SURGICAL SIMULATION
The New Frontier of Surgical Education

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Disclosure
Dr. McDougall is the co-founder, with Dr.’s Ralph Clayman & Jaime Landman, of the company LapEd® which has developed, and is marketing, several devices for surgical training and practice of urologic minimally invasive surgery techniques and procedures.
Simulators for Urologic Training

- **Endourologic**
  - Cystoscopy & Ureteroscopy
  - TURP
  - Percutaneous Renal Access
- **Laparoscopic**
- **Robotic**
- **Warm-up practice for surgeons**

**SIMULATION**

- **Low Fidelity**
  - Mentor required
- **High Fidelity**
  - Virtual Instructor

- **Skill training**
- **Task training**
- **Procedure training**
- **High reliability team training**
Why Simulation?

**Simulator based skills training:**
- Provides deliberative, repetitive skills practice with feedback
- Allows exploration of all possible outcomes
- Is a risk-free environment in which to experience all possible errors and complications
- Can reduce the time of training complex surgical skills

“ATTENTION MUST BE PAID!”

SIMULATORS: IMPACT

- Tailor training to individual needs: procedure and technique specific
- Patient specific, pre-procedure planning
- Practice management of complications
- Test proficiency – performance based graduation criteria - ? Shorter training programs for the “gifted”
- Certification and recertification
- Maintain competence (case numbers)

(Simulators for Training Workshop: January 25, 2003)

Cystoscopy & Ureteroscopy

- LapEd KUB model
- Uro-Scopic trainer by Limbs & Things
- Scope Trainer by Mediskills
- UroMentor by Simbionix

Price range
$256 to $60,000
Cystoscopy & Ureteroscopy Simulation

- Simulator trained medical students outperformed students with no training in objective and subjective measures of performance of URS.

Watterson JD et al: J Urology 2004; 171: 320

Cystoscopy & Ureteroscopy Simulation

- URS performance by medical students, but NOT residents, in a cadaver was improved by simulator training.

Ogan K et al: J Urology 2004; 172: 667
Jacomides L et al: J Urology 2004; 171: 320
Cystoscopy & Ureteroscopy Simulation

• No difference between high-fidelity and low fidelity in training basic URS to medical students.

Chou DS et al: J Endourology 2006; 20: 266

Transurethral Resection Simulators

• Two commercially available LUT simulators
• Storz URO-Trainer – face and content validity
• METI SurgicalSIM TURP – face, content, construct & concurrent validity

Reich O et al: Urology 2006;67:1144
Sweet R et al: J Urol 2004; 172:1953
Transurethral Resection Simulators

- METI SurgicalSIM TURP presently undergoing predictive validity testing by Dr. Robert Sweet.

Percutaneous Renal Access Models

- Southern Illinois University
  - Pig kidney inside a chicken

- University of California, Irvine
  - Silicone slab fashioned around a mold of collecting system

Percutaneous Renal Access Surgery

- Trainees randomized to practice on PERCMentor were faster and more accurate at PCN access in pig model.

Knudsen BE et al: J Urol 2006; 176: 2173

Laparoscopic Simulators

- LapSim
- ProMIS
- SurgicalSIM
- EZ Trainer
- LapMentor
EZ Trainer from LapEd®

IN SEARCH OF SIMULATOR PREDICTIVE VALIDITY

Landmark study: VR to OR

16 surgical residents, randomized to MIST VR training – simulator diathermy task repeated until achieving expert criterion on two consecutive runs (3-8 sessions) – all similar scores on fundamental abilities test and all saw same training video of a lap cholecystectomy – then all 16 performed laparoscopic cholecystectomy under eyes of a proctor.

<table>
<thead>
<tr>
<th>VR+</th>
<th>VR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>time: 14.2 min.</td>
<td>20 min. 29%</td>
</tr>
<tr>
<td>Errors: 1.2</td>
<td>7.4*</td>
</tr>
</tbody>
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*Significant difference (*p<.05)

(Errors: lack of progress, gallbladder injury, liver injury, incorrect plane of dissection, burn nontargeted tissue, tearing tissue, instrument out of view, instructor takeover)

American Board of Surgery

Effective July 2010
All candidates for the ABS certifying examination must be certified by the Fundamentals of Laparoscopic Surgery* (FLS) curriculum and skills training test.


Preliminary Study of Virtual Reality and Materials Model Simulation for Learning Laparoscopic Suturing Skills

RESULTS: Cystorrhaphy Procedure Data

<table>
<thead>
<tr>
<th></th>
<th>Group 1 Silicone Model</th>
<th>Group 2 VR Simulator</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to complete cystorrhaphy</td>
<td>40 ± 10</td>
<td>41 ± 15</td>
<td>0.87</td>
</tr>
<tr>
<td>(mins)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average quality OSATS* score</td>
<td>8.0 ± 1.9</td>
<td>7.8 ± 1.5</td>
<td>0.81</td>
</tr>
<tr>
<td>by Fellows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average quality OSATS* score</td>
<td>9.6 ± 1.8</td>
<td>8.6 ± 1.8</td>
<td>0.24</td>
</tr>
<tr>
<td>by Expert Lap Surgeon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined average quality</td>
<td>8.8 ± 2.1</td>
<td>8.2 ± 1.6</td>
<td>0.32</td>
</tr>
<tr>
<td>OSATS* score by Fellows &amp; Expert</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bladder Leakage</td>
<td>3/10</td>
<td>6/10</td>
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</table>

*OSATS maximum possible score = 25
Laparoscopic Simulation

- High fidelity or low fidelity
- For basic skills low fidelity seems adequate
- For complex skill practice, such as suturing/knot tying low and high fidelity simulators are equivalent
- For procedure based practice high fidelity may be more important

Collaboration between industry and surgical subspecialties

METI + AUA

To create the first ever VR Laparoscopic Transperitoneal Nephrectomy (LTN) Simulator
LAPAROSCOPIC TRANSPERITONEAL NEPHRECTOMY SIMULATOR

METI - $$$ To develop the LTN simulator in close collaboration with the AUA to define the cognitive and manipulative objectives of the curriculum & create the procedural training platform

AUA - $$ To perform the validation studies & develop the educational formats for simulation training

Robotic Surgery Simulation

• The prototype MIMIC dV Trainer was determined to have content validity at AUA Advanced Lap course.
Mimic dV Trainer

Why Simulation?

- Deliberative practice with feedback
- Error management learning
- Proficiency documentation
- Certification

- Individual and team training
- Standardize surgery training
- Reduce errors
- Improve patient outcomes
HIGH RELIABILITY TEAM TRAINING

Much can be learned from observing errors as they occur and studying how they can be managed.*


Practice Makes Perfect

Dancer

Musician

Pilot

Surgeon
A CONUNDRUM

IN THE PRACTICE OF SURGERY – NOBODY PRACTICES!

In all high skill professions, individuals practice before “play”. The preplay “warm-up” is viewed as essential to the best of performances.

Is the surgeon different? LIKELY NOT!

FIRST PROOF…

Arizona State Univ.:
Subjects: 46 surgeons (PGY 1 – 14, PY2 – 10, PGY3 – 11, Trauma attendings – 10) (19 females and 27 males)
Method: I. Simulator based virtual ring transfer exercises (8 variations)
   8 Sessions: 3 exercises per session repeated times 2 – warm-up/follow-up trials. Done over 4 weeks;
   Time: 15 minutes.
   4 done post call, 4 done before call
II. Warm-up vs. none with peg exercises followed by simulator electrical diathermy exercise.
(Used sophisticated instrument tracking, hand tracking equipment to determine economy of motion and proficiency)

• In addition to improved sensorimotor co-ordination there are cognitive improvements from warming up: attention, cognitive arousal, working memory, processing of perceptual information
• Reduction in errors, PGY 1,2,3 and attending: 31%, 30%, 44%, and 29%
• Warm-up post call returns one to precall nonwarm up status by 32-198%!


• Does “warm-up” improve proficiency: Yes
• Should even experienced faculty surgeons warm-up? : Yes
• Is warming-up more than just a “learning curve” phenomenon?: Yes
• Will warming up help the fatigued surgeon? Yes
• Does warming up improve performance with both sensorimotor as well as more cognitive tasks? Yes
• Will warming up with a simple task be beneficial when proceeding to a more complex task (i.e. is the benefit task independent)? Yes

NAY-SAYERS

WHAT’S NEXT:

- Does warming-up result in improved performance in the operating room?
- Will improved performance in the operating room, be measurable as improved clinical outcomes?


WHERE MIGHT WE BE HEADED…?

- All operating room suites will be equipped with warm-up equipment.
- There may be a REQUIRED preoperative warm-up period.
- It may be necessary for surgeons to document that they completed a proscribed warm-up prior to starting a procedure.
- There may be a specific, quantifiable level of proficiency the surgeon should demonstrate in the warm-up period prior to beginning a surgical procedure.
- If a surgeon does not warm-up and there is an adverse outcome, is the surgeon, medical staff and/or hospital liable?

SURGICAL TRAINING FOR THE 21ST CENTURY

See some,
Practice many,
Do one competently.