hu et al, (2012) found a nearly 10% communication failure rate during

complex operations. According to the JC, communication failure is a root cause (or

fundamental reason for failure) in 63% of reviewed sentinel events (Joint Commission,

2013)

A variety of factors are known to undermine communication quality. A lack of

information or misinformation can result in patient care errors. Lingard et al (2004)

classified communication failures into 4 types: audience (missing key individuals),

purpose (issue nonresolution), content (insufficient/inaccurate information) and/or

occasion (timing issue). Communication can also suffer from too much information or

"cognitive overload." The operating room is a data-rich, technological environment with

so much information that the burden is sifting through the less-critical, irrelevant

information in a timely manner (Steinberger et al, 2009).

Structural barriers such as educational silos, authority gradients, role

specialization and incentives that favor individual rather than team performances also

lead to ineffective communication (Clancy, 2008). Leonard et al (2004) suggest that the

communication styles of nurses and physician are different and contribute to

miscommunication. Nurses tend to provide broad, narrative descriptions and physicians

prefer factual highlights that pertain to the situation at hand.

There are two additional factors that have been identified that allow or promote

communication failures. They are "migration of practice" and "normalization of

deviance." Amalberti (2006) described the migration of practice from a safety zone into

a zone of potential danger. This migration of practice towards danger occurs when

communication failures do not produce immediate effects, lulling one into a false sense

of security.

The normalization of deviance (Prielipp et al, 2010) is an incremental process and a gradual erosion of standard procedures that would never be tolerated in a single movement. Instead the small, gradual movement is tolerated. Without incident, these deviant changes become "normalized." Normalization of deviance tolerates more risk and more errors, always in the interest of efficiency (Prielipp et al, 2010). This type of thinking places productivity and efficiency above vigilance and safety.

Communication failures may cause errors in patient care and other negative consequences such as delay, inefficiency and tension among team members (Lingard et al, 2004). Communication failures that occur during patient transfers or handoffs are also concerning. Whether or not handovers worsen patient outcomes remains unclear (Saager et al, 2014). The purpose of this study is to determine the effect of latent conditions on the communication that occurs during the patient handoff process.

Patient Handoffs

The handoff process is the transfer of patient care and responsibility among caregivers (Solet et al, 2005; Hunt et al, 2007; Catchpole et al, 2010; Saager et al, 2014). Handoffs are inevitable, as care is transferred among providers during breaks and shift changes. Patient care generally involved multiple providers and different specialties. Additionally, care providers are not present for 24 hour shifts so care has to be transferred. The amount of patient handoffs has increased as a result of the resident duty-hour restrictions (Lane-Fall et al, 2014). When transferring care to another provider, clinicians have a duty to ensure that an effective handoff occurs (Jorm et al, 2009).

Although little precedence for standardized handoffs exists in healthcare, examples of organizations with a high consequence for failure using standardized handoffs are well known. Handoff strategies from a National Aeronautics and Space Administration (NASA) space center, a nuclear power plant, a railroad dispatch center and an ambulance dispatch center were observed to determine how handoffs could be modified to improve patient safety. Handoffs from these organizations used strategies including face-to-face updates with interactive questioning, limited interruptions during the update, topics initiated by incoming as well as outgoing, and incoming receives paperwork that includes handwritten annotations (Patterson et al, 2004).

Handoff communication is a high priority for regulatory and educational purposes (Lane-Fall et al, 2014). The Accreditation Council for Graduate Medical Education (ACGME) recognized the importance of handoffs and requires all ACGME-accredited programs confirm competence in handoff communications for their residents (Lane-Fall et al, 2014). The Joint Commission has recognized the potential for communication failure during patient handoffs. In 2006, the Joint Commission (JC) made handoffs a focus of the National Patient Safety Goals (NPSG). The JC NPSG (Figure 5) requires a standardized approach to hand-off communications. The Joint Commission also expects hand-offs to include interactive communications, accurate information, limited interruptions, a verification process and the opportunity for questions and review (Dracup & Morris, 2008).

Sidebar 1. Joint Commission National Patient Safety Goal 2: Improve the Effectiveness of Communication Among Caregivers

Requirement 2E

Implement a standardized approach to "hand-off" communications, including an opportunity to ask and respond to questions.

Rationale for Requirement 2E

The primary objective of a "hand off" is to provide accurate information about a patient's care, treatment, and services, current condition and any recent or anticipated changes. The information communicated during a hand off must be accurate in order to meet patient safety goals. In health care there are numerous types of patient hand offs, including but not limited to nursing shift changes, physicians transferring complete responsibility for a patient, physicians transferring on-call responsibility, temporary responsibility for staff leaving the unit for a short time, anesthesiologist report to post-anesthesia recovery room nurse, nursing and physician hand off from the emergency department to inpatient units, different hospitals, nursing homes and home health care, critical laboratory and radiology results sent to physician offices.

Implementation Expectations for Requirement 2E

1. The organization's process for effective "hand off" communication includes: Interactive communications allowing for the opportunity for questioning between the giver and receiver of patient information.
2. The organization's process for effective "hand off" communication includes: Up-to-date information regarding the patient's care, treatment and services, condition and any recent or anticipated changes.
3. The organization's process for effective "hand off" communication includes: A process for verification of the received information, including repeat-back or read-back, as appropriate.
4. The organization's process for effective "hand off" communication includes: An opportunity for the receiver of the hand off information to review relevant patient historical data, which may include previous care, treatment and services.
5. Interruptions during hand offs are limited to minimize the possibility that information would fail to be conveyed or would be forgotten

Source: Joint Commission on Accreditation of Healthcare Organizations: *2007 National Patient Safety Goals Hospital Version Manual Chapter, including Implementation Expectations.* http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/07_hap_cah_npsgs.htm (last accessed Sep. 5, 2006).

Figure 5. Joint Commission National Patient Safety Goal 2

Prior to the JC requirement, little attention was given to handoff communications. The majority of research to date evaluates resident handoffs, especially in the specialties of emergency medicine and intensive care. Kitch et al (2008) surveyed residents in a large academic medical center to determine the quality and effects of handoffs during their most recent rotation. The results of the study showed that 59% of residents reported harm, to one or more patients, during their most recent rotation due to a poor patient handoff. Many residents reported handoffs were conducted in noisy environments with multiple interruptions. The authors concluded that harm to patients from problematic handoffs is common.

A study examining the change of shift report in medical and surgical units showed a lack of content structure, high noise levels, interruptions and no use of the electronic health record during the change of shift report. The authors concluded that

improvements were needed for the change of shift report including a consistent structure and reduced interruptions and noise (Staggers & Jennings, 2009).   There is also complacency with the handoff process and little recognition of the high-risk nature of handoffs (Jorm et al, 2009).   Problems that can occur due to a poor handoff include the administration of an incorrect medication, the failure to administer a medication, treatment delays and preventable readmissions. Poor handoffs waste time, strain limited healthcare resources and causes harm to patients (Jorm et al, 2009). Healthcare professionals need to know that handoffs add risk to patient care and that a clearly communicated handoff is integral to the delivery of safe patient care.

Berkenstadt, et al (2008) conducted a study of patient handoffs using high fidelity medical simulation. The researchers conducted a study that observed critical care nurses during a handoff scenario in a simulation environment. The authors noted that medical simulation provides a unique opportunity for training in team and interpersonal communication skills that is rarely addressed in traditional medical education. Clancy (2008) states that simulation allows researchers to analyze common practices, such as handoffs, in order to discover opportunities for improvement that may not be easily detectable during patient care.

Patient handoffs are recognized as a vulnerable point in the process of patient care (Dracup & Morris, 2008). During the handoff, valuable information can be omitted or misinterpreted leaving the patient at risk for errors. The handoff is a period of great risk to the patient because handoffs occur in a chaotic environment. During the handoff, there is typically a lot happening at one time and opportunities for critical information to be lost or misinterpreted (Clancy, 2008).

Patient handoffs may occur many times during a patient's care. The more frequently handoffs occur, the greater the risk of miscommunication and patient care errors (Solet et al, 2005). The discontinuity of care is unavoidable, as one person no longer provides patient care 24 hours a day. In fact, patient care has the potential to be transferred several times in a 24-hour period (Solet et al, 2005).

Patient handoffs occur frequently in the perioperative setting and are frequent among anesthesia providers. Jayaswal et al (2011) reported the transfer of care between anesthesia providers usually occurred at least 5 times per operating room prior to 3:00pm. Anesthesia providers (certified registered nurse anesthetists and anesthesiologists) perform patient handoffs for bathroom breaks, meal breaks and shift changes. Handoffs also occur when patients are received in the operating room from the intensive care unit (ICU) and postoperatively when patient care is transferred to the ICU or post-anesthesia recovery unit.

Given the number of patient handoffs that occur in the operative setting, there is considerable risk to the patient from communication failure. Research reveals numerous examples of communication failures occurring in the operating room have been reported (Hains, 2012). A survey of anesthesia providers showed that 84% reported giving poor handoffs and 57% reported receiving a poor handoff. 25% of the anesthesia providers related an adverse outcome to a poor handoff (Jayaswal et al, 2011). Barriers to effective anesthesia hand-off communication are listed in Figure 6 below.

Simulation

Simulation is a technique, not a technology, used to replace or augment real

experiences with guided, simulated experiences that evoke or replicate most aspects of the real world in a fully interactive manner (Gaba, 2004). The experience is immersive, so that participants are involved in the task or setting as they would be in the real world. Experience shows that participants in immersive simulations suspend disbelief and act much like they do in their clinical setting (Gaba, 2004). Simulation has been used extensively in aviation, nuclear power production and armed forces training. Healthcare is now following their lead, using simulation to manage hazards and complexity.

Table 3. Barriers to Effective Anesthesia Hand-off Communication

Standardization	Systems factors
• Absent or insufficient hand-off training	• Multitasking during report
• Lack of evidence-based research to guide hand-off best practices	• Interruptions and distractions
• Mnemonic difficulties: which one should be used and how should it be taught?	• Lack of privacy
• Staff resistant to changes in hand-off system	• Time constraints
• Lack of hand-off procedural protocols or tools	• Too much noise
• Problems with the standardized protocols or tools	• Poor lighting
• Poor recognition and/or understanding of protocol or tool in use	
General communication	Clinical factors
• Lack of understanding of how to engage in an effective hand-off dialogue	• Patients with multiple complex, medical problems
• Omissions, errors, or misunderstandings	• Too many patients (*e.g.*, ICU, pain, OB)
• Language communication barriers (*i.e.*, dialectic, accent, vernacular barriers)	• Rapid case turnover
• Social interactions occurring during handoffs	• Change in patient status during hand-off
• Incorrect information recall	
• Disorganized report	Human factors
• Hierarchical culture that discourages questions	• Fatigue or illness
• Differences in clinical knowledge	• Stressful shifts
	• Memory limitations
	• High staff turnover
	• Information and sensory overload

ICU = intensive care unit; OB = obstetrics.

Figure 6. Barriers to Effective Anesthesia Hand-Off Communication

In the current safety climate, it is not acceptable for novice learners to practice basic skills on real patients with the risks of error and harm (Kneebone et al, 2004). Ethically, it is important to minimize the risk to the patient when possible. With simulation learning, students and practitioners develop and refine skills without putting

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patients at risk. Hotchkiss et al (2002) noted that simulation offered modestly authentic and nonhazardous opportunities for both pedagogy and clinical experience.

Simulation allows learners to fail and provides a learning opportunity that would not be possible with a real patient. This allows students to learn from their own mistakes. Just as important, it allows students to learn vicariously from the mistakes of others (Biddle et al, 2005). Simulation is used in most nurse anesthesia programs to teach basic technical skills such as IV insertion and airway management techniques. High-fidelity simulation is also used in nurse anesthesia education to improve teamwork and critical thinking skills crisis resource management (CRM) and factors involved in human error (Hotchkiss et al, 2002).

The IOM recognized the potential for simulation to reduce medical errors and patient harm. The IOM recommended the use of simulation and team training to improve patient care, care systems, processes and ultimately patient safety (Kohn et al, 2000). The IOM report also recommended increased funding of simulation research, improved simulation technologies and an increase in the number of simulation centers. Simulation training provides for skill development as well as the ability to integrate knowledge, clinical judgment, communication and teamwork into practice (Murray, 2005). Simulation is also considered an emerging tool to identify latent hazards within healthcare systems (Shear et al, 2013).

Simulation is utilized by many industries to promote team communication, procedural skill training, and educational evaluations (Hunt et al, 2007). Medical simulation provides an immersive and interactive clinical experience for the learner. Simulation offers realistic, experiential learning without the added risk to the patient.

Simulation is now considered a key technique for decreasing error, increasing patient safety and identifying and correcting the human factors that affect clinical outcome (Brindley & Dunn, 2009).

The simulation setting allows for evaluation of patient handoffs without risk to the patient. This environment allows the learner to make mistakes, which can be identified and corrected during the debriefing. There is widespread use of simulation in the VCU nurse anesthesia program. The Center for Research in Human Simulation (CRHS) is housed at the Virginia Commonwealth University (VCU) in the Nurse Anesthesia Department. This is a state of the art facility designed to look and feel like a real operating room environment.

Simulation is used to teach skill development, familiarity with the OR environment, anesthetic sequences and crisis management. The videos that will be used for this study are all Anesthesia Crisis Resource Management (ACRM) scenarios. These are realistic scenarios that challenge the participants to use critical thinking, teamwork and communication skills.

The experience of simulation allows the researchers to observe patient handoffs without risk to patient safety yet the realism of high-fidelity simulation will allow the study results to be generalized to the target population. Simulation also facilitates the observation of participants with audiovisual technologies and audio-taping. This is critical for researching the communications that occur during the handoff process.

This study will observe the handoff process of anesthetists in a simulated operating room environment. The purpose of this study is to determine the effects of latent conditions on the handoff process. The handoff process during simulated

anesthetics will be observed and coded to determine the type and number of latent

conditions that occur during an anesthesia patient handoff. Coding will also observe the

quantity and quality of handoff content to determine if a relationship exists between

latent conditions and handoff content.

Chapter Three: Methodology

There is limited research that correlates system failures (latent conditions) with human failures (low quality handoffs) during the anesthesia patient handoff process. Research is needed to examine the relationship between system failures (latent conditions) and human failures (low quality handoffs) during the anesthesia patient handoff process. This study will determine whether the presence of latent conditions contributes to poor anesthesia handoffs.

The purposes of this study is to:

1- Identify latent conditions that are present during the handoff.

2- Identify communication failures during anesthesia patient handoffs performed in a simulated OR environment.

3- Correlate the latent conditions to handoff scores during the simulated anesthesia patient handoff.

This is a non-experimental, observational study because there is no manipulation of the independent variable (Polit & Beck, 2008). This correlation study is designed to explore the strength of the relationship between the independent variable, which is latent conditions, and the dependent variable, which is the handoff score (Figure 7). The null hypothesis is that no relationship exists between latent conditions present during the anesthesia patient handoff and the handoff quality (judged by a handoff score).
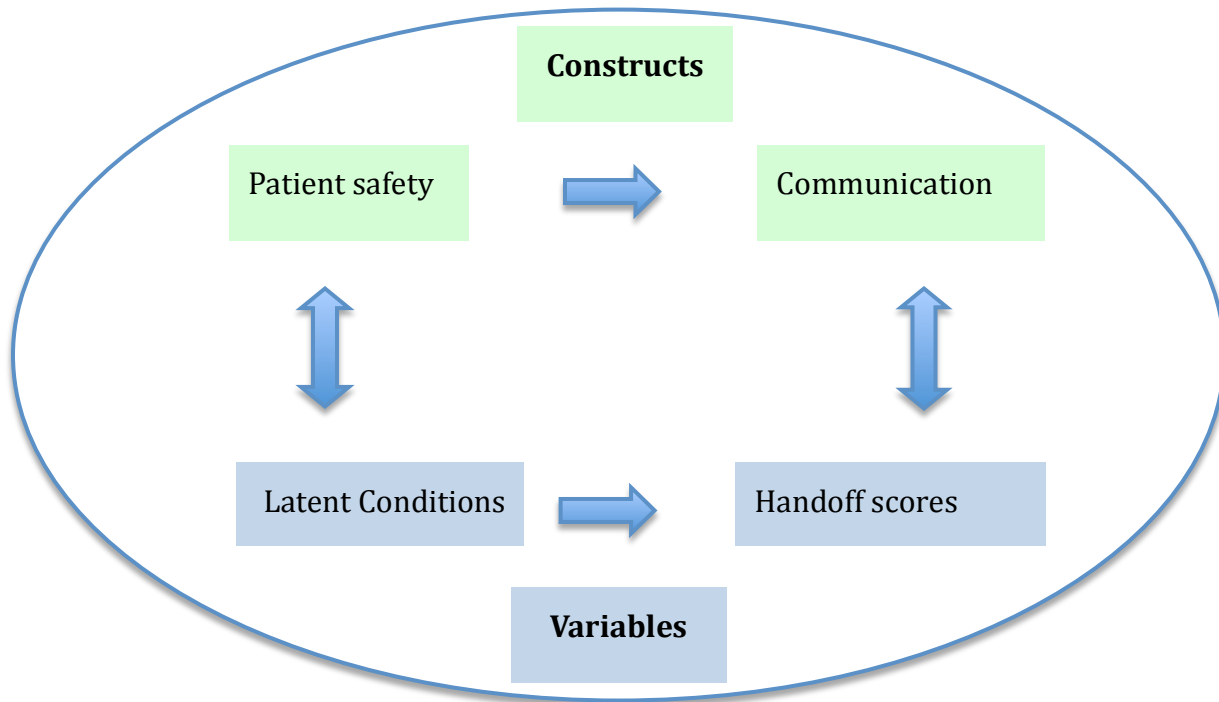
Figure 7. Constructs and Variables

The setting for this study will be The Center for Research in Human Simulation (CRHS) at the Virginia Commonwealth University (VCU) in the Nurse Anesthesia Department. It is a 1500-foot simulation facility that has two full-body Laerdal patient simulators (Vital Sim; Laerdal Medical Corp.. Wappingers Falls, New York), which are used in a simulated operating room environment. The CRHS is dedicated to integrating simulation in the graduate curriculum, advancing the art and science of anesthesiology, and improving patient safety (sahp.vcu.edu/nrsa/simulation, 2014). State-of-the-art audiovisual equipment allows scenarios to be recorded and archived for subsequent study and analysis. The educational approach is for learning to occur in a realistic

operating room environment to promote effective learning. The simulation center is set-up to look exactly like a real operating room. In addition to a high-fidelity simulator, the simulation center also includes an anesthesia gas machine, medication and equipment carts and monitors, exactly as an operating room would.

The CRHS has an extensive video library of surgical and anesthesia simulations from crisis resource management scenarios. Videos from 2006 to the present are available for study. From this convenience sample, 60 patient handoffs (n=60) will be selected for this study. Scenarios will be randomly selected from the video library by the director of information technology in the VCU nurse anesthesia department. In selecting this sample size as part of performing a power analysis, this number is twice the required sample size previously reported in the literature. Weller et al, (2003) evaluated anesthetist performance in simulation using a sample size of 28 to demonstrate validity in the assessment of clinical practice using simulation. Hulley et al, (2007) report a sample size of 26 is needed for a predicted correlation coefficient of 0.60 with a one-tailed test and an alpha of 0.05. The proposed larger sample size was chosen to provide the researchers with more learning opportunities with data collection and to strengthen the methodological validity and rigor of this study. The videos will be randomly selected from the library and placed on a DVD for coding by the coding team (see below).

The participants in the simulation scenarios included anesthesiologists, certified registered nurse anesthetists (CRNAs) and student registered nurse anesthetists (SRNAs). The scenarios were created for the purpose of anesthesia crisis resource management training and the participants were instructed to perform their anesthetic

care as they would in the operating room setting. The participants in these scenarios did not receive special training in anesthesia patient handoffs prior to their simulation, nor were they aware that their handoff was being evaluated.

The simulation participants arrived at the simulation center and were briefed on the simulated operating room environment, room set-up, patient history and the surgery being performed. The participants were presented with a standardized anesthesia scenario. The scenario represented a common operating room case and anesthetic management. At some point during the case, a patient handoff will occur between the anesthesia provider who is being relieved and the anesthesia provider who is providing the relief. The handoff process only, from beginning to end, will be evaluated for this study.   Because the scenarios were designed for anesthesia crisis management, the handoffs were not scripted or planned.

Written informed consent was obtained from each participant and is on file in the Department of Nurse Anesthesia. Participants consented to having their simulation video and audiotaped and also consented for having their video archived for future quality assurance and research purposes. Participant names and other identifying information will not be used on the coding forms. Participants will not be identified in any way during the study to insure confidentiality. The inclusion criterion for this study is a simulation video that includes an anesthesia patient handoff with audio and visual quality that allows for evaluation. Exclusion criteria include simulation videos that do not contain a handoff or simulations with poor audio/visual content that prevent coding. Institutional review board (IRB) approval will be obtained from the Virginia Commonwealth University (Richmond, VA).

Simulation videos will be evaluated and coded by five researchers from the study team that have completed extensive training. All coders are experienced registered nurses with practical experience in patient handoffs. All coders are also familiar with the handoff literature and the safety concerns associated with patient handoffs. Coders will also complete training on the use of the VCU Anesthesia Coding Instrument and the operational definitions that will be used for this study. Each coder will receive a DVD with the identical 60 simulation cases. Coding will be performed by each of the five researchers independently.

The research team met to discuss the coding of the simulation videos. The first meeting was conducted via video teleconference to discuss the key elements that would be necessary for a complete anesthesia patient handoff. The handoff literature had been reviewed to determine the key elements of an anesthesia patient handoff. The team agreed that the ten-handoff content items listed under heading number 3 on the Anesthesia Handoff Coding Instrument (Appendix B) were necessary for a complete transfer of information during the anesthesia patient handoff.

Each handoff video will be evaluated for whether the handoff content item is present and will be recorded as a yes/no response. The outcome being measured is the handoff score that indicates whether handoff content items were discussed. A maximum score of 10 would indicate that all handoff content items were discussed. A minimum score of 0 would indicate that no handoff content items were discussed. Each handoff content item is also operationally defined for coding purposes (Appendix A).

The literature was also reviewed to determine the most common latent conditions identified that occur during handoffs. Latent conditions are innate, mostly hidden, workplace factors that may become the central cause of or an exacerbating factor in adverse patient outcomes (Reason, 1990). Studies in other industries have shown that latent conditions can be a key variable that allows for errors. Although latent conditions have been studied in other fields such as aerospace, aviation, nuclear power, business management, and military operation, few studies exist in the medical literature that seek to demonstrate how latent conditions may affect medical practice (Lighthall et al, 2010). Coders will look for the presence of the following four latent conditions during the simulated anesthesia patient handoffs:

1-distractions

2-production pressure

3-one-way communication

4-handoff timing at critical points.

These four latent conditions are commonly identified in the literature (van Beuzedom et al, 2010; Joint Commission, 2007; Feil, 2014; Lane-Fall et al, 2014). Distractions are the most common latent condition in anesthetic practice (Campbell et al, 2012). The Joint Commission (2007) identified that interactive two-way communication was critical to a successful handoff process. Handoffs should not occur at "task-dense" critical points of the case. Handoffs that occur at this time are shown to result in increased errors.

Each handoff video will be evaluated for whether the latent condition item is present and will be recorded as a yes/no response. The predictor variable being

measured is the latent condition (communication characteristics) score that indicates how many latent conditions were present during the anesthesia patient handoff. A maximum score of 4 would indicate that all latent conditions were present. A minimum score of 0 would indicate that no latent conditions were present. The null hypothesis is that no relationship exists between latent conditions and handoff score. Each of these latent conditions is given an operational definition in the Coding Instrument Definitions under the heading "Communication Characteristics" (Appendix A).

Initially the team will evaluate three videos to determine interrater reliability using the Kappa statistic. Because there are five independent observers/coders, reliability assessment is needed to determine the amount of agreement about the scoring on an instrument (Polit & Beck, 2008). If a high level of agreement is achieved then the assumption is that measurement and coding errors are minimal. The study group meetings and the operational definitions are designed to enhance the reliability ratings. Interrater reliability will be assessed using a multi-rater kappa (Fleiss, 1971) because there are more than two raters. The goal will be to achieve a kappa of greater than 0.60 which is generally considered the minimally acceptable value.

As an integral part of the team training process, the study group will meet again after coding the first three randomly selected simulations to review the interrater reliability. We will look for inconsistencies and will correct any problems or misunderstandings with the coding tool and the operational definitions. It is important that the operational definitions are clear as greater clarity allows for greater reliability (Polit & Beck, 2008). We will also examine each item of the handoff content for retention, modification or deletion.

Validity is also an important criterion for measurement instruments. Validity is the degree to which an instrument measures what it is supposed to measure (Polit & Beck, 2008). The content validity for this study is strengthened by using several handoff studies in the literature to create the list of handoff content that is considered important for the anesthesia patient handoff (Figure 8). Face validity is demonstrated by having experienced, domain-familiar coders experienced in the patient handoff process create the coding instrument. Evidence for construct validity will be demonstrated using hypothesized relationships to show the relationship between patient handoffs and latent conditions.

McQueen-Shadfar and Taekman (2010)	Used I PASS the BATON pneumonic
Lane-Fall et al (2014)	Used I PASS pneumonic
Saager et al (2014)	No standardized handoff format
Wright (2013)	Used PATIENT pneumonic
Salzwedel (2013)	Used a checklist
Kalkman (2010)	Used a checklist

Figure 8. Anesthesia handoff content studies

The data collection tool (Appendix B) will be used to gather data about the independent variable (communication characteristics/latent conditions) and the dependent variable (handoff content). There are four communication characteristics and they are either present (yes response) or absent (no response). There are ten

handoff content items. Each handoff items is either communicated (yes response) or not communicated (no response). Each of the five coders will complete a VCU anesthesia handoff coding instrument form for each of the 60 cases and the data will be entered into a spreadsheet (excel) for analysis.

A combination of statistical techniques will be utilized to organize, interpret and communicate the numerical data. Descriptive statistics will provide a range of values for the latent conditions and the handoff scores. When calculating central tendency values for the 5 coders, the mode will be used because it is most suitable to nominal level measurements (Field, 2009). Frequency of occurrence will also be determined for latent conditions and handoff scores. The frequencies of each latent condition will be determined to show how often the conditions were present during the handoff. The frequencies for handoff content will show which content items were missed and how often.   A frequency distribution table will be used to show frequency and percentage data. Histograms will be used to show the distribution of latent conditions and handoff scores.

Correlation testing will be calculated using a Spearman's correlation coefficient or a Spearman's rho. Spearman's rho is a non-parametric statistic and will be used in place of the parametric statistic Pearson's r because of the use of nominal data (Pearson's r requires interval or ratio data). It will be a one-tailed test as the hypothesis is directional.

Spearman's rho is both descriptive and inferential. As a descriptive measure, the correlation coefficient summarizes the magnitude and direction of a relationship between two variables. As an inferential measure, the correlation coefficient tests

hypotheses about population correlations (Polit & Beck, 2008). Spearman's correlation coefficient can range from -1 to 1. A value of 1 indicates a perfect positive relationship while an r value of -1 indicates a perfect negative linear relationship. A value of 0 indicates that no linear relationship exists. A significance value of less than .05 will be used to determine that there is a significant relationship between latent factors and handoff scores. A scatter-plot diagram will be used to visually depict the correlation of the latent conditions and handoff score.

Chapter Four: Data Analysis

Communication failure is the leading cause of patient harm due to healthcare-related errors. Communication failure is known to occur during anesthesia patient handoffs. Latent conditions, such as distractions or production pressure, allow errors to proceed through system defenses and cause harm.   The purpose of this study is to determine the effect of latent conditions on the communication that occurs during the patient handoff process.

Simulated anesthesia handoff videos were randomly selected from a large database of anesthesia crisis resource management videos at the VCU Nurse Anesthesia Program's, Center for Research in Human Simulation. Five trained raters reviewed the videos and used the VCU anesthesia handoff coding form for data collection. All of the forms were collected by the principal investigator and entered into an Excel spreadsheet. A pilot study was conducted reviewing three simulated anesthesia patient handoff videos to gather data for interrater reliability determination and for use with the sample size estimation.

The agreement between two-raters is typically measured using Cohen's kappa coefficient (Gross, 1986). Cohen's kappa is not appropriate for this study because there are more than two raters. However, when there are more than two raters, a Fleiss' kappa is useful to determine multi-rater reliability (Fleiss, 1971). Fleiss' kappa was calculated to be 0.79 for the five raters in this study. After completing the data analysis,

one rater (rater four) was dropped from the study due to a large amount of missing data (see discussion on missing data). Fleiss' kappa was calculated again using four raters and the resulting kappa was 0.90 (see Table 1). Kappa values of 0.75 or greater indicate excellent agreement (Fleiss, 1971 & Polit and Beck, 2008).

Table 1. *Fleiss' Kappa for Multirater Reliability (four raters)*

				N	10	number of items
				n	4	number of raters
				k	2	number of categories
	Appy Scenario Categories					
Content	Number of 0's	Number of 1's	Sum of squares	1/n(n-1)	Pi	
a	0	4	16	0.083333333	1.00	
b	0	4	16	0.083333333	1.00	
c	4	0	16	0.083333333	1.00	
d	0	4	16	0.083333333	1.00	
e	0	4	16	0.083333333	1.00	
f	4	0	16	0.083333333	1.00	
g	0	4	16	0.083333333	1.00	
h	4	0	16	0.083333333	1.00	
i	4	0	16	0.083333333	1.00	
j	1	3	10	0.083333333	0.50	
sums	17	23				
N x n	40	40		SUM of Pi	9.50	
sums / Nxn	0.425	0.575		P bar	0.95	
(sums / Nxn) squared	0.180625	0.330625				
Pe	0.51125					

Kappa (Fleiss)	0.898

Hulley (2007) reported that a sample size of 26 would be recommended for a correlation coefficient of 0.60 with a one-tailed test with an alpha of 0.05 and a beta of 0.80. The sample size was calculated using data from the pilot study of three cases.

The calculation was performed with an alpha of 0.05 and a beta of 0.80 and an effect size (Spearman's rho, one-tailed) of -0.427 from this pilot study. The sample size calculation (Appendix C) recommended a sample size of 33 cases. The literature and sample size calculation indicated a sample size of approximately thirty would be necessary for a correlation of 0.60. For this study the recommended sample size was doubled to increase the methodological rigor. Therefore, Sixty cases (n=60) were studied to strengthen validity of this study and to account for possible missing rater scores or videos that could not be rated.

Of the 60 cases reviewed, two were excluded from the study. Case number 51 was excluded because an anesthesia patient handoff did not occur during this case. Case number 53 was excluded because of poor audio content that made the anesthesia handoff review impossible. With the two exclusions, the sample size for this study was 58 cases (n=58).

All researchers have faced the problem of missing quantitative data at some point in their work (Pigott, 2001). The missing values result in deciding how to best to analyze the data without jeopardizing methodological rigor. There were missing values on 16 of the 58 cases. Rater two had missing values on three of the cases and rater four had missing values on 16 cases (overlap in three of the cases). Due to the high number of missing values, the scores from rater four were excluded from the study. After the exclusion of rater four, only three missing values remained out of 232 reviewed cases (58 cases x four raters). The missing values were on the handoff scores (all latent condition values were recorded) and in each case were one of the ten-handoff content items.

One strategy for missing values is to delete those cases. Cases were not deleted in this study though as the loss of cases can have a large impact on power when the sample size is small (Polit and Beck, 2008). Rather than using imputation or mean substitution for missing values, the median scores of the other three raters were calculated and used for the score. The effect of the missing data is minimized by having multiple reviewers and by using the median scores for each variable. When median scoring resulted in a non-integer (1.5 rather than 1 or 2), the lesser value was included to avoid inflating the scoring.

Each simulated anesthesia handoff case was reviewed and produced two scores, a latency score and a handoff score. The latency score (from 0-4) is based on the number of latent conditions that were present during the handoff. A score of zero indicated that no latent conditions were present and a score of four indicated that all four latent conditions were present. The handoff score (from 0-10) is based on the handoff content that was communicated. A score of zero indicated that no handoff content was communicated and a score of ten indicated that all the handoff content was communicated. The latent total score (Table 2) and the handoff total score (Table 3) were determined for each case and each rater. The median value of the four-raters produced the latent score and the handoff score for each video reviewed.

- Research Question One:
    - What are the frequencies of latent conditions that occur during the anesthesia patient handoff?

Descriptive statistics were performed using SPSS statistical software. The frequency of each latent condition was tabulated. Distractions were the most common

Table 2. *Latency Scores*

Latency Total Median Score

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	8	13.8	13.8	13.8
	.50	3	5.2	5.2	19.0
	1.00	23	39.7	39.7	58.6
	1.50	6	10.3	10.3	69.0
	2.00	11	19.0	19.0	87.9
	2.50	1	1.7	1.7	89.7
	3.00	1	1.7	1.7	91.4
	3.50	2	3.4	3.4	94.8
	4.00	3	5.2	5.2	100.0
	Total	58	100.0	100.0	

Table 3. *Handoff Scores*

Handoff Total Median Score

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	1	1.7	1.7	1.7
	.50	2	3.4	3.4	5.2
	1.00	1	1.7	1.7	6.9
	1.50	1	1.7	1.7	8.6
	3.00	1	1.7	1.7	10.3
	3.50	2	3.4	3.4	13.8
	4.00	3	5.2	5.2	19.0
	5.00	4	6.9	6.9	25.9
	5.50	4	6.9	6.9	32.8
	6.00	4	6.9	6.9	39.7
	6.50	5	8.6	8.6	48.3
	7.00	13	22.4	22.4	70.7
	7.50	8	13.8	13.8	84.5
	8.00	2	3.4	3.4	87.9
	8.50	4	6.9	6.9	94.8
	9.00	2	3.4	3.4	98.3
	10.00	1	1.7	1.7	100.0
	Total	58	100.0	100.0	

latent condition and were present in 47 (81%) of the cases. Production pressure was present in 16 (28%) of the cases. Twelve cases (21%) did not have two-way interactive communications and 14 (24%) did not handoff with safe relief timing. There were no latent conditions in 11 (19%) of the cases, one latent condition present in 29 (50%) of the cases, two latent conditions present in 12 (20.7%) of the cases, three latent conditions present in three (5.1%) of the cases and four latent conditions present in three (5.2%) of the cases.

The following handoff items were communicated with a high frequency; patient ID (81%), procedure (91%), review of systems (85%), medications (81%), anesthesia technique (81%), and pertinent events (71%). Airway technique was communicated 53% of the time. Two handoff items that were infrequently communicated were vital signs, 29% of the time and intake and output, 26% of the time.

The latent conditions (Figure 9) and the handoff scores (Figure 10) were graphed and a Kolmogorov-Smirnov (K-S) test was conducted to determine whether the scores were normally distributed (Table 4). The p-value for latency was 0.004 indicating a non-normal distribution. The p-value for handoff score is 0.051, just meeting the significance for a normal distribution.

- Research Question Two:

  - Is there an association between latent conditions and handoff scores?

A correlation statistic is necessary to assess the effect of latent conditions on handoff scores. The latency and handoff scores are ordinal data and the latency scores are not normally distributed. Because the data violated the parametric assumption of
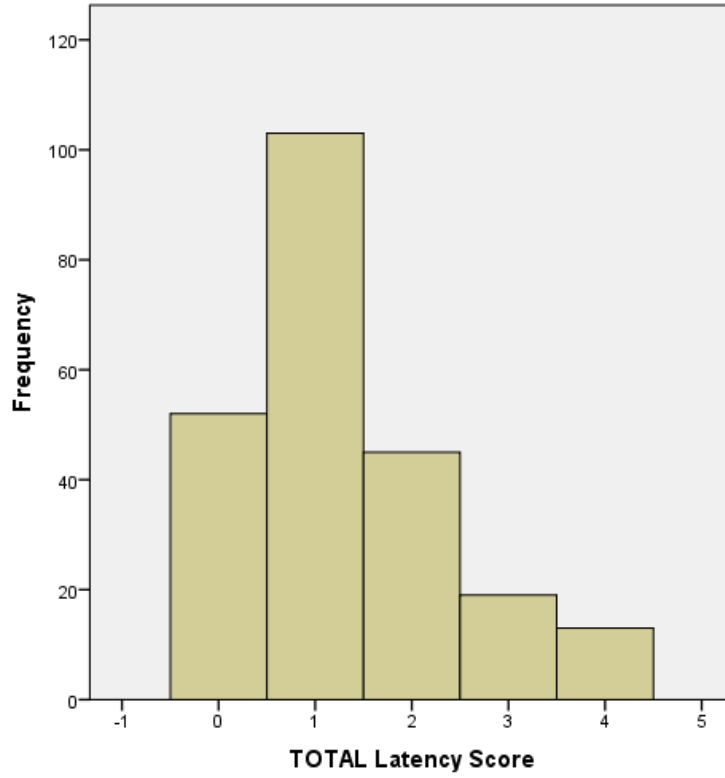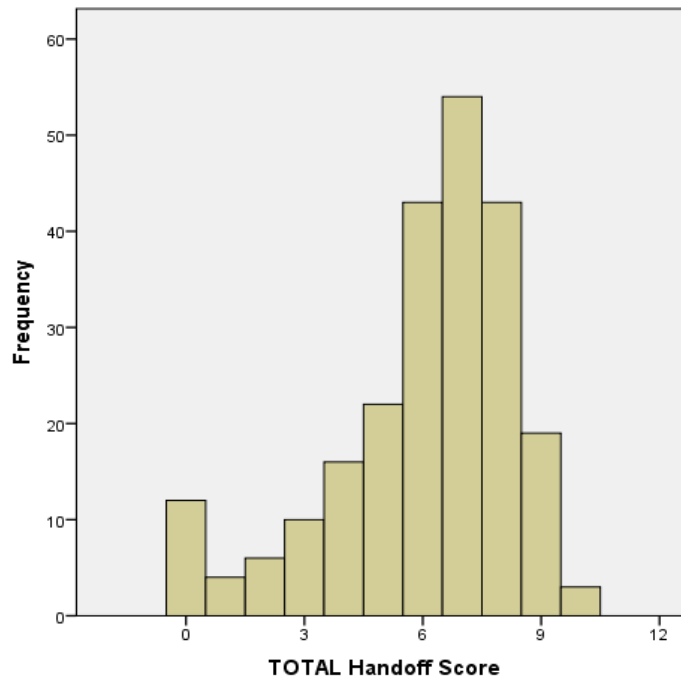
Figure 9. Distribution of Latency Scores

Figure 10. Distribution of Handoff Scores

Table 4. *Kolmogorov-Smirnov Normality Test*

One-Sample Kolmogorov-Smirnov Test

		Handoff Total Median Score	Latency Total Median Score
N		58	58
Normal Parameters[a,b]	Mean	6.0862	1.3793
	Std. Deviation	2.21268	1.01442
Most Extreme Differences	Absolute	.178	.232
	Positive	.106	.232
	Negative	-.178	-.165
Kolmogorov-Smirnov Z		1.353	1.767
Asymp. Sig. (2-tailed)		.051	.004

a. Test distribution is Normal.

b. Calculated from data.

being normally distributed (Field, 2009) and since the data is not ratio or interval level a non-parametric test is required. Therefore, the non-parametric, Spearman's correlation coefficient (Spearman's rho) is used in place of the parametric, Pearson's r correlation coefficient. The Spearman's correlation coefficient is a bivariate measure of correlation/association that is employed by rank-ordering the data (Sheskin, 1997). The study hypothesis, that handoff scores are inversely related to latency scores, is directional, so a one-tailed test is used (see Table 5).

Table 5. *Spearman's Correlation*

Correlations

			handoff	Latency
Spearman's rho	handoff	Correlation Coefficient	1.000	-.422[**]
		Sig. (1-tailed)	.	.000
		N	58	58
	Latency	Correlation Coefficient	-.422[**]	1.000
		Sig. (1-tailed)	.000	.
		N	58	58

**. Correlation is significant at the 0.01 level (1-tailed).

The Spearman's correlation shows output for the variables handoff score and latency score. The Spearman's correlation coefficient value can range from -1.0 to +1.0. The correlation coefficient between latency and handoff scores was -0.422 with a p-value less than 0.001. This indicates a significant relationship between the latency and handoff scores. Since the correlation coefficient is negative, it indicates an inverse relationship between the variables. The inverse relationship indicates that as latency scores increase, handoff scores decrease (Figure 11). The coefficient -0.422, indicates a moderate inverse relationship between latency and handoff scores. Values of 0.1 represent a small effect, 0.3 a medium effect and 0.5 a large effect (Field, 2009). The r value was calculated for both the linear and curvilinear regression on the data. The higher R^2 0.45 vs. 0.60 indicates that the curvilinear scatterplot provides a better estimate of variability between the variables. The R^2, the coefficient of determination, is a measure of the amount of variability in one variable that is shared by the other (Field, 2009). The R^2 of 0.60 for the curvilinear relationship demonstrates that 60% of the variability in handoff scores can be attributed to the latent conditions. The curvilinear relationship (Figure 12) shows that high latency scores may predict low handoff scores but as latency score drops to two or less, the handoff scores tend to cluster in the higher range (from five to nine).

Table 6 is a frequency distribution for the handoff scores. The table provides the percent that each latent condition was present for that handoff score. This table shows that there were few handoffs with very low or very high scores. The highest percentage
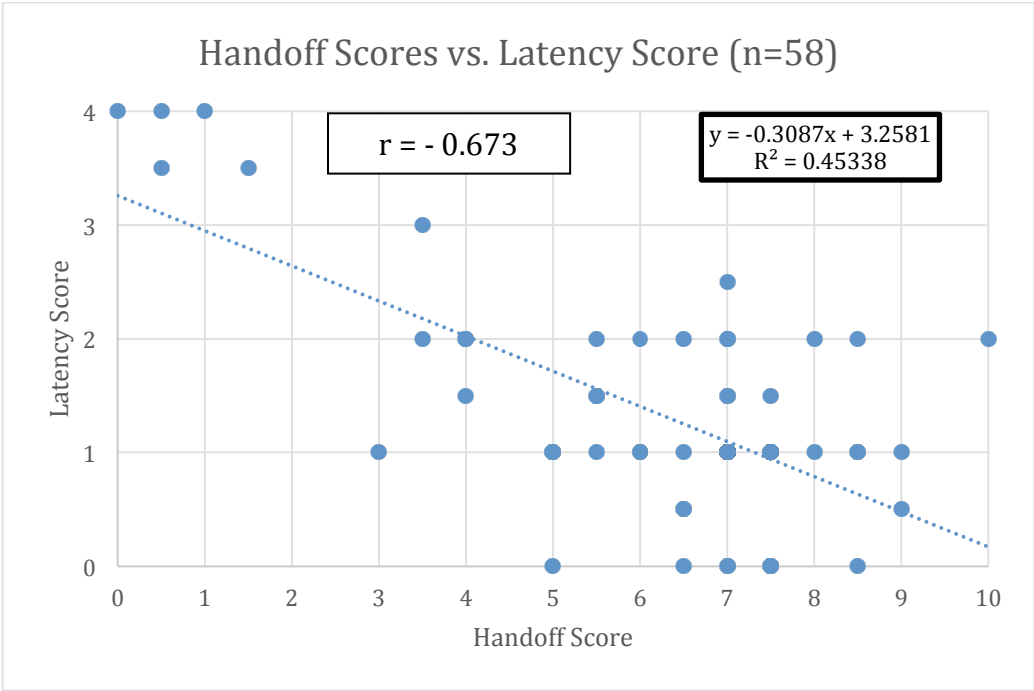
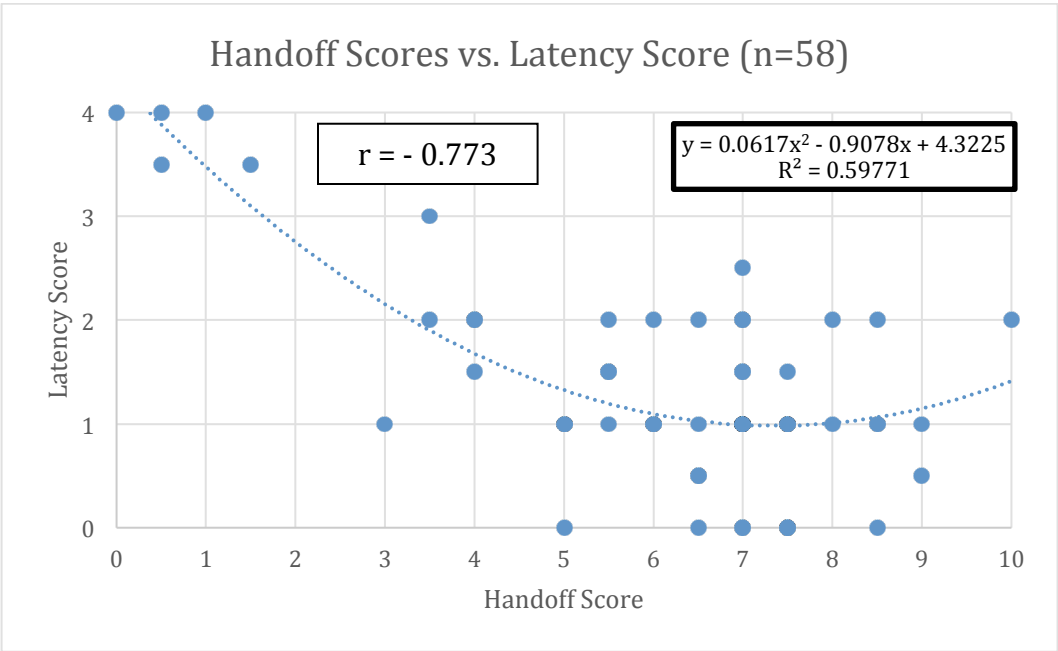*Figure 11.* *Scatterplot with Linear Relationship*

Figure 12. Scatterplot with Curvilinear Relationship

Table 6. *Frequency Distribution of Latency and Handoff Scores*

| | Latency Factors | | | | |
	Distractions	Production Pressure	Not Interactive	Not Safe to Relieve	n
0	100.0%	91.7%	91.7%	83.3%	3
1	100.0%	100.0%	100.0%	75.0%	1
2	83.3%	50.0%	66.7%	0.0%	2
3	100.0%	30.0%	20.0%	0.0%	2
4	68.8%	25.0%	25.0%	25.0%	4
5	59.1%	18.2%	36.4%	18.2%	7
6	72.1%	11.6%	18.6%	14.0%	11
7	63.0%	11.1%	3.7%	13.0%	13
8	69.8%	23.3%	0.0%	7.0%	9
9	63.2%	15.8%	0.0%	5.3%	5
10	100.0%	100.0%	0.0%	0.0%	1

of handoff scores was in the range of scores from five to eight. The most common latent condition was distractions, followed by production pressure, not interactive and not safe to relieve.

The Spearman's correlation coefficient suggests that increasing latency scores leads to lower handoff scores but it does indicate which of the latent conditions is most predictive of handoff score. A multiple regression analysis was performed (see Table 7) to show the predictive value of each latent condition in the handoff score. The latency variable, "not interactive", was the most significant predictor of handoff scores, B = -3.36 (p < .001) and was followed by safe relief timing which was also a significant predictor, B=-0.230 (p< 0.05).

Table 7. *Multiple Regression Analysis of Latent Conditions*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.482	.445		16.808	.000
	Distractions	-.460	.523	-.083	-.881	.383
	Production Pressure	-.681	.548	-.126	-1.243	.219
	Interactive	-3.357	.598	-.563	-5.609	.000
	Safe Relief Timing	-1.470	.642	-.230	-2.290	.026

a. Dependent Variable: Handoff Total Median Score

Summary

This study examined the relationship of latent factors and handoff scores of 58 simulated anesthesia patient handoffs. Four raters reviewed the videos of the 58 cases and provided a latency score (number of latent conditions) and a handoff score. Fleiss' kappa for the four raters is 0.90, indicating a high level of inter-rater reliability. Therefore, the median latent score and median handoff score of the four raters were provided for each of the 58 cases.

The most common latent condition revealed in the analysis was distractions. Distractions were present in 81% of the cases, followed in frequency, by production pressure, observed in 28% of the cases. Handoff timing "not safe to relieve" was observed in 24% of the cases and handoffs that were "not interactive" was observed in 21% of the cases. The majority of handoffs (70%) were judged to be either good or excellent, with a handoff score between 6 and 10. The majority of handoff items were frequently communicated. The exceptions were airway technique (communicated in 53% of cases), vital signs (communicated in 29% of the cases) and intake and output (communicated in 21% of the cases).

The lowest handoff scores (0,1 or 2) were associated with three or more latent conditions. Handoff scores were high even when distractions and production pressure were present. This seems to indicate that handoffs can be good or excellent with 0, 1 or 2 latent conditions present but when there are 3 or more latent conditions, handoffs quality invariably degraded to poor handoff scores. An interesting finding was that handoffs scores were higher if they were interactive and perform at safe times. Handoff scores were lower when the handoff was "not interactive" and "not safe to relieve.. This is validated by the multiple regression analysis demonstrating a significant relationship between handoffs that were not interactive and not safe to relieve and handoff scores.

Chapter Five: Conclusion and Summary

This chapter presents a summary of the research study. It also highlights important conclusions drawn from the data presented in chapter 4. This chapter provides a discussion of the implications for action and recommendations for further research.

Research Summary

Every day patients are harmed by medical errors. Despite the goals of providing safe and effective patient care, healthcare is not as safe as it should be. A recent estimate by James (2013), reports that death from preventable harm in US hospitals is between 210,00 to 400,00 deaths per year. A lot of research money and numerous resources are devoted to help solve this patient safety epidemic.

Healthcare is learning lessons from other industries on how to improve patient safety. Current error theory explains that medical errors are not usually caused by careless providers but are the result of defective systems. Patient safety is now benefitting from systems-level error analysis that has been long employed in aviation. The systems-based approach to error investigation shifted the focus to prospective systemic safety remedies and prophylaxis, rather than on assessment of blame.

The systems approach assumes that humans are fallible and that systems need to be designed to prevent and absorb inevitable human error. The systems approach also emphasizes attention to organizational and environmental factors that are

precursors to individual errors. When the environment allows for errors by individuals, the environment can be searched for underlying conditions that have recognized or tolerated (van Beuzekom, et al, 2010).

James Reason (1990) described the "Swiss cheese model" designed for accident investigations in the aviation, nuclear power and railway industries. Reason explained that latent conditions are present in a system long before an error occurs and allow an error to proceed through defenses and cause harm. Evidence shows that discovering and neutralizing latent conditions will have a much greater effect on system safety than efforts to minimize active errors (Reason, 1990).

In healthcare, as well as in aviation, communication failures are well known to be a leading cause of errors. Root cause analysis from the Joint Commission associates communication failure with over 60% of reported sentinel events in hospitals (Joint Commission, 2006) and the Federal Aviation Association associates communication failure with 70% of commercial aviation accidents (NTSB, 2006). Communication quality can be undermined by a lack of information or misinformation or even too much information (cognitive overload).

There are additional factors that can lead to communication failure. Prielipp, et al (2010) described phenomenom of "normalization of deviance." This is an incremental process and a gradual erosion of standard procedures that would never be tolerated as a single event. Normalization of deviance tolerates more risk and more errors, always in the interest of efficiency. This process is a small, gradual movement and without incident, these deviant changes become "normalized." Poor communication and the

"normalization of deviance" are identified as human factors that contribute to anesthesia mishaps (Prielipp et al, 2010).

Communication failures are known to occur during patient handoffs between caregivers. The handoff process is the transfer of patient care and responsibility among caregivers. Handoffs are inevitable and necessary as care is transferred among providers. Patient handoffs take place frequently in anesthesia during breaks, shift changes or transfers of patients to and from the operating room. Anesthesia patient handoffs have been identified as a vulnerable time for patients as communication failures commonly occur at these transitions in care.

The Joint Commission acknowledges the risk of communication failures during the handoff process and prioritizes handoffs as one of their major National Patient Safety Goals (NPSG). The Joint Commission has called for a standardization of handoff communications. The Joint Commission also identified latent conditions that frequently contribute to communication failure. The Joint Commission NPSG 2E (2006) stated that handoffs should include interactive, two-way communication; should limit interruptions or distractions and should allow for a review of relevant data.

There is a scarcity of research that correlates latent conditions with the quality of handoff content. The purpose of this study was to identify latent conditions that are present during the anesthesia patient handoff and to correlate the latent condition score with the handoff content score during simulated anesthesia patient handoffs. The research questions are:

- What are the frequencies of latent conditions that occur during the anesthesia patient handoff?

- Is there an association between latent condition scores and handoff scores?

The research hypothesis is that "handoff scores are inversely related to latent condition scores."

This was a nonexperimental, observational study. Simulation center videos from the Center for Research in Human Simulation (CRHS) at the Virginia Commonwealth University's Nurse Anesthesia Program were examined for latent conditions and handoff content. The simulations were conducted between 2006 to the present. The realistic simulation experiences took place during anesthesia crisis resource management training. The participants in the simulation scenarios included anesthesiologists, certified registered nurse anesthetists (CRNAs) and student registered nurse anesthetists (SRNAs). They were instructed to perform their anesthetic care as they would in the operating room setting.

The participants in these scenarios did not receive special training in anesthesia patient handoffs prior to their simulation, nor were they aware that the handoff process was being evaluated. Written informed consent was obtained from each participant and is on file in the Department of Nurse Anesthesia. Institutional review board (IRB) approval was obtained from the Virginia Commonwealth University (Richmond, VA). Videos were evaluated and coded by four researchers from the study team that have completed extensive training.

Sixty videos were randomly selected from the CRHS video library. All four raters reviewed each video. The VCU anesthesia handoff coding form (appendix B) was utilized for data collection. Raters evaluated each archived scenario for the following

latent conditions; distractions, production pressure, communication that was not interactive and handoff timing that was not safe. Latent condition scoring could range from zero (no latent conditions) to four (all latent conditions present). The handoff was also evaluated for the communication of ten handoff criteria including patient identification, procedure identification, allergies, review of systems, medications, vital signs, anesthesia technique, airway technique, intake and output and pertinent events. Each item was operationally defined (appendix A). The handoff score could range from zero (no handoff content communicated) to ten (all handoff content communicated).

Two cases were excluded from the study due to poor audio quality. Sample size calculation indicated that 33 cases would be needed for a one-tailed Spearman's correlation with an alpha of 0.05 and a beta of 0.80. The final sample size of 58 cases strengthened the methodological rigor and validy of this study. Reliability was determined using a Fleiss' kappa for multirater reliability. Fleiss' kappa was 0.90 indicating excellent agreement among 4 raters. The most common latent condition observed during the anesthesia handoffs was the spectrum of conditions known as distractions (81%).   Production pressure was present in 28% of anesthesia handoffs, handoff timing was "not safe to relieve" in 24% of the handoffs and handoffs were "not interactive in 21% of the cases.

Major Findings

Handoff scores were low (0,1,2) when three or more latent conditions were present. The presence of two or fewer latent conditions was not predictive of low handoff scores. Handoff scores were high (9 or 10) even in the presence of both distractions and production pressure. Handoff scores were only significantly predicted

66

by the latent conditions "not interactive" (p < 0.001) and "not safe to relieve" (p< 0.05) using multiple regression analysis.

A Spearman's correlation coefficient of -0.422 suggests a significant (p< 0.001) inverse relationship between latency scores and handoff scores.   Linear regression demonstrates a curvilinear relationship between latent conditions and handoff scores. This shows a stronger relationship between high latent condition scores and low handoffs scores. The R2 value of 0.60 indicates that 60% of the variability in handoff scores can be attributed to latent conditions.

The purpose of this research was to discover the latent conditions present during the anesthesia handoff process and to identify the relationship between latent conditions and handoff communication. The Joint Commission urges that the handoff process should be free of interruptions and distractions. They also suggest that the handoff process should be highly interactive. There is also evidence from a wide range of high-profile, safety-conscious industries (commercial aviation, nuclear power, military, NASA) that handoffs should not occur during task dense situations.

The handoff literature indicates that distractions and interruptions are barriers to safe patient handoffs. Distractions and interruptions are common in the operating room and were common during the simulations (81% of the cases). However distractions were not predictive of handoff scores in this study (p>0.05). One reason for this finding could be that providers are so used to distractions that they are able to "work around" this latent condition.

Production pressure is very common in the surgical and anesthetic care environment. Production pressure can lead to a hurried handoff and communication

failure. Production pressure also was not predictive (p>0.05) of handoff scores for this study. It was thought that these two latent conditions, distractions and production pressure, would have more of an effect on handoff scores but in fact, some handoff scores were very high (9 or 10) even in the presence of both distractions and production pressure. Again, an explanation could be that providers are used to overcoming distractions and productions and were able to provide quality handoff communications despite these latent conditions. Error theory and the "normalization of deviance" explain that despite the successes of overcoming these latent conditions, eventually the system will fail and harm will occur from these latent conditions.

Unexpected Findings

Surprisingly, the latent condition "not interactive" was the greatest predictor of handoff scores and was significant (p<0.001). When handoff scores were low (0,1,2) the handoffs were frequently "not interactive." When handoff scores were high (8,9,10) the handoffs were always interactive. This indicates that the seemingly straightforward act of communicating is anything but straightforward. As stated by George Bernard Shaw, "the problem with communication…is the illusion that it has been accomplished."

Relief timing was also a significant factor in this study. The literature shows that communication failures are common during task dense situations (such as aviation take-offs or landings). Communication failure has also been an issue during anesthesia handoffs when the handoff occurs during the induction or emergence phase. For this study, handoff scores were generally lower when the handoff was deemed "not safe to relieve."

Link to Theory

Communication failures contribute to patient harm during anesthesia patient handoffs. Modern error theory explains that these communication errors are not necessarily an individual error. The recurrence of the same error, in the same situation, by different people indicates an error-prone situation rather than error-prone people (Peltomaa, 2012). Error-prone situations arise from conditions in the system called latent conditions. Latent conditions, such as distractions and interruptions, produce two tasks going on in parallel which compete for your attention and the elements of one migrate into the other (Peltomaa, 2012).

Latent conditions are often present but rarely cause harm. Because of this, if you do today what you did yesterday and got away with it (no bad outcome) then system issues remain concealed. The concealed system problems become "normalized" (normalization of deviance) and a safe system becomes unsafe (Peltomaa, 2012). This is commonly seen in the operating room where distractions and production pressures are the norm.

A robust and growing body of scholarly work is dedicated to improving handoff safety. Current guidelines for safe handoffs tend to focus on standardizing the handoff process. Examples include the evaluation of handoff checklists and handoff pneumonics as "forcing functions" in the genesis of effective communication. This study was designed to create a safer system for patient handoffs by examining the relationship between latent conditions and communication failures during the anesthesia handoff process.

Weaknesses

A weakness for this study was the setting being simulated anesthetics rather than "real" anesthetic cases. It is very difficult to perform observational studies in the operating room as this would require permission from the surgical and anesthesia providers, as well as obtaining patient consent. The use of observers in the operating room could also lead to the Hawthorne effect where handoffs performance is improved due the presence of the observer. The observer effect could also present a problem in this study as the participants know that their performance is being watched and recorded. This could lead to higher quality handoffs in this study than in actual practice.

Another weakness is that each latent condition was considered equal in this study.   Latent factors were identified as either present or not present. For example, if music was playing in the background, then a distraction was recorded. This did not indicate whether the music was loud or soft but only that it was present. During the review of the handoffs, it was clear that not all distractions, or any of the other latent conditions, were equal in their impact on handoff communication.   It is likely that certain latent conditions "outweigh" others. Future research could quantify the latent conditions and provide a weight based on the impact or significance that it has on communication. As an example, during task dense periods where it was determined as "not safe to relieve" a weight could be added to the score if the handoff communication was interrupted.

This weakness could also be considered strength though. The simulations were conducted in a state-of-the-art, high-fidelity simulation center. The simulated operating room was set-up nearly identical to an actual operating room. The scenarios were

realistic and the operating room team (surgeon, circulating nurse and scrub nurse) was present and performing their roles. The greatest strength of the simulation center was that study participants were focused on their anesthetic performance (just like they would be in the operating room) and not on the handoff performance. Because the anesthesia patient handoff was just a typical part of their anesthetic management, it allowed for a realistic handoff to occur without the caregivers being concerned about handoff quality.

Conclusion

Anesthesia patient handoffs are a vulnerable time for patient care. Handoffs occur frequently during anesthesia care. Latent conditions are common during anesthesia handoffs. This research provides evidence that latent conditions can lead to poor handoff communication during the anesthesia patient handoff. The number of latent conditions and the types of latent conditions affected handoff scores. Handoff scores were inversely related to increasing latent conditions. Handoffs that were not interactive or handoffs with unsafe timing predictably resulted in poor handoff communication.

Clinicians must acknowledge that handoffs are a high-risk event that can result in patient harm. The complexity of healthcare mandates competent communication to ensure safe patient care. Clear and effective communication is key to safe, quality care. Clinicians must be aware that providing a good handoff requires an understanding of the purpose, leadership, protected time, a systematic approach, and a supportive clinical environment (Jorm et al, 2009). This includes being aware of and minimizing the impact of latent conditions during the anesthesia patient handoff.

Future

Effective communication and good handoffs take effort. It is important for healthcare to learn from the successes of other industries. Many industries have created standardized approaches to the handoff process. In healthcare, handoffs are often individualized and without standardization. There are examples of effective communication and good handoffs that take place in settings with high consequences for failure.

Patterson et al, (2004) studied handoffs from NASA Johnson Space Center, nuclear power plants, a railroad dispatch center and an ambulance dispatch center. They included the following handoff coordination and communication strategies: face-to-face verbal update with interactive questioning, limited interruptions, limit initiation of operator actions during update, incoming assesses current status, incoming scans historical data before update, outgoing oversees incoming's work following update and delay the transfer of responsibility when concerned about status/stability of process. These strategies provide for a systematic approach and protected time for the handoff. These strategies also address several latent conditions while providing a supportive environment for the handoff to occur.

Durso et al (2007) described the four phases of a handoff that occur for air traffic controllers. Phase 1, end of shift, is when the outgoing prepares for the handoff meeting while the incoming attempts to gather information. Phase 2, arrival, is the face-to-face meeting. During phase 2, the outgoing maintains control while the incoming observes and gains information. Phase 3 is the verbal exchange between outgoing and

incoming. Phase four, taking post, is when the incoming assumes responsibility. The

outgoing remains present for a short time to ensure handoff is complete.

These examples from other industries demonstrate the importance of defining

the handoff process. W. E. Deming stated "If people do not see the process, they

cannot improve it." Anesthesia handoffs lack the defining properties described above.

Future study could test these strategies for effectiveness during the anesthesia handoff.

References

Allen, M. (2013). How many die from medical mistakes in US hospitals? Retrieved April 8, 2013 from http://www.propublica.org/article/how-many-die-from-medical-mistakes.

Altman, L. K. (1995). Big doses of chemotherapy drug killed patient, hurt 2nd. Retrieved October 22, 2014 from http://www.nytimes.com/1995/03/24/us/big-doses-of-chemotherapy-drug-killed-patient-hurt-2d.html.

Amalberti, R., Vincent, C., Auroy, Y. & de Saint Maurice, G. (2006). Violations and migrations in health care: A framework for understanding and management. *Quality and Safety in Health Care, 15*(Suppl 1), i66-71.

Agency for Healthcare Research and Quality (AHRQ). (2009). Retrieved Feb 18, 2013 from www.webmm.ahrq.gov.

Andel, C., Davidow, S. L., Hollander, M. & Moreno, D. A. (2012). The economics of health care quality and medical errors. *Journal of Health Care Finance*, *39*(1), 39-50.

Anesthesia Patient Safety Foundation (2014). Retrieved September 26, 2014 from http://www.apsf.org.

Barr, D. P. (1955). Hazards of modern diagnosis and therapy: The price we pay. *Journal of the American Medical Association, 159*(15), 1452-1456.

Beecher, H. K. & Todd, D. P. (1954). A study of the deaths associated with anesthesia and surgery: Based on a study of 599,548 anesthesias in ten institutions 1948-1952, inclusive. *Annuals of Surgery, 140*(1), 2-35.

Berkenstadt, H., Haviv, Y., Tuval, A., Shemesh, Y., Megrill, A., Perry, A., Rubin, O. & Ziv, A. Improving handoff communications in critical care: Utilizing simulation-based trainingtoward process improvement in managing patient risk. *Chest, 134*(1), 158-162.

Berwick, D. M., Hackbarth, A. D. & McCannon, C. J. (2006). IHI replies to "the 100,000 lives campaign: A scientific and policy review. *Joint Commission Journal for Quality and Patient Safety, 32*(11), 628-630.

Biddle, C. J., Hartland, W. & Fallacaro, M. (2005). Patient safety vignettes: Observations on a novel use of an old methodology. *The Internet Journal of Allied Health Sciences and Practice, 3*(1), 1-4.

Brennan, T. A., Leape, L. L., Laird, N. M., Hebert, L., Localio, A. R., Lawthers, A. G., Newhouse, J. P., Weiler, P. C. & Hiatt, H. H. (1991). Incidence of adverse events and negligence in hospitalized patients: Results of the Harvard medical practice study 1. *New England Journal of Medicine, 324*(6), 370-376.

Brindley, P. G. & Dunn, W. F. (2009). Simulation for clinical research trials: A theoretical outline. *Journal of Critical Care, 24*(2), 164-167.

Burke, J. P. (2003). Back to the future. *Quality and Safety in Health Care, 12*, 63-64.

Catchpole, K. R., Dale, T. J., Hirst, D. G., Smith, J. P. & Giddings, T. A. (2010). A multicenter trial of aviation-style training for surgical teams. *Journal of Patient Safety, 6*(3), 180-186.

Cooper, J. B., Newbower, R. S., Long, C. D. & McPeek, B. (1978). Preventable

anesthesia mishaps: A study of human factors. *Anesthesiology, 49*(6), 399-406.

Clancy, C. M. (2008). The importance of simulation: Preventing hand-off mistakes.

AORN Journal, 88(4), 625-627.

Clancy, C. M. (2009). Patient safety: One decade after To Err is Human. *AHRQ,*

Retrieved from http://www.psqh.com/septemberoctober-2009/234-september-

october-2009-ahrq.html.

Classen, D. C., Resar, R., Griffin, F., Federico, F., Frankel, T., Kimmel, N., Whittington,

J. C., Frankel, A., Seger, A. & James, B. C. (2011). Global trigger tool shows that

adverse events in hospitals may be ten times greater than previously measured.

Health Affairs, 30(4), 581-589.

de Vries, E. N., Prins, H. A., Bennink, M. C., Neijenhuis, P., van Stijn, I., van Helden, S.

H., Smorenburg, S. M., Gouma, D. J. & Boermeester, M. A. (2012). Nature and

timing of incidents intercepted by the SURPASS checklist in surgical patients.

BMJ Quality & Safety, 21(6), 503-508.

Dekker, S. (2006). *The field guide to understanding human error*. Burlington, VT:

Ashgate Publishing Company.

Dracup, K., and Morris, P.E. (2008). Passing the torch: The challenge of handoffs.

American Journal of Critical Care, 17(2), 95-97.

Eichhorn, J. H. (2012). The anesthesia patient safety foundation at 25: A pioneering

success in safety, 25th anniversary provokes reflection, anticipation. Anesthesia &

Analgesia, 114,(4), 791-800.

Eisenberg, J. M., Meyer, G. & Foster, N. (2000). Medical errors and patient safety: A

growing research priority. *Health Services Research, 35*(3), 11-15.

Elder, N. C. & Dovey, S. M. (2002). Classification of medical errors and preventable

adverse events in primary care: A synthesis of the literature. *The Journal of Family*

Practice, 51(11), 927-932.

Emanuel, L., Berwick, D., Conway, J., Hatlie, M., Leape, L., Reason, J., Schyve, P.,

Vincent, C. & Walton, M. (2008). What exactly is patient safety? Advances in

Patient Safety: New Directions and Alternative Approaches (AHRQ). 1-18.

Entin, E. B., Lai, F. & Barach, P. (2006). Training teams for the perioperative

environment: A research agenda. *Surgical Innovation, 13*(3), 170-178.

Feil, M. (2014). Distractions in the operating room. Pennsylvania Patient Safety

Authority, Retrieved from

http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2014/Jun;11%282%

29/Pages/45.aspx.

Field, A. (2009). *Discovering Statistics Using SPSS 3rd ed*. Thousand Oaks, CA: Sage.

Fleiss, J. L. (1971). Measuring nominal scale agreement among many raters.

Psychological Bulletin, 76(5), 378-382.

Gaba, D. M. (2004). The future vision of simulation in health care. Quality and Safety in

Health Care, 13(Suppl 1), i2-i10.

Gawande, A. (2002). *Complications: A surgeon's notes on an imperfect science*. New

York, New York: Picador.

Gawande, A. (2009). *The checklist manifesto: How to get things right*. New York, New

York: Metropolitan Books.

Gawande, A. A., Zinner, M. J., Studdert, D. M. & Brennen, T. A. (2003). Analysis of

errors reported by surgeons at three teaching hospitals. *Surgery*, *133*(6), 614-621.

Hains, I. M. (2012). Transfer troubles. Web M & M. Retrieved Jan. 4, 2013 from

http://webmm.ahrq.gov/printviewCase.aspx?caseID=269.

Hotchkiss, M. A., Biddle, C. & Fallacaro, M. (2002). Assessing the authenticity of the

human simulation experience in anesthesiology. *AANA Journal, 70*(6), 470-473.

Hu, Y. Y., Arriaga, A. F., Peyre, S. E., Corso, K. A., Roth, E. M. & Greenberg, C. C.

(2012). Deconstructing intraoperative communication failures. *Journal of Surgical

Research*, *177*(1), 37-42.

Hunt, E. A., Shilkofski, N. A., Stavroudis, T. A. & Nelson, K. L. (2007). Simulation:

Translation to improved team performance. *Anesthesiology Clinics, 25*, 301-319.

Hulley, S. B., Cummings, S. R., Browner, W. S., Grady, D. G & Newman, T. B. (2007).

Designing Clinical Research. Philadelphia, PA: Lippincott, Williams & Wilkins.

James, J. T. (2013). A new evidenced-based estimate of patient harms associated with

hospital care. *Journal of Patient Safety, 9*(3), 122-128.

Jayaswal, S., Berry, L., Leopold, R., Hart, S. R., Scuderi-Porter, H., DiGiovanni, N. &

Phillips, A. (2011). Evaluating safety of handoffs between anesthesia care

providers. *The Ochsner Journal, 11*(2), 99-101.

Joint Commission. (2004). Retrieved Feb 17, 2013 from

www.jointcommission.org/sentinelevents/statistics.

Joint Commission. (2007). Retrieved June 12, 2013 from

http://www.jointcommission.org/patientsafety/nationalpatientsafetygoals/06_npsg_

ome.htm.

Joint Commission. (2006). Retrieved May 27, 2014 from

www.jointcommission.org/sentinelevents/statistics.

Joint Commission. (2013). Retrieved May 27, 2014 from

www.jointcommission.org/sentinelevents/statistics.

Joint Commission. (2014). Retrieved October 22, 2014 from

http://www.jointcommission.org/patientsafety/nationalpatientsafetygoals/14_npsg_

ome.htm.

Jorm, C.M., White, S. & Kaneen, T. (2009). Clinical handover: Critical communications.

Medical Journal of Australia, 190(11 supplement), S108-S109.

Kalkman, C. J. (2010). Handover in the perioperative care process. *Current Opinion in*

Anesthesiology, 23(6), 749-753.

Kneebone, R. L., Scott, W., Darzi, A. & Horrocks, M. (2004). Simulation and clinical

practice: Strengthening the relationship. *Medical Education, 38*(10), 1095-1102.

Kitch, B. T., Cooper, J. B., Zapol, W. M., Marder, J. E., Karson, A., Hutter, M. &

Campbell, E. G. (2008). Handoffs causing patient harm: A survey of medical and

surgical house staff. The Joint Commission Journal on Quality and Patient Safety*,*

34(10), 563-570.

Kohn, L. T., Corrigan, J., & Donaldson, M. S. (2000). *To err is human: Building a safer*

health system. Washington, D. C.: National Academy Press.

Lane-Fall, M. B., Brooks, A. K., Wilkins, S. A., Davis, J. J. & Riesenberg, L. A. (2014).

Addressing the mandate for hand-off education: A focused review and

recommendations for anesthesia resident curriculum development and evaluation.

Anesthesiology, 120(1), 218-229.

Leape, L. L., Brennan, T. A., Laird, N., Lawthers, A. G., Localio, A. R., Barnes, B. A., Hebert, L., Newhouse, J. P., Weiler, P. C. & Hiatt, H. (1991). The nature of adverse events in hospitalized patients: Results of the Harvard medical practice study 2. *New England Journal of Medicine, 324*(6), 377-384.

Leape, L. L. (2008). Scope of problem and history of patient safety. *Obstetric and Gynecologic Clinics of North America, 35*(1), 1-10.

Leape, L., Berwick, D., Clancy, C., Conway, J., Gluck, P., Guest, J., Lawrence, D., Morath, J., O'Leary, D., O'Neill, P., Pinakiewicz, D. & Isaac, T. (2009). Transforming healthcare: A safety imperative. *Quality & Safety in Health Care*, *18*, 424-428.

Leonard, M., Graham, S., and Bonacum, D. (2004). The human factor: The critical importance of effective teamwork and communication in providing safe care. *Quality Safe Health Care, 13*(suppl 1), 85-90.

Levy, F., Mareiniss, D., Iacovelli, C. & Howard, J. (2010). The patient safety and quality improvement act of 2005. *Journal of Legal Medicine, 31*(4), 397-422.

Lighthall, G. K., Poon, T. & Harrison, T. K. (2010). Using in situ simulation to improve in-hospital cardiopulmonary resuscitation. *The Joint Commission Journal on Quality and Patient Safety, 36*(5), 209-216.

Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G. R., Reznick, R., Bohnen, J., Orser, B., Doran, D. & Grober, E. (2004). Communication failures in the operating room: An observational classification of recurrent types and effects. *Quality and Safety in Health Care, 13*, 330-334.

McCannon, C. J., Hackbarth, A. D. & Griffin, F. A. (2007). Miles to go: An introduction to the 5 million lives campaign. *The Joint Commisson Journal on Quality and Patient Safety*, *33*(8), 477-484.

McQueen-Shadfar, L. & Taekman, J. (2010). Say what you mean to say: Improving patient handoffs in the operating room and beyond. *Simulation in Healthcare, 5*(4), 248-253.

Mistry, K. P., Jaggers, J., Lodge, A. J., Alton, M., Mericle, J. M., Frush, K. S. & Meliones, J. N. (2008). *Using six sigma methodology to improve handoff communication in high-risk patients*. Retrieved May 23, 2013 from www.ahrq.gov.

Murray, D. (2005). Clinical simulation: Measuring the efficacy of training. *Current Opinion in Anaesthesiology. 18*(6). 645-648.

National Patient Safety Foundation (2014). Retrieved June 6, 2013 from http://www.npsf.org/?page=safetyissues.

Nagpul, K., Arora, S., Vats, A., Wong, H. W., Sevdalis, N., Vincent, C. & Moorthy, K. (2012). Failures in communication and information transfer across the surgical care pathway: Interview study. *BMJ Quality and Safety*, *21*(10), 843-849.

Nightengale, F. (1860). Notes on nursing: What it is and what it is not. London: Harrison and Sons.

Patterson, E.S., Roth, E.M., Woods, D.D., Chow, R. and Gomes, J.O. (2004). Handoff strategies in settings with high consequences for failure: Lessons for health care operations. *International Journal for Quality in Health Care. 16*(2), 125-132.

Peltomaa, K. (2012). James Reason: Patient safety, human error, and swiss cheese. *Quality Management in Health Care, 21*(1), 59-63.

Prielipp, R. C., Magro, M., Morell, R. C. & Brull, S. J. (2010). The normalization of deviance: Do we (un)knowingly accept doing the wrong thing? *Anesthesia & Analgesia, 110*(5), 1499-1502.

Polit, D. F. & Beck C. T. (2006). *Nursing Research: Generating and Assessing Evidence for Nursing Practice 8th edition*. Philadelphia, PA: Lippincott Williams & Wilkins.

Saager, L., Hesler, B. D., You, J., Turan, A., Mascha, E. J., Sessler, D. I. & Kurz, A. (2014). Intraoperative transitions of anesthesia care and postoperative adverse outcomes. *Anesthesiology*, *121*(4), 695-706.

Sahp.vcu.edu/nrsa/simulation, 2014. Accessed September 2, 2014.

Salzwedel, C., Bartz, H. J., Kuhnelt, I., Appel, D., Haupt, O., Maisch, S. & Schmidt, G. N. (2013). The effect of a checklist on the quality of post-anaesthesia patient handover: A randomized controlled trial. *International Journal for Quality in Health Care, 25*(2), 176-181.

Schimpff, S. C. (2007). Improving operating room and perioperative safety: Background and specific recommendations. *Surgical Innovation, 14*(2), 127-135.

Schimmel, E. M. (1964). The hazards of hospitalization. *Annual of Internal Medicine, 60*, 100-110.

Segall, N., Bonifacio, A. S., Schroeder, R. A., Barbeito, A., Rogers, D., Thornlow, D. K., Emery, J., Kellum, S., Wright, M. C. & Mark, J. B. (2012). Can we make postoperative patient handovers safer? A systematic review of the literature. *Anesthesia & Analgesia, 115*(1), 102-115.

Shear, T. D., Greenberg, S. B. & Tokarczyk, A. (2013). Does training with human

    patient simulation translate to improved patient safety and outcome? *Current*

    Opinion in Anaesthesiology, 26(2), 159-163.

Sheskin, D. (1997). Handbook of parametric and nonparametric statistical procedures.

    Boca Raton, FL: CRC Press.

Solet, D.J., Morvell, M., Rutan, G.H., and Frankel, R.M. (2005). Lost in translation:

    Challenges and opportunities in physician-to-physician communication during

    patient handoffs. *Academic Medicine, 80*(12), 1094-1099.

Staggers, N. and Jennings, B. M. (2009). The content and context of change of shift

    report on medical and surgical units. *The Journal of Nursing Administration, 39*(9),

    393-398.

Steinberger, D. M., Douglas, S. V. & Kirschbaum, M. S. (2009). Use of failure mode and

    effects analysis for proactive identification of communication and handoff failures

    from organ procurement to transplantation. *Progress in Transplantation, 19*(3),

    208-214.

Strauch, B. (2002). *Investigating human error: Incidents, accidents, and complex*

    systems. Burlington, VT: Ashgate Publishing Company.

Reason, J. T. (1990). *Human error*. Cambridge, England; New York: Cambridge

    University Press.

Van Beuzekom, M., Boer, F., Akerboom, S. & Hudson, P. (2010). Patient safety: Latent

    risk factors. *British Journal of Anaesthesia, 105*(1), 52-59.

Wachter, R. M. (2010). Patient safety at ten: Unmistakable progress, troubling gaps.

    Health Affairs, 29(1), 165-173.

Weller, J. M., Bloch, M., Young, S., Maze, M., Oyesola, S., Wyner, J., Dob, D., Haire, K., Durbridge, J., Walker, T. & Newble, T. (2003). Evaluation of high fidelity patient simulator in assessment of performance in anaesthetists. *Anaesthesia, 90*(1), 43-47.

Weinger, M. B. & Ancoli-Israel, S. (2002). Sleep deprivation and clinical performance. *Journal of American Medical Association, 287*(8), 955-957.

Wilson, R. M., Runciman, W. B., Gibberd, R. W., Harrison, B. T. & Hamilton, J. D. (1995). The quality in australian health care study. *Medical Journal of Australia, 163*, 458-471.

Wright, S. M. (2013). Examing transfer of care processes in nurse anesthesia practice: Introducing the PATIENT protocol. *AANA Journal*, 81(3), 225-232.

Appendix A

Coding Instrument Definitions

1. **Demographics**
   a. **Video #/identifier**—surgery type and date as labeled on CD (ie **Appy_2010**)
   b. **COMMENTS**: Each video has a unique name. Please identify video by it's disc name.
2. **Communication Characteristics**
   a. **Distractions** – only patient-specific conversation can occur during the handover. Examples of distractions include: environmental barriers such as noise or poor lighting and distractions from staff conversations, competing interests (having to move bed or administer a medication).
   b. **Production pressure** – refers to overt or covert pressures and incentives on personnel to place production, not safety, as their primary priority. Pressure to maximize the number of cases performed, having to hasten the anesthetic or alter the way the anesthetic is conducted, pressure to avoid appearing overly concerned. Institutional pressure not personal pressure.
   c. **Interactive communication** – two way communication between the outgoing and relieving anesthesia provider. **The interactive communication is pertinent to the patient handoff.**
   d. **Safe relief timing** – Timing was appropriate for safe patient handoff. Timing is considered unsafe if conducted during a critical, task dense period including **induction, emergence or while the patient is unstable.**

3. **Handoff Content**
   a. **Patient identification** – identified patient by NAME or AGE or GENDER
   b. **Procedure** – identified the procedure being performed
   c. **Allergies** - identified ANY allergies (must be stated as allergies or reaction to)
   d. **Review of Systems** – reviewed ANY body system OR reported patient as healthy (no issues)
   e. **Medications** – identified ANY medication administered OR meds the patient is taking
   f. **Vital signs** – identified as VSS (vital signs stable) or ANY abnormal vital sign values
   g. **Anesthesia technique** – identified anesthetic administered or it is obvious from the handoff report
   h. **Airway technique/review** – Identified airway assessment OR the airway technique performed
   i. **Intake and Output** – ANY mention of fluids administered OR fluids out (blood loss OR foley)
   j. **Pertinent events** – ANY identification of events during procedure or anesthetic administration

Appendix B

VCU Anesthesia Handoff Coding Instrument

1. Demographics
   a. Video #/identifier--_____
   b. **COMMENTS**:

2. Communication Characteristics
   a. Distractions -- YES or NO   comments_____
   b. Production pressure -- YES or NO
           comments_____
   c. Interactive communication -- YES or NO
           comments_____
   d. Safe relief timing -- YES or NO
           comments_____

   COMMENTS:

3. Handoff Content
   a. Patient identification   YES or NO
   b. Procedure   YES or NO
   c. Allergies   YES or NO
   d. Review of Systems   YES or NO
   e. Medications   YES or NO
   f. Vital signs   YES or NO
   g. Anesthesia technique   YES or NO
   h. Airway technique/review   YES or NO
   i. Intake and Output   YES or NO
   j. Pertinent events   YES or NO
      COMMENTS:

Appendix C

Sample Size calculation

One Tailed Calculations, a=0.05, B=0.20							
Lat x Han MED Correl			r's	Cr	Za	Zb	N
-0.657			0.207000604	-0.787516785	1.645	0.84	13
Lat x Han MEAN Correl							
-0.61			0.242236025	-0.70892136	1.645	0.84	15
Lat x Han MED Spear Correl							
-0.427			0.401541696	-0.45622195	1.645	0.84	33
Lat x Han MEAN Spear Correl							
-0.418			0.410437236	-0.44526613	1.645	0.84	34
Two-tailed Calculations, a=0.05, B=0.20							
Lat x Han MED Correl			r's	Cr	Za	Zb	N
-0.657			0.207000604	-0.787516785	1.96	1.28	20
Lat x Han MEAN Correl							
-0.61			0.242236025	-0.70892136	1.96	1.28	24
Lat x Han MED Spear Correl							
-0.427			0.401541696	-0.45622195	1.96	1.28	53
Lat x Han MEAN Spear Correl							
-0.418			0.410437236	-0.44526613	1.96	1.28	56

$$C(r) = \tfrac{1}{2}\log_e \frac{(1 + r)}{(1 - r)}$$

$$N = \left(\frac{z_\alpha + z_\beta}{C(r)} \right)^2 + 3$$

Vita

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