Role of Simulation in Training a Hepatic Surgeon

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Overview of Sections

1. History of Medical Simulations
2. Types of Surgical Simulations
3. Impacts of Simulations
4. How can Educators do Better?
5. Future of Surgical Simulations
Declaration

• Architecture for Image-Guided Robot Assisted Surgical Training (IRAS). Patent No.: 201001593-1
What is Simulation?

simulation

(n.) the representation of the behavior or characteristics of one system through the use of another system, especially a computer program designed for the purpose.

Image from Penn Medicine
History of Medical Simulation (Pre-90’s)

Case of Military Simulation

First Plastic Skeleton

Resusci Annie was born

Link Trainer – First Flight Simulator

First Rocket Flight Simulator

Comprehensive Anesthesia Simulation Environment built

History of Medical Simulation (Post-90’s)

1991
- Development of KISMET Simulator for Telesurgery

1993
- Release of Super Nintendo

2000
- Laerdal SimMan begins beta testing
- Virtual Reality 'Patient' Teaches Bedside Manners

2007
- First robotic surgery simulator prototype

2012
- Development of Robot-assisted Trainer

# Types of Surgical Simulations

<table>
<thead>
<tr>
<th>Simulator Type</th>
<th>Mechanism</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didactic Scenario Based</td>
<td>• Directed Viva&lt;br&gt;• Group discussion</td>
<td>• No equipment cost</td>
<td>• Low Fidelity</td>
</tr>
<tr>
<td>Box or Mechanical Models</td>
<td>• Task-based training&lt;br&gt;• Ranges from basic enclosures to complex powered systems</td>
<td>• Effective in acquiring psycho-motor skills</td>
<td>• Low-Medium Fidelity</td>
</tr>
<tr>
<td>Virtual Reality (VR) and Haptic Systems</td>
<td>• Computer-based technology&lt;br&gt;• Allows scenario-based training&lt;br&gt;• Often integrated with physical interaction and haptic feedback</td>
<td>• Medium-High fidelity&lt;br&gt;• Growing evidence of effectiveness</td>
<td>• Expensive equipment</td>
</tr>
<tr>
<td>Biological or Animal Models</td>
<td>• Working with animal tissues prior human</td>
<td>• Highest fidelity among all&lt;br&gt;• Ethical issues&lt;br&gt;• Expensive upkeep</td>
<td></td>
</tr>
</tbody>
</table>
Impacts of Simulations on Skills

- Comparisons were studied before and after training with endovascular simulator
- Significant improvement in skills and knowledge after undergoing simulation

<table>
<thead>
<tr>
<th>TABLE 1. Simulator-Generated Objective Performance Criteria for the Entire Cohort of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 41 Medical Students</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Pretest Mean</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Procedure time (min)</td>
</tr>
<tr>
<td>Time to aortogram (min)</td>
</tr>
<tr>
<td>Time to intervention (min)</td>
</tr>
<tr>
<td>Residual stenosis (%)</td>
</tr>
<tr>
<td>Lesion covered (%)</td>
</tr>
<tr>
<td>Placement accuracy (mm)</td>
</tr>
<tr>
<td>Fluoroscopy time (min)</td>
</tr>
<tr>
<td>Contrast injected (ml)</td>
</tr>
<tr>
<td>Activated clotting time at intervention (sec)</td>
</tr>
</tbody>
</table>

Maran, N. J., & Glavin, R. J. (2003). Low- to high-fidelity simulation - a continuum of medical education?
Study investigates the Transfer-Effectiveness Ratio of a surgical VR
TER used in airline industry to assess quality of simulator
TER score of 2.28: 1 min. on VR simulator = 2.28 mins. on cadaveric porcine cholecystectomy


FIGURE 5. Learning curves for control and VR-trained groups for video-based rating score, and benchmark levels of experienced surgeons.
How can Educators do Better?

- Improving the fidelity of training instruments
- ‘Hands-held’ training vs ‘trial and error’ training
- Efficacy of 1 trainer vs multiple trainees
Surgical Trainer using Animal-organ Reperfusion (STAR)

- Low-cost model that mimics organ bleeding
  - Dyed water is pumped to simulate circulation
  - Pressure can be adjusted to simulate types of bleeding

- Easily reproducible and reusable training tool

Surgical Trainer using Animal-organ Reperfusion (STAR)

- The main components of the model include:

(i) Casing (ii) Pump system (iii) A porcine liver – hepatic artery and bile duct are ligated to prevent ‘back bleed’

Improvement in suturing skill was seen with repeated practice

- Participants approached performance set by an experienced surgeon

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**Surgical Trainer using Animal-organ Reperfusion (STAR)**

![Image of surgical trainer setup with a computer monitor and medical equipment]

**Fig 5.8.1 Progress of Suture timing**

Image-guided Robot Assisted Surgical-training (IRAS)

- Consists of 3 systems:
  - Recording platform
  - Robotic laparoscopic surgical trainer platform
  - ‘Free-play’ assessment platform

Image-guided Robot Assisted Surgical-training (IRAS)

- 12 students viewed video of cholecystectomy in porcine done by expert surgeon

- Group A underwent IRAS training vs. Group B dry box training

- Both groups went on to perform cholecystectomy on pigs

Table 1  Surgeon and participants’ performance evaluated by average task time, trajectory length of the left and right instruments

<table>
<thead>
<tr>
<th>Test session</th>
<th>Participants</th>
<th>Time (s)</th>
<th>Left (mm)</th>
<th>Right (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surgeon</td>
<td>239.5 ± 38</td>
<td>530.1 ± 184.4</td>
<td>1512.0 ± 144.2</td>
</tr>
<tr>
<td></td>
<td>Group A</td>
<td>246.7 ± 70.9</td>
<td>579.8 ± 275.4</td>
<td>1578.3 ± 369.0</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>268.4 ± 149.5</td>
<td>978.7 ± 861.4</td>
<td>1850.6 ± 824.0</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.18</td>
<td>&lt;0.001</td>
<td>0.011</td>
</tr>
</tbody>
</table>
Impacts of Simulations on Interest

18 months after their live porcine surgery training, they were surveyed on their interest in surgery.

- Results did not show a significantly increase interest in surgery but students better appreciated psychomotor abilities.
- Exposure was highly recommended to juniors before residency application.

Impacts of Simulations on Interest

- Early exposure to simulators provides an effective recruitment tool for students
- Simulation experience shown to enhance interest in Cardiothoracic Surgery

Impacts of Simulations on Interest

- Early exposure provides an effective teaching and recruitment tool for students
- Ability to practice on simulator was a major reason for continued interest (1-3 years)

Future of Surgical Simulation

We look to the entertainment industry:

“Surgeon Simulator 2013 is not a brilliant game. But it is a brilliant joke...”

Rock, Paper, Shotgun
Future of Surgical Simulation

• Augmented Reality (AR) could be the next big thing...
  • Focus on affordable wearables: Google Glass, Microsoft Halolens
  • Developed Medical Mobile App & Wireless Infrastructure

Creating with Microsoft Halolens
Testing of Google Glass during Surgery
Conclusions

• Simulators have definite value in surgical training

• Fidelity of the simulators commensurate the training efficacy

• Various forms of simulators are available

• Simulators may increase the interest towards the speciality
Role of Simulation in Training a Hepatic Surgeon

Thank you.

Acknowledgments

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Impact of Games on Surgical Skills

- Study showed surgeons who played video games in the past (>3 h/wk) performed better in a simulator than non-video gaming group.

- Another study showed how a video game as a preoperative warm-up increased peg transfer and cobra rope scores.

*Fig. 1* A photo of the custom-made underground hardware and an in-game screenshot of the game.

Introduction of game mechanics significantly boosted the usage of training simulator.

Leaderboards were posted every 1-2 weeks. Tournament prizes ranged from $50 to an iPad.

Video games used to stimulate and intensify voluntary training in young surgeons.