2007 Jack L. Maatsch Address

Advances in Simulation-Based Medical Education and Research

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NORTHWESTERN
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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."

McGaghie, 1999

Common Characteristics

- Cues and consequences like those in the real environment
- Trainees placed in complex situations
- Trainees act as they would in real environment
- 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

McGaghie, 1999

Educational Outcomes

MILLER PYRAMID

KIRKPATRICK CRITERIA

4. Results

A. Change in organizational practice
B. Benefits to patients/clients

3. Behavior

A. Transfer learning to workplace
B. Learners apply new knowledge & skills

2. Learning

A. Change attitudes/perceptions
B. Change knowledge/skills

1. Reaction

Customer 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

S. Barry Issenberg, William C. McGaghie, Emil R. Petrusa, David Lee Gordon and Ross J. Scalese

Medical Teacher 2005; 27(1): 10-28

BEME Systematic Review

Background & Context

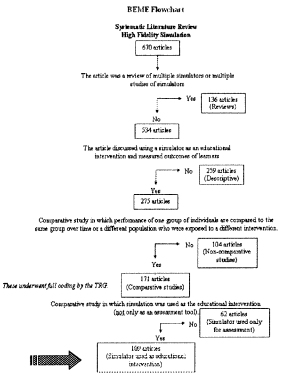
Simulations are now in widespread use in medical education and medical personnel evaluation. Outcomes research on the use and effectiveness of simulation technology in medical education is scattered, inconsistent, and varies widely in methodological rigor and substantive focus.

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

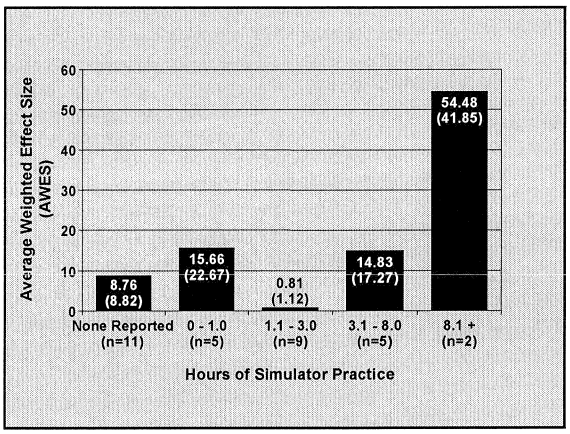
The "*Right Conditions*"

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 η^2
- Results: $F_{[4, 27]} = 5.77, p < .002; \eta^2 = .46$
- Approximates a dose-response relationship

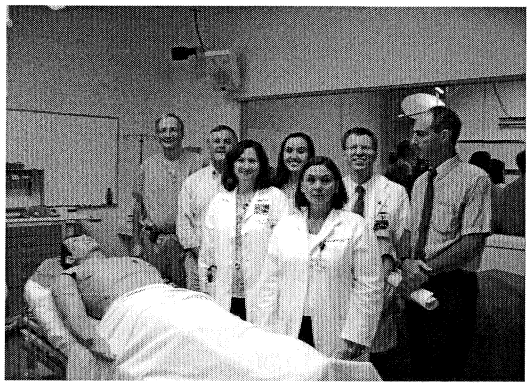
McGaghie WC et al. Effect of practice on standardized learning outcomes in simulation-based medical education. *Medical Education* 2006; 40: 792-797.



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

Ericsson, *Academic Medicine*, 2004

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

Ericsson *Acad Med.* 2004; McGaghie et al., *Chest* 2008

Simulation-Based Training of Internal Medicine Residents in Advanced Cardiac Life Support Protocols: A Randomized Trial

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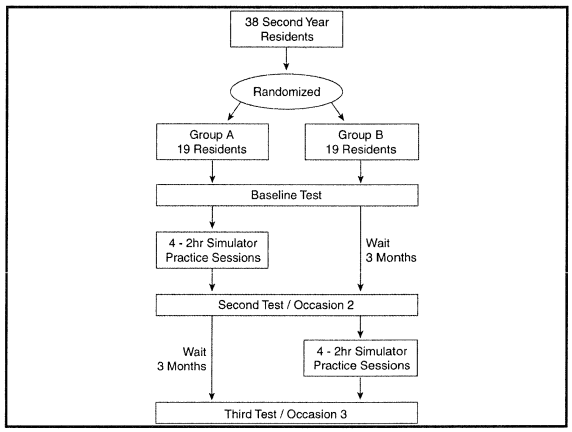
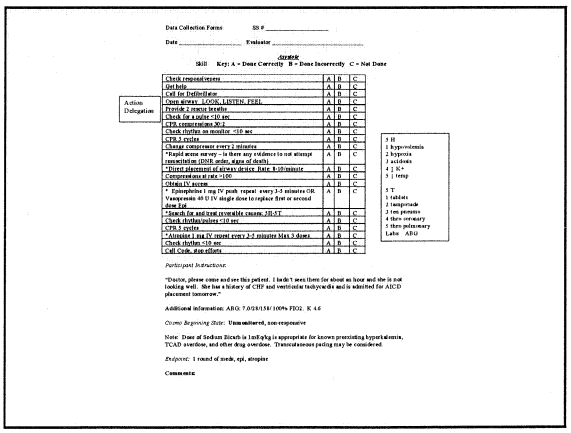




Data Collection Forms SS #

Date Evaluator

Accurate
Skill Key: A = Done Correctly B = Done Incorrectly C = Not Done

Action Delegation				
Check responsiveness	A	B	C	
Get help	A	B	C	
Call for Defibrillator	A	B	C	
Open airway LOOK, LISTEN, FEEL	A	B	C	
Provide 2 rescue breaths	A	B	C	
Check for a pulse <10 sec	A	B	C	
CPR compressions 30:2	A	B	C	
Check rhythm on monitor <10 sec	A	B	C	
CPR 5 cycles	A	B	C	
Charge compressor every 2 minutes	A	B	C	
*Rapid arrest survey – is there any evidence to not attempt resuscitation (DNR order, signs of death)	A	B	C	
*Direct placement of airway device Rate: 8-10/minute	A	B	C	
Compressions at rate >100	A	B	C	
Obtain IV access	A	B	C	
* Epinephrine 1 mg IV push repeat every 3-5 minutes OR Vasopressin 40 U IV single dose to replace first or second dose Epi	A	B	C	
*Search for and treat reversible causes: 3H,3T	A	B	C	
Check rhythm/pulses <10 sec	A	B	C	
CPR 5 cycles	A	B	C	
*Atropine 1 mg IV repeat every 3-5 minutes Max 3 doses	A	B	C	
Check rhythm <10 sec	A	B	C	
Call Code stop efforts	A	B	C	

3 H
1 hypovolemia
2 hypoxia
3 acidosis
4 ↓ K+
5 ↓ temp

3 T
1 tablets
2 tamponade
3 tox poisons
4 thrm coronary
5 thrm pulmonary
Labs ABG

Participant Instructions:

"Doctor, please come and see this patient. I hadn't seen them for about an hour and she is not looking well. She has a history of CHF and ventricular tachycardia and is admitted for AICD placement tomorrow."

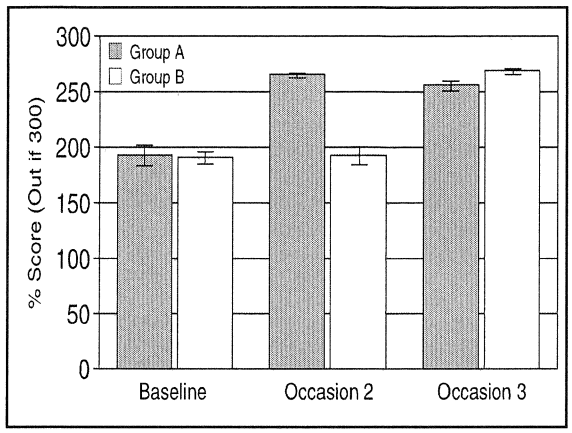
Additional information: ABG: 7.02/81/158/100% FIO2. K 4.6

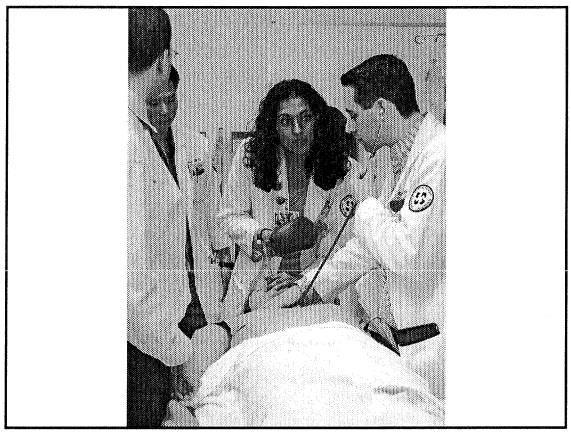
Events Beginning State: Unresponsive, non-responsive

Note: Dose of Sodium Bicarb is 1mEq/kg is appropriate for known preexisting hyperkalemia, TCAD overdose, and other drug overdose. Transcutaneous pacing may be considered.

Endpoint: 1 round of meds, epi, atropine

Comments:





Moderator: John Bolker, PhD
Discussant: Brian Clauser, PhD

Comparison of Two Standard-setting Methods for Advanced Cardiac Life Support Training

Glenn R. Wayne, Monica J. Furdon, John Butler, Vito J. Siddall, Joe Feinglass, Leonard D. Wiese, and William C. McGaghie

Abstract

Background
This study used the Angoff and Hofstee standard-setting methods to derive minimum passing scores for six advanced cardiac life support (ACLS) procedures.

Method
An expert panel provided item-based Angoff and group-based Hofstee judgments about six ACLS performance checklists on two occasions separated by ten weeks. Inter-rater reliabilities and test-retest reliability (stability) of the judgments were calculated. Derived ACLS passing standards are compared to historical ACLS performance data from two groups of ACLS-trained internal medicine residents.

Results
Both the Angoff and Hofstee standard-setting methods produced reliable and stable data. Hofstee minimum passing scores (MPSS) were uniformly more stringent than Angoff MPSs. Interpretation of historical ACLS performance data from medical residents shows the MPSs derived in this study would yield higher-than-expected failure rates.

Conclusions
[illegible] standard setting for ACLS [illegible] is defensible. Our findings [illegible] educational programs.

Acad Med 2005;80(10 Suppl):S63–S66

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**

McGaghie et al., *Chest* 2008

JGIM

ORIGINAL ARTICLE

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

Diane B. Wayne, MD,[1] John Butter, MD,[1] Viva J. Siddall, MS,[2] Monica J. Fudala, BA,[1] Leonard D. Wade, MS,[2] Joe Feinglass, PhD,[1] William C. McGaghie, PhD[3]

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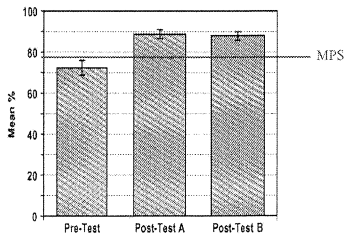


Mastery Learning Study

1. One group pretest-posttest design (n = 41)
2. Highly reliable data
3. Pretests below MPSs
4. Posttest A = Posttest B, 24% improvement from Pretest
5. 33/41 (80.5%) achieved mastery in 8 hours, 8/41 (19.5%) needed more time
6. *Bottom Line*: *ALL* residents met or surpassed MPS for *ALL* skills

Wayne DB et al. *Journal of General Internal Medicine* 2006

Postgraduate Education Outcomes

Moderator: Reena Karni, MD
Discussant: Michelle Rabik, MD

A Longitudinal Study of Internal Medicine Residents' Retention of Advanced Cardiac Life Support Skills

Diane B. Wayne, Wuai J. Siddall, John Butter, Monica J. Fudala, Leonard D. Wade, Joe Feinglass, and William C. McGaghie

Abstract

Background
Internal medicine residents must be competent in Advanced Cardiac Life Support (ACLS) for board certification. Traditional ACLS courses have limited ability to enable residents to achieve and maintain skills. Educational programs featuring reliable measurements and improved retention of skills would be useful for residency education.

Method
We developed a training program using a medical simulator, small-group teaching and deliberate practice. Residents received traditional ACLS education and subsequently participated in four two-hour educational sessions using the simulator. Resident performance in six simulated ACLS scenarios was assessed using a standardized checklist.

Results
After the program, resident ACLS skill improved significantly. The cohort was followed prospectively for 14 months, and the skills did not decay.

Conclusions
Use of a simulation-based educational program enabled us to achieve and maintain high levels of resident performance in simulated ACLS events. Given the limitations of traditional methods to train, assess and maintain competence, simulation technology can be a useful adjunct in high-quality ACLS education.

Acad Med. 2006;81(10 Suppl):S9–S12.

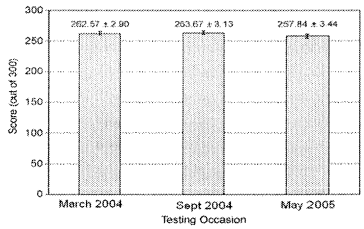


Figure 1 Combined ACLS baseline and follow-up outcomes. Group mean ± 95% confidence interval.

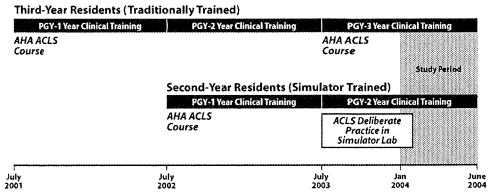
CHEST
Official publication of the American College of Chest Physicians

Simulation-Based Education Improves Quality of Care During Cardiac Arrest Team Responses at an Academic Teaching Hospital: A Case-Control Study

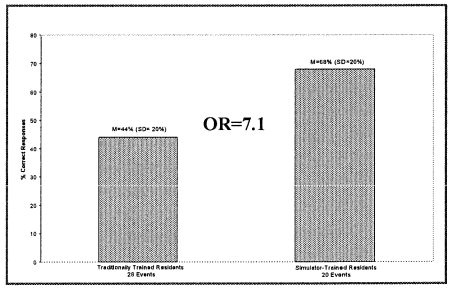
Diane B. Wayne, Aashish Didwania, Joe Feinglass, Monica J. Fudala, Jeffrey H. Barsuk and William C. McGaghie

Chest published online June 15, 2007;
DOI 10.1378/chest.07-0131

Retrospective Case-Control Study



Team Responses to Real Hospital "Codes"



Wayne et al., *Chest* 2008, in press

Education and Research Projects in Progress

1. Situation Awareness
2. Mastery Learning: Central Lines
3. Standard Setting: Communication Skills
4. Mastery Learning: ICU Skills

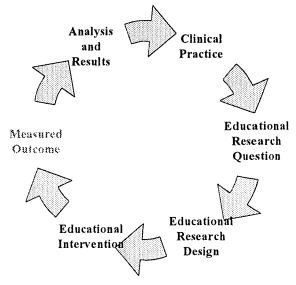
Benefits – Medical Simulation

- *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



Simulation Effectiveness

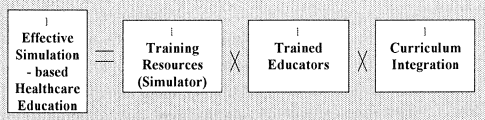


Figure 1. Formula for the effective use of simulation-based healthcare education: Effective Simulation-based Healthcare Education = Training Resources X Trained Educators X Curriculum Integration (Issenberg, 2007)

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