THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH

The Faculty of Surgical Trainers

ASME

FST/ASME Educational Research Grant Report 2020 - 21

Kartik Logishetty

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RESEARCH GRANT RECIPIENT

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DEPARTMENT

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PROJECT TITLE

Can team-training in Virtual Reality improve performance of complex open surgery?

SUMMARY

Background:
System errors are the most common cause of adverse events in surgery, so team-based (for the scrub nurse, first assistant and surgeon) training may be more effective for delivering successful surgery than individual members training alone. Virtual Reality (VR) headsets enable healthcare professionals to be fully immersed in a simulated operating room, use virtual instruments to perform surgery, and interact with other participants in the same environment.

Method:
This study was a randomised controlled trial of a team-based simulation curriculum. It tested whether the surgical team which trains to perform virtual hip replacement together performed real-world surgery better than these individuals trained independently – as is current practice.

Conclusion:
We found that teams who had trained together in VR performed more steps of hip replacement correctly, and demonstrated better collaborative, problem-solving, decision making, and communication skills, and committed fewer mistakes. This indicates that the future of surgical training should change to incorporate team-based training, and that virtual reality can facilitate this.

RESEARCH GRANT REPORT

A) Clinical and Scientific Significance of Advances Made

Performing planned complex surgery requires role-specific skills executed in sequenced choreography between surgical team members; yet conventionally, surgeons and scrub nurses are trained separately. This study assessed if collaborative training – using immersive virtual reality (iVR) for anterior approach total hip arthroplasty (AA-THA) – was superior to individual, role-specific training for acquisition of technical and non-technical skills.

40 participants with no prior experience of AA-THA (20 surgeons (PGY1-3 level) and 20 scrub nurses) were randomised to individual or team training. Individually trained participants learnt to perform AA-THA with a simulated AI surgeon or nurse counterpart, while teams trained live in pairs (surgeon and nurse). Both groups underwent 5 iVR training sessions over six weeks. Subsequently, they underwent a real-world assessment in which they performed AA-THA on a high-fidelity model with real equipment in a simulated operating room. Team-trained participants were assessed as a pair, and individually trained participants were randomly paired with a participant in a complimentary role. The primary outcome was team performance as graded by two independent blinded raters using video-based assessments to measure NOTSS, NOTECHS-II and SPLINTS. Secondary outcomes were procedural duration, and number of technical errors.

Teams-based training was superior to training separately for acquiring non-technical skills (NOTECHS-II score 51.7 ± 5.5 vs 42.3 ± 5.6, p=0.001). Teams completed the assessment 28.1% more quickly (27.2 minutes ± 5.5 vs 41.8 ±8.9, p<0.001), and made approximately half the number of technical errors when compared to the individual group (12.9 ± 8.3 vs 25.6 ± 6.1, p=0.001).

Training surgeons and scrub nurses together improved the acquisition of procedural and non-technical skills and resulted in faster simulated hip replacement surgery. Team training has previously been used in the emergency setting and for some endoscopic procedures. The present study is the first to demonstrate the importance of team-based training for complex open surgery. This method can improve the safety, effectiveness, and efficiency of these procedures. Further, this is the first study which demonstrates that virtual reality facilitates team-based training in a reproducible, safe, accessible, and measurable way.

B) Problems Encountered and Steps Taken to Overcome Them

Challenges to this study were two-fold:

1) Developing a novel virtual reality platform for team-training for hip replacement surgery – this platform did not exist prior to this study. Challenges involved working with an industrial partner to work remotely and collaboratively to communicate the workings of hip surgery, the operating room environment, and the dynamics of the scrub nurse/surgeon relationship in the choreography of surgery. This required a cognitive task analysis approach to break down the procedure and responsibilities in great detail and translate this knowledge to software engineers in lay language. The platform underwent exhaustive testing to ensure the educational impact and relevance, as well as finding and fixing software bugs to allow a seamless implementation in this study's randomised controlled trial.
2) Recruiting and delivering this study during the COVID-19 pandemic – national restrictions and the diversion of healthcare staff to assist in helping patients with COVID-19 initially limited our ability to recruit nurses and training surgeons. This improved with time, but also meant that we recruited some senior undergraduate medical students to be in the 'scrub nurse' role. We also created 'COVID-safe' protocols for when participants did attend our VR laboratory for training and ensured that these were vetted by Imperial College London prior to starting.

C) Collaborations Established

This project strengthened our collaborations with industry (Pixelmolkerei, Switzerland and Depuy Synthes Johnson & Johnson, Switzerland), as well as beginning new relationships with scrub nurse training programs in universities around London. This has resulted in ease of recruitment to future studies, and the integration of VR training into King's College London's nursing curriculum – planned for Summer 2022.

D) Publications and Presentations

First Prize for Oral Presentation at the Liverpool 7th Annual Research Conference, Adaptability in Medicine: Healthcare for the 21st Century and Beyond - **First Prize** for Oral Presentation at the Liverpool 7th Annual Research Conference, Adaptability in Medicine: Healthcare for the 21st Century and Beyond
Issued by Liverpool Research Society - National Student Research Conference · Feb 2022

Oral Presentation: "A Randomised Controlled Trial Comparing Multiplayer and Single Player Immersive Virtual Reality Training for Anterior Approach Total Hip Arthroplasty Surgery" - Oral Presentation: "A Randomised Controlled Trial Comparing Multiplayer and Single Player Immersive Virtual Reality Training for Anterior Approach Total Hip Arthroplasty Surgery"
Issued by BOMSA · Feb 2022

First Prize at the High Yield Poster Competition of the Imperial College London Surgical

Society International Conference of Trauma Medicine - **First Prize** at the High Yield Poster Competition of the Imperial College London Surgical Society International Conference of Trauma Medicine
Issued by Imperial College London Surgical Society · Nov 2021

Poster Presentation: "A Randomised Controlled Trial Comparing Multiplayer and Single Player Immersive Virtual Reality Training for Anterior Approach Total Hip Arthroplasty Surgery" - Poster Presentation: "A Randomised Controlled Trial Comparing Multiplayer and Single Player Immersive Virtual Reality Training for Anterior Approach Total Hip Arthroplasty Surgery"
Issued by GIANT Health · Nov 2021

Poster Presentation: "A Randomised Controlled Trial Comparing Multiplayer and Single Player Immersive Virtual Reality Training for Anterior Approach Total Hip Arthroplasty Surgery"Poster Presentation: "A Randomised Controlled Trial Comparing Multiplayer and Single Player Immersive Virtual Reality Training for Anterior Approach Total Hip Arthroplasty Surgery"
Issued by British Orthopaedic Research Society · Sep 2021

Poster Presentation: "Who learns best: The tortoise or the hare? A randomised controlled trial of spaced practice versus intense training in immersive virtual reality" - Poster Presentation: "Who learns best: The tortoise or the hare? A randomised controlled trial of spaced practice versus intense training in immersive virtual reality"
Issued by British Orthopaedic Association · Sep 2021

Surgical teams who train together in virtual reality out-perform those who train individually: A randomised controlled trial for learning anterior approach total hip arthroplasty
Thomas C Edwards, J P Cobb, K Logishetty
Issued by Royal Society of Medicine, UK · Feb 2022

This study's report has been submitted for consideration for publication to JAMA Surgery. During the same period, our group performed a study for scrub nurse training for complex total knee replacements. The publication is:

Edwards TC, Patel A, Szyszka B, Coombs AW, Liddle AD, Kucheria R, Cobb JP, Logishetty K. Immersive virtual reality enables technical skill acquisition for scrub nurses in complex revision total knee arthroplasty. Arch Orthop Trauma Surg. 2021 Dec;141(12):2313-2321. doi: 10.1007/s00402-021-04050-4. Epub 2021 Jul 28. PMID: 34319473; PMCID: PMC8317146.

E) Acknowledgments

ASME and FST.

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