Simulation-Based Team Training in Healthcare

Walter Eppich, MD, MEd;

Valerie Howard, EdD, RN;

John Vozenilek, MD;

Ian Curran, BSc, AKC, MBBS, FRCA, PG Dip Med Ed (Hons), FFPMR

Introduction: Simulation-based team training (SBTT) in healthcare is gaining acceptance. Guidelines for appropriate use of SBTT exist, but the evidence base remains limited. Insights from other academic disciplines with sophisticated models of team working may point to opportunities to build on current frameworks applied to team training in healthcare. The purpose of this consensus statement is threefold: (1) to highlight current best practices in designing SBTT in healthcare and to identify gaps in current implementation; (2) to explore validated concepts and principles from relevant academic disciplines and industries; and (3) to identify potential high-yield areas for future research and development.

Methods: We performed a selective review and critical synthesis of literature in healthcare simulation related to team learning as well as from other relevant disciplines such as psychology, business, and organizational behavior. We discuss appropriate use of SBTT and identify gaps in the literature.

Results: Healthcare educators should apply rigorous curriculum development processes and generate learning opportunities that address the interrelated conceptual levels of team working by addressing learning needs at the level of the individual, the team, the organization, and the healthcare system. The interplay between these conceptual levels and their relative importance to team-based learning should be explored and described. Instructional design factors and contextual features that impact the effect of SBTT should be studied. Further development of validated assessment tools of team performance relevant to professional practice is a high priority and is essential to provide formative, summative, and diagnostic feedback and evaluation of SBTT. Standardized reporting of curriculum design and debriefing approaches, although difficult, would help move the field forward by allowing educators to characterize effective SBTT instruction.

Conclusions: Much work is needed to establish a robust and defensible evidence base for SBTT. The complexity and expense of SBTT require that specific programs or interventions are appropriately designed, implemented, and evaluated. The healthcare sector needs to understand how team performance can be optimized through appropriate training methods. The specific role of simulation in team training needs to be more clearly articulated, and the training conditions that make SBTT in healthcare effective need to be better characterized.

(*Sim Healthcare* 6:S14–S19, 2011)

Key Words: Simulation, Team training, Curriculum development.

Simulation-based team training (SBTT) has been increasingly adopted in healthcare. Despite its widespread acceptance, the evidence base underpinning the efficacy of SBTT in healthcare remains limited. Currently, SBTT focuses largely upon intra-/interprofessional team working, highlighting patient safety, human factors, crisis resource management (CRM), and team-based behaviors. Other academic disciplines such as psychology, organizational behavior, and management have generated sophisticated models of team working in a wide range of professional contexts. Further exploration of these generic principles may highlight potential opportunities to optimize the current conceptual and educational paradigms applied to healthcare team training.

In preparing this consensus statement, we have endeavored to capture and conceptualize current approaches to SBTT in healthcare and incorporate input from attendees of the Society for Simulation in Healthcare (SSH) Research Summit. We performed a selective review of the healthcare SBTT literature and drew from other disciplines with the aim of critically synthesizing this diverse literature.[1,2] From this wider context, we strove to distill the current best practices in SBTT in healthcare and challenge current thinking on how to use SBTT to prepare healthcare teams to deliver safe effective care. This approach has highlighted areas of congruence with other disciplines and identified potential areas of relevance to the design and development of SBTT. The purpose of this consensus statement is therefore threefold: (1) to highlight current best practices in designing and implementing simulation-based educa-

From Children's Memorial Hospital (W.E.), Chicago, IL; Northwestern University Feinberg School of Medicine (W.E., J.V.), Chicago, IL; Robert Morris University School of Nursing and Health Sciences (V.H.), Moon Township, PA; London Deanery & St. Bartholomew's Hospital and The London School of Medicine and Dentistry (I.C.), Queen Mary University of London, London, United Kingdom.

Dr. Eppich receives grant funding from the Agency for Healthcare Research and Quality.

Reprints: Walter Eppich, MD, MEd, Children's Memorial Hospital, 2300 Children's Plaza Box 62, Chicago, IL 60614(e-mail: w-eppich@northwestern.edu).

Copyright © 2011 Society for Simulation in Healthcare

DOI: 10.1097/SIH.0b013e318229f550

Copyright © Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited

tional interventions for healthcare teams and to identify gaps in the literature; (2) to explore validated concepts and principles from relevant academic disciplines and industries; and (3) to identify potential high-yield areas for future research and development.

TEAMS AND TEAMWORK

The definition of team is similar across domains.[3,4] Baker et al[4] define a team as two or more individuals with specialized knowledge and skills who perform specific roles, and complete interdependent tasks, to achieve a common outcome or goal. The constantly changing membership and power hierarchies of "ad hoc" healthcare teams complicate team processes in dynamic, complex clinical environments.[5,6] Indeed, healthcare teams even within a given institution have diverse typologies across various healthcare settings in terms of stability and variability of both role and personnel.[7]

Teamwork is comprised of the individual team members' interrelated thoughts, actions, and feelings which allow them to function as a team[8,9] and promote coordinated, adaptive performance that leads to value-added outcomes.[10] Key features of teamwork have been distilled to the "Big Five": (1) team leadership; (2) performance monitoring; (3) backup behavior; (4) adaptability; and (5) team orientation.[8] Shared mental models, "closed loop" communication, and mutual trust support the coordination of these team processes. Team processes such as effective communication and coordination promote team cognition, a multilevel phenomenon influenced by individual mental models and environmental cues; for a discussion of team cognition and shared mental models, see the article by Salas et al.[11]

Gaba et al[12–17] introduced anesthesia CRM into healthcare and prompted a paradigm shift that continues to evolve to the present day. Several research groups have responded to the growing evidence supporting the need for communication and team training in healthcare.

Early efforts by the MedTeams group[5,18] and in emergency medicine (EM)[19] showed promise and led to work that demonstrated the benefit of linking simulation to didactic instruction.[20] The Agency for Healthcare Quality and Research and the United States Department of Defense Patient Safety Program developed TeamSTEPPS.[21] TeamSTEPPS incorporates four competencies of effective team training, namely team leadership, situation monitoring, mutual support, and communication,[22] but until recently lacked a simulation component (Training Guide: Using Simulation in TeamSTEPPS Training. http://www.ahrq.gov/teamsteppstools/simulation/index.html. Accessed March 14, 2011).

Several research groups augmented the TeamSTEPPS training program with SBTT; positive training outcomes were reported. [23–25] As the progression of these efforts illustrates, the critical issue is how to build on information and demonstration-based training[26] to design and integrate practice-based approaches such as simulation-based educational strategies into team training curricula.

Table 1. Eight Evidence-Based Principles for Team Training in Healthcare (Modified After Salas et al)[9]

1. Focus training content on critical teamwork competences
2. Emphasize teamwork and team processes over task work
3. Guide training based on desired team-based learning outcomes and organizational resources
4. Incorporate hands-on, guided practice
5. Match similar on-the-job mental processes and simulation-based training content to augment training relevance and transfer to practice
6. Provide both outcome- and behavior-based feedback
7. Evaluate training impact through clinical outcomes and work behaviors
8. Reinforce desired teamwork behaviors through coaching and performance evaluation

CURRENT STATUS OF SBTT AND GAPS IN THE LITERATURE

In our selective review and synthesis of the healthcare simulation literature, several recurring themes emerged. Although evidence-based principles for healthcare team training exist (see Table 1), adherence to many of these best practice recommendations is inconsistent. Multiple authors emphasize rigorous educational design processes for the development of SBTT curricula, including robust needs assessment.[9,26–37] Too few studies of SBTT, however, provide sufficient information on how training needs were determined.[38,39] A clear needs analysis to guide curriculum development and choice of target team competencies is even more essential in healthcare, given the various team typologies.[7,40] SBTT often occurs with personnel known to one another despite the fact that, especially in emergency healthcare settings, teams may form in an ad hoc manner.[38,40] As Salas et al note, "not all healthcare teams are created equal."[41]

Effective team working requires alignment of insight and skills at three interrelated, interdependent, and complex levels of practice, including not only the team but also the individual and organizational levels.[42] As such, the tripartite contribution of the individual, the team, and the organization must fundamentally inform any educational strategy aimed at producing effective, functional teams. At an individual level, team performance is influenced by psychologic and behavioral factors; insight and self-awareness in this domain likely mediate functioning within a team. Established psychometric tools from other domains heighten individual self-awareness about teamworking (Belbin Preferred Team Roles: http://www.belbin.com/, Aston Team Performance Inventory (ATPI): http://www.astonod.com/atpiView.php?page=1; Hogan Assessments: http://www.hoganassessments.com/assessments-hogan-development-survey. Accessed January 17, 2011); such insights may better support individual learning and self-efficacy in team-based activities and contexts. While such tools were not specifically designed with short-lived healthcare teams in mind, they highlight the potential value in exploring how an individual's personal insights inform team participation and reflection during SBTT activities. Organizational culture is also of critical importance and influences team functioning.[27,30,43,44] Organizational factors influence the ultimate effectiveness of team training interventions,[41,45] can considerably impact the learning climate,[46] and significantly undermine or promote team training activ-

© 2011 Society for Simulation in Healthcare

Copyright © Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited

Table 2. Event-Based Approach to Training (EBAT): Specific Considerations for Scenario Design (From Rosen et al)[33]

1. Focus on a subset of teamwork competencies
2. Define specific learning objectives rooted in teamwork competencies
3. Choose a clinical context to frame the scenario development
4. Develop a targeted set of knowledge, skills, and attitudes to capture the predefined objectives and competencies
5. Craft the scenario to ensure team members have the opportunity to display the targeted knowledge, skills, and attitudes—define the critical events
6. Define a set of targeted responses
7. Create diagnostic measurement tools
8. Create scenario script

ities. A better understanding of the role of educational and professional context is another key research need.[47]

Several studies provide positive examples of how needs assessment and detailed task analysis at the team and system level drive team training curriculum development and performance assessment.[27–29,43,48–50] As an excellent example, Fernandez et al[48] present a robust EM team taxonomy that includes temporal elements, related processes, and supporting mechanisms. This model reliably informs (a) the knowledge, skills, and attitudes for effective team working in EM as well as (b) strategies for scenario design and debriefing that specifically address each element.[48,49]

Careful scenario designers deliberately incorporate events that create a requirement to act. Event-based approach to training (EBAT) is a general methodology that links critical events with targeted responses based on explicitly defined knowledge, skills, and attitudes necessary for team performance in clinical settings.[33,34] Table 2 summarizes the key steps of EBAT. Brooks-Buza et al[51] used in situ simulations to evaluate teamwork and system organization during pediatric dental emergencies. Although the domain is a quite specific and the sample size small, this report is noteworthy. It provides an excellent example of a detailed and contextualized needs assessment and task analysis explicitly linked to objectives for scenario, clinical management, team processes, and systems-related issues. Scenario design was event-based with clear triggers aimed to prompt both management and team behaviors. Unfortunately, few other studies report this level of detail; this gap prevents precise comparison between studies. Finally, the use of actors and role playing[52,53] and heightening relevant aspects of realism[54–57] to promote psychologic fidelity are also key considerations in scenario design which are essential but need more precise characterization.

Two recent systematic reviews assessed the effectiveness of healthcare team training and highlighted the inability to compare studies due to lack of detail about the team training intervention.[39,58] Buljac-Samardzic et al[58] systematically reviewed 48 empirically based peer-reviewed studies to identify evidence-based interventions that improve team effectiveness. While SBTT improves nontechnical team skills, the level of evidence was low even for studies that focused on CRM. Furthermore, comparison and synthesis between studies was challenging as studies did not evaluate precisely the same intervention. Training focused mostly on the acute care settings, and appropriate outcome measures needed more concordance. The authors' key recommendations for further research include (1) replication of same intervention studies to enable validation of findings and (2) a diagnostic framework of dysfunctional team performance to ensure better remediation and intervention at the level of the individual, team, and organization.

Weaver et al[39] evaluated 40 peer-reviewed articles after a comprehensive literature search and explored issues related to training design, implementation, feedback and debriefing, evaluation metrics, and outcomes. Programs using SBTT employed approaches that blended information, demonstration, and practice-based methods. Although most programs were modeled on CRM principles and targeted teamwork competencies, insufficient detail about program features such as precise focus and mode of information delivery limited comparison. The authors highlighted cognitive fidelity and context-specific features of particular practice settings as most critical to promote transfer and generalization of targeted competencies.

An essential component of SBTT is postsimulation debriefing in which performance feedback can be provided; the specificity, timeliness, and diagnostic nature of postscenario feedback have been emphasized.[9,41,59] Multiple authors have addressed both the importance of debriefing and specific strategies to promote its effectiveness.[60–63] Debriefing in simulation is a topic of another SSH Research Summit consensus statement. Most descriptions of the debriefing component of SBTT lack the specificity that would allow inferences about high-yield debriefing strategies. A precise characterization of an effective debriefer of SBTT is also lacking.

Performance assessment is an essential component of descriptive and timely feedback after team simulations. The field is moving beyond reaction data and knowledge acquisition as markers of training efficacy as they provide neither learners nor curriculum developers with meaningful information for performance improvement. Instead, multiple authors endorse rigorous performance assessment for SBTT.[47,64–66] Specific examples of performance assessment tools include the Anaesthesists' Non-Technical Skills (ANTS),[67] the Ottawa Global Rating Scale,[68,69] the Mayo High Performance Teamwork Scale,[70] the SMARTER approach,[71] and Team Emergency Assessment Measure (TEAM).[72] Some approaches target assessment of individual performance (ANTS, Ottawa Global Rating Scale, SMARTER) whereas others target the performance of the team as a whole (Mayo High Performance Teamwork Scale, TEAM). See Cooper et al[72] for a detailed discussion. Other clinically relevant surrogates of team efficiency, such as time to administration of an essential drug, have been shown to be related to effective use of team behaviors.[73]

Rosen et al[64,66] provide an overview of best practices related to assessing team performance in healthcare. The assessment tools presented above capture information about performance outcomes; however, the process the team used to achieve the end result is equally important. In practice, this requires clearly defining critical scenario events and capturing the behavioral responses. The SMARTER approach (Simulation Module for Assessment of Resident Targeted Event

Copyright © Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited

Responses) is an example of how targeted responses inform scenario development and performance assessment as well as the quality of corrective feedback provided to learners.[71] Team performance measurement that yields specific diagnostic information helps correct team processes. It is important to note here that rigorous process and outcomes assessment also help identify training needs that lead to curriculum modification and improved implementation; as such, assessment is part of the ongoing needs analysis we emphasized previously.

Several authors report patient-centered outcomes of simulation-based team interventions in a variety of domains, including pediatrics[74] and obstetrics.[75–77] A discussion about simulation-based training as translational science is the focus of another Research Summit working group.

PRACTICE RECOMMENDATIONS FOR APPROPRIATE USE OF SBTT AND FUTURE DIRECTIONS

Through selective review and critical synthesis of literature from healthcare simulation and other disciplines and with moderating input from attendees of the SSH Research Summit, several recommendations for appropriate use of SBTT and key areas of future research have been identified.

1. Healthcare educators should perform thorough needs assessments and address the three dynamic and interrelated levels of team working (individual, team, and organization). Studies reported in the healthcare simulation literature should clearly indicate how training needs were determined. Further clarification about the contribution of an individual learner's teamwork skills and approach to teamwork will likely inform the future SBTT design and implementation. Similarly, we recommend future work to define the relative impact of organizational culture on SBTT and the transfer of skills to the clinical arena. Ongoing partnerships with cognitive and behavioral psychologists and other related disciplines involved in team training will likely yield further beneficial insights.
2. Well-designed scenarios are a core component of SBTT. Event-based approaches to scenario design are recommended as the gold standard for team training. In addition, other instructional design factors that likely impact the implementation of SBTT scenarios should be characterized, including the role of pretraining preparatory work; the use of role-play and confederate actors during SBTT; and key contextual features that augment relevant degrees of realism and psychologic fidelity. Finally, the relative influence and merit of training site, such as point of care/in situ, established simulation center, or distributed simulation, on desired outcomes should be further explored.
3. Feedback and debriefing are key elements of SBTT. Further performance assessment tools that yield both specific individual and team level process feedback linked to clear behavioral triggers need to be developed. Moreover, a thorough understanding of SBTT instructor characteristics such as skill set and background (clinical vs. nonclinical, physician vs. nonphysician) remain to be elucidated as a variable influencing outcome of SBTT that have programmatic implications in terms of resource allocation and faculty development.
4. Reporting standards on specific training conditions that are deliberately manipulated during simulation-based team interventions would help to advance the field. Standards should relate to adherence to curriculum development frameworks, scenario descriptions, clear definitions of training concepts, contextual features of the training environment, and factors related to the debriefing. Reporting standards would allow replication of same intervention team training studies and improve our ability to describe, synthesize, and assess specific team behaviors.
5. Teamwork training in healthcare is context-dependent and standardized training programs may not fit the needs of all stakeholders in an organization. Although it appears that SBTT should be anchored in relevant clinical contexts (eg, resuscitation, obstetrical emergencies), the relationship between SBTT and clinically relevant task work needs more precise definition. In addition, the relative merits of interprofessional team training compared with discipline-specific team training should be further studied. For example, the evidence related to SBTT in nursing practice is sparse especially in light of their critical role in a wide range of healthcare settings.
6. To advance the field, we must describe the effectiveness of SBTT in healthcare at various levels. To this end, SBTT will have greater impact if assessment tools allow us to provide better feedback to individuals and teams. Finally, SBTT in healthcare will only be fully validated in the context of improved patient and institutional outcomes. Given the difficulty of reliably attributing patient outcome to SBTT, risk mitigation as a marker of good team working should also be explored.

CONCLUSIONS

Effective team working is a complex, challenging, adaptive social phenomenon and requires the alignment of many capabilities and attributes at the level of the individual, the group, and the organization. The complexity and expense of SBTT requires that meaningful outcome measures be used to design, implement, and monitor appropriately resourced educational interventions. Further research in this field will promote SBTT interventions that are fit for purpose and yield meaningful educational, organizational, and patient-based outcomes.

REFERENCES

1. Norman GR, Eva KW. *Quantitative Research Methods in Medical Education.* Edinburgh: Association for the Study of Medical Education; 2008.
2. Eva KW. On the limits of systematicity. *Med Educ* 2008;42:852–853.
3. Katzenbach JR, Smith DK. The discipline of teams. *Harv Bus Rev* 1993; 71:111–120.
4. Baker DP, Gustafson S, Beaubien JM, Salas E, Barach P. Medical teamwork and patient safety: the evidence-based relation. 2005. Available at: http://www.ahrq.gov/qual/medteam/. Accessed January 9, 2010.

© 2011 Society for Simulation in Healthcare

Copyright © Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited

5. Risser DT, Rice MM, Salisbury ML, Simon R, Jay GD, Berns SD. The potential for improved teamwork to reduce medical errors in the emergency department. The MedTeams Research Consortium. *Ann Emerg Med* 1999;34:373–383.

6. Klein KJ, Ziegert JC, Knight AP, Xiao Y. Dynamic delegation: shared hierarchical, and deindividualized leadership in extreme action teams. *Admin Sci Q* 2006;51:590–621.

7. Andreatta PB. A typology for health care teams. *Health Care Manage Rev* 2010;35:345–354.

8. Salas E, Sims DE, Burke CS. Is there a "Big Five" in Teamwork. *Small Group Res* 2005;36:555–599.

9. Salas E, DiazGranados D, Weaver SJ, King H. Does team training work? Principles for health care. *Acad Emerg Med* 2008;15:1002–1009.

10. Salas E, Sims DE, Klein C. Cooperation and teamwork at work. In: Spielberger CD, ed. *Encyclopedia of Applied Psychology.* San Diego, CA: Academic Press; 2004.

11. Salas E, Rosen MA, Burke CS, Nicholson D, Howse WR. Markers for enhancing team cognition in complex environments: the power of team performance diagnosis. *Aviat Space Environ Med* 2007; 78(5 Suppl):B77–B85.

12. Gaba DM. Improving anesthesiologists' performance by simulating reality. *Anesthesiology* 1992;76:491–494.

13. Howard SK, Gaba DM, Fish KJ, Yang G, Sarnquist FH. Anesthesia crisis resource management training: teaching anesthesiologists to handle critical incidents. *Aviat Space Environ Med* 1992;63:763–770.

14. Gaba DM. The future vision of simulation in health care. *Qual Saf Health Care* 2004;13(Suppl 1):i2–i10.

15. Gaba DM. Crisis resource management and teamwork training in anaesthesia. *Br J Anaesth* 2010;105:3–6.

16. Gaba DM, Fish KJ, Howard SK. *Crisis Management in Anesthesiology*. New York, NY: Churchill Livingstone; 1994.

17. Gaba DM, Howard SK, Fish KJ, Smith BE, Sowb YA. Simulation-based training in anesthesia crisis resource management: a decade of experience. *Simul Gaming* 2001;32:175–193.

18. Morey JC, Simon R, Jay GD, et al. Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project. *Health Serv Res* 2002;37:1553–1581.

19. Small SD, Wuerz RC, Simon R, Shapiro N, Conn A, Setnik G. Demonstration of high-fidelity simulation team training for emergency medicine. *Acad Emerg Med* 1999;6:312–323.

20. Shapiro MJ, Morey JC, Small SD, et al. Simulation based teamwork training for emergency department staff: does it improve clinical team performance when added to an existing didactic teamwork curriculum? *Qual Saf Health Care* 2004;13:417–421.

21. Clancy CM. Mistake-proofing in health care: lessons for ongoing patient safety improvements. *Am J Med Qual* 2007;22:463–465.

22. Alonso A, Baker D, Holtzman A, et al. Reducing medical error in the Military Health System: How can team training help? *Hum Resour Manage Rev* 2006;16:396–415.

23. Capella J, Smith S, Philp A, et al. Teamwork training improves the clinical care of trauma patients. *J Surg Educ* 2010;67:439–443.

24. Robertson B, Kaplan B, Atallah H, Higgins M, Lewitt MJ, Ander DS. The use of simulation and a modified TeamSTEPPS curriculum for medical and nursing student team training. *Simul Healthc* 2010;5:332–337.

25. Maxson PM, Dozois EJ, Holubar SD, et al. Enhancing nurse and physician collaboration in clinical decision making through high-fidelity interdisciplinary simulation training. *Mayo Clin Proc* 2011;86: 31–36.

26. Rosen MA, Salas E, Pavlas D, Jensen R, Fu D, Lampton D. Demonstration-based training: a review of instructional features. *Hum Factors* 2010;52:596–609.

27. Andersen PO, Jensen MK, Lippert A, Ostergaard D, Klausen TW. Development of a formative assessment tool for measurement of performance in multi-professional resuscitation teams. *Resuscitation* 2010;81:703–711.

28. Fuhrmann L, Ostergaard D, Lippert A, Perner A. A multi-professional full-scale simulation course in the recognition and management of deteriorating hospital patients. *Resuscitation* 2009;80:669–673.

29. Fuhrmann L, Perner A, Klausen TW, Ostergaard D, Lippert A. The effect of multi-professional education on the recognition and outcome of patients at risk on general wards. *Resuscitation* 2009;80:1357–1360.

30. 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(Suppl 1): i96–i104.

31. Salas E, Wilson KA, Burke CS, Priest HA. Using simulation-based training to improve patient safety: what does it take? *Jt Comm J Qual Patient Saf* 2005;31:363–371.

32. Shapiro MJ, Gardner R, Godwin SA, et al. Defining team performance for simulation-based training: methodology, metrics, and opportunities for emergency medicine. *Acad Emerg Med* 2008;15:1088–1097.

33. Rosen MA, Salas E, Wu TS, et al. Promoting teamwork: an event-based approach to simulation-based teamwork training for emergency medicine residents. *Acad Emerg Med* 2008;15:1190–1198.

34. Fowlkes JE, Dwyer DJ, Oser RL, Salas E. Event-based approach to training (EBAT). *Int J Aviat Psychol* 1998;8:209–221.

35. Ostergaard HT, Ostergaard D, Lippert A. Implementation of team training in medical education in Denmark. *Postgrad Med J* 2008;84: 507–511.

36. Jeffries PR. A framework for designing, implementing, and evaluating simulations used as teaching strategies in nursing. *Nurs Educ Perspect* 2005;26:96–103.

37. Anderson JM, Aylor ME, Leonard DT. Instructional design dogma: creating planned learning experiences in simulation. *J Crit Care* 2008; 23:595–602.

38. Weaver SJ, Salas E, Lyons R, et al. Simulation-based team training at the sharp end: a qualitative study of simulation-based team training design, implementation, and evaluation in healthcare. *J Emerg Trauma Shock* 2010;3:369–377.

39. Weaver SJ, Lyons R, DiazGranados D, et al. The anatomy of health care team training and the state of practice: a critical review. *Acad Med* 2010;85:1746–1760.

40. Masiello I. Why simulation-based team training has not been used effectively and what can be done about it. *Adv Health Sci Educ Theory Pract* February 11, 2011 [Epub ahead of print].

41. Salas E, Weaver SJ, DiazGranados D, Lyons R, King H. Sounding the call for team training in health care: some insights and warnings. *Acad Med* 2009;84(10 Suppl):S128–S131.

42. Mickan SM, Rodger SA. Effective health care teams: a model of six characteristics developed from shared perceptions. *J Interprof Care* 2000;19:358–370.

43. Thomas EJ, Sexton JB, Helmreich RL. Translating teamwork behaviours from aviation to healthcare: development of behavioural markers for neonatal resuscitation. *Qual Saf Health Care* 2004;13(Suppl 1):i57–i64.

44. Andersen PO, Jensen MK, Lippert A, Ostergaard D. Identifying non-technical skills and barriers for improvement of teamwork in cardiac arrest teams. *Resuscitation* 2010;81:695–702.

45. Salas E, Almeida SA, Salisbury M, et al. What are the critical success factors for team training in health care? *Jt Comm J Qual Patient Saf* 2009;35:398–405.

46. Garvin DA, Edmondson AC, Gino F. Is yours a learning organization? *Harv Bus Rev* 2008;86:109–116, 134.

47. McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research: 2003–2009. *Med Educ* 2010;44:50–63.

48. Fernandez R, Kozlowski SW, Shapiro MJ, Salas E. Toward a definition of teamwork in emergency medicine. *Acad Emerg Med* 2008;15:1104–1112.

Copyright © Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited

49. Fernandez R, Vozenilek JA, Hegarty CB, et al. Developing expert medical teams: toward an evidence-based approach. *Acad Emerg Med* 2008;15:1025–1036.

50. Siassakos D, Draycott TJ, Crofts JF, Hunt LP, Winter C, Fox R. More to teamwork than knowledge, skill and attitude. *BJOG* 2010;117:1262–1269.

51. Brooks-Buza H, Fernandez R, Stenger JP. The use of in situ simulation to evaluate teamwork and system organization during a pediatric dental clinic emergency. *Simul Healthc* 2011;6:101–108.

52. Kassab ES, King D, Hull LM, et al. Actor training for surgical team simulations. *Med Teach* 2010;32:256–258.

53. Nikendei C, Zeuch A, Dieckmann P, et al. Role-playing for more realistic technical skills training. *Med Teach* 2005;27:122–126.

54. Beaubien JM, Baker DP. The use of simulation for training teamwork skills in health care: how low can you go? *Qual Saf Health Care* 2004; 13(Suppl 1):i51–i56.

55. Kneebone R. Simulation, safety and surgery. *Qual Saf Health Care* 2010;19(Suppl 3):i47–i52.

56. Dieckmann P, Gaba D, Rall M. Deepening the theoretical foundations of patient simulation as social practice. *Simul Healthc* 2007;2:183–193.

57. Rudolph JW, Simon R, Raemer DB. Which reality matters? Questions on the path to high engagement in healthcare simulation. *Simul Healthc* 2007;2:161–163.

58. Buljac-Samardzic M, Dekker-van Doorn CM, van Wijngaarden JD, van Wijk KP. Interventions to improve team effectiveness: a systematic review. *Health Policy* 2010;94:183–195.

59. Salas E, Klein C, King H, et al. Debriefing medical teams: 12 evidence-based best practices and tips. *Jt Comm J Qual Patient Saf* 2008;34:518–527.

60. Fanning RM, Gaba DM. The role of debriefing in simulation-based learning. *Simul Healthc* 2007;2:115–125.

61. 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. *Simul Healthc* 2006;1:49–55.

62. Rudolph JW, Simon R, Raemer DB, Eppich WJ. Debriefing as formative assessment: closing performance gaps in medical education. *Acad Emerg Med* 2008;15:1010–1016.

63. Simon R, Raemer DB, Rudolph JW. Debriefing Assessment for Simulation in Healthcare: Rater Version. Cambridge, MA: Center for Medical Simulation; 2009.

64. Rosen MA, Salas E, Wilson KA, et al. Measuring team performance in simulation-based training: adopting best practices for healthcare. *Simul Healthc* 2008;3:33–41.

65. Salas E, Rosen MA, Held JD, Weissmuller JJ. Performance measurement in simulation-based training: a review and best practices. *Simul Gaming* 2009;40:328–376.

66. Rosen MA, Weaver SJ, Lazzara EH, et al. Tools for evaluating team performance in simulation-based training. *J Emerg Trauma Shock* 2010;3:353–359.

67. Fletcher G, Flin R, McGeorge P, Glavin R, Maran N, Patey R. Anaesthetists' Non-Technical Skills (ANTS): evaluation of a behavioural marker system. *Br J Anaesth* 2003;90:580–588.

68. Kim J, Neilipovitz D, Cardinal P, Chiu M, Clinch J. A pilot study using high-fidelity simulation to formally evaluate performance in the resuscitation of critically ill patients: The University of Ottawa Critical Care Medicine, High-Fidelity Simulation, and Crisis Resource Management I Study. *Crit Care Med* 2006;34:2167–2174.

69. Kim J, Neilipovitz D, Cardinal P, Chiu M. A comparison of global rating scale and checklist scores in the validation of an evaluation tool to assess performance in the resuscitation of critically ill patients during simulated emergencies (abbreviated as "CRM simulator study IB"). *Simul Healthc* 2009;4:6–16.

70. Malec JF, Torsher LC, Dunn WF, et al. The mayo high performance teamwork scale: reliability and validity for evaluating key crew resource management skills. *Simul Healthc* 2007;2:4–10.

71. Rosen MA, Salas E, Silvestri S, Wu TS, Lazzara EH. A measurement tool for simulation-based training in emergency medicine: the simulation module for assessment of resident targeted event responses (SMARTER) approach. *Simul Healthc* 2008;3:170–179.

72. Cooper S, Cant R, Porter J, et al. Rating medical emergency teamwork performance: development of the Team Emergency Assessment Measure (TEAM). *Resuscitation* 2010;81:446–452.

73. Siassakos D, Bristowe K, Draycott T, et al. Clinical efficiency in a simulated emergency and relationship to team behaviours: a multisite cross-sectional study. *BJOG* 2011;118:596–607.

74. Andreatta P, Saxton E, Thompson M, Annich G. Simulation-based mock codes significantly correlate with improved pediatric patient cardiopulmonary arrest survival rates. *Pediatr Crit Care Med* 2011;12: 33–38.

75. Draycott TJ, Crofts JF, Ash JP, et al. Improving neonatal outcome through practical shoulder dystocia training. *Obstet Gynecol* 2008;112: 14–20.

76. Siassakos D, Hasafa Z, Sibanda T, et al. Retrospective cohort study of diagnosis-delivery interval with umbilical cord prolapse: the effect of team training. *BJOG* 2009;116:1089–1096.

77. Siassakos D, Fox R, Crofts JF, Hunt LP, Winter C, Draycott TJ. The management of a simulated emergency: better teamwork, better performance. *Resuscitation* 2011;34:518–527.

© 2011 Society for Simulation in Healthcare

Copyright © Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited