WHAT WE WILL COVER

• Application of Simulation in medicine / healthcare
• The value of high-fidelity simulation in medical education
• Serious games / Game Based Learning
• Examples of Screen Based Simulation in Medical Education and Healthcare
• Limitations of Screen Based Simulation and alternatives (VR / AR)
CLASSIFICATION OF SIMULATION PER FIDELITY

- **Low fidelity Screen based text simulations**: Create scenarios with user selecting one of the several responses. E.g., in a scenario involving a patient with severe headache, the user may be offered options such as prescribing an analgesic or getting a CT scan of the head. Simple to construct and are less expensive but they focus on single skills and there is poor immersion.

- **Static mannequins**: Used for hands-on practice. E.g., intubation, laparoscopic training or cardio pulmonary resuscitation (CARDIAC) skills.

- **Medium fidelity Screen-based graphical simulations**: S suits to demonstrate physiological, pharmacological processes. Provide a more realistic representation, are portable, and relatively less costly. These help one to understand the basic concepts but do not confer actual practical skills. E.g., computer simulation of changes in Blood pressure in response to drug administration (E’s pharm).

- **Mannequins with mechanical movement**: Includes a mannequin and software. Computer-based pictures help confer practical skills. Includes ‘range of normal variation’ E.g., Cardio-pulmonary resuscitation (AMBU Man).

- **High fidelity simulators**: Combine part or whole body mannequins to carry the intervention with computers that drive them to produce physical signs. They are usually designed to resemble the reality. They can talk, breathe, blink, and respond either automatically or manually to physical and pharmacological interventions.

- **Non-physiologic programming**: Manually set parameters dependent on operator programming. Parameters need to be reset after intervention.

- **Physiologic programming**: Automatic generation of appropriate physiological responses to treatment-interventions in the mannequin allowed. E.g., human patient simulator.

**Standardized Patients**

APPLICATION OF SIMULATION IN MEDICAL EDUCATION

- **Standardized patients / High fidelity simulations in medical and nursing student education**

- **Procedural training for variety of surgical specialties (from resident to attending level)**

- **Use of high-fidelity simulation within various residency programs for curriculum integration and reinforcement**

- **Use of simulations to identify and address systems issues in healthcare (in-situ simulations)**

- **Use in teaching and application of Crisis Resource Management**

- **TeamSTEPPS**

- **CPR**: Faster skill acquisition & better skill retention

- **Games For patients**
HIGH-FIDELITY SIMULATION (HFS) IN MEDICAL EDUCATION: IT'S VALUE

• Ability to provide standardized practice
• Ability to provide repetition
• High-fidelity environments for participant buy-in
• Useful to teach / learn about rare and critical events
• Feedback to participants during debrief
• Stress-related positive learning / retention
• Acquisition of knowledge and skills / patient outcomes


BUT, HIGH-FIDELITY SIMULATION IS NOT ALWAYS FEASIBLE OR PRACTICAL...

High-fidelity simulation (HFS), using standardized patients or advanced technologically-driven mannequin-based simulators, aren’t cheap

• Startup and maintenance cost of simulation lab / center
• Initial price and lifelong maintenance of simulators (including the advanced, physiologically-responsive mannequins vs. task trainers)
• Personnel (time + pay for being away from clinical duties)
• Ancillary equipment for simulation center to increase the fidelity of environment (i.e., anesthesia machine, OR bed, anesthesia carts, supplies for the carts, etc)

HFS has limitations

• Requires physical presence of participants
• Limits amount of participants that can undergo simulation (simultaneously, or serially)
• Not every department in an institution, or even the institution itself, has easy or affordable access to use / learn from simulation
• Limited realistic human interactions
What is a serious game?

• A game with a primary purpose other than pure entertainment

• They can be specifically designed for a particular field
  • Military - MACS
  • Healthcare
  • Emergency management

They can be commercially designed and applied for a different purpose

• The SimS – for Hospitality Management OR gateway to architecture

Figure 1. Simulation games-based learning/virtual environments sit at the intersection of simulation and video games.
VIRTUAL ENVIRONMENTS / GAMES-BASED LEARNING

Concept of **Flow**: aka “In the zone”, “head in the game”

- A psychological / mental state, in which the person is fully engaged, focused, and committed to the success of an activity
- Common in game design (challenges / missions are staged - aren’t too easy to bore the participants, and not so hard that they give up)
- Needs to be incorporated and strived for, in medical education, since it is a component of efficient learning, especially when developing expertise through deliberate practice.

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TYPES OF VIRTUAL ENVIRONMENTS FOR SIMULATION

1. Screen-based
2. Virtual Reality (VR)
3. Augmented Reality (AR)
SCREEN BASED SIMULATION

- Multiple views and vantage points
- Easy to time constrict and dilate
- Allows for shortcuts
- May be very expensive to develop
- May be expensive to maintain
- Require additional purchases
  - Computer
  - Phone
  - Peripherals
- Require multiple outcomes or levels for replay value
- Limited real estate depending on platform
- Learning curve on gameplay mechanics (where to position hands or icons)

BENEFITS OVER MANNEQUIN-BASED LEARNING

- Convenience and lower cost - phone, tablet, personal computer + internet connection
- Scalability & Distributability
- Repetition
- Tracking progress
- Anonymity
- Instant Feedback (frequent / customized)
- Rewards and Competition

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Procedural Training
- Laparoscopic Skills (The Underground)
  - Better skills acquisition on Lap Simulator
    - Vs Control of Standard Practice
    - Vs Control of Lap Simulator
- CPR
  - Faster Skill Acquisition
  - Better Skill Retention
- Ultrasound Needle Placement
  - Better Targeting
  - Higher Success Rate


Knowledge Base Training
- OLT Anesthesia Trainer
  - Enhanced skill gains on rotations
- abcdeSIM
  - Improved Clinical Competencies in ER
  - abcdeSIM available for:
    - Emergency physicians
    - Emergency department nursing
    - Pre-hospital primary care
    - Severe burn victims
    - Pediatrics
- Triage Trainer
  - Higher tagging and step accuracy

OLT ANESTHESIA TRAINER

Platform
• iPad

• Engine
  • GameSalad
    • Low Cost
    • No Coding

• Graphic Assets
  • Artist

• Content created using:
  • Basic Concepts
  • Local experts
  • Best practices
  • Guidelines


The old liver is out, we will now begin our anastomoses.

Serum K: 500 CR 0.0Meq/L

Hematocrit %: 500 CR 28%

Urine Output: 100 CR 0.5ml/kg/hr

Ionized Ca: 500 CR 1.08 mmol/L

Lactate: 500 CR 6.15 mmol/L

Serum Glucose: 500 CR 220Meq/L

Hypervolemic
10 Seconds
25 CR

Calcium Chloride 4g
500 CR

Calcium Citrate
100 CR

NA

Nitroglycerin
100 CR

Estesol
0 mg

Phenylephrine
Infusion 15 CPR/sec

NorEpI
Infusion 30 CPR/sec

Vasopressin
Infusion 30 CPR/sec

Epinephrine
Infusion 30 CPR/sec

Nitroglycerin
Infusion 30 CPR/sec

PAUSE

Credits: 88390

FINDINGS FROM A PROSPECTIVE RANDOMIZED CONTROL TRIAL

<table>
<thead>
<tr>
<th>Stage of Game</th>
<th>Score Difference Gaming Group</th>
<th>Score Difference Control Group</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Operative Assessment</td>
<td>2.67 (2.09)</td>
<td>1.17 (1.43)</td>
<td>p=0.01</td>
</tr>
<tr>
<td>Induction and Monitoring</td>
<td>1.97 (1.49)</td>
<td>1.00 (1.41)</td>
<td>p=0.22</td>
</tr>
<tr>
<td>Dissection Phase</td>
<td>0.75 (0.61)</td>
<td>0.92 (0.83)</td>
<td>p=0.45</td>
</tr>
<tr>
<td>Pre-Aneupletic and Aneupletic Phase</td>
<td>1.62 (1.01)</td>
<td>0.75 (1.28)</td>
<td>p=0.02</td>
</tr>
<tr>
<td>Reperfusion Phase</td>
<td>1.32 (1.07)</td>
<td>0.97 (0.80)</td>
<td>p=0.25</td>
</tr>
<tr>
<td>Total Score</td>
<td>7.95 (3.65)</td>
<td>4.8 (4.48)</td>
<td>p=0.02</td>
</tr>
</tbody>
</table>

Numbers Reported as Mean (SD), GG (Gaming Group), CG (Control Group)


EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Non-Technical Skills

- Improved Situational Awareness
- After 1 hour of gaming (Surgeon Trouble)
- Enhanced response to equipment failure

- Better Adherence to Standardized Protocols
- Central Line Placement


EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Online Simulation

<table>
<thead>
<tr>
<th>Description</th>
<th>Online simulation that realistically replicates clinical scenarios that participants can work through using computer technology. These options are approved:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• ASA Anesthesia SimStat (up to 5 points per module)</td>
</tr>
<tr>
<td></td>
<td>• VHA DAIRC (up to 8 points)</td>
</tr>
</tbody>
</table>

Point Value

1 point per hour spent on the activity, up to 25 points.

Reporting

The ASA will report completion to us for Anesthesia SimStat.

Mechanism

Self-report completion for VHA DAIRC based on time spent on the activity.

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

Acquired Brain Injury

- Supplement to cognitive/physical rehabilitation
  - Programs lasting months
  - Repetitive exercises
  - Home-based therapies

Alzheimer’s Disease and Related Disorders and Frailty

- Exergames
  - Enhanced balance
  - Timed up and go (TUG)

- Cognitive Games
  - Enhanced Cognition
    - As good or better than medication
  - Less Neuropsychiatric Symptoms
    - As good or better than medication


TEAMSTEPPS VIRTUAL TEAMS

EXAMPLES OF SCREEN BASED SIMULATION IN HEALTHCARE

• Novel multiplayer game created to teach learners about the management of Post-Partum Hemorrhage

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre</th>
<th>Post</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective</td>
<td>7.70 ± 1.75</td>
<td>9.00 ± 1.46</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cognitive</td>
<td>7.46 ± 1.69</td>
<td>8.73 ± 1.51</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Psychomotor</td>
<td>8.31 ± 1.72</td>
<td>9.11 ± 1.81</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ave. combined</td>
<td>7.83 ± 1.58</td>
<td>8.95 ± 1.42</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Questions were categorized into one of three domains of Bloom’s Taxonomy. Pre and post survey consisted of four psychomotor questions, six cognitive questions, and five affective questions. Following the screen-based simulation experience, significant gains in confidence were seen in each of the domains as well as the combined overall confidence score.

LIMITATIONS OF GAME BASED LEARNING — KNOW WHEN IT WON’T WORK

• Culture / traditions of medicine
• Familiarity with computers / virtual environments
• Nonverbal communication
• Level of fidelity
• Educational objective
• Cost

IN SUMMARY

Screen based simulation is a form of serious gaming that fosters learning in medical education and healthcare, in a manner that is:
• more feasible
• more scalable
• low maintenance costs
• drives to induce “Flow” in participants

However, currently, initial development costs can be high.

Coding knowledge is not always a necessity.
THANK YOU!