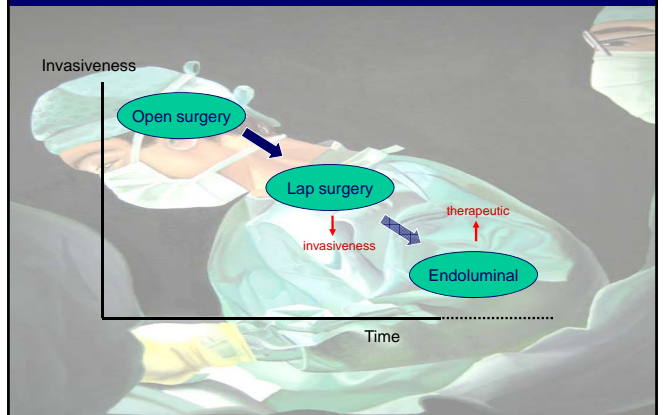


Enhancing Surgical Performance through Simulation

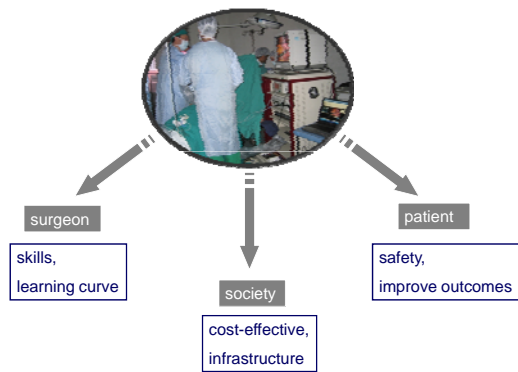
Rajesh Aggarwal PhD MA MRCS
 Division of Surgery, Department of Surgery & Cancer, Faculty of Medicine

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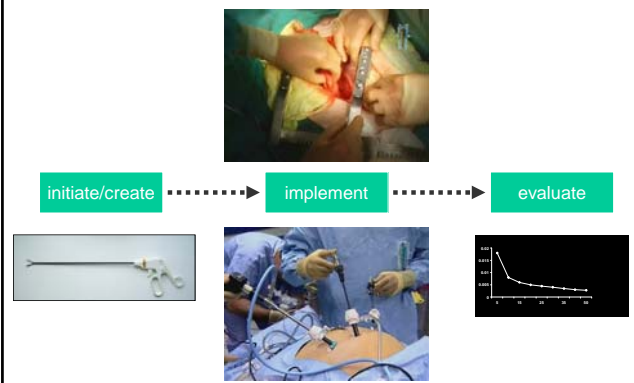
Changes to the Delivery of Surgical Care



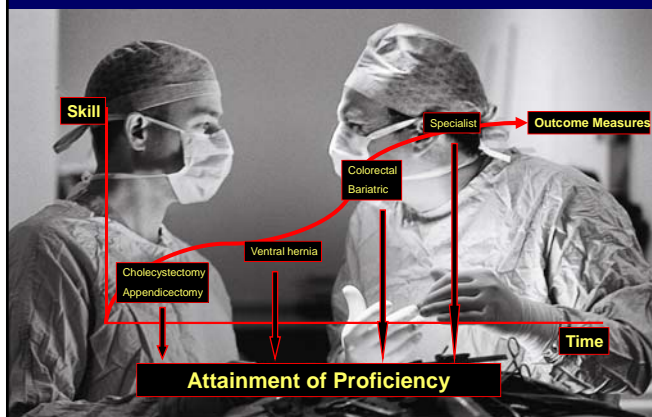
New Surgical Technologies



Innovation pathway



Learning Curve...



Training Needs to Shift from the OR to the Skills Lab



Proving the Value of Simulation in Laparoscopic Surgery
Gerald M. Fried, MD, Eusebio Padua, MD, Melissa C. Tanaka, MD, Shomay A. Pinar, MD, Dawn Southbridge, RN, Gabriela Chiriac, MD, and Christopher G. Andrew, MD

A Meta-Analysis of the Training Effectiveness of Virtual Reality Surgical Simulators
Ryan Hague, MSc, PhD, and Shoukat Siddiqui

Randomized clinical trial of virtual reality simulation for laparoscopic skills training
E. P. Grantcharov^{1,2,3}, V. B. Kolesnikov¹, J. Rendall¹, L. Bonham¹, J. Benschler⁴ and P. Funch-Jensen⁵

Proving the Effectiveness of Virtual Reality Simulation for Training in Laparoscopic Surgery
Rajesh Agarwal, MEd, MSc, James Ward, BSc, Indrajit Kalanidharan, MBBCh, Parthiv Patel, MRCGS, Shomay Alkhatib, MD, PhD, FRCGS, and the team, RAE, MD, FACS, FRCR, West Riding, FRCR(S)

Surgical Simulation: A Systematic Review
Lester M. Ishwaran, PhD, Phillipa F. Stoddart, MPH, Arjun Arshava, MBBCh, FRCGS, Jiguo Shen, MBBCh, PhD, FRCGS, Patrick Cooper, MBBCh, FRCGS, David Scott, MD, MSc, FRCGS, and Guy J. Maddum, MBBCh, MEd, PhD, FRCGS^{1,2}

Virtual Reality Training Improves Operating Room Performance: Results of a Randomized, Double-Blinded Study
Nadav Saper, MD, Anthony G. Salazar, PhD, Doreen B. Neman, MD, Michael C. Oliver, MD, Isaac Kaveh, MD, David A. Aronoff, MD, and Michael S. Green, MD

Virtual Reality Simulation for the Operating Room: Proficiency-Based Training as a Paradigm Shift in Surgical Skills Training

VR Laparoscopic Simulators

VR Training Curriculum

Easy Level – settings
7 tasks performed twice on the same day in two sessions, each session >1 hour apart

Medium Level – settings
7 tasks performed twice on the same day in two sessions, each session >1 hour apart

Difficult Level – settings
2 tasks (Lifting and Grasping, and Clip Applying)
Performed for a maximum of two sessions per day, each session >1 hour apart
Completion of training when all of the following levels of skill are achieved on two consecutive sessions

<p>Difficult Level (Lift & Grasp) R Path length <1.2m L Path length <1.2m Time taken <40 secs</p>	<p>Difficult Level (Clip Applying) R Path length <1.2m L Path length <1.2m *Error score <0.33 Time taken <80 secs</p>
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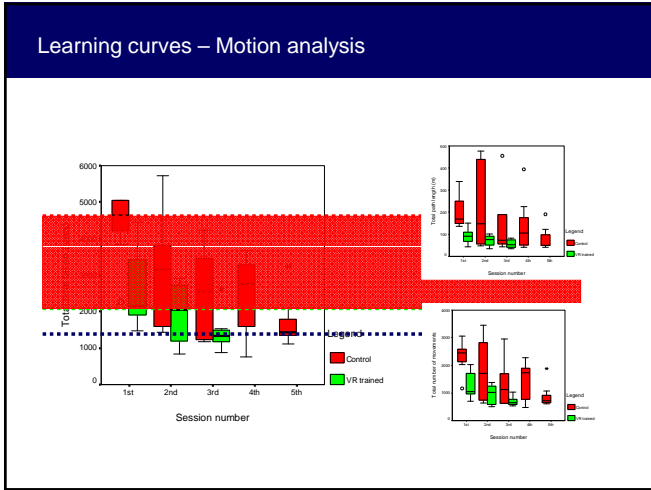
Dissection Module
Two sessions per day, each session >1 hour apart
Completion of training when all of the following levels of skill are achieved on two consecutive sessions:
Time taken (450 secs); Dissected volume (>20%); R Path length (3.0 metres); L Path length (3.0 metres)

Aggarwal R, Grantcharov TP, Eriksen JR, Blirup D, Kristiansen V, Funch-Jensen P, Darzi A. An evidence-based virtual reality training program for laparoscopic surgery. Ann Surg. 2006 Aug; 244(2): 310-4.

Application of a VR curriculum to real procedures

```

    graph TD
      A[Pre-assessment - Glove model] --> B[Theory]
      B --> C[VR training curriculum LapSim (basic + dissection)]
      B --> D[Cadaveric pig GB]
      C --> E[Cadaveric pig GB]
      E --> F[Cadaveric pig GB]
      F --> G[Cadaveric pig GB]
      D --> H[Cadaveric pig GB]
      H --> I[Cadaveric pig GB]
      I --> J[Cadaveric pig GB]
  
```



Transfer Effectiveness Ratio for Surgical Simulation

$$TER = \frac{T_0 - T_1}{X}$$

where T_0 is the median time required by the control group to reach performance criterion and T_1 is the corresponding measure for the VR trained group after having received a median of X amount of training time on the simulator, which is also the denominator.

The control group required a median of 14,759 seconds (T_0) to complete five cadaveric porcine LCs, whilst the VR-trained group required a median of 5,700 seconds (T_1) to complete three LCs. In addition, the VR-trained group underwent a median of 3967 seconds (X) training time on the simulator. Applying this data to the TER equation results in a calculation of:

$$TER = \frac{14759 \text{ seconds} - 5700 \text{ seconds}}{3967 \text{ seconds}} = 2.28$$

Learning to play golf...

driving range

in the bar... (debrief)

play the course...

The role of warm up (simulation)

OK performance score

warm-up status

warm-up status	min	Q1	Median	Q3	max
no warm-up	15	18	20	22	25
warm-up	25	28	30	32	35

Performance under Varied Conditions...

The role of Deliberate Practice

THE CAMBRIDGE HANDBOOK OF Expertise and Expert Performance

Editors: K. Anders Ericsson, Neil Charness, Robert T. Hoffmann, Paul J. Lehmann

Performance

Experience

Expert Performance

Arrested Development

Everyday Skills

Specialist

General Practitioners

0-9 years

10-20 years

Over 20 years

Instruction and Experience

Deliberate practice – K. Anders Ericsson

How expertise is acquired in other domains?

Deliberate Practice (KA Ericsson)

Would it work for surgery ?

Results on porcine laparoscopic cholecystectomy model

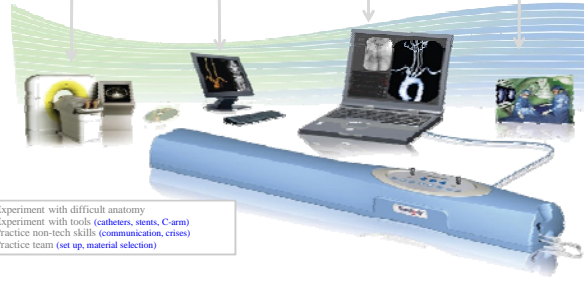
Total score Generic Global OSATS scale

Group	First L.C.	Second L.C.
DP = Control (19.5 vs. 17.5, P=0.258)	19.5	17.5
DP > Control (24.5 vs. 19.5, P=0.047)	24.5	19.5

DP group

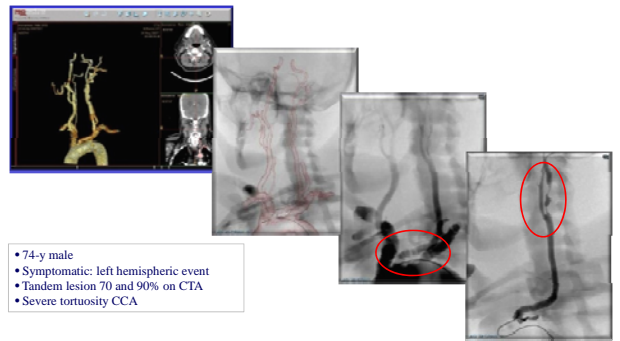
Control group

Procedure rehearsal for endovascular intervention



- Experiment with difficult anatomy
- Experiment with tools (catheters, stents, C-arm)
- Practice non-tech skills (communication, crises)
- Practice team (set up, material selection)

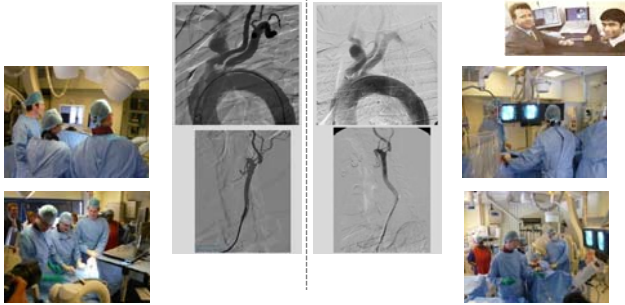
Methods – procedural case



- 74-y male
- Symptomatic: left hemispheric event
- Tandem lesion 70 and 90% on CTA
- Severe tortuosity CCA

First real case Procedure rehearsal

VR Real



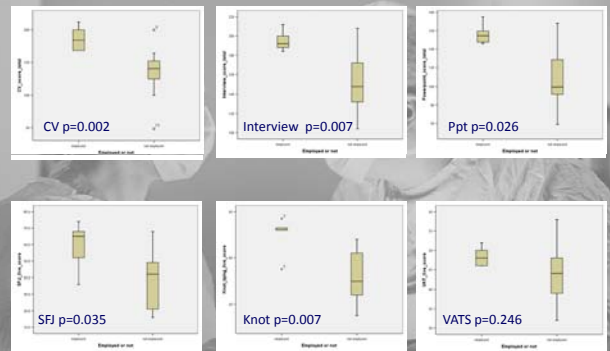
Cardiac surgery



Bench-top Technical Skills Assessments



Comparison of APPOINTED versus NOT APPOINTED – live

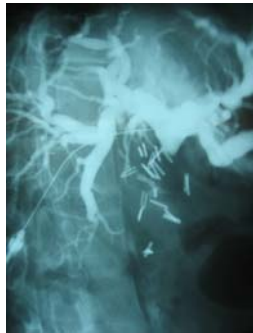


Technical-Skills Training in the 21st Century

Rajesh Aggarwal, M.R.C.S., and Ara Darzi, M.D.

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The New Intakes at Imperial College Medical School...



Thank you!

- Professor Ara Darzi
- Professors Nick Cheshire, Charles Vincent and Guang Zhong-Yang
- Patrice Crochet, Sonal Arora, David James, Vishal Patel, Willem Willaert, Isabelle Van Herzele, Rosamond Jacklin, Roger Kneebone, Debra Nestel, Fernando Bello, Cordula Wetzel, Julian Hance, Julian Teare, Tanya Tierney, Rachel Davies, Kate Miles, Julian Leong, Aristotelis Dosis