Teamwork and Communication

Didactic and Simulation Nontechnical Skills Team Training to Improve Perinatal Patient Outcomes in a Community Hospital

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Birth trauma is a low-frequency, high-severity event that makes obstetrics a major challenge for patient safety in the hospital setting. At least 1.5% of hospitalized obstetric patients in the United States experience an adverse event,[1] and communication failure is associated with 72% of root cause analyses of sentinel events in perinatal units.[2] Despite tremendous individual commitment and the conscientious efforts of superbly trained professionals, high reliability is not a dominant feature of the health care delivery system.[3] The United States ranks 17th in the world in the perinatal mortality rate, largely because of obstetric causes,[4] and 29th worldwide in infant mortality—near the bottom of industrialized nations.[5]

Nontechnical skills (NTS) are the cognitive and interpersonal skills, supplementing clinical and technical skills, necessary to ensure safe patient care.[6,7] Two of the foremost NTS in health care are communication and teamwork,[8,9] both of which have been identified as major risks in perinatal units.[10] Poor communication increases the risk of error tenfold,[11] and poor teamwork accounts for approximately 55% of all active failures in a hospital setting.[12]

Interdisciplinary team training is highly effective at improving communication and teamwork,[13] while simulation is a learning strategy to amplify real clinical situations with guided experiences in an interactive fashion.[14] Simulation training is commonplace in high-reliability organizations (HROs)[15] and strongly recommended by the Institute of Medicine to improve patient safety.[16] However, there is little empirical evidence of the direct impact of simulation training on patient outcomes.[15] Simulation training programs affects knowledge, attitudes, and behavior about team skills[17] and have been applied extensively throughout health care to enhance both technical and nontechnical skills in many specialties and procedures,[18] such as anesthesia,[19] emergency medicine,[20] neonatal resuscitation,[21] perinatal emergencies,[22,23] critical care air support,[24] and surgery,[25] as well as to expose process failures in hospital systems.[26] However, proficiency during simulation does not ensure proficiency in clini-

Article-at-a-Glance

Background: Birth trauma is a low-frequency, high-severity event, making obstetrics a major challenge for patient safety. Yet, few strategies have been shown to eliminate preventable perinatal harm. Interdisciplinary team training was prospectively evaluated to assess the relative impact of two different learning modalities to improve nontechnical skills (NTS)—the cognitive and interpersonal skills, such as communication and teamwork, that supplement clinical and technical skills and are necessary to ensure safe patient care.
Methods: Between 2005 and 2008, perinatal morbidity and mortality data were prospectively collected using the Weighted Adverse Outcomes Score (WAOS) and a culture of safety survey (Safety Attitudes Questionnaire) at three small-sized community hospitals. In a small cluster randomized clinical trial conducted in the third quarter of 2007, one of the hospitals served as a control group and two served as the treatment intervention sites—one hospital received the TeamSTEPPS® didactic training program and one hospital received both the TeamSTEPPS program along with a series of in-situ simulation training exercises.
Results: A statistically significant and persistent improvement of 37% in perinatal morbidity was observed between the pre- and postintervention for the hospital exposed to the simulation program. There were no statistically significant differences in the didactic-only or the control hospitals. Baseline perceptions of culture of safety were high at all three hospitals, and there were no significant changes.
Conclusions: A comprehensive interdisciplinary team training program using in-situ simulation can improve perinatal safety in the hospital setting. This is the first evidence providing a clear association between simulation training and improved patient outcomes. Didactics alone were not effective in improving perinatal outcomes.

cal settings.[27] In-situ simulation is a high-fidelity team-based simulation strategy that occurs on a patient care unit rather than in a simulation laboratory and provides the unique opportunity for individual hospitals and hospital units to improve NTS and correct latent conditions that may contribute to patient safety hazards.[28]

In the prospective cohort study described in this article, we examine the relative impact of a didactic TeamSTEPPS® program[29] and a didactic TeamSTEPPS program supplemented by an in-situ simulation program in relation to a comparison hospital on patient outcomes and culture of safety in the context of perinatal emergencies in small-sized community hospitals.

Methods

Study Design

In a four-year period between 2005 and 2008, we conducted a prospective study of pre- and postintervention periods at three small-sized community hospitals (50 to 66 beds) serving comparable rural/suburban patient populations in the Midwest (Table 1, page 359). Together, the three hospitals represent approximately 1,800 deliveries per year. We randomly assigned the hospitals to three conditions, as follows:

- One hospital had no intervention and served as a control.
- One hospital received the TeamSTEPPS didactic training.
- The third hospital received a full intervention, which consisted of TeamSTEPPS augmented by a series of in-situ training exercises, which were repeated until summative staff saturation and repetition targets were met.

The randomization was that of the clusters, not the individual women. All analyses were conducted at the cluster level because the intervention goal was to improve NTS and reduce perinatal harm. All labor and delivery staff at the three hospitals were eligible to participate. Comparisons were made between the three hospitals, each subjected to a different treatment in the first quarter of 2007. All women who were admitted to the hospitals between 2005 and 2008 were included in the study.

Interventions

We used two methods for interdisciplinary team training—didactic training and in-situ simulation. The didactic intervention is used to teach team members knowledge about key NTS. The second method used experiential learning based on in-situ simulation training to provide an opportunity for practice, application, and coaching. We hypothesized that this method would be more effective in creating behavioral change.

Didactic Training. Didactic training was based on the TeamSTEPPS training curriculum, an evidence-based teamwork curriculum developed by the U.S. Department of Defense and the Agency for Healthcare Research and Quality with a focus on four learnable, teachable skills to improve team performance: leadership, situation monitoring, mutual support, and communication.[29] The TeamSTEPPS program is an extensive curriculum that involves several days of classroom training. In previous research, we found that four key behaviors are responsible for the majority of team and communication failures during critical events.[12,28] We focused specifically on the following behaviors to develop a condensed curriculum for critical skills that are necessary for effective communication in safety-critical environments: situational awareness, standard communication of Situation-Background-Assessment-Recommendation-Readback (SBAR-R), closed-loop communication, and shared mental model. The full format and techniques of our condensed curriculum are explained elsewhere.[30] A 30-minute audiovisual webinar presentation of these four key TeamSTEPPS skills was developed for the participants. The webinar used a combination of visual prompts, audio narration of key elements, and a video of simulated scenarios. The participants completed a 10-item test at the conclusion of the didactic training, with a 90% score as a target to track learner comprehension.

We created obstetrical emergency scenarios based on incidents abstracted from actual sentinel events for use in the in-situ simulation team training sessions. We used an event-set methodology in the simulation scenario that incorporated the same key TeamSTEPPS behaviors from the didactic training.

Previous work describes the development, categorization and validation of an evaluation tool for assessing near misses and active failures by collecting, analyzing, and validating 36 simulations of emergency C-sections in a 390-bed community hospital.[26] Following Reason's model,[i] these "breaches" in patient safety barriers were categorized according to active failures (standardized communication, situational awareness and shared mental model) and latent conditions (process design and compliance with policy and procedure).

In-Situ Simulation. The in-situ simulation for perinatal critical events consisted of five components: (a) briefing, (b) in-situ simulation, (c) debriefing, (d) rapid-cycle follow-through with process improvements, and (e) repetition to reinforce skills and create resiliency.[32] During the briefing, participants who were directly involved in the simulation were educated about the simulation scenarios. The simulated patient was followed from triage, through labor and the operating room (OR), and then to the recovery area. The simulation, which typically ran 30 to 45 minutes, was initiated in a manner similar to a typical handoff, with a brief history from one provider to the next. A two-hour

Table 1. Hospital and Labor and Delivery Staff Demographics*

Hospital	Beds	L&D Beds	Level 1 Nursery	Births/Year	Population Served
Full Intervention	50	6	Yes	380	Rural/Suburban
Didactic Training	66	6	Yes	889	Rural/Suburban
Control	55	5	Yes	500	Rural/Suburban

Staff	ObGyn	Family Practitioners	Pediatricians	RNs	CRNAs	MDAs
Full Intervention	5	2	5	18	5	1
Didactic Training	5	12	5	30	8	0
Control	3	9	4	17	5	0

* L&D, labor and delivery; ObGyn, Obstetrics/Gynecology; RN, registered nurse; CRNA, certified registered nurse anesthetist; MDA, physician assistant.

debriefing session, with the use of advanced debriefing techniques, was held immediately following each simulation.[33,34] Eleven simulation training sessions were conducted at the simulation treatment hospital from September 2007 through February 2008.

Scenarios and triggers were taken from actual occurrences in the hospital unit. We used an event-set methodology[36] to develop scenarios for uterine rupture, placental abruption, and post-partum hemorrhage. The event sets specified phases for each of the three scenarios. Five clinical triggers were designed to prompt NTS behaviors: situational awareness, shared mental model, closed-loop and SBAR-R[29] communication, leadership and teamwork, and latent conditions.*

Measures

We prospectively collected data on perinatal morbidity and mortality as well as culture of safety (COS).

Outcomes. To measure perinatal outcomes at each hospital, we used the Weighted Adverse Outcomes Score (WAOS), calculated quarterly. WAOS is a quality indicator developed to evaluate the effects of teamwork on obstetric care.[35] The WAOS, constructed from a set of 10 weighted outcome measures, is a summary metric representing the average adverse event score per delivery.[23] Unlike other obstetric outcome measures,[36] the WAOS weighting system adjusts for the severity of adverse events. WAOS data were electronically collected from hospital records.

Culture of Safety. To measure subjective impressions of the COS, we administered the Safety Attitudes Questionnaire (SAQ)[37] to all obstetricians, pediatricians, anesthesiologists, nurses, and ancillary staff at each hospital before and after a one-year period of intervention. This 5-point Likert-scale questionnaire, with 38 items in seven scales, is one of the primary measures used for assessing culture of safety (COS)[38] has been administered in multiple settings and has established reliability and validity. We used the 38-item version of the total scale, modifying the demographic items to fit perinatal staff and units.

* Situational awareness, shared mental model, closed-loop communication, SBAR, and leadership are defined in Agency for Healthcare Research and Quality: *TeamSTEPPS® Instructor Guide Glossary.* http://www.ahrq.gov/teamsteppstools/instructor/reference/glossary.htm (last accessed Jun. 29, 2011).

Statistical Analysis

We conducted two sets of analyses. In the first set, we used control chart analysis and statistical process control (SPC) to analyze process performance.

Control Chart Analysis and Statistical Process Control. SPC and control chart methods, which quantify how a process performs over time, are being increasingly used in health care.[39–41] Control charts are time-series representations of data used to track the consistency of calculated statistical information generated from a variety of data sampling strategies.[42–44] The usefulness of control charts resides in their ability to detect significant changes in a process; if special cause is detected in the process, then action can be directed at eliminating this form of variation.[29,45] Control charts analyze a time-ordered sequence to track a process to determine the type of variation present[29] and whether the process meets desired performance targets.[46] This technique was especially appropriate for our study because it enabled us to determine the longitudinal trends regarding perinatal morbidity at the three hospitals and whether a process shift (statistically significant change that is indicative of lasting alteration in performance) occurred as a result of the intervention. We used an XMR chart based on the interval-level measurement and number of observations in subgroups.[46] We conducted five tests to assess the presence of special-cause variation (if any type of special cause is detected, the process is considered unstable and, therefore, unpredictable).

Bivariate and Multivariate Relationships. The second set of analyses examined bivariate and multivariate relationships between our key study variables. We used Wilcoxon's rank sum test to compare independent samples from the pre-intervention and post-intervention periods in an effort to determine whether the data provided evidence of a normal distribution so parametric tests could be used[46]; we used the chi-square test and Fisher's exact test when sample sizes were below five.[48]

Results

Outcomes

The four-year trends in perinatal outcomes in the three hospitals were examined by plotting and analyzing the quarterly WAOS for all hospitals using an SPC approach[46] to measure process performance using a time-series analysis.

The individual run charts, as shown in Figure 1 (right), indicated no special cause in either the control group or the didactic-only condition. There was, however, special-cause variation in the full-intervention condition, as demonstrated by a long run immediately subsequent to the first simulation trial in the first quarter of 2007. The run chart analysis indicates wide variability for both the control group and the didactic-only condition. The variation in the full-intervention group was substantially reduced during the postintervention period.

As a result of the special cause detected in the full-intervention condi-

Run Chart Analysis for Weighted Adverse Outcome Scores, January 2005–December 2008

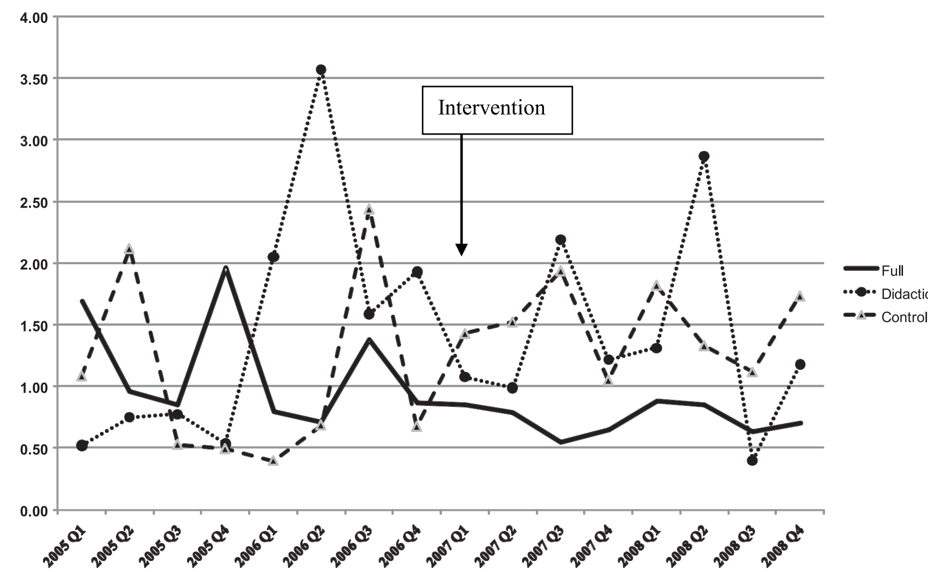

Figure 1. *The individual run charts indicate no special cause in either the control group or the didactic-only condition (the center lines are excluded for clarity). There was, however, special-cause variation in the full-intervention condition, as demonstrated by a long run immediately subsequent to the first simulation trial in the first quarter (Q1) of 2007.*

XMR Control Chart Analysis for Weighted Adverse Outcome Scores (WAOSs) and Moving Ranges for Full-Intervention Hospital, January 2005–December 2008

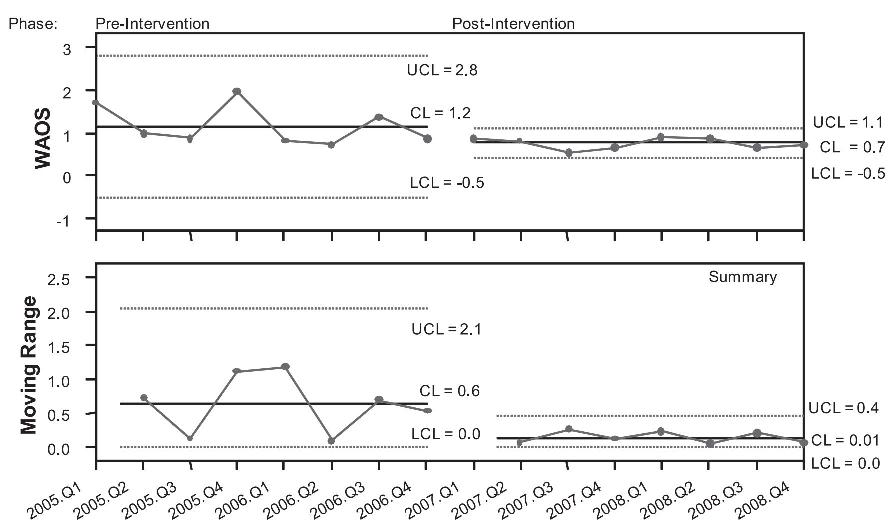

Figure 2. *The moving range chart (bottom) indicates stable variation, with no special cause in either the pre- or postintervention phases. The individual control chart (top) shows that both the pre- and postintervention processes were stable, with a process shift representing 37% reduction in perinatal harm. UCL, upper control limit; CL, control limit; LCL, lower control limit.*

Table 2. Pre-Intervention and Postintervention WAOS Means (and Standard Deviations)*

Hospital	Pre-intervention Mean (SD)	Postintervention Mean (SD)	% Change (Pre to Post)
Full Intervention	1.15 (0.47)	0.72 (0.12)	–37.4%†
Didactic-Only	1.46 (1.05)	1.45 (0.82)	–1.0%
Control	1.05 (0.79)	1.50 (0.35)	+42.7%

* WAOS, Weighted Adverse Outcomes Score; SD, standard deviation.
† Significant at the .05 level.

tion, we concluded that a process shift occurred after the intervention and further analyzed the process shift, as shown in the XMR control chart (Figure 2, page 360). The moving range chart indicated stable variation, with no special cause in either the pre- or postintervention phases. The individual control chart showed that both the pre- and post-intervention processes were stable, with a process shift representing 37% reduction in perinatal harm. Figure 2 also indicated reduced process variation during and after the intervention period.

Table 2 (above) shows the results of a t-test performed to compare pre- and post-intervention WAOS means for all three hospitals in the study. As indicated by the SPC analysis, the only significant change observed was for the full-intervention condition. The WAOS in the full-intervention condition was 1.15 pre-intervention, decreasing to 0.72 postintervention, a 37% decrease in this measure of perinatal harm.

Culture of Safety

Confirmatory factor analysis, performed on both pre- and postintervention COS data sets, confirmed the seven-scale structure of the instrument. All baseline perceptions of safety were generally high at all three hospitals. The results show no change in safety attitudes during the two-year period of the study for either the control group or didactic-only condition, with an increase in teamwork for the full-intervention hospital at the .05 level. However, the statistical significance no longer held when a Bonferroni adjustment was applied to the level of significance.

Discussion

The major objective of this study was to examine the impact of two interdisciplinary team training methods on perinatal outcomes. The primary finding indicates that the full intervention (in-situ simulation and didactic training) resulted in a 37% improvement in WAOS in an eight-quarter period. To our knowledge, this is the first time a reduction in perinatal harm has been shown to occur in a controlled trial. Although several studies have shown changes in the WAOS scores,[17] these have been natural histories and case studies. Analysis of variance also shows that the didactic-only hospital started with a slightly higher WAOS than the other two sites. The full-intervention hospital's variance was significantly lowered from a baseline low level to begin with, and the variance was stabilized.

In terms of the study's second objective—to examine the effect of team training on perceptions of COS—we found no significant improvement. It may be possible that a longer lag time is needed to show the influence of in-situ simulation on COS. Baseline perceptions of safety were high, indicating a potential ceiling effect limiting improvement. It is also plausible that the relationship between team training and safety culture is weak and that training does not necessarily positively affect safety culture, especially in the short term. Finally, it is possible that more training/simulation would have been necessary to show improvement in safety culture. Additional research is needed to address this question.

People consistently make errors, not because they are incompetent, uncaring, or careless, but because of the complicated systems in which they work[31] and the lack of training in NTS.[8] Mistakes are evidence of a faulty system, not necessarily human failing.[49] Although failures are inevitable, hazards and errors can be anticipated, and processes can be designed both to avoid failures and to prevent patient harm when a failure occurs.[50] Although some initial research on evaluating COS in health care settings has been promising,[51,52] there are few examples of a proven relationship between COS and health care outcomes,[53] and no controlled trials to test such relationships. In safety-critical industries, a process is carefully designed, tested, audited, and monitored on an ongoing basis using sophisticated process engineering techniques.[54] Although the importance of process design has become increasingly recognized for health care,[55,56] the application of rigorous quality improvement methods and techniques for high reliability and safety is not yet firmly in place.[57] A fundamental goal of quality improvement is to improve process performance by distinguishing between routine (common-cause) and unusual (special-cause) variation to determine the type of interventions necessary to achieve sustainable change.[58]

This article makes several contributions to the field of patient safety. As suggested by the literature review, it is the only study with a scientific design to document an actual reduction in adverse events based on an experiential simulation interdisciplinary team training protocol. Previous research using didactic training showed a 32% improvement in perinatal outcomes,[38] while an interdisciplinary training protocol in six obstetrics emergency drill stations found a reduction in two measures of neonatal harm (five-minute Apgar and hypoxic-ischemic encephalopathy).[59] However, the former study did not use simulation training, and the later study was a retrospective five-year cohort observational study that excluded selected high-risk deliveries and did not measure maternal outcomes. Our findings of improved perinatal outcomes in only the simulation group, with a lack of improvement in culture of safety across intervention groups, suggests that experiential training is critically important in changing the behavior of practicing professionals. Likewise, the findings raise questions regarding the role of didactic training as a stand-alone for altering behavior by practicing health care professionals. This is consistent with fundamental adult learning theories, which emphasize building experiential strategies on underlying didactic concepts.[60]

This study's findings also suggest an important role for applied in-situ simulation as both an effective assessment tool and interdisciplinary team training strategy. Not only does in-situ simulation assist health care workers and managers in assessing safety and team functioning, it is equally effective, the findings suggest, in training teams to improve performance on NTS. Debriefing and experiential learning play an important role in training teams, and simulation techniques provide a level of experiential learning beyond what is possible with didactic training. Experienced practitioners have a thorough grasp on technical skills, but often lack training, competence, and insight into their NTS, mastery of which is essential for improving reliability in health care organizations. Although simulation has been extensively used in simulation laboratories, it is not nearly as common in the actual patient unit, where teams deliver care and process flaws lurk undetected and unrecognized until they make themselves known by combining with other factors to cause injury.[61] This study suggests an important and expanded role for simulation techniques in improving the quality and safety of health care delivery processes. Simulation training techniques for NTS must be moved out of the laboratory and become part of the mainstream processes by which health care professionals are educated.

Limitations

The improved outcomes in the full-intervention hospital were the result of 11 simulation sessions. In contrast, only one didactic TeamSTEPPS session was held, and we did not examine whether the success achieved with multiple simulations could also be achieved with repetitive didactic sessions without the use of simulation. In addition, personnel departed and were hired during the course of this study at all three settings, and there was no assessment of the impact of these changes in professional staff. Although the hospitals randomly were assigned to each intervention, there were some differences that might have affected the outcomes, as suggested by a cluster analysis, such as number of births for obstetricians as compared to those for family practitioners. There is no way to know whether the reported effects can be attributed to other influences in this study. Given the difficulties of this type of design, there may be possible contamination effects (such as change of policy or change in personnel). The improved outcomes could be related to the greater willingness of a smaller, less busy obstetrical unit in which care is predominantly provided by obstetricians more willing to embrace the team concepts irrespective of the in-situ simulation intervention. This study was conducted in three smaller hospitals in suburban/outer rural areas, and the application of these findings to other settings is limited. Many features of larger hospitals, including less consistency between teams, more complex care processes, and higher-risk patients, were not explored in the settings where this study occurred. Moreover, the in-situ simulation is by definition, a replication of a critical event, not the event itself. No postsimulation assessment of the participants was conducted to determine the extent of perceived authenticity of the simulation experience. In addition, it is possible that the didactic TeamSTEPPS curriculum, which represented an abbreviated version of the four-to-six-hour workshop provided in a conventional TeamSTEPPS training session, did not constitute an adequate test of the TeamSTEPPS program. Finally, although there were no other safety initiatives going on in the obstetrics units of the participating hospitals, we are unaware of broader hospital-level safety initiatives that could have affected the perception of COS or the outcome data.

Conclusion

Although no hazardous industry has waited for unequivocal proof of the benefits of simulation training,[62] there has been little evidence that simulation training improves patient care.[17,27,63] This cohort study provides evidence that interdisciplinary in-situ simulation training is effective in decreasing perinatal morbidity and mortality for perinatal emergencies at a small-sized community hospital. In-situ simulation is important for both the training of NTS and improving process design by uncovering latent conditions. This model of training should be further adapted for implementation at larger institutions and considered for application to other similar critical care scenarios. J

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