Simulation in Interventional Cardiology—An Overview

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How Do Interventional Cardiologists Learn to Perform New Procedures?

- “Throw-away” magazines on medical topics
- Attend annual or semi-annual meetings of professional societies with didactic lectures
- E-mails sent with links to educational websites
- Local continuing education programs
  - Lunch or dinner programs with speakers
  - Watch live cases at meetings
- Practice on patients in their hospitals
  - Apprenticeship model of training of fellows

Human Learning: Level of Interactivity

Why Use Simulations?

- Interaction is associated with learning achievement and retention of knowledge
- Participants learned faster and had better attitudes when they used an interactive instructional environment

Teach Others 90% Collaborative Simulations
Learn By Doing 75% Simulations
Discussion Groups 50% Web Seminars, IM, chat
Demonstration 30% Animation
Audio Visual 20% PowerPoint Slides
Lecture 10% Streaming media

Retention

Medical Simulation

Training tools developed to imitate:
- Anatomic regions
- Clinical tasks
- Real patients
- Real-life circumstances in which medical care is rendered

Spectrum of Simulations

Recommendations from IOM

- Use simulators to ensure that clinical training is safe for patients
- Develop simulators for use in skills assessment
- Use simulation technology to improve individual and team performance through interdisciplinary team training
- Use simulation for problem solving and recovery from problems — “crisis management”

To Err is Human: Building a Safer Health System, Institute of Medicine, Committee on Quality, National Academy Press, 1999
Features and Uses of Medical Simulations That Lead to Most Effective Learning

- Feedback
- Repetitive Practice
- Range of Difficulty
- Multiple learning strategies
- Clinical variation
- Controlled environment
- Individualized learning
- Defined outcomes and benchmarks
- Simulator validity and realism
- Curricular integration


Goals of Simulation Training

- Improve skills through interval practice
- Improve consistency of performance
- Decrease errors
- Provide proximate and summative feedback
- Allow for assessment of progress
- Incorporate a standardized, comprehensive curriculum
- Optimize patient safety by accelerating the learning curve prior to patient exposure


Overview of Simulation Based Training Techniques

<table>
<thead>
<tr>
<th>Simulation Type</th>
<th>Teamwork competencies</th>
<th>Primary Strengths</th>
<th>Primary Weaknesses</th>
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<tbody>
<tr>
<td>Case Studies/ Role Plays</td>
<td>Knowledge, attitudes</td>
<td>Low costs, (+) stress reactions</td>
<td>Few opportunities for skill practice</td>
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<tr>
<td>Partial Task Trainers</td>
<td>Knowledge, skills</td>
<td>Low costs, distraction free environment</td>
<td>No opportunity for dual task practice</td>
</tr>
<tr>
<td>Full Mission Simulations</td>
<td>Knowledge, skills</td>
<td>Can simulate rare (but critical) tasks in safe environment</td>
<td>High cost, currently limited to few medical specialties</td>
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Why Interventional Cardiology?

- Procedures carry significant risk
- Procedures are becoming more complex
- In the US, too many low volume centers with too many low volume operators
- Training needs to be safe for patients
- Need patient specific anatomy to practice appropriate (rehearsal)

Simulation Platforms for Endovascular Simulation

- Coronary Angiography
  - Femoral access
  - Radial access
- Right heart catheterization
- Angioplasty
  - Balloon/stent
  - Complications
  - Scenario (rotablator)
- Special tools
  - Atherectomy
  - Embolic protection devices

Simulations in Cardiac Catheterization
Learning New Skills--
Transradial Intervention

Radial Access is associated with reduced bleeding complications and vascular injury. Rates of use in US are very low (<10% of PCI). Rapid uptake in training and practice.

TRIP Program:
Didactic curriculum developed by radial experts with hands-on simulation training:
- Access simulator
- Catheter navigation
- Angiography and intervention
- Complications

Next generation will use simulation evaluation.

Simulations in Peripheral Intervention

Peripherals
- Carotid Intervention
- Angiography
- Stenting
- Embolic protection
- Aortoiliac stenting
- SFA/popliteal
- Aneurysm repair
- EVAR
- TEVAR

Simulation in Structural Heart Disease

- Percutaneous Aortic Valve Replacement (TAVR)
- Transseptal puncture
- Congenital defect closure
  - PFO/ASD
  - LAA occlusion
  - Mitral Valve Clipping

Features of Current Generation Simulators

- Use of current cath lab equipment
- Realistic imaging
  - X-ray, echocardiography, ultrasound
- Realistic hemodynamic monitoring
  - Electrocardiograms and pressures
- Pharmacology models
- Realistic catheter/device manipulation

Metrics Applicable to Interventional Procedures

- Procedural time
- Fluoroscopy time
- Catheter advancement time and errors
- Wiring time and errors
- Appropriate diagnostic images obtained
- Device selection, positioning and use
- Recognition and management of errors

Validation Studies in Endovascular Simulation

- Predominantly face validity
  - Does the simulator appear to be a realistic training environment?
- Small studies, with few randomized trials
- Well received by trainees
- No impact on clinical care noted yet
Simulation Training for Carotid Ctening

N=20 interventional cardiologists
Instruction on carotid angiography
Performed 5 simulated cases
Metrics included:
- Procedural time
- Fluoro time
- Contrast volume
- Catheter errors

Patel AD et al. J Am Coll Cardiol 2006;47:1796-802

Catheter manipulation errors over time

Patel AD et al. J Am Coll Cardiol 2006;47:1796-802

Peripheral Vascular Intervention- VR to OR


Validation Study in PAD

- 20 surgical residents included with randomization to simulation based training versus standard
- Performance of two simulated cases with consecutive mentored catheter-based interventions for lower extremity occlusive disease in an OR/angiography suite.
- Resident performance was graded by attending surgeons blinded to the resident's training status, using 18 procedural steps as well as a global rating scale.


PAD Simulation Training

Mean Global Rating Scores for Procedure 2
Simulator Trained 33±6 vs Standard 21±6, p<0.005

ABIM Validation Study—Coronary Angioplasty

ABIM Interventional Cardiology, with input from other medical specialties, developed six high-fidelity medical simulation cases. The objective was to develop a valid tool to evaluate technical and cognitive skills of interventional cardiologists.

Methods: Six cases were designed for high-fidelity simulation with multiple events, immediate feedback, and high sensory load. Simulation scenarios were designed by experts from diverse areas of medicine such as interventional cardiology, anesthesiology, critical care, and emergency medicine.

Recruitment of subject physicians was conducted by the ABIM Interventional Committee and 10 hospitals around the US.

Study Population

Case and Total Score Performance by Experience Level

Cognitive Skills/Decision Making by Experience

ABIM Study—Conclusions

Physician evaluation using high-fidelity medical simulation to assess technical and cognitive skills can be used to identify physicians who are poor performers in interventional cardiology.

The use of a high-fidelity simulator incorporating situations with multiple events, immediate feedback, and high sensory load would complement the results of traditional written examinations of medical knowledge to provide a more comprehensive assessment of physician ability in interventional cardiology.
ABIM MOC Training

Earn 20 points of MOC credit and up to 2AMA PRA Category 1 Credits™ by completing a medical simulation, which provides hands-on opportunity to perform cases that mirror what a physician would typically face in daily practice.

Simulations are completed on-site at one of Medical Simulation Corporation’s SimSuite® education centers, and are also offered at several meetings and conferences throughout the year.

Simulations currently offered by ABIM Interventional Cardiology – Four ABIM-developed cases

**Locations**
Medical Simulation Corporation SimSuite® Centers at:
- Duke University Medical Center, Durham, NC
- University of California at Davis Medical Center, Sacramento, CA
- Riverside Methodist Hospital, Columbus, OH
- University of South Florida at Tampa General Hospital
- Medical Simulation Corporation headquarters, Denver, CO (part time)

IV.A.2) Systems-based Practice
Fellows must demonstrate an awareness of and responsiveness to the larger context and system of health care, as well as the ability to call effectively on other resources in the system to provide optimal health care.

IV.A.3. Curriculum Organization and Fellow Experiences

a) All 12 months must include clinical experiences and appropriate protected time for research.

b) Fellows must participate in training using simulation.

c) The core curriculum must include a didactic program based upon the core knowledge content in the subspecialty area.

**In effect 7/2012 for Cardiovascular Disease and Interventional Cardiology**
Current Status of Simulation in Interventional Cardiology
- Collaborative evaluation of the current state of simulation
  - ABIM
  - Society of Cardiovascular Angiography and Intervention
  - American College of Cardiology
- Survey of simulation use in interventional cardiology training
- White paper on Simulation in IC

Challenges
- Funding
- Integration of simulation with a didactic curriculum
- Standardizing and validating metrics
- Broad dissemination of simulation training

Unanswered Questions
- What is the value?
  - Does simulation training improve clinical outcomes?
- Will this continue as part of maintenance of certification?
- How do we best incorporate this into training from a cardiology societal perspective?
- What is the role is testing?

Summary
- Simulation training (and testing) is available for interventional cardiology but needs further investigation
- The simulated procedures have expanded dramatically in the last several years with limited evaluation
- There needs to be a societal and accreditation approach to guide the use and incorporation of simulation in interventional cardiology

Questions