A Revised Simulation-Based Cataract Surgery Course for Ophthalmology Residents

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KEYWORDS: virtual simulation, ophthalmology resident education, cataract surgery

Since their introduction over a decade ago, virtual reality (VR) simulators have grown in use at many graduate medical education (GME) programs.[1] Simulation-based training in ophthalmic surgery is no exception. In 2015, 78 percent of United States (US) ophthalmic GME programs had access to virtual eye surgery training.[2] However, the paucity of published VR curricula has precluded the systematic analysis of simulation training outcomes.[3] We present herein a revised simulation-based cataract surgery course, which we have made publically available on the Brown Digital Repository (**see link below**) to encourage feedback from other ophthalmic GME programs.

The course is divided into two main components: (1) a didactic section based on the American Academy of Ophthalmology (AAO) Basic and Clinical Science Course® (BCSC), "Lens and Cataract" and (2) a virtual reality (VR) section designed for use alongside the EyeSi® ophthalmosurgical simulator (VRMagic, Mannheim, Germany). This latter section is organized by post-graduate year (PGY). Each of the three required PGYs (II-IV) have specific modules that the resident must successfully complete before advancing to the next level. The original course was developed in 2013[4]; key revisions include an update of didactic materials to reflect the most recent edition of the BCSC and the incorporation of new VR cataract surgery modules.

The didactic section provides an introduction to lens pathophysiology and cataract surgery and serves as a reference for the simulation portion of the course. It is comprised of the following subsections: Lens Anatomy, Lens Pathophysiology, Preoperative Care, Procedure, Postoperative Care, and Complications of Cataract Surgery. It also includes instructions for more detailed reading in the BCSC text.

The VR component takes place at the simulator, which is comprised of an eye model with side holes for instrument insertion and a microscope that projects its images onto a side monitor. Users look into the microscope as they would in a real-life setting, and the hand-pieces they see through the scope are simulated to represent actual cataract surgery instruments. Users are also able to control the microscope, hand piece, and phaco machine settings through a foot pedal as they would in live surgery. The residents learn microsurgical skills and eye-hand-foot coordination, which are integral to the key steps of cataract surgery. Basic skills programmed into the software include intraocular navigation, anti-tremor handling of instruments, bimanual coordination, forceps maneuvering, and phacoemulsification machine calibration. Subsequent modules incorporate these elements into advanced tasks and steps of cataract surgery—capsulorhexis, hydrodissection, nuclear rotation, irrigation, aspiration, emulsification, nuclear disassembly, intraocular lens insertion. Modules also prepare users for difficult cataract surgery cases, which may include soft nuclei, white cataracts, and capsular plaques.

This simulation-based course requires construct validation, a process of confirming VR model accuracy by comparing surgical performance on the simulator between novices (e.g., PGY2 ophthalmology residents) and experienced ophthalmologists.[3] In addition, the VR training should be (a) integrated into a comprehensive surgical educational program that includes classroom and wet-lab based learning,[5] and (b) linked to resident cataract surgery outcomes.[3] Feedback and analysis of resident operating room performance after implementation of the course can guide future revisions and assist in providing meaningful educational outcomes data.

Course link: http://dx.doi.org/10.7301/Z08913SK

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Acknowledgment

This material is the result of work supported with resources and the use of facilities at the Providence VA Medical Center, Providence, Rhode Island.

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Financial Disclosures

The authors have no financial interests to disclose.

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