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Team Training in Obstetrics: A Multi-Level Evaluation

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Introduction: Obstetric complications and adverse patient events are often preventable. Teamwork and situational awareness (SA) can improve detection and coordination of critical obstetric (OB) emergencies, subsequently improving decision making and patient outcomes. The purpose of this study was to assess the effectiveness of a team training intervention in improving learning and transfer of teamwork, SA, decision making, and cognitive bias as well as patient outcomes in OB. ***Method:*** An adapted TeamSTEPPS training program was delivered to OB clinicians. Training targeted communication, mutual support, situation monitoring, leadership, SA, and cognitive bias. We conducted a repeated measures multilevel evaluation of the training using Kirkpatrick's (1994) framework of training evaluation to determine impact on trainee reactions, learning, transfer, and results. Data were collected using surveys, situational judgment tests (SJTs), observations, and patient chart reviews. ***Results:*** Participants perceived the training as useful. Additionally, participants acquired knowledge of communication strategies, though knowledge of other team competencies did not significantly improve nor did self-reported teamwork on the unit. Although SJT decision accuracy did not significantly improve for all scenarios, results of behavioral observation suggest that decision accuracy significantly improved on the job, and there was a marginally significant reduction in babies' hospital length of stay. ***Discussion:*** These findings indicate that the training intervention was partially effective, but more work needs to be done to determine the conditions under which training is most effective, and the ways in which to sustain improvements. Future research is needed to confirm its generalizability to additional OB units and departments.

Keywords: decision accuracy, health care, patient safety, situation awareness, team training

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Globally, approximately 287,000 women annually die as a result of pregnancy or childbirth complications (World Health Organization, 2010). In modern obstetric units, maternal deaths have increased in the last two decades to about 22,980 adverse events in the U.S. alone (Bailit & Blanchard, 2004). Human error is one of the greatest contributors to the occurrence of adverse events (Cook & Woods, 1994) in medicine. Human error is often a result of human factors like cognitive workload, (the mental resources required of a person at any one time; Hart & Staveland, 1988; Paas, Renkl, & Sweller, 2004), a lack of situation awareness (SA; the perception of the elements in the environment in a volume of time and space, the comprehension of their meaning, and projection of this status in the near future; Endsley, 1995; Sitterding et al., 2012), cognitive bias (CB; errors that occur as a result of reliance on heuristics to make decisions; Tversky & Kahneman, 1974), and teamwork (Joint Commission, 2014; the attitudinal, cognitive, and behavioral drivers that allow interdependent individuals to attain a common goal; Salas, Burke, & Cannon-Bowers, 2002). Literature suggests that improving human shortcomings in these areas may decrease the occurrence of patient care errors (Carayon & Wood, 2010; Gaba, Howard, & Small, 1995; Gregory et al., 2014). Accordingly, we developed and evaluated a training program to improve teamwork, SA, and decision making.

Deficient SA increases the potential for error as clinicians are less able to anticipate patient or environmental problems. However, complete SA is insufficient to ensure optimal patient safety. For example, high cognitive workload is one driver of poor problem detection, low SA, and suboptimal teamwork. It may also exacerbate CBs (Elstein, 1999; Bordage, 1999; Redelmeier & Shafir, 1995; Kahneman, Slovic, & Tversky, 1982). In turn, CBs reduce SA and contribute to erroneous diagnoses resulting from fixation on initial assessments, emphasis on confirmatory evidence, or misinterpreting likelihood of risk (Croskerry, 2002, 2003; Redelmeier & Shafir, 1995). Thus, to realize successful patient outcomes, it is critical to reduce clinicians' cognitive demands and improve their problem detection, SA, and teamwork (Ebright et al., 2003).

Previous research has supported the use of training programs to improve decision making and communication in nonclinical (Salas et al., 2008) and clinical settings (e.g., Gregory et al., 2014; Morey et al., 2002; Grogan et al., 2004). Several studies demonstrate that obstetric nontechnical skills training may be effective in preventing error (Merién et al., 2010), improving patient outcomes (Phipps et al., 2012; Siassakos et al., 2009), and perceptions of patient safety (Freeth et al., 2009; Phipps et al., 2012). The American Congress of Obstetricians and Gynecologists (2009) recommends teamwork training for obstetrics, to improve patient safety. Training has been recommended to attenuate CB that causes incorrect judgments, and to repair incorrect judgments made under the influence of CB (Croskerry, 2003).

Encouraged by this collective body of evidence and recommendations from experts, we developed, implemented, and conducted a multilevel evaluation of a nontechnical skills training program in a labor and delivery (L&D) unit. The aims of the current study are to determine whether training improves (a) teamwork, (b) situation awareness, (c) decision making, (d) cognitive bias, and (e) patient outcomes. We believe this study is unique in that it not only addresses these concepts within L&D but also explores how they materialize across multiple levels.

Method

Needs Analysis

We conducted a multimethod needs analysis using interview, observation, and retrospective chart review methods. Chart reviews identified that clinicians at times failed to recognize signals indicating a need for emergent Cesarean delivery. Interview and observation data elucidated facilitators and barriers to impending emergency detection on the unit (see Hughes et al., 2013). Our interview, observation, and chart reviews revealed that often, in emergent situations, teamwork, SA, problem detection, and decision-making were lacking. Therefore we developed our training to target these deficiencies.

Design

We employed a pre-post design to evaluate training.

Participants and Setting

Forty-three clinical obstetric staff members at a 2,338-bed southeastern U.S. teaching hospital participated. Staff members included 38 registered nurses, nurse managers, licensed practical nurses, and nurse educators of a total 60 nurses on the unit. Two of four resident physicians on the unit participated, and three staff members did not indicate their profession. All participants were located on the L&D, mother–infant, high risk, or triage units. Participants had not previously received team training. Participants were 20 to 60 years old, worked 20 to 100 hours a week, and had worked <1 to 20 years on their unit. Hospital employees and members of the external research team recruited participants for all parts of the study, and the researchers obtained IRB approval from both participating hospital and university institutions.

Training Intervention

The researchers modified the TeamSTEPPS program, an evidence-based teamwork system for health care professionals designed by the Agency for Health care Research and Quality (AHRQ; Webster et al., 2008) that has been used successfully in other medical centers (Colcacchio et al., 2012; Thomas & Galla, 2013), in accordance with the science of training and instructional design principles. Specifically, the researchers modified the training to target four content areas: (a) problem detection, (b) SA, (c) CB, and (d) teamwork. Obstetrics literature and subject matter experts (SMEs) were consulted to assist with contextual details. The research team created an instructor script to provide talking points and helpful directions to allow a novice TeamSTEPPS instructor (hospital clinician with 20 Years L&D nursing experience) to present the information in a reproducible way.

The resulting training program was a lecture-based, interactive program delivered to 43 participants in an 85-minute session, and was divided into two modules. Module 1 addressed the importance of early accurate detection of emergent crises through maintenance of SA and elimination of CB. Module 2 encompassed training of teamwork competencies critical to health care (leadership, situation monitoring, mutual support, and communication; see Table 1). The lecture was punctuated with interactive practice and discussion opportunities as well as videos to demonstrate teamwork knowledge, skills, and attitudes (KSAs).

Method of Evaluation and Measures

We used a pre–post design and applied Kirkpatrick's training evaluation framework to evaluate the training program (i.e., reactions, learning, transfer, and results; Kirkpatrick, 1994, 1996). Data were collected via surveys, situational-judgment tests (SJTs), observations, and chart reviews (see Table 2).

Kirkpatrick Evaluation

Reactions. A 6-item survey asking the extent to which trainees were satisfied with the training and found the program useful on a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .96$), was given immediately after the training.

Learning. We administered a 7-item multiple choice and true/false questionnaire asking trainees to select the correct responses to SA items (e.g., which signal indicates that a patient is experiencing a problem or complication?), and teamwork items (e.g., which of these is not an effective tool for communicating patient status?) to determine a change in skills post training. These items were asked both immediately before and after training.

Transfer. To investigate whether trainees transferred the learned skills to the job, we explored what Detterman (1993) terms 'near' and 'far' transfer. Detterman's definition of transfer is the degree to which a behavior will be repeated in a new situation. Transfer to situations that are similar to the original learning environment are conceptualized as 'near transfer' and dissimilar situations are conceptualized as 'far' transfer. As such, training transfer was captured in three ways: (a) eight SJT items to assess how learned KSAs would be applied to paper patient scenarios as a proxy for on-the-job decision making (i.e., near transfer) and three SJTs to assess transfer of CB reduction skills; (b) self-reported perceptions of teamwork on the unit (i.e., far transfer); (c) behavioral observations of decision accuracy on the unit (i.e., far transfer).

SJTs. The research team developed eight patient vignettes with the assistance and validation of clinical experts within our research team (i.e., two nurse practitioners). Another experi-

Table 1
Competencies Trained in Each Module

Competency	Module	Definition	Trained skills
Problem detection	Module 1	Recognizing a cue or cue pattern that is impacting or may potentially impact outcomes for the patient (i.e., mother and/or baby).	1. Cue salience 2. Cue source 3. Importance
Situation awareness	Module 1	The perception of elements in the environment in a volume of time and space, the comprehension of their meaning, and projection of this status in the near future.	1. Scan and search 2. Pay attention 3. Remain watchful 4. Compare and critique information 5. Diagnose 6. Extrapolate 7. Ask 'what if?'
Cognitive bias reduction strategies	Module 1	Cognitive short-cutting strategies for quick decisions that are likely to be misleading and decrease patient safety (Croskerry, 2002, 2003).	1. Develop insight 2. Consider alternatives 3. Metacognition 4. Decrease reliance on memory 5. Cognitive forcing strategies 6. Minimize time pressures 7. Accountability
Cognitive workload reduction strategies	Module 1	The relationship between the cognitive resources of the individual and the demands of the situation (Norman & Bobrow, 1975).	1. Adapt to excessive workloads 2. Eliminate common interruptions (Human, technology, environmental)
Leadership	Module 2 adapted from TeamSTEPPS	The ability to direct and coordinate the activities of other team members.	1. Briefs 2. Huddles 3. Debriefs
Situation monitoring	Module 2 adapted from TeamSTEPPS	The process of actively scanning situational elements to gain awareness of the situation in which the team functions.	1. Cross monitoring 2. STEP tool
Mutual support	Module 2 adapted from TeamSTEPPS	The ability to anticipate and support other team members' needs through accurate knowledge about their responsibilities and workload.	1. Task assistance 2. Feedback 3. Assertiveness and advocacy
Communication	Module 2 adapted from TeamSTEPPS	The process by which information is clearly and accurately exchanged among team members.	1. Clear, complete, brief, timely information exchange 2. SBAR 3. I-Pass the Baton for shift changes 4. Call outs

enced obstetric nurse reviewed and edited the vignettes. Then, two experienced obstetric nurses with doctoral degrees ranked the scenario response options, and came to consensus before providing the expert score. Participants were asked to rank order 8 to 10 decision options based on the order in which they would engage in each decision behavior in a real patient situation. Each SJT had varied levels of patient signals to represent different levels of salience (e.g., screaming vs. moaning) and importance (e.g., nausea vs. bleeding) in predicting potential emergencies. We also administered three additional CB SJTs presenting patient situations with missing information designed to prompt reliance on heuristics. We offered three to four treatment/decision options for the participant to choose the best course of action (i.e., least reliant on CB). SJTs were scored by comparing the trainees' ranking to clinical expert rankings to obtain a difference score indicative of accuracy. SJT scores were

Table 2
Evaluation Tools

Program	Research question	Evaluation tool
Reactions	• Do clinicians like the training? • Do clinicians think training is useful?	• Reactions survey (Post training)
Learning	• Does training improve learning of teamwork skills and situation awareness skills?	• Knowledge tests (Pre and post training)
Behavioral transfer–Teamwork	• Does training improve perceptions of team performance on the unit?	• Teamwork Perceptions Questionnaire (TPQ) Self-report (Pre and Post training)
Behavioral transfer–Cognitive bias and decision making accuracy	• Does training reduce cognitive bias? • Does training improve decision making accuracy on a paper patient task?	• Situational judgment tests: Paper patient scenarios (Pre and post training)
Behavioral transfer–Decision making accuracy	• Does training improve decision making accuracy on the job?	• Behavioral observation on the unit by trained observers (pre and post training)
Organizational results	• Does training improve patient outcomes?	• Patient chart review (Pre and post training)

aggregated to represent near transfer and had a reliability of $\alpha = .53$. Although this is relatively low, it is in line with research noting that SJTs typically do not have a strong internal consistency due to the heterogeneity between the scenarios (Prewett, Brannick, & Peckler, 2013). All SJTs were administered between one and three months pre and post training.

Teamwork Perceptions Questionnaire. An adapted TeamSTEPPS *Teamwork Perceptions Questionnaire TPQ;* Webster et al., 2008) was used to assess perceptions of teamwork transfer on the unit. This scale assesses the degree to which trainees perceive communication, mutual support, situation monitoring, and leadership to exist on the unit using a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*; $\alpha = .98$). This measure was administered both pre and post training between one and three months before and after the training.

Behavioral observations. Six trained independent observers collected behavioral observation data, with two observers present for each observation to ensure reliable data. After piloting, observers conducted 40 hours of pre- and posttraining observations approximately two months before and after training. Observers recorded rich descriptions of all patient-related decisions that each clinician made during the shift (e.g., prepare patient for emergency Cesarean delivery; induce labor).

Results. Results represent the organizational outcomes and benefits of the training, such as increased safety. To evaluate results, we collected and analyzed 120 patient charts for both pre ($n = 60$) and post ($n = 60$) training periods to determine the impact of the training on patient health outcomes. Data points collected included risk factors, mother and infant/fetus age, morbidities, length of stay, transfer to ICU, infection rates, crisis, and mortality. The researchers chose patient charts randomly from all patients who had adverse birth events.

Analysis

We analyzed the survey and SJT-based data using independent groups *t* tests, comparing means pre and post training. We conducted a power analysis and found that a sample size of 173 would be needed to achieve a power of 0.80 in all analyses. We conducted post hoc item analyses. To analyze observation data, three independent raters (clinical SME and two patient safety researchers), identified and came to consensus on discrete patient related decisions carried out on the unit. Each rater categorized decisions as either accurate (i.e., commensurate with protocol, sound medical procedures) or inaccurate/risky (i.e., failure to collect enough patient information; inappropriate course of action given patient's condition). Interrater reliability was 80%, and all discrepancies were resolved via discussion to achieve consensus. To analyze the patient chart reviews, chi-square tests, *t* tests, and logistic regressions were con-

ducted. All analyses were one-tailed, as we expected a specific direction for results (i.e., improvement posttraining).

Results

Results of each level of evaluation can be found in Table 3.

Reactions

The reactions of trainees, as shown in Figure 1, illustrate the positive feelings toward the training; 90% of participants agreed they were likely to apply the tools provided in the training to a variety of situations on the job, and 85% responded that they enjoyed the training modules.

Learning

Our data do not show improvement in knowledge of SA, $p > .05$, and therefore we can conclude that SA learning did not occur (see Table 3). However, SA knowledge improvement was marginally significant for Item 3 and Item 4, $t(42) = 1.555$, $p = .06$, Cohen's $d = .346$, $t(42) = 1.548$, $p = .06$, Cohen's $d = 0.34$. Teamwork knowledge on the other hand, improved significantly for some items, $t(41) = 4.265$, $p < .001$, Cohen's $d = .966$ but similar results were not found with regard to other team competencies, $p > .05$, because of ceiling effects.

Transfer

Teamwork Perception Questionnaire. Although the TPQ results show an improvement in self-reported team behaviors on the unit, the results are nonsignificant (leadership, $t(49) = -0.035$, $p > .05$; situational monitoring, $t(49) = -0.099$, $p > .05$; mutual support, $t(49) = 0.495$, $p > .05$; and communication, $t(49) = 0.203$, $p > .05$).

SJTs. Seven of the eight scenarios showed a smaller difference between participants' ranking and the SME key after training (see Table 3). Although the decision making accuracy scenarios trended in the desired direction, $M_{pre} = 14.38$ ($SD = 2.72$), $M_{post} = 13.74$ ($SD = 2.93$), with low values indicating greater accuracy, for the most part the effects were not statistically significant, $p > .05$. Only three of eight decision accuracy scenarios significantly improved, $t(46) = 2.701$, $p = .01$, Cohen's $d = .84$, $t(44) = 2.188$, $p = .017$ Cohen's $d = .70$, and $t(40) = 2.004$, $p = .026$, Cohen's $d = .67$. The two scenarios had high salience and high importance patient signals, which are more likely to evoke responses commensurate with protocol than more subtle patient cues. Scores on CB scenarios did not significantly improve, $p > .05$.

Behavioral observations. Observers recorded 65 patient-related decisions pretraining. 61.54% ($n = 40$) were categorized as accurate decisions (e.g., alerting physician of abnormal fetal heart rate), and 23.08% ($n = 15$) as incorrect/risky decisions (e.g., Failure to respond to alarms indicating patient distress). Post training, there were 41 patient related decisions observed, with 82.9% ($n = 34$) determined to be accurate (e.g., Fetus has gastroschisis, a congenital defect characterized by defect in the anterior abdominal wall; clinicians decide to do an emergency Cesarean delivery and transfer directly to NICU for immediate surgery), and 17.1% ($n = 7$) determined to be inaccurate or 'risky' (e.g., send patient home after she had a fall and clot in the placenta). These results reflect an improvement in decision accuracy by 21.36%. A two-sample t test between proportions was performed to determine whether there was a significant difference between the pretraining group and the posttraining group with respect to decision accuracy, $t(104) = 2.333$, $p < .05$, Cohen's $d = .470$.

Patient Outcomes

Tables 4 and 5 show infant and mother demographics of patients who were included in the chart review pre- and posttraining, after the removal of two outliers.

Chart review results showed that the length of stay for infants decreased, from 3.85 days (SD 5.17) to 2.83 days (SD 1.44), $p = .07$, Cohen's $d = .27$ (see Table 4). However, this effect was only marginally significant. Other pre–post comparisons (e.g., mother length of stay, transfer to NICU, morbidity of infant) showed no significant change ($p > .05$). Many planned patient outcome analyses were unable to be run because of low base rate of certain occurrences. For example, there were no instances of mothers being transferred to the ICU in the charts reviewed for either the pre- or posttraining pe-

Table 3
Training Effectiveness Results

Program	*M*	*SD*	*df*	*t*	*p*	*d*
Reactions	5.67	1.15				
Learning[a]						
Teamwork						
Overall						
Pre	.695	.293	82	3.960	.00	0.875
Post	.919	.216				
Item 1						
Pre	.95	.22	82	0.624	.27	0.138
Post	.98	.15				
Item 2						
Pre	.44	.50	78	4.265	.00	0.966
Post	.85	.36				
Situational awareness						
Overall						
Pre	.828	.188	82	0.944	.17	0.208
Post	.862	.135				
Item 1						
Pre	.98	.16	81	1.000	.16	0.222
Post	1.00	.00				
Item 2						
Pre	.50	.51	76	0.657	.26	0.151
Post	.43	.50				
Item 3						
Pre	.78	.42	81	1.555	.06	0.346
Post	.91	.30				
Item 4						
Pre	.85	.36	80	1.548	.06	0.34
Post	.95	.22				
Item 5						
Pre	1.00	.00	—	—	—	—
Post	1.00	.00				
Transfer						
Cognitive bias[a]						
Overall						
Pre	.52	.26	39	0.383	.35	0.135
Post	.55	.22				
Sc. 1						
Pre	.38	.49	39	0.781	.22	0.275
Post	.25	.45				
Sc. 2						
Pre	.61	.50	38	0.348	.37	0.123
Post	.67	.49				
Sc. 3						
Pre	.63	.49	37	0.383	.18	0.257
Post	.75	.45				
Decision making accuracy (SJTs)[b]						
Overall						
Pre	14.38	2.72	47	−0.759	.23	0.236
Post	13.74	2.93				
Sc. 1						
Pre	7.94	2.85	47	2.701	.01	0.840
Post	11.50	4.89				
Sc. 2						
Pre	13.19	3.51	45	2.188	.02	0.700
Post	10.80	3.44				

Table 3 (*continued*)

Program	*M*	*SD*	*df*	*t*	*p*	*d*
Sc. 3						
Pre	23.40	5.48	42	0.493	.31	0.163
Post	22.57	4.47				
Sc. 4						
Pre	27.97	5.14	41	2.004	.03	0.668
Post	24.43	5.98				
Sc. 5						
Pre	16.39	3.75	40	1.606	.06	0.539
Post	14.57	2.77				
Sc. 6						
Pre	16.82	4.71	38	0.569	.29	0.197
Post	15.85	5.68				
Sc. 7						
Pre	6.10	2.78	40	1.323	.10	0.453
Post	4.92	2.40				
Sc. 8						
Pre	5.45	3.02	38	1.394	.09	0.506
Post	4.00	2.68				
Teamwork Perceptions Questionnaire						
Overall						
Pre	20.71	4.14	50	0.172	.43	0.057
Post	20.95	4.52				
Leadership						
Pre	5.44	1.50	50	−0.035	.49	0.012
Post	5.42	1.15				
Situation monitoring						
Pre	5.17	1.18	50	−0.099	.46	0.034
Post	5.13	1.35				
Mutual support						
Pre	4.83	1.34	50	0.495	.31	0.171
Post	5.05	1.27				
Communication						
Pre	5.27	1.25	50	0.203	.42	0.07
Post	5.35	.97				
Decision making accuracy (observations)						
Pre (%)	61.5		104	2.333	.021	0.470
Post (%)	82.9					
Results						
Infants length of stay (in days)						
Pre	3.85	5.17	116	1.47	.07	0.271
Post	2.83	1.44				

Note. Sc. = scenario.
[a] Learning and Cognitive Bias were scored on a 0 or 1 scale. [b] Smaller scores in SJT Decision Making Accuracy represent smaller deviations from expert rankings.

riods; therefore, we were not able to analyze this information.

Discussion

We evaluated our modified TeamSTEPPS training program in the L&D using four levels of outcomes: reactions, learning, transfer, and results. Consistent with prior research that employees tend to have positive reactions to training (Arthur et al., 2003), and tend to be dissatisfied with teamwork and communication in health care (Thomas et al., 2003), training was found to be well-received. Although the findings did not demonstrate that the training program worked to significantly improve knowledge of SA, it did show improved knowledge of communication competencies. Moreover, although CB did not significantly improve, and decision making only

Table 4
Infant Demographics

Information	Pretraining	Posttraining	*df*	*t*	*p*	*d*
Received prenatal care, *n*/*N* (%)	47/58 (81.03)	50/61 (81.97)				
Considered high risk, *n*/*N* (%)	21/58 (36.21)	28/61 (45.90)				
Transferred to NICU, *n*/*N* (%)	4/58 (6.90)	7/61 (11.48)				
Gestation age (weeks), *M* (*SD*)	39.29 (1.23)	38.96 (1.21)	118	1.48	.14	0.27
Weight (lbs), *M* (*SD*)	6.80 (1.09)	7.19 (1.26)	118	1.81	.07	0.33
Hospital stay (days), *M* (*SD*)	3.85 (5.17)	2.83 (1.44)	118	1.47	.14	0.27

Note. NICU = neonatal intensive care unit.

significantly improved in two of the SJTs, behavioral indicators of decision accuracy on the job were found to significantly improve, which is where the greatest value of the training lies (Detterman, 1993). Additionally, although perceptions of teamwork on the job did not significantly improve, there was a marginally significant reduction in infants' length of stay.

Learned competencies transferred to two of the eight SJT decision making paper patient scenarios, both of which had high salience (i.e., were easy to detect) and high importance cues (i.e., potentially fatal). Perhaps such SJTs provide clearer direction as to the appropriate decision making response, and after being trained to look for such emergency cues, result in improved decision making accuracy. Future work should include practice, such as role-play, in training to facilitate SJT performance (Prewett et al., 2013).

Our study did not demonstrate a reduction in CB. This is unsurprising as CB is extremely pervasive and resistant to change (Tversky & Kahneman, 1974). Even when people are aware of CBs and are told to avoid them, they are often still unable to do so (Tversky & Kahneman, 1974). Training may need to take a different approach to successfully reduce preexisting CBs (Hallion & Ruscio, 2011).

Although TPQ ratings changed in a positive direction, they were not significant. Participants may have had an inflated sense of their own teamwork skills before being trained on what team competencies are in the context of medical teams.

The observational results suggest that as a result of team training, decision accuracy improved by 20%. Our findings show promise that decision accuracy can be improved as a result of training. Although we observed significant improvements in on the job decision making ('far transfer'), these results were discrepant with the SJT measures of transfer ('near transfer'). Salience was an important characteristic that influenced decision accuracy in the SJTs. In the field, salience is generally higher than what any patient paper scenario could convey, which might explain this discrepancy.

Finally, there was a marginally significant decrease in infants' length of stay at the hospital post training. However, there were no changes in other patient outcomes, such as infant ICU transfer rates. This was attributable to limited variance in these outcomes resulting from a small sample size and infrequency of such adverse events. These findings

Table 5
Mother Demographics

Information	Pretraining	Posttraining	*df*	*t*	*p*	*d*
Age (years), *M* (*SD*)	28.84 (7.01)	29.52 (5.82)	118	0.58	.56	0.11
Weight (lbs), *M* (*SD*)	179.03 (39.29)	181.20 (36.37)	118	0.31	.75	0.06
No. past pregnancies, *M* (*SD*)	3.07 (2.21)	2.92 (1.89)	118	0.40	.69	0.07
No. past live births, *M* (*SD*)	1.64 (2.05)	1.31 (1.36)	118	1.04	.30	0.19
Hospital stay (days), *M* (*SD*)	2.94 (0.73)	2.90 (0.73)	118	0.30	.76	0.06

Note. No. = Number.

point to the practical and professional benefits of team and SA training for families and physicians.

Implications

Practitioners should consider implementing portions of this training program. For example, CB training was not as effective as expected, therefore practitioners may consider implementing the training without the CB components. However, training on teamwork and SA should be implemented in obstetrics units. Importantly, reactions, learning, transfer, and results are likely to diminish over time (Arthur et al., 1998). As such, refresher training of these competencies should be provided at regular intervals to minimize skill decay (Gregory et al., 2013). Transfer of trained competencies are also contingent upon the unit culture, climate, reinforcement of the behaviors through rewards, and accurate evaluations. Accordingly, units should strive to foster transfer of training using these methods.

Limitations and Future Research

There are several limitations to this research. First, to retain participant anonymity, we were unable to match participants' data across the training period. Thus, our data analyses were confined to global comparisons, which decreases the probability of observing a significant effect.

Furthermore, low statistical power may have limited our ability to detect training effects; Type II error was a concern. Nonetheless, despite limited power, some significant training effects were detected. Although the nonsignificant effect sizes found were relatively small, the high stakes context which they describe warrants more cautious interpretation (i.e., small effect sizes in patient outcomes are still meaningful). Moreover, failure to detect significant improvement in particular outcomes may have been attributable to ceiling effects. Further, self-report is subject to a number of biases (Donaldson & Grant-Vallone, 2002), so self-reported teamwork and SA may have been inflated because of the increased opportunity for concentration on an SJT as opposed to the heightened level of distractions that occur on the job.

Another limitation is that our sample was not well-represented by non-nurse professionals. Therefore, the extent to which these findings generalize to other professions is unknown. Further, the lack of interprofessional participation may have precluded the inclusion of valuable perspectives that may have strengthened the effects of teamwork training. Future research should involve physicians at the beginning of the training initiative.

Moreover, SJTs were developed for this study and therefore not previously validated. They represent an indication of 'near' transfer and should be interpreted with caution.

Another limitation is that the training modules were covered in only 85 minutes. It is likely that more time must be devoted to training these skills for trainees to absorb, process, practice, and ultimately master these skills. Future research should explore the role of practice and whether the results are replicable in other contexts. Finally, organizational results were difficult to examine and analyze because of the low base rate of certain adverse outcomes (e.g., mother to ICU, sepsis). To more accurately quantify the effect of team training on results-oriented outcomes, many more years of data would need to be collected. Although not logistically feasible in this study, future research should consider a more longitudinal approach to evaluating training, controlling for individual differences like experience, decision making style, and tenure, which might influence outcomes of interest.

Taking these limitations into consideration, future research should aim to replicate this training within obstetric units in other institutions and across other units and medical domains. Given the potential benefits to families, future work should consider expanding on the training, validating the training in other hospitals and units, and augmenting the training with practice opportunities crafted to elicit and evaluate use of teamwork and SA KSAs.

References

American Congress of Obstetricians and Gynecologists. (2009). Patient safety in obstetrics and gynecology (Committee opinion #447). *Obstetrics and Gynecology, 114,* 1424–1427. http://dx.doi.org/10.1097/AOG.0b013e3181c6f90e

Arthur, W., Jr., Bennett, W., Jr., Edens, P. S., & Bell, S. T. (2003). Effectiveness of training in organizations: A meta-analysis of design and evaluation features. *Journal of Applied Psychology, 88,* 234–245. http://dx.doi.org/10.1037/0021-9010.88.2.234

Arthur, W., Jr., Bennett, W., Jr., Stanush, P. L., & McNelly, T. L. (1998). Factors that influence skill decay and retention: A quantitative review and analysis. *Human Performance, 11,* 57–101. http://dx.doi.org/10.1207/s15327043hup1101_3

Bailit, J. L., & Blanchard, M. H. (2004). The effect of house staff working hours on the quality of obstetric and gynecologic care. *Obstetrics and Gynecology, 103,* 613–616. http://dx.doi.org/10.1097/01.AOG.0000119225.57285.c1

Bordage, G. (1999). Why did I miss the diagnosis? Some cognitive explanations and educational implications. *Academic Medicine, 74,* S138–S143. http://dx.doi.org/10.1097/00001888-199910000-00065

Carayon, P., & Wood, K. E. (2010). Patient safety - the role of human factors and systems engineering. *Studies in Health Technology and Informatics, 153,* 23–46.

Colcacchio, K., Johnston, L., Zigmont, J., Kappus, L., & Sudikoff, S. N. (2012). An approach to unit-based team training with simulation in a neonatal intensive care unit. *Journal of Neonatal-Perinatal Medicine, 5,* 213–219.

Cook, R. I., & Woods, D. D. (1994). Operating at the sharp end: The complexity of human error. In M. E. Boger (Ed.), *Human error in medicine* (pp. 255–310). Hillsdale, NJ: Erlbaum Inc.

Croskerry, P. (2002). Achieving quality in clinical decision making: Cognitive strategies and detection of bias. *Academic Emergency Medicine, 9,* 1184–1204. http://dx.doi.org/10.1197/aemj.9.11.1184

Croskerry, P. (2003). The importance of cognitive errors in diagnosis and strategies to minimize them. *Academic Medicine, 78,* 775–780. http://dx.doi.org/10.1097/00001888-200308000-00003

Detterman, D. K. (1993). The case for prosecurion: Transfer as an apiphenomena. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 1–23). Norwood, NH: Ablex.

Donaldson, S. I., & Grant-Vallone, E. J. (2002). Understanding self-report bias in organizational behavior research. *Journal of Business and Psychology, 17,* 245–260. http://dx.doi.org/10.1023/A:1019637632584

Ebright, P. R., Patterson, E. S., Chalko, B. A., & Render, M. L. (2003). Understanding the complexity of registered nurse work in acute care settings. *The Journal of Nursing Administration, 33,* 630–638. http://dx.doi.org/10.1097/00005110-200312000-00004

Elstein, A. S. (1999). Heuristics and biases: Selected errors in clinical reasoning. *Academic Medicine, 74,* 791–794. http://dx.doi.org/10.1097/00001888-199907000-00012

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors, 37,* 32–64. http://dx.doi.org/10.1518/001872095779049543

Freeth, D., Ayida, G., Berridge, E. J., Mackintosh, N., Norris, B., Sadler, C., & Strachan, A. (2009). Multidisciplinary obstetric simulated emergency scenarios (MOSES): Promoting patient safety in obstetrics with teamwork-focused interprofessional simulations. *The Journal of Continuing Education in the Health Professions, 29,* 98–104. http://dx.doi.org/10.1002/chp.20018

Gaba, D. M., Howard, S. K., & Small, S. D. (1995). Situation awareness in anesthesiology. *Human Factors, 37,* 20–31. http://dx.doi.org/10.1518/001872095779049435

Gregory, M. E., Benishek, L. E., Hughes, A. M., Sonesh, S., Joseph, D. L., King, H. B., & Salas, E. (2014, May). Does healthcare team training work? A review of what matters. In M. Kerry & E. H. Lazzara (Chairs), *A look at a paradigmatic shift in healthcare training*. Symposium presented at the 29th annual meeting of the Society for Industrial and Organizational Psychology, Honolulu, HI.

Gregory, M. E., Feitosa, J., Driskell, T., Salas, E., & Vessey, W. B. (2013). Designing, delivering, and evaluating team training in organizations: Principles that work. In E. Salas, S. I. Tannenbaum, D. Cohen, & G. Latham (Eds.), *Developing and enhancing high-performance teams: Evidence-based practices and advice*. San Francisco, CA: Jossey-Bass.

Grogan, E. L., Stiles, R. A., France, D. J., Speroff, T., Morris, J. A., Jr., Nixon, B., . . . Pinson, C. W. (2004). The impact of aviation-based teamwork training on the attitudes of health-care professionals. *Journal of the American College of Surgeons, 199,* 843–848. http://dx.doi.org/10.1016/j.jamcollsurg.2004.08.021

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin, 137,* 940–958. http://dx.doi.org/10.1037/a0024355

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Result of empirical and theoretical research. *Advances in Psychology, 52,* 139–183. http://dx.doi.org/10.1016/S0166-4115(08)62386-9

Hughes, A. M., Lazzara, E. H., Gregory, M. E., Benishek, L. E., Dietz, A., & Salas, E. (2013, March). Don't throw the training out with the bathwater: Identifying signals, facilitators, and barriers in obstetric emergencies for team training in obstetrics. Human Factors and Ergonomics Society 2013 International Symposium in Healthcare. Baltimore, MD.

Joint Commission. (2014). Medical device alarm safety in hospitals. *The Joint Commission Sentinel Event Alert, 50,* 1–3.

Kahneman, D., Slovic, P., & Tversky, A. (1982). *Judgment under uncertainty: Heuristics and biases.* Cambridge, UK: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511809477

Kirkpatrick, D. L. (1994). *Evaluating training programs: The four levels*. San Francisco, CA: Berrett-Koehler.

Kirkpatrick, D. K. (1996). Great ideas revisited: Revisiting Kirkpatrick's four-level model. *Training & Development, 50,* 54–59.

Merién, A. E. R., van de Ven, J., Mol, B. W., Houterman, S., & Oei, S. G. (2010). Multidisciplinary team training in a simulation setting for acute obstetric emergencies: A systematic review. *Obstetrics and Gynecology, 115,* 1021–1031. http://dx.doi.org/10.1097/AOG.0b013e3181d9f4cd

Morey, J. C., Simon, R., Jay, G. D., Wears, R. L., Salisbury, M., Dukes, K. A., & Berns, S. D. (2002). Error reduction and performance improvement in the emergency department through formal teamwork training: Evaluation results of the MedTeams project. *Health Services Research, 37,* 1553–1581. http://dx.doi.org/10.1111/1475-6773.01104

Norman, D. A., & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive Psychology, 7,* 44–64. http://dx.doi.org/10.1016/0010-0285(75)90004-3

Paas, F., Renkl, A., & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science, 32,* 1–8. http://dx.doi.org/10.1023/B:TRUC.0000021806.17516.d0

Phipps, M. G., Lindquist, D. G., McConaughey, E., O'Brien, J. A., Raker, C. A., & Paglia, M. J. (2012). Outcomes from a labor and delivery team training program with simulation component. *American Journal of Obstetrics and Gynecology, 206,* 3–9. http://dx.doi.org/10.1016/j.ajog.2011.06.046

Prewett, M. S., Brannick, M. T., & Peckler, B. (2013). Training teamwork in medicine: An active approach using role play and feedback. *Journal of Applied Social Psychology, 43,* 316–328. http://dx.doi.org/10.1111/j.1559-1816.2012.01001.x

Redelmeier, D. A., & Shafir, E. (1995). Medical decision making in situations that offer multiple alternatives. *JAMA: Journal of the American Medical Association, 273,* 302–305. http://dx.doi.org/10.1001/jama.1995.03520280048038

Salas, E., Burke, C. S., & Cannon-Bowers, J. A. (2002). What we know about designing and delivering team training: Tips and guidelines. In E. Salas (Ed.), *Creating, implementing, and managing effective training and development: State-of-the-art lessons for practice* (pp. 234–261). San Francisco, CA: Jossey-Bass.

Salas, E., DiazGranados, D., Klein, C., Burke, C. S., Stagl, K. C., Goodwin, G. F., & Halpin, S. M. (2008). Does team training improve team performance? A meta-analysis. *Human Factors, 50,* 903–933. http://dx.doi.org/10.1518/001872008X375009

Siassakos, D., Hasafa, Z., Sibanda, T., Fox, R., Donald, F., Winter, C., & Draycott, T. (2009). Retrospective cohort study of diagnosis-delivery interval with umbilical cord prolapse: The effect of team training. *BJOG: An International Journal of Obstetrics and Gyneaecology, 116,* 1089–1096. http://dx.doi.org/10.1111/j.1471-0528.2009.02179.x

Sitterding, M. C., Broome, M. E., Everett, L. Q., & Ebright, P. (2012). Understanding situation awareness in nursing work: A hybrid concept analysis. *Advances in Nursing Science, 35,* 77–92. http://dx.doi.org/10.1097/ANS.0b013e3182450158

Thomas, E. J., Sexton, J. B., & Helmreich, R. L. (2003). Discrepant attitudes about teamwork among critical care nurses and physicians. *Critical Care Medicine, 31,* 956–959. http://dx.doi.org/10.1097/01.CCM.0000056183.89175.76

Thomas, L., & Galla, C. (2013). Building a culture of safety through team training and engagement. *British Medical Journal Quality & Safety, 22,* 425–434. http://dx.doi.org/10.1136/bmjqs-2012-001011

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185,* 1124–1131. http://dx.doi.org/10.1126/science.185.4157.1124

Webster, J. S., King, H. B., Toomey, L. M., Salisbury, M. L., Powell, S. M., Craft, B., & Salas, E. (2008). Understanding quality and safety problems in the ambulatory environment: Seeking improvement with promising teamwork tools and strategies. In K. Henriksen, J. B. Battles, M. A. Keyes, M. L. Grady (Eds.), *Advances in patient safety: New directions and alternative approaches* (Vol. 3, pp. 1–15). Rockville, MD: Agency for Healthcare Research and Quality.

World Health Organization. (2010). *Maternal mortality* (Fact Sheet No. 348). Retrieved December 10, 2013 from http://www.who.int/mediacentre/factsheets/fs348/en/

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