**comment**

**Principles of simulation and their role in enhancing cataract surgery training**

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**INTRODUCTION**

Simulation allows surgical trainees to develop technical skills (TS) and non-technical skills (NTS) in reproducible environments without compromising patient safety [1]. The Halstedian model of apprenticeship-based learning has traditionally been used to achieve competency in ophthalmic surgery, however, factors such as workforce redeployment and suspension of elective surgery secondary to COVID-19 have compromised learning and skills progression [2]. Trainees may not achieve their mandatory 350 cataract procedures, or be adequately experienced with managing complications such as posterior capsule rupture (PCR) by the end of their training [2]. Simulation-based training modalities could be used to mitigate these issues, however, few are immersive, NTS focussed, or are used within scenario-based settings [3]. This article explores the role of simulation in cataract surgery training, the educational theory underpinning simulation-based scenarios, and perceived barriers to implementation.

**SIMULATION IN AVIATION AND CATARACT SURGERY TRAINING**

Simulation in aviation is mandatory and routine; pilots obtain basic and advanced TS and NTS through simulator training, and continue to be assessed in simulated settings for the remainder of their careers [4]. Simulators allow pilots to rehearse managing emergencies (including engine failures and rapid decompression) in preparation for their real-world occurrence [4]. NTS failures contribute to 70% of incidents and accidents in aviation, and simulation-based NTS training has greatly improved safety standards in aviation in recent decades [5, 6]. NTS failures are frequently implicated in cataract surgery complications and errors, including intracocular lens events [5]. The NTS required for managing intraoperative emergencies can be trained and rehearsed through simulation [7, 8].

Suboptimal management of intraoperative cataract surgery complications can result in adverse visual outcomes [9, 10]. PCR occurs in 5–9% of the first 100 cases performed by trainee cataract surgeons [11]. Participating in simulation-based training prior to undertaking cataract surgery for the first time has been associated with significantly reduced risks of PCR and vitreous prolapse [12]. However, the utilisation of complication-based simulation within cataract surgery remains poorly integrated with formalised curricula [1].

Supervising surgeons commonly take over when intraoperative complications occur, thus limiting the trainee’s ability to develop their skills in live settings [13, 14]. Kolb’s ‘Experiential Learning Theory’ states that new knowledge is created when a learner participates in transformative experiences [13, 15]. Simulation-based training should therefore follow specific structures in order for transformative learning to occur [13, 15]. The experiential learning cycle advances the learner through ‘concrete experience’, ‘reflective observation’, ‘abstract conceptualisation’, and ‘active experimentation’; each of which should be incorporated into a simulation’s design [13, 15]. Simulation-based scenarios should therefore contain specific learning outcomes, and be written according to approved guidelines [16].

Prior to the learner participating in a simulated scenario, a pre-brief must occur where the expectations and learning objectives are stated [16]. The pre-brief provides a chance for the facilitator to establish the ‘safe learning environment’, affirming that making mistakes when developing new skills constitutes valuable learning opportunities, and are not sources of humiliation or retribution [16–19]. The briefing introduces the scenario, before the scenario itself allows the learner to manage an event by applying their TS and NTS, thus forming the ‘concrete experience’ [13]. The reflective debrief is then considered to be the point of simulation whereby maximal learning occurs, allowing the ‘reflective observation’ and ‘abstract conceptualisation’ phases to occur [13, 15, 16, 20, 21]. The learner reflects on the scenario, considers what they may have done differently, and applies this with the aim of improving future performance [13, 15, 16]. ‘Active experimentation’ occurs subsequently, whereby the learner applies what they’ve learned in future clinical settings [13, 15].

**BARRIERS TO SIMULATION IN CATARACT SURGERY TRAINING**

Despite the educational benefits of integrating simulation with cataract surgery training, barriers exist at the level of the organisation, simulation design and the learner [19].

**Learner and organisational factors**

Individuals and organisations frequently avoid openness and transparency in addressing deficiencies and failings, and may
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2. Hussain R, Singh B, Shah N, Jain S. Impact of COVID-19 on ophthalmic specialist training in the United Kingdom—the trainees experience should and low-fidelity models can be used to achieve desirable learning outcomes. Organisations will therefore need appropriate time and financial resource allocation to optimise engagement with simulation [23].

Realism

The learner’s ‘buy-in’ to simulation may be negatively affected if a simulation’s realism does not accurately reflect real-world parameters [19, 22]. Flight simulators reflect reality through standardised and expensive technology and are specific to individual aircraft models [4]. At present, cataract surgery simulators are not comparably standardised to the same degree [4]. Direct skills transfer from simulated to live surgical environments therefore remains challenging [4]. As Gaba states; ‘simulation is a technique, not a technology’ [24]. Simulation will always depend somewhat on the ‘buy-in’ of the learner and facilitator, as subtle differences in haptics, environment, patient factors and the expectation of upcoming stressful events prevent absolute realism [25]. If potential problems with realism are addressed during the pre-brief, the learner’s experience should not be negatively affected [25].

CONCLUSION

Simulation is a valuable tool in cataract surgery training. Efforts should be made to further incorporate simulation into this subspecialty, in order for trainees to develop their TS and NTS through experiential learning cycles [13, 15]. With investment, cultural change and improved understanding of adult learning theories, simulation has the potential to enhance cataract surgery training, improve patient safety and maximise visual outcomes [23].

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AUTHOR CONTRIBUTIONS

TCW contributed to the article’s concept and design, as well as drafting and revision of the manuscript. SM contributed to the article’s drafting and revision of the manuscript, provided regular supervision, and approved the final manuscript. WS contributed to revision of the manuscript, provided regular supervision, provided technical and non-technical advice from an aviation perspective, and approved the final manuscript. AS contributed to revision of the manuscript, provided regular supervision, provided practical simulation advice, and approved the final manuscript. DL contributed to the article’s concept and design, drafting and revision of the manuscript, provided regular supervision, and approved the final manuscript. MAN contributed to the article’s concept and design, drafting and revision of the manuscript, provided regular supervision, and approved the final manuscript. SR contributed to the article’s concept and design, drafting and revision of the manuscript, provided regular supervision, and approved the final manuscript.
COMPETING INTERESTS
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