Mastery Learning and Translational Science
William C. McGaghie, PhD
Financial Relationships

- Taylor & Francis Group
- John Wiley Publishing
- Northwestern University
Premise

Only innovators are asked to present evidence that novel [educational] approaches are effective.

*Status quo never requires supporting data!*
Goals of this Presentation

1. Transfer of training pathway from the simulation education lab to patient care settings
2. Address translational science
3. Features of rigorous simulation-based medical education (SBME)
4. Interpret data from selected research studies on SBME transfer of training
5. Unexpected collateral effects
“The Barsuk et al. study is clearly a wake-up call for all of us who were trained in the era of ‘see one, do one, teach one’—the so-called ‘apprenticeship’ model of clinical training. The old training methods are no longer enough to ensure the best education, and thus the best care for patients.”

Goal: Educate Superb Clinicians

• Effective & Safe
• Quality Patient Care
• Good Patient Outcomes
Simulation Lab

Deep Probe

Transfer to Patient Care

Attitudes

Professionalism
MEDICAL EDUCATION

Medical Education Research As Translational Science

William C. McGaghie

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**Medical Education Research as Translational Science**

Contributions of *powerful medical education interventions* to T1 – T4 outcomes

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<th>Focus</th>
<th>Level of Translation</th>
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<td>Increased or Improved</td>
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<td>Target Groups</td>
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<td>Setting</td>
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McGaghie 2010; Barsuk & Szmuilowicz, 2015
Key SBME Research Concepts

Mastery Learning

Deliberate Practice
Mastery Learning Bundle

Feature
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 + feedback → mastery of each unit;
6. Advancement if performance ≥ MPS; or
7. Continued practice or study until MPS is reached

Time can vary, outcomes are uniform
Deliberate Practice (DP)

Features

1. Highly motivated learners with good concentration;
2. Engagement with a well-defined learning objective or task; at an appropriate level of difficulty; with
3. Focused, repetitive practice; that leads to
4. Rigorous, precise measurements; that yield
5. Informative feedback from educational sources (e.g., simulators, teachers); and where
6. Trainees also monitor their learning experiences and correct strategies, errors, and levels of understanding, engage in more DP; and continue with
7. Evaluation to reach a mastery standard; and then
8. Advance to another task or unit
9. Goal: constant improvement
If you practice the way you play, there shouldn’t be any difference, that’s why I practiced so hard.

I WANT TO BE PREPARED FOR THE GAME.

I love the competition of practice, I got that from North Carolina, where Coach Smith would make every drill competitive.

That grows on you, so everything we did in practice became competitive.

I TOOK PRIDE IN THE WAY I PRACTICED.
“The acquisition of skills requires a regular environment, an adequate opportunity to practice, and rapid and unequivocal feedback about the correctness of thoughts and actions. When these conditions are fulfilled, skill eventually develops, and the intuitive judgments and choices that quickly come to mind will mostly be accurate.”

Daniel Kahneman [Nobel Laureate]

*Thinking, Fast and Slow*
SBME Translational Science (TS)

Example Program

CVC  T1 → T2 → T3 → T4 (costs, retention, collateral effects)

Thematic → Sustained → Cumulative
SBME-TS Research Example

Central Lines

1. CVC Placement in Simulation Lab (T1)
2. CVC Insertion → ↓ Complications in MICU (T2)
3. CVC Insertion → ↓ CLABSI in MICU (T3)
4. CVC Insertion → ↑ Cost Savings (T4-$)
5. CVC Insertion Skills Retention (T4-R)
6. Unexpected collateral effects (T4-CE)
Use of Simulation-Based Mastery Learning to Improve the Quality of Central Venous Catheter Placement in a Medical Intensive Care Unit

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J Hosp Med. 2009; 4: 397-403
(T1 Outcomes)
Simulation-based mastery learning reduces complications during central venous catheter insertion in a medical intensive care unit* 

Jeffrey H. Barsuk, MD; William C. McGaghie, PhD; Elaine R. Cohen, BA; Kevin J. O’Leary, MD; Diane B. Wayne, MD

*Presented at the 33rd Annual International Conference on Nursing Research, May 7-10, 2009, Chicago, IL.
Clinical Outcomes: Complications (T2 Outcomes)

Barsuk et al. Critical Care Medicine 2009

% of Inserted Lines

Complications

- Eumothorax
  \( p = .757 \)
- Arterial Puncture
  \( p < .0005 \)
- CVC Adjustment
  \( p = .002 \)
- Insertion Failure Rate
  \( p = .005 \)
Use of Simulation-Based Education to Reduce Catheter-Related Bloodstream Infections

Jeffrey H. Barsuk, MD; Elaine R. Cohen, BA; Joe Feinglass, PhD; William C. McGaghie, PhD; Diane B. Wayne, MD
Timeline of residents rotating in the medical intensive care unit (ICU) and a comparison ICU
Monthly central line-associated bloodstream infection rates in a medical intensive care unit (MICU) and a comparison intensive care unit (ICU) before and after a simulation-based educational intervention in the MICU (T3 Outcomes)


85% ↓ in CLABSI
Cost Savings  
(T4-$ Outcomes)

• Cost savings from reduced catheter-related bloodstream infection after simulation-based education for residents in a medical intensive care unit.

7:1 ROI

• Cost savings of performing paracentesis procedures at the bedside after simulation-based education

IR vs. Bedside
5 times higher cost
↑ platelet transfusions
↑ fresh frozen plasma transfusions

Long-Term Retention of Central Venous Catheter Insertion Skills After Simulation-Based Mastery Learning

Jeffrey H. Barsuk, Elaine R. Cohen, William C. McGaghie, and Diane B. Wayne

Abstract

Background
Simulation-based mastery learning (SBML) of central venous catheter (CVC) insertion improves trainee skill and patient care. How long skills are retained is unknown.

Method
This is a prospective cohort study. Subjects completed SBML and were required to meet or exceed a minimum passing score (MPS) for CVC insertion on a posttest. Skills were retested 6 and 12 months later and compared with posttest results to assess skill retention.

Results
Forty-nine of 61 (80.3%) subjects completed follow-up testing. Although performance declined from posttest where 100% met the MPS for CVC insertion, 82.4% to 87.1% of trainees passed the exam and maintained their high performance up to one year after training.

Conclusions
Skills acquired from SBML were substantially retained during one year. Individual performance cannot be predicted, so programs should use periodic testing and refresher training to ensure competence.
Figure 1  Individual residents’ internal jugular (IJ) and subclavian (SC) checklist scores at pretest, posttest, six-month, and one-year follow-up. Pass rate (PR) is reported for each interval, and minimum passing score (MPS) is indicated for each checklist.
Unexpected Collateral Effects of Simulation-Based Medical Education

Jeffrey H. Barsuk, MD, MS, Elaine R. Cohen, Joe Feinglass, PhD, William C. McGaghie, PhD, and Diane B. Wayne, MD

Abstract

Purpose
Internal medicine residents who complete simulation-based education (SBE) in central venous catheter (CVC) insertion acquire improved skills that yield better patient care outcomes. The collateral effects of SBE on the skills of residents who have not yet experienced SBE are unknown.

Method
In this retrospective, observational study, the authors used a checklist to test the internal jugular and subclavian CVC insertion skills of 102 Northwestern University second- and third-year internal medicine residents before they received simulation training. The authors compared, across consecutive academic years (2007–2008, 2008–2009, 2009–2010), mean pretraining scores and the percent of trainees who met or surpassed a minimum passing score (MPS).

Results
Mean internal jugular pretest scores improved from 46.7% (standard deviation = 20.8%) in 2007 to 55.7% (±22.5%) in 2008 and 70.8% (±22.4%) in 2009 (P < .001). Mean subclavian pretest scores changed from 48.3% (±25.5%) in 2007 to 45.6% (±31.0%) in 2008 and 63.6% (±27.3%) in 2009 (P = .04). The percentage of residents who met or surpassed the MPS before training for internal jugular insertion was 7% in 2007, 16% in 2008, and 38% in 2009 (P = .004); for subclavian insertion, the percentage was 11% in 2007, 19% in 2008, and 38% in 2009 (P = .028).

Conclusions
SBE for senior residents had an effect on junior trainees, as evidenced by pretraining CVC insertion skill improvement across three consecutive years. SBE for a targeted group of residents has implications for skill acquisition among other trainees.
Pretest Pass Rate

- **Internal Jugular**
  - 2007: 7%
  - 2008: 16%
  - 2009: 38%

- **Subclavian**
  - 2007: 11%
  - 2008: 19%
  - 2009: 38%

**Statistical Significance**

- Internal Jugular: $p=0.004$
- Subclavian: $p=0.028$
APPLIED RESEARCH

Raising the Bar: Reassessing Standards for Procedural Competence

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## Study Findings

<table>
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<th>Study</th>
<th>Findings</th>
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<tr>
<td>Draycott et al. BJOG (2006)</td>
<td>S-B obstetric team training significantly reduces incidence of low infant APGAR scores and infant brain injury</td>
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<tr>
<td>Butter et al. J Gen Intern Med. (2010)</td>
<td>S-B mastery learning improves medical students’ cardiac auscultation skills that transfer to actual patients</td>
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<tr>
<td>Cook et al. Acad Med. (2013)</td>
<td>Systematic review and meta-analysis show mastery learning has large effects on skill acquisition and moderate effects on patient outcomes</td>
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