2007 Jack L. Maatsch Address
Advances in Simulation-Based Medical Education and Research

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Goal: Educate Superb Clinicians

Background
- What's Important?
- What's a Simulation?
- Educational Outcomes
  Research Synthesis
  Original Research
ACGME General Competencies

- Patient Care
- Medical Knowledge
- Practice-Based Learning and Improvement
- Interpersonal and Communication Skills
- Professionalism
- Systems-Based Practice

Simulation - Definition

“In broad, simple terms a simulation is a person, device, or set of conditions that attempts to present [education and] evaluation problems authentically. The student or trainee is required to respond to the problems as he or she would under natural circumstances. Frequently the trainee receives performance feedback as if he or she were in the real situation.”

McCcape, 1999

Common Characteristics

- Cues and consequences like those in the real environment
- Trainees placed in complex situations
- Fidelity (exactness of duplication) is never completely isomorphic with the “real thing”
- Varied formats: static (anatomical model), automated (computer and VR technology), individual (solitary performance), interactive (team performance), resoluteness (playful vs. deadly serious)
- Personnel evaluation: high stakes, low stakes, no stakes decisions

McCcape, 1999
Educational Outcomes

Kirkpatrick Criteria

4. Results
   - Change in organizational practice
   - Financial justifications

3. Behavior
   - Improved learning in workplace
   - Learners apply new knowledge & skills

2. Learning
   - Change attitudes/capacities
   - Change knowledge/skills

1. Reaction
   - Content Satisfaction

Roadmap for this Presentation

1. Best Evidence Medical Education (BEME) Systematic Review
2. "Son of BEME"
3. Diane B. Wayne, MD Cumulative Education and Research Program at Northwestern University
4. Concluding Remarks

Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review


Medical Teacher 2005;27(2):19-28
BEME Systematic Review

Background & Context

Simulations are now in widespread use in medical education and medical personnel evaluation. Outcomes research on the use and effectiveness of simulation technology in medical education is scattered, inconsistent, and varies widely in methodological rigor and substantive focus.

BEME Systematic Review

Objective

Review and synthesize existing evidence in educational science that addresses the question, “What are the features and uses of high-fidelity medical simulations that lead to most effective learning?”

Intent: Quantitative Meta-Analysis
BEME Systematic Review

Data Extraction & Synthesis

Data were extracted from 109 journal articles by nine independent coders using a standardized protocol. Qualitative data synthesis and tabular presentation of research methods and outcomes. Heterogeneity of research designs, educational interventions, outcome measures, and timeframe precluded data synthesis using meta-analysis.

BEME Systematic Review

"Headline" Results

- Coding accuracy for journal article features is high
- Quality of published research is generally weak
- Qualitative summary: weight of evidence suggests high-fidelity medical simulations facilitate learning under the right conditions

BEME Systematic Review

The "Right Conditions"

1. Feedback is provided during the learning experience
2. Learners engage in repetitive practice
3. Simulator is integrated into overall curriculum
4. Learners practice with increasing levels of difficulty
5. Adaptable to multiple learning strategies
6. Clinical variation
7. Controlled environment
8. Individualized learning
9. Outcomes or benchmarks clearly defined & measured
10. Validity of simulator
"Son of BEME"

- BEME review subset: 31 journal articles, 32 studies
- Adequate data for quantitative synthesis
- Question: Is there an association between hours of simulation-based practice and standardized learning outcomes?
- Standardized learning outcomes = AWES
- Hours of practice in 5 categories
- Statistics: ANOVA and $\eta^2$
- Results: $F_{(4,27)} = 5.77, p < .002; \eta^2 = .46$
- Approximates a dose-response relationship


Diane B. Wayne, MD, Research Program at Northwestern University

Thematic: Advanced cardiac life support (ACLS)
1. Skill acquisition (Wayne et al. 2005) [a]
2. Standard setting (Wayne et al. 2005 [b], 2007 [a])
3. Mastery learning (Wayne et al. 2006) [a]
4. Resident self-assessment (Wayne et al. 2006) [b]
5. Skill maintenance/decay (Wayne et al. 2006) [c]
6. Practice payoff re: response to hospital "codes" (Wayne et al. 2008)
7. Situation awareness (WIP)
8. Other procedures: e.g., thoracentesis (Wayne et al. 2007) [b], central lines, ICU skills, etc.
Deliberate Practice

Goal: skill improvement

4/10 rule for "world class" performance

Erkonen, Academic Medicine, 2004

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Deliberate Practice (DP)

Features
1. Highly motivated learners with good concentration;
2. Engagement with a well-defined learning objective or task; at an
3. Appropriate level of difficulty; with
4. Focused, repetitive practice; that leads to
5. Rigorous, precise measurements; that yield
6. Informative feedback from educational sources (e.g., simulators, teachers); and where
7. Trainees also monitor their learning experiences and correct strategies, errors, and levels of understanding, engage in more DP; and continue with
8. Evaluation to reach a mastery standard; and then
9. Advance to another task or unit

Erkonen Acad Med. 2004; McGaghie et al., Chest 2000
### Comparison of Two Standard-setting Methods for Advanced Cardiac Life Support Training

**Object**
- To compare the effectiveness of two standard-setting methods for Advanced Cardiac Life Support (ACLS) training.

**Methods**
- **Group A**
  - Family-centered care
  - Comprehensive approach
  - Emphasis on patient's needs
  - Enhanced team coordination

- **Group B**
  - Traditional methods
  - Modular approach
  - Focus on specific skills
  - Less emphasis on patient interaction

**Results**
- Both groups showed significant improvement in ACLS skills.
- Group A showed higher satisfaction in patient care and team collaboration.

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**Figure**

Bar chart showing the comparison of Group A and Group B scores at baseline, occasion 2, and occasion 3.

- **Baseline**: Group A = 150, Group B = 120
- **Occasion 2**: Group A = 230, Group B = 200
- **Occasion 3**: Group A = 250, Group B = 240

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**Conclusion**
- The family-centered approach in Group A improved overall patient care and team collaboration.

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**Acknowledgments**

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Mastery Learning

Features
1. Baseline, i.e., diagnostic testing;
2. Clear learning objectives, units ordered by difficulty;
3. Educational activities (e.g., deliberate skills practice) focused on objectives;
4. Minimum passing mastery standard (MPS) for each unit;
5. Formative testing — mastery of each unit;
6. Advancement if performance ≥ MPS; or
7. Continued practice or study until MPS is reached

McGarigal et al., Child 2009

ORIGINAL ARTICLE

Mastery Learning of Advanced Cardiac Life Support Skills by Internal Medicine Residents Using Simulation Technology and Deliberate Practice

Chiao S, Wayne MD, John Butler MD, Viva, Siddal MS, Leona M, Fusaro BA, Leonid D Wainz, MS, Joe Riehl, PhD, William C, McGarigal, MD

Department of Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, USA. Department of Anesthesiology, Northwestern University Feinberg School of Medicine, Chicago, IL, USA. "Effect of Clinical Education and Faculty Development on Northwestern Medical School's Skills Laboratory in Chicago, IL, USA.

![Mastery Learning Study](image)

1. One group pretest-posttest design (n = 41)
2. Highly reliable data
3. Protocols below MPS
4. Pretest A = Posttest B, 2% improvement from Pretest
5. 2004: 86% pretraining mastery in 8 hours; 90% (95.5%) needed more time
6. Bottom Line: All residents met or surpassed MPS for ALS skills

Wayne DB et al. Journal of General Internal Medicine 2006
A Longitudinal Study of Internal Medicine Residents' Retention of Advanced Cardiac Life Support Skills

Methods

Background:
Internal medicine residents are expected to perform Advanced Cardiac Life Support (ACLS) skills. Inadequate performance can have serious consequences.

Objectives:
To evaluate the feasibility of integrating technology into an ACLS training program.

Method:
An ACLS training program using a medical student and group training was developed.

Results:
The ACLS knowledge and performance improved significantly after the training.

Conclusions:
Integrating technology into ACLS training can improve knowledge and performance.

Figure 1: Combined ACLS baseline and follow-up outcomes. Group mean ± 95% confidence interval.
Retrospective Case-Control Study

Team Responses to Real Hospital “Codes”

OR=7.1

Education and Research Projects in Progress

1. Situation Awareness
2. Mastery Learning: Central Lines
4. Mastery Learning: ICU Skills
Benefits – Medical Simulation

- Safe environment, mistake forgiving
- Trainee focused vs. patient focused
- Controlled, structured, proactive clinical exposure
- Reproducible, standardized, objective
- Debriefing as a norm in everyday practice
- Increase public trust in the profession

Lessons Learned

1. Diverse, Talented Team
2. “Hothouse” Effect
3. Rigorous Measurement: Baseline, Formative, Outcome
4. Rater Training and Calibration
5. Research Should Not be an Extra-Ordinary Event
6. Research is Routine
7. Transfer to Practice

Medical Education Research Cycle

[Diagram showing the cycle of analysis and results, clinical practice, educational research question, educational research design, and educational intervention]
Reference


References


