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A CORRELATIONAL STUDY OF THE HANDOFF COMMUNICATION PROCESS AS A RESULT OF VARIATION IN STAFFING LEVELS

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ABSTRACT

The patient handoff is an intricate process that takes on many forms within the healthcare domain. One incredibly common, yet complex handoff is that from the Emergency Department (ED) to the respective floor unit for the extended care of a patient upon hospital admission. While the specifics of the protocol for this process vary between institutions, the importance of a successful handoff for patient safety is universal. This study will examine the effects of the variation in staffing levels on the effectiveness of communication handoff process.

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I would like to thank Dr. David Neyens for serving as my co-advisor and for being so willing to help a student outside of his own department. It became evident that he truly cares about the success off all students with which he comes in contact. He encouraged me in choosing my selected thesis topic, which stemmed from an internship, which he oversaw.

Lastly I would like to thank Mrs. Shannon Harris who served as my supervisor for the internship from which my thesis data came. She provided me with incredible guidance in the process of data collection in the field based on her vast experience. She was also so kind to allow me to use this data for my thesis, taking her personal time to assist in preparing the data for my use.

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High	105.7 (SD= 63.7)	15	10	70; 60	7	5	0	12
Low	51.7 (SD= 30.9)	100	85	85; 80	1	2	0	3

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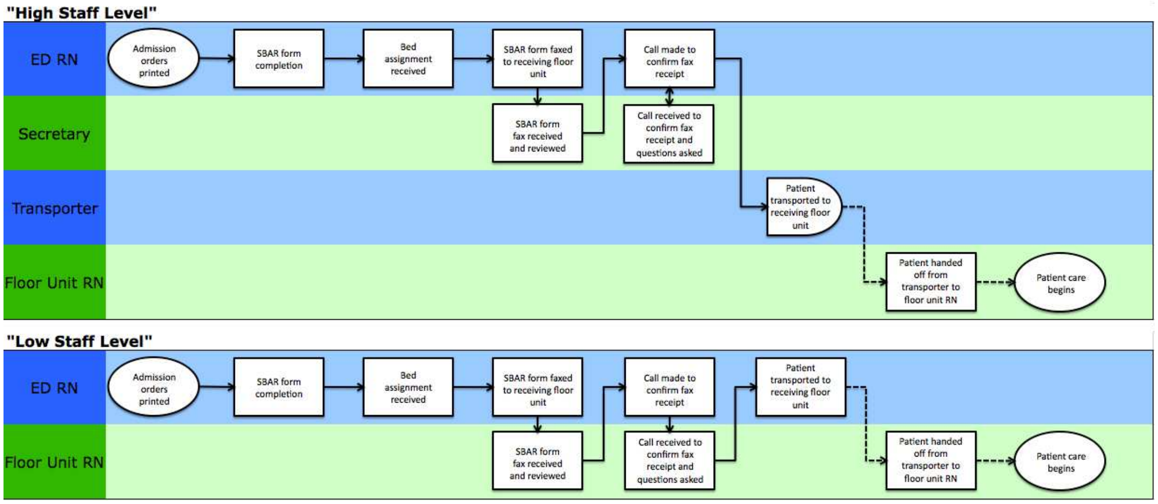

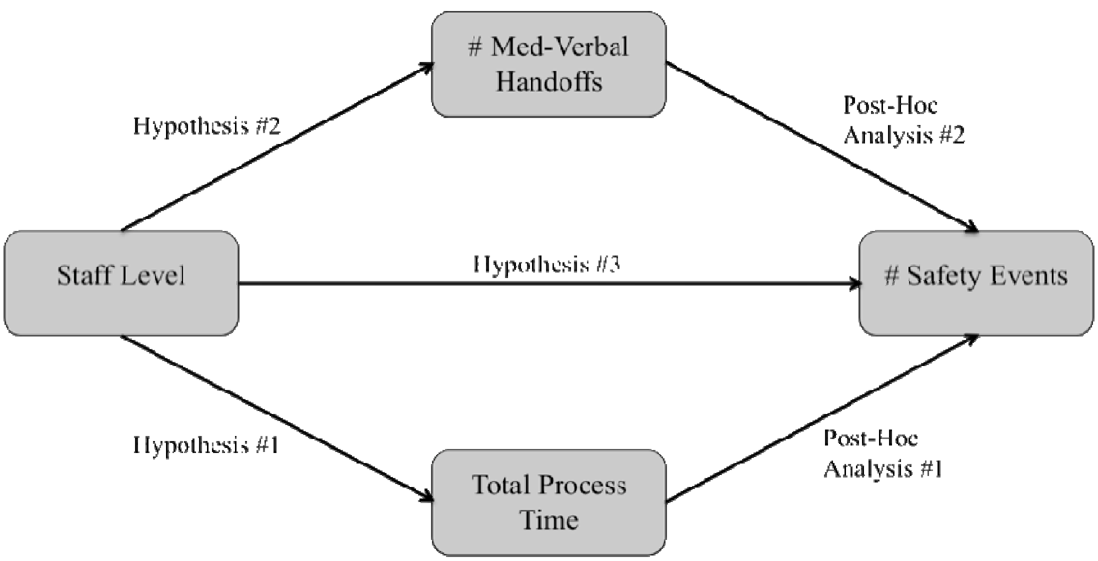

I. INTRODUCTION

The study to be completed will look at data collected during a process improvement project conducted to improve outcomes during patient handoff events between the Emergency Department (ED) and receiving floor units. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) describes a patient "handoff" as a "contemporaneous, interactive process of passing patient-specific information from one caregiver to another for the purpose of ensuring the continuity and safety of patient care" (JCAHO, 2008). Six floor units at a hospital in the southeastern US were chosen based on highest volume of admissions from the ED. Observational and survey data were collected from hospital personnel involved in handoffs during all hours and shifts during the week. The data collected were categorized as either generated from "High Staff Level" or "Low Staff Level" processes. "Low Staff Level" data were inclusive of the hours of 11pm until 6am the following morning and "High Staff Level" data were inclusive of the hours of 6am until 11pm. These categorizations are based on both medical and non-medical staffing levels during the defined hours for each. The number of non-medical hospital staff members involved in the handoff process is markedly lower during the "Low Staff Level" hours than during the "High Staff Level" hours, while the number of medical staff members involved in the handoff does not fluctuate between the two staffing levels.

This large difference in staffing levels raised the question addressed in this study of how staffing levels would influence the handoff process. Will fewer parties, specifically non-medical parties, involved in the handoff communication process result in a more successful handoff with a shorter total process time, fewer patient safety events, and higher nurse satisfaction? During the intricate handoff process, there are many opportunities for error, error that could potentially lead to patient safety events. Therefore, it is important to determine the type of errors that occur in this process, the nature of these errors, and why these errors are occurring. Only then may this process be enhanced to reduce these errors, thus improving patient safety in this area of care.

For the purpose of this study, the handoff process was observed from start to finish for a total of 40 teams. Of these observations, 20 were observed during the "High Staff Level" hours and 20 were observed during the "Low Staff Level" hours. The observer began in the ED monitoring the activities of the ED Registered Nurse (RN) as the process began with the patient receiving admit orders from their physicians. The observer recorded all time stamps relevant to the process and its efficiency. Additionally, the observer recorded the success or failure of any attempts to communicate between the ED and the unit that would be receiving the patient. As the patient was prepared to move and moved from one unit to another, any delays or setbacks as a result of missing information were recorded. Time stamps were recorded as the patient was transferred, because any delays in the process at this point could result in unmonitored changes or needs of the patient. Upon arrival on the unit, and after the receiving RN had performed initial patient care tasks, this marked the conclusion of the handoff process. The Inpatient RN was then interviewed to obtain subjective data on his or her satisfaction with the handoff. The causes of the RN's satisfaction or dissatisfaction in the process were also recorded. The observer then returned to the ED to complete the same interview process with the ED RN. The ED RN was interviewed last to allow for any additional communication or findings that may have occurred after the patient's departure to be taken into consideration by the ED RN.

THE CURRENT HANDOFF PROCESS

The patient handoff process begins in the ED. Initially, the ED RN is cued that a handoff is beginning when an admission order prints or appears in the electronic information system, whichever is seen first. The ED RN is then aware that it is time to begin preparing the patient's documents for transfer and completing the SBAR (Situation-Background-Assessment-Recommendations) form to be faxed to the receiving unit after a bed assignment has been made. This is exactly what patient information is included on this form. Based on the current process, the ED RN may complete the SBAR form before, during, or after the bed assignment is made based on personal preference. The SBAR form includes any pertinent information that the receiving unit will need to prepare for the patient's arrival and to immediately begin patient care upon the patient arriving. Once Bed Management has assigned a bed on an inpatient unit to the patient, this piece of information will appear in the ED's electronic information system as well. Once the bed assignment appears, the ED RN then knows to which unit he/she should fax the SBAR and physician orders. Once the fax is completed, the nurse allows 5 to 10 minutes for the fax to process and send. The ED RN then makes a call to the inpatient unit to confirm receipt of the fax and possibly have a conversation about the patient. The Inpatient RN, Inpatient Unit Charge Nurse, or the unit secretary may answer the phone on the receiving end. Once this occurs, either a transporter staff member or a healthcare provider will transport the patient to the floor from the ED, depending on the time of day and staffing level. Upon arrival on the inpatient unit and being transferred to the new bed, the healthcare providers in the accepting unit complete initial patient care. Once the initial patient care is completed, the handoff communication process has concluded. (See Figure 1.1).

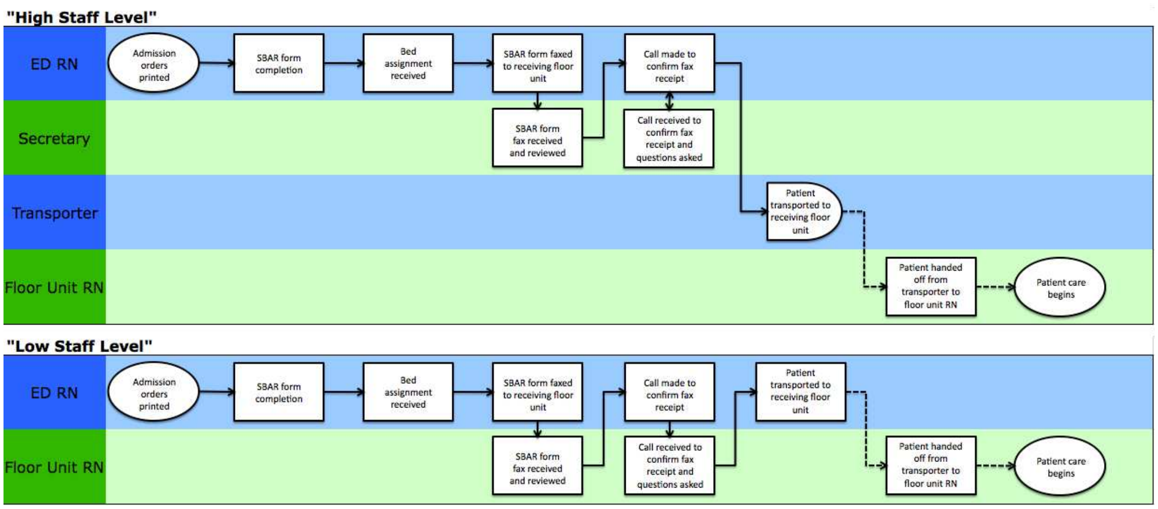

Figure 1.1 Basic timeline for the communication handoff from the ED to the floor unit.

II. LITERATURE REVIEW

THE PATIENT HANDOFF

Similar to the definition given by the Joint Commission, Runy (2008) defines a handoff as "anytime there is a transfer of responsibility for a patient from one caregiver to another" and also that "the goal of the handoff is to provide timely, accurate information about a patient's care plan, treatment, current condition, and any recent or anticipated changes" (Runy, 2008, p.41). This article addresses the different types of handoffs that occur in a hospital, and these include: nurse shift changes, physicians transferring responsibility for a patient, physicians transferring on-call responsibility, temporary relief of coverage, anesthesiologist report to post-anesthesia recovery room nurse, and nursing and physician handoff from the emergency department to an inpatient unit. While the Joint Commission does not dictate how each organization should approach the process of establishing a handoff system, they provide details as to what should be included in a standardized, successful approach. The article describes the U.S. Department of Defense Handoff Model, which is organized to help illustrate where communication gaps may occur. While not all of the elements of the model apply to all handoff cases, the model represents the elements required of a more complex patient handoff. The elements of the model are grouped into broad categories of what must be communicated about a patient: "background," "evaluate," "major considerations," and "urgency." With each element, there is a set of "questions to ask" to assist in identifying where these gaps may be occurring. The article also then identifies "10 Barriers to Effective Handoffs" and "10 Tips for Effective Handoffs." Some examples of the barriers include “lack of education at nursing and medical schools,” “resistance of change among staff,” and “lack of time for providers to devote to handoffs.” Some examples of tips for effective handoffs include “allow for face-to-face handoffs whenever possible,” “allow as much time as necessary for handoffs,” and “ensure two-way communication during the handoff process.”

TEAM COMPOSITION: SHARED MENTAL MODELS

A mental model is an organized knowledge structure in an individual’s long-term memory that serves as a method for allowing the individual to interact with his or her environment (Wilson & Rutherford, 1989). The way in which mental models do so is by allowing individuals to predict and explain the interactions with the world around them (Mathieu et al., 2000). This is accomplished by a person recognizing and remembering relationships between different components of the environment, thus allowing the individual to then construct expectations for a given situation (Rouse & Morris, 1986). Because teams must be able to adapt quickly and efficiently to task demands, it is suggested that they draw from shared or common mental models (Cannon-Bowers et al. 1993). Shared mental models allow team members to predict the information and resource requirements of their fellow teammates in order to complete the task (Mathieu et al, 2009). For a team to effectively use mental models as a method of teamwork interaction, team members must share the same mental models, which come as a result of sharing common knowledge and experiences. This is because the success of shared mental models in teamwork lies in the ability of team members to draw on their own knowledge as a basis for predicting the needs and actions of their teammates (Mathieu et al, 2009). Shared mental models are important to my research question and hypotheses when it comes to determining which staff members could perform a handoff most efficiently as a team.

A correlational study was conducted to examine the influence of teammates' shared mental models on team processes and performance (Mathieu, 2000). The participants were 112 undergraduate students who were assigned to 56 two-person teams. Each team flew a series of missions using a flight-combat computer simulation. Each experimental session took 2.5 to 3 hours to complete. Sessions included: 1) an overview of the task and an automated simulation of the missions they would be completing, 2) a hands-on training program, and 3) 6 missions lasting approximately 10 minutes each. Dependent, measured variables were: team performance, team process, and mental models assessed by teammates' individual ratings of relationships between various attributes.

Mental models, both of task and team, were assessed based on each participant's individual ratings of degree of relatedness among critical task concepts. A detailed task analysis identified eight attributes for the task mental model. These attributes were: 1) diving versus climbing, 2) banking or turning, 3) choosing airspeed, 4) selecting and shooting weapons, 5) reading and interpreting radar, 6) intercepting the enemy, 7) escaping the enemy, and 8) dispensing chaff and flares. A literature review identified seven attributes that would be used to determine team mental models. These attributes were: 1) amount of information, 2) quality of information, 3) coordination of actions, 4) roles, 5) liking, 6) team spirit, and 7) cooperation. Each participant was provided with two matrices, one for the task mental model and one for the team mental model. Definitions of each attribute, as listed above, were provided for their reference. Participants rated the degree of relatedness of the attributes within the task and team matrix on a 9-point scale, from -4 to 4 with -4 representing most negative relatedness and 4 representing most positive relatedness. Participants were provided with a matrix for each mental model (task and team). These matrices formed a grid with the same attributes listed down the top and side of each matrix. Using a matrix, participants rated the degree of relatedness (from highly positive to highly negative) between each attribute of a given mental model and all other attributes of that mental model. For example, during training participants were instructed that adjusting airspeed and modifying direction were key elements to position their plane behind an enemy plane to engage. Considering that engaging and shooting down an enemy plane exemplified high team performance, a participant would rate these highly to indicate positive relatedness.

Each type of mental model (task and team) was analyzed using UCINET, a network-analysis program. UCINET converted the relatedness ratings for each participant (e.g., a participant’s relatedness ratings for task terms) into a two-dimensional spatial network showing how each task term was closely or weakly related to other task terms.

In addition, comparing the networks of teammates allowed the degree of sharedness of mental models between teammates to be calculated. Given two teammates network of the same set of terms, UCINET provided the researchers with an index of convergence, or QAP correlation, between the two networks. The QAP correlations were zero-order correlations between the same elements on two participants’ mental model matrices. These resulted in correlation of -1 (complete counter-sharedness) to 1 (complete sharedness) between two participants' mental models.

Actual team performance was measured based on points assigned based on successfully completing various tasks during the mission. For each mission the teams had three objectives which were: 1) to survive (3 points), 2) to fly a route with four waypoints (2 points each) and 3) to shoot down enemy planes (1 point each).

Actual team process was measured by two expert observers watching videotapes of the missions and independently rating 21 items based on three dimensions: 1) strategy formation and coordination, 2) cooperation, and 3) communication. Each of the 21 items was rated on a 5-point scale. The scale ranged from 1 (not at all) to 5 (to a very great extent).

Across teams, the degree of sharedness of task and team mental models was positively correlated with the quality of team processes and of team performance. The direct effects of task and team mental-model-convergence indices, which measured sharedness of mental models, on team process were significant, $R^2 = .10$, $F(4, 108) = 3.30$, $p < .05$; β team = .26, $p < .01$; and β task = .31, $p < .01$. Additionally, the direct effect of team process on team performance was significant, $R^2 = .09$, $F(2, 110) = 18.70$, $p < .01$; β process = .49, $p < .01$. Additionally, team processes mediated the relationship between mental model convergence and team effectiveness. The results showed that shared mental models, both of task and team, related positively to actual team process and, indirectly, to performance when completing the missions.

A correlational study was conducted to investigate the effects of shared mental models on the relationship between episodic team behavioral processes and performance (Wang & Zhou, 2010). Shared mental models were examined as moderators of team process-performance relationships. Participants were 150 undergraduate students who were formed into 50 three-person teams. The task was a simulated construction project planning program. Each team had one member assigned to each of the following roles: project manager, procurement manager, and human resource manager. The goal of each team was to create an optimized construction plan and then to execute it. This task had to be completed within a time limit and while using the lowest cost. Measured variables were shared taskwork mental models (measured using individual ratings of relatedness between critical task concepts), shared teamwork mental models assessed by having participants rank potential strategies for completing a task in order of predicted success, team processes (measured by trained subject matter experts watching videos and rated individually twice), and team performance (measured in terms of sum of material cost, human resource cost, and potential extra costs – higher total costs reflected poorer team performance).

Analyses were performed on the process-performance relationship as well as on the moderation effect of sharedness of team mental models (SMMs). For the process-performance relationship, the results indicated that the effectiveness of the two types of team processes, action and transition, were positively and significantly related to team performance. As team process effectiveness (as rated by subject matter experts) increased, team performance also increased (with measured project cost decreasing). For the moderation effect of shared mental models, when a hierarchical linear regression was performed with team performance being predicted by team process effectiveness and the sharedness of mental models, it was found that the sharedness of teamwork mental models moderated the effects of team process (transition or action) effectiveness on performance. That is, there was a significant interaction effect between team process effectiveness and the sharedness of teamwork mental models. When sharedness of teamwork mental models were high, there was a substantial positive effect of the effectiveness of team processes on performance, β task = -.56, $p < .05$, however when sharedness of teamwork mental models were low, there was only a small effect of team process effectiveness on performance, $\beta = -.35$. The results indicated that the effectiveness of team process made positive contributions to team performance. Additionally, when a hierarchical linear regression was performed, it indicated that the sharedness of teamwork SMMs moderated the effects of team process on team performance. The positive impact of team process on team performance was higher for teams who had more similar teamwork SMMs and lower for those teams who has less similar teamwork SMMs.

FACE-TO-FACE HANDOFFS

A face-to-face handoff, with both the sending and receiving nurses present, provides not only a continuity of care, but it also eliminates the dangerous amount of time that patients are sometimes left unattended during a handoff (Aagesen, 2010). When a face-to-face handoff occurs at “bedside” when the nurses are passing the responsibility of care for the patient, there is the added benefit of the receiving nurse gaining a visual understanding of the patient's current condition concurrently with the sending nurse's report. Nurse satisfaction is also found to be higher when face-to-face handoffs occur. In a study conducted at a regional tertiary medical center, the process of the handoff between Labor and Delivery and Mothers/New Babies was observed implementing face-to-face handoffs with nurse satisfaction obtained (Olvera, 2010). Nurses indicated that they were more satisfied with handoffs when they occurred face-to-face because they knew that they had given a direct report to the appropriate nurse and that they would not find themselves answering questions or correcting errors post-transport.

A study by Craig (2012) examined three morning handoff methods (varying by communication method used). The three handoff communication methods studied were: written, electronic, and face-to-face. These three methods were implemented over a single academic year, each during one of three study phases. Participants in the study consisted of all interns within the internal medicine inpatient teaching service at the hospital. Methods of data collection included survey-based interviews of the interns, and descriptive and comparative analyses to examine differences between the study phases. It was found that a scheduled face-to-face handoff process resulted in the fewest protocol deviations, and the fewest errors.

PATIENT HANDOFF ERRORS

When errors occur during a patient handoff, patient harm can occur. However, these results are generally preventable with the implementation of methods to reduce error in the handoff process. A life-threatening delay in diagnosis or treatment can occur as a result of a failure to pass on important information accurately and in a timely manner. In addition, if the admission process is slow or experiences delays, the patient's status might change, or there might be an overlap in or a void in medication. With respect to the organization itself, handoff errors can lead to "higher healthcare costs, public dissatisfaction, longer hospital stays, and a higher rate of return visits" (Dorsey, 2010, p. 93). Dorsey also reported that 29% of physicians interviewed in a study admitted that at least one of their patients had experienced an adverse medical event as a result of inadequate communication during the handoff process.

The Agency for Healthcare Research and Quality (2008) conducted a hospital safety survey in 2008 with a response rate of 160,176 hospital staff members. Of these respondents, 41 percent responded that things "fall between the cracks" during patient handoffs from one unit to another. Additionally, 42 percent indicated that problems that occur are often in the exchange of information between different units within the hospital.

In another study (Maughan, 2009), patient handoff characteristics in a large teaching hospital were observed. The eight-week study documented 992 patients and 110 handoff sessions. The investigators observed the characteristics of handoffs (e.g., duration, location, and type of interruptions). They also studied topics occurring in handoffs such as (e.g., disposition, diagnosis, and examinations). In this study, handoff errors were considered "clinically significant examination or laboratory findings in physician documentation that were reported significantly differently during or omitted from verbal handoff" (Maughan, 2009, p.502). Of the 992 patients observed, handoff errors occurred in 130 cases, and omissions of information occurred in 447 cases. With longer handoff times per patient, there was an increase in examination errors. There were also fewer omissions of information when written or electronic support materials were used. The authors concluded that the errors and omissions that occur in the handoff process were a result of handoff time (more with increased time), ED length of stay (more with longer stay), and the use of support materials (less with more use).

COMMUNICATION IN HANDOFFS

Successful communication is a key element to any type of medical handoff. With a more direct handoff, there is less room for medical errors to occur as a result of loss or misinterpretation of information. For this reason, the safest handoff is one in which information is relayed in the form of a face-to-face handoff. The Joint Commission published a set of National Patient Safety Goals which require hospitals to implement a standardized method for handoff communication, and that within this handoff communication there must be an opportunity present for individuals on both the sending and receiving ends to ask and respond to questions (JCAHO, 2006). While this goal may be met with a phone conversation, there are many added benefits of a face-to-face conversation that will be lost over the phone. According to Richard M. Frankel, a medical sociologist, “body language and other crucial factors are lost when the handoff is done over the phone and a written handoff may be difficult to read” (Solet, 2005, p 1094). A face-to-face conversation allows for the relay of conversation-enriched with emotions expressed through facial expressions and body language.

A method that many hospitals are beginning to use to promote better communication during the handoff process is called the SBAR technique. Many hospitals have adopted this technique in response to a lack of consistent messages throughout the handoff process at their organization (Ardoin, 2011). The Situation-Background-Assessment-Recommendation approach represents the steps, in order, that must be taken in the process of an effective communication between two staff members. This technique provides a framework for methods of communicating between team members in a medical setting, promoting an accurate relay of information regarding the patient's condition at all times. Ardoin (2011) notes that studies have found that both nurses and physicians that have adopted the SBAR technique have indicated that they are satisfied with this new approach to handoff communication.

III. HYPOTHESES

Hypothesis #1:

I anticipate that with fewer parties involved in the handoff process (specifically, the elimination of non-medical intermediaries), there will be a decrease in the total time taken to complete the handoff process. The event times for both the time that the SBAR form is begun by the ED RN and the time that the handoff concludes on the inpatient unit (when patient care begins) will be recorded. This time interval is the time taken to complete the entire handoff process (see Figure 1.1).

A team should consist of only the minimum number of team members necessary for the given task (Mickan & Rodger, 2005). Furthermore, the Shared Mental Model Theory suggests that these team members should be those who share individual mental models (Mathieu et al, 2000). Team members must have equal knowledge and experience in different aspects of the task to be performed for shared mental models to work effectively to their advantage. Shared mental models are important drivers of team effectiveness for efficient and effective task completion (Cannon-Bowers et al, 1993). In the case of the patient handoff, efficient and effective task completion translates to a reduction in total process time. Therefore, the Shared Mental Model Theory would suggest that a handoff team should consist of only ED RNs and Inpatient RNs, as they have similar mental models. The mental models of a non-medical secretary or transporter and the mental models of RNs are dissimilar due to different knowledge and experience, so involving these parties may result in a longer total process time.

Hypothesis #2:

I anticipate that with fewer parties involved in the handoff process (specifically, the elimination of non-medical intermediaries), more medical-verbal and face-to-face handoffs will occur. In this study, medical-verbal handoff were defined as anytime a medically trained professional who has cared for the patient in the ED spoke directly to another medically trained professional who was receiving the patient into his or her care. This may have occurred as a phone conversation or as a face-to-face physical conversation. Within the category of medical-verbal handoffs, a more specific type of handoff observed was face-to-face handoffs. These occurred when two medically trained staff members had a verbal conversation face-to-face in which they handed off information. Does the ED nurse speak to a non-medical secretary or the receiving nurse when he or she makes the call to the unit? This will be determined by documenting whether the nurse from the ED comes into contact and has a conversation about the patient with the receiving RN on the floor unit when transporting the patient.

During the "High Staff Level" hours, non-medical transporters provide a means of transportation from the ED to the inpatient unit, decreasing the likelihood of healthcare providers from the sending and receiving units coming in contact. Due to this current process, it is unknown how often circumstances allow for a face-to-face handoff to occur during the day. Also, during the current process, a non-medical worker, the floor unit secretary, may receive the phone call from the ED, further decreasing the likelihood of a medical-verbal handoff. When the ED RN provides transportation of the patient to the floor unit during the "Low Staff Level" hours, they create an increased opportunity for a face-to-face, med-verbal handoff to occur. It is currently unknown how often this increased opportunity for a face-to-face medical, verbal handoff actually results in the occurrence of one.

Hypothesis #3:

I anticipate that with fewer parties involved in the handoff process (specifically, the elimination of non-medical intermediaries), ED and Inpatient RNs will be more satisfied with the success of the handoff communication. Satisfaction will be determined by looking at the answers to the interview questions at the end of the handoff data collection.

In a study conducted at a regional tertiary medical center, the process of the handoff between L&D and MNB was observed implementing face-to-face handoffs with nurse satisfaction obtained. Nurses indicated that they were more satisfied with handoffs when they occurred face-to-face because they knew that they had given a direct report to the appropriate nurse and that they would not find themselves answering questions or correcting errors post-transport (Olvera, 2010).

The Shared Mental Model Theory claims that in order for team members to complete a task well, team members need to predict the actions and anticipate the needs of other team members based on their own mental models, which are shared with team members (Rouse & Morris, 1986). Mathieu (2000) presented empirical evidence to support this claim. Because ED RNs and Floor Unit RNs are much more likely than RNs and non-medical intermediaries to share mental models of the medical situation, the exchange of information between RNs should benefit from their shared mental models.

Non-medical secretaries and transporters do not share mental models with RNs, so therefore they cannot effectively anticipate the information and resource requirements to complete the task by using shared mental models. In the exchange of information during a task, mental models allow team members to anticipate the information needed by other team members in order to effectively complete the task (Mathieu et al, 2009). According to the Shared Mental Model Theory, RNs may be more satisfied during the "Low Staff Level" when they have the opportunity complete the task with another RN, who shares mental models and can more accurately anticipate the actions and needs of the RN, than a non-medical staff member who does not share mental models could.

Hypothesis #4:

I anticipate that with fewer parties involved in the handoff process (specifically, the elimination of non-medical intermediaries), there will be greater task effectiveness, that is, a decreased number of patient safety events. A patient safety event is defined as any deviation from the ideal or acceptable methods of the process. These events may or may not ever reach the patient. They may be categorized from least to most seriousness as: a Near Miss Safety Event (NME), a Precursor Safety Event (PSE), or a Serious Safety Event (SSE) (The World Health Organization, 2009).

A team should be comprised of only the minimum number of team members required to fulfill the appropriate mix of expertise for the given task (Mickan & Rodger, 2005). The shared mental model theory suggests that team members should be those who share individual mental models (Mathieu et al, 2000). The Shared Mental Model Theory suggests that a team of individuals complete a task by using individual mental models that are shared as a result of common knowledge and experiences. Shared mental models are important drivers of team effectiveness for successful task completion (Cannon-Bowers et al, 1993). Therefore, team members must have equal knowledge and experience in different aspects of the task to be performed for shared mental models to work effectively to their advantage. In the case of the patient handoff, for shared mental models to be used maximally to benefit the handoff task, team members completing the handoff should have equal knowledge and experience. This occurs when the handoff team consists of only ED RNs and Inpatient RNs, as they have similar mental models. The mental models of a non-medical secretary or transporter and the mental models of RNs are dissimilar due to different knowledge and experience. Therefore the mix of medical and non-medical staff members in the process is a hindrance to the implementation of shared mental models for team effectiveness.

IV. METHOD

PARTICIPANTS

A total of 40 teams, each consisting of one ED RN (all hours), one Inpatient RN (all hours), one non-medical floor unit secretary (“High Staff Level” hours only) and one non-medical transporter (“High Staff Level” hours only) were observed completing the current handoff communication process at a hospital in the southeastern US. A particular ED or Inpatient RN were a part of more than one of these 40 teams in some cases, but never did the same team combination of a particular ED RN and Inpatient RN repeat. These RNs were inclusive of both genders and a variety of ages as these factors were not relevant to the outcome of the study.

Of the 40 teams observed, 20 completed handoffs during the “High Staff Level” hours of 6 am to 11 pm and 20 completed handoffs during the “Low Staff Level” hours of 11 pm to 6 am. The hours determined for “High Staff Level” and “Low Staff Level” are based on the shifts worked by non-medical staff members (secretaries and transporters), as their presence in the process serves as a predictor variable. The nurses observed within the “High Staff Level” and the “Low Staff Level” hours were not necessarily always working the same shifts, as RN shifts and non-medical staff shifts are not inclusive of the same hours. As a result, “High Staff Level” observations included two different shifts of RNs and “Low Staff Level” observations also included two different RN shifts. Nurses were aware that they were being observed, but for participant privacy and for the purposes of this study, no patient names, RN names, or specific receiving units were recorded. Tracking data was labeled according to team rather than individual participants or patients; i.e., each handoff was recorded as "HIGH1" through "HIGH20" and "LOW1" through "LOW20".

To see whether RN experience might explain differences between "High Staff Level" and "Low Staff Level" hours, the average experience (i.e., years working in the field since earning a nursing degree) was obtained for nurses of the observed units. Average experience of a "High Staff Level" ED RN was 10.8 years (SD = 6.0), while the average years of experience for a "Low Staff Level" ED RN was 10.5 years (SD = 5.9). The average years of experience of a "High Staff Level" Inpatient RN was 16.1 years (SD = 8.9), while the average years of experience for a "Low Staff Level" Inpatient RN was 15.6 years (SD = 8.5). While the average years of experience varied slightly between ED RNs and Inpatient RNs, within the ED-RN and Inpatient-RN groups, the average years of experience was very similar for "High Staff Level" and "Low Staff Level" team members. This means that amount of experience is not confounded with the main explanatory variable of staffing level.

DESIGN

This was a correlational study that characterized the differences in the handoff communication process during the "High Staff Level" versus the "Low Staff Level" defined hours. There were no manipulations in this study. The observations took place in the field, observing a frequent process in the hospital setting.

MATERIALS AND TASKS

A data collection form was designed to collect all relevant data points throughout the communication handoff process (see Appendix). While no patient-specific or employee-specific information was captured, the number and types of staff members involved in each process was recorded. This allowed the number of parties and the role of each given party to be determined for each process observed. The form captured multiple timestamps during the process, allowing total process time to be calculated, as well as times of particular events within the process. The form included areas for any occurrences of patient safety events to be recorded, and the form also documented whether or not a medical-verbal handoff occurred in the process. Lastly, the form included free-response areas for interviews with the ED RN and Unit RN of each team after the process was completed. The purpose of this interview was to determine the satisfaction of each RN involved in the process and also to record any additional responses.

PROCEDURE

The observer began each process observation and data collection in the ED, positioned behind the nurses' station to monitor the electronic information system that would alert of a patient receiving an admission order. Once an admission order was confirmed, the observer began to watch the designated RN perform any necessary steps to prepare the patient and their medical documents for transfer. At the time that a specific bed assignment on a designated unit appeared in the electronic information system, the observer began to watch the current process of the communication handoff between the

ED and the unit, all while recording relevant data points on the collection form. Upon arrival of the transporter who would transfer the patient from the ED to the unit, the observer continued to record many time-specific data points while following the patient up to the floor unit. Once the patient was transferred to his or her assigned bed on the floor unit and initial patient care was complete, a short interview was held with the Inpatient RN. This RN was asked a number of questions about their satisfaction of the communication handoff, whether they were provided with all information needed to prepare for and begin patient care, and if any problems were encountered during the handoff. Following this interview, the observer returned to the ER and conducted a similar interview with the ER RN who had been caring for the patient before his or her admission.

The volume of ED admissions during the “High Staff Level” versus the “Low Staff Level” hours is not indicative of a higher volume during the “High Staff Level” hours. According to a national survey of ED’s in 2007, there were 116.8 million ED visits over the course of the year (Niska et al, 2010). Of these visits, 34.1% arrived in the ED during business hours (8 a.m. to 5 p.m.) and 64.7% arrived after business hours. Business hours account for 37.5% of the day, and non-business hours account for the other 62.5% of the day. With respect to the current study, this reduces the plausibility of the hypothesis that lower ED volume is an explanation for shorter process time, higher nurse satisfaction, fewer errors, or increased medical-verbal handoffs during the Low Staff Level that occurs during non-business hours.

V. RESULTS

Binary data collected, such as yes/no of whether or not a direct med-verbal handoff occurred and whether or not the nurse was satisfied with the handoff were coded as 1 or 0. A 1 represented a "yes' and a 0 represented a "no."

Patient safety events were categorized based on "The Conceptual Framework for the International Classification for Patient Safety" that has been established by the World Heath Organization (WHO) (The World Health Organization, 2009). This classification system categorized patient safety events into one of three different categories: Near-Miss, Precursor, or Serious Safety Event. In a Near-Miss Safety Event, the error is caught by a detection barrier or by chance and never reaches the patient. In a Precursor Safety Event, the error reaches the patient but results in minimal or no detectible harm. A Serious Safety Event reaches the patient and results in moderate to severe harm or death. To establish inter-rater reliability for the classification of these events, in addition to myself, the events were also classified based on the established scale by a medically trained professional. Cohen's kappa was used to measure the agreement and to determine the inter-rater reliability between myself and the other coder. If an event was not initially coded in agreement, then the two coders had a discussion to come to a conclusion as to how the event should be coded. If an agreement could be made, then a third coder, another medically trained professional, served as a tie-breaker for how the event should be coded.

Because this study was performed in the field with a low number of participants, I used a p-value of .10 to determine statistical significance.

The first hypothesis stated that with fewer parties involved in the handoff, a shorter total process time would be observed. The "High Staff Level" group had a mean total process time of 123.0 min (*SD*=98.8) with a skewness value of 2.2; and the "Low Staff Level" group had a mean process time of 60.2 min (*SD*=48.2) with a skewness value of 2.4. These means were significantly different, $t(38) = 2.56$, $p = .05$.

There were two outliers (more than 3 *SDs* from mean) in the total-process-time data, one in each of the "High Staff Level" and the "Low Staff Level" groups. After removing these outliers from the dataset, the "High Staff Level" had a mean of 105.7 min (*SD* = 63.7) and a skewness value of 1.1, and the "Low Staff Level" had a mean of 51.7 min (*SD* = 30.9) and a skewness value of 1.9. Thus, dropping the outliers reduced the skewness of the process-time data to acceptable levels. The means were still significantly different $t(36) = 3.33$, $p = .01$. Regardless of whether the outliers were included or dropped, these analyses supported the hypothesis that process times would be longer during high staff levels.

The second hypothesis stated that fewer parties involved in the handoff process would be associated with more medical-verbal (phone or face-to-face) and face-to-face handoffs. During the 20 observed "High Staff Level" cases, there 2 cases in which a face-to-face handoff occurred; whereas, of the 20 observed "Low Staff Level" cases, there were 17 cases in which a face-to-face handoff occurred. A Pearson Chi-Squared test showed that the association between staff level and occurrence of a face-to-face handoff was statistically significant, $X^2(1, N=40) = 22.56$, $p < .001$.

During the 20 observed "High Staff Level" cases, there 3 cases in which a medical-verbal handoff occurred. However, of the 20 observed "Low Staff Level" cases, a medical-verbal handoff occurred in all 20 cases. The association between staff level and occurrence of a medical-verbal handoff was statistically significant, $X^2(1, N=40) = 29.57$, $p < .001$. These two findings supported the second hypothesis that fewer parties involved in the handoff would be associated with more medical-verbal and face-to-face handoffs.

The third hypothesis stated that both ED and Inpatient RN satisfaction would be higher with fewer parties involved in the handoff. These relationships were examined using a Chi-Square contingency table test. Of the 20 observed cases during the "High Staff Level," the ED RN reported being satisfied with the handoff in 14 of the cases. The 20 observed cases during the "Low Staff Level" resulted in ED RN satisfaction in 17 of the cases. The association between staff level and ED RN satisfaction was not significant, $X^2(1, N=40) = 1.29$, $p = .26$.

Of the 20 observed cases during the "High Staff Level," the Inpatient RN reported being satisfied with the handoff in 12 of the cases. The 20 observed cases during the "Low Staff Level" resulted in Inpatient RN satisfaction in 16 of the cases. The association between staff level and Inpatient RN satisfaction was not significant, $X^2(1, N=40) = 1.91$, $p = .17$. Thus, the third hypothesis, stating that ED and Inpatient RN satisfaction would be higher with fewer parties involved in the handoff process, was not supported.

The fourth hypothesis stated that with fewer parties involved in the handoff, fewer patient safety events would be observed. To establish inter-rater reliability for the coding of the patient safety events, both a registered nurse and myself classified the events independently based on the established scale. Of the 15 patient safety events, registered nurse and I categorized 13 (86.67%) in agreement initially. For the two we coded differently, we were able to come to an agreement after a short discussion. Each event was determined as coded in agreement if both the registered nurse and myself coded an event to be the same level of safety event classification. Cohen's kappa was used to measure the agreement and determine the inter-rater reliability between myself and the other coder. This was based on the 13 events initially coded in agreement and the two events initially coded differently. The Kappa value for our inter-rater reliability was 0.733. The strength of agreement was considered to be good.

Of the 40 cases observed, 13 experienced one or more patient safety events, for a total of 15 observed patient safety events. There were 27 cases that experienced no safety events, 11 cases that experienced one safety event, and 2 cases that experienced 2 safety events. There were 12 patient safety events observed during the "High Staff Level" and 3 observed events during the "Low Staff Level." As Table 1 shows, there were no serious patient safety events, but near miss and precursor events were more frequent with high than with low staffing. The number of total patient safety events was significantly greater during high staffing than during low, $X^2(1, N=40) = 9.23$, $p = .002$. Therefore, the fourth hypothesis, stating that with fewer patient safety events would be observed with fewer parties involved in the handoff, was supported.

Table 1.1 Summary Results Data Table.

Staff Level	Total Process Time (min)	% Med-Verbal Handoff	% Face-to-Face Handoff	% Nurse Satisfaction Occurred (ED; Inpatient)	# Near Miss Events	# Precursor Events	# Serious Events	# Total Safety Events
High	105.7 (SD=63.7)	15	10	70; 60	7	5	0	12
Low	51.7 (SD=30.9)	100	85	85; 80	1	2	0	3

Two relationships which prompted further analyses were that of: 1) total process time and number of patient safety events and 2) number of medical-verbal handoffs and number of patient safety events. Examining these two relationships was valuable to understand the causal relationships of the hypotheses in more depth. Because there was a relationship between staff level and occurrence of safety events, determining if this relationship was mediated by the occurrence of medical-verbal handoffs and total process time was critical in determining specific suggestions and applications for process improvements. Although this was a correlational study, staffing level can be considered as the ultimate causal variable and patient-safety events as the outcome variable. Furthermore, number of medical-verbal handoffs and total process time can be considered as process variables potentially mediating the effect of staffing levels on safety events. Figure 2 diagrams these relationships. Given the low number of participants, I am using mediation in a conceptual rather than statistical sense.

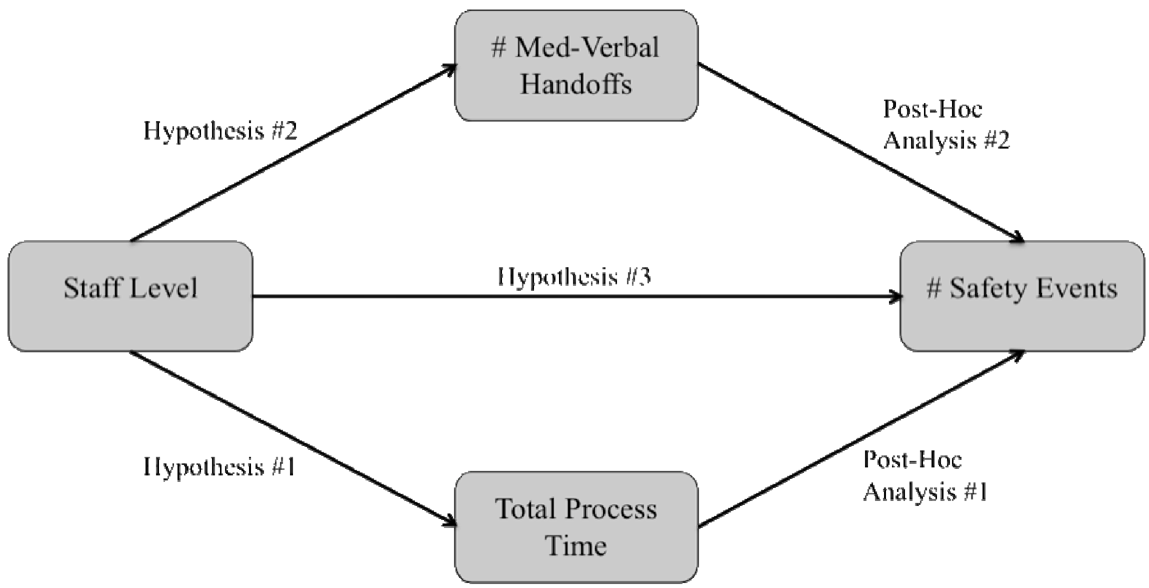

Figure 1.2 Variable Relationships.

Examining these relationships, I expected to see an increase in medical-verbal handoffs associated with a decrease in the number of patient safety events. I also expected to see a decrease in the number of patient safety events as total process time decreased. Figure 2 below shows the initial 3 hypothesized relationships that were supported, as well as the two post-hoc analyses to be examined.

For the relationship between the total process time and the number of observed safety events, a logistic regression analysis was conducted with as the predictor and occurrence of patient safety events as the criterion. In processes in which a safety event occurred, the mean total process time was 66.9 min (*SD* = 39.6). In processes in which a safety event did not occur, the mean total process time was 142.8 min (*SD* = 121.7). This relationship was found to be significant and show a moderate effect size, $R^2 = .18$, $X^2(1, N=40) = 8.06$, $p = .005$. For this analysis, it seemed appropriate to include the two outliers (which were extremely high process times) because long process times are potentially informative data points rather that statistical noise. However, with the total process time outliers removed, the relationship was weaker but still significant, $R^2 = .10$, $X^2(1, N{=}38) = 4.01$, $p = .045$.

I also examined whether medical-verbal handoffs, encompassing face-to-face handoffs, helped reduce the number of patient safety events by looking at the association between these two variables. Of the 23 medical-verbal handoffs, 5 of these handoffs (22%) involved patient safety events. Of the 17 handoffs where medical-verbal handoffs did not occur, 8 of these handoffs (47%) involved patient safety events. This association was significant given the alpha level adopted for this study, $X^2(1, N{=}40) = 3.01$, $p = .08$. Thus, the occurrence of medical-verbal handoffs was associated with fewer patient safety events, which supported this post-hoc hypothesis.

VI. GENERAL DISCUSSION

This study examined the effects of the variation in staffing levels on the processes and the effectiveness of the communication handoff process. During the "High Staff Level" there were medically trained staff and additional non-medical staff members working together to complete the patient handoff process, while during the "Low Staff Level," patient handoff process teams were comprised of only medical staff members.

I hypothesized that decreases in staffing level would be associated with particular changes in handoff processes (total process time and number of medical-verbal handoffs) and with handoff outcomes, number of patient safety events. These relationships are shown in Figure 2. These three hypotheses were supported and found to be statistically significant. In particular, a decrease in staff level was associated with a decrease in total process time, an increase in medical-verbal handoffs, and a decrease in the number of patient safety events. These relationships were in the expected direction and considered statistically significant at a cutoff of $p < .10$ due to the low N of the field study.

The main causal variable, staff level, can be seen influencing the main outcome variable, number of patient safety events, by the mediation of the two variables that characterized the handoff process: the occurrence of medical-verbal handoffs and the total process time. With a decrease in staff level, there were more medical-verbal handoffs, and this may have resulted in fewer patient safety events to occur. Evidence for this second causal link comes from post-hoc analysis #2, which examined whether the occurrence of medical-verbal handoffs mediated the relationship between staff level and the number of patient safety events, and which determined the relationship to be significant. Similarly, with a decrease in staff level, there was a decrease in total process time, which may have resulted in fewer patient safety events. Evidence for this second causal link comes from post-hoc analysis #1, which examined whether the total process time mediated the relationship between staff level and the number of patient safety events to occur, and which determined the relationship to be significant. This mediation interpretation suggests tentatively that low staffing levels are associated with fewer safety events because of the greater quality (more medical-verbal communication) and greater speed of handoffs with low vs. high staffing. It should be emphasized that there were not enough participants to test the mediation interpretation statistically, so this interpretation is only a hypothesis, but one that may merit further investigation.

The one hypothesis that could not be supported involved the relationship between staff level and RN satisfaction. It was found that reducing the number of parties involved in the handoff process did not significantly increase RN satisfaction. As seen in Table 1, the percentage of nurses satisfied with the handoff process was 70% for ED RNs and 60% for Floor Unit RNs during the "High Staff Level." During the "Low Staff Level," the percentage of nurses satisfied with the handoff process was 85% for ED RNs and 80% for Floor Unit RNs. The relationship was not strong enough to yield significance, despite the numbers being in the expected direction based on my hypothesis. I suspect that this is due to a limitation in the low N of the study and that a larger sample might have yielded a significant relationship.

The findings of this study suggest that the variation in staffing levels does influence the processes and the effectiveness of the handoff communication process.

These findings support the theory of shared mental models given that the hypotheses whose relationships may have been influenced by shared mental models were supported. The results are consistent with the idea that reducing the handoff team to only medically trained personnel, who probably shared mental models, resulted in a decrease in safety events. Shared mental models allow team members to predict the information needed and resource requirements of their fellow teammates in order to complete the task more efficiently and effectively (Mathieu et al, 2009).

The theory that successful communication leads to a reduction in safety events was also supported by these results. With a more direct handoff in which two medical parties communicate, there is less room for medical errors to occur as a result of loss or misinterpretation of information. The results showed that with an increase in medical-verbal handoffs, there was a decrease in patient safety events, which supports this theory.

The primary limitation to this study was a low number of participants, as a result of having been performed in the field during normal hospital operations. While there were limitations associated with the nature of a field study, this would not be a good fit for an experimental, clinical study. In future research on this topic, I would like to follow up on the finding that the outcome of the handoff was improved by allowing handoff information to be communicated directly between medical professionals. I assumed that this benefit had to do with the shared mental models of the medical professionals, but this was only a hypothesis. Thus, I would implement a method of measuring the mental models of team members (both medical and non-medical) to determine if shared mental models do, in fact, benefit the handoff process.

The results of this study suggest that the patient handoff communication process may be improved in a number of ways through the reduction in parties involved in the handoff, specifically the elimination of non-medical staff from the process, a reduction in the total process time, and the implementation of medical-verbal handoffs. First, to decrease total process time, it is suggested that the number of parties involved in the handoff process be kept to a minimum with only medically trained parties involved, when possible. This will eliminate delays in the process that were due to a patient and their information being handled and delayed by too many parties. I would suggest to the organization that staffing be reconsidered and that non-medical transporters be eliminated from the process during the "High Staff Level" hours, allowing ED RNs to perform the transport task as they do regularly during the "Low Staff Level" hours. Secretaries must remain staffed during the day as they serve purposes outside of the handoff. To address their hindrance in the handoff process, I would suggest that policy be implemented stating that if a secretary receives a phone call for a handoff, he or she must have the floor unit nurse take the call rather than doing so himself or herself.

It was also found that with fewer parties involved in the process, specifically with the elimination of non-medical parties, fewer patient safety events occurred. This may be a result of shorter process time associated with fewer parties involved and also the shared mental models of handoff teams consisting of only medically trained professionals that results in fewer errors.

Fewer patient safety events occurred with medical-verbal handoffs. Implementing medical-verbal handoffs in every process would ensure that patient handoff information and current patient status information was always exchanged between the two pertinent staff members in each process. This could be accomplished by implementing the staffing and policy changes mentioned above, as well as implementing an additional policy and procedural requirement stating that a medical verbal handoff must occur in every handoff case. To go even further, a face-to-face handoff could be required as this type of handoff is best practice.

Based on these findings, it is suggested that medical-verbal handoffs be implemented in every handoff process, total process time be reduced as much as possible, and staff level be kept at a minimum of only those required to complete the task and those medically trained, in an effort to ultimately reduce patient safety events.

Appendix A

Data Collection Form

Timing	Information to Obtain	Detailed Instructions	V4 Order	Response	Comments
Start of Data Collection in ER	Time sync to GHS atomic clock	Sync up watch or other device to GHS atomic clock and circle complete when done; needs to be within 5 seconds	1	Circle Complete When Time Sync Done	
	Observation date	Record on form	2	Observation Date	
	Observer name	Record on form	3	Observer Name	
	ER HUC name	Obtain from ER HUC; enter as First Name and Last Initial	4	ER HUC Name (First Name, Last Initial)	
	ER RNs assigned to IMC rooms	Look at dry erase board closest to rooms 5-7 and record which RNs are assigned to which IMC rooms at start of data collection	5	Area 1: Rooms 1-5, 21, 22 / Area 2: Rooms 6-10, 23, 24 / Area 3: Rooms 11-15, 25, 26 / Area 4: Rooms 16-20, 27, 28, 29	
	Patient name	Observer obtains from IBEX and records on form	6	Patient First Name / Patient Last Name	
	Patient location in ER IMC area	Observer obtains from IBEX and records on form	7	Patient's ER Location	
	Patient account number	Observer clicks on patient name on IBEX screen and records on form	8	Patient Account Number	
	ER RN initials in IBEX	Obtain ER RN initials from screen in IBEX	9	ER RN Initials from IBEX Screen	
	ER RN name	Obtain from #4 above and verify with the RN; enter as First Name and Last Initial	10	ER RN Name (First Name, Last Initial)	
	ER RN start of shift	Enter time that this patient's ER RN shift ends; enter as military time	11	ER RN Start of Shift (hh:mm) in military time	
	ER RN end of shift	Enter time that this patient's ER RN shift ends; enter as military time	12	ER RN End of Shift (hh:mm) in military time	
	ER RN ratio at start of data collection	Look at IBEX screen and count the number of rooms occupied and assigned to the ER RN who is assigned to the observed patient	13	From IBEX: number of patients ER RN has	
	ER RN ratio at start of data collection	Interview RN	14	Ask RN: number of patients he/she has now	
	Inpatient room number	Observer obtains from IBEX disposition field when it becomes available and records on form	15	Inpatient Room Number	
ER RN Observations in ER	When does the ER RN initiate the SBAR?	Record the time; circle if directly observed or estimated by staff through interview	16	Record SBAR start time / Circle if observed or staff estimated	
	Did the ER RN type SBAR in computer and then print or print/manually record information?	Circle option on form	17	Type then print / Print/manually record	
	When does the ER RN complete the SBAR except for the room number?	Record the time; circle if directly observed or estimated by staff through interview	18	Record SBAR complete time / Circle if observed or staff estimated	
	When does the ER RN fax the SBAR?	Record time on form when ER RN touches start button	19	Record Fax Start Time	
	Obtain a copy of the fax confirmation sheet	Circle complete on form	20	**Circle Complete When Fax Confirmation Copied**	
	Fax confirmation sheet date/time stamp	Record time from confirmation sheet onto form	21	Record Fax Confirmation Time Stamp	
	Did the fax go OK the first time?	Circle yes/no on form	22	Yes / No	
	Did ER RN fax to the correct number?	Compare confirmation sheet to reference sheet above fax machine	23	Yes / No	

Figure A-1: Form used to collect data throughout process.

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