The Relationship between Team Briefings and Non-Routine Events:

Developing a Model of Team Briefings in the Operating Room

by

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ABSTRACT

Preoperative team briefings have been suggested to be important for improving team performance in the operating room. Many high risk environments have accepted team briefings; however healthcare has been slower to follow. While applying briefings in the operating room has shown positive benefits including improved communication and perceptions of teamwork, most research has only focused on feasibility of implementation and not on understanding how the quality of briefings can impact subsequent surgical procedures. Thus, there are no formal protocols or methodologies that have been developed.

The goal of this study was to relate specific characteristics of team briefings back to objective measures of team performance. The study employed cognitive interviews, prospective observations, and principle component regression to characterize and model the relationship between team briefing characteristics and non-routine events (NREs) in gynecological surgery. Interviews were conducted with 13 team members representing each role on the surgical team and data were collected for 24 pre-operative team briefings and 45 subsequent surgical cases. The findings revealed that variations within the team briefing are associated with differences in team-related outcomes, namely NREs, during the subsequent surgical procedures. Synthesis of the data highlighted three important trends which include the need to promote team communication during the briefing, the importance of attendance by all surgical team members, and the value of holding a briefing prior to each surgical procedure. These findings have implications for development of formal briefing protocols.

Pre-operative team briefings are beneficial for team performance in the operating room. Future research will be needed to continue understanding this relationship between how briefings are conducted and team performance to establish more consistent approaches and as well as for the continuing assessment of team briefings and other similar team-related events in the operating room.

DEDICATION

I dedicate this dissertation to my Mom, Dad, Leslie, and Traci who have supported me through every endeavor over the course of my life and to Devin, who supported me each and every step of the way in completing this program. Thank you and I love you all.

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INTRODUCTION AND LITERATURE REVIEW

Overview and Research Objective

In many high risk environments, for example aviation, team briefings have shown benefits to individuals and teams by facilitating effective communication (Einav, Gopher, & Donchin, 2010; Whyte, Lingard, Espin, & Baker et al., 2008). However, compared to other domains, research on the study of briefings and their effect on surgical teams in the operating room (OR) is lacking. Whereas, there has been consistent work showing that implementing briefings positively affects team communication in the OR (Henrickson, Wadhera, ElBardissi, Wiegmann & Sundt, 2009; Lingard, Espin, Rubin, & Whyte et al., 2005; Lingard, Regehr, Orser, & Reznik et al., 2008; Papaspyros, Javangula, Adluir, & O'Regan, 2010) and perceptions of teamwork (Einav et al., 2010; Makary, Mukherjee, Sextin, & Syin et al., 2007; Papaspyros et al., 2010;), the approaches to performing briefings are extremely varied and their relationship with outcome variables is still not well understood. Consequently, a standardized protocol or methodology for conducting surgical team briefings in the OR has not yet been developed.

In comparison, over the last decade there has been a large body of literature promoting the implementation of standardized surgical safety checklists which are suggested to positively impact morbidity and mortality rates by improving teamwork and team communication in the operating room (Haynes, Weiser, Berry, & Lipsitz et al., 2009; Lyons & Popejoy, 2014; Russ, Rout, Sevdalis, & Moorthy et al., 2013; Walker, Reshamwalla, & Wilson, 2012). These checklists include important general information for teams to remember prior to incision in surgery and often recommend that a team briefing should occur. However, the checklists do not prescribe standards for how a briefing should be conducted. Upon further examination, it may also turn out that pre-operative team briefings are different from other surgical safety checklist items in terms of their contributions to the surgical team. For example, surgical safety checklists are typically aimed at verifying important information, whereas team briefings are meant to motivate team processes (e.g. communication) and functioning.

Currently, most healthcare facilities only rely on surgical safety checklists and do not have a separate protocol for conducting separate team briefings. Despite a large body of research (Gawande, 2009) and an international campaign (Haynes et al., 2009), surgical checklists have been shown to have variable or low compliance (Rydenfalt, Johansson, Odenrick, & Ackerman et al., 2013). Thus, even if team briefings are recommended, they may not be performed at all. This makes it difficult to connect the quality of the team briefing process to team performance and surgical outcomes. Reasons for low compliance could be due to a number of issues including lack of perceived importance of checklist items for the briefing event (Rydenfalt et al., 2013; Tannenbaum & Cerasoli, 2013), checklist fatigue (McConnell, Farge, & Mocco, 2012), or the checklist structure not matching how actual briefing events occur in the operating suite (Levy, Senter, Hawking, & Zhao et al., 2012; Whyte et al., 2008). With the vast amount of research associating errors in the operating room with poor teamwork (Awad, Faga, Bellows, & Albo et al., 2005; Greenberg, Regenbogen, Studdert, & Lipsitz et al., 2007; Halverson, Casey, Andersson, & Anderson et al., 2010; Lingard, Reznick, Espin, Regehr, & DeVito, 2002; Lingard, Espin, Whyte, Gegehr, & Baker, 2004), surgical teams may be missing out on important benefits that emerge specifically from team briefings

(Tannenbaum & Cerasoli, 2013) including decreases in miscommunication (Lingard et al., 2008; Nundy, Mukherjee, Sexton, & Provonost et al., 2008), increases in team satisfaction, and reductions in surgical flow disruptions (Einav et al., 2010; Henrickson et al., 2009).

There have been some efforts to create pre-operative team briefing checklists or protocols separate from the surgical safety checklists. These protocols have typically been generalized for all types of surgeries. Recent research suggests that team briefing checklists or protocols may need to be more specialized to improve perceived importance and effectiveness (Rydenfalt et al., 2013), likelihood of adoption (Whyte et al., 2008), and importantly, to reduce the occurrence of surgery-specific non-routine events (Einav et al., 2010; Henrickson et al., 2009). The use of specialized briefing checklists for different types of surgical procedures would also mirror how checklists are typically used in other high-risk environments (e.g. aviation) (Gawande, 2009; Weiser, Haynes, Lashoher, & Dziekan et al., 2010). Further, though studies have successfully assessed the feasibility of implementing a briefing checklist or protocol (Henrickson et al., 2009; Lingard et al., 2005; Papaspyros et al., 2010), it has been noted in three separate meta-analyses of the field that there is a paucity of literature regarding "*how well*" these tools are used within the healthcare environment (Lyons & Popejoy, 2014; Russ et al., 2013; Wauben, Lange & Goossens, 2012). This refers not only to implementation fidelity (Karl, 2010; Levy et al., 2012) but also understanding how individual characteristics of these tools may impact outcomes for the team and the surgical procedure.

The specific goal of this study was to investigate the current practice of pre-operative team briefings in a surgical gynecology department in order to understand how team briefings specifically can prove more beneficial to surgical team functioning and potentially reduce the occurrence of non-routine events (NREs) (Weinger & Slagle, 2002) in the operating room. Characterizing team briefings as they are now and identifying how different variables impact their relationship to the occurrence of NREs also facilitated the development of a model of team briefings for gynecological surgery. Analysis of the relationship between team briefing characteristics, NREs, and the model of team briefings were used to provide recommendations towards developing a briefing protocol for the Division of Gynecological Surgery at the Mayo Clinic.

For this study, pre-operative team briefings will be defined as the period prior to surgery and the patient entering the operating room where all members of the surgical team meet to discuss the plans and expectations for the upcoming patient procedure. Pre-operative team briefings will synonymously be referred to as team briefings and briefings. NREs, which will be discussed in detail later, refer to any event that occurs during a surgical procedure which deviates from or disrupts optimal, standard, or expected work flow (Weinger & Slagle, 2002).

The Challenges for Teams in Healthcare

Teams are becoming an increasingly important aspect of today's world, especially in healthcare for which surgical teams are an essential component of safe patient care. It is important to note that a team is not just a group of any individuals, but cam be formally defined as a special type of group in which individual team members have specific yet differentiated roles and are interdependent upon each other to complete their tasks (Salas, Dickinson, Converse, & Tannenbaum, 1992). Despite the importance of teamwork, teams often perform below par due to poor “awareness of team goals, conflicts between team members, mismatched individual goals, and breakdowns in process and coordination between team members” (Ashoori & Burns, 2013). Continuing research on the conditions of healthcare supports the notion that teams and individuals alike may in fact be performing below their potential (Wauben et al., 2012).

In 1999, the Institute of Medicine (IOM) report informed the world that approximately 98,000 patients die every year due to preventable medical errors and adverse events (Kohn, Corrigan, & Donaldson, 1999). Additionally, it’s been reported that half a million deaths occur each year in the OR alone as a consequence of an avoidable adverse event (Gawande, 2009; Weiser et al., 2008). Further, one of the most often cited causes of error in the OR is team communication (Gawande, Zinner, Studdert, & Brenner, 2003; Lingard et al., 2002; Lingard et al., 2004). It has been suggested that the difficulties with team communication in the OR may be due to a lack of standardization and team integration (Awad et al., 2005).

In response to these findings, there has been much subsequent research in the field of healthcare to identify strategies used by other high-risk industries, such as commercial aviation, that can be adapted to achieve and maintain higher levels of safety (Lyons & Popejoy, 2014; Russ et al., 2013; Wauben et al., 2012). One of the recommendations made in the IOM report was to implement more rigorous verification processes into medical practice (e.g., checklists) (Kohn et al., 1999). Although verification of critical information is important, it doesn’t necessarily promote meaningful team communication, which has been found to be critical for effective team coordination in healthcare (Miller, Scheinkestel, & Joseph, 2007). Thus, strategies that not only verify information but which can also facilitate team communication have been suggested as critical approaches to pursue (Wauben et al., 2012).

Typically, these types of approaches are often implemented in the form of checklists (Wauben et al., 2012), which have been used successfully for teams in aviation and other high-risk industries since the early 1900s to prevent accidents that could result from human error (Gawande, 2009; Russ et al., 2013; Wauben et al., 2012). However, implementing a checklist is “more than checking a box” (Levy et al., 2012) and it’s critical to not only assess compliance and implementation fidelity of interventions but to evaluate the quality of such interventions (Levy et al., 2012; Russ et al., 2013).

Overall, operating rooms are becoming increasingly complex and chaotic environments. Technology is constantly being improved and upgraded. Healthcare providers are becoming more specialized (Gawande, 2009) and as a result, surgical teams are growing in size and variability. Surgical teams must take advantage of and optimize every opportunity in which team interactions occur to reduce the opportunity for adverse events in the OR, ultimately increasing the capacity to provide safe patient care.

Team Orientation Events in the Operating Room

This research describes an orientation event as a formal opportunity for team members to interact and communicate in the OR regarding surgical procedures. The term ‘orientation event’ is similar to the concept of ‘communication events’, introduced by Miller, Miller, Hutchinson, Weinger, and Buerhaus (2008) when describing all verbal interactions among individual intensive care unit (ICU) employees. Essentially, communication events are opportunities to achieve common understanding among individuals (Miller et al., 2008). In the OR, interactions take place at the team level and can vary from verifying and confirming procedures are correct to providing an opportunity for the surgical teams to exchange information or both (Whyte et al., 2008). Miller et al. (2008) identified five types of communication events in the ICU ranging from formal exchanges such as handoffs, to informal exchanges such as two employees discussing information in passing. Conversely, in the OR, it is suggested that there are six general occasions during which surgical teams formally interact to complete tasks. These six events that currently occur in the OR, and that have been discussed in the literature, include pre-operative briefings, patient sign-in, time-outs, patient sign-outs, post-operative debriefings, and handoffs. Although these occasions all have different characteristics, timing, and team members involved, they all serve the same function of orienting the team to information that is relevant for the current situation. Thus, for the purposes of this research, these occasions will be referred to as orientation events.

Currently, some orientation events can be aided by a standardized protocol or a checklist (IHI, 2013; Joint Commission, 2004; WHO, 2009), but some studies have also suggested that verbal discussion only or the use of visual displays may both be adequate approaches as well (Einav et al., 2010). Typical characteristics for each type of orientation event will be briefly described.

The pre-operative briefing should occur before the surgical procedure begins but the literature varies as to whether this event needs to take place before or after the patient enters the room and further, if it should occur before or after the patient is under anesthesia. Whyte et al. (2008) defined pre-operative briefings as “a predictable opportunity for professionals to exchange information, ensure that any variations in routine procedure are made apparent and establish shared situation awareness of how the case is expected to proceed." Papaspyros et al. (2010) adds that a "briefing can establish a platform for common understanding…and provide a structure for collaborative planning." As the composition of OR teams can change from day to day, or even between surgical procedures on the same day, the briefing orientation event can also serve as an opportunity for team members to introduce themselves and become familiar with the structure of the team (Russ et al., 2013; Whyte et al., 2008).

The patient sign-in, timeout, and patient sign-out are all events that have been well documented through research, mostly revolving around the World Health Organization (WHO) Surgical Safety Checklist (2009). These three events are opportunities, from the time the patient enters the operating room until they leave, for verification of important steps that are most critical, known to be often overlooked, and that put the patient at high risk if omitted (Weiser et al., 2010). The concept of a timeout was first introduced by the Joint Commission as a strategy to reduce wrong-site surgeries. In 2004, the Joint Commission published the Universal Protocol which recommended that surgical teams take a timeout prior to the first incision and verify they have the correct patient, correct operative site, and are going to be performing the correct procedure (Joint Commission, 2004).

Debriefings are an orientation event that should occur immediately following the surgical procedure. These events are similar to briefings in that it is a time for the whole team to come together and discuss the previous surgical case (Tannenbaum & Cerasoli, 2013). Debriefings are a time for reflection and an occasion for the team to learn from the previous surgery (Paull, Mazzia, Wood, & Theis et al., 2010). Importantly, debriefings can be used as an opportunity to provide immediate feedback to teams as they can easily identify near misses, that may not be captured in operating room records, recognize the underlying contributors, and discuss opportunities for future improvement (Papaspyros et al., 2010).

Handoffs are a unique orientation event in that they can occur anytime throughout a surgical procedure and typically take place between two team members who work in the same role. A handoff occurs when one team member transfers control of or responsibility for tasks related to the surgical care of a patient to another team member, and then subsequently leaves the operating room for any given period of time (Blocker, 2012; Cohen & Hilligoss, 2010). There has been much published literature regarding handoffs (Cohen & Hilligoss, 2010) and most research has promoted the use of standardized communication documents or checklists, for example the SBAR (Situation, Background, Assessment, Recommendation) technique, to ensure optimal handoff performance (IHI, 2013).

The Benefits of Team Orientation Events

Not only are orientation events important opportunities for surgical teams to interact and share information, but they have the potential to provide many benefits to team cognitive functioning, team performance, and surgical outcomes. These benefits, largely facilitated by team communication overall, can include improved team cognition, shared mental models, shared situation awareness, and prospective memory (Whyte et al., 2008).

Each orientation event revolves around communication among surgical team members. Whereas, poor team communication is frequently identified as one of the main contributors to medical error in the OR (Lingard et al., 2004; Makary et al., 2007), the literature suggests that orientation events are effective in improving the quantity and quality of communication and thus, can potentially reduce medical errors (Awad et al., 2005; Lingard et al., 2008; Lyons & Popejoy, 2014; Russ et al., 2013). For example, Wadhera, Henrickson Parker, Burkhart, and Greason et al. (2010) found that initiating structured communication around critical events for teams in the operating room alleviates cognitive workload and reduces breakdowns in team communication. Interactive team cognition (Cooke, Gorman, Myers, & Duran, 2013) accounts for these improvements in team performance by positing that team cognition emerges from observable team activities, such as communication. Further, when teams are engaged in cognitive tasks, such as planning, assessing situations, and decision making, as a team, their communication reveals cognitive processing (Cooke et al., 2013; Gorman, Cooke, Winner, & Duran et al., 2007). Thus, it's not surprising that processes, such as orientation events, which promote team communication, are successful for improving team performance and team coordination in healthcare environments (Miller et al., 2007). Further, analysis of communication can serve as reliable predictors of team performance (Gorman et al., 2007). Across multiple domains, research has shown that higher performing teams will exhibit distinct patterns and structure to their communication (Bowers, Jentsch, Salas, & Braun, 1998; Cooke et al., 2005; Kanki, Lozito, Foushee, 1989; Xiao, Seagull, Mackenzie, Ziegert & Klein, 2003). Effective team communication has also been shown as a driver for increasing and coordinating other constructs of team cognitive functioning including shared mental models and situation awareness (Entin & Serfaty, 1999).

A team mental model has been described as organized cognitive representations of a team's tasks, equipment, roles, and interaction patterns (Cannon-Bowers, Salas, & Converse, 1993). Thus, a team having a shared mental model would imply that all team members have common cognitive representations that are important for making predictions about the current situation (Mathieu, Heffner, Goodwin, Salas & Cannon-Bowers, 2000; Smith-Jentsch, Cannon-Bowers, Tannenbaum & Salas, 2008). Entin and Serfaty (1999) have shown that teams who can coordinate shared mental models of the situation, task environment, and interactions among team members increased a team's ability to function effectively under high levels of stress. Further, Miller et al. (2007) found that team coordination in healthcare relies on interaction between different team roles through communication. With the constantly changing composition of surgical teams in the operating room, it would appear that efforts to promote communication among different team roles during orientation events is critical for improving shared mental models.

Situation awareness is complementary to and can be described in terms of either interactive team cognition (Gorman, Cooke, & Winner, 2006) or shared mental models (Mathieu et al., 2000). As teams are made up of interdependent roles, in order for teams to be successful, they must maintain high levels of shared situation awareness (Endsley & Jones, 2012). Shared situation awareness can be described as team members having a shared understanding of required information that is necessary for the current situation and a shared understanding of how the current situation may change in the near future

(Endsley & Jones, 2012). Good shared situation awareness is a critical component in decision making for medical practitioners (Wright, Taekman,& Endsley, 2004) as it allows for better anticipation of and adaptation to changes in processes and the environment (Endsley & Jones, 2012). Throughout surgical procedures in the operating room, team members are often busy completing complex tasks specific to their role while having to maintain an understanding of the larger team task of the surgical procedure. Research has suggested that communication and coordination processes at the team level support cognitive team activities such as shared situation awareness (Cooke, Gorman, & Winner, 2006). Thus, orientation events are critical opportunities for teams to maintain this mutual understanding among each other with regard to the patient or surgical procedure (Whyte et al., 2008).

Prospective memory is another important construct that can be supported through orientation events. Prospective memory is remembering to perform tasks that will be carried out at a later time (Dismukes & Nowinski, 2006). In prospective memory, there is a primary distinction made between event-based intentions and time-based intentions (Dismukes, 2010). An event based intention is a task to be completed when a specific situation occurs and a time based intention is when a task needs to be completed at a specific time. Both events are prevalent in the operating room. Research has shown that reminder cues are one of the most powerful ways to facilitate prospective memory. Reminder cues can include checklists or standardized team procedures (Dismukes, 2010). Implementation planning is another powerful aid for prospective memory and this involves thinking in depth about the tasks to be performed in the future and imagining additional context including other activities that will be ongoing, environmental cues associated with those activities, and potential unforeseen events that could occur (Dismukes, 2010). Continuing research suggests that support at the team level is necessary for prospective memory of teams in complex sociotechnical systems such as healthcare (Grundgeiger, Sanderson, & Dismukes, 2014).

Even though all of the orientation events mentioned above occur in the OR, each type of event serves a different purpose and is believed to provide a different contribution to surgical team functioning. Whereas there is potential for significant benefits to emerge from each event, depending on the methods or approaches used, these contributions may occur in different ways and to varying degrees.

Previous Research on Orientation Events

The orientation events discussed above are all currently applied in healthcare practice. However, much of the published literature, especially with regard to surgical teams, has focused on four of the six events: handoffs, patient sign-ins, timeouts, and patient sign-outs, the latter three of which are consistently captured within surgical safety checklists (WHO, 2009). Significantly less research has focused on briefings and how they impact surgical team performance and outcomes. Whereas briefings are often recommended by surgical safety checklists, very little is known about the individual effects of briefings on surgical teams. Further, it is believed that briefing orientation events may contribute or have the potential to contribute different benefits to the surgical teams. For example, the primary goal of orientation events included within a surgical safety checklist is to verify important patient-related information (Haynes et al., 2009; Weiser et al., 2010) whereas team briefings are aimed at identifying and creating a shared understanding for how the case is expected to proceed (DeFontes & Surbida, 2004; Whyte et al., 2008). Thus, the team briefing orientation event deserves and requires separate research into understanding how it can prove more beneficial to surgical team functioning. Accordingly, this also implies that team briefings will likely necessitate separate methodology or protocols for conducting these orientation events in the operating room.

The Impact of the Surgical Safety Checklist. As stated previously, much of the published literature on orientation events has concerned handoffs or the patient sign-ins, time-outs, and patient sign-outs within the context of surgical safety checklists. Very little is known about surgical team briefings. Even though they are often recommended within checklists, briefings have been slow to be adopted in healthcare (Henrickson et al., 2009). Surgical safety checklists, on the other hand, have experienced widespread adoption and acclaim in a short amount of time (Weiser et al., 2010). To better understand the impact of these prevailing orientation events included in surgical safety checklists, literature review was conducted. The goal was to identify what has been accomplished to date, if and when briefings played a role in these checklists, and what weaknesses or limitations exist. Because handoffs are a unique orientation event, usually occurring between only two team members at any given time during the surgical procedure, they were not reviewed for this proposal.

The first widely disseminated surgical safety checklist for the operating room was the Universal Protocol, published by the Joint Commission in 2004 (Appendix A). Prior to this checklist, it was reported that wrong-site surgeries were occurring as often as 40 times per week in the United States (Joint Commission, 2004). Wrong-site surgery can include wrong site, wrong patient, wrong procedure, or wrong side surgeries (Joint Commission, 2004). The Universal Protocol was designed to be a one-page checklist for verification of critical steps towards performing correct site surgery. One important contribution by the Universal Protocol was the popularization the “time-out” concept. Essentially, this checklist required the surgical team to pause prior to incision, or take a “time-out”, and verbally confirm the identity of the patient that they were operating on the correct site, and were performing the correct procedure (Joint Commission, 2004). The protocol attempts to promote teamwork by requesting that all immediate members of the surgical team are present and that they actively communicate during the time-out (Joint Commission, 2004). However, with the only requirement being to verify the correct patient, site, and side, the Universal Protocol lacks cues that stimulate meaningful dialogue. Further, the timeout typically occurs after the patient is already under anesthesia so waiting until then to prompt any lengthy team communication could cause unnecessary delays in the surgical procedure. The Universal Protocol did not recommend any team discussion prior to the start of the surgical procedure.

Following the introduction on the Universal Protocol the use of surgical checklists continued to grow, expanding upon the concept of the timeout, and began to show positive impacts on surgical team functioning. These checklists were mainly aimed at creating standardized communication for orientation events which were associated with fewer team miscommunications during surgical procedures (Lingard et al., 2005; Nundy et al., 2008) and improved team perceptions of coordination and decision making (Lingard et al., 2008; Makary et al., 2007; Whyte et al., 2008). This research continued to illustrate the importance of initiating communication for surgical teams.

In 2009, a team of experts in surgery, anesthesia, nursing, infection control, human factors, and quality improvement worked together publish and disseminate the WHO Surgical Safety Checklist (Haynes et al., 2009; Walker et al., 2012) (Appendix B). This checklist was created in response to the WHO's Patient Safety Programme initiative of improving the safety of surgical care around the world (Haynes et al., 2009; Weiser et al., 2010). The WHO Surgical Safety Checklist was designed to be generalizable for any operating room in the world and consists of three main phases including: 1) the Sign In, which occurs once the patient has entered the room but before induction of anesthesia, 2) the Time Out, which occurs just before the surgical incision, and 3) the Sign Out, which occurs before the patient leaves the operating room. The developers recognized from aviation that opportunities for orienting a team, in this case using a checklist, should be designed around operational work flow patterns and not in place of them (Gawande, 2009; Weiser et al., 2010). This was the rationale behind the three phases of the checklist, which were identified as already established "natural pauses" in the surgical workflow (Weiser et al., 2010).The sign-in phase occurs after the patient enters the room and before anesthesia is administered and involves verifying and confirming information regarding correct patient, site, and side as well as patient allergies and anesthesia checks.. The time-out phase occurs after anesthesia right before the skin incision. During this phase, team members are asked to introduce themselves by name and role followed by a traditional time-out, per the Universal Protocol. Next there are a number of tasks that are designed to promote team discussion regarding the expectations and concerns regarding the patient or surgical procedure. Finally, during the sign-out phase equipment counts are completed, specimens are checked for correct labeling and an opportunity is provided for the team to discuss any equipment problems that arose during the surgery.

The developers incorporated principles of user-centered design to ensure this checklist was easy to use, for example by keeping the length succinct, ensuring language was simple and clear, and limiting clutter and color (Weiser et al., 2010). Aside from striving for exceptional user-centered design and usability, the WHO conducted the most comprehensive evaluation of surgical checklists to date (McConnell et al., 2012) to determine the effectiveness of the checklist. The WHO Surgical Safety Checklist was initially piloted in 8 hospitals worldwide with varying economic circumstances and populations (Haynes et al., 2009). Following implementation of the checklist, it was found that rates of mortality and inpatient surgical complications decreased significantly by .7% and 4% respectively (Haynes et al., 2009).

Since the launch of the WHO Surgical Safety Checklist over 4000 hospitals across the world have adopted and actively use the checklist in their facility (Walker et al., 2012) and its use is endorsed by national and international healthcare safety organizations (Joint Commission, 2004; WHO, 2009; IHI, 2013). However, subsequent research findings have identified weaknesses with the implementation fidelity of the WHO surgical safety checklist suggesting that the checklist is not always applied as intended (Levy et al., 2012; Rydenfalt et al., 2013). Overall, multiple studies have reported compliance rates between 60-80% and as low as 53% for the sign-in, time-out, and sign-out phases (Fourcade, Blache, Grenier, Bourgain & Minvielle, 2012; Henderson, Fung, Bhatt, & Bdesha, 2012; Levy et al., 2012; Rydenfalt et al., 2013). Despite the capability of the WHO checklist to decrease mortality and improve aspects of surgical teamwork, van Klei, Hoff, and Aranhem et al. (2012) revealed that these benefits are dependent on full checklist completion.

Although it is apparent that the WHO checklist is trying to support orientation events that promote team discussion and establish a shared understanding for the surgical procedure, there are three issues with its approach to doing so and these may be reasons why implementation fidelity is a problem.

The first issue is one of timing. Information sharing and communication are important contributors to team cognition, shared mental models, and situation awareness (Cooke et al., 2013; Entin & Serfaty, 1999; Mathieu et al., 2000). Waiting to initiate team communication until the time-out phase of the WHO checklist when the patient is already under anesthesia seems like an untimely approach to establishing these constructs. Inappropriate timing of checklist items has been shown as a barrier to adoption of checklists and is also correlated with poor checklist compliance (Fourcade et al., 2012; Levy et al., 2012). Further, promoting lengthy conversation with a patient under anesthesia could not only reduce the likelihood that teams will engage in meaningful communication but it could also result in surgical delays. For example, if it is determined that a special piece of equipment will be needed and this is not discovered until the time-out, there could be a significant delay in the surgical procedure while the circulating nurse retrieves the equipment and the certified scrub technician opens, examines, tests, and assembles the equipment. Promoting communicating regarding expectations (e.g. special equipment needs) and concerns during a team briefing, prior to the start of the surgical procedure, may be better than waiting until the time-out. Additionally, the surgical safety checklist requires teams to introduce themselves during the time-out.

Whereas research has shown that this in an effective method for "promoting an individual's sense of participation and responsibility and increases the probability that individuals will speak up if they anticipate or detect a problem" (Russ et al., 2013), these benefits may be hindered by another case of poor timing. At the point of the time-out, team members have likely already been working together prepping the operating room and completing the patient sign-in for up to an hour. As such, this item may seem irrelevant or extraneous to team members completing the checklist. Introductions of team members would be more appropriate during a team briefing prior to the start of the surgical procedure.

The second issue relates to team participation. The WHO checklist does not involve all of the team members at any its three orientation events (i.e., patient sign-in, time-out, patient sign-out), except where they are all requested to introduce themselves. Action items for discussion are only explicitly given to the surgeon, nurse, and anesthesiologist, which may discourage other critical team members (e.g. certified scrub technician, certified surgical assistant, certified registered nurse anesthetist, resident) from voicing opinions or concerns. Rydenfalt et al. (2013) suggests that to obtain full participation and compliance there must be a perceived relevance of checklist items for all team members.

The third issue is one of generalizability. The WHO has actually sent a contradictory message by aiming to create a generalized and standard methodology for certain orientation events (Haynes et al., 2009). However disclaimers have been added promoting the modification of the WHO checklist (i.e., only adding to, not removing items) to meet local facility needs (Haynes et al., 2009; Weiser et al., 2010). Between and within any surgical specialties, there are vastly different procedures that can occur within the same operating room on any given day and requiring different compositions of surgical teams. For example, gynecology procedures can include open cases, robotic cases, and laparoscopic cases. Each of these procedures requires different information for each team member. If cues are not present to prompt discussion or concerns that are specific to different surgical procedures, errors of prospective memory may occur (Dismukes, 2010).

In an attempt to improve upon shortcomings of the prevailing surgical checklists, a Dutch group of researchers developed a checklist using a methodology that follows patients from admission to discharge (deVries, Hollmann, Smorenburg, Gouma & Moermeester, 2009). This checklist, called the Surgical Patient Safety System (SURPASS) is more comprehensive than the WHO Surgical Safety Checklist as it encompasses the entire surgical pathway (deVries et al., 2009; McConnell et al., 2012). The premise for such an elaborate checklist came from a previous study conducted by the same group (deVries, Smorenburg, Gouma, & Boermeester, 2008). In observing over 170 patients undergoing surgery, deVries et al. (2008) found that 50% of observed incidences actually occurred before or after the surgical procedure. Thus, the SURPASS was developed and piloted in six different hospitals (deVries et al., 2009). After the implementation period, there was a 5% decrease in number of complications for in-hospital patients and a decrease in surgical mortality rates from 1.5% – 0.8%. A hallmark of this checklist implementation study, which added valuable validity for the SURPASS, was the inclusion of a control group (deVries et al., 2009; Walker et al., 2012). In 5 control hospitals, there were no significant changes in outcomes during the same period of time the SURPASS was implemented (deVries et al., 2009). This study not only reaffirmed the positive impact that checklists can provide for teams during orientation events, but more importantly, it provided evidence for the need to focus teamwork-oriented efforts before and after the surgical procedure as well.

Surgical safety checklists have been successfully adopted on a widespread level (Walker et al., 2012). They have been shown to be beneficial for communication and teamwork (Lyons & Popejoy, 2014; Russ et al., 2013). Although these checklists have quickly become the standard of care in the operating room (McConnell, 2012), there are still weaknesses and missed opportunities to increase communication and improve shared understanding and team coordination, which could be accounted for by implementing a team briefing prior to the surgical procedure.

Outcome Measures for Orientation Events: The Role of Non-Routine Events. Most of the research to date on orientation events has looked at distal outcomes to evaluate the effectiveness of any intervention. These outcomes usually include morbidity and mortality rates (deVries et al., 2009; Haynes et al., 2009). Whereas these measures are extremely important they often require large scale studies with a high number of participants to see significant results and larger adverse events such as death do not occur that frequently. Further, these distal outcomes do not reveal much about the effectiveness of the intervention within a given surgical procedure, which is equally important to understand (Burtscher, Wacker, Grote, & Manser, 2010). Thus there is a need for more proximal outcome measures with regards to orientation events. To accomplish these requirements, the outcome measure used in this research was non-routine events.

The term non-routine event (NRE) was introduced by Weinger and Slagle (2002) as ‘any event that is perceived by care providers or skilled observers to be unusual, out-of-the-ordinary, or atypical’ during surgical procedures. Initially, NREs were used to retrospectively analyze work flow disruptions in anesthesia teams (Weinger & Slagle, 2002). Since then, NREs have been used to assess surgical flow of cardiac surgery teams (Henrickson Parker, Laviana, Wadera, Wiegmann, & Sundt, 2010; Wiegmann, ElBardissi, Dearani, Daly, & Sundt, 2007), trauma teams, (Blocker, Duff, Wiegmann, & Catchpole, 2012) and in preliminary studies of team performance in the OR (Schraagen, Schouten, Smit, & Haas et al., 2010; Schraagen, Schouten, Smit, & Haas, 2011). The term NRE is also used synonymously with surgical flow disruptions (Blocker et al., 2013; Catchpole et al., 2013; Wiegmann et al., 2007).

Traditionally, all patient safety research methods have relied on “hard patient outcome variables” (Weinger, Slagle, Jain, & Ordonez, 2003) such as adverse or sentinel events. Weinger et al. (2003) explains, “…the root causes of most adverse events are systemic factors such as dysfunctional organizational structure, inadequate training, faulty communication, or poorly designed medical device user interfaces.” Thus, these factors are essentially latent errors that may only result in larger adverse events through very specific coincidental occurrences of related events (Reason, 1990). Consequently, Weinger et al. (2003) suggests that it is important to use alternative data collection strategies that can examine these smaller “non-routine events” which may reveal basic latent errors that are present within the current system. Further, as adverse events are usually very specific to a given event and occur rarely, they make it difficult to collect additional and generalizable data about healthcare processes.

The construct of NREs have become attractive as an outcome measure of team performance in the operating room for a number of reasons. First, NREs allow researchers to study underlying system processes without the negative connotations of "medical error" (Weinger & Slagle, 2002). Second, Wiegmann et al. (2007) found that greater occurrences of surgical flow disruptions led to increases in surgical errors. Thus, NREs have a clinical significance that other objective measures cannot provide. Third, there are validated tools available for collecting, categorizing, and analyzing NREs (Blocker, Eggman, Zemple, Wu, & Wiegmann, 2010; Henrickson Parker et al., 2010). Fourth, understanding the frequency and nature of NREs in relation to teamwork allows for the development of evidence-based interventions (Blocker et al., 2012; Wiegmann et al., 2007).

Recently, Blocker (2012) identified NREs as an effective outcome measure for intraoperative handoff orientation events. In this study, Blocker (2012) found that inefficient handoffs during cardiac surgery can create NREs which could result in compromises to patient safety. The results from this study led to the development of more effective methodologies for intraoperative handoff orientation events (Blocker, 2012). This study illustrates the viability of and potential for using non-routine events to assess and improve upon orientation events in the operating room. Further, some initial work has been accomplished tying non-routine events to briefing orientation events (Einav et al., 2010; Henrickson et al., 2009). The implications of these studies will be discussed in the following section.

Previous Research on Team Briefings

The need for team briefings in surgeries is apparent and upon review of the literature there has been a number of studies accomplished focused solely on implementing surgical team briefings. In fact, surgical team briefings have been mentioned in the literature for the last decade (DeFontes & Surbida, 2004). However, there is still a great deal of variability in how team briefings are performed and the outcomes with which they have been validated. Again, most research has only focused in feasibility of implementing briefings (Einav et al., 2010; Henrickson et al., 2009; Lingard et al., 2005; Makary et al., 2007; Nundy et al., 2008) or team perceptions of briefings (Carney, West, Neily, Mills & Bagian, 2010; Makary et al., 2007; Papasypros et al., 2010) and not necessarily on understanding how the quality of or variations in briefings impact outcomes. Unlike the orientation events in surgical safety checklists, there lacks a consistent and dominant approach for briefings and consequently, a standard best practice or methodology does not yet exist.

A common approach for implementing team briefings has been to hold them in conjunction with the time-out procedures. Makary et al. (2007) implemented a 2-minute OR briefing to be conducted after the patient was anesthetized and before the first incision. The briefing (Appendix C) included 3 critical steps: the OR team members introducing themselves, the surgeon leading a timeout, per the Universal Protocol standards, and a discussion regarding potential safety hazards (Makary et al., 2007). Using a pre-post implementation study design, Makary et al. (2007) used surveys to determine that team briefings significantly reduced perceived risk of wrong-site surgeries and improved perceptions of team collaboration. In a later study by the same group, it was found that implementation of the 2-minute OR briefing also reduced self-reports of delays in the operating room by surgical team members (Nundy et al., 2008). Although the findings from these studies are promising, the outcomes mainly rely on self-reports which are inherently subjective and may not correlate with actual team improvements. By holding a briefing in conjunction with the timeout orientation event, teams will have experienced the same limitations as previously discussed (e.g. lack of established shared mental models and situation awareness).

Lingard et al. (2005) was one of the first studies to assess implementing a briefing prior to the surgical procedure. In this study, the feasibility of implementing a pilot briefing was examined. Lingard et al. (2005) developed a checklist to guide and prompt team communication for the briefing. The checklist (Appendix D) was comprehensive, including space for recording briefing attendance, patient information items to verifying (e.g. diagnosis, history, allergies, etc.), and in-depth talking points concerning operative issues (e.g. procedure, operative plan, patient positioning, expectations). The briefing checklist was implemented and usage was observed in 18 vascular surgical cases (Lingard et al., 2005). Ethnographic notes and brief feedback interviews were used to determine that a preoperative briefing checklist is in fact a feasible tool to initiate surgical team communication regarding procedural issues before a surgical case (Lingard et al., 2005).

In a subsequent study by the same group, communication failures were observed in pre-post implementation study design (Lingard et al., 2008). In this study, 172 procedures (86 pre- and 86 post-intervention) were observed by trained researchers using a validated scale for collecting data on communication failures and their visible consequences (Lingard et al., 2008). The results from this study revealed that implementation of the briefing significantly reduced the number of observed communications failures per procedure. This study was important as it was one of the first to connect team briefings to an objectively measurable outcome. However, there were issues of skewed data in the post-intervention observations (Lingard et al., 2008). Additional limitations of this study include the fact only 3 team members participated in the briefing on average and the timing of the briefing was not standardized. Only 23% of the briefings occurred prior to the patient entering the room and almost half (47%) occurred after the patient was anesthetized (Lingard et al., 2008). Variations in these briefing characteristics may result in differential effects on team performance. For example, if the briefing does improve team cognition and facilitate shared situation awareness, and the briefing is not conducted until after the patient under anesthesia, there may be inconsistencies in team performance up to that point.

A study by Papaspryos et al. (2010) illustrates the variation in approaches for conducting team briefings. In this study, there were three steps of the briefing identified (Appendix E), the first being a "General Step Process" where the team is introduced and the surgeon leads a discussion regarding the expectations for the procedure (Papaspryos et al., 2010). The second step is referred to as the briefing step; however its purpose is more akin to a timeout as the team is required to verify patient information, allergies, etc. The third step is to conduct a debriefing process following the end of the surgical procedure (Papaspryos et al., 2010). Following implementation, it was found that the briefing improved perceptions of teamwork and communication (Papaspyros, 2010).

Although these results are good news for briefings in general it leads one to question how briefings that are conducted very differently still achieve similar positive results. What is it about the briefing that leads to better quality? Further, are there more objective outcomes that can be used to assess this quality?

Henrickson et al. (2009) was seemingly the first study to develop a specialty-specific briefing and evaluate its implementation using surgical flow disruptions, a clinically objective outcome measure (Wiegmann, 2007). The researchers acknowledged that despite briefings generally being accepted as useful, they have not been widely implemented which could be due to a lack of specialized and standardized protocols (Henrickson et al., 2009). Thus, Henrickson et al. (2009) developed a briefing protocol specifically for cardiovascular surgery (Appendix F). This study used focus groups with actual surgical team members to design a protocol for team briefings. Following implementation, there was a significant decrease in surgical flow disruptions, which included patient-related errors, equipment issues, procedural knowledge, and miscommunication events (Henrickson et al., 2009). This study was important for furthering the field of briefings research for three reasons. First, this study corroborated existing evidence that it is feasible to implement team briefings that will be accepted by staff and result in improved perceptions of teamwork. Second, this study introduced the need and provided rationale for surgery specific protocols. Based on the assumed benefits provided by orientation events in general, surgery-specific protocols would likely increase perceived relevance for team members and thus, better support team cognition, shared mental models, situation awareness and prospective memory for that given surgery. Additionally, briefing information that is relevant may be more effective in preventing disruptions or errors in the subsequent surgery. Third, the researchers were able to use an objective outcome measure (e.g. surgical flow disruptions) to effectively assess the clinical impact of the surgical team briefing implementation.

Despite the contributions from these research results, this study was not without its weaknesses. Whereas Henrickson et al. (2009) did evaluate the feasibility of implementing team briefings, they did not assess the quality of briefings. They did capture some briefing characteristics, for example the fact that during the "roll-in" period before briefings were evaluated, the length of time required to perform a briefing dropped consistently from 8 minutes to 1 minutes (Henrickson et al., 2009). Yet, these variations in how briefings were conducted were not related back to outcome measures. It would be interesting to know whether the length of the briefings or other characteristic nuances had any impact on briefing quality. Further, the researchers only assessed the impact of briefings on the first case of the day. While this was a deliberate choice in methodology for this study, one could assume that if only one briefing occurs in the morning for all surgical cases throughout the day, procedures later in the day may experience more surgical flow disruptions.

Finally, there was a recent study by Einav et al. (2010) that used non-routine events as an outcome measure for implementing surgical team briefings; although, once again a different approach to the briefing procedure was used. Following an extensive observation period of 130 surgeries conducted without briefings, Einav et al. (2010) developed a generic briefing protocol in the format of a poster (Appendix G) that could hang on any operating room wall. The goal was to create a tool that was more "accessible and salient" than a paper checklist (Einav et al, 2010). Another difference in this approach was that the briefing was to be conducted in the operating room while the patient is still awake, prior to anesthesia (Einav et al., 2010). Following implementation of the briefing protocol, researchers conducted prospective observations in the operating room, finding a 25% reduction in the occurrence of non-routine events from when there was no briefing at all (Einav, et al., 2010).

The findings from this study are important because they emphasize the ability for non-routine events to correlate with effects of team briefings. However, the researchers did not use validated methods (Blocker et al., 2010; Henrickson Parker et al., 2010) for capturing or categorizing non-routine events. Instead the researchers created categories by consensus based on the data collected (Einav, 2010). Further, the use of a visual cognitive aid to guide the briefing seems to be a promising approach for prompting team communication (Einav et al.). However, conducting the briefing in the room with the patient awake could inhibit the team from engaging in meaningful conversation and fully disclosing expectations or concerns for the upcoming surgery.

Overall, a solid foundation of work has been building in the field of surgical team briefings. However, there is still too much variation in the approaches and methodology for conducting the briefings and in the outcomes used to evaluated their effectiveness. Further, no work to date has been accomplished to understand the relationship between individual briefing variables and objective outcomes.

Purpose of Present Study

Whereas there has been much study of the orientation events that occur in the operating room during surgical procedures, there has been significantly less research regarding the team briefing orientation event and its impact on subsequent surgical procedures. Further, the research that has been accomplished has focused mostly on compliance and feasibility of implementation. No research to date has related specific characteristics of team briefings (e.g. who led the briefing, who was present, who contributed, how long it lasted, etc.) to the quality of teamwork (Russ et al., 2013). Understanding how the quality of a team briefing and/or variations in practice impact team-related outcomes is necessary for designing effective methods (e.g. checklists or protocols) to improve the process. Therefore, the purpose of the present research study was to evaluate pre-operative team briefings and gain a deeper understanding of the relationship between variations in quality and team performance in gynecological surgery.

Following are the specific aims of this research study:

1. Identify the characteristics of team briefings during gynecological surgeries.
2. Identify the characteristics of non-routine events during gynecological surgeries.
3. Describe the relationship between characteristics of team briefings and non-routine events for gynecological surgery.
4. Develop a model of team briefings for gynecological surgery.

To address the first aim, prospective observations of gynecological surgeries and cognitive interviews with individual surgical team members were performed in an attempt to answer several basic questions regarding team briefings. The interviews gave the researcher an opportunity to understand the knowledge that individual team members had regarding briefings and what informational needs were required from the briefings. Thus, conducting the interviews sought to answer the following questions:

a) When and how should a team briefing occur?

b) How long should a briefing last?

c) What team members should be involved in the briefing?

d) What information is important to discuss at a briefing and do these needs vary by role?

e) What are the critical steps involved in a good team briefing?

The purpose of the prospective observations was to get an accurate picture of how briefings actually occur. Thus, conducting the observations sought to answer the following questions:

a) Does a briefing always occur?

b) How long does the briefing last?

c) What team members are present for and actively involved in the briefing?

d) What does the communication look like (e.g. structure, frequency, number of questions asked)?

To address the second aim, prospective observations of gynecological surgeries were conducted to identify and categorize the occurrence of non-routine events. The data were used to answer several basic questions regarding non-routine events. These questions included:

a) How often do non-routine events occur per case?

b) What types of non-routine events occur?

c) Which types of non-routine events occur most often?

d) What is the impact (severity) of non-routine events on the surgical team or the patient?

e) Which role on the surgical team is impacted the most?

To address the third aim, quantitative analysis of the data was performed to address the following questions:

a) Are specific characteristics of team briefings associated with any characteristics of non-routine events (e.g. longer briefing is correlated with less non-routine events per case)?
b) Is the difficulty of the case, as rated by surgical team members, associated with team briefing or non-routine event characteristics?
c) Are team ratings of "how well did the surgical procedures match the expectations team members had based on the information provided at the team briefing" associated with team briefing or non-routine event characteristics?

To address the fourth aim, quantitative methods were used to develop a model for team briefings in gynecological surgery. The primary goal for this aim was model development, but a secondary goal was to determine the predictive ability of the model. The specifics of the methodology used to develop the model and test its predictive capacity will be described in more detail in the following sections.

Significance of Study

The present research study contributes to the field of human factors and healthcare. This study is the first to assess the quality of pre-operative team briefings and its relationship to subsequent surgical procedures. No research to data has related specific characteristics of team briefings back to the quality of teamwork and objectively-measured outcomes. Accordingly, this work has provided further evidence of the value of using non-routine events as an outcome measure in healthcare research. Further, this research will be the first to develop a model of team briefings for predicting frequency of non-routine events in subsequent surgical procedures. Finally, the findings from this study will contribute recommendations and guidance to the development of a formal briefing protocol for the Division of Gynecological Surgery at the Methodist Hospital at the Mayo Clinic.

CHAPTER 2

METHODS

Participants and Study Site Information

This research involved observations and interviews with surgical teams in the Division of Gynecological Surgery at Methodist Hospital at the Mayo Clinic in Rochester, MN. Participants were members of the surgical teams, which included the following roles: surgeon, resident, anesthesiologist, certified registered nurse anesthetist (CRNA), circulating nurse (RN), certified surgical assistant (CSA), and certified surgical technologist (CST). In this division, the anesthesiologists are responsible for overseeing 1 - 4 operating rooms at a time, so they were in the room intermittently to check in with the CRNA who was referred to as the “in-room provider” for the anesthesia team. The observed surgical procedures included minimally invasive laparoscopic surgeries, general open surgeries, and robotic surgical procedures.

In this division, a team briefing for each operating room (OR) is conducted in the morning prior to all surgical cases. This team briefing reviews all of the surgical cases that will take place in that specific OR for that day. For this study, a surgical case was defined as the surgical procedures for an individual patient. Thus, surgical teams typically completed between 1 and 3 cases per day. In this division team members often varied between cases and within cases (due to handoffs, shift changes, etc.), so different teams and team members were observed throughout the data collection period. It should be noted that briefings are not currently implemented across all departments or divisions at this institution, however this division has been conducting team briefings for approximately 2 years. Although there are mandated start times for when the team briefing should occur, there is no formal protocol for instructing teams how to appropriately conduct the briefings.

Initially, data for this research was collected as part of a larger Quality Improvement project studying teamwork in the operating room. Prior to collecting any data, the principal investigator and research team met with the larger department for each role on the surgical team (e.g. Nursing, Anesthesiology, etc.) during their morning meetings. At these meetings, a presentation was given about the research objectives and plans for data collection. The meetings gave surgical team members an opportunity to raise questions and concerns and helped to build a rapport with the research team. Building a positive relationship with and gaining acceptance from the surgical teams was an essential component for efficiently accomplishing this type of research (Blocker, 2012; Neuman, 2000).

The observational data were collected over a period of 5 months, which yielded data for 24 briefings and 45 surgical cases. As part of a Quality Improvement project there was no requirement to obtain informed consent for observations from surgical team members and as this is a teaching facility, patients consent to participating in research and educational endeavors upon enrollment. However, surgical team members were informed when observations would take place and were given the opportunity to opt out of any portion of the study. There was one instance where a surgeon asked that their case not be video-recorded and one instance where a CSA chose not to participate in completing the surveys; the researcher complied with both requests. When the observational data collection was complete for the Quality Improvement project, the researcher coded the briefing videos and subsequent surgical case videos making sure to not include any personally identifiable information for either the surgical team members or the patient. Retrospective review of the de-identified and coded data for analysis in the current study was approved by the Institutional Review Board (IRB).

The cognitive interviews were conducted separately from the observations and were collected over a one week period. The IRB approved this study as exempt and agreed to waive informed consent. There was no personally identifiable information collected during the interviews. Participant data was coded only according to their role on the surgical team. Although participation in this portion of the study was voluntary, the participants were compensated with meal tickets for their time.

Materials and Apparatus

Cognitive Task Analysis Interview. Questions for the interview portion of this study were adapted from the Applied Cognitive Task Analysis (ACTA) methodology (Millitello & Hutton, 1998). ACTA was chosen as a framework for the interviews for its ability to elicit important cognitive strategies used to accomplish tasks and describe the cognitive knowledge necessary for judgments and decision making (Millitello & Hutton, 1998). As the purpose of the interviews was to understand informational needs from the different roles on the surgical team, questions for the interview were semi-structured to prompt participants to share opinions and experiences openly (Millitello & Hutton, 1998).

Video-recording. A Hero3 Black Edition GoPro camera (Figure 1) was used to record all observational data. The researcher would hold the camera to record the morning team briefings, which occurred either outside of the operating room in the hallway or inside the operating room, prior to the start of the surgical procedure. To record the surgical cases, the camera was mounted to an IV pole that was reserved for research use and positioned towards the foot of the patient bed, outside of the sterile environment. Video recording for the surgical cases began when the patient arrived in the operating room and ceased when the patient left the room.

Figure 1. Hero3 Black Edition GoPro Camera used for observational data collection.

Data Collection Tool. To record the occurrence of non-routine events, a tablet PC-tool (see Appendix H) was used that has been developed and validated for the prospective collection of non-routine events in healthcare environments (Blocker et al., 2010). The data-collection tool allows for the real-time collection of multiple NRE data points including when the disruption occurs, how long the disruption lasts, what is the type of disruption (Table 1), a brief description of the disruption, how severe the disruption is to the surgical flow (Table 2), and which roles on the surgical team are impacted by the disruption.

The data collection tablet tool was initially developed using the Systems Engineering Initiative for Patient Safety (SEIPS) framework (Blocker et al., 2010; Blocker, 2012; Carayon, Hundt, Karsh, & Gurses, 2006). The SEIPS approach has been used in several studies to successfully identify a relationship between NRE's and errors that could potentially affect patient safety and team outcomes (Blocker, 2012; Wiegmann, 2007). Therefore, utilizing the data collection tool, derived from the SEIPS framework, is an appropriate approach for this research. Whereas the data collection table tool was originally designed for observing cardiac surgical cases (Blocker et al., 2010), it has since been generalized and found to also be a valid tool for use in other healthcare domains including trauma (Blocker et al., 2012; Blocker, Shouhed, Gangi, & Ley et al., 2013; Catchpole, Gangi, Blocker, & Ley et al., 2013).

Table 1. Non-Routine Event Categories with Definitions and Examples (Blocker, et al. 2010; Blocker 2012; Blocker et al., 2013; Hendrickson, et al. 2010)

NRE Type	Definition	Example
Teamwork	Any breach or lapse in team communication, coordination, cooperativeness, and/or familiarity negatively affecting surgical flow.	"Surgeon had to repeat his request to the RN three times."
Equipment	Equipment problems hindering the smooth progression of the surgical team's procedure.	"Monitor was malfunctioning during laparoscopic procedure."
External Interruptions	Disruptions imposed on the procedure from outside, which include extraneous people, phone calls, or intercom messages that did not directly relate to the procedure at hand.	"RN receives phone call for surgeon with updates from surgery in second OR."
Environment	Disruptions affecting the auditory or visual status of the operating room and not directly relevant to the treatment of the patient.	"Anesthesiologist tripped over cord near the bed."
Technical factors	Skill-based or decision (thinking) error, including poorly executed tasks, omitted steps, or misinterpretation of relevant information.	"CSA did not know how to correctly operate the harmonic device."
Training	Training or supervision that hinders the natural progression of the surgical procedure.	"Resident had difficulty locating the ureter and needed guidance from surgeon."
Patient factors	Patient-specific issues resulting in disruptions to the natural progression of the surgical procedure.	"Patient's blood pressure (BP) spikes in trundellemburg position and the bed must be returned to normal position until BP becomes regular."
Other	Any disruption not falling into one of the above categories.	"A specimen got on the CSA's shoe and the RN removed it."

For this research, there were two observers who independently collected NRE data during the prospective observations. The observers consisted of a post-doctoral researcher and a graduate student researcher both of whom had backgrounds in human factors. Prior to starting data collection, there was a training period where both observers would watch the same surgical cases and code NRE's independently. Through this training, the researchers were able to establish high inter-rater reliability (90%) levels that were consistent with other research (Blocker et al., 2010; Blocker, 2012).

Table 2. Non-routine Event Severity Classification (Blocker et al., 2010; Blocker, 2012; Henrickson et al., 2010)

Severity	**Definition**
No impact	No acknowledgement of the disruption.
Acknowledge/No Delay	A surgical team member is aware of the disruption, but there is no pause in the flow of the operation.
Momentary Delay	Brief pause in surgical flow of the operation for <1 minute as a result of the disruption.
Moderate Delay	Significant pause in the surgical flow of the operation for <1 minute as a result of the disruption.
Full Case Cessation	One or more surgical team members must pause their current task and engage in a secondary activity that impeded the progress of the original task and significantly disrupts surgical flow of the operation.

Surveys. Surgical team members were asked to complete surveys (Appendix I) immediately following the morning briefing and at the end of each surgical case for that day. The purpose of the surveys was to capture team members' perceptions of the information discussed in the morning briefing and its relevance to the subsequent surgical procedures. The surveys also collected demographic information and ratings of how difficulty for the previous surgical procedures.

Procedures

***Interviews*.** The researcher aimed to conduct cognitive interviews with 1-2 participants for each role on the surgical team (e.g. surgeon, resident, anesthesiologist, CRNA, RN, CST, and CSA). The researcher worked with the nurse managers for the OR to schedule the interviews with members of the surgical teams. Once a participant was scheduled, the researcher would meet with the participant in an empty OR to conduct the interview. The empty OR was important in providing context for the participant's responses. The interviews typically lasted 20 minutes. The interviews were kept short intentionally as time was valuable for the surgical team members and they were often participating on their break or prior to the start of their shift. The researcher would begin by describing in general the objectives of the research and reminding the participant that no individually identifiable information was being collected. Next, the researcher would begin the interview, asking the semi-structured questions in the same general format for each participant. The researcher made sure to appropriately query the participant further for "situation assessment actions, critical cues, and potential errors" (Millitello & Hutton, 1998) in regards to what, how, and whether specific information should be provided in a team briefing. The researcher took notes during the interview, which were later transcribed for analysis.

Observations. The researcher worked with the nurse managers to schedule days for observations. On observation days, researchers would arrive to the OR in the morning in time to video record the team briefing using the GoPro camera. At the team briefing, the researcher would introduce themselves and remind the surgical team of the research objectives. When the team briefing began, the researcher would hold the camera and video record the entirety of the team briefing. Following the team briefing, all surgical team members assigned to the OR being observed were asked to complete the "After Briefing" portion of the survey. This portion of the survey recorded demographic information, assessed perceptions of the team briefing content quality, and obtained ratings of what information provided at the briefing was most memorable.

Next, the researcher would set up the camera for to record the surgical cases by attaching the GoPro to a mount on an IV pole that was reserved for research use. The IV pole was always positioned towards the foot of the patient bed, outside of the sterile environment. The researcher would begin video recording for the surgical cases when the patient arrived in the operating room and ceased video recording when the patient left the room. After each surgical case, the same team members who were present at the morning team briefing were asked to complete the "After Surgery" portions of the survey. These portions of the survey assessed how well the actual surgery matched the team member's expectations of how the surgery would proceed based on the morning briefing content. Ratings of surgical difficulty were also obtained. The researcher always made sure to ask the surgical team members to complete the survey when they had free time so as not to disrupt their work flow in either cleaning up from the previous surgical case or preparing for the next surgical case.

During the observations, once the patient was in the room and draped, the researchers collected non-routine event data using the validated data collection PC-tablet tool (Blocker et al., 2010; Blocker, 2012). The researcher would categorize the NREs in real time according to the type of disruption, impact of the disruption on the surgical team, the duration of the disruption, and a free-text description of the event. Each entry was time-stamped automatically by the data collection software. As stated above, prior to data collection, all researchers trained to properly identify and categorize NRE disruptions and had a high (90%) inter-rater reliability. At least one researcher was present for the entirety of the team briefing and each subsequent surgical case. The data collection tool automatically transferred all data points into a spreadsheet for analysis.

As previously mentioned, data were collected intermittently over a period of 5 months, yielding data for 24 briefings and 45 surgical cases. Video-recordings of the team briefings and surgical procedures were downloaded at the end of each data collection day to a password protected hard drive. Within seven days of each data collection day, the video recording of the team briefing and surgical procedures were coded into de-identified data sets and then the videos were deleted.

Finally, during observations and video recording, the researcher always took great care to not compromise the surgical procedures being performed. Study participants were notified that video recording, observations, and surveys may be delayed or skipped by giving a short verbal notice to the research team if any of these processes interfered with or jeopardized the surgical procedure being performed.

Data Analysis

***Overview of Data Analysis Strategy*.** This study employed the use of both qualitative and quantitative methods at different points in the data analysis. For the cognitive task analysis interviews, qualitative coding techniques were employed to understand key themes in the data. Descriptive statistics were used to analyze the characteristics of the team briefings (Aim #1) and the non-routine events (Aim #2) for gynecological surgery. To assess the relationship between team briefing characteristics and non-routine events (Aim #3), Pearson's correlations and independent samples t tests were conducted. Finally, principle component regression analysis was used to build a model of team briefings in gynecological surgery that could describe and potentially predict the nature of the relationship between team briefing characteristics and non-routine events.

The following sections describe in more detail the qualitative methods used to analyze the cognitive task analysis interviews, the technique used to generate networks for describing and analyzing team briefing communication (Aim #1), and the steps followed to complete the principle component regression analysis (Aim #4).

Coding of Cognitive Task Analysis Interviews. The transcribed notes from all interviews were independently reviewed by two human factors researchers who have experience in the operating room and had previously observed multiple team briefings for gynecological surgery. As the primary goal for conducting the interviews was to understand the cognitive knowledge needs and informational requirements at both the team and individual team member level, two coding strategies were employed to further analyze the transcribed interview data.

Descriptive coding (Saldana, 2013) was first used to identify the broader team briefing content topics that are important across all team members. To accomplish this, descriptive coding assigns nouns or phrases to describe the basic topic of a short passage of data which in this situation as the responses to the interview questions. Descriptive coding is a useful first step to "categorize data at a basic level, providing the researcher with an organizational grasp of the study" (Saldana, 2013, p. 91). Next, another round of descriptive coding was conducted to identify the team briefing topics that are important across the individual team roles.

To more specifically understand the critical steps involved in a good team briefing, process coding (Saldana et al., 2013) was employed for its ability to identify routine and strategic human processes in observable activities (Corbin & Strauss, 2008; Saldana, 2013). In process coding, gerunds ("ing" words) and verbs are used to code the data (Saldana, 2013).

For both strategies, the researchers would first coded independently, then jointly reviewed the data, combining and dividing coded topics as needed until a consensus was met. Frequency of coded items was recorded, which allowed the data to be organized into three general topic areas that will be further discussed in the results section.

Team Briefing Communication Networks. From each team briefing video, the researcher was able identify communication flow by coding instances of communication between surgical team members. For each communication instance, the researcher noted who talked to whom. This data were then submitted to Node XL, an open-source, network analysis and visualization software add-on package for Microsoft Excel. Within Node XL, the researcher was able to create directed networks for each team briefing event and calculate various metrics for each network.

For this research, graph density was used as the metric of analysis for team briefing communication. Graph density is "the ratio that compares the number of edges in the graph with the maximum number of edges the graph would have if all the vertices were connected to each other" (NodeXL, Microsoft Excel). The literature largely concludes that there is a positive relationship between the quantity of communication and improved team-related outcomes (Bowers et al., 1998; Cooke et al., 2005; Cooke, et al., 2008). Therefore, in this research, it was assumed that greater density is representative of better communication and a lower density is representative of poorer communication.

Aside from creating networks to visualize the communication from each individual team briefing, the data were also averaged across all briefings to create networks representing the average communication among teams during all briefings, and briefings led by either surgeons or residents. In all networks, each node (or vertex) represents a role on the surgical team (e.g. surgeon, anesthesiologist, resident, CRNA, RN, CSA, CST). The size of the node indicates the frequency with which that role on the surgical team communicates (e.g. larger node = more communication) in general. A link between each node suggests there is, on average, at least one instance of communication between the two nodes (e.g. roles) for that briefing. The weight (e.g. thickness) of the link between two nodes indicates the frequency with which one role communicates with another role (e.g. thicker link = more communication).

***Principle Components Regression Analysis*.** As previously stated, the primary goal of Aim #4 in this research study was to develop a model for team briefings in gynecological surgery. The secondary goal was to determine if the model was predictive of the dependent variable, which in this research was the frequency of non-routine events. The non-routine event data provided several data points that had the potential to serve as a dependent variable for the model, including frequency, duration, and severity. However, NRE frequency was chosen as the final dependent variable in this study because the literature has reliably found a relationship between the amount of NRE's that occur and surgical errors (Wiegmann et al., 2007). Severity and duration of non-routine events have yet to be linked to team outcomes.

Principle components regression was the method chosen to develop the model due to expectations of high multicollinearity among the predictor variables used to build the model. Multicollinearity occurs when two or more predictor variables are highly correlated with each other (Kachigan, 1991). Table 3 lists the dependent variable and the specific predictor variables, whose values were identified in Aim #1 and Aim #2 of the data analysis, that were used in developing the model of team briefings.

Table 3. Predictor and Dependent Variables Used to Develop Team Briefing Model

Predictor Variables	**SPSS Code**
Duration of briefing	Briefing time
Duration of each case discussion at briefing	Briefing case time
Number of cases briefed	Number cases briefed
Time between briefing and case (e.g. position)	Case position
Team members present at briefing	Surgeon, ANT, CRNA, resident, RN, CSA, CST
Number of extra people present (e.g. RN manager)	Extra people
Percent of team present at briefing	Team present at briefing
Percent of same team present at each case	Team present at case
Team member leading briefing	Leader
Tool used to lead briefing (e.g. SHA, memory)	Tool
Location of briefing (e.g. OR or hallway)	Location
Number of questions asked	Questions
Communication network density	Communication density
Introductions	Intros
Number of items discussed at briefing	Items
Number of items discussed per case at briefing	Items per case
Number of interruptions	Interruptions
Average years of experience of team members	Team experience
Average degree of case difficulty	Team difficulty
Average degree to which case matched expectations set forth by briefing	Team expectations
Multiple surgeons in one briefing	Multiple surgeons
Dependent Variable	
Frequency of non-routine events	NRE Frequency

The selection of predictor variables was derived based on findings in the literature, common themes identified in the cognitive task analysis interviews, or because they were constructs that were highly variable from briefing to briefing during preliminary observations. Further, as this research study is one of the first to develop a model for team briefings, the strategy was to utilize all available and observable data points possible. However, the use of all data points possible resulted in a high probability that multicollinearity would occur. For example, briefing time and number of items briefed were highly correlated, which is not surprising given that the longer a briefing lasts suggests that people are talking longer and accordingly, covering more "items".

Thus, principle component regression was employed for its capacity to reduce multicollinearity among the data (Liu, Kuang, Gong, & Hou, 2003). Essentially, Liu et al. (2003) claim that the principal component regression is

> "a method of combing linear regression with principle component analysis such that it can gather highly correlated independent variables into a principal component, and all principal components are independent of each other, and so in effect, a set of correlated variables have been transformed into a set of uncorrelated principle components. (p.142)"

Therefore, the use of principle components regression is appropriate as it alleviates the problem of multicollinearity by combining the statistical methods of regression and factor analysis to convert correlated variables into uncorrelated components that can then be transformed back into a general linear regression equation (Liu et al., 2003).

For this research, the six step tutorial outlined by Liu et al. (2003) for completing principle component regression in SPSS was employed. The steps are described in further detail below:

1. Conduct a stepwise regression using the dependent and all independent variables to determine which independent variables are statistically significant ($p<.05$) and to reveal whether the independent variables have multicollinearity or not. Multicollinearity was evident when independent variables displayed low tolerance

and high VIF as well as eigenvalues close to zero. The "best" model from this analysis will be chosen based on how close its adjusted R^2 value is to 1 as this a measure of goodness of fit for linear models (Liu et al., 2003).

2. Use the statistically significant independent variables to conduct a principal component analysis to transform the independent variables to a set of uncorrelated principle components. This calculation will also reveal the cumulative variance proportion of the different principle components.
3. Calculate the standardized dependent and independent variables. Use the standardized variables to compute the standardized versions of the principle components.
4. Using the standardized principle components, conduct the principle component regression analysis. This involves starting with the first principal component, then adding each additional principal component backwards, one by one, until all possible standardized principle component regression equations are calculated.
5. Transform the "best" standardized principle component regression equation into a standardized linear regression equation. Again, the "best" model will be chosen based on how close its adjusted R^2 value is to 1 (Liu et al., 2003).
6. Compute the partial regression coefficients and constant to finally transform the standardized linear regression equation into the general linear regression equation.

In this study, the researcher followed the six steps outlined above to satisfy the primary goal of developing a model for team briefings. As mentioned previously, the observational data collection yielded data for 45 surgical cases. Thus, to satisfy the secondary goal of testing the predictive capacity of the model, only data from 40 surgical cases was used to develop the model while 5 cases were randomly chosen to be reserved for predictive testing. Once the model was complete, the data from the reserved 5 cases was submitted to the model to determine whether it could predict the actual value (e.g. frequency) of the non-routine events that occurred in the surgical case. Measures of error between the predicted values and the actual values were calculated to assess the predictive capability of the model.

CHAPTER 3

RESULTS

The results from the four aims of this study are presented below. First, the findings from the individual interviews with surgical team members are presented. Next, the characteristics of team briefings as identified from the video-recordings are shown, followed by the characteristics of the non-routine events, which were recorded during observations of the surgical procedures. Finally, the model of team briefings, developed using principle component regression analysis, will be revealed.

Cognitive Task Analysis Interviews

Interviews were conducted with 13 team members including 3 surgeons, 1 resident, 1 anesthesiologist, 2 CRNAs, 2 RNs, 2 CSTs, and 2 CSAs. Initial analysis revealed that all team members indicated that it was important for the surgeon to be present for and leading the briefing and that the duration needs to be as “brief” as possible. The preference for a short briefing was not because team members felt it would be more efficient, but rather they have other more important tasks to get to. Interestingly, all team members indicated that the best time for the briefing was in the morning prior to all surgical cases, except for 1 surgeon, 1 RN, and 1 CST who indicated that a briefing before each surgical case would be more helpful and more efficient. These team members recognized that team members change throughout the day as does information about an upcoming surgery and having a briefing closer to the time that surgery occurs would be effective.

The data coded from the interviews were organized into three topic areas to better understand the knowledge and information that these team members acknowledged as most important for briefings in gynecological surgery. Table 4 shows the top ten most frequently identified “purposes” for holding the team briefings. The findings in this table represent all roles on the surgical team.

Table 4. Top ten reasons for the purpose of a team briefing in gynecological surgery.

Purpose of a briefing
1. Get on the “same page”
2. Promote team communication
3. Coordinate team tasks
4. Clarify information and ask questions
5. Review patient information
6. Discuss surgeon preferences
7. Discuss expectations and risks
8. Facilitate teamwork
9. Review special needs
10. Introductions

During the interviews team members were asked to break down the common steps of a briefing to identify the most critical components. Team members consistently identified the same 6-8 factors, shown here in Table 5. These factors had significant overlap with the items from Table 4 but tended to be more specific to individual surgical procedures. For example, identifiers and co-morbidities of specific patients were recognized as vital steps to cover during the briefing.

Table 5. Eight critical steps for conducting a team briefing in gynecological surgery.

Critical steps of a briefing
1. Conducting introductions
2. Providing patient identifiers
3. Discussing co-morbidities
4. Providing the surgical plan
5. Discussing anticipations/expectations
6. Discussing surgeon preferences
7. Identifying special needs
8. Asking questions/discussing concerns

Overall, the interviews found that across team members, there were similar opinions on the purpose of a team briefing and the critical steps involved in conducting a team briefing was consistent across all teams roles. However, when the data were analyzed across individual team roles, there were different topics that emerged as critical content for team briefings including chance of proceeding, patient characteristics, and medications. Table 6 shows the three most frequently discussed topics by role on the surgical team throughout the interviews.

Table 6. Critical briefing content by team role for gynecological surgery.

Content	ANT	CSA	CST	RN	RES
Chance of proceeding			•	•	
Patient information		•			•
Surgeon preference	•	•	•		•
Anticipations/Expectations					•
Special needs		•	•	•	
Patient Characteristics	•				
Medications	•			•	

Medications were discussed as important information to cover at the briefing by the anesthesiologist and CRNAs, which is not surprising since they administer the medication, and the RNs who must chart the medications being administered. Patient characteristics refer to the personality or emotional state of the patient prior to surgery. Members of the anesthesia team commented that this was critical information to know, as they are the ones who interact with the patient and have to keep them calm prior to administering anesthetics. For example, it was mentioned that it’s helpful to know if the patient is unusually upset so that the anesthesia care provider can prepare for how to handle the patient. In gynecological surgery, there are often many ways that the surgery may proceed once the surgical team has gone in and evaluated the patient. Thus, "chance of proceeding" refers to the fact that the surgical plan may be to start a procedure laparoscopically however, there may be a 50% chance that once they begin the procedure they will see signs of cancer and if so, the surgical plan may then change to an open surgery. Accordingly, it's important to specific team members (e.g. the CST) to know possible directions the case may go so that appropriate equipment can be pulled from the core and be prepared for potential use.

Characteristics of Team Briefings

There were 24 observed briefings that originally briefed on 49 surgical cases. There was not a day that a researcher observed when a briefing did not occur. Despite there originally being 49 surgical cases that were briefed on, there were only 45 surgical cases that were able to be observed; 3 cases were cancelled or moved to a different OR, and 1 case was requested by the surgeon to be excused from observation.

The briefings that were observed were typically held in the hallway (79%) and less often were held in the operating room (21%). On average, it was noted that for each briefing there was an average of 5 interruptions (*SD* = 3.19, *range:* 0 – 9, *Mdn* = 5). Some examples of interruptions included people walking through the briefing, team members leaving to answer phones or pagers, team members arriving late to the briefing, or team members leaving abruptly half way through the briefing.

The duration of team briefings was calculated by subtracting the briefing end time from the start time. It was observed that briefings lasted an average of 3 minutes and 38 seconds (*SD* = 0:01:19, *range:* 0:01:56 – 0:06:31, *Mdn* = 0:03:38). The observed team briefings typically covered information for either one (12.5%), two (70.8%), or three (16.7%) individual cases depending on the operating room schedule for that day. Per each briefing, mean discussion time for individual cases was 1 minute and 42 seconds (*SD* = 0:00:37, *range:* 0:01:00 – 0:03:56, *Mdn* = 0:01:25).

On average 83% of the whole surgical team was typically present for the briefing. Attendance by individual team role including the surgeon (92%), CRNA (83%), resident (83%), RN (100%), CSA (88%), CST (96%) was good with the anesthesiologist (42%) being the only role that attended the briefing less than half the time. Aside from the main surgical team, there was often an average of 3 extra people present at the team briefing (*SD* = 1.66, *range*: 0 – 6, *Mdn* = 3). These "extra people" often included core personnel, nurse managers, additional residents or CRNAs, or visiting students to name a few.

The briefings were most frequently led by the surgeons (75%) with the only other role to lead the briefings being the residents (25%). Even though the residents led 6 of the 24 observed briefings, the surgeons were still present and participated in the briefing for 4 of those cases. There were also instances (25%) when the briefing was led by 2 different surgeons who would be overseeing separate cases consecutively in the same operating room. These are unique briefings as the surgeon and resident will change from one case to the next however the rest of the surgical team will remain the same. Briefing leaders, regardless of role, relied on either the SHA (75%) or their memory (25%) to support the information they were providing at the briefing. The SHA is a specific document used in the OR at the Mayo Clinic. Essentially, the SHA is a print out for each OR containing the scheduled cases for that day and case-specific information such as the patient name, ID number, age, indication (e.g. why they are doing the procedure), procedure name, special equipment, and notes on the anesthesia protocol for that procedure.

Interestingly, introductions only occurred at 25% of briefings. When they did occur, it was typically the surgeon that would initiate the introductions. Introductions were always informal with each team member presenting themselves by their first name and role for the day (e.g. "Hi, I'm Bob and I'm the surgeon", or "I'm Mary and I'll be the nurse in the room"). It should be noted however that of the instances where introductions did occur, half of these occurrences began with the surgeon introducing the team to the researcher and reminding the team of objectives for this research. This suggests that the mere presence of the observers may have affected some aspects of team behavior.

The surveys revealed that on average the team experience for those observed at the briefings was 12.37 years (*SD* = 11.51; *range:* 6 months – 37 years, *Mdn* = 13.25). It should be noted however the surgeons, residents, and anesthesiologists often did not complete the surveys due to lack of time, so their data is largely absent from the team experience results.

The communication for all team briefings was analyzed using NodeXL. Twenty-four networks were developed, one for each briefing, revealing a mean communication density of 0.46 (*SD* = 0.18, *range:* 0.21 – 1.00, *Mdn* = .43). Figure 2 depicts a directed network for the overall communication averaged across all 24 observed briefings. This network has a communication density of 0.38 and reveals that only the surgeon talked to every other role at least once on average across the 24 observed briefings. On average, the resident spoke to every other role except for the anesthesiologist at least once per briefing. While the RN, CRNA, CST, and CSA would talk to the surgeon at least one per briefing on average, the anesthesiologist did not communicate with any other role at least one time per briefing. Thus, the structure of the network overall suggests a hierarchical nature to the team briefing communication on average, with whomever leads the briefing (e.g. surgeon or resident) dictating most of the communication to the other roles on the team.

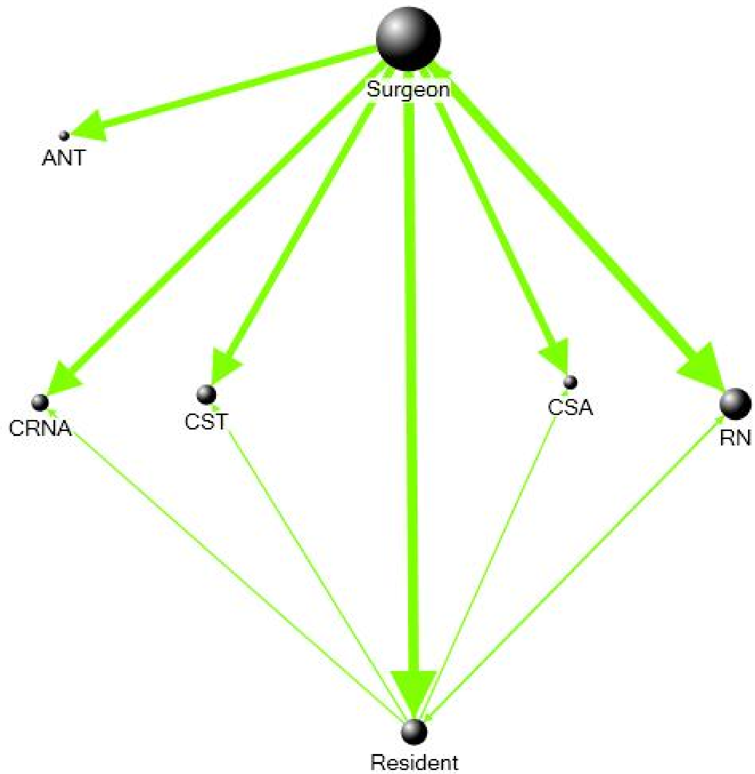

Figure 2. Average overall communication network for briefings.

When comparing the communication networks for the individual briefings with the greatest density and the least density, there were clear differences in communication structure. Figure 3 depicts a directed network for the briefing with the greatest communication density (graph density = 1.00). Here, even though the resident led the briefing, the surgeon still spoke the most frequently, as indicated by the size of the surgeon node, and each team member talked to every other team member at least once;

except for the anesthesiologist, who was not present at the briefing. Figure 4 depicts a directed network for the briefing with the least density (graph density = 0.21). Here, the surgeon led the briefing and clearly dominated the communication. Whereas the resident, anesthesiologist, and RN did communicate back with the surgeon at least once, no team members communicated with one another during the briefing.

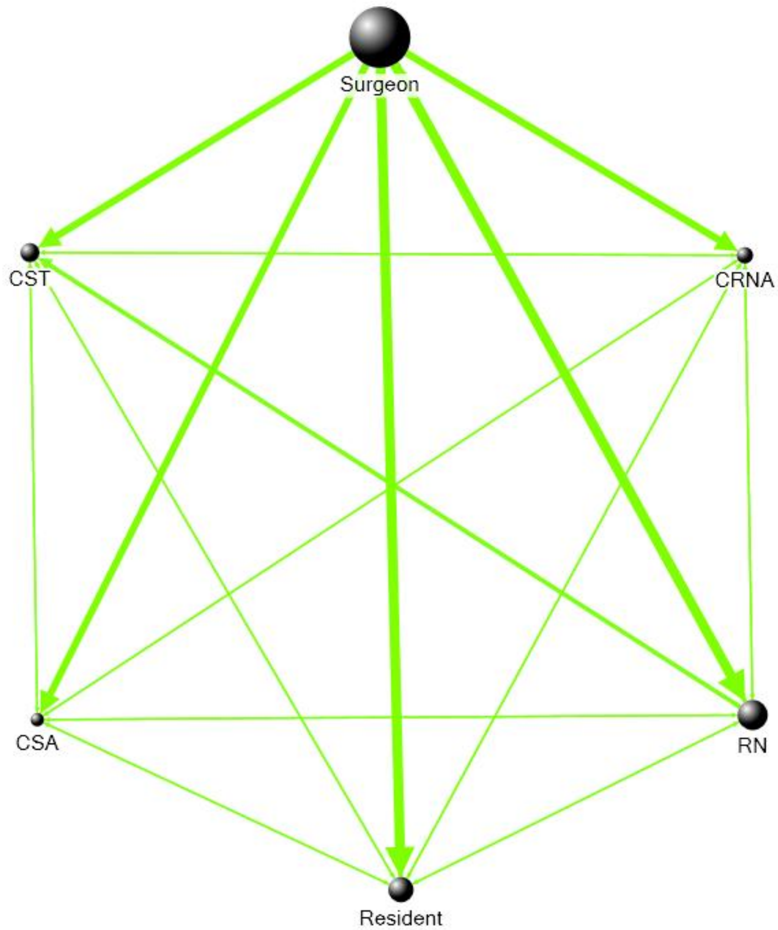

Figure 3. Network with the greatest communication density (1.00).

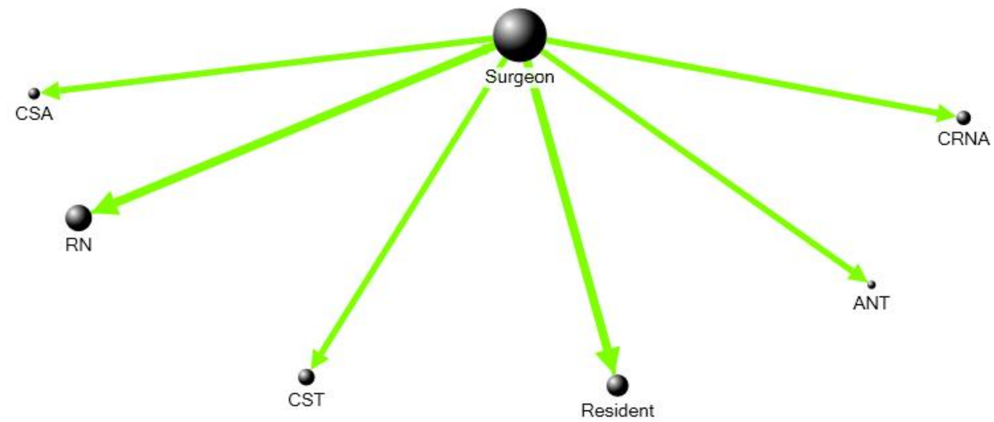

Figure 4. Network with the smallest communication density (0.21).

As the network with the greatest density resulted from a resident-led briefing, the researcher was interested in comparing the differences in the networks of average resident-led briefing communication and average surgeon-led briefing communication. Figure 5 depicts the directed network of average communication across the 6 resident led team briefings (graph density = 0.50). Whereas the surgeon spoke more frequently than the resident, all team members communicated back with the resident at least once on average when they led the briefing. Further, there was communication among all team members on average, except for the anesthesiologist. Figure 6 depicts the directed network of average communication across the 18 surgeon-led team briefings (graph density = 0.21). In this network, the surgeon appears to again be dominating the conversation, with only the CRNA, RN, and CST communicating back at least once on average across all 18 briefings. Further, there is no communication among any of the team members.

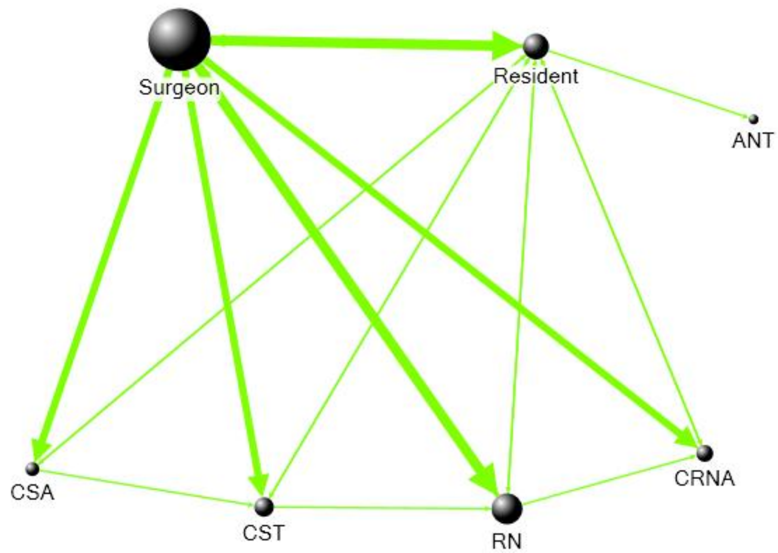

Figure 5. Network of average communication during briefings led by residents (density = 0.50)

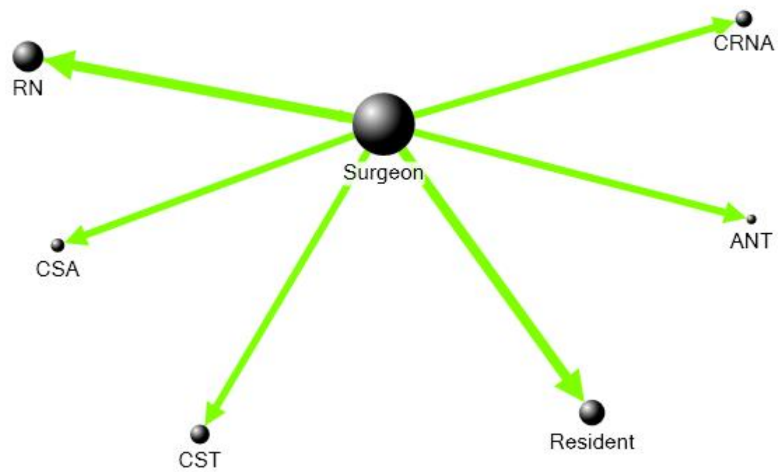

Figure 6. Network of average communication during briefings led by surgeons (density = 0.21).

Additional analysis of the communication revealed that the mean number of questions asked to be approximately 7 (*SD* = 4.08, *range*: 1 – 17, *Mdn* = 6) per briefing. On average 27.53 items (*SD* = 7.57, *range:* 18 – 46, *Mdn* = 27) were discussed at the team briefings. Per case, mean items discussed was 13.20 (*SD* = 4.91, *range:* 9 – 38, *Mdn* = 11.50). Important item categories were identified from the cognitive task analysis interviews. Some examples of item categories include patient identifiers, co-morbidities, and steps of the surgical plan, special equipment needed, surgeon preferences, or medications.

Characteristics of Non-Routine Events (NREs)

Across the observed gynecological surgical cases, there was an average of 12.51 non-routines events per case (*SD* = 13.41, *range:* 2 – 57, *Mdn* = 6). The majority of non-routine events were either external interruptions (40%), teamwork related (26%), or equipment related (21%). Technical skills (4%) and training related (5%) non-routine events were the next most prevalent types of disruption and environment (1%) and other (<1%) non-routine events occurred least frequently (Figure 7). To better understand the majority of non-routine events that occurred, the researcher analyzed those disruption types to see what the specific non-routine events categories were.

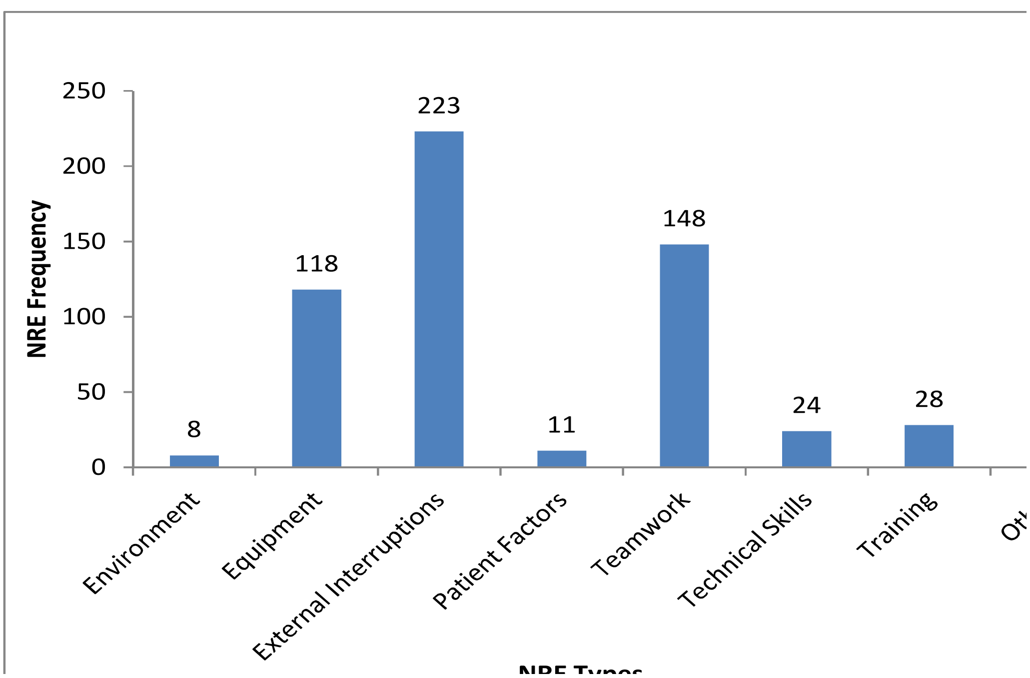

Figure 7. Non-Routine Events (NREs) Types

External interruption non-routine events mostly included pagers and phones (51%) and external visitors coming in to the operating room (39%). The specific teamwork related non-routine events included providing updates to the surgeon about progress in their second operating room (26%), miscommunication among team members (17%), and handoffs (36%) between team members for breaks or shift changes. Equipment related non-routine events included instances when a piece of equipment was needed and was not working (40%), was needed and was not present in the operating room (32%), or was needed and was in the room, but was not ready to be used (23%). Table 7 provides examples from the specific categories in which the majority of non-routines events occurred.

Table 7. Examples of specific non-routine events captured by observers

Disruption Type	**Specific Category**	**Example**
External Interruption	Pagers and phones	"RN had to answer the phone in the middle of the count and asked CST to wait for them to finish"
	External visitors	"Another CST comes in to talk with the CST in the room"
Teamwork	Providing updates to the surgeon	"The team is waiting for the surgeon to come back from second OR and check on port placement"
	Miscommunication	"RN asks CRNA to re-call the next case because no one did it the first time she asked"
	Handoffs	"CRNA returns from a lunch break"
Equipment	Not ready	"Cautery tools were not plugged in, pedal was not at surgeon's foot"
	Not working	"Suction canister is leaking"
	Not present/missing	"RN had to go to the core for a vag pack that should have already been out for surgeon to use"

On average, a non-routine event would last 1 minute and 22 seconds (*SD* = 0:02:46, *range*: 0:00:01 – 0:34:26, *Mdn* = 0:00:40). A brief non-routine event was usually due to an external interruption such as answering a phone call or pager. The longest observed non-routine event lasted 0:34:26 and was teamwork related. Specifically, in this case, the team experienced a full case cessation while waiting on pathology results which were not sent to the lab at the appropriate time due to miscommunication between the surgeon and the RN

Analysis of the non-routine events (Figure 8) revealed that the RN (43.16%) was involved the majority of the time. The entire surgical team (13.68%) was the second most prevalent “role” involved in non-routine events. The surgeon (10.12%), resident (10.12%), and anesthesia team, including both the anesthesiologist and the CRNA (10.48%), experienced similar amounts of non-routine events. The CSA (4.2%) and CST (8.17%) were the members least frequently involved in non-routine events.

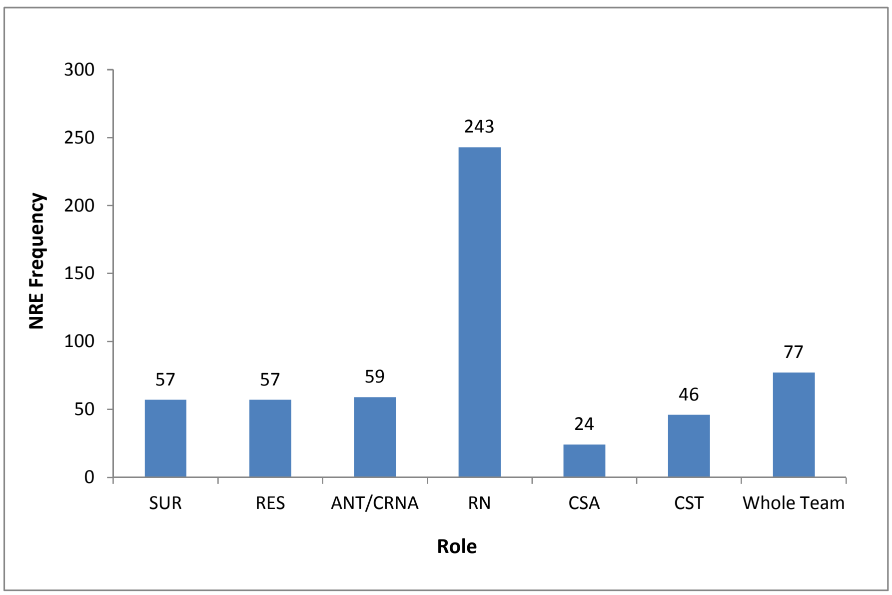

Figure 8. Team members involved in non-routine events.

The results (Figure 9) revealed that the impact of non-routine events observed in the gynecological surgeries ranged from No Impact (2.13%) to Full Case Cessation

(4.26%). The majority of non-routine events were identified as Momentary Delay (62.34%) or Acknowledge/No Delay (18.83%), with a small but significant percentage of the non-routine events deemed Moderate Delay (8.17%). The non-routine events identified as Momentary Delay were most often instances of external interruptions such as answering pagers/phones or dealing with an external visitor.

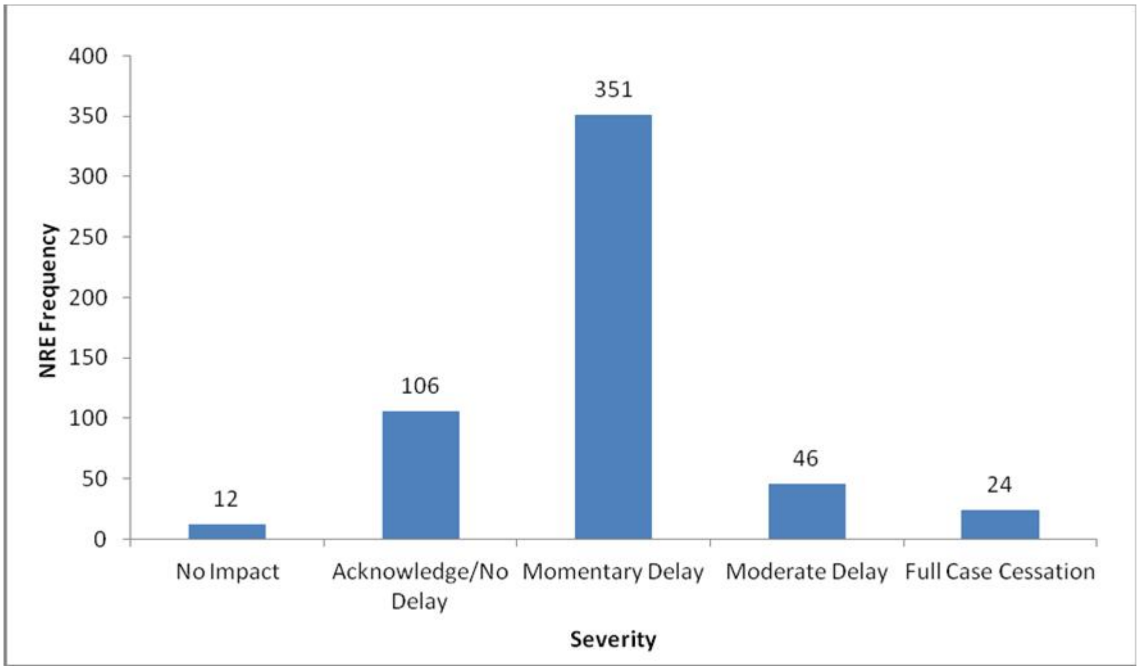

Figure 9. Non-routine events by level of severity

In Figure 10 the severity levels are analyzed according to the most common types of non-routine events illustrating that external interruptions are the most frequent non-routine events, which cause a momentary delay. Interestingly, non-routine events related to teamwork and equipment tends to be more severe in impact than external interruptions.

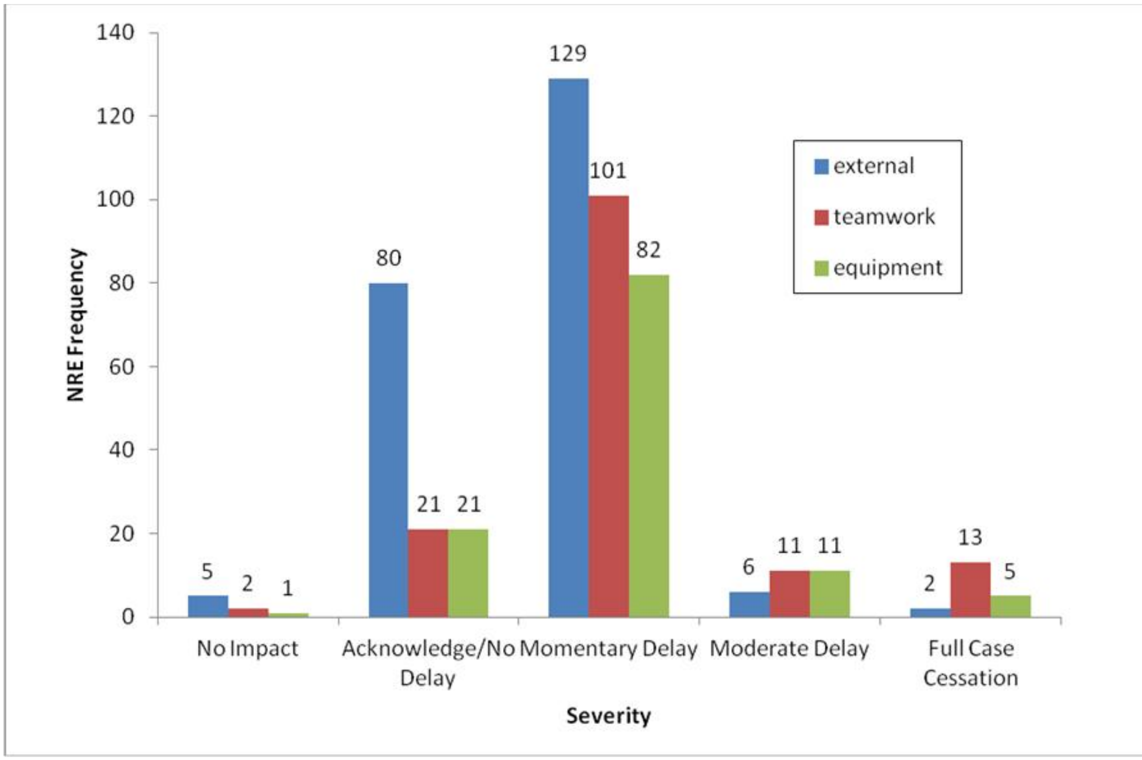

Figure 10. Severity level for most common types of non-routine events

Relationship between Characteristics of Team Briefings and NREs

To understand the relationship between non-routine events (NREs) and briefing characteristics, correlations were calculated for quantitative variables and t tests were conducted for qualitative variables. Specifically, Pearson product-moment correlation coefficients (*r*) were computed to assess the relationship between the frequency of NREs, the duration of NREs, the severity of NREs, and quantitative team briefing characteristics (Table 8).

There were significant correlations between the number of interruptions during a briefing and NRE frequency ($r = .336$, $p<.05$), the percent of the team present at the briefing and NRE severity ($r = .377$, $p < .05$), the number of extra people present at the briefing and NRE frequency ($r= -.476$, $p<.05$), the number of extra people present at the briefing and NRE severity (*r*= -.364, *p*<.05), and the number of items discussed and NRE severity (*r* = -.470, *p*<.05).

Though not significantly correlated, there were other interesting relationships revealed through this analysis including a negative correlation between the position of a case and NRE frequency indicating that surgical cases first thing in the morning are associated with higher NREs than cases later in the day. A negative correlation was also revealed between communication density and NRE frequency suggesting that less communication during the briefing is associated with more NREs in the subsequent surgical case. Despite communication density being negatively correlated, there was a positive correlation between the number of questions asked and NRE frequency. Finally, there was a negative correlation between the average team experience for each case and the frequency, severity, and duration of NREs on subsequent surgical cases.

Table 8. Correlations between NREs and Briefing Characteristics

Predictor Variable	**NRE Frequency**	**NRE Duration**	**NRE Severity**
Case position	-.089	.114	.076
Briefing time	-0.033	-0.043	-0.143
Briefing case time	-0.032	-0.043	-0.143
Communication density	-0.101	0.045	-0.027
Questions	0.206	0.018	-0.190
Interruptions	-.336*	-0.224	0.138
Team present at briefing	0.051	0.194	.377*
Team present at case	-0.022	-0.067	-0.219
Extra people	-.476**	-.364*	0.083
Items	0.130	-0.110	-.470**
Items per case	0.176	-0.001	-0.080
Team experience	-0.142	-0.043	-0.213

*p<.05

Independent samples t tests were computed to assess the relationship between frequency of NREs and qualitative briefing characteristics including whether introductions were given, who led the briefing, what tool did the briefing leader rely on, the location of the briefing, and whether there were multiple surgeons briefing in for the same surgical team operating room and surgical team (Table 9). To ensure there homogeneity of variance in all t tests, Welch's correction was used when necessary. There was a significant effect for introductions, t (14) = 2.60, $p < .05$, suggesting that NREs are more frequent when introductions do not occur. There was a significant effect for the briefing leader t (11) = 2.76, $p<.05$, suggesting that NREs are more frequent when the surgeon leads the briefing as opposed to the resident. Finally, there was a significant effect found for briefings involving multiple surgeons t (9) = -2.26, $p<.05$, implying that when there are more surgeons briefing for the same operating room, there are more NREs which occur in the subsequent surgical cases. There were no significant differences for the location of the briefing or the tool used by the briefing leader.

Table 9. Results for Independent Samples t tests for Briefing Characteristic and NREs

Briefing Characteristic	**Condition**	**M**	**SD**	**t**	**df**	**P**
Introductions n= 14	No	22.14	18.13	2.60	26	0.02*
	Yes	8.43	7.75			
Briefing leader n= 11	Surgeon	14.36	11.41	2.76	20	0.03*
	Resident	6.09	3.89			
Briefing tool n= 12	SHA	16.17	16.24	0.97	17.60	0.34
	Memory	10.83	9.37			
Location n=8	Hallway	10.13	10.83	-1.25	11.37	0.24
	OR	19.5	18.28			
Multiple Surgeon n=9	No	6.44	4.19	-2.26	16	0.04*
	Yes	22.67	21.27			

*<.05

After each surgical case was complete, team members filled out the surveys and rated the difficulty of the previous surgery. The Pearson product-moment correlation coefficient was computed to assess the relationship between the frequencies of NREs, the duration of NREs, the severity of NREs, and the average difficulty ratings of each surgical case. There was a significant correlation between case difficulty and NRE frequency ($r = .534$, $p<.05$). Though not significant, the correlation between NRE duration, NRE severity and case difficulty was also positive.

After each surgical case, team members filled out the surveys and rated how well the actual surgical case matched the expectations they had based on the team briefing. The Pearson product-moment correlation coefficient was computed to assess the relationship between the frequencies of NREs, the duration of NREs, the severity of NREs, and the average team expectations for each surgical case. While none of the correlations were significant, there was a negative correlation between team expectations and all NRE measures suggesting that when the briefing was indicative of how the surgical case was actually going to proceed, the frequency, duration and severity of NREs were lower.

Model of Team Briefings for Gynecological Surgery.

Principle component regression analysis was used to develop a model of team briefings using the frequency of non-routine events as the dependent variable and selected predictor variables from 24 briefings and 40 surgical cases. The predictive accuracy of the model was then tested using the data from five surgical cases that had been randomly reserved. Measurements of predictive accuracy were calculated by comparing the values predicted by the model to actual, observed values. The results from this analysis are described below.

Using SPSS, a stepwise regression (backward) was conducted to determine which of the original predictor variables (Table 3) were significant with regards to the dependent variable of NRE frequency. Table 10 provides the model summary for the regression analysis. Model 7 was selected as it had the highest adjusted R^2 value (.836) (Liu et al., 2003). Table 11 suggests that this model does in fact exhibit multicollinearity among the predictor variables, as shown by the multiple low tolerance levels (< 0.2), high VIF values (> 5), low eigenvalues (close to zero), and high condition indices (< 15). The evidence of multicollinearity confirms the need for the principle components regression analysis.

Table 10. Model Summary for Stepwise Regression with all Predictor Variables

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.957[a]	.916	.796	6.269
2	.957[b]	.916	.808	6.082
3	.957[c]	.916	.818	5.921
4	.957[d]	.915	.826	5.784
5	.956[e]	.913	.831	5.699
6	.954[f]	.910	.833	5.672
7	.953[g]	.908	.836	5.611
8	.949[h]	.900	.830	5.716

Table 11. Model 7 Partial Regression Coefficient and Collinearity Statistics

Predictor Variables	b_i	t	*p*	Collinearity Statistics			
				Tolerance	VIF	Eigenvalue	Condition Index
(Constant)		-5.152	.000	-	-	13.081	1.000
Case position	-.184	-2.559	.018	.807	1.239	1.253	3.321
Team experience	-.393	-3.208	.004	.280	3.576	.926	3.758
Team difficulty	.452	4.723	.000	.459	2.179	.781	4.094
Briefing time	-.902	-5.900	.000	.179	5.572	.582	4.739
Num. cases briefed	1.344	7.017	.000	.114	8.741	.353	6.091
Comm. density	.668	3.410	.003	.109	9.139	.285	6.770
Leader	-.352	-1.367	.185	.063	15.802	.222	7.680
Tool	-.736	-6.569	.000	.334	2.995	.134	9.888
Location	.470	3.891	.001	.287	3.483	.104	11.191
Interruptions	.983	5.404	.000	.127	7.895	.083	12.517
Surgeon	.617	4.308	.000	.204	4.893	.072	13.504
ANT	.332	2.508	.020	.239	4.188	.051	15.966
CRNA	-.326	-3.298	.003	.429	2.330	.035	19.209
Resident	.365	3.117	.005	.306	3.270	.021	25.020
CST	-.404	-2.750	.012	.194	5.145	.011	34.604
Extra people	-.450	-3.753	.001	.292	3.429	.004	57.068
Items per case	1.354	8.067	.000	.149	6.717	.001	102.765

There were 16 significant predictor variables ($p<.05$) in the selected model. These variables were submitted to a principle component analysis to transform them into a set of sixteen uncorrelated principle components. The results from this step of analysis revealed that a large proportion of the cumulative variance is accounted for by the first 8 – 9 principle components (Table 12). The correlation coefficients produced from the factor analysis were combined with the standardized predictor variables to compute standardized principle component equations.

Table 12. Eigenvalues and % of Variance for Each Principle Component

Component (C)	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	3.117	19.480	19.480
2	2.779	17.370	36.850
3	1.742	10.886	47.736
4	1.527	9.544	57.279
5	1.306	8.162	65.441
6	1.167	7.292	72.733
7	.905	5.657	78.390
8	.858	5.360	83.750
9	.679	4.244	87.994
10	.606	3.785	91.779
11	.402	2.511	94.290
12	.327	2.046	96.336
13	.250	1.561	97.897
14	.220	1.374	99.271
15	.072	.447	99.718
16	.045	.282	100.000

Next, using the standardized principle components equations a regression analysis was run, starting with the first component (e.g. C_1) and then adding another principle component (e.g. C_1, C_2), until all possible standardized principle component regressions were calculated. Table 13 provides the summary for the “best” model (e.g., the one with the highest adjusted R^2, of 0.830) chosen from this step in the analysis. Table 14 illustrates evidence that the multicollinearity has been removed from the overall model with tolerance values, VIF values, eigenvalues, and condition indices all closer or equal to 1.

Table 13. Model Summary for the Best Model from Principle Component Regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
C_{16}	.949[a]	.900	.830	.41203750

Table 14. Principle Component Regression Model Coefficients and Collinearity Statistics

Principle components	B_i	t	Sig.	Collinearity Statistics			
				Tolerance	VIF	Eigenvalues	Condition Index
(Constant)		.000	1.000				
c1	-.422	-6.402	.000	1.000	1.000	1.036	1.000
c2	.224	3.391	.003	.999	1.001	1.016	1.009
c3	-.365	-5.536	.000	.999	1.001	1.008	1.014
c4	-.104	-1.581	.128	1.000	1.000	1.005	1.015
c5	.164	2.481	.021	1.000	1.000	1.003	1.016
c6	.000	.003	.998	1.000	1.000	1.002	1.017
c7	-.005	-.077	.939	1.000	1.000	1.002	1.017
c8	.184	2.787	.010	1.000	1.000	1.000	1.018
c9	.029	.438	.666	1.000	1.000	1.000	1.018
c10	-.094	-1.422	.168	1.000	1.000	1.000	1.018
c11	.241	3.653	.001	1.000	1.000	.998	1.019
c12	.019	.292	.773	1.000	1.000	.998	1.019
c13	.289	4.377	.000	1.000	1.000	.997	1.019
c14	.052	.782	.442	1.000	1.000	.995	1.020
c15	-.097	-1.473	.154	1.000	1.000	.991	1.022
c16	.548	8.309	.000	.999	1.001	.980	1.028

The principle components that were significant ($p < .05$) from the chosen model were selected to compute the "best" standardized principle component regression (1):

$$\boldsymbol{y' = -.422C_1 + .224\,C_2 - .365C_3 + .164C_5 + .184C_8 + .241C_{11} + .289C_{13} + .548C_{16}} \quad (1)$$

The individual standardized principle component equations were substituted into this model to generate a standardized linear regression equation. Then, in the final step, the final coefficients and constant were calculated to create the general linear regression equation, which represents the model for predicting NRE frequency based on attributes of team briefings in gynecological surgery. The general linear regression equation (2) and the general linear regression equation with the predictor variables are (3):

$$\boldsymbol{y = 20.005 - 4.264X_1 - .271X_2 + .434X_3 - .822X_4 + .686X_5 - 9.523X_6 - 3.465X_7 + 15.471X_8 - 1.817X_9 + 4.849X_{10} - 2.410X_{11} - .101X_{12} + 4.008X_{13} + 3.708X_{14} - 4.564X_{15} + .697X_{16}} \quad (2)$$

$$\boldsymbol{y = 20.005 - 4.264(\text{case position}) - .271(\text{team experience}) + .434(\text{team difficulty}) - .822(\text{briefing time}) + .686(\text{number cases briefed}) - 9.523(\text{communication density}) - 3.465(\text{tool}) + 15.471(\text{location}) - 1.817(\text{interruptions}) + 4.849(\text{surgeon}) - 2.410(\text{anesthesiologist}) - .101(\text{CRNA}) + 4.008(\text{resident}) + 3.708(\text{CST}) - 4.564(\text{extra people}) + .697(\text{items per case})} \quad (3)$$

To test the predictive accuracy of the model, reserved data from five surgical cases was submitted to the general linear regression equation to determine if it could predict the actual number of non-routine events that occurred in the case. This analysis resulted in a high root mean squared error (*RMSE* = 11.56) suggesting the model is not highly predictive.

CHAPTER 4

DISCUSSION

The section discusses the research results and implications of the relationship between team preferences for briefing information, actual team briefing characteristics, and occurrences of non-routine events (NREs). Although the model developed for team briefings was not found to be predictive of NRE frequency for the data of five reserved surgical cases, utility can still be derived from the model. Finally, future applications for the findings and next steps in the research will be proposed.

Surgical Team and Individual Preferences for Briefings

The thirteen interviews revealed a general consensus across team members for both the purpose of performing team briefings and the critical steps for a good briefing. The teams were also unified in opinions that briefings should be led by the surgeon, kept as short as possible, attended by all immediate members of the surgical team, and held only in the mornings. Such a strong consensus among team members was unexpected considering that there is no formal briefing protocol for this division.

Almost every person interviewed mentioned that a briefing was important for "getting on the same page". Although this is not a technical term, it implies that establishing a shared understanding of the upcoming surgical procedures may be a critical component of a quality briefing. This is consistent with previous findings in the literature that promote the value of shared mental models and shared situational awareness for improved team performance (Endsley & Jones, 2012; Entin & Serfaty, 1999). Further, these findings suggest that metrics assessing shared mental models or situational awareness could be appropriate for evaluating the quality of team briefings or the effectiveness of different briefing implementations.

Further analysis of the interviews revealed that promoting team communication was not only frequently identified as important but was implicitly included in each one of the 8 critical steps of a team briefing (Table 5). Each critical step involved the communication of knowledge for some aspect of the patient or the surgical procedure. For example, Step 1, “conducting introductions”, would require all team members to communicate who they are and what their role is on the team. Step 6, “discussing surgeon preferences”, implies that the surgeon will communicate their preferred methods for the surgical procedure with the appropriate team members, including things like patient positioning, specific types of equipment, or perhaps when they want specimens sent to pathology. So, though team communication is still one of the most cited causes of error in the operating room (Gawande et al., 2003; Lingard et al., 2004), the findings from these interviews suggest that surgical teams recognize the importance of communication for quality team briefings. Thus, briefing interventions designed to promote and facilitate communication will not only meet team expectations, but would also theoretically provide the team with additional benefits including improved team cognition (Cooke et al., 2013) and increased shared mental models (Entin & Serfaty, 1999).

The content from the “8 Critical Steps” was compared to other briefing implementations that have undergone feasibility evaluations. These items were consistent with other protocols identified in the literature (Einav et al., 2010; Henrickson et al., 2009; Lingard et al., 2005; Makary et al., 2007; Papaspyros et al., 2010). However, when the data were analyzed across individual roles, there were specific topics that emerged as being critical specifically for gynecological team briefings, including chance of proceeding, patient characteristics, and medications. Interestingly, “chance of proceeding” and “patient characteristics” were not explicitly addressed in any of the other protocols. In gynecological surgery, there are often many ways the procedure will proceed once the surgical team has evaluated the patient. An example of “chance of proceeding” could be that the surgical plan for a particular patient is to start laparoscopically, however there is a 50% chance that once they begin the procedure they will see signs of cancer, and if so, the surgical plan will change to an open surgery. This information was specifically voiced as critical by CSTs and RNs, which is not surprising since they are responsible for securing appropriate equipment from the core and ensuring it is ready for potential use. Providing this information at the team briefing, prior to the surgery, would allow CSTs, RNs, and other team members to plan for equipment that will be necessary, and thus reduce delays during the surgical procedure. Members of the anesthesia team commented on the importance of knowledge regarding patient characteristics at the briefing. Patient characteristics refer to the personality or emotional state of the patient prior to procedure. The anesthesia team is responsible for interacting with the patient and keeping them calm prior to initiating anesthetics. Thus, it is helpful for them to know whether a patient is unusually upset, for example. This information could only be covered at a briefing as it would depend on the surgeon’s pre-operative visit and their evaluation of the patient just prior to the surgical procedure.

Overall, the interviews revealed a consensus among team members regarding the purpose of a briefing and the critical steps for a good briefing. These findings were consistent with other research, providing further evidence for the appropriateness of these items for a briefing protocol. However, it was interesting to see differences between roles, indicating that a general protocol may be inadequate and implying the importance of including surgery-specific information.

Implications of Variations in Team Briefings

Twenty four team briefings were observed for 49 surgical cases consisting of laparoscopic, open, and robotic surgeries. Across the 24 days of data collection, there was not one day when a briefing did not occur. The briefings were typically led by the surgeon, and well attended by all team members, except for the anesthesiologist, who attended less than half of the time. The fact that briefings always occurred and were well attended could be due to the fact that briefings have been a division practice for two years. Further, there were two established start times for briefings, depending on the start time of the first surgical case, thus setting an expectation for where team members should be at that time.

The observed briefings would cover 1-3 surgical cases and lasted, on average, 3 minutes and 38 seconds. Only an average of 1 minute and 42 seconds is spent discussing each individual case. The average briefing duration fits with recommendations from the literature, such as the 2-Minute OR Briefing (Makary, 2007). Although shorter briefing durations also align with team preferences identified in the interviews, understanding how variations in briefing duration affect other team briefing characteristics and non-routine events is critical. For example, putting a “time limit” on the briefing may impede opportunities for communication to persist. Thus, it will be important to assess how communication interacts with other briefing variables in the model of team briefings.

The communication of team briefings revealed a number of variations in structure and density. First, introductions only occurred in 25% of the briefings, and half of those occurrences can be attributed to an observer effect whereby introductions were initiated to present the researchers. Despite recommendations for introductions in the literature (Russ et al., 2013) and team members viewing introductions as a “critical step”, the actual practice of introductions was meager.

The findings from the network analysis of communication revealed that the average team briefings (Figure 2) exhibit a hierarchical structure, with the surgeon speaking the most frequently and dominating the conversation. On average, team members only communicated directly with the surgeon or resident and did not speak to each other during the briefing. The average graph density of individual team briefing communication networks was 0.46, with the lowest density at 0.21, and the highest density at 1.00 suggesting a wide range of communication styles are occurring at the briefings. When the average communication networks for resident-led briefings were compared with the networks for surgeon-led briefings, there were drastic differences in the density and structure of the graphs. The average communication network for surgeon-led briefing displayed a hierarchical structure, with only three team members talking back to them and no other team members talking to each other. Further, the surgeon-led briefing network had a density of 0.21 which is equal to the lowest observed individual team briefing communication network density. On the other hand, the average network for resident-led briefings displayed a non-hierarchical structure where all team members communicated back with the resident at least once per briefing and communicated with each other. As previously mentioned, in this research, denser graphs are assumed to equate to better communication. Given that, it is interesting that the residents had better communication at their briefings when the interviews revealed a strong preference among team members for surgeon-led briefings. It was not clear from the research exactly why team members talked more during the resident-led briefings. Team members could have been asking more questions for clarification or less fearful of speaking up when the surgeon was not leading.

Implications of Non-Routine Events

Across the 45 observed surgical cases, there were 563 NREs identified by observers, with an average of approximately 12 NREs per each surgical case. The three most frequent types of NREs, which accounted for over 80% of all NREs, were related to external interruptions, teamwork, and equipment.

Further examination of external interruptions revealed that these events most often included answering phones and pagers or dealing with external visitors coming into the OR. Although these types of NREs may appear to be inconsequential to the larger surgical procedure, the findings are consistent with other research which has associated latent errors to minor NREs (Blocker, 2012; Catchpole, Giddings, Wilkinson, & Hirst et al., 2007; Wiegmann et al., 2007). Also, the accumulation of many smaller NREs increases the likelihood that surgical errors will occur (Weinger & Slagle, 2002; Wiegmann et al., 2007). Thus, a briefing which provides a clear surgical plan and identifies expectations for how the surgery will proceed can alleviate the potential for minor NREs to significantly disrupt work flow.

Teamwork –related NREs were typically categorized as handoffs, miscommunication among team members, and instances when the surgeon needed to be provided updates regarding a second OR. These types of NRE's can be more harmful to team performance and patient safety. For example, inefficient handoffs have the potential to result in NREs that compromise patient safety (Blocker, 2012). Further, as previously mentioned, breakdowns in communication are the number one cited cause of errors in the OR (Gawande et al., 2003; Lingard et al., 2004). A briefing that establishes good communication prior to the surgery and outlines a plan for how to proceed regardless of whether the surgeon is in the room or not could reduce these types of NREs. Also, documentation of the briefing could be beneficial for reducing negative consequences from these types of events. For example, it was observed that some RNs took notes during the morning briefing. If notes or a documentation of the briefing are available during a handoff, this would facilitate the transfer of knowledge between two team members and could ensure that no critical information is forgotten in the exchange.

Equipment-related NREs were categorized in three ways including, equipment is needed and it is not in the room, equipment is needed and it is in the room but it is not ready to use, or equipment is needed and it is in the room, ready to use, but not working properly. These types of NREs are consistent with other findings which suggest that equipment-related disruption events have potential for serious consequences depending upon the phase of surgery in which they occur (Blocker, 2012; Wadhera et al., 2010). Interestingly, while "discussing equipment" was talked about during the interviews, it never emerged as a critical step for briefings. Equipment could easily fall under "providing the surgical plan", "discussion surgeon preferences", or "identifying special needs", but perhaps it needs to be recognized as its own step. A briefing protocol that explicitly discusses not only which equipment will be needed, but when in the surgical procedure it should be ready to use could help to reduce this frequently occurring type of NRE.

The findings revealed that the duration of NREs are typically brief (approximately 40 seconds on average) but can last as long as 34 minutes. The RNs were found to be the team role that was most often impacted by the occurrence of a NRE, which is consistent with other research (Blocker, 2012; Henrickson et al., 2010). Interestingly, the whole team was the second most frequent "role" to be impacted by NREs. Previous research suggests that NREs which distract the entire surgical team can lead to errors (Wiegmann, 2007). Understanding and considering the types of NREs that tend to impact the whole team will be critical when developing a briefing implementation that has the potential to reduce these types of events.

Overall, the results showed that most of the NREs did not have a severe impact on the surgical work flow. Of the observed NREs, approximately 62% were categorized as Momentary Delay and 18% were categorized as Acknowledge/No delay. Again, despite these types of NREs appearing to be non-significant since they do not seriously "delay" the work flow, as the number of minor NREs increases, so does the probability of error (Weinger & Slagle, 2002; Wiegmann, 2007). The number of NREs that were categorized in the most severe level, Full Case Cessation (~2%), appear to be low in comparison to the other levels. However, if the frequency of these occurrences is averaged across all briefings, it's alarming to realize that there would be one Full Case Cessation per surgical day observed. Further examination of the Full Case Cessation events revealed that these disruptions are typically due to team-work related NREs. As teamwork-related NREs mostly consist of breakdowns in communication, which are known to lead to errors (Gawande et al., 2003; Lingard et al., 2004), it's apparent that a briefing intervention which supports and improves team communication will be valuable for surgical team performance and ultimately, patient safety.

Impact of the Relationship between Team Briefings and NREs

In the previous section, it was established that there were noteworthy NREs which disrupted the surgical work flow in gynecological procedures. However, the analysis above could only assess the impact of the NRE as it occurred in the context of the surgical procedure. Therefore, to better understand how variations in the team briefing prior to the surgical procedure could potentially impact the occurrences of NREs, correlations were computed for quantitative variables and t tests were calculated for qualitative variables.

The findings from the correlations revealed some interesting relationships between the briefing characteristics and the measures of NREs including frequency, severity, and duration. Overall, there were not a high number of significant correlations, most likely due to a low sample size, however the trends that emerged can still begin to describe the relationship between briefings and NREs. For example, it was not surprising that there was a negative correlation between briefing duration and case duration with NRE frequency, duration, and severity. It should be expected that if less time were spent on the briefing, there would likely be more disruptions in the subsequent surgeries. However, this contradicts the preferences revealed in the interviews where most team members desired short briefings and also, the trends in the literature which recommend short protocols (Makary et al., 2007). Although the findings from this research do not indicate how long a briefing should last, it is apparent that the briefing should be long enough to be effective. Thus, the aim should not be for briefings to be shorter, but for briefings to be concise, however long that may take.

There was a negative correlation between communication density and NRE frequency and severity. This suggests that less communication during the briefing is associated with more frequent and severe disruptions in the subsequent surgical cases. As discussed previously, there is much literature that ties communication during a task to team performance (Cooke, Gorman, & Kiekel, 2008; Cooke & Gorman, 2009). There are also multiple studies which have shown that merely implementing a briefing reduces communication breakdowns during surgery (Lingard et al., 2008; Nundy et al., 2008). However, these results extend these findings by suggesting that the amount and quality of communication during the actual briefing may also be critical to team performance and task outcomes.

Interestingly, there was a negative correlation between case position and NRE frequency, and positive correlations between case position and NRE duration and severity. As the day goes on, team members are more likely to be fatigued, and cases that occur later in the day often have different team members, due to handoffs or shift changes. Thus, it was expected that there would be positive correlations among all three NRE characteristics. However, when one considers that the most difficult cases of the day are often listed first, it’s not surprising that more NREs are likely to be observed in the first case of the day. Further evidence that more difficult cases are associated with more frequent NREs was provided by the significant positive correlation between NRE frequency and the case difficulty ratings provided team members following each surgery. Previous research suggested that it is more critical to hold a briefing for frequent and familiar procedures (Einav et al., 2010). However, these findings suggest that good briefings which allow the team to discuss the surgical plan and anticipations may be more critical for surgeries which are expected to be more difficult.

When considering the actual team members and their relationship to NREs, it was surprising to see that the percentage of the surgical team at the briefing was positively correlated with NRE frequency, duration, and severity. It was expected that if fewer team members were at the briefing there would be more disruptions throughout the subsequent surgical case, though since overall attendance by team members was high at the briefings, the lack of variance could account for this finding. On the other hand, when looking at the percentage of the team at the briefing that was also present at the start of each case, there was a negative correlation with NRE frequency. This suggests that when the surgical case started with few people who were originally present for the briefing, there was likely to be more NREs of higher severity and duration. Although these correlations were not statistically significant, this finding could support the recommendation that it is better to have a briefing before each case when the team members at the briefing will be guaranteed to be the same team members starting that case.

Much of the previous research on briefings has focused on the implementation of the briefing and not any consequences from who on the team was present at the briefing. Thus far, the findings from this study have revealed that who is at the briefing compared to who is at each surgical case might matter. Additionally, there was a significant negative correlation between the number of extra people present at the briefing and NRE frequency. There were often extra people at team briefings including nurse managers, additional residents, and core personnel to name a few. This finding suggests that when there are more "extra people" present at the briefing, there are fewer NREs in the subsequent surgery. This finding was not surprising as often the additional personnel provide supportive roles to the surgical team. For example, when core personnel are present they can listen for additional equipment that might be needed and prepare the equipment without having to be asked and followed up with by the RN or CST. Another team-related finding revealed that the experience of the team is negatively correlated with NRE frequency, severity, and duration. Although these findings were not significant, and the team experience data often did not include the surgeon, resident, or anesthesiologist, there is, at the very least, a relationship emerging which suggests that less experienced teams are associated with more NREs.

The t tests for team briefing characteristics revealed interesting results. When teams performed introductions, there were significantly fewer NREs that would occur in the subsequent surgical cases. This finding continues the trend of communication being a focal component of team briefings and supports previous findings, which suggest introductions are effective methods for familiarizing team members with each other (Russ et al., 2013). In fact, Russ et al. (2013) claims that introductions "promote an individual's sense of participation and responsibility in the case…increasing the probability that individuals will speak up if they anticipate or detect a problem. (p. 856)"

Providing further evidence that variations in team briefing communication affect the subsequent surgery, it was found that when the resident leads the briefing there are significantly fewer NREs. This finding is important because it supports earlier claims in this research stating that greater graph density is associated with better communication. On average, the team briefing communication networks for the residents display greater density and here, resident-led briefings are also associated with significantly fewer NREs than surgeon-led briefings. Therefore, future briefing interventions should not only be designed to promote more communication but should consider the specific communication style of residents.

Finally, the t tests revealed that when multiple surgeons briefed on different cases for the same operating room, there were significantly more NREs in subsequent surgical cases. The interviews revealed that surgeon preferences are a critical step in the team briefing process. However, having to account for and adapt to different surgeon preferences in one briefing could create an information overload. Thus, this finding could again be evidence that briefings before each surgery would be more beneficial to team cognitive functioning and to team performance.

Impact of the Model for Team Briefings

The principle component regression revealed a model for predicting NRE frequency based on attributes of team briefings in gynecological surgery. Principle component regression analysis effectively reduced the inherent multicollinearity in the data and decreased the number of selected predictor variables from an initial 26 to 16 significant variables. These variables included case position, briefing duration, the number of cases briefed, communication density, the briefing leader, the briefing tool, the briefing location, the number of interruptions, extra people present, team experience, team difficulty ratings, the number of items discussed per case, and whether or not the surgeon, anesthesiologist, CRNA, resident, and CST were present at the briefing.

The predictor variables residing in the model as expected include, case position, briefing duration, communication, extra people, ratings of team difficulty, and team experience were all previously discussed above. The effects and potential implications for each of these predictors were discussed in detail above. The only other predictable predictor variable was the number of cases briefed. This variable has a negative coefficient in the model suggesting that when more cases are discussed at a single briefing, there are likely to be more NREs which occur. This finding suggests that discussing multiple cases during one briefing could be an overload of information for team members and critical knowledge could be forgotten by the time the subsequent surgical case begins. On the other hand, as the number of cases briefed increases, the briefing leader may feel more pressure to fit more information regarding each case into a short amount of time, thus omitting critical details. Further, team members change throughout the day due to handoffs and shift changes. If there are a high number of cases that occur, it is more likely that the team present at the briefing could be on a break or have gone home by the time the subsequent surgical cases begin. This finding provides more support for holding briefing prior to each surgical case.

Some of the predictor variables in the model were surprising. For example, it was unexpected that the surgeon, resident, CST, and CRNA were included in the model because all team members, except for the anesthesiologist, had good attendance (80-90%) for the team briefings. With such low variance, these variables were not expected to provide any predictive value in the model. The inclusion of the tool and location were also unexpected because t tests revealed that there was not a significant difference for briefing tool (e.g. SHA or memory) used or whether the briefing took place in the hallway or in the OR. The relationship that emerged between interruptions and NRE frequency was also unanticipated. Again interruptions included team members answering pagers/phones during the briefing, arriving late or leaving abruptly, or people walking through the briefing. The coefficient for the variable was negative suggesting fewer interruptions during the briefing are associated with more NREs. The researcher had expected that more interruptions during the briefing would have been associated with more NREs as team members could have been distracted during the briefing and missed pertinent information. Finally, the fact that the number of items per case was included in the model with a positive correlation to NRE frequency was puzzling. It was expected that an increase in the number of items discussed would be associated with a decrease in NREs as, theoretically, more information would be communicated at the team briefing. Perhaps, the content and conciseness of information is more important than quantity of information for an effective briefing.

Ultimately, this model was not highly predictive of NRE frequency. Using reserved data for 5 surgical cases, the predictive accuracy of the model was tested revealing a high mean squared error. Additional analyses have revealed that poor predictive accuracy of the model could be result of a lack of power due to low sample size. Following the development of the model and predictive accuracy testing, the G*Power analysis program for testing the power of the multiple regression model (Faul, Erdfelder, Lang, & Buchner, 2007; Faul, Erdfelder, Buchner, & Lang, 2009) was employed to assess power. The power analysis suggested that a sample size between 70 –

143 would be needed to achieve a power of .80 and a medium to large effect size. The sample size available for the development of this model was 45 surgical cases. Thus, obtaining a higher sample size could increase the predictive accuracy of the model.

Another potential contributor to the low predictive accuracy could include predictor variable selection. Given that development of the team briefing model for gynecological surgery was an exploratory attempt at building a model to describe team briefings and predict outcomes in subsequent surgeries, all observable and available data points were used to create the model. Whereas only predictors that were statistically significant were included in the final equation, statistical significance does not always indicate predictive value (Hyndman & Athanasopoulos, 2013). This could explain why the various team members were included in the model even though they were essentially always at the briefings, and thus their presence was not very predictive of NRE outcomes. Further, Kachigan (1991) cautions that often, predictor variables are chosen that are not actually predictive and yet, these can still be selected for inclusion in the regression equation based purely on chance relationships. If this occurs, it's possible that these variables are interacting with each other in ways that decrease the predictive accuracy of the model (Kachigan, 1991).

Finally, the fact that the model is not significantly predictive does not mean the model is not useful. In fact there are a number of things that can be learned from the model. For example, the model is predictive with regard to the set of data that was used to build it. Thus, it is useful in understanding the observed behavior for these team briefings and how different variables interact. Further, coefficients of the different variables in the model can be compared in turn to see different relationships emerge and how changes in one variable seemingly affect the rest. As with other models in cognitive science, this research has established a starting point for a continuing line of research from which to pose new questions, test new hypotheses, and provide an initial method for organizing data and findings.

Real World Applications

This study generated a large number of findings regarding team briefings and non-routine events. The findings from this study will not only contribute to the growing field of empirical studies for team briefings in the operating room, but will be used to develop new practices that can be implemented immediately to improve surgical team processes. From the results of this study, there were three important trends that will be relied on to provide recommendations for the development of a briefing protocol in the Division of Gynecological Surgery at Mayo Clinic.

The first recommendation is to promote and facilitate communication during the briefing among all surgical team members. As seen from the resident-led briefings and introductions, when all members participate it less likely that NREs will occur in the subsequent surgeries. This can be accomplished in a briefing protocol by requiring introductions take place and by making each team member responsible for providing or verifying certain information relevant to their position throughout the briefing. For example, the CST should be responsible for reporting what equipment will be pulled and prepped for the upcoming case. The surgeon can then verify this equipment is correct and provide any additional instructions or preferences.

Second, briefings should be conducted prior to the start of each surgical case instead of only in the morning prior to all surgical cases. The findings regarding case position, number of cases briefed, multiple surgeons briefing together, and whether team members at the briefing were also present at the start of the case suggested that holding a briefing which only covers one surgical case at a time may be more beneficial. This recommendation also satisfies the finding that longer briefings are more likely to be associated with fewer NREs. If teams are not trying to squeeze in discussion of multiple surgeries at one time, they may be more likely to discuss the surgical case in depth, which aids in accomplishing the first recommendation of promoting team communication.

The final recommendation is for attendance to be mandatory by all immediate surgical team members. Previous research has only suggested that representatives for the surgeon, anesthesiologist, and nursing are necessary at the briefing (Makary et al., 2007). The findings in this study revealed that communication of all team members is important and that the team present at the briefing should also be the team present at the surgery. To comply with these findings, it is important for all team members to be present at the briefing. This study also found that extra people at the briefings were also associated with fewer NREs, the protocol should also encourage supporting staff to attend briefings. For example, core personnel could be present at cases that are expected to be difficult and may require lots of different equipment. Similarly, to account for the fact that less experienced teams tend to be associated with more NREs, RN managers and CRNA managers should be present at team briefings with newer surgical team members so that they can provide necessary support.

Limitations

Although this study has revealed a number of interesting and potentially impactful findings, caution should be taken before extrapolating these results. The findings are based on a small number of observed briefings and surgical cases at a single institution that were available to the researcher as a sample of convenience. Whereas convenience sampling can be criticized for being biased and not representative of the larger population, in this case it provided an opportunity to study real teams in context, which does provide a validity that cannot always be achieved in laboratory studies. Further, this research answers the call for more empirical work studying teams "in the wild" (Salas, Cooke, & Rosen, 2008). As little information is still known about how teams interact in real, live, uncontrolled environments (Salas et al., 2008), this research was critical for understanding how surgical teams adapt and respond to dynamical changes in team briefings.

Although observations and video-recording were always announced to the surgical team, it's possible that the mere presence of the observer confounded the normal surgical work flow for that team. For example, this was observed during the briefings when the surgeon would begin introductions as a way to present the researcher observing for the day. There was also only one researcher at a time prospectively recording NREs and retrospectively coding team briefing characteristics. Although researchers achieved a high level of inter-rater reliability for the coding of NREs, when 1 observer is present, they can only attend to so many things at a time and thus may not have captured all NREs or all details of NREs that occurred. Finally, even though it was not possible to track surgical teams and individual surgical members and all participants came from the same division, there was a considerable diversity in the participant group (e.g. multiple surgeons, multiple residents, etc.). Also, there were no repeat observations of one completely identical surgical team.

Future Research

As with all research, the findings from this study are not definitive; there is much more work to be done. Although the model of team briefings was not found to be predictive of NRE frequency for the reserved data in this study, future work should continue to revise and refine the model. This could involve increasing the power for predictive accuracy by collecting more data. Similarly, continued research could investigate using alternative methods to narrow down or amend the selection of inputs to the model, ensuring a substantial relationship between the predictor variables and the criterion variable. For example, the content and type of the items discussed at each briefing are likely to be more valuable than just the quantity of items discussed. This would require further research, likely with subject matter experts, to analyze and operationalize different types of content discussed at team briefings. Additional research will also be needed to determine whether all of the findings can be generalized across different fields of surgery or whether briefings should in fact be surgery specific.

Future studies will be needed to evaluate the efficacy of briefing protocols or interventions derived from the findings in this research. For example, the recommendations provided above would require more research to ensure there would be no unintended consequences from changing the current practice. For example, mandating attendance could be difficult for surgeons who are running a second OR and thus may have to interrupt their surgery in order to attend. It could also be found that people are better at preparing for upcoming surgeries when they are briefed in the morning and can take care adapt plans as things related to the surgery may change throughout the day.

Finally, it will be important that this research is eventually examined as one component of a larger system of orientation events. Although this research looked at the local affects between variations in team briefings and outcomes in subsequent surgeries, that other orientation events may also be affected by team briefings or interacting briefing information to impact outcomes. For example, the quality of team briefings may affect the quality of the time-out, the reliability of a handoff, or even determine the requirements for a debriefing. Studying each of these orientation events in concurrently will provide a more accurate account of teamwork in the operating room.

CHAPTER 5

CONCLUSION

The purpose of this research was to increase understanding of team briefings in the operating room. Specifically, the aim was to determine how variations in the quality of team briefing characteristics affected team-related outcomes in subsequent surgical procedures. Further, this research was the first to explore that relationship between team briefings and team-related outcomes by developing a model for team briefings.

Cognitive interviews were conducted with surgical team members to better understand important information surrounding briefings and prospective observations generated data for 24 briefings and 45 surgical cases. Variations in communication were found to be critically associated with the occurrence of non-routine events (NREs). When team briefings were led by residents, had greater density in their communication networks (e.g. more communication), or conducted introductions there were significantly fewer NREs which occurred in subsequent surgical procedures. The timing of the briefing was also found to be important and findings revealed that when more cases were briefed or multiple surgeons briefed at the same time, there were likely to be more NREs in subsequent procedures. Finally, the attendance of surgical team members at the briefing appears to have a substantial relationship to NREs. When all surgical team members were at the briefing and also at the start of the surgical case or when supporting staff attended, there were fewer NREs observed in the following procedures.

This study suggests that team briefings are associated with more communication. Across the literature, greater communication been widely shown to support teamwork by increasing team cognition, facilitating shared mental models and situation awareness, and aiding in prospective memory. The ability to support and improve team cognitive functioning and performance in the operating room is critical for maintaining high standards of safe patient care and reducing the opportunities for errors to occur.

This study produced feasible recommendations that can be immediately implemented into the practice of briefings and used to support the development of a formal briefing protocol. Future studies will be needed to evaluate the efficacy and effectiveness of team briefing interventions. More research in general is needed to continue understanding how briefings can prove more beneficial to team functioning for the subsequent surgery and understanding how briefings, in relation to all other orientation events, can positively affect surgical team performance.

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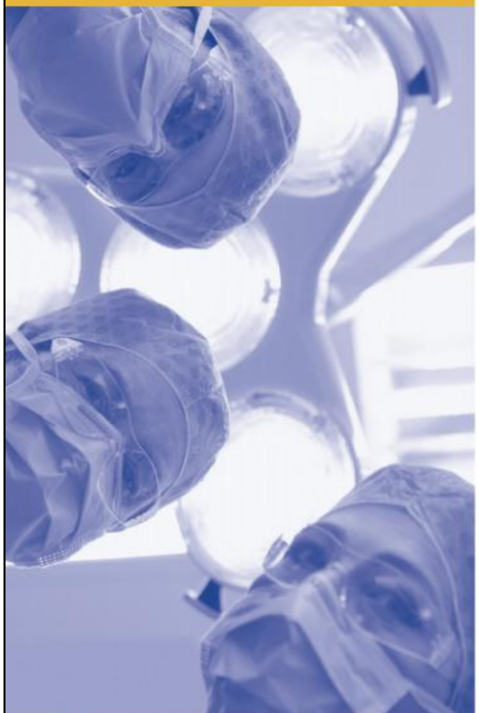
APPENDIX A

THE JOINT COMMISSION'S UNIVERSAL PROTOCOL (2004)

SpeakUP™



The Universal Protocol

for Preventing Wrong Site, Wrong Procedure, and Wrong Person Surgery™

Guidance for health care professionals

The Joint Commission

Conduct a pre-procedure verification process

Address missing information or discrepancies before starting the procedure.

- Verify the correct procedure, for the correct patient, at the correct site.
- When possible, involve the patient in the verification process.
- Identify the items that must be available for the procedure.
- Use a standardized list to verify the availability of items for the procedure. (It is not necessary to document that the list was used for each patient.) At a minimum, these items include:
  - ❑ relevant documentation
    Examples: history and physical, signed consent form, preanesthesia assessment
  - ❑ labeled diagnostic and radiology test results that are properly displayed
    Examples: radiology images and scans, pathology reports, biopsy reports
  - ❑ any required blood products, implants, devices, special equipment
- Match the items that are to be available in the procedure area to the patient.

Mark the procedure site

At a minimum, mark the site when there is more than one possible location for the procedure and when performing the procedure in a different location could harm the patient.

- For spinal procedures: Mark the general spinal region on the skin. Special intraoperative imaging techniques may be used to locate and mark the exact vertebral level.
- Mark the site before the procedure is performed.
- If possible, involve the patient in the site marking process.
- The site is marked by a licensed independent practitioner who is ultimately accountable for the procedure and will be present when the procedure is performed.
- In limited circumstances, site marking may be delegated to some medical residents, physician assistants (P.A.), or advanced practice registered nurses (A.P.R.N.).
- Ultimately, the licensed independent practitioner is accountable for the procedure – even when delegating site marking.
- The mark is unambiguous and is used consistently throughout the organization.
- The mark is made at or near the procedure site.
- The mark is sufficiently permanent to be visible after skin preparation and draping.
- Adhesive markers are not the sole means of marking the site.
- For patients who refuse site marking or when it is technically or anatomically impossible or impractical to mark the site (see examples below): Use your organization's written, alternative process to ensure that the correct site is operated on. Examples of situations that involve alternative processes:
  - ❑ mucosal surfaces or perineum
  - ❑ minimal access procedures treating a lateralized internal organ, whether percutaneous or through a natural orifice
  - ❑ teeth
  - ❑ premature infants, for whom the mark may cause a permanent tattoo

Perform a time-out

The procedure is not started until all questions or concerns are resolved.

- Conduct a time-out immediately before starting the invasive procedure or making the incision.
- A designated member of the team starts the time-out.
- The time-out is standardized.
- The time-out involves the immediate members of the procedure team: the individual performing the procedure, anesthesia providers, circulating nurse, operating room technician, and other active participants who will be participating in the procedure from the beginning.
- All relevant members of the procedure team actively communicate during the time-out.
- During the time-out, the team members agree, at a minimum, on the following:
  - ❑ correct patient identity
  - ❑ correct site
  - ❑ procedure to be done
- When the same patient has two or more procedures: If the person performing the procedure changes, another time-out needs to be performed before starting each procedure.
- Document the completion of the time-out. The organization determines the amount and type of documentation.

This document has been adapted from the full Universal Protocol. For specific requirements of the Universal Protocol, see The Joint Commission standards.

APPENDIX B

WHO SURGICAL SAFETY CHECKLIST (2009)

World Health Organization

SURGICAL SAFETY CHECKLIST (FIRST EDITION)

Before induction of anaesthesia ▸▸▸▸▸▸▸▸▸ Before skin incision ▸▸▸▸▸▸▸▸▸▸▸▸▸▸ Before patient leaves operating room

SIGN IN

☐ PATIENT HAS CONFIRMED
- IDENTITY
- SITE
- PROCEDURE
- CONSENT

☐ SITE MARKED/NOT APPLICABLE

☐ ANAESTHESIA SAFETY CHECK COMPLETED

☐ PULSE OXIMETER ON PATIENT AND FUNCTIONING

DOES PATIENT HAVE A:

KNOWN ALLERGY?
☐ NO
☐ YES

DIFFICULT AIRWAY/ASPIRATION RISK?
☐ NO
☐ YES, AND EQUIPMENT/ASSISTANCE AVAILABLE

RISK OF >500ML BLOOD LOSS (7ML/KG IN CHILDREN)?
☐ NO
☐ YES, AND ADEQUATE INTRAVENOUS ACCESS AND FLUIDS PLANNED

TIME OUT

☐ CONFIRM ALL TEAM MEMBERS HAVE INTRODUCED THEMSELVES BY NAME AND ROLE

☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE VERBALLY CONFIRM
- PATIENT
- SITE
- PROCEDURE

ANTICIPATED CRITICAL EVENTS

☐ SURGEON REVIEWS: WHAT ARE THE CRITICAL OR UNEXPECTED STEPS, OPERATIVE DURATION, ANTICIPATED BLOOD LOSS?

☐ ANAESTHESIA TEAM REVIEWS: ARE THERE ANY PATIENT-SPECIFIC CONCERNS?

☐ NURSING TEAM REVIEWS: HAS STERILITY (INCLUDING INDICATOR RESULTS) BEEN CONFIRMED? ARE THERE EQUIPMENT ISSUES OR ANY CONCERNS?

HAS ANTIBIOTIC PROPHYLAXIS BEEN GIVEN WITHIN THE LAST 60 MINUTES?
☐ YES
☐ NOT APPLICABLE

IS ESSENTIAL IMAGING DISPLAYED?
☐ YES
☐ NOT APPLICABLE

SIGN OUT

NURSE VERBALLY CONFIRMS WITH THE TEAM:

☐ THE NAME OF THE PROCEDURE RECORDED

☐ THAT INSTRUMENT, SPONGE AND NEEDLE COUNTS ARE CORRECT (OR NOT APPLICABLE)

☐ HOW THE SPECIMEN IS LABELLED (INCLUDING PATIENT NAME)

☐ WHETHER THERE ARE ANY EQUIPMENT PROBLEMS TO BE ADDRESSED

☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE REVIEW THE KEY CONCERNS FOR RECOVERY AND MANAGEMENT OF THIS PATIENT

THIS CHECKLIST IS NOT INTENDED TO BE COMPREHENSIVE. ADDITIONS AND MODIFICATIONS TO FIT LOCAL PRACTICE ARE ENCOURAGED.

APPENDIX C

2-MINUTE OR BRIEFING (MAKARY ET AL., 2007)

- ☐ **Introduction of first names and roles which are written on the whiteboard**

- ☐ **Review critical information**
  - ☐ Do we have the correct patient?
  - ☐ Is the correct side or site marked?
  - ☐ Has the procedure been agreed upon?
  - ☐ Have antibiotics been given?

- ☐ **Identify and Mitigate Hazards**

- ☐ **SURGERY:** Discuss plans for the surgical procedure:
  - ☐ Describe critical steps
  - ☐ Provide team with pertinent information, including problems that may be encountered
  - ☐ Ask team: If something were to go wrong with this procedure, what would it be, and how could we prevent the problem?
  - ☐ Risks during procedure, such as bleeding, fluid loss
  - ☐ Surgeon suggests, "If anyone has a concern during the case, please let me know."

- ☐ **ANESTHESIOLOGY:** Discuss all relevant issues:
  - ☐ Patient co-morbid disease that will increase risk
  - ☐ Aspects of surgery that increase risk, such as need for IV access
  - ☐ Availability of blood products
  - ☐ Interventions to prevent complication, such as myocardial infarction, surgical site infection

- ☐ **NURSING:** Discuss all relevant issues:
  - ☐ Are all necessary instruments available?

APPENDIX D

PRE-OPERATIVE BRIEFING CHECKLIST (LINGARD ET AL., 2005)

PREOPERATIVE TEAM CHECKLIST

Attendance for completion of checklist

At least one senior responsible representative from each profession should be present.

Anesthesia:	☐ Staff	☐ Fellow	☐ Senior resident	☐ Junior resident
Nursing:	☐ Staff	☐ Student		
Surgery:	☐ Staff	☐ Fellow	☐ Senior resident	☐ Junior resident

PATIENT INFORMATION

- ☐ Spoken language
- ☐ Family/visitor location
- ☐ Diagnosis
- ☐ History
  - Medical
  - Surgical
  - Anesthetic
- ☐ ASA status
- ☐ Medications given/held
- ☐ Allergies
- ☐ Tests
  - Images
  - Bloodwork
  - ECG
- ☐ Preoperative consultations
- ☐ Other considerations
  - Cognitive
  - Psychosocial
  - Special requests

OPERATIVE ISSUES

- ☐ Procedure
- ☐ Operative plan
  - Description of procedure
  - Side of surgery
  - Intraoperative testing and pathology specimens
  - 'Go-ahead likelihood'
  - Estimated duration
- ☐ Informed consent
- ☐ OR team
  - Experience with procedure
  - Students
- ☐ Visitors to the OR
- ☐ Operative medications
  - Antibiotics
  - Anticoagulants
- ☐ Anesthesia requirements
  - Airway
  - General or local
  - Invasive monitoring
  - Temperature maintenance (e.g., warming blankets)
  - Regional block (e.g., epidural)
- ☐ Blood products
  - Crossed and typed?
  - Grouped and reserved?
- ☐ Patient positioning and supports
- ☐ Special instruments and equipment
  - Retractor
  - Laparoscopic
  - Cell saver
  - Headlights
- ☐ Recovery location

APPENDIX E

BRIEFING/DEBRIEFING TOOL (PAPASYPROS ET AL., 2010)

BRIEFING/DEBRIEFING TOOL

Name:	Unit No:	Dob:
Operation:	Date:	Time:

	General Step Process	Check
1.	Does everyone know each other? Anything to celebrate? Anything troubling anybody?	Delete as appropriate Yes / No
2.	Is everyone familiar with theatres/equipment?	Yes / No
3.	Do we anticipate problems?	Yes / No
4.	Does everyone understand the procedure/critical steps?	Yes / No
	Reinforce to stop process 'I am not happy' is the trigger	Yes / No

	Briefing – Before every procedure	
1.	First names and roles to be written on board	Yes / No
2.	Do the following match:- Patient ID band, informed consent (read out loud), site marking, OR posting, patient's verbalization of procedure (if patient awake), other clinically relevant documentation (H&P, clinic note)	Yes / No
3.	Have antibiotics been given, what are the anticipated times of antibiotic redosing?	Yes / No
4.	Is glycaemic control/beta blockers indicated?	Yes / No
5.	Is the patient positioned to minimise injury?	Yes / No
6.	Has the prep been applied properly, without pooling and allowed to dry?	Yes / No
7.	Is the appropriate amount of blood available?	Yes / No
8.	Is DVT prophylaxis indicated?	Yes / No
9.	Any special precautions? If yes, describe	Yes / No
10.	Are warmers on the patient?	Yes / No
11.	Is the time allotted for this procedure an accurate estimate?	Yes / No

	Debriefing – After every procedure	
1.	Are there any concerns – communication/safety	Yes / No
2.	Could anything have been done to make this case safer or more efficient?	Yes / No
3.	Where can we improve?	
4.	Are the patient's name, history, number and the surgical specimen name and laterality on the paperwork? (Specimen paperwork/labeling to be independently verified by Surgeon)	Yes / No
5.	Did we have problems with instruments?	Yes / No
6.	Plan for transition of care to post op unit discussed? To include: Fluid management/blood (all slips in chart), Antibiotics – continue post op (dose interval), PACU tests/X-rays, Pain/PCA plan, New meds needed (immediate periop), Beta blockers (as required), Glycaemic control (as required, DVT prophylaxis	Yes / No

APPENDIX F

BRIEFING CHECKLIST FOR CARDIAC SURGERY (HENRICKSON ET AL., 2009)

1. RESIDENT (Surgeon)

History:

- Diagnosis
- Planned Procedure
- Significant past history
  - Low EF
  - Redo
    - CABG
    - Valve
  - Previous vein stripping
- Allergies

2. SURGEON (Resident)

- Cannulation
  - Arterial Cannula
    - Placement
      - Arch
        - Aneurysm
      - Axillary
      - Femoral
  - Venous Cannula
    - Placement
    - Type
      - Bi-caval
      - Two stage

3. SURGICAL ASSISTANT

- Length of Vein
- Positioning (IF Atypical)
- Prep (IF Atypical)

4. PERFUSIONIST

- Perfusion Pressure
- Perfusion Temperature
- Cannula Size
- Circulatory Arrest
  - Cool down temperature

5. SURGICAL TECH

- Suture
- Instrumentation

6. RN

- Valve type
- Graft
- Patch
- Special Precautions
- Concerns

7. ANESTHESIA/CRNA

- Line Placement
  - Arterial Line
    - Right
    - Left
    - Femoral
    - Radial
- Antifibrolytics
  - Aprotinin
  - Tranexamic Acid
- OR list management plan for the da

8. OTHER CONCERNS- UNIQUE TO THIS CASE

APPENDIX G

BRIEFING POSTER (EINAV ET AL., 2010)

Briefing Prior To Surgery

ENTIRE team present

Nurse

- Patient name
- Operation
- Side of operation or incision
- Special patient information e.g.
  Medical history, prosthesis

Anesthesiologist

- General, regional, combined
- Drug allergies
- Antibiotic coverage

Surgeon

Details of surgery

- Type of operation, approach
- Position
- Planned change in position
- Non routine activities
- Imaging and equipment positioning
- Special equipment
  argonbeam, cryosurgery, optics, tourniquet

Medications

- Prior to start of surgery
- During surgery

Blood

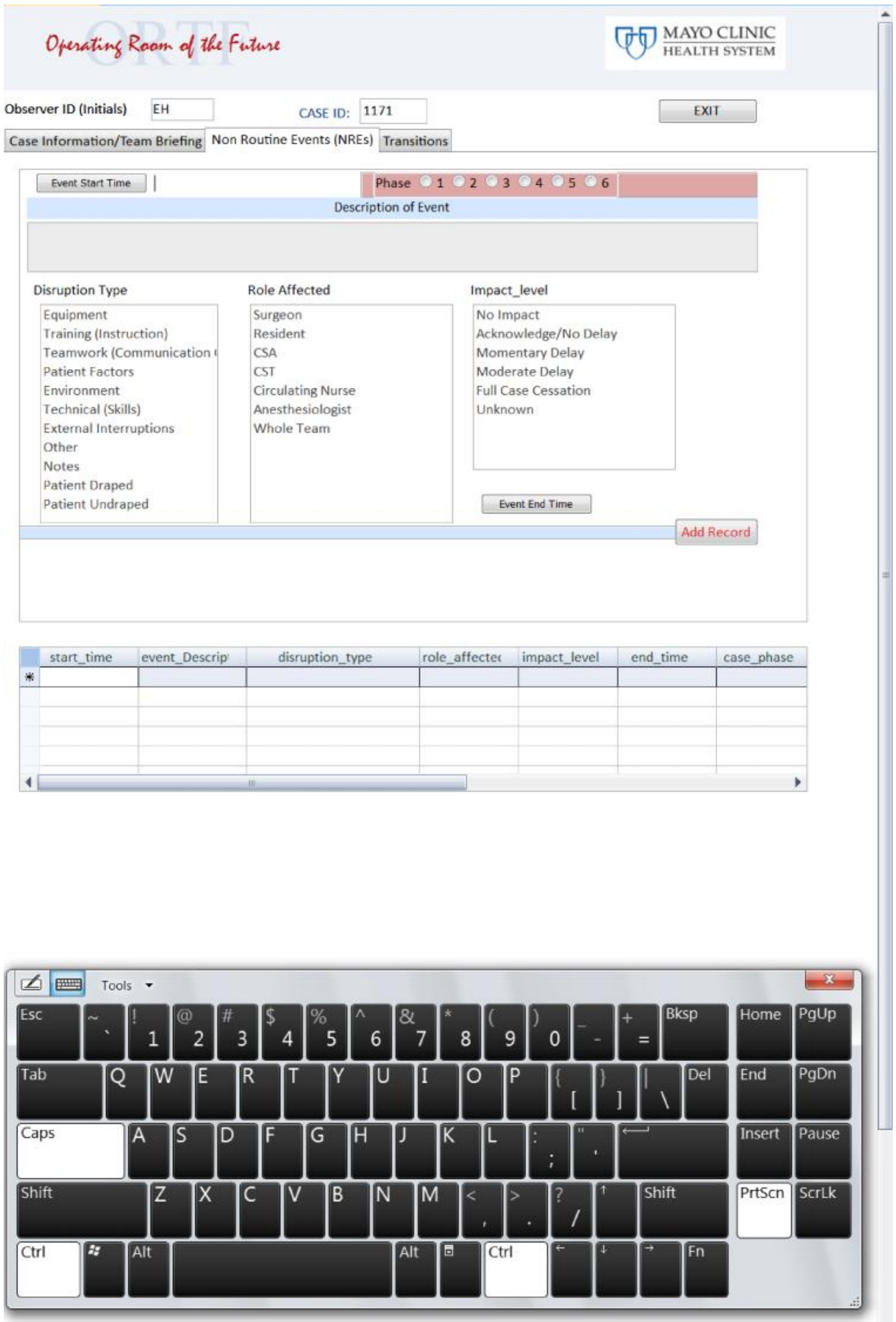
- Ordered units
- Blood Type
- Transfusion equipment
- Units available in the OR

Pathology

- Planned frozen section
- Anticipated change based on results
- Planned specimens
- Receiving Laboratory

APPENDIX H

NRE DATA COLLECTION TOOL


Operating Room of the Future
MAYO CLINIC HEALTH SYSTEM
Observer ID (Initials) EH
CASE ID: 1171
EXIT
Case Information/Team Briefing
Non Routine Events (NREs)
Transitions
Event Start Time
Phase 1 2 3 4 5 6
Description of Event
Disruption Type
Equipment
Training (Instruction)
Teamwork (Communication
Patient Factors
Environment
Technical (Skills)
External Interruptions
Other
Notes
Patient Draped
Patient Undraped
Role Affected
Surgeon
Resident
CSA
CST
Circulating Nurse
Anesthesiologist
Whole Team
Impact_level
No Impact
Acknowledge/No Delay
Momentary Delay
Moderate Delay
Full Case Cessation
Unknown
Event End Time
Add Record
start_time
event_Descrip
disruption_type
role_affectec
impact_level
end_time
case_phase
Tools

APPENDIX I

SURVEYS

Survey 1: After Pre-briefing

1. During the team briefing, which of the following items were discussed? (Circle all that apply)

a. Patient name	f. What to Anticipate
b. Patient Age	g. Additional information not on SHA
c. Patient History	h. Equipment requests
d. Diagnosis	i. Additional concerns for surgeon, resident, or anesth.
e. Surgical Procedure	j. Other, please specify ___________________

2. What do you believe should have been mentioned or included in the team briefing cases?

3. If there were multiple cases discussed during the team briefing, which case do you remember the most information about? (Circle all that apply)
    a. Case #1
    b. Case #2
    c. Case #3
    d. Case #4
4. Of the cases selected above, why do you remember so much about the case(s)? (Circle all that apply)
    a. The amount of detail provided during the team briefing
    b. It's a complicated case(s)
    c. It's the first or last case(s) of the day
    d. I will only work in this case(s)
    e. It's a familiar case
    f. Not enough details were provided about the case(s)
    g. Other, please specify _________________________

5. What do you remember from the team briefing about Case #1 specifically? (Circle all that apply)

a. Patient name	f. What to Anticipate
b. Patient Age	g. Additional information not on SHA
c. Patient History	h. Equipment requests
d. Diagnosis	i. Additional concerns for surgeon, resident, or anesth.
e. Surgical Procedure	j. Other, please specify ___________________

6. Gender? Male Female
7. What is your role? Surgeon Resident Nurse CSA CST CRNA Anesthesiologist
8. How long have you been in this role?
9. Do you normally work in gynecology? Yes No

Survey 2: After Case #1

1. Compared to other similar surgeries, how difficult was that surgery? Please rate from 0% (not difficult at all) to 100% (most difficult surgery of that kind I've done to date). Mark your rating below.

0%	25%	50%	75%	100%

2. How close would you say the actual surgical procedure matched the expectations you had based on the information you were given during the morning team briefing? Please rate from 0% (no match between pre-surgery expectation and actual surgery) to 100% (total match between pre-surgery expectation and actual surgery). Mark your rating below.

0%	25%	50%	75%	100%

3. What do you believe should have been mentioned or included in the team briefing about this case that wasn't?

4. During the time-out, do you remember the surgeon/resident reciting the following items? (circle all that apply)

   a. Patient Name
   b. Mayo Clinic Number
   c. Date of Birth
   d. Surgical Procedures
   e. Allergies
   f. Antibiotics

5. What do you believe should have been mentioned or included in the time-out about this case that wasn't?

6. Information presented at the morning team briefing helped you in managing this surgical case?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

7. The time-out helped refresh your memory regarding information presented about this case at the morning team briefing.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

8. What do you remember from the team briefing about your next case?

   a. Patient name
   b. Patient Age
   c. Patient History
   d. Diagnosis
   e. Surgical Procedure
   f. What to Anticipate
   g. Additional information not on SHA
   h. Equipment requests
   i. Additional concerns for surgeon, resident, or anesth.
   j. Other, please specify ____________________
   k. NO NEXT CASE