Medical Simulation in Ophthalmology

A virtual reality program can accelerate and augment cataract surgery training and maximize skills transfer.

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Medical simulation is analogous to a dress rehearsal. It is the best time for mistakes to be made and for lessons to be learned.[1] Many occupations, such as emergency services, aviation, and the military, use simulation as a vital part of training. As in medicine, professionals in these fields often have to work in high-pressure situations. A crucial difference, however, is that medical professionals often must learn under pressure rather than during simulated activities.

The first recorded use of a medical simulation device was in the 17th century, when Gregoire stretched skin across a mannequin's pelvis to recreate an abdomen and used a deceased fetus to demonstrate complicated deliveries to midwives.[2] Despite this early example, the medical community has been slow to adopt surgical simulation, mainly due to cost but also because of reluctance to alter teaching methods and skepticism regarding the transferability of simulated skills.[1] In 1992, the American anesthetist Gaba claimed, "No industry in which human lives depend on the skilled performance of responsible operators has waited for unequivocal proof of the benefit of simulation before embracing it."[3]

TYPES OF MEDICAL SIMULATION

Medical simulation includes wet labs, mannequins or simulated patient models, and simulated hospital environments such as emergency rooms or operating theaters. Some surgical specialties have developed virtual reality simulators to reproduce endoscopic or laparoscopic procedures, with promising results.[4,5] In ophthalmology, the Eyesi Surgical Simulator (VR Magic; Figure 1) is the only widely available model for medical simulation. The main features of this system are a virtual eye mounted on a mannequin head and an operating microscope through which virtual reality surgery is projected. The system also has a touchscreen monitor, providing opportunity for a supervisor to watch and offer feedback during the procedure. The Eyesi is connected to a customized computer.

All images courtesy of VR Magic

Figure 1. Complete Eyesi Surgical Simulator set-up.

As in a real operating situation, two footpedals are used to control the microscope and the phacoemulsification, vitrectomy, and infusion/aspiration modes. Instruments contain colored heads from which optical tracking systems convert movements into electronic signals that are relayed to the simulator after being inserted into the artificial eye (Figure 2). All necessary instrument types can be recreated, from the phacoemulsification probe to capsulorrhexis forceps, and algorithms have been fine-tuned to recreate accurate tissue response and allow realistic simulation of procedures including capsulorrhexis creation.[6,7] The Eyesi has also demonstrated validity for both antitremor and forceps-handling training (Figure 3).[8]

The Eyesi creates a platform for exploring aspects of working in an operating theater that otherwise cannot be ethically investigated without putting patients at risk, such as the effects of distraction[9] and fatigue.[10] Similarly, new techniques can be practiced safely to evaluate their worth before being tried on patients (Figures 4 and 5).[11]

A CLINICAL MODEL

Since 2008, Moorfields Eye Hospital has integrated the Eyesi Surgical Simulator into its training program for specialty trainees (residents). Our facility has a dedicated simulation suite overseen by an appointed consultant staff member with significant experience in surgical training.

Figure 2. Eyesi surgical instruments interacting with a virtual eye.

As the Director of Simulation and the Simulation Lead for the London Deanery Surgical Training Program, one of the authors (George M. Saleh, MBBS, FRCS(Ed), FRCOphth) works with a growing team of simulation trainers. Simulation sessions can be freely booked by surgeons at all levels from Moorfields and across the Greater London region, following a supervised induction session. Simulator use can augment surgical training, given reduced theater time as a result of the European Working Time Directive.

Whereas most training programs worldwide involve primarily trainee-directed simulator learning, Moorfields—with the endorsement of the London Deanery and National Health Service London's Simulation and Technology-Enhanced Learning Initiative—has started a pilot scheme to expose trainees to the full breadth of simulator modules. This structured, sequential, individualized program allows trainees to acquire the full range of skills it was built to impart. Consultants can supervise simulation sessions and provide feedback and structured debriefs, and the sessions also allow remote monitoring of trainees.

A wide range of input and educational theory has been employed in the creation of this program and its structured courseware. The courseware includes cataract-specific and generic 3-D dexterity tasks to test the range of skills the simulator teaches; parameters including validity (accuracy of what the simulator measures) and reproducibility (repeatability of results) are evaluated to discriminate between junior and senior trainees.

What is missing at present, however, is evidence of how and when this strategy fits within ophthalmic training. A series of research initiatives has been developed to provide this evidence. Moorfields' simulation team invites wider participation for the broader benefit of the profession, and it has established the International Forum for Ophthalmic Simulation (IFOS), which now has input and participants from all continents. Through the IFOS, we have established a networked cloud of Eyesi simulators, allowing both software upgrades and data exchange to be uploaded and downloaded, locally or remotely, through a global user interface hosted by Eyesi. *(Editors' Note: For*

TAKE-HOME MESSAGE

- Medical simulation includes wet labs, mannequins or simulated patient models, and simulated hospital environments.
- During training programs with Eyesi surgical simulation, consultants can supervise sessions and provide feedback and structured debriefs.

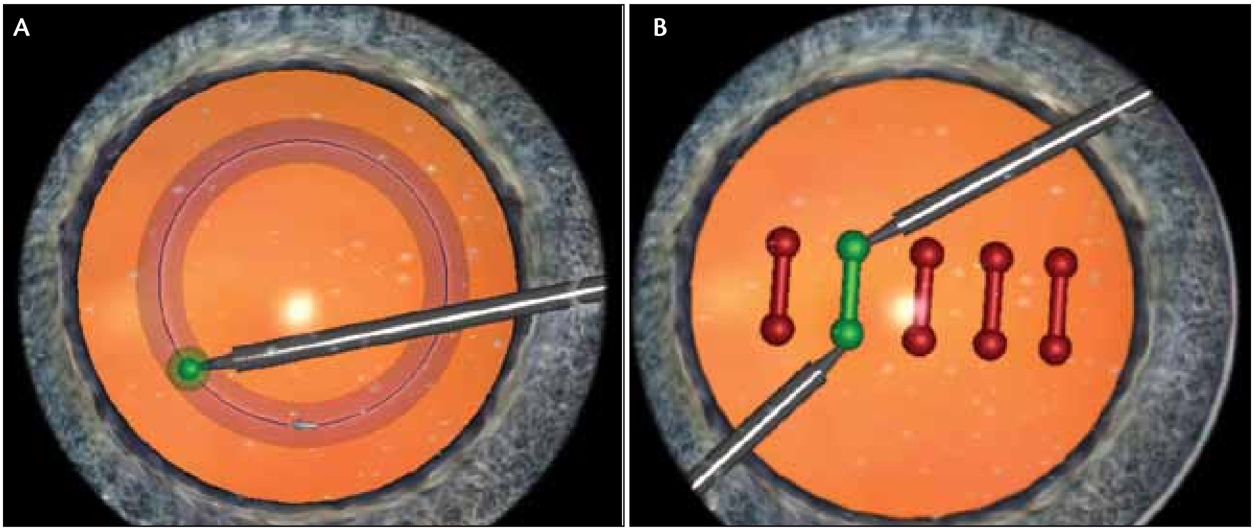

Figure 3. The Eyesi simulator courseware contains a number of training modules such as (A) antitremor and (B) bimanual techniques.

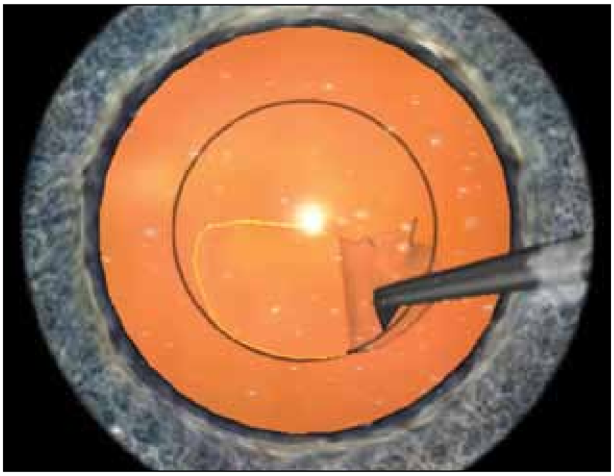

Figure 4. Capsulorrhexis simulation.

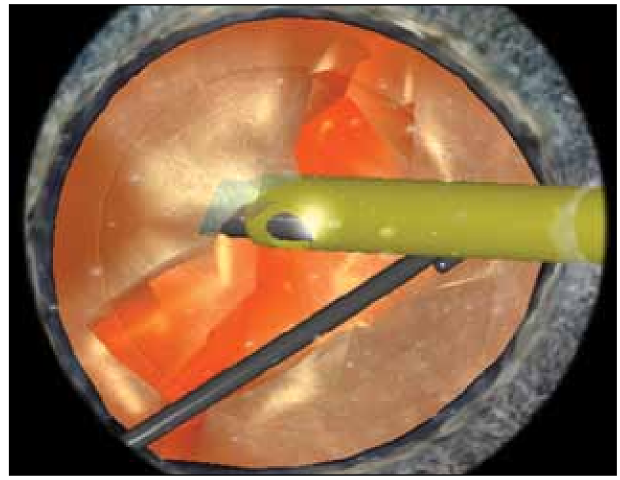

Figure 5. Phacoemulsification simulation.

more information on cloud computing, visit wikinvest.com/concept/Cloud_Computing.) This system allows the group to extract and analyze research data and provides a new level of educational benefit wherein the anonymous pool of data creates a global repository that can be used to benchmark training and progression.

This forum has uncovered variation in cataract training globally, including time granted, surgical exposure, and access to simulators. It is hoped that data from this forum can be used to improve the overall simulation program and that, by reporting specific and relevant data to regional areas, local courseware can be modified and tailored accordingly.

CONCLUSION

The goal of IFOS is to deliver a virtual reality program that accelerates and augments surgical training and provides maximal skills transfer in the most timely and cost-efficient manner. It may also facilitate the beginnings of extrapolation for potential improvement of patient safety through skills acquisition with a simulator as opposed to live patients. Important questions remain, such as where surgical simulation should be done, at what stage in training, and exactly how much exposure trainees should have to this technology. Essentially, cross-validation should reveal the level of the skills transfer to help answer these questions and create a more effective training program.

Simulation has been demonstrated to yield significant benefits in other fields. If implemented effectively within ophthalmology, similar benefits could include accelerated learning using a process of formative feedback and structured debriefs, improvements in training programs and trainers, and, most important, improved patient safety and outcomes. ■

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