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A Contingency Model of Team Leadership for Emergency Medical Teams

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by

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ABSTRACT

Emergency medical teams operate under unusual circumstances. They assemble for a singular, temporary purpose, potentially change in size and composition, and their performance can influence whether a patient lives or dies. Although leadership is a critical component to team success, it is rarely investigated in the context of emergency medical teams. This study sought to examine the relationship between directive leadership behaviors and team performance outcomes. It was hypothesized that directive leadership would be particularly effective for emergency medical teams. In addition, a contingency model was proposed. Specifically, it was hypothesized that the effectiveness of directive leadership is contingent upon the complexity of the situation and the experience level of the team such that directive leadership is more effective when teams are inexperienced and the situation is complex. Neonatal resuscitation teams served as the emergency medical teams in this study. The proposed relationships were tested using observations from high-fidelity, neonatal resuscitation team training simulations. Hypotheses were not supported. Limitations and suggestions for future research for the development of leadership training curriculum are discussed.

INTRODUCTION

Leadership is a vital component to any organization (Yukl, Gordon, & Taber, 2002). Appropriately reflecting the importance of organizational leadership, volumes of research have been produced on the topic. Although leadership research has proved fruitful to some extent, room for improvement remains. Most leadership theory and research is conceptualized at the individual level (Salas, Sims, & Burke, 2005). Relations between a subordinate and leader are examined and individual outcomes are observed. However, it is well documented that teams are a popular method for organizing work in most organizations (Salas et al., 2005). It follows that the team leadership is an important organizational function.

Leadership is believed to be a central factor in trauma team management (Hjortdahl, Ringen, Naess, & Wisborg, 2009). However, in the few cases in which team leadership is examined, the teams observed are rarely emergency medical teams (Yun, Faraj, & Sims, 2005). Few studies offer specific behavior recommendations for leaders (Komaki, 1994) and it is not clear whether recommendations based on one type of team such as sailing crews would transfer to another type, such as medical emergency teams. Medical emergency teams face special circumstances. They are assembled for a temporary purpose and they are not set, permanent, or long-term in the traditional work-team sense. Their compositions may change during the execution of an activity and the activity can escalate from routine to highly complex. Most significantly, their performance can affect whether a patient lives or dies.

This study sought to study the role that specific leadership behaviors play in team performance outcomes. It was hypothesized that directive leadership is particularly effective in emergency medical teams. In addition, a contingency model that is based on the special circumstances of emergency medical teams was tested. Specifically, complexity and team experience were hypothesized as moderators. Neonatal resuscitation teams were the particular type of emergency medical teams examined for this study. The proposed relationships were tested using high fidelity, neonatal resuscitation team training simulations. Overall, the aim was to provide empirical evidence for directing team leaders toward the appropriate behaviors in a given situation.

Neonatal Resuscitation Teams

One of the most dangerous events a human being encounters is one's own birth. In the United States, approximately 10% of newborns are unable to breathe on their own when they are delivered (Boyle & Bloom, 2006). In such instances, a neonatal resuscitation is performed. With over 4 million U.S. births annually, this translates to over 400,000 neonatal resuscitations being performed in hospitals every year.

Several medical professionals are needed to perform a neonatal resuscitation. As soon as the emergency is known, available healthcare professionals rush to the newborn in need. The team they form is multidisciplinary and cross-functional, consisting of some of the following roles: neonatologists; pediatric, family practice, and obstetrical residents; pediatricians caring for newborns; neonatal nurse practitioners; neonatal, labor and delivery, post-partum, and emergency room nurses; pre-hospital staff including emergency medical technicians; and paramedics. These individuals immediately respond to the emergency, regardless of whether they know one another or the patient. Suddenly, the life of a newborn is in the hands of a team that may never have worked together previously. On top of the highly demanding task of resuscitation, team members must work with possible strangers in order to accomplish the task.

An algorithm exists to direct the technical steps needed to perform these resuscitations. However, there is no algorithm for the nontechnical teamwork skills required for this task.

The composition of these teams is highly variable. Not only is team membership based on who is physically present at the time of the emergency, composition also changes based on the severity of the situation. Both the number of team members and the type of medical professional(s) present are subject to the needs of the newborn. Generally, as the severity of the situation increases, the size of the team increases and the most knowledgeable for the task (i.e., a neonatologist) is more likely to be present.

This fluid composition creates a unique leadership situation. Formal leadership may not be directly designated to a single member of the team. Even if leadership is formally designated, the leader could change with each composition change. The leader could be the most senior member, the person with the most knowledge about the specific case, or shared between a few members simultaneously. For these reasons, this study examines leadership behaviors from a team leadership perspective. Team leadership involves providing direction, structure, and support to other team members (Salas et al., 2005). Such actions do not always come from formal authority given to a single individual, and thus leadership can emerge from any member of the team.

With exception of the task being performed and the knowledge required to accomplish it, neonatal resuscitation teams are highly similar to other medical emergency teams like cardiac and trauma teams due to shared characteristics including the objective to save a life and rapidly changing team composition (e.g. Yun et al., 2005; Tschan et al., 2006). Although these characteristics create similarity among medical emergency teams, they distinguish them from other teams such as cockpit crews and traditional work teams whose tasks do not consist of needing to save a life within minutes with a team composition that is likely to change within minutes.

Distinguishing medical emergency teams from other teams. It is important to highlight how medical emergency teams are distinct from other work teams to illustrate that (a) findings from these studies might not generalize to medical emergency teams and (b) recommendations from these studies may prove difficult or impossible to apply to medical emergency teams.

Like medical emergency teams, crews consist of highly trained professionals with a range of statuses and roles working together on a shared task. Among the well-studied crews are cockpit crews. These crews usually consist of a pilot and a co-pilot. Although the pilot might not always have the same co-pilot and vice versa, there is a set number for team membership, a luxury not afforded to medical emergency teams. Additionally, crews usually implement pre-briefing in their routine. Pre-briefing provides an opportunity to share information about the environment and/or task before the task actually begins. This briefing has been shown to be positively related to team performance (Marks, Zaccaro, & Mathieu, 2000). However, in fast-paced emergency environments, the team has to act as it is being formed, making time for preaction briefing highly unlikely (Tschan et al., 2006). Even if the team that begins the medical action pre-briefs, preaction briefing for the team members that enter the situation as it progresses is not possible because the action has already begun.

Traditional work teams are the standard representation of teams. Their composition can vary depending on the function of the team but usually remains the same over a considerable period of time or at least until the task is completed. The team could be the board of a not-for-profit organization revising their constitution, a research and development team working on a new product, or a basketball team drawing up a new play. In these instances, the members know one another or get the opportunity to develop relations with each other over time. A highly recommended way of leading teams is by using relations-oriented behaviors like supporting, empowering, developing, consulting, and recognizing (Yukl et al., 2002). In the case of a medical emergency team leader, however, there is most likely no time allotted for consultation about the next action or kudos for a successful intubation during the task. Health professionals do have the opportunity to get to know one another over time but are unlikely to work with the same group of people for every emergency situation.

Despite such differences from teams as they are traditionally conceptualized, medical emergency teams are still in fact teams. The literature is cluttered with varying definitions of teams but most definitions are highly similar to one another. For the purposes of this study, a team will be defined as two or more people with different tasks who work together adaptively to achieve specified and shared goals (Brannick, Salas, & Prince, 1997). Work within the team is both simultaneous and sequential. Specifically for neonatal resuscitation, when a team member performs chest compressions while another pumps the air bag, simultaneous task performance is occurring; when a resident administers medicine once it's been measured by a nurse, sequencing has occurred.

Team Leadership

Because medical emergency teams meet general standards of what constitutes a team, theoretically, a model of teamwork can be applied to them. In an effort to analyze and synthesize over 138 team models in the literature, Salas et al. (2005) proposed five competencies that a vast majority of these models share: team leadership, mutual performance monitoring, backup behavior, adaptability, and team orientation. Despite the existence of over 100 team models, most agree that leadership is a central component of team work. Leadership is perceived as a key component of emergency medicine by trauma team leaders and team members as well (Hjortdahl et al., 2009). Team leadership is defined as the "ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team knowledge, skills, and abilities, motivate team members, plan and organize, and establish a positive atmosphere" (Salas et al., 2005, p. 560). Leadership also serves as a means of guiding the remaining competencies.

Several studies have linked leadership to team effectiveness (Stewart & Manz, 1995; Cooper, 2001) but few provide specific behaviors that can be used to improve team performance (Komaki, 1994) and far fewer have studied leadership in the context of medical emergency teams. This study attempts to reduce the ambiguity of prescribing leadership behaviors by examining specific leadership behaviors and their associated outcomes.

Directive leadership. In an effort to describe and explain leadership processes, a plethora of leader behavior theories have been proposed and tested. Like the leaders that are the subjects of these theories, the success of leader behavior theories has ebbed and flowed. A consistent behavior classification system that has been used over the years is task-oriented versus relational-oriented leadership behaviors. Task-oriented behaviors include actions like identifying and clarifying roles, setting performance expectations, anticipating a task-oriented issue, and taking corrective action (Derue, Nahrgang, Wellman, & Humphrey, 2011). Relational-oriented behaviors include being friendly, welcoming input from followers, and being concerned with team members as individuals. Central to the purpose of these behaviors is to make followers put the well-being of the team at the forefront (Derue et al., 2011). Often, these categories of leader behavior are treated as opposite ends of a continuum. However, the presence of task-oriented behaviors does not mean the absence of relations-oriented behaviors or vice versa.

The high level of cognitive skills and technical skills needed to resuscitate a newborn contribute to the task-oriented nature of this situation. In addition, the fact that multiple people are needed to simultaneously and sequentially complete specific tasks means that considerable coordination is necessary. In this context, task-oriented leader behaviors like directive leadership behaviors should be beneficial. Directive leadership behaviors consist mostly of communications that direct team traffic (e.g. giving directions for immediate action or planning ahead) and have been shown to be positively related to medical team performance (Tschan et al., 2006; Yun et al., 2005). On the other hand, the possible unfamiliarity with team members and changing team composition can make it difficult to establish meaningful relationships within the team. Because resuscitation teams vary in composition, they might not be as familiar with one another as members of a formal work team. Additionally, one goal of relational-oriented behaviors is to promote the well-being of the group but the greatest concern of resuscitation teams is the well-being of the newborn. Because of these factors, relational-oriented leader behaviors might not be particularly useful. Of course, team members should not be egregiously inconsiderate of team members (e.g. name calling).

Studies have shown that both types of leader behavior predict successful team performance (Bates, Bass, Avolio, Jung, & Berson, 2003). However, when the team is a medical emergency team, these findings do not necessarily apply. Cooper and Wakelam (1999) found that task-oriented behaviors positively influenced performance while relations-oriented behaviors had no effect in a study of cardiovascular resuscitation teams. For these reasons, task-oriented directive leadership behaviors will be examined.

In addition to task-oriented behavior, directive leadership is sometimes empirically investigated under the umbrella of initiating structure (Pearce et al., 2003). Initiating structure behaviors are those behaviors that focus on achieving task assignment by reducing ambiguity and providing structure. Directive behaviors are a subset of initiating structure, and include actions such as initiating and organizing work activity, assigning tasks, deciding how work will be done, and providing clear communication channels (Pearce et al., 2003).

In a meta-analysis conducted to explore the outcomes of initiating structure leadership behaviors, Judge, Piccolo, and Ilies (2004) found moderate relationships with leadership outcomes (.29) and group-organization performance (.23). In an effort to expand upon these results, Burke et al. (2006) found that initiating structure significantly impacted perceptions of team effectiveness and team productivity. In addition, for perceptions of team effectiveness, task-focused leadership accounted for 11% of the variance in highly interdependent teams like medical teams (as opposed to only 1% for teams with low interdependence) (Burke et al., 2006). In the context of health care, perceptions of team effectiveness have been shown to be related to less burnout and fewer labor and delivery delays (Sexton et al., 2006 as cited in Thomas et al., 2007).

The direct, clear communication that directive leadership provides is critical for healthcare teams. Seventy-two percent of perinatal death and injuries are attributed to failures of communication (Joint Commission, 2004). Hynes, Kissoon, Hamielec, Greene, and Simone (2006) attributed deficiencies in leadership of cardiac arrest teams to ineffective delegation and communication skills. These deficiencies can lead to a poor team climate which could ultimately negatively affect patient treatment.

When directive leadership is present, it can have substantial benefits for medical teams. Leaders that provide structure for the team, give direction that maintains standards and prioritizes medical treatment, and explicitly communicate what needs to be done and how it needs to be done were associated with effective team performance (Klein, Ziegert, Knight, & Xiao, 2006). These directive leadership behaviors give team members the opportunity to coordinate and cooperate with one another as well. A study of cardiopulmonary resuscitation teams during simulation training revealed that successful teams displayed significantly more leadership behaviors than unsuccessful teams (Marsch et al., 2004). Leadership behaviors included letting the team know what is expected of them, deciding what should be done, deciding how it should be done, and assigning group members to particular tasks. These behaviors capture the scope of directive leadership behaviors.

In another cardiopulmonary resuscitation simulation study, Hunziker et al. (2010) tested the effects of providing brief leadership instruction as opposed to technical instruction before teams participated in the simulation exercise. The teams that received leadership instruction performed more successfully (using objective measures of uninterrupted resuscitation time and time to start resuscitation) and had more leadership utterances. Even brief, minimal leadership training seemed to be beneficial.

These findings suggest that team performance benefits from leadership that provides clarity and direction for team members. This leads to the first hypothesis.

Hypothesis 1: Directive leadership behaviors will positively impact team performance.

Contingencies in Medical Emergency Team Leadership

A contingency model of leadership posits that there are certain aspects of the situation that can affect leadership effectiveness (Miner, 2005). First theorized by Fiedler in 1967, the situational variables usually examined in a contingency model concern task type or structure, the leader's position power, and the leader's interpersonal relationship with team members (as cited in Miner, 2005). For example, Fiedler (1978) proposed that a leader high in task orientation will perform best in low and high control situations whereas a leader high in relations orientation will perform best in moderate control situations (as cited in Ayman, Chemers, & Fielder, 1995). Since the theory's inception, these variables have evolved and others have been tested. Although the model has received substantial criticism over the decades, it has also inspired hundreds of empirical studies (Ayman et al., 1995).

Three meta-analyses indicate support for contingency models (Strube & Garcia, 1981; Peters, Hartke, & Pohlman, 1985; Schriesheim, Tepper, & Tetrault, 1994). Despite some limitations, the theory seems to be mostly correct in terms of predicting performance. Performance was best for groups lead by leaders in which the situation aligned with the leader's task or relations orientation. Situations varied by factors such as level of control, position power, and task structure.

In comparison to individual differences, research by Vroom, Yetton, and Jago (Vroom, 2000; Vroom & Jago, 1988; Vroom & Yetton, 1973) suggests that the situation explains approximately three times more variance (as cited in Vroom & Jago 2007). Over the years, situational factors or contingencies considered have expanded to include such diverse topics as type of industry, group membership, cultural differences, goal type, and performance criterion type (Avolio, 2007). For example, Hofman, Morgeson, and Gerras (2003) found that the leader's style positively influenced the follower's safety citizenship behavior only in positive safety climates. The relationship did not hold in less positive safety climates, indicating safety climate as a contingency for this study. For virtual teams, Huang, Kahai, and Jestice (2010) suggested that leadership styles influence task cohesion and cooperative climate but only in environments low in media richness (technology low in ability for immediate feedback, multiple cues, ability to reduce ambiguity, and personalization; e.g. instant messenger applications). These studies illustrate how leadership effectiveness is moderated by situational moderator variables, a relationship first posited by contingency theory.

Greater familiarity with the task, environment, and special circumstances of a team can provide better insight about what aspects of the situation can augment or deter the effect leadership has on team performance. With respect to medical team leadership:

> Depending upon varying external factors such as the patient's condition, standardization, and the experience and knowledge of other team members, different levels of leader involvement and different leadership patterns relative to these varying external factors seems to be the most effective. The effectiveness of a leader in critical care teams appears to be strongly contingent on the particular situation… (Kunzle, Kolbe, & Grote, 2010, p. 14).

Based on the characteristics of medical emergency teams described previously and some empirical findings, two situational aspects that seem to influence leadership effectiveness on performance are complexity and experience.

Complexity. Factors that contribute to complexity in neonatal resuscitations include the severity of the patient's illness and other environmental factors (e.g. responding to questions from the newborn's parents). Neonatal resuscitations vary in their difficulty. The length of time needed to resuscitate the patient serves as an indication of difficulty. As time increases, the number of resuscitation procedures used usually increases as well. In addition, the procedures increase in difficulty (more technical and teamwork skills needed). Some newborns begin breathing on their own after only a few chest compressions while others require more time, needing intubation and medication.

As complexity changes, the demands on the leader change. In a study of sailing teams, Komaki and Minnich (2002) found that leaders changed supervisory behaviors according to the task that needed to be completed by the team. These tasks varied on the degree of technical and teamwork skills needed to accomplish them. In complex situations, leaders that plan and implement relevant structuring activities tend to emerge, and these structuring activities (similar to directive leadership behaviors) are associated with high quality performance (Marta, Leritz, & Mumford, 2005). Also, planning is more likely to occur as complexity increases.

In the specific context of medical emergency teams, a few empirical studies have demonstrated the importance of the interaction between complexity and leadership. In a study of cardiovascular resuscitation teams, directive leadership behaviors positively influenced performance during the most complicated phases of the task (Tschan et al., 2006). Similarly, Yun et al. (2005) illustrated that directive leadership (as opposed to empowering leadership) was more potent in high severity cases of trauma resuscitation. These findings lead to the second hypothesis.

Hypothesis 2: The relationship between directive leadership and team performance is moderated by complexity. The positive influence of directive leadership behaviors on team performance will be stronger in more complex situations.

Experience. The remaining situational variable studied here is experience. Because a neonatal resuscitation team could be potentially staffed by so many different professionals, their level of experience with the task varies. Certain medical professionals like neonatal nurses might participate in neonatal resuscitations more often than paramedics, for example. As a result of neonatal resuscitation being a more novel task for some, inexperienced teams need more direction. Allowing an inexperienced person to lead could have fatal consequences. Inexperienced teams might welcome directive leadership and begrudge nondirective leadership behaviors like consultation because of low knowledge and skill level.

Many theories articulate that directive leadership behaviors are less relevant for experienced teams. The path-goal theory of leadership supports this notion (e.g. House, 1971). A high presence of directive leadership in experienced teams could have negative consequences like dissatisfaction among team members (House, 1971). Perhaps members highly familiar with the task resent direction they perceive as unnecessary. Some researchers even contend that experience can serve as a substitute for leadership (Kunzle, Zala-Mezo, Kolbe, Wacker, & Grote, 2010).

Yun et al. (2005) illustrated that nondirective leadership behaviors (specifically, empowering leadership behaviors) are more important for teams high in experience. However, directive leadership behaviors proved most useful with inexperienced teams when patient severity was high. In anesthesia teams, nurses fit their leadership behaviors to the experience of other team members (Kunzle et al., 2010). The final hypothesis reflects these theoretical developments and empirical findings.

> *Hypothesis 3:* The relationship between directive leadership and team performance is moderated by team experience. The positive influence of directive leadership behaviors on team performance will be stronger in teams with low experience.

Some of the proposed hypotheses have been tested and mostly supported by Yun et al. (2005). Their findings are a rare example of an examination of contingency leadership in medical emergency teams. However, these findings were based on a written scenario method. The current study sought to establish and provide greater support for these relationships using a high fidelity simulation setting that more closely approximates an actual resuscitation task.

METHOD

Participants

Healthcare providers at a large, urban teaching hospital in the southeastern U.S. participated in a team training course for neonatal resuscitation. This training is a part of an ongoing certification process for neonatal resuscitation required for healthcare providers that (potentially) staff labor and delivery, newborn, and neonatal intensive care units. The medical occupations of those who took part in the study included attending physician, nurse practitioner, resident, transport registered nurse, respiratory therapist, neonatal intensive care unit (NICU) registered nurse, or registered nurse from departments outside of the NICU. The neonatal intensive care unit is a level III unit ("defined by having continuously available personnel (neonatologists, neonatal nurses, respiratory therapists) and equipment to provide life support for as long as needed," (Committee on Fetus and Newborn, 2004, p. 1344)) that delivers around 5000 infants annually.

Training took place in a team training center that provides a high fidelity simulation experience. All individuals that participated in the neonatal resuscitation program (NRP) were eligible. No other factors were used to determine who was or was not included as participants in the current research. All trainees were asked to participate. Participation involved agreeing to allow videos recorded during simulation to be watched and coded for various behaviors and outcomes by researchers. Individual identities were not revealed throughout the research and publication process. It is possible that some trainees might be included in more than one training session. Data were collected for 26 training courses; the number of participants was 288. Due to concerns for anonymity (e.g. creating a psychologically safe space for learning), further demographic information about participants was not made available.

Local IRB permission was obtained before any data were collected, and informed consent was obtained from all study participants.

Training Program

Prior to arrival at the team training center, participants were expected to have completed a number of exercises as part of the Neonatal Resuscitation Program (NRP) certification process. Self-study materials consist of the NRP Textbook, 5^{th} Edition and Simply NRP, a 45-minute DVD. The DVD provides learner-directed exercises that allow participants to view basic skills that include using a mask and resuscitation bag for ventilation, performing chest compressions, and simulating the first few steps of resuscitation with a manikin and a simulated wall panel equipped with oxygen tubing. In addition, trainees must pass an online NRP multiple-choice test before attending team training.

During each team training session, four NRP instructors taught up to twelve participants. A minimum of two of these instructors were highly trained in simulation technology and team debriefing specifically. An entire training session lasted about 5 hours.

Simulation used during the course was considered to be high fidelity. Learners used a realistic, infant manikin for hands-on resuscitation experience in a simulated delivery room. The room was fully equipped with real medical equipment that would be readily available in an actual hospital delivery room. The simulation allowed learners to practice skills repeatedly without causing harm to patients. After each simulated scenario, learners and instructors could watch the videotaped resuscitation to review the positive and negative aspects of each simulation in a psychologically safe environment. Repetition, guaranteed patient safety, and debriefing are difficult to effect in a clinical setting with real patients. Physician and nurse learners have positively evaluated such a high fidelity simulation program (Halamek et al., 2000). When attempting to train complex skills, simulation has been proven to be a successful tool (Salas & Burke, 2002).

Although learners were instructed to organize roles such as team leader among themselves before each simulation, such role assignment was never formally taught. Therefore the roles may not have been clear. Furthermore, the policy at the time allowed for changes in the designated leader during the exercise. Formal leadership training was not covered prior to the training session.

Experimental Design

All of the participants that attended the same training day constituted a team. On a given training day, learners participated in four out of a possible 15 resuscitation scenarios. Thus, each team completed four trials or simulated scenarios as part of training. Scenario complexity (difficulty) was randomly assigned without replacement across trials. The assignment of scenarios by complexity was designed to avoid confounding trials by complexity (for example, not all teams completed the easiest scenario first). Random assignment by complexity also helped prevent researchers from determining the scenario's placement in the sequence of trials based on the scenario's content. The sampling of four of 15 scenarios helped to ensure that the teams would not have known what scenario to expect.

Each scenario or trial was digitally recorded with audio and video from two different angles. The recording also included continuous, real-time data from the simulated neonate (EKG, respiration, etc.). The videos for a given training trial were separated from the other trials, given a unique identifier, and randomized across trials and teams before assignment to the judges. Therefore, judges were blind to scenario order and typically saw different teams across videos rather than the same team over multiple scenarios. Each resuscitation simulation (trial) was rated by the judges for specific leadership behaviors and outcomes. Different raters coded team process variables and team outcome variables. Twenty-six training days were included in the study so there were 26 teams in all. However, due to audio and/or visual technical difficulties in recording, four recordings were not included (two teams only had two trials each). In total, 100 trials were rated.

Rater Training

Rater training for directive leadership behaviors consisted of a combination of frame-of-reference training (FOR) and behavioral observation training (BOT). FOR training provides a shared frame of reference for raters to evaluate performance. In an effort to make evaluations of behavior accurate, raters are trained to match ratee behaviors to corresponding dimensions of performance and judge the quality of specific ratee behaviors (Noonan & Sulsky, 2001). FOR focuses on evaluation of behavior; BOT is principally concerned with how well raters *observ*e behavior. BOT explicitly tells raters what specific behaviors to look for and urges that notes are taken during performance (Noonan & Sulsky, 2001). Both raters were knowledgeable about common rater issues like halo and leniency.

As an exemplar of high quality team and leadership performance, a scripted training video with paid actors was used (MasterTrainInc, 2008). In the video, the doctors treat a pediatric patient in cardiac arrest. The high quality of leadership behaviors displayed in this training video allowed for FOR training. The frequent and clear use of directive leadership behaviors provided material for BOT. A codebook that clearly defined each directive leadership behavior, provided a specific time stamp for when that behavior occurred in the example video, and provided space for taking notes was used by raters. The codebook also listed behaviors specific to neonatal resuscitation that would likely occur during simulation training and categorized them according to which directive leadership behavior they would apply to.

In the first rater training session, raters meticulously watched the exemplar video, stopping frequently to point out directive leadership behaviors and classify them as direction, instruction, correction, or planning. Disagreements about whether or not a leadership behavior occurred and how to classify it were discussed. Over three more training sessions, raters independently coded eight videos from the same NRP training used for this study (these ratings were not included in analyses). Agreement between raters increased with each rater training session. In the last round of training, ratings between raters were within one point of each other.

Measures

Directive leadership behaviors. Directive leadership behaviors from Tschan et al. (2006) were used to ascertain leadership in this study. Behaviors from team members were coded as directive leadership behaviors if a team member: (1) gave directions for immediate action (direction); (2) gave specific instructions about how a technical act should be performed (instruction); (3) corrected the acts of others (correction); or (4) planned ahead (planning) (see

Appendix A). These behaviors have been previously shown to positively impact team performance (Tschan et al., 2006).

Two psychology doctoral students served as raters and independently coded the videos for the frequency of the four kinds of behaviors. A score of '0' was given if the behavior did not occur, '1' if only one or two rare examples of the communication/behavior occurred, '2' if there were isolated examples of the behavior/communication throughout the simulation, '3' if the behaviors/communications occurred intermittently, and '4' if there were frequent, explicit examples of the behavior/communication throughout the simulation. Scores from each rater were averaged for each type of leadership behavior. Average scores from each type of leadership behavior were added to create a directive leadership behavior total.

Scenario complexity. To target specific technical, behavioral, and cognitive learning objectives, multiple scenarios were developed for the NRP training course. These scenarios are varied in their degree of complexity. Some scenarios require only a few steps of the NRP algorithm to be completed while others might require that all steps are completed before successful resuscitation occurs. The different technical skills used during resuscitation (e.g. intubation, injection) also affect complexity. The complexity of the simulation is also increased when a confederate is added to the scenario. The confederate, a team training center staff member, could portray the role of an upset mother, for example. A neonatologist evaluated all scenarios and assigned a numerical score to indicate complexity from one for low complexity to five for highest complexity (see Appendix B). This score reflected the intended complexity of the scenario based on the initial diagnosis of the patient along with the confederate. That is, complexity was a function of the scenario as it was designed, rather than as it evolved in response to the team's actions.

Experience. Participants in the training session had varying levels of actual neonatal resuscitation experience. For example, a neonatologist would likely perform better than a paramedic due to the neonatologist's routine resuscitation involvement. Therefore, the performance of a team with a neonatologist would be predicted to be superior to that of a team without one. Based on these factors, a neonatologist provided a numerical score indicating each team's level of experience. Points for each participant were assigned based on their medical occupation as follows: five points for attending physician, four points for mid-level (e.g. nurse practitioner or resident), three points for transport registered nurse (RN) or respiratory therapist, two points for neonatal intensive care unit (NICU) RN, and one point for non-NICU RN. These points were summed for a team experience score (see Appendix C).

Performance. Each resuscitation (trial) by each team was evaluated by a trained NRP instructor to assess performance. Evaluation was based on the NRP performance checklist (see Appendix D). The performance checklist was developed according to the NRP algorithm steps of resuscitation. The instructor used a data sheet to indicate whether each step of the resuscitation was appropriate for the situation and whether the step was completed within the sequential boundaries established by the algorithm. Others have used similar methods to establish objective performance measures (Carbine, Finer, Knodel, & Rich, 2000; Thomas et al., 2006). The instructor providing algorithm scores did not provide any scores related to leadership.

RESULTS

Rater Agreement

Leadership behavior ratings between two fixed raters were evaluated for consistency using a two-way mixed model to compute intra-class correlation coefficients (ICC). The two-way mixed model was appropriate for these analyses because it assumes error from raters is fixed and allows for random error from subjects. ICCs were *.21* for direction, -*.12* for instruction, *.20* for correction, and *.53* for planning. Ratings of instruction (specifying directions about how a technical act should be performed) were removed due to its negative ICC value. Although remaining ICC values were below a desirable level, analyses for the hypotheses were conducted using the aggregated ratings, ratings from the first rater only, and raters from the second rater only, respectively. No differences between analyses in terms of inferences were discovered; therefore, the results discussed here are from aggregated ratings.

Descriptive Statistics

Descriptive statistics can be found in Table 1. Correlations for all measured variables are also shown in Table 1. Significant correlations are marked within the table. Experience and performance were significantly correlated (.21, $p < .05$). It is also important to note that there is a significant correlation between complexity and trial (.32, $p < .01$). A significant relationship between intended scenario complexity and trial appears to violate the assumption that complexity was randomly assigned to trial.

Table 1. Descriptive Statistics and Correlations

	M	*SD*	1	2	3	4	5	6	7	8
1. Trial										
2. Complexity	2.84	0.84	0.32**							
3. Experience	6.91	1.38	-0.12	0.06						
4. Direction	3.52	0.36	-0.07	0.01	-0.03					
5. Instruction	0.22	0.36	0.09	0.11	0.04	0.21*				
6. Correction	0.40	0.48	0.00	-0.02	-0.06	0.09	0.12			
7. Planning	0.45	0.49	0.11	0.18	-0.01	0.24*	0.47**	-.04		
8. Leadership Total	4.38	0.84	0.04	0.10	-0.05	0.62**	0.70**	0.59**	0.67**	
9. Performance	0.77	0.11	-0.03	-.05	0.21*	0.19	0.01	0.09	-0.17	0.03

*Notes: *p < 0.05; **p < 0.01; N = 100 trials*

Hypotheses Tests

An analysis of covariance model (maximum likelihood mixed model implemented in SPSS version 22) was used to test hypotheses. For each analysis, trial was the repeated factor and team was the subject. This model analysis allows for time-varying covariates. The time-varying covariates in this study were experience, complexity, and leadership. The dependent variable was performance (score on adherence to the NRP algorithm). The model allowed for testing the study hypotheses. The results for the main model (analysis of covariance) are shown in Table 2. The categorical variable (trial) and the continuous variables (leadership, experience, and complexity) were all considered fixed rather than random. The model coefficients were estimated simultaneously.

Hypothesis one. Hypothesis one concerned the impact of directive leadership. As can be seen in Table 2, the coefficient for directive leadership was not significant and thus the hypothesis was not supported. The same model was analyzed for individual leadership behaviors by replacing total leadership with the scales for direction, correction, and planning ahead, respectively. These individual leadership behaviors also did not significantly predict performance.

Table 2. Results of ANCOVA on Performance

	Numerator df	Denominator df	*F*	Sig.
Intercept	1	88.33	50.13	0.00
Experience	1	72.82	2.32	0.13
Trial	3	73.77	0.11	0.96
Complexity	1	89.35	0.04	0.84
Leadership Total	1	92.96	0.09	0.76

Note: Dependent variable is Performance.

Hypothesis two. To test hypothesis two (whether complexity moderated the hypothesized relationship between leadership behaviors and performance), trial, leadership total, and complexity were entered as predictors of performance with experience as a covariate. Fixed effects included trial, leadership, complexity, experience, and an interaction term of leadership and complexity. Table 3 shows the results of this model test. The test of the interaction was not significant (nor were the main effects for leadership and complexity). As done for hypothesis one, models with individual leadership behaviors (rather than the total) were tested. These models also failed to support the hypothesized interaction.

Table 3. Results of ANCOVA with Complexity as a Moderator

	Numerator df	Denominator df	*F*	Sig.
Intercept	1	84.59	11.27	0.00
Experience	1	68.43	2.54	0.12
Trial	3	73.32	0.08	0.97
Complexity	1	85.62	0.28	0.60
Leadership Total	1	87.01	0.16	0.69
Complexity x Leadership Total	1	85.43	0.25	0.62

Note: Dependent variable is Performance.

Hypothesis three. The third hypothesis concerned whether experience moderated the proposed relationship between leadership behaviors and performance. Performance remained as the dependent variable. Again Trial, Experience, and leadership were entered as predictors while complexity served as a covariate. This model included an interaction term between experience and leadership. Model results are listed in Table 4. Additionally, giving direction, correcting others, and planning ahead, respectively, were modeled as predictors (in place of leadership total). They were not significant predictors.

Table 4. Results of ANCOVA with Experience as a Moderator

	Numerator df	Denominator df	*F*	Sig.
Intercept	1	89.67	3.93	0.05
Experience	1	91.32	0.33	0.57
Trial	3	73.29	0.11	0.95
Complexity	1	88.93	0.06	0.81
Leadership Total	1	85.69	0.09	0.76
Experience x Leadership Total	1	87.92	0.06	0.80

Note: Dependent variable is Performance.

In addition to tests of hypotheses, secondary analyses were conducted to test what factors predicted the presence of leadership behaviors (see Table 5). Trial, experience, nor complexity significantly predicted leadership total, direction, correction, or planning.

Table 5. Results of ANCOVA on Leadership Total

	Numerator df	Denominator df	*F*	Sig.
Intercept	1	88.33	50.13	0.00
Experience	1	72.82	2.32	0.80
Trial	3	73.77	0.11	0.73
Complexity	1	89.35	0.04	0.36

Note: Dependent variable is Leadership Total.

DISCUSSION

This research investigated the role of directive leadership behaviors in medical team simulations. Specifically, a contingency model in which the effectiveness of directive leadership behaviors depended on the team's experience level and the complexity of the simulation was proposed and tested. However, analyses did not support this model.

Table 1 shows a positive correlation between directive leader behavior and team performance that is consistent with the first hypothesis (and previous findings in the literature), although the result is not statistically significant. Statistical power is an issue for this research; the study was powered for a larger effect than what was observed.

Although many contingency models seem theoretically and practically sound, they can be difficult to empirically support (Podsakoff, MacKenzie, Ahearne, & Bommer, 1995). Because there are so many possible candidates for situational variables, it can be a challenging task to isolate the variables that are significantly moderating the relationships between predictors and outcomes if any exist.

It is also worrisome that there was no effect of trial on team performance. One would expect that performance would improve with deliberate practice with feedback. Although the teams may have encountered more difficult scenarios later in practice, scenario complexity was controlled statistically, and thus the learning over trials was expected to accrue and result in a significant trial effect.

One possible reason for the lack of significant findings may be the reliability of the team performance score. The score represents adherence to an algorithm devised by the NRP to benchmark excellent care. The measure is clearly relevant to the quality of care, but we do not have data on test-retest or alternate forms (scenarios) reliability of the scores. If team performance itself is unreliable, then it will be very difficult to predict or to show improvement over trials.

Limitations

The limitations of this study included the low presence and low variability of directive leadership behaviors. For example, out of a possible 20, the average frequency for directive leadership behavior total was 4.38 (SD = .84). Most teams provided plenty of direction, but there were very low instances of instruction, correction, and planning (see Table 2). Not being able to model outcomes across several levels of leadership behavior (i.e., range restriction) could have been problematic for the analysis of hypotheses. In addition, low occurrence and low variability of leadership behaviors possibly explains the low ICC between raters.

Although external validity was augmented by the use of video recordings of high fidelity simulations (as opposed to written scenarios like those used by Yun et al. (2005)), lack of experimenter control was also a limitation. For instance, efforts to randomly assign intended scenario complexity to trial were made but the correlation between trial and complexity suggests that this did not fully occur. This research had to be conducted within the confines of the NRP training program as it existed at this particular hospital. Changes to the training program could not occur before data were collected. For example, researchers could not identify individual team members and track their individual leadership behavior output or performance across the training trials.

Suggestions and Conclusion

In order to better investigate the contingency models of leadership proposed in this study, collecting data from training sessions that explicitly provide participants with training of directive leadership behaviors would be ideal. Providing leadership training could increase the frequency and variability of leadership behaviors. These specific directive leadership behaviors have been used in previous research of medical teams (e.g. Tschan et al., 2006) but other leadership behavior typologies could be more advantageous. The performances of teams that received leadership training could be compared to those that did not receive any leadership training.

If it is established that leadership behaviors influence resuscitation performance, then steps can be taken to discover how or when this relationship occurs. Other factors beyond complexity and experience could be explored and/or different ways of measuring these factors could be implemented. For example, whether an attending physician was present or not could be more predictive than the experience level of the entire team.

There were many barriers to assessing the team and leadership dynamics that occurred during simulations in this particular training program. If assessment is kept in mind as the training curriculum is being planned, improved, and implemented, medical organizations could provide substantial quantifiable evidence as to how well training is (or isn't) working. These findings could provide a basis for the development of leadership curriculum for neonatal resuscitation training, a curriculum which currently does not exist. A leadership curriculum has been shown to improve team performance of advanced life support (Cooper, 2001). Ultimately, the goal of any training is that it transfers to the actual task. With a task as perilous as neonatal resuscitation, it is critically important that team and leadership training is developed, executed, and evaluated accordingly.

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APPENDICES

Appendix A: Measure of Directive Leadership

Rating Information

Date ________________

Time________________

Rater ID _____________

Video Information

Video ID ______________________

Video Length__________(minutes)

Resuscitation Length ___________

Leadership Markers		Frequency	Comments
Directive Leadership	Gave direction for immediate action		
	Specified directions about how a technical act should be performed		
	Corrected the acts of others		
	Planned ahead		

Appendix B: Measure of Scenario Complexity

Description	Simple		Moderate		Complex
Rating	1	2	3	4	5

Appendix C: Measure of Team Experience

Medical Occupation	Points A	Number of team members with occupation B	Point total by occupation C (A X B)
Attending Physician	5		
Nurse Practitioner or Resident	4		
Transport Registered Nurse or Respiratory Therapist	3		
Neonatal Intensive Care Unit RN	2		
RN - other	1		
		Grand Total (total of C column) =	

Appendix D: Measure of Outcome Performance

Timing	NRP Algorithm	Indicated	Performed
PREP	1. Checks Equipment	☐	☐
	2. Term gestation?	☐	☐
	3. Prepares equipment for special considerations	☐	☐
INITIAL STEPS 30 seconds	4. Clear amniotic fluid?	☐	☐
	5. Infant vigorous if meconium?	☐	☐
	6. Suction mouth and trachea if meconium*	☐	☐
	7. Places baby on preheated warmer	☐	☐
	8. Clear/ position airway		
	9. Suctions mouth, then nose with bulb syringe	☐	☐
	10. Stimulate, dry infant	☐	☐
	11. Removes wet linens	☐	☐
	12. Repositions baby in sniffing position	☐	☐
	13. Evaluate respirations, HR, and color	☐	☐
	14. Provides supplemental oxygen	☐	☐
	15. Indicates need for PPV	☐	☐
	16. Evaluates color	☐	☐
	17. Continues to observe HR, respirations, and color	☐	☐
	18. Completes Initial Steps in 30 seconds	☐	☐
POSITIVE PRESSURE VENTILATION 30 SECONDS	19. Selects resuscitation device and assures oxygen source	☐	☐
	20. Selects appropriate-sized mask	☐	☐
	21. Positioned at head of bed, baby in sniffing position	☐	☐
	22. Calls for assistance		
	23. Positions mask properly	☐	☐
	24. Provide PPV with proper rate	☐	☐
	25. Looks for chest movement		
	26. Checks seal, head position	☐	☐
	27. Appropriate pressure applied	☐	☐
	28. Evaluate heart rate after 30 seconds of effective PPV	☐	☐
	29. Checks for spontaneous respirations if HR >100	☐	☐
	30. Provides stimulation and oxygen (then to 30,35)	☐	☐
	31. Indicates need for chest compressions if HR<60, (then 32, 33)	☐	☐
	32. Continues ventilation if HR <100 (then 33, 34, 35)	☐	☐

	33. Considers intubation*	☐	☐
	34. Considers OG tube placement	☐	☐
	35. Indicates need for post-resuscitation care	☐	☐
CHEST COMPRESSIONS 30 seconds	36. Locates proper position on lower one third of sternum	☐	☐
	37. Provides firm back support	☐	☐
	38. Proper thumb technique: uses distal portions of thumbs or 2-finger technique *OR*	☐	☐
	39. Proper 2-finger technique: fingertips of middle and index or ring finger	☐	☐
	40. Compresses sternum one third of the AP chest diameter	☐	☐
	41. Keeps fingers/thumbs on sternum during release	☐	☐
	42. Coordinate compressions with ventilation: 1-and-2-and-3-and-Breathe	☐	☐
	43. Checks HR after 30 seconds	☐	☐
	44. Evaluates effectiveness of PPV, compressions	☐	☐
	45. Considers intubation*	☐	☐
ENDOTRACHEAL INTUBATION	46. Selects correct sized tube	☐	☐
	47. Selects appropriate-sized blade	☐	☐
	48. Attaches blade, checks light	☐	☐
	49. Prepares tape for securing tube	☐	☐
	29. Correctly positions head	☐	☐
	30. Holds laryngoscope correctly	☐	☐
	31. Inserts blade correctly	☐	☐
	32. Lifts blade in correct motion	☐	☐
	33. Identifies landmarks	☐	☐
	34. Takes appropriate corrective actions	☐	☐
	35. Inserts tube into trachea	☐	☐
	36. Attaches meconium aspirator and withdraws with suction applied	☐	☐
	37. Identifies proper depth and places it there	☐	☐
	38. Confirms placement with CO2 detector and auscultation	☐	☐
	39. Performs procedure in less than 20 seconds	☐	☐
	40. Evaluate HR between attempts	☐	☐
	41. Stabilize ventilation between attempts	☐	☐
MEDICATIONS	50. Prepare for lines: Fills syringe with saline Attaches stopcock to catheter Flushes catheter Closes stopcock to catheter	☐ ☐ ☐	☐ ☐ ☐

		☐ ☐	☐ ☐
	51. Preps site with antiseptic	☐	☐
	52. Ties umbilical tape around base of cord	☐	☐
	53. Using sterile technique, cuts cord	☐	☐
	54. Inserts catheter into vein	☐	☐
	55. Aspirates for blood return	☐	☐
	56. Clears air from catheter	☐	☐
	57. Estimates baby weight	☐	☐
	58. Commence line placement	☐	☐
	59. States epinephrine dose correctly (ETT or IV)	☐	☐
	60. Checks medication label	☐	☐
	61. Calculates and draws up correct dose	☐	☐
	62. Verbalizes dose being administered	☐	☐
	63. Gives dose and flushes line, ventilates appropriately to ensure dose reaches baby	☐	☐
	64. Records epinephrine dose, route, time , and response on code sheet	☐	☐
	65. Evaluates heart rate	☐	☐
	66. Re-evaluates ventilation, compressions, perfusion	☐	☐
	67. Indicates need for volume expander	☐	☐
	68. Chooses NS, O Rh-neg blood, or Ringer's Lactate	☐	☐
	69. Give 10 mL/kg	☐	☐
	70. Administers over 5-10 minutes	☐	☐
	71. Evaluates heart rate	☐	☐
	72. Stop chest compressions if HR>60	☐	☐
	73. Continues ventilation at proper rate	☐	☐
	74. Stops resuscitation after 10 minutes of systole despite effective resuscitation methods	☐	☐

NRP COMPLIANCE	A. Number of indicated steps	A.	
	B. Number of performed steps once indicated		B.
	C. Number of performed steps not indicated		C.
	D. Score = |B-C|/A		D.