The Power of Data and Analytics in Robotic Surgery Simulation

Jeff Berkley, PhD
CEO & Founder
Mimic Technologies, Inc

www.MimicSimulation.com info@MimicSimulation.com (800) 918-1670
Disclosure

Dr. Jeff Berkley is the CEO, Chairman and Founder of Mimic Technologies
Executive Summary

- The clinical battle in robotic is nearly won. The focus is now on cost and efficiency.

- Differences in surgical skill drive patient outcomes and costs. This is true for robotic surgery as well.

- Identifying the surgeons who need the most help and putting a program in place to help remediate as well as support objective privileging and credentialing is key.

- Strong robotic training programs are focused on “proficiency” and leverage simulation and data to achieve consistency of performance.
The Clinical Battle Over Robotics is Nearly Won

- Data is beginning to support that robotic surgery is equivalent or superior to open or laparoscopic surgery in the following areas:
  - Urology - Prostate, Kidney, Bladder (20% of robotic procedures in the U.S. in 2015)
  - Gynecology - Hysterectomy (48% of robotic procedures in the U.S. in 2015)
  - General Surgery - Developing for Hernia and Low Anterior Resection (28% of robotic procedures in the U.S. in 2015)

- Robotic surgery is continuing to capture more of the laparoscopic market, despite costs (currently 10% of laparoscopic procedures) with increases in robotic procedures worldwide from **570,000 in 2014** to **652,000 in 2015**, according to the 2015 ISI Annual Report

- Capital equipment and instrument costs will decrease with new robotic surgery vendors entering the market and increased robot availability will increase procedure growth

**The challenge?**

- More pressure on hospitals to monitor the training and skill levels of surgeons, especially as it relates to managing risks and lowering costs
- Increased training demand for credentialing and privileging programs
The Current Debate is About Cost

50% of costs are related disruption in the OR:
- Consumables
- Setup times
- OR times
- Standardization of Procedures

50% of costs are related to inadequate surgical skills and techniques:
- Surgeon console skills
- Clinical decision making
- First Assistant / OR Team skills

- OR Operational Efficiency Costs
- OR Surgical Efficiency Costs
- Complication Rates
- Re-admissions

Surgeon Proficiency
Technical skill impacts clinical outcomes

Example:
In a study of bariatric surgeons, who were separated into quartiles based on technical skill assessment, poor performers generated:

- 2.5x more readmissions (6.7% vs 2.7%)
- 3x more complications (14.5% vs 5.2%)
- 5x more deaths than top performers (0.26% vs 0.05%)

This study was conducted with 20 Surgeons and 10,343 patients between August 2006 and August 2012

*(Birkmeyer, et al, NEJM, October 2013)*
## Examples from Robotic Surgery

Data from 250 surgeons  
200,000 robotic cases  
36 institutions

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Avg Op time Hrs</th>
<th>Complications % (major + minor)</th>
<th>LOS Days</th>
<th>Re-Admissions %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benign Hysterectomy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robotic Only</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Top 25% Volume</strong></td>
<td>1.5</td>
<td>1%</td>
<td>&lt;1.0</td>
<td>&lt;1.0%</td>
</tr>
<tr>
<td><strong>Bottom 25% Volume</strong></td>
<td>2.4</td>
<td>4%</td>
<td>1.8</td>
<td>3%</td>
</tr>
</tbody>
</table>

55 Surgeons  
5200 Cases

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Avg Op time Hrs</th>
<th>Complications %</th>
<th>LOS Days</th>
<th>Re-Admissions %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cholecystectomy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robotic Only</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Top 25% Volume</strong></td>
<td>0.60</td>
<td>2%</td>
<td>&lt;1.0</td>
<td>&lt;1.0%</td>
</tr>
<tr>
<td><strong>Bottom 25% Volume</strong></td>
<td>1.5</td>
<td>6%</td>
<td>1.5</td>
<td>6%</td>
</tr>
</tbody>
</table>

Impact of about between $3,900 and $4,550 per case in increased cost for bottom performers tied to skill

*(data / study from CAVA Robotics, Dr. Rick Low et al, 2015)*
## Cost Model Based on Hysterectomy

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost</th>
<th>Top 25%</th>
<th>Cost per case</th>
<th>Bottom 25%</th>
<th>Cost per case</th>
<th>Delta per case</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR Times</td>
<td>$50 per minute</td>
<td>90 mins</td>
<td>$4,500</td>
<td>140 mins</td>
<td>$7,000</td>
<td>$2,500</td>
</tr>
<tr>
<td>Complications</td>
<td>$20,000 per complication</td>
<td>1%</td>
<td>$200</td>
<td>4%</td>
<td>$800</td>
<td>$600</td>
</tr>
<tr>
<td>LOS</td>
<td>$500 per day</td>
<td>1 day</td>
<td>$500</td>
<td>1.8 days</td>
<td>$900</td>
<td>$400</td>
</tr>
<tr>
<td>Re-Admissions</td>
<td>$20,000 per re-admission</td>
<td>1%</td>
<td>$200</td>
<td>3%</td>
<td>$600</td>
<td>$400</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$5,400</td>
<td></td>
<td>$9,300</td>
<td>$3,900</td>
</tr>
</tbody>
</table>

Delta = $3,900 per case
Procedural Volumes Across a Surgeon Population

Robotic Cases/Surgeon
2012 - 2014

Sample: A hospital group doing 4,500 cases a year using 20 robots with the lowest performing 50 surgeons doing approximately 225 cases a year

Potential savings from training bottom performing 50 surgeons and teams: $926,200 per year

(data / study from Loftus Health Healthcare Consulting, 2015)
Improvements to existing operations realized through the inclusion of robotic surgery simulation training:

**Figure 1. Summary of Simulation Effects on Surgical Practice**

*Smith, et al, Robotic Simulators: A Case for the Return on Investment*
Financial Impact of Robotic Surgery Simulation Training

**Simulation Training**

**Surgeon Productivity & Competency**
- Increase number of competent surgeons
- Improve surgeon ergonomics
- Improve surgeon stamina
- Increase length of OR career

**Training Costs**
- Reduce outside training events
- Reduce surgeon/instructor mentoring time
- Reduce overall training costs
- Development of certification of skills program

**Hospital Costs**
- Decrease the mean length of surgeries
- Increase number of surgeries per day
- Reduce medical errors
- Reduce instrument breakage
- Reduce liability insurance & OR Staff

**Increased Revenue**

**Effects of Simulation-based Training on Robotic Surgery Business**

*Smith, et al, Robotic Simulators: A Case for the Return on Investment*
What Have We Learned in 10 Years?

- Simulation can help accelerate the learning curve for surgeons without impacting patient safety.
- Simulation can help distinguish the innate skill levels of individuals.
- Having a structured curriculum is vital to success.
- User performance benchmarking through simulation can be used as part of a hospital or institution’s risk management strategy.
## Culligan Study – Morristown Protocol

<table>
<thead>
<tr>
<th></th>
<th>Expert Surgeons</th>
<th>Study Group</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>5</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Demographics</td>
<td>N/A</td>
<td>Same (49.1)</td>
<td>Same (53.5)</td>
</tr>
<tr>
<td>Average simulation hours</td>
<td>Some</td>
<td>20 (9.7 to 38.2)</td>
<td>0</td>
</tr>
<tr>
<td>Number of cases</td>
<td>Average 142 per year</td>
<td>0</td>
<td>Enough to be granted privileges</td>
</tr>
<tr>
<td>Mean Hyst operative times</td>
<td>20.2 Minutes</td>
<td>21.7 Minutes</td>
<td>30.9 Minutes</td>
</tr>
<tr>
<td>EBL</td>
<td>25ml</td>
<td>25.4ml</td>
<td>31.25ml</td>
</tr>
<tr>
<td>Goals score</td>
<td>50</td>
<td>34.7</td>
<td>31.1</td>
</tr>
</tbody>
</table>

“Completing this protocol of robotic simulator skills translated to expert-level surgical times during live human surgery. As such, we have established predictive validity of this protocol.”

(Culligan, et al, FPMRS, Jan/Feb 2014)
Surgical Aptitude Can Be Predicted Through Simulation

- Study completed using 26 simulation exercises
- Statistically differentiated
  - Best 7% of Medical Students
  - Worst 12% of Medical Students

(Moglia, et al, JSE, Jan 2014)
N = 121
Target time = 12 Weeks
1-week intensive simulation training activity

(Volpe, et al, EAU, Oct 2014)
Continuous Improvement

Energy and dissection - Energy switch 2

Needle driving - Suture sponge 2

Fig. 2 – Progressive improvement in overall scores for different tasks on the da Vinci surgical simulator before, during (weeks 4 and 5), and after completion of the curriculum. * Significant difference compared to overall score before the curriculum \( p < 0.05 \). ° Significant difference compared to overall score in week 4 \( p < 0.05 \).

Results of the European Association of Urology Robotic Training Curriculum

(Volpe, et al, EAU, Oct 2014)
Example:

- A Hospital Group with five hospitals, four robots (1-S & 3-Si), 49 accredited surgeons

- Implemented annual privileging curriculum based on five simulation exercises (one exercise per skill)

- Removed robotic surgery privileges from four surgeons due to inability to pass required curricula:
  - Too much tremor
  - Eyesight deterioration / lack of depth perception
The Importance of Proficiency

- To become a good surgeon trainees need to become proficient at:
  - Technical Skills
  - Clinical Decision Making
  - Teamwork

- Proficiency can be measured through simulation by the implementation of:
  - Structured curriculum
  - Agreed expert level performance benchmarks
  - Specified numbers of required passes
    - Ex. two consecutive, five non-consecutive

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What Does an Excellent Training Program Look Like?

- Individuals are uniquely identified and training results and data are recorded
- Proficiency levels are discussed and agreed upon
- Curriculum has been developed, assigned to users and measured regularly
- Simulation platforms are easily accessible
- Simulation time is transferable to the real tool
- Teams can train together
- Cognitive and psychomotor skills can be validated
Data is key in monitoring and tracking surgeon training progress

- Objectively determines true proficiency
- Helps to identify trends and weak areas
- Allows for comparison between users and institutions
Conclusion – Discussion Points

- Do you know how your robotic surgical program is doing?

- Do you track the differences in outcomes and costs of the surgeon population?

- Do you know what % of surgeries are performed by your top and bottom 25%?

- Are you focusing on the amount of training completed or reaching proficiency with a data feedback loop?

- Is objective data a key component of your privileging and credentialing program?
Evidence-Based References

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Flight plan for robotic surgery credentialing: New AAGL guidelines
John P. Lenihan Jr, MD
Questions