Using In Situ Simulation to Identify and Resolve Latent Environmental Threats to Patient Safety: Case Study Involving a Labor and Delivery Ward

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Abstract: Since the publication of *To Err is Human*, health care professionals have looked to high-reliability industries such as commercial aviation for guidance on improving system safety. One of the most widely adopted aviation-derived approaches is simulation-based team training, also known as crew resource management (CRM) training. In the health care domain, CRM training often takes place in custom-built simulation laboratories that are designed to replicate operating rooms or labor and delivery rooms. Unlike these traditional CRM training programs, in situ simulation occurs on actual patient care units, involves actual health care team members, and uses actual organization processes to train and assess team performance. During the past 24 months, our research team has conducted nearly 40 in situ simulations. In this paper, we present the results from one such simulation: a patient who experienced a difficult labor and delivery resulting in an emergency caesarean section and a hysterectomy. During the simulation, a number of latent environmental threats to safety were identified. The following article presents not only the latent threats but also the steps that the hospital has taken to remedy them.

Results from clinical simulations in operational health care settings can help identify and resolve latent environmental threats to patient safety.

Key Words: simulation, health care systems, patient safety

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In situ simulation is an intervention based on the principles of commercial aviation's Advanced Qualification Program (AQP), which have been quantitatively and qualitatively validated by the Federal Aviation Administration. The AQP employs scenarios based on real-world events to focus on team performance and teamwork skills, rather than individual performance and technical skills.[1,2] The in situ simulation process involves 3 steps: scenario development, enactment in an existing health care setting, and immediate debrief with participants. Other researchers have used in situ simulation as a methodology to improve the understanding of risks and failures in the health care organization.[3]

Scenarios are developed based on seminal or common events identified by health care settings, ensuring a realistic progression of actions and consequences. The story line of the event is then broken down into a series of scenes in which elements of the environment or patient condition are manipulated to evoke responses from the health care team.[4,5] When scenarios are carried out, the research team uses simulators, pregenerated magnetic resonance imaging, radiograph, and other reports, along with confederate actors to keep the sequence of events flowing smoothly.

Conducting an in situ simulation in existing health care settings provides at least 2 benefits. First, it increases the psychological engagement of participants by asking them to perform in their home environment.[6] As a result, fewer disconnects in the fidelity of the scenario occur because of unfamiliar surroundings. Second, working in a preexisting setting allows for the identification, diagnosis, and remediation of latent environmental threats to safety[7] that would be otherwise impossible to identify in the laboratory. Third, this method allows investigators to observe and record health care teams' responses to crises and unanticipated problems as they unfold, which is not possible in actual patient care situations. These latent threats provide the subject matter for this paper.

The final step of in situ simulation is an immediate debrief after the scenario is completed. A member of the research team facilitates a discussion with all the participants to explore team issues including communication, task assignment and prioritization, and situational awareness. Health care professionals are encouraged to focus on the systems and team behaviors that present patient safety risks, rather than individual errors in performance. The debrief experience also creates a unique opportunity for health care professionals from different units of the hospital to discuss system and other issues surfaced in the simulation in a nonthreatening environment.

The study below discusses the results from the careful planning, execution, and debrief of a designed in situ simulation. The scenario was designed using real-world issues as the basis but is not a replication of an actual case. The combination of simulation, access to existing systems, and the immediate interdepartmental debrief in a nonthreatening environment provides an excellent milieu for surfacing and addressing latent threats to patient safety. As a result of participation in the following simulation, the health care teams were able to develop the effective system solutions presented here, which, in turn, have had a positive impact on patient care.

SUMMARY OF THE STUDY

The information presented here is a compilation of results from 4 in situ simulations conducted at a midsized Midwestern community hospital in 2006 and 2007. Follow-up interviews were conducted with 3 obstetrics (OB) nurses, 1 administrator, 1 obstetrician, 2 neonatal nurses, the director of the blood laboratory, and an OB informational technology specialist. During

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the follow-up debriefing session, the research team and the health care professionals watched the scenario video and discussed the threats and consequences they observed. Based on those observations, the hospital staff took steps to address the threats and improve patient safety. The research team conducted follow-up interviews approximately 6 to 9 months after the simulation, which confirmed the subsequent systems solutions that are still being followed today. Names and identifying information have been removed to protect confidentiality.

THE SCENARIO

In the first half of the scenario, the simulated patient was represented by a live actor (standardized patient) along with a fetal heart tone simulator. In the second half, a wireless mannequin made by Gaumard was used to represent the mother, and a wireless mannequin also made by Gaumard represented the infant.

Over the course of 4 separate simulations, the scenario maintained relative consistency. The patient was a woman in her 30s who arrived on the OB unit of a midsized Midwestern hospital with the complaint of abdominal pains of a few hours' duration. She was visiting relatives and away from home. She was a healthy woman in the 36th gestational week of her second pregnancy, and she had abdominal pains for the last few hours. Her first pregnancy resulted in a caesarean section (C-section), and she wanted a vaginal birth after C-section for this birth.

Throughout these simulations, the first nurse on the scene began her assessment of the patient by attaching the fetal heart tone monitor and checking the patient's cervix. A cervix simulation device was used to portray the patient's cervix for this scenario. The cervix was dilated 3 cm, and there were decelerations in the baby's heart rate during contractions. The nurse immediately contacted the obstetrician on call. Other nurses arrived, started an intravenous IV, instructed the patient to move onto her left side, obtained the necessary informed consent signatures, and tried to obtain the patient's medical history from her primary physician and hospital.

The on-call obstetrician entered the room and received a briefing from one of the nurses. The obstetrician asked the patient a few additional questions and learned that, despite other medical variables necessitating a C-section during the first pregnancy (e.g., breech and preeclampsia), there had not been any problems during this pregnancy. The patient informed the obstetrician that she did not want another C-section and instead would prefer a vaginal delivery.

At this point, the research team used a fetal heart tone simulator to indicate a loss of variability in the fetal heart tones, leading to repetitive late decelerations. At the same time, the standardized patient actress was instructed to break a bag of red-colored water to simulate a ruptured uterus. After looking at the fetal heart tone monitor, the obstetrician informed the patient that she did not think the baby would be able to survive a vaginal delivery because of the following: (1) the baby's heart rate was dropping, and (2) the presence of approximately 500 mL of vaginal bleeding and severe abdominal pain indicated a possible ruptured uterus. Because of the immediate risks to the baby and potentially life-threatening risks to the mother, the obstetrician explained to the patient that an emergency C-section would be necessary for the safety of both mother and child. The patient consented to the procedure. The obstetrician asked a nurse to call an emergency C-section.

First Environmental Threat to Safety

The unit clerk was new and did not know the callout policy for emergencies with regard to the neonatal intensive care unit (NICU).

Observed Consequence

The NICU team in this simulation realized that they did not receive the first notice from the OB unit regarding the emergent situation. This subsequently delayed the NICU response. As a result, the NICU team had limited time to prepare in the OR before the baby was born and given to them for care.

System Solution

To ensure that the unit clerks are well prepared for emergencies in the department. The solution was developed by the nurse educators of OB department within a few weeks after the simulations took place.

Reported Result

The OB unit nurse educator added the emergency callout procedure into the orientation for the new unit clerks. In case of an emergency C-section, the protocol requires the unit clerk to send a text via pager to the NICU staff and call the NICU unit clerk as well. Anyone educating a new clerk must sign off that he/she covered the callout protocol during the training.

The obstetrician also asked the nurse to page anesthesia. The patient arrived in the OB–operating room (OR) suite and was prepared for surgery. The anesthesiologist arrived shortly thereafter and consulted with the obstetrician about the patient condition.

Second Environmental Threat to Safety

All phone lines at the nurses' station were busy with nurses calling out to get necessary external resources.

Observed Consequence

In the simulation, the anesthesiologist observed that he was unable to reach the OR by phone to determine the urgency of the situation and the condition of the patient. This communication barrier led to the anesthesiologist arriving late to the OB-OR to prepare the patient for surgery. As the clinical nurse specialist that participated in the simulation reported, "…anesthesia was paged and they couldn't get through; they didn't know what was going on; whether this was an emergency or not. The line they called was a busy signal because it was being used to call out for other resources. They didn't know what the situation was."

System Solution

To establish a process in which everyone receives emergency information without the need to call back into the unit. This solution was developed by a working group made up of the participants of the simulation within a few weeks after the simulations took place.

Reported Result

In the case of OB alerts, anesthesia is paged directly along with NICU. However, in emergency situations, all calls to and from anesthesia are now routed through the OB charge nurse, rather than the primary nurse on the case. The OB department also established a specific page code for anesthesiologists in case of emergency C-sections: 911#.

Once informed by the obstetrician, the anesthesiologist consulted a nurse to acquire the necessary drugs to prepare the patient for surgery.

Third Environmental Threat to Safety

Anesthesia does not have appropriate medications on hand in the OB-OR to address emergent situations.

Observed Consequence

The anesthesiologist and the nurse observed that they had to spend time looking for what they needed; the nurse had to

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leave the OR to get meds from the pyxis. The clinical nurse specialist that participated in the simulation reported that the process could take anywhere from 2 to 5 minutes, interrupting the flow of care to the patient and creating a delay in a critical situation.

System Solution

The OB worked with the hospital pharmacy to provide C-section boxes for the OB-OR. Now, when anesthesia comes on the unit, they stop by the pyxis and pick up a box that contains all the possible medications they may need for the C-section. This solution was developed by a working group of OB and Pharmacy personnel within a few weeks after that simulations took place.

Reported Results

The health care team uses these boxes every day for every C-section in the OB-OR. The clinical nurse specialist for OB reported that this new process benefits patients in both emergent and nonemergent situations. "In a scheduled C-section, there are only 2 nurses, if one leaves, then prepping the patient, setting up equipment, helping the docs, getting the paperwork (computer) ready all has to be done by the one nurse, so it either gets delayed, or corners get cut because not everyone can do everything. The boxes address this issue."

The anesthesiologist administered the necessary drugs, intubated the patient, and announced that he was ready for the obstetrician to begin surgery. Meanwhile, the NICU team (who received a late call about the procedure) entered the OR suite and began to prepare their area to receive the baby. The operation was performed quickly; the baby was delivered blue, floppy, and depressed and was handed over to the neonatal team. A neonatal simulator was used to portray the distressed baby. Because the neonatal simulator cannot provide signs of cyanosis and decreased muscle tone, the investigator informed the neonatal team that these findings were present. After assessing the uterus, the obstetrician decided to perform an emergency hysterectomy.

Fourth Environmental Threat to Safety

The nurse assisting the OB physician had never participated as the scrub in a hysterectomy before. As a result, she was unfamiliar with where the tray was and the instrumentation.

Observed Consequences

The OB team observed that they lost time in the hysterectomy because, first, the nurse had to find the tray; then, the OB physician had to describe the equipment he needed, rather than being able to ask for it by name.

System Solution

The OB nurses now shadow OR scrub nurses on scheduled hysterectomies as part of formal orientation for new nurses. This solution was developed by the OB nurse educators within a few weeks after the simulations took place.

Reported Result

The OB nurse educator reported, "At the very least [the nurses] are familiar with the instruments. They may still need to have the doctor tell them what he needs next, but at least they are familiar." Observation of a simulation scenario conducted later in the year showed a substantial change. The scrub nurse knew the exact location of the hysterectomy tray and gave specific clear directions to the nurse who was fetching it for her. She also, in anticipation, called for the tray before the obstetrician announced that they would be doing a hysterectomy.

During the hysterectomy, the patient deteriorated hemodynamically; both the obstetrician and the anesthesiologist called for blood.

Fifth Environmental Threat to Safety

The nurses working the case were unsure how to order uncrossed matched blood from the laboratory.

Observed Consequences

The OB nurse educator that observed the simulation said, "Having to give uncrossed matched blood [in the simulation] was a new request, so it brought out the issue that we didn't know how to get the product and get it quickly." As a result, there was a further delay in getting blood for the patient who was already in danger because of blood loss.

System Solution

Identify a process to educate the nursing staff on how to order uncrossed matched blood from the laboratory. This solution was developed by OB nurse educators within a few months of when the simulations took place.

Reported Results

The OB medical staff has been trained on the use of priority one slips necessary to get uncrossed matched blood from the laboratory, at both the annual safety fair and as part of new hire orientation. The clinical nurse specialist described the training: "It was presented in poster form; this is what the slip looks like, this is the process to get it, this is when you need it, who needs to sign it, how many you can order at a time, etc."

Once the blood arrived, the patient stabilized, and the obstetrician successfully finished the emergency hysterectomy.

Meanwhile, the NICU team provided care to the newborn, who had presented with respiratory depression, central cyanosis, decreased muscle tone, and bradycardia. After their rapid assessment, the neonatal team determined that the newborn required oxygenation, ventilation, intubation, chest compressions, and epinephrine. However, the NICU physician could not find the necessary equipment and medications in the nearby cart. A nurse left the baby to assist, leaving only 1 NICU team member to ventilate and do chest compressions.

Sixth Environmental Threat to Safety

Medications and equipment were stocked differently from warmer to warmer throughout the OB unit.

Observed Consequences

Nurses from the NICU and OB units who participated in the simulation agreed that time lost looking for equipment posed a risk to the baby for two reasons: (1) it caused a delay in treatment, and (2) fewer health care personnel were consistently available to treat and monitor the baby.

System Solution

Stock baby warmers in a consistent manner. This solution was developed by the NICU and OB participants within a few weeks after the simulations took place.

Reported Results

First, nurses now stock all warmers in a consistent fashion throughout all areas of OB unit, and they sort and label medications. Second, administration purchased new carts and placed them throughout antepartum, NICU, and OB-OR. Nurses stock these carts in a standardized fashion, with all drawers labeled. Third, they also stock transport carts to match warmers. Fourth, the nurses created a labeled tackle box and stocked them with

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necessary medications and equipment for use when deliveries occur off the labor and delivery floor. The nurses from OB and NICU worked together to standardize the drawers, and they called it an "easy fix."

Once the pediatric team assembled the necessary equipment and medications, they were able to successfully treat the baby.

SUMMARY

In this paper, we have shown how 4 in situ simulations at a Midwestern community hospital's OB unit helped to identify 6 latent threats.

Participation in the scenario and video debriefing enabled the health care team to see the consequences of the threats. These insights, coupled with their commitment to improving patient care and safety, led the health care workers at this hospital to generate the solutions and results presented here. Their efforts enhanced patient safety through addressing these 6 solutions: first, critical staff training deficiencies involving communication; second, access to blood products; third, technical competencies in assisting with unroutine surgery; fourth, anesthesiology's interaction with OB for communication; fifth, preparation of boxes of medications at the pyxis for anesthesia; and sixth, the team ensured that critical materials and supplies are available, accessible, and standardized throughout the unit for when a delivery happens off the unit. The observations and system solutions that are included in this paper indicate how in situ simulation can be used to expose every day gaps in processes and procedures to fill those gaps and help health care professionals provide the best quality of care possible.[8–10]

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