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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 wrong intraocular 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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therefore resist these being highlighted through simulation [19]. Whilst trainee enthusiasm for cataract surgery simulation is generally high, it is not uncommon for learners to feel that their skills are being scrutinised and their professional identities questioned [2, 12, 22]. Some learners are not naturally reflective, and may struggle to discuss their simulation performances during the debrief [22]. By affirming the '*safe learning environment';* a key factor for learning according to constructivist principles, this gives trainees assurances that their simulation-based actions will not carry negative consequences [16–19, 22].

However, the implications of suboptimal simulator performance require careful consideration. Suboptimal simulator performance could ultimately be beneficial for the trainee's education and patient outcomes by highlighting specific training needs. For senior surgeons, suboptimal simulator performance has no implications at present. In contrast, suboptimal simulator performance in aviation may result in flight suspensions until pilots meet the approved standards through further training and assessment [4].

Concerns surrounding cost effectiveness exist, however, arguments are multifaceted and lack conclusion [3]. Establishing true cost benefit requires the assessment of a simulation's target and collateral effects, which are difficult to prove [3]. Whilst computer-based ophthalmic surgery simulation may be expensive, both high 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].

REFERENCES

1. Thomsen ASS, Subhi Y, Kiilgaard JF, la Cour M, Konge L. Update on simulation-based surgical training and assessment in ophthalmology: a systematic review. Ophthalmology. 2015;122:1111–30.
2. Hussain R, Singh B, Shah N, Jain S. Impact of COVID-19 on ophthalmic specialist training in the United Kingdom-the trainees' perspective. Eye. 2020;34:2157–60.
3. Lee R, Raison N, Lau WY, Aydin A, Dasgupta P, Ahmed K, et al. A systematic review of simulation-based training tools for technical and non-technical skills in ophthalmology. Eye. 2020;34:1737–59.
4. Wood TC, Maqsood S, Sancha W, Nanavaty MA, Rajak S. Comparisons between cataract surgery and aviation. Eye. 2022;36:490–1.
5. Steeples LR, Hingorani M, Flanagan D, Kelly SP. Wrong intraocular lens events—what lessons have we learned? A review of incidents reported to the National Reporting and Learning System: 2010-4 versus 2003-10. Eye. 2016;30:1049–55.
6. Brennan PA, Mitchell DA, Holmes S, Plint S, Parry D. Good people who try their best can have problems: recognition of human factors and how to minimise error. Br J Oral Maxillofac Surg. 2016;54:3–7.
7. Wood TC, Maqsood S, Zoutewelle S, Nanavaty MA, Rajak S. Development of the HUman Factors in intraoperative Ophthalmic Emergencies Scoring System (HUFOES) for non-technical skills in cataract surgery. Eye 2021;35:616–24.
8. Saleh GM, Wawrzynski JR, Saha K, Smith P, Flanagan D, Hingorani M, et al. Feasibility of human factors immersive simulation training in ophthalmology the London pilot. JAMA Ophthalmol. 2016;134:905–11.
9. Chan E, Mahroo OAR, Spalton DJ. Complications of cataract surgery. Clin Exp Optom. 2010;93:379–89.
10. Yorston D, Duncalfe M. Managing emergencies: lessons from aviation. Community Eye Health. 2018;31:58.
11. Baxter JM, Lee R, Sharp JAH, Foss AJE. Intensive cataract training: a novel approach. Eye. 2013;27:742–6.
12. Staropoli PC, Gregori NZ, Junk AK, Galor A, Goldhardt R, Goldhagen BE, et al. Surgical simulation training reduces intraoperative cataract surgery complications among residents. Simul Healthc. 2018;13:11.
13. Kolb DA. Experience as the source of learning and development. Upper Saddle River: Prentice Hall; 1984.
14. Turnbull AMJ, Lash SC. Confidence of ophthalmology specialist trainees in the management of posterior capsule rupture and vitreous loss. Eye. 2016;30:943–8.
15. Poore JA, Cullen DL, Schaar GL. Simulation-based interprofessional education guided by Kolb's experiential learning theory. Clin Simul Nurs. 2014;10:241–7.
16. Krogh K, Bearman M, Nestel D. "Thinking on your feet"—a qualitative study of debriefing practice. Adv Simul. 2016;1:1–11.
17. Kostovich CT, O'Rourke J, Stephen L-A. Establishing psychological safety in simulation: faculty perceptions. Nurse Educ Today. 2020;91:104468.
18. Bradley P, Postlethwaite K. Simulation in clinical learning. Med Educ. 2003;37:1–5.
19. Kolbe M, Eppich W, Rudolph J, Meguerdichian HC, Catena H, Cripps A, et al. Managing psychological safety in debriefings: a dynamic balancing act. BMJ Simul Technol Enhanc Learn. 2020;6:164.
20. Shinnick MA, Woo M, Horwich TB, Steadman R. Debriefing: the most important component in simulation? Clin Simul Nurs. 2011;7:105–11.
21. Levett-Jones T, Lapkin S. A systematic review of the effectiveness of simulation debriefing in health professional education. Nurse Educ Today. 2014;34:58–63.
22. Rudolph JW, Raemer DB, Simon R. Establishing a safe container for learning in simulation: the role of the presimulation briefing. Simul Healthc. 2014;9:339–49.
23. Lockington D, Saleh GM, Spencer AF, Ferris J. Cost and time resourcing for ophthalmic simulation in the UK: a Royal College of Ophthalmologists' National Survey of regional Simulation Leads in 2021. Eye. 2021;1–4. [Epub ahead of print].
24. Gaba DM. The future vision of simulation in health care. BMJ Qual Saf. 2004;13:2–10.
25. Arora S, Sevdalis N, Nestel D, Woloshynowych M, Darzi A, Kneebone R. The impact of stress on surgical performance: a systematic review of the literature. Surgery. 2010;147:318–30.

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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

None of the authors have any financial interest in any product or procedures mentioned in this manuscript.

ADDITIONAL INFORMATION

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