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In Situ Simulation
A Method of Experiential Learning to Promote Safety and Team Behavior

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The healthcare system has an inconsistent record of ensuring patient safety. One of the main factors contributing to this poor record is inadequate interdisciplinary team behavior. This article describes in situ simulation and its 4 components—briefing, simulation, debriefing, and follow-up—as an effective interdisciplinary team training strategy to improve perinatal safety. The purpose of this manuscript is to describe the experiential nature of in situ simulation for the participants. Involved in a pilot study of 35 simulations in 6 hospitals with over 700 participants called, "In Situ Simulation for Obstetric and Neonatal Emergencies," conducted by Fairview Health Services in collaboration with the University of Minnesota's Academic Health Center. **Key words:** *closed-loop communication*, *debriefing*, *experiential learning*, *in situ simulation*, *situational awareness*, *shared mental model*

Despite tremendous advances in perinatal outcomes, approximately 1.5% of hospitalized obstetric patients experience an adverse event.[1] It is estimated that there are approximately 22,980 adverse events caused by medical errors in obstetric hospitalizations each year,[2] with communication failures present in 72% of root cause analyses of sentinel events in perinatal units across the United States.[3] These communication failures reflect a basic paradox that a team of healthcare experts does not necessarily constitute an expert team.[4] Interdisciplinary team training has been recognized as an effective method to create more effective team performance resulting in improved safety outcomes.[5] This manuscript describes an in situ simulation training session and its 4 components—briefing, simulation, debriefing, and follow-up. Methods, strategies, and content when designing and conducting team-training instruction are summarized.

It is well established that teams make fewer mistakes than do individuals.[6,7] However, most clinical units continue to function as discrete collections of individuals.[8] Healthcare professionals are predominately educated as individuals and trained separately within their disciplines.[9] The training of individuals is a different undertaking when contrasted with the training of teams.[10,11] Training is defined as the systematic acquisition of knowledge, skills, and attitudes that lead to improved performance for a particular environment.[9] Acquiring proficiency for individual performance skills involves task training, whereas team training involves behaviors that professionals must acquire to function effectively as part of an

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Table 1. Categories and number of core team members

Obstetrician	81
Registered nurse	50
Anesthesiologist	16
Neonatal nurse practitioner	12
Operation room scrub tech	14
Nurse anesthetist	35
Total	208

From Riley and Davis.[19]

interdependent team.[12] The healthcare professions are extremely adept in training individuals in the technical aspects of each discipline, yet have been slow to train for team skills for enhanced interdisciplinary team performance.[13,14] However, simply installing a team structure does not automatically ensure that it will operate effectively.[9,15,16] Team failures occur because the perinatal team works in complicated systems and has a culture where safety is assumed, and not assured. The reliance is on the expertise of an individual, not on integrated teams of experts that work together on an agreed-upon plan of care.[4,17]

Many types of healthcare teams do not have stable membership or constant leadership, and team members rarely train together.[18] For example, an analysis of the possible number of teams that might form rapidly for a perinatal emergency is instructive. Table 1 shows the discipline and number of professionals for 6 categories of core team members required for an emergency cesarean delivery in a representative community hospital with 3500 deliveries per year.[19]

The potential number of teams that could be constituted from this core staff is staggering—381 million potential teams[19] ($81 \times 50 \times 16 \times 12 \times 14 \times 35$); this team composition variability is the prime impediment to the high reliability required for consistent and safe care within a perinatal unit.[20] One solution to reduce the impact of team variability has been to develop a program of in situ simulation that focuses on experiential group and individual learning to achieve team training. In situ simulation is a training strategy that takes place on a patient care unit[4,21] rather than in a laboratory. One emphasis of in situ simulation is to help individuals learn how to become better team members. The focus is not to train a large number of individual teams to competency, but rather to train individuals to become effective team members through focused communication and team behaviors.

The simulation recreates, as closely as possible, the real-world environment, equipment, and psychological reality for the participants.[22,10] The individual and team experiential nature of in situ simulations allows for the systematic acquisition of knowledge of effective team concepts (what we think), skills in team behavior (what we do and say), and attitudes about team performance (what we feel or value).[20,4]

IN SITU SIMULATION LITERATURE REVIEW

Developing the appropriate training environment for team skill acquisition is challenging,[10] and simulation is a critical tool[23] that exposes learners to the complexity of clinical settings without the hazards of real life.[24] In situ simulation is a team-based simulation strategy that occurs on actual patient care units involving healthcare team members and organization processes[21] and can create a much more engaged learning experience.[22] In situ simulation recreates stressful critical events in a safe situation, involving highly realistic scenarios requiring complex decision making and interaction with multiple personnel.[25] Simulation fidelity has been defined as the degree to which the simulator or simulation replicates reality or how closely they represent the real system.[22] Simulation has potential for developing innovative approaches to clinical education,[26] especially simulations that capture the complexity of teamwork situations in the real world.[27]

In situ simulation aims to achieve high fidelity (realism) by performing the training in the setting where patient care is delivered and real errors occur. The simulation-based experiential learning focuses on interdisciplinary professional teams. Practicing professionals are well versed in their particular field, possess a fair amount of experience, and prefer their learning to be problem-centered and meaningful to their professional lives. Adults learn best when they can immediately apply what they have learned. Traditional teaching methods (ie, a teacher imparts facts to the student in a unidirectional model) are not particularly effective in adult learning because it is important for adults to make sense of what they experience or observe.[28]

FAIRVIEW HEALTH SERVICE "IN SITU" SIMULATION

A pilot study[18] of 35 simulated obstetrics emergencies at 6 different hospitals involving physicians, nurses, and support staff called, "In Situ Simulation for Obstetric and Neonatal Emergencies," was conducted by Fairview Health Services in collaboration with the Academic Health Center of the University of Minnesota from January 2006 to January 2007. Each simulation

involved an average of 20 persons for a total of approximately 700 participants from the medical staff and hospital staff. All trials were videotaped for use in debriefings and for content analysis by the researchers.[18]

COMPONENTS OF IN SITU SIMULATION

The in situ simulation experience consists of 4 separate components: (1) the briefing, (2) the simulation, (3) the debriefing, and the (4) follow-up.

THE BRIEFING

The first component of the simulation is briefing participants about the purpose of the training experience immediately before the simulation. Particular emphasis is placed on the idea that technical skills are not being evaluated; the focus is on how teams perform and their members communicate. The participants are asked to treat the simulated event, as much as possible, in the same way they would treat an actual patient situation. Like a briefing in medical care itself, the briefing is key to developing a shared mental model regarding the purpose of the simulation, and how the simulation works among the participants. Like any effective interdisciplinary briefing, the briefing before simulating the scenario should include all participants, such as physician, anesthesiologist, nurse, nurse anesthetist, neonatal nurse practitioner, scrub tech, nurse aide, clerk, phlebotomist, pharmacist, blood bank personnel, and any volunteer actors who will play the patient and/or family member. Information is shared about what it is like to work with the manikin and the time frame. Input from the participants is sought. Finally, the briefing is used to set ground rules for participation and develop trust between the simulation staff and the participants. It is critical to emphasize the communication and downplay the technical skills. Participants are reassured that there will be no "pink slips," that what is being done is extremely important, and that the training is not about individual technical skill. The "suspension of disbelief" is encouraged. It is crucial for everyone to understand that mistakes or process failures are mostly the result of imperfect systems, not people. The errors discovered during simulation are opportunities for improved patient care and safety.

THE SIMULATION

The second component is the simulation. The in situ simulation program creates obstetric emergencies on the basis of actual sentinel events that have occurred within the hospital system. Production of the in situ simulation requires the use of a labor and delivery room, a fetal heart tone simulator (connected to our usual fetal heart tone monitor), a cervical dilatation box, volunteer actors playing the mother and significant others, an operating room, and 2 manikins (SimMan and SimBaby by Laerdal Medical Corporation, Wappingers Falls, NY, USA). An artificial gravid uterus is made by enveloping a rubber toy infant in a plastic bag with water, sometimes colored red by gelatin (to mimic blood) or green by pea soup (to mimic meconium). This is then wrapped in fabric foam and taped to mimic the uterus, and, finally, the uterus is placed on the manikin and covered with thin dark fabric to mimic skin. The normal documentation format from labor and delivery is completed.

Video cameras are placed in the labor and delivery room and in the operating room to capture all interactions of the surgical and pediatric teams. A handheld video camera captures all events as the team travels through hallways from the labor and delivery room to the operating room. The stationary video cameras in the delivery room and the operating room are wired to an observation room where nonparticipants, such as debriefers and researchers monitor the simulation in real time. A simulation director can also communicate wirelessly to the obstetrician and describe the operative field during the emergency cesarean delivery, (Code C-Section) as dictated by the scenario.

IN SITU SIMULATION SCENARIOS

An obstetrician, a clinical nurse specialist, and a nurse researcher created 3 scenarios for the in situ simulation trials. These were placental abruption, ruptured uterus, and postpartum hemorrhage. The scenarios were based on real sentinel events that had occurred on the perinatal unit and were recreated from medical record review and interviews with the perinatal staff. Each scenario was designed to prompt specific human factor behaviors such as leadership, shared mental model, situational awareness, and structured communication techniques of **s**ituation, **b**ackground, **a**ssessment, **r**ecommendation (SBAR), and closed-loop communication.[29] The scenarios were developed with specific triggers (sudden clinical changes) and distractors (elements designed to divert the team's attention) to create stress for team members. The scenarios incorporated typical distractions such as an overly inquisitive or rude significant other, a language barrier, talkative mother, lack of a prenatal record, and other factors that

interrupt team flow so that the simulation team would be stressed by both the clinical and social aspects of the care.

In situ simulations start with the nurse's first encounter with the patient, often walking into the room with the patient who had just been admitted to the labor room. Actors who had received prior instruction or clinical history as the patient and the husband created a more life-like situation. An obstetric emergency typically progresses through 6 separate stages of group formation and reformation[18]: Stage 1 included 1 nurse, the patient, and a companion; Stage 2 involved 1 or 2 nurses, the patient, and a companion; Stage 3 involved the addition of an obstetrician; Stage 4 entailed taking the patient to the operating room for an emergency cesarean delivery (Code C-Section); Stage 5 introduces new team members, upon entry to the operating room, that is, the obstetric, anesthesia, and the neonatal teams, delivery of the infant, and need for blood products; and, Stage 6 focused on the neonatal resuscitation. Each stage has specific key team behaviors to be observed (Table 2).[18] At the beginning of each of the above 6 moments in time, or what are called "critical junctures," there is a greater chance for a failure in team safety to occur.

Table 2. Description of team behaviors and latent conditions

Human factors	Latent conditions
SA—Situational awareness	PP—Policy
Manage task saturation	Policy or procedure not followed
Handoffs	Lack of role definition
Prioritize tasks	Lack of knowledge, skills, or training
Verbalize key observations	
SMM—Shared mental model	T—Technical
Call outs	Equipment or environment failure or not available
Pause for the cause	
Think out loud	
Verbalize observations, rationale	
Complete handoffs	
Use common terminology	
C—Communication	SP—System process
Closed-loop communication	Failure of interdepartmental process or unit for:
Situation, background, assessment, and recommendation	Services
Answers questions	Support
Verbally acknowledge responses	Communication of information
Seek and provide clarification	
Verbally acknowledge the receipt of information, instructions and inquiries	

From Riley et al (in press).[18]

THE DEBRIEFING

The third component of in situ simulation is the debriefing. An effective debriefing is the cornerstone of experiential learning for in situ simulation training. The debriefing closes the gap between the experience and the making sense of it[10] and allows the participants to reflect on the active experience.[19,30,31] The power of the debriefing is multifold: it allows for great self-discovery, provides a forum to express concerns and ideas regarding patient safety, enables individuals to discuss how they performed on an interdisciplinary team, uncovers the collective intelligence of participants regarding problem solving, and reveals systems failures.

Immediately following each simulation, a debriefing session is held for approximately 2 hours. The 2-hour debriefing is much longer than the typical debriefings in most simulation centers, which may last only 15 minutes. Participants discuss what went well during the simulated event, what did not go well, and what could have been better. The debriefing starts in a spacious conference room with drinks and food. A round table is set up with table tents made from cardstock placed in front of the participants. During the debriefing, one leader is a "scribe" who records comments from the participants so that they recognize that they were heard. These comments are used also for subsequent research and analysis. Two experienced debriefers using video playback of the simulation trial facilitate the debriefing. The video playback highlights effective team performance as well as instances of communication lapses affecting patient safety. All participants are encouraged to add comments before and after viewing the video playback. The goal of debriefing is to provide a supportive climate where participants feel valued, respected, and free to share their experiences in an open, honest manner. Participants were to reflect further on what had happened and discuss potential solutions.

The impact of experiential learning during in situ simulation occurs when the focus is the human factors necessary for team performance rather than technical skills. The participant's personal insights during the debriefings teach fellow participants about communication and teamwork in a structured environment. In situ simulation debriefings are a safe environment in which difficult team situations can be addressed without the

guilt, embarrassment, and shame that may occur when reviewing a true adverse event.

FOLLOW-UP

The fourth component of a successful in situ simulation is follow-up from the lessons learned about communication, teamwork, and safety. Changes in the perinatal unit at the system level are communicated as an outcome of the simulation. Feedback from participants after the simulations are documented can be very revealing because cognitive changes may occur several days after simulation. Changes in the attitudes of the participants are measured in culture-of-safety surveys performed several months following the event. Administrative support is critically important at this juncture. To have no follow-up after so much information is gleaned about employees' work environment is counterproductive to the simulation experience.

THE VALUE OF DEBRIEFING

The debriefing fulfills 2 important functions. It provides experiential learning for the participant and identifies key active failures or latent conditions on the perinatal unit. The simulation creates the clinical criteria for the scenario, but it is the healthcare team's own evaluation of its performance and system processes that has the most powerful impact. The participants' evaluation provides insight into the communication lapses and team failures that could become part of a follow-up strategy for the unit leadership.[19]

The authors observed consistent communication and team-failure patterns among care teams during simulated critical events. The information from the debriefing was used to further refine and develop an interdisciplinary team-training curriculum. Table 3 shows 6 competencies that need to be learned for effective interdisciplinary team performance in perinatal

Table 3. Competencies for effective interdisciplinary team work

Competency	Definition	Behavioral example
Situational awareness	Conscious, mindful observation of one's own environment or recognition of patient condition	Circulator entering the OR for Code CS becomes "task saturated" and "multitasks" for patient preparation. Situational awareness is maintained when he/she asks for help.
Closed-loop communication	Communication to a specific person that is acknowledged by the receiver and then affirmed by the sender (eg, VORB)	Physician speaks to RN by name, requests 2 units of O-negative blood STAT. The RN replies, "I will order 2 units of O neg blood." Affirmed by physician.
SBAR-R	Technique of communication about a critical situation that involves clear specification of Situation–Background–Assessment–Recommendation–Response	S: The patient has intense supra pubic pain, bleeding. B: She is a VBAC. A: I think she may be rupturing. R: Do you want me to call the OR team for a Code CS? R: When can I expect you?
Shared mental model	A team trait characterized by an articulated common understanding of the problem and/or the plan. Everyone "being in the same movie"	Code Blue for a mother with amniotic fluid emboli—OB states: How long has she "been down"? "If there is no response, we need to get her into the OR within 5 minutes to save the baby." The Code team agrees.
Leadership and leadership transfer	Explicit handoff of responsibility or providing direction from one team member to another when team reforms or mission changes	The anesthesiologist calls out to the obstetrician: "Rx given, intubating now, you can 'cut'.".
Team formation/reformation	Assembly of a group of persons with special expertise to execute a specific task/addition or deletion of team members directly involved in the event.	Entering OR for a Code CS, the obstetrician speaks to the neonatal nurse practitioner: "This mother is a VBAC, term, may be rupturing, FHR has been 60 for 9 minutes."

Abbreviations: FHR, fetal heart rate; OR, operation room; RN, registered nurse; STAT, immediate; VBAC, vaginal birth after cesarean; VORB, verbal order read back.
From Riley et al (in press)[18] and Agency for Healthcare Research and Quality.[5]

units.[18,5] These competencies are consistent with the interdisciplinary team training curriculum developed by the Agency for Healthcare Research & Quality Team STEPPS (Team Strategies & Tools to Enhance Performance & Patient Safety).[5] These patterns are consistent with observations that mishaps tend to fall into recurrent patterns and that the same set of circumstances can provoke similar errors, regardless of the people involved.[11]

EXAMPLES OF TEAMWORK FAILURES

The failure to use effective interdisciplinary team behaviors in the course of a critical event may increase the likelihood of a near miss or adverse event. Examples of these failures in teamwork, as reported by participants during simulation debriefings, are listed below:

1. Loss of situational awareness due to task saturation.

   The circulator was busy trying to do the tasks to prepare the patient for surgery, perform the Pause for the Cause, make numerous phone calls, document, and keep track of sponge and instrument counts. Nurses reported that they were unable, or felt uncomfortable, to ask for help, or lost their own situational awareness when task saturated.
2. Lack of closed-loop communication (the clear sending of information, affirmation of information received, and confirmation by the sender that the information is correct).

   Physicians recognized that the mother had lost a large amount of blood and was hemodynamically unstable. Orders were simply "called out into the air." Blood products needed to save the life of the mother were not ordered. No one had "heard" or confirmed the order. As a result, blood never reached the operating room in a timely fashion.
3. Lack of standardized communication, such as SBAR.

   As the physician entered the room, the nurse may attempt to give a report, but the physician would walk past her to the fetal monitor or speak first to the patient and may not verbally acknowledge the nurse. Conversely, the nurse may welcome the physician and expect that he or she can quickly assess the urgent situation without any direct verbalization. The physician is multitasking during this critical time frame. Clear standardized communication would direct the physician to the critical issue so that a plan of care could be made.
4. Lack of a shared mental model (all members of the team not being on the same page)

   The nurse notes that the laboring patient suddenly has severe unrelenting uterine pain and ruptures membranes with bloody fluid, and the fetal heart rate changes to bradycardia. She calls the physician. Upon entering the room, the physician sees the patient in pain, notes the bleeding, and asks the patient questions. Instead of stating a clear sense of urgency directly, the nurse "hints and hopes" by calling out that the fetal heart rate is "90," or "now 60," and, "I have the Operating Room team on standby."
5. Lack of following the policy or standardized protocol.

   The patient had a latex allergy that was noted on the prenatal and the admission history. The anesthetist stated "latex allergy" upon entering the operating room "into the air." Scrub tech or circulator did not hear this information and continued to use natural rubber latex gloves and Foley catheter. Once this information was shared in the debriefing, staff immediately acknowledged the importance of how the "Pause for the Cause"("Hard Stop") is really a great way for the newly formed operating room teams to have a *new shared mental model* for critical patient information.
6. Interdepartmental process issue.

   The process to order laboratory tests, get them carried out, and receive results was inconsistent, and confusion existed. The process was dependent on (1) the obstetrician remembering 5 different necessary laboratory tests—type and screen, hemoglobin, platelets, fibrinogen, protime, and activated partial thromboplastin time; (2) the circulator taking the order and calling the health unit coordinator at a desk remote from the operating room to put the order into the computer; (3) the laboratory technician having to respond to the operating room to draw the blood samples and return them for analysis; and (4) the results being called to the main labor and delivery desk and not into the operating room.

These 6 categories of ineffective interdisciplinary team behavior and latent conditions reflect numerous insights gained by the participants as a result of the experiential learning process created by the in situ simulation training strategy.

POSTSIMULATION TEAM AND SAFETY SURVEY

Sexton et al[32] report that organizational culture plays a major role in guiding individual behaviors and,

ultimately, team performance. One outcome of poor team climate is medical error. Team climate can be measured using survey instruments as a snapshot of attitude. Sexton[32] utilizes a Safety Attitudes Questionnaire (SAQ) for teamwork and safety. The SAQ is a psychometrically sound inventory of frontline caregivers' assessments of the work environment and the context in which they deliver care. The SAQ measures 6 domains: teamwork climate, safety climate, job satisfaction, perceptions of management, stress recognition, and working conditions. The responses are a composite measure of the extent to which caregivers (1) report that they feel supported, can speak up comfortably, and can ask questions; (2) feel that nurse input is heeded, conflicts are resolved, and physicians and nurses collaborate. They report that good teamwork scores were associated with lower levels of caregiver burnout, familiarity with other caregivers, knowing the names of one's colleagues, and being able to predict their actions during emergencies. Conversely, poor teamwork climate was associated with communication breakdowns that led to delays in patient care that can be very costly.

Fairview Health Services has used the Sexton SAQ surveys across all 7-hospital sites since 2003 to trend staff attitudes about safety and teamwork. The annual Sexton SAQ was administered in fall 2005 before the initiation of the "in situ simulation for Obstetric and Neonatal Emergencies" pilot study, which occurred from January through May 2006 in one suburban hospital. The yearly Sexton SAQ survey was administered again in the fall of 2006. Whereas the hospital aggregate data showed a decline or no significant change in team and safety scores, the perinatal unit had key indices reported in the teamwork and climate survey that were improved.

DISCUSSION

Interdisciplinary team training for obstetric and neonatal emergencies using in situ simulation is an effective method of experiential learning that reinforces the value of becoming an expert team member. The realistic simulation scenarios have deliberate design features that create stress and influence participants to gain awareness of key communication and team learning behaviors. One key realization from this study has been the distinction between the training needs for the individual expert practitioner in contrast with the training needed for a group of experts to become a well-functioning team. Table 4 highlights several conceptual distinctions between training an individual and training an interdisciplinary team.[19] As indicated in the table, the desired characteristics needed to train effective interdisciplinary teams are quite distinct from the desired characteristics when training the individuals to competency levels in their respective professional programs.

Table 4. Individual versus team training characteristics

Individual or discipline training	Interdisciplinary or team training
Subject matter expert	Team member expertise
Independence	Interdependence
Individual accountability	Team accountability
Errors reflect incompetence or lack of vigilance—"Blame and shame"	Errors reflect team or system failure
No redundant backup or monitoring	System redundancy
Hierarchical	Collegial

From Riley and Davis.[18]

Observations by the authors have shown that the true power and experiential learning of in situ simulation happened during the conversations in the debriefing. Debriefers could guide the discussion to prompt analysis of human factor behaviors, such as shared mental model, situational awareness, SBAR, closed-loop communication, teamwork, and leadership. The review of the video was a method that provided invaluable insight for participants. It was the healthcare team's evaluation of the perinatal system processes and their own performance that allowed for insight into the communication lapses, team failures, and latent conditions. This level of learning could not be replicated in a purely didactic presentation of definitions and brainstorming. Early qualitative findings have given direction to operational leaders on the unit level not only to continue with process improvement initiatives but also to include team training as an equally important topic for staff development and education.

SUMMARY

Successful team-training initiatives require methodical preparation and implementation.[13] Similar to the Perinatal Patient Safety Project at Kaiser Permanente,[33] the simulation training strategy adopted at Fairview Health Services and the University of Minnesota Academic Health Center is aimed at providing the necessary competencies at both the individual and team levels to provide care safely on the perinatal unit. This model follows the framework that depicts team training as a set

of interventions designed with 4 main elements—a set of tools, delivery methods, instructional strategies, and content.[4] Simulation is a tool used to assess and remediate team performance before, during, and after training. This information is used as the basis to develop the training method and content to achieve the desired interdisciplinary team knowledge, skills, and attitudes.

REFERENCES

1. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *N Engl J Med*. 1991;324:370–376.
2. Bailit JL, Blanchard MH. The effect of house staff working hours on the quality of obstetric and gynecologic care. *Obstet Gynecol*. 2004;103:613–616.
3. Joint Commission, The. Preventing infant death and injury during delivery. *Sentinel Event Alert*. 2004;21:30. http://www.jointcommission.org/SentinelEvents/SentinelEventAlert/ Accessed August 14, 2007.
4. Burke CS, Salas E, Wilson-Donnelly K, Priest H. How to turn a team of experts into an expert medical team: guidance from the aviation and military communities. *Qual Saf Health Care*. 2004;13:i96–i104.
5. Agency for Healthcare Research and Quality. Team STEPPS Curriculum® 2007.
6. Smith-Jentsch KA, Salas E, Baker DP. Training team performance-related assertiveness. *Pers Psychol*. 1996; 49:909.
7. Salas E, Cannon-Bowlers JA. The anatomy of team training. In: *Training and Retraining: A Handbook for Business, Industry, Government, and the Military*. New York, NY: Macmillan Reference; 2000.
8. Knox GE, Simpson KR. Teamwork: the fundamental building block of high-reliability organizations and patient safety. In: *Patient Safety Handbook*. Boston, MA: Jones and Bartlett; 2004.
9. Henriksen K, Patterson M. Simulation in Health Care: Setting Realistic Expectations. *J Pat Saf*. 2007;3(3):127–134.
10. Hamman WR. The complexity of team training. What we have learned from aviation and its applications to medicine. *Qual Saf Healthc*. 2004;13(suppl 1):72–79.
11. Reason J. *Managing the Risks of Organizational Accidents*. England; MPG Books, Ltd; 1997.
12. Salas E, Cannon-Bowers JA. The science of training: a decade of progress. *Annu Rev Psychol*. 2000;13:471–499.
13. Salas E, Cannon-Bowers JA, Johnston JH. How can you turn a team of experts into an expert team? Emerging training strategies. In: *Naturalistic Decision Making*. Mahwah, NJ: Lawrence Erlbaum Assoc; 1997.
14. Baker DP, Day R, Salas E. Teamwork as an essential component of high-reliability organizations. *Health Serv Res*. 2006;41:1576–1598.
15. Baker DP, Gustafson S, Beaubien JM, Salas E, Barach P. Advances in patient safety: from research to implementation. In: *Medical Team Training Programs in Health Care*. Vol. 4. AHRQ Publication No. 05-0021-4. Rockville, MD: Agency for Healthcare Research and Quality; 2005.
16. Salas E, Burke CS, Cannon-Bowers JA. Teamwork: emerging principles. *Int J Manag Rev*. 2000;2:339–356.
17. McIntyre RM, Salas E. Measuring and managing for team performance: emerging principles from complex environments. In: *Team Effectiveness and Decision Making in Organizations*. San Francisco, CA: Jossey-Bass; 1995.
18. Riley W, Hanson H, Gurses A, Davies S, Miller K, Priester R. The nature, characteristics, and patterns of perinatal critical events teams. In: *Advances in Patient Safety: New Directions and Alternative Approaches*. (in press).
19. Riley W, Davis S. *Patient Safety and Breeches in Defensive Barriers Caused by Latent Conditions and Active Failures: An Application of In Situ Simulation. Redesign for Results: Quantum Leaps in Health Care*, 10th Annual ICSI/IHI Colloquium on Clinical Quality Improvements, St Louis Park, Minnesota, May 16–18, 2007.
20. Davis S, Miller K, Riley W. *Achieving High Reliability by Identifying and Reducing Breaches in Defensive Barriers*. In: 19th Annual National Forum on Quality Improvement in Health Care. Orlando, FL: Institute for Healthcare Improvement; December 9–12, 2007.
21. Hamman W, Rutherford W, Liang BA, et al. *In-Situ Simulations: Moving Simulation to New Levels of Realism Within Healthcare Organizations*. Third Conference on Safety Across High-Consequences Industries. St Louis, MO: St Louis University; 2007.
22. Beaubien JM, Baker DP. The use of simulation for training teamwork skills in health care: how low can you go? *Qual Saf Healthc*. 2004;13:i51–i56.
23. Gaba DM. The future vision of simulation in health care. *Qual Saf Healthc*. 2004;13(suppl 1):i2–i10.
24. Kneebone RL. 2006; Crossing the Line: simulation and boundary areas. *Simul Healthc.* Fall 2006;1(3):160–163.
25. Gaba DM, Howard SK, Fish KJ, Smith BE, Sowb YA. Simulation-based training in anesthesia crisis resource management (ACRM): a decade of experience. *Simul Gaming*. 2001;32(2):175–193.
26. Kneebone R, Kidd J, Nestel D, et al. An innovative model for teaching and learning clinical procedures. *Med Educ*. 2002;36:628–634.
27. Gaba DM. What Does Simulation Add to Teamwork Training? AHRQ Morbidity & Mortality Founds on the web. http://www.webmm.ahrq.gov/perspective.aspx?perspectiveID=20&searchStr=Gaba+DM. Accessed April 15, 2008.
28. Dismukes RK, Gaba DM, Howard SK. So many roads: facilitated debriefing in healthcare. *Soc Simul Healthc*. 2006;1:23–25.
29. Miller K, Davis S, Riley W. *In Situ Simulation of Obstetric Emergencies: Improving Medical Systems and Teams*. 2007 Premier Annual Breakthroughs Conference & Exhibition, Orlando, FL; 2007.
30. Fanning RM, Gaba D. The role of debriefing in simulation based learning. *Soc Simul Healthc*. 2007;2:115–125.

31. Rudolph JW, Simon R, Dufresne RL, Raemer DB. There's no such thing as "nonjudgmental" debriefing: a theory and method for debriefing with good judgment. *Soc Simul Healthc*. 2006;1(1):49–55.
32. Sexton JB, Holzmueller CG, Pronovost PJ, Thomas EJ, McFerran S, Nunes J, Thompson DA, Knight AP, Penning DH, Fox HE. Variation in caregiver perceptions of teamwork climate in labor and delivery units. *J Perinatol*. 2006;26:463–470.
33. McFerran S, Nunes J, Pucci D, Zuniga A. Perinatal patient safety project. A multicenter approach to improve performance reliability at Kaiser Permanente. *J Perinat Neonat Nurs*. 2005;19:37–45.