Virtual Reality, Simulators and Surgical Training

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What is a Simulator?

• A laboratory device that enables the operator to reproduce under test conditions phenomena likely to occur in actual performance
  - Webster’s Dictionary (seventh ed.)

• A training and feedback device in which learners practice tasks and processes in lifelike circumstances using models or virtual reality
Some Methods of Simulation Used in Medical Education for Some Time

- **Other Students**
  - Commonly Used in Medical School to Learn IV and/or NG Placement

- **Cadavers**
  - Commonly Used for Practicing Surgical Procedures

- **Animal Models**
  - Used For Developing Microsurgical Skills

- **Models or Mannequins**
  - Teach ACLS Skills
Limitations of Current Simulation Techniques

• Other Students
  – Can Be Painful

• Cadavers
  – Incorrect Physiology-No Bleeding
  – Incorrect Haptics

• Animals
  – Anatomy May Not Be Accurate
  – Animal Rights Activists have Concerns

• Mannequins
  – Incorrect Haptics and Physiology
Why Do We Need Better Simulators Now?

• Increased Concerns Regarding Patient Safety
  – Traditional See One, Do One, Teach One May Not Be the Safest Teaching Method for Patients
  – 98,000 Die Annually Due to Medical Errors

• Need to Teach Full Complement of Surgical Skills in More Limited Time Period Due to Work Hour Restriction

• Patients in Hospital Less Providing Less Time for Learner Interaction

• Need to Efficiently Use OR time to Increase Clinical Billing so Programs Can Survive
What is Virtual Reality?

• Term Coined by Jaron Lanier in the late 1980’s
• Defined as a Human-Computer Interface that Simulates Realistic Environments while Enabling Participant Interaction
  - Has to Provide Sense of Immersion in the Environment
• Provides Most Realistic Simulation
• Link Simulator- Developed by Edward Link – Son of Piano Manufacturer
• Training of Pilots to fly by instrument control
• Surgeons Behind Pilots in the Development and Utilization of Surgical Simulators
Advantages of Simulators

• No Harm to Patients

• Teaching Technique not Dependent on Patient Availability
  – Can Provide Exposure to Rare Pathology
  – Can Assure Ability to Effectively Manage Rare Emergencies

• Can Be Utilized in Less Technologically Advanced Medical Environments (Third World) to Provide Surgical Training
What is ‘Virtual Reality’? - Not Just One Thing

• Tool That Allows Student to Carry Out Surgical Procedure or Technique on a Virtual Patient
  - Particularly Applicable to Laparoscopic Techniques

• Animated Model of a Patient on Which Procedures Are Simulated
  - Court Cutting’s Simulations of Cleft Procedure

• Clinical Scenario Described or Demonstrated and Student Responds with Evaluation and/or Treatment
  - Develops and Evaluates Patient Management Skills
  - Develops and Evaluates Ability to Work Within Healthcare System
• Simulate an Environment eg ER
Other Uses Less Applicable to Education

- Telesurgery - Operating on Patients Separated from the Surgeon
- Robotic Surgery
  - Robodoc Used to Mill Femoral Shaft
  - DaVinci Device for Urologic Surgery etc.
• Surgeon Controls a Robot
• Robot Improves Upon Surgeon’s Skills by Reducing Tremor
Need Computerized Models on Which to Work
What Can Simulators Be Used For?

• Teaching and Developing Competence in Surgical Techniques
• Evaluating Surgical Skills Using Defined Metrics in a Defined Environment
  – Need High Inter-rater reliability
  – Probably More Accurate than Traditional OR Evaluations
• Demonstrating Surgical Techniques in Models of Patients in Videos eg Court Cutting
• Evaluating and Teaching Cognitive Patient Management Skills
• Proving Competence in a Particular Procedure
Simulation of Nasal Reconstruction
What Simulators Are Currently Being Utilized?

- Minimally Invasive Surgical Trainer (MIST) VR Device, Endotower and Computer Enhanced Laparoscopic Training System (CELTS) for Laparoscopic Techniques
- Vascular Intervention System Training
- Endoscopic Training Devices
- Epidural injection Simulators
- IV Insertion Simulators
- Ophthalmologic Simulators
- Others
Train IV Insertion
Microsurgery Simulation
Virtual Reality Training Improves Operating Room Performance: Results of a Randomized, Double Blinded Study

- 16 Yale Surgical Residents Randomized to either receive training on MIST VR simulator or not after Baseline Assessments
- One Half Underwent a Supervised Training Session on the MIST VR System Simulating a Cholecystectomy
- Residents Trained Until They Were Competent in Required Manipulations with Both Hands
- All Performed Laparoscopic Cholecystectomy with a Blinded Surgeon Investigator Which was Videotaped
Virtual Reality Training Improves Operating Room Performance (cont)

• VR Trained Residents 29% Faster
• Gall Bladder Injury and Burn to Nontarget tissue 5x More Likely in Non-VR Trained
• Non-VR Trained Residents 9x More Likely to Demonstrate Lack of Progress
• Non-VR Trained Made 6x More Errors Including Liver Injury, Incorrect Plane of Dissection and Attending Takeover (Tissue Tearing Not Noted in Either Group)
Challenges for Virtual Reality Systems

- **Accurate Haptics**
  - Provide Feel of Natural Tissue
  - Provide Normal Viscoelasticity of Tissue
  - Provide Accurate Simulations of Bleeding

- **Represent Immediate and Delayed Postsurgical Results of Interaction**

- **Providing Accurate Simulation of Entire Environment eg OR, ER**

- **Provide Accurate Simulation of Activities Requiring a Team of Individuals**

- **Develop Tools that Can Be Utilized on a PC at Reasonable Expense**
Possible Future Uses

• Screen Resident Applicants for Surgical Aptitude
  – Alternative to Carving Ears
  – Early Identification of Those With Limited Aptitude
    • Currently May Not Be Noted Until PGY 3-4

• Board Certification Process

• Train and Validate Competency in New Procedures by Established Practitioners
  – Required for New Carotid Stent