• "LapSim® is a mandated component in our laparoscopic surgical competency training that provides us confidence in objectively assessing our residents’ performance."

Teodor Grantcharov, MD, PhD, FACS
Associate Professor of Surgery
University of Toronto
Scientist, Keenan Research Centre of the Li Ka Shing Knowledge Institute
OUR MISSION IS
SAFER SURGEONS FASTER
AGENDA

- Laparoscopic surgery
- Why simulation training?
- Features of a VR simulator
- Validation of VR simulation
- Challenges in surgical training
LAPAROSCOPY

- Advantage: Smaller incisions, less blood loss, less infection risk, shorter recovery time.
- Challenge: 2-dimensional visualization; depth perception, eye-hand coordination, counterintuitive instrument movements, etc.
WHY DO WE SIMULATE?

“Given their education curriculum, a surgeon would rather be the first passenger of a pilot than a pilot being the first patient of a surgeon”

Wentink 2003 Surg Endosc
WHY TRAIN ON A SIMULATOR?
WHY TRAIN ON A SIMULATOR?

- Medical error reported to be the 3rd-leading cause of death in the USA. Between 210,000 and 440,000 patients suffer preventable harm every year.
- Train away from patient!

A New, Evidence-based Estimate of Patient Harms Associated with Hospital Care, J of Patient Safety 2013
WHY VIRTUAL REALITY SIMULATION?

- How are your residents trained today?
- Proficiency level at OR debut?
- Do all residents get identical training?
- Supervision time – worth lowering?
- How do you train on rare events?
ROLE OF SIMULATOR

- Technical Skills
- Time
- Fundamental skills
- Interventional skills
- Simulator
- Operation room
- Learning curve
ROLE OF SIMULATOR

- **Technical Skills**
  - Fundamental skills
  - Interventional skills

- **Time**

  - Learning curve

- **Automated learning**
  - Compare to driving: don’t look at the gear stick – look forward!
COMPANY FACTS

- Founded 1999 in Göteborg, Sweden.
- Committed to developing simulators that will help train safer medical professionals faster.
- Close ties to prestigious clinical and academic institutions worldwide.
- More than 500 installations worldwide.
- Direct sales or distributors on all continents.
EXAMPLES OF CUSTOMERS

- St. Michaels Hospital, Toronto, Canada
- Rigshospitalet, Copenhagen, Denmark
- Karolinska University Hospital, Stockholm, Sweden
- Practicum, Lund, Sweden
- Harvard Medical School, Boston, USA
- Trondheim University Hospital, Norway
- Università di Milano, Italy
- Cuschieri Skills Centre, Univ. of Dundee, UK
- Macau Univ of Science and Technology, Macau
- Universitätsklinikum Giessen und Marburg, Germany
- Imperial College of London, UK
- Kalafong Hospital, Pretoria, South Africa
- University Hospital, Mainz, Germany
- King Faisal Univ. Hospital, Saudi Arabia
- Royal College of Surgeons, Ireland
- Yale School of Medicine, CT, USA
LAPSIM® - YOUR FIRST CHOICE

- Only system marketed with published **validated transfer of skills** from VR to OR
- Procedural training based on **real graphics**
- Compose your own **curriculum**
- Objective, extensive **metrics & feedback**, including recording of your exercise
- Procedural & exercise **movie instructions**
LAPSIM® HAPTIC SYSTEM

Input devices:
instruments and camera

Touch screen

Exercise menu touchpad

LAPSIM® computer
STEP-BY-STEP TOWARDS OR

Classroom

Basic Skills

Depth perception
Eye-Hand Coordination
Instrument handling
Precision and speed
etc.

Procedural training

Team Training

Operation Room

surgical science
LAPSIM® CORE SOFTWARE MODULES

**BASIC SKILLS**
Camera and Instrument Navigation, Lifting & Grasping, Coordination, Seal & Cut, Clip Applying, Precision & Speed, Fine Dissection, Suturing, Catheter Insertion, and more.

**TASK TRAINING**
Peg Transfer
Pattern Cutting
Ligating Loop
Intracorporeal Suturing

**CAMERA ANATOMY TRAINING**
Gastrointestinal
Gynecology
LAPSIM® DETAILED EXERCISE FEEDBACK

You Passed!

Weighted Score: 63%

Session Comment:
This result was randomly generated!
LAPSIM® TEACHER MODE
STEP-BY-STEP TOWARDS OR

Classroom

Basic Skills

Procedural training

Cognitive Training
- Hands-on training
- Instrument selection/handling
- Step-by-step recognition
- etc

Team Training

Operation Room
LAPSIM® essence – PORTABLE AND AFFORDABLE

- Convenient **online subscription** to avoid investment budgets
- Stay **updated automatically** with the latest software
- Worry-free usage with **100% hardware replacement guarantee** included
- With published **validated transfer of skills** from VR to OR
- Objective, extensive **metrics & feedback**, including recording of your exercise
- Instructive **video tutorials**
- Desktop setup, ideal for **mobile course programs**
THIS IS LAPSIM® essence

- All-new sensing technology
- Portable and light
- Ready-to-use
- No haptics
- No camera
- To be used separately or as a complement to LapSim Haptic System
- Desktop setup, runs with laptop
STEP-BY-STEP TOWARDS OR

- **Classroom**
  - Basic Skills
    - Depth perception
    - Eye-Hand Coordination
    - Instrument handling
    - Precision and speed
    - etc.

- **Procedural training**
- **Team Training**

- **Operation Room**
LAPSIM®essence FEATURES

- Includes Basic Skills only, and no procedural modules
- Includes Student & Course management
- Includes 9 predefined courses
- No configuration of exercises or courses
- Automatic software updates through online connection
THE ONLINE CONCEPT

- Automatic search for software and license updates when online
- You can work offline, but need to go online once every payment period to confirm license
- If no license: admin accessible, but no simulation (same as LapSim Haptic today)
STEP-BY-STEP TOWARDS OR

Classroom

Basic Skills

Procedural training

Team Training

Communication
Stress-handling
Complication Training
etc

Operation Room
TEAMSIM® INTER-PROFESSIONAL TRAINING

- **TEAMSIM®** is **LAPSIM®** for teams
- Training set up in an OR environment
- Engage the whole team!
TEAMSIM®: STRESS THE SURGEON

- Instructor-controlled scenarios & complications
- Manipulate bleedings, instrument and camera mal-function, port bleedings
CONSTANTLY EVOLVING SOFTWARE

Subscribers to our Update & Service agreement receive upgrades – every year!
ANNUAL UPDATE 2016

- All-new version of Cholecystectomy!
- New anatomy in VATS
- New port position display. Instant preview of each procedure scene
- New instrument configuration. Pre-set your preferred instrument setup in any procedural exercise.

Plus a range of improvements to Teacher Mode to simplify and help administrating your courses, including survey data export to Microsoft Excel, visualized import routines, and various bug fixes.
ANNUAL UPDATE 2017

Next generation of LapSim® Gynecology and Appendectomy Modules
- Complete remodeling
- Latest technology platform
- New graphics and fresh visual look
  - **Gynecology Module**
    - New anatomy of the module
    - Amended tactile feedback
    - Improved feeling of tissue handling
  - **Appendectomy Module**
    - Now including Retro-Caecal Anatomy Case
    - New Free-Hand Mode unguided approach to the appendix

Instrument Selection
- Instrument selection by turning the rotation wheel
- Improved user-friendliness
- Applicable in all modules
- Easy to customize

Other updates
- Licensed/Unlicensed courses now marked in teacher mode
- Faster loading of databases
- Visible timer added in Basic Skills exercises
- Course search function added
- Translation expanded to include all course names
STEP-BY-STEP TOWARDS OR

Classroom

Basic Skills
- Depth perception
- Eye-Hand Coordination
- Instrument handling
- Precision and speed
- etc.

Procedural training
- Cognitive Training
- Hands-on training
- Instrument selection/handling
- Step-by-step recognition
- etc.

Team Training
- Communication
- Stress-handling
- Complication Training
- etc.

Operation Room
DOES IT WORK?

- Technical Skills
- Time
- Learning curve
- Simulator
- Operation room
DEMONSTRATED BENEFITS OF LAPSIM®

- VR training reduced operating time by half
  - How many OR hours/week would you save with LAPSIM®?

- Novice performance level bypassed
  - What would you switch supervision time to?

Christian R Larsen et al., British Medical Journal 2009;338:b1802
VALIDATION STUDIES, A SELECTION

- **Skills acquired on LapSim transfer into the operating room**
  Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies, Gunnar Ahlberg MD, PhD, et al., *The American Journal of Surgery* 193 (2007) 797-804

- **Virtual reality training takes you to a level equal to 20-50 lap operations**
  Impact of virtual reality training on laparoscopic surgery, Christian Rifbjerg Larsen MD, PhD, et al., *British Medical Journal* 2009;338:b1802

- **LapSim curriculum with construct validity**

- **LapSim more effective than a box trainer**

- **LapSim construct validity**
Compulsory simulator training for residents prior to performing laparoscopic cholecystectomy?

Gunnar Ahlberg, M.D., et al.
Karolinska Hospital, Stockholm
OBJECTIVE

- To assess the efficacy of metric-based virtual reality training to proficiency for the first ten laparoscopic cholecystectomies that novices performed.

13 Surgical Trainees

VR-training

Randomization

LapSim training to expert level

Baseline assessment

VR-training

Video Evaluation by 2 independent blinded experts

Conventional training in home hospital

Video Evaluation by 2 independent blinded experts

Apprenticeship model

Standard training

LapSim Basic Skills tasks with increasing difficulties

• 5 Surgeons with > 300 procedures each

• LapSim Cholecystectomy

• 6 Exercises (Suturing x 2, Lift & Grasp, Clip Applying, Cutting X 2)

10 cholecystectomies by each subject, performed and videotaped

10 cholecystectomies by each subject, performed and videotaped

"expert level"

Median results from experts
EVALUATED PROCEDURES

- All subjects performed their ten first individual full procedure laparoscopic cholecystectomies under supervision by an experienced laparoscopic surgeon.
- Supervisor blinded to subjects training status.
- Each procedure was videotaped and a protocol was filled out stating, on a minute by minute basis, what parts of the procedure that were performed by the subject.
- Defined errors in the assessment form were demonstrated and discussed on beforehand.

"Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies", Gunnar Ahlberg MD, PhD, et al., *The American Journal of Surgery* 193 (2007) 797-804
ERROR DEFINITIONS

- Exposure Errors
  - Lack of progress
  - Burn Nontarget Tissue
  - Nontarget Structure Injury
  - Instrument Out Of View
  - Attending Takeover
  - Gallbladder Injury
  - Cystic Duct Injury
  - Inappropriate Dissection
  - Incorrect Angle of Gallbladder Retraction Error
  - Dropped Retraction

- Dissection Errors
  - Lack of Progress
  - Burn Nontarget Tissue
  - Instrument Out of View
  - Attending Takeover
  - Gallbladder Injury

- Dissection Errors (cont.)
  - Liver Injury
  - Incorrect Plane of Dissection
  - Tearing Tissue

- Clipping and Tissue Division Errors
  - Attending Takeover
  - Clip Overlap
  - Clip Spacing Error
  - Poor Clip Orientation
  - Partial Closure
  - Poor Application
  - Poor Visualization
  - Nontarget Tissue Clipped
  - Clip Drop
  - Inappropriate Division
  - Clip Cutting
  - Nontarget Injury

"Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies", Gunnar Ahlberg MD, PhD, et al., The American Journal of Surgery 193 (2007) 797-804
MEAN NUMBER OF INTRA-OPERATIVE ERRORS

- Significant difference!

"Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies", Gunnar Ahlberg MD, PhD, et al., The American Journal of Surgery 193 (2007) 797-804
CONCLUSION

• “In conclusion, we believe that the results in this study demonstrate that skills acquired in LapSim simulator improves the initial learning curve in laparoscopic cholecystectomy and that the system is clinically validated for this purpose.

It is also clear that all laparoscopists should train on the simulator until they reach the established proficiency level prior to performing laparoscopically on patients”

"Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies", Gunnar Ahlberg MD, PhD, et al., The American Journal of Surgery 193 (2007) 797-804
VALIDATION STUDIES, A SELECTION

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Effect of virtual reality training on laparoscopic surgery

Christian Rifbjerg Larsen MD, PhD, et al.

British Medical Journal 2009;338:b1802
METHOD

Inclusion of Trainees and patients n=24

Randomization

LapSim training to expert level n=13
Laparoscopic Salpingectomy

Conventional clinical education n=11
Laparoscopic Salpingectomy

Assessment blinded to training status
OSA-LS Performance score

RESULTS

Effect of virtual reality training on laparoscopic surgery, Christian Rifbjerg Larsen MD, PhD, et al.
British Medical Journal 2009;338:b1802
3 **cornerstones** in successful surgical training

- **Validated simulator**
  Larsen, Grantcharov, Seymour, Ahlberg

- **Motivated trainees**
  Motivation is essential for learning; it fuels participation in training

- **Dedicated personnel & organization**

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**Curriculum**

- **KNOWS**
  - Declarative Knowledge
  - Procedural Knowledge
  - Cognitive Knowledge
  - Meta-Cognitive Knowledge
  - Social Knowledge

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*surgicalscience*
BUILDING A CURRICULUM

Miller’s framework of competence and assessment in education. The four-step curriculum in basic laparoscopy and Fitts and Posner’s three-stage theory on motor skills learning can be applied.

- Step 1: The 1-day course Basic Laparoscopy
- Step 2: Multiple-choice test in basic laparoscopy
- Step 3: Structured training on a virtual reality simulator
- Step 4: An operation

PhD thesis: Jeanett Østergaard, MD
Development and validation of a structured curriculum in basic laparoscopy
- A four-step model
DENMARK AT THE FOREFRONT

- Capital Region in Denmark first healthcare authority in the world to introduce mandatory simulation-based training for doctors within all specialties (2015)
- Denmark launched national curriculum requiring all OB/GYN residents to undergo a structured laparoscopic training on a VR simulator (2014)

“Today, the last exam a specialist faces is when they leave medical school. With the introduction of our driver's license, we will change this”.

Prof. Torben V. Schroeder, head of the Center for Clinical Education (CEKU) at Copenhagen University Hospital.
WHY VIRTUAL REALITY SIMULATION?

- Reduce time to proficiency outside the OR
  - Increasing focus on patient safety.
- Objective evaluation
  - by standardized training.
- Rare events training
  - No limits in a VR exercise.
WHY LAPSIM® BY SURGICAL SCIENCE?

- Only system marketed with published validated transfer of skills from VR to OR
- Exercises ranges from individual basic skills to inter-professional team training
- Powerful course management with outstanding parameter control
- Dedicated support – yearly updates
Thank you for your attention!
extra slides
ADVANTAGES OF SIMULATION TRAINING

• Practice without risk to patients
• Reduces the risk of errors during first operations
  (Ahlberg 2007 Am J Surg)
• Reduces operating time (Larsen 2009 BMJ)
• Reduces complications (Zendejas 2011 Ann Surg)
TEAMSIM® OPTIONS

- Sold as separate system, or
- Add the TEAMSIM® framework to your LAPSIM® system
LAPAROSCOPY LEARNING CHALLENGES

- 2D view of 3D surgical space
- Fulcrum effect: counter-intuitive movements
- Limited space awareness
- Reduced tactile feedback
- Modified hand-eye coordination – think radius and angle
- Camera misalignment