Evidence Brief: Virtual, augmented, and extended reality

Contents

Produced by the Knowledge Management team Evidence Briefs offer an overview of the published reports, research, and evidence on a workforce-related topic.

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Key publications – the big picture

The Digital, Data and Technology Playbook
UK Government, June 2023
This document sets out key policies and guidance for how digital projects and programmes are assessed, procured and delivered.

Shaping the future of digital technology in health and social care
The King's Fund, April 2021
The potential of digital technology to transform the health and social care system has still not been realised, though the Covid-19 pandemic has caused a rapid shift towards the remote delivery of care through online technologies.

Building our future digital workforce
Health Education England (no date)
Key to our work is establishing a workforce planning model for our health informatics workforce – those who work in data, digital, technology and knowledge - so we can understand both our current workforce, the demand for our future workforce and to develop a comprehensive plan to bridge the gaps.

Digitally-enabled primary and outpatient care will go mainstream across the NHS
NHS Long Term Plan, 2019
Digital technology will provide convenient ways for patients to access advice and care. For patients and staff the starting point is interoperability of data and systems, as set out in Chapter Five. Then, building on progress already made on digitising appointments and prescriptions, a digital NHS 'front door' through the NHS App will provide advice, check symptoms and connect people with healthcare professionals – including through telephone and video consultations.

The Topol Review: Preparing the healthcare workforce to deliver the digital future
Health Education England, February 2019
The Topol Review outlined recommendations to ensure the NHS is the world leader in using digital technologies to benefit patients. It will involve implementing technologies such as genomics, digital medicine, artificial intelligence and robotics at a faster pace and on a greater scale than anywhere else in the world.

Case Studies

Reducing the use of restrictive practices on psychiatric wards through virtual reality immersive technology training
World Journal of Psychiatry 14 (10), October 2024
This study explores the feasibility and effectiveness of a virtual reality (VR) platform for reducing restrictive practices in psychiatric care. Conducted at Southern Health National Health Service Foundation Trust, United Kingdom, the study used VR scenarios for training staff in three inpatient psychiatric wards. Various outcome measures like the general self-efficacy scale, generalised anxiety disorder assessment, and others were used. Results indicated high statistical significance for some variables, although some showed lower statistical power. The VR platform, evaluated using the System Usability Scale, was found to be highly usable. No significant differences in confidence levels were observed between the VR and treatment as usual groups, indicating the potential of VR as an effective tool for training in reducing restrictive practices.

Virtual Reality for Anatomy and Surgical Teaching Abstract only*
Advances in Experimental Medicine and Biology 1397, December 2022
At all levels of training, undergraduate through to postgraduate specialty-based training, conventional methods of learning anatomy have had to be adapted due to difficulties encountered during the pandemic. The importance of hands-on cadaveric anatomy experience in surgical training cannot be understated. The decline in face-to-face sessions, as well as a reduction in bedside training due to the prioritisation of service provision and diminishing time spent in theatre have meant less exposure for trainees when it comes to learning procedural skills. Virtual Reality in Medicine and Surgery, a free for trainee resource utilising virtual reality technology, delivered 51-week courses with the aim to ensure high-quality training still occurred.

Virtual Reality combined with Robotic facilitated movements for pain management and sensory stimulation of the upper limb following a Brachial Plexus injury: A case study
2022 International Conference on Rehabilitation Robotics (ICORR), July 2022
The case study is presented with long standing complex combination of phantom limb and neuropathic pain. A decrease in perceived levels of pain was reported which amounts to a 50% reduction in pain from baseline and an improved range of motion.

Innovations in Practice: Avatar-based virtual reality in CAMHS talking therapy: two exploratory case studies
Child and Adolescent Mental Health 24 (3), September 2019
The two young people felt ProReal was highly accessible, with both young people positively describing how ProReal helped them externalize their inner worlds to help them to reappraise their thoughts, feelings and experiences. They also reported ProReal being a helpful tool to facilitate communication with the clinician.

Innovative use of virtual reality in autism spectrum disorder: A case-study
Applied Neuropsychology: Child 10 (1), May 2019
According to this experience, the use of VR in addition to CBT could be a useful and promising tool to improve cognitive function in individuals severely affected by ASD.

The Star for workforce redesign

More resources and tools are available by searching for ‘technology’ or ‘virtual reality’ in the Star

National Data Programme

Workforce, Training and Education staff can look at the National Data Warehouse (NDL) SharePoint site to find out more about datasets and Tableau products.

Published Peer Reviewed Research

Leadership and strategy

Digital Competence among Healthcare Leaders: A Mixed-Methods Systematic Review
Journal of Nursing Management 1, July 2024
This review suggests that developing and supporting healthcare leaders’ digital competencies should be considered in healthcare organizations, research, and education to make their digital

competencies meet the demands of increasingly digitalising healthcare development work.

Immersive virtual reality to promote leadership among health professions students Abstract only*
Journal of Medical Imaging and Radiation Sciences 54 (1), March 2023
Leadership has been widely recognized as contributing to the delivery of high-quality healthcare. Leadership is an important aspect of practice, essential across all health professions including but not limited to medicine, nursing, radiation sciences and allied health. While leadership is often associated with formal leadership roles and positions (e.g., directors and managers), leadership skills are equally important for point of care providers.

Future of Precision Healthcare
In: Precision Health and Artificial Intelligence, January 2023
Now that data and technology are readily available and affordable, improvements in diagnostics and support are enabling better patient management. The quantity and complexity of data reflect a patient's genetics, environment, and lifestyle.

Leadership in the context of digital health services: A concept analysis
Journal of Nursing Management 30 (7), August 2022
Leadership attributes concerned leaders' behaviour, roles and qualities. Antecedents concerned informatics skills and competence, information and tools, understanding care systems and their complexity and education. Consequences related to organization, professionals and patient and care.

Virtual Reality as an Emerging Methodology for Leadership Assessment and Training
Frontiers in Psychology 9, September 2018
By seamlessly embedding assessment methods into virtual learning environments, VR can provide objective assessment methods with high ecological validity. VR also holds unlimited opportunities for leadership training providing subjects with intelligent tutoring systems that adapts situations in real time according to the observed behaviors.

Virtual reality: implementation and effectiveness

VR supported rehabilitation and wellbeing

Virtual reality in specialist palliative care: a feasibility study to enable clinical practice adoption
BMJ Supportive & Palliative Care 14(1), February 2024
Our paper highlights a number of practical questions to support organisations considering use of VR in palliative care. Although the clinical use of VR in palliative care appears feasible and safe, further evidence of its benefit, effectiveness and practicality are required before recommendations can be made about its usefulness. Further research is needed to examine whether VR can effectively improve symptom management in palliative care and to ensure its use is practical, meaningful and evidence based.

Integrating a virtual reality relaxation clinic within acute psychiatric services: A pilot study
Psychiatry Research 329, November 2023
Patients reported that virtual reality relaxation sessions were enjoyable, relaxing, and helpful, and made them feel less stressed and anxious. Virtual reality relaxation sessions for patients appear to have potential to reduce violent incidents and restrictive practices on psychiatric wards. Therapists had a

positive experience facilitating VR relaxation sessions for patients but highlighted important clinical, technological, and practical challenges, emphasising the importance of their training and supervision needs.

Feasibility of a virtual reality intervention targeting distress and anxiety symptoms in patients with primary brain tumors: Interim analysis of a phase 2 clinical trial
Journal of Neuro-oncology 162 (1), March 2023
This interim analysis confirmed feasibility and acceptability of a novel VR intervention to target psychological symptoms for PBT patients. Trial enrollment will continue to assess for intervention efficacy.

Virtual reality relaxation for people with mental health conditions: a systematic review
Social Psychiatry and Psychiatric Epidemiology, January 2023
VR relaxation has potential as a low-intensity intervention to promote relaxation and reduce stress for adults with mental health conditions, especially anxiety and stress-related problems. Further research is warranted on this promising intervention.

A Safe Place to Learn: Peer Research Qualitative Investigation of gameChange Virtual Reality Therapy
JMIR Serious Games 11, January 2023
Automated VR can provide a therapeutic simulation that allows people diagnosed with psychosis to learn and embed new ways of responding to the situations that challenge them. An important process in anxiety reduction is enabling the presentation of stimuli that induce the original anxious fears yet allow for learning of safety.

Automatic Detection of Cognitive Impairment with Virtual Reality
Sensors 23 (2), January 2023
Cognitive impairment features in neuropsychiatric conditions and when undiagnosed can have a severe impact on the affected individual's safety and ability to perform daily tasks. Virtual Reality (VR) systems are increasingly being explored for the recognition, diagnosis and treatment of cognitive impairment.

Virtual reality in post-stroke neurorehabilitation – a systematic review and meta-analysis
Topics in Stroke Rehabilitation 30 (1), 2023
This review supports that stroke rehabilitation programs incorporating virtual reality are associated with improved functional outcomes, but there is no statistically significant difference compared to standard therapy.

Can virtual reality technology be considered as a part of the surgical care pathway?
The Annals of The Royal College of Surgeons of England 105 (1), November 2022
The current applications of VR in relation to surgical care fall into four main categories: preoperative education, supporting mental health, postoperative pain management, and pre and postoperative patient optimisation. Future studies and validation of VR applications should be carried out so the technology can be utilised throughout the entire patient pathway as VR surgical care bundles.

Automated virtual reality therapy to treat agoraphobic avoidance and distress in patients with psychosis (gameChange): a multicentre, parallel-group, single-blind, randomised, controlled trial in England with mediation and moderation analyses
The Lancet Psychiatry 9 (5), May 2022
The moderation analysis indicated that the VR therapy particularly benefited patients with severe agoraphobic

avoidance, such as not being able to leave the home unaccompanied. gameChange VR therapy has the potential to increase the provision of effective psychological therapy for psychosis, particularly for patients who find it difficult to leave their home, visit local amenities, or use public transport.

Developing a user-informed intervention study of a virtual reality therapy for social anxiety in autistic adolescents
Design for Health 6 (1), April 2022
The aim was to develop user-informed case series, treatment, and VR design protocols for testing the intervention for the first time. Consultees indicated that the VRCBT exposure tasks ought to be self-paced, as individualizable as possible, viewable to the therapist, and provide a step towards real-life exposure. Consultees identified exposure tasks for simulating in VR: approaching and conversing with others, experiencing perceived injustice, the feeling of being the centre of attention, and situations involving novelty and/or lower predictability.

Virtual reality as a tool to promote wellbeing in the workplace
Digital Health 4 (8), March 2022
The findings of this study indicate that the administration of VR for the promotion of NHS staff wellbeing in the workplace is a potentially fruitful avenue of exploration that warrants further investigation.

Meta-analysis of Virtual Reality Based on Delaying Mild Cognitive Impairment
The Journal of Nervous and Mental Disease 210 (3), March 2022
VR can effectively improve the cognitive function of MCI patients and delay cognitive impairment, which can be further developed as a treatment to delay the development of MCI.

Automated Virtual Reality Cognitive Therapy for People With Psychosis: Protocol for a Qualitative Investigation Using Peer Research Methods
JMIR Research Protocols 10 (10), October 2021
The study, employing a peer research approach, may provide a unique insight into the experiences of anxious social avoidance in people with psychosis and its treatment using automated VR therapy. This will inform potential future implementation of VR automated therapies in mental health services.

Immersive virtual reality in children with upper limb injuries: Findings from a feasibility study
Journal of Pediatric Rehabilitation Medicine 14 (3), June 2021
Children rated the session as more enjoyable, less difficult and painful than their usual rehabilitation exercises. Findings suggested that HMD-VR was an engaging, enjoyable experience that distracted children from the pain and boredom of therapy. Also, it seemed to enhance the movement they achieved. Participants perceived it was useful for rehabilitation and adaptable to individual needs and other patient groups. Suggestions were made to increase adaptability and build in practical safeguards.

Virtual reality in hospice: improved patient well-being
BMJ Supportive & Palliative Care 11 (3), 2021
The majority of participants enjoyed the experience. Many expressed joy and delight at the process. VR holds possibilities for relieving symptoms such as pain and anxiety frequently experienced by people in hospices. Furthermore, the technology offers the capacity to reconnect with a previous sense of self and to allow respite through the capacity to transcend current reality and connect with another meaningful reality.

Virtual Reality Cognitive Therapy in Inpatient Psychiatric Wards: Protocol for a Qualitative Investigation of Staff and Patient Views Across Multiple National Health Service Sites
JMIR Research Protocols 9 (8), August 2020
Patients in psychiatric wards typically have very limited access to individual psychological therapy. Inpatients often have significant time available, and an important transition back to everyday life to prepare for—but historically, there have been few trained therapists available on wards for the delivery of evidence-based therapy. Automated virtual reality (VR) therapy may be one route to increase the provision of powerful psychological treatments in psychiatric hospitals.

Co-designing a virtual world with young people to deliver social cognition therapy in early psychosis
Early Intervention in Psychiatry, 14 (1), 2020
Twenty young service users of local mental healthcare services provided feedback on the design and delivery of the intervention. Reflecting the demographic of the sample, young people felt the virtual environment should be familiar, urban spaces, akin to therapy rooms or classrooms they have used in real-life situations rather than non-traditional therapy spaces that were initially proposed.

Meditation through virtual reality has a positive effect on the sleep of intensive care unit patients
Australian Critical Care 33 (Supplement 1), 2020
The subjective sleep quality of the experimental group was significantly higher than that of the control group. In activity tracker measurements, total sleep time and light sleep time did not differ between the two groups. However, in the experimental group, the awake time was shorter, the deep sleep time was longer, and the sleep efficiency was significantly higher than the control group.

A Virtual Reality–Supported Intervention for Pulmonary Rehabilitation of Patients With Chronic Obstructive Pulmonary Disease: Mixed Methods Study
Journal of Medical Internet Research 22 (7), July 2022
Overall, this study demonstrates how remotely supervised VR-based pulmonary rehabilitation could help to overcome current issues and limitations associated with providing this service to patients with COPD at scale.

Training the workforce using VR

Essential components and validation of multi-specialty robotic surgical training curricula: a systematic review
International Journal of Surgery 111 (4), April 2025
Essential components in robotic training curricula identified were didactic teaching, dry laboratory skills, and VR simulation. However, variability in assessment methods used and notable gaps in curricula validation remain evident. This highlights the need for standardized evidence-based development, evaluation, and reporting of robotic curricula to ensure the effective and safe adoption of robotic surgical systems.

Virtual Reality Simulation as a Tool for ENT Training: An Autoethnographic Study
Journal of Surgical Education 82 (4), April 2025
The study yielded 6 themes: About 3 themes highlight new insights: 1) VMT as a surgical learning tool, 2) overcoming technological issues, 3) and physical impacts of simulated surgery; About 3 themes support existing evidence relating to surgical skill acquisition: 4) rushing leading to inaccuracy, 5) reflections and feedback, and 6) overcoming demotivation.

Virtual Reality Versus Simulation in the Management of Trauma Based Scenarios-A Systematic Review
Health Science Reports 7(12), December 2024
VR can be useful for training and evaluation of trauma-based scenarios. It is a useful adjunct but is unlikely to replace simulation at present. More robust and replicable studies with larger sample sizes are needed to evaluate the long-term integration of virtual reality and augmented reality into the medical and surgical teaching curriculum.

The road to Net Zero: incorporating virtual reality technology to reduce the carbon footprint of medical training Abstract only*
British Journal of Anaesthesia 133 (6), December 2024
VR-based training offers the potential to reduce the carbon footprint of education by eliminating travel to and from training venues, training facility running costs, and the need for training and simulation equipment. Alongside myriad educationalists, institutions, and regulatory bodies, we recommend moving towards remote, digital learning to limit travel to educational events in an attempt to improve the carbon efficiency of the intensive care unit, and more widely throughout the healthcare ecosystem.

Virtual reality current use, facilitators and barriers to implementation in paediatric physiotherapy: cross-sectional online survey of UK paediatric physiotherapists
Disability and Rehabilitation Assistive Technology 20 (3), August 2024
This study shows that the current use of VR is limited. The findings from this study suggest that multiple factors need to be reconciled to enhance VR implementation. Specifically, therapists need to be provided with time, appropriate training, and financial and technical support. Stakeholders may also need to consider developing practical manuals to ensure therapists are implementing VR consistently and correctly.

Comparing virtual reality and simulation to teach the assessment and management of acute surgical scenarios: A pilot study
Health Science Reports 7(7), July 2024
VR benefits by allowing off-site training and improves short-term markers of confidence. Where VR prevails in aspects such as fostering independent learning and allowing immediate feedback, it lacks elements of what Simulation provides participants with, including the opportunity to practice communication skills and make clinical decisions following a more natural flow. Overall, both VR and mannequin-based simulation training methods are effective educational modalities which can be used to train junior doctors in acute surgical scenarios but present different educational benefits.

Want doctors to use VR simulation? Make it mandatory, accessible, educationally valuable, and enjoyable!
MedEdPublish 14 (8), June 2024
Recommendations from these findings include: (1) VR simulation should be mandatory but with a degree of learner autonomy; (2) sessions should be integrated into doctors' rotas as protected time; (3) more challenging scenarios ought to be created aligned with postgraduate courses, examinations, and specialty training, and (4) presented as a difficulty level system akin to gaming experiences.

Feasibility of a virtual reality course on adult tracheostomy safety skills
Anaesthesia Reports 12(1), June 2024
This technical feasibility study demonstrated that there was no difference in participant knowledge immediately after and 4 weeks following face-to-face and virtual reality courses. Virtual reality offers an immersive experience that can be delivered remotely and offers potential benefits of reducing travel and venue costs for attendees, therefore increasing the flexibility of training opportunities.

Use of augmented and virtual reality in resuscitation training: A systematic review
Resuscitation Plus 18, June 2024
Augmented and virtual reality can be used to support resuscitation training of lay people and healthcare professionals, however current evidence does not clearly demonstrate a consistent benefit when compared to other methods of basic and advanced life support training.

Virtual reality in simulation-based emergency skills training: A systematic review with a narrative synthesis
Resuscitation Plus 16, December 2023
There may be educational benefit to using VR in the context of simulation-based emergency skills training including knowledge gain and retention, skill performance, acceptability, usability, and validity. Currently, there is insufficient evidence to demonstrate clear cost-effectiveness, or direct improvement of patient or institutional outcomes, at this stage.

The range of uses of virtual reality for intensive care unit staff training: A narrative synthesis scoping review
Journal of Computer Assisted Learning 39 (3), February 2023
The findings of this review highlight that virtual reality for ICU staff training is still in the early stages of development. Notably, existing research is currently of weak methodological quality and as such, no recommendations to clinical practise can be made.

Developing an Evidence-Based Surgical Curriculum: Learning from a Randomized Controlled Trial of Surgical Rehearsal in Virtual Reality
The Journal of International Advanced Otology 19 (1), January 2023
In this study, patient-specific virtual reality rehearsal provided no additional advantage to cortical mastoidectomy performance by novice operators compared to generic practice on a virtual reality simulator. Further, virtual reality training did not improve cortical mastoidectomy performance on 3D printed bones, highlighting the impact of anatomical diversity and changing operating modalities on the acquisition of new surgical skills.

Is there a benefit for anesthesiologists of adding difficult airway scenarios for learning fiberoptic intubation skills using virtual reality training? A randomized controlled study
PLoS ONE 18 (1), January 2023
Fiberoptic intubation for a difficult airway requires significant experience. Traditionally only normal airways were available for high fidelity bronchoscopy simulators. It is not clear if training on difficult airways offers an advantage over training on normal airways. This study investigates the added value of difficult airway scenarios during virtual reality fiberoptic intubation training.

Bariatric Surgery May Benefit From New Advances in Virtual Reality as A Virtual Eco-System
Surgical Innovation 30 (5), January 2023
With the increase investment and applications of various technologies to improve patients' satisfactions and outcomes, VR will play a major role in surgical patients and more specifically in bariatric patients. This could be applied as a surgical care package that can be dedicated and personalized to the patients for the preoperative period till home recovery and long term follow up plans. This will lead to a fully virtual ecosystem in the future integrations in healthcare systems.

Impact of haptic feedback on surgical training outcomes: A Randomised Controlled Trial of haptic versus non-haptic immersive virtual reality training
Annals of Medicine and Surgery 83, November 2022
This study demonstrates better performance for an orthopaedic surgical task when using a VR-based simulation model

incorporating haptic feedback, compared to one without haptic feedback supporting the pursuit and implementation of haptics in surgical training simulation models to enhance their educational value.

Rehabilitation using virtual gaming for Hospital and hOMe-Based training for the Upper limb post Stroke (RHOMBUS II): protocol of a feasibility randomised controlled trial
BMJ Open 12 (6), June 2022
Upper limb (UL) rehabilitation is most effective early after stroke, with higher doses leading to improved outcomes. For the stroke survivor, the repetition may be monotonous. For clinicians, providing a clinically meaningful level of input can be challenging. As such, time spent engaged in UL activity among subacute stroke survivors remains inadequate. Opportunities for the stroke survivor to engage with UL rehabilitation in a safe, accessible and engaging way are essential to improving UL outcomes following stroke.

The effect of mobile virtual reality on operating room nursing education
Teaching and Learning in Nursing 17 (2), April 2022
The intervention group outperformed the control group in most surgical aseptic skills and the control group participants reported anxiety during conventional education. This result is consistent with the literature.

Comparison of a virtual reality compression-only Cardiopulmonary Resuscitation (CPR) course to the traditional course with content validation of the VR course - A randomized control pilot study
Annals of Medicine and Surgery 73, January 2022
This pilot study suggests that VR teaching could deliver CPR skills in an attractive manner, with no inferiority in acquisition of these skills compared to traditional methods. To corroborate these findings, we suggest a follow-up study with a larger sample size after adding ventilation and Automated External Defibrillator (AED) skills to the VR course with re-examination after 3-6 months to test retention of the skills.

Use of Virtual Reality to Support Rapid Upskilling of Healthcare Professionals during COVID-19 Pandemic
In: XR Case Studies. Management for Professionals, September 2021
During the first six months of the COVID-19 crisis Virti, a UK based training and development company, created, distributed, and analysed training and development support to NHS organisations across the United Kingdom and United States. This innovative and rapid response to the emerging needs of the healthcare sector has demonstrated how VR can be used to provide adaptive training at scale and pace.

Virtual Reality in Health Care: Bibliometric Analysis
JMIR Serious Games 9 (4), October-December 2021
The strongest growth in publications occurred in 2020, accounting for 29.49% of all publications so far. The most productive countries are the United States, the United Kingdom, and Spain; the most influential countries are the United States, Canada, and the United Kingdom.

Virtual reality videos used in undergraduate palliative and oncology medical teaching: results of a pilot study
BMJ Supportive & Palliative Care 9 (3), January 2021
The project has proved sufficiently popular in medical student feedback, that the VR experience is now available on YouTube and has been permanently introduced into routine teaching. Further 360-degree teaching environments have been filmed. Of note is that our 360-degree videos have been viewed in Africa,

so this format of teaching could prove valuable due to its global reach.

Reducing orthopaedic theatre exposure during the COVID-19 lockdown: does a shift towards virtual reality-based training offer a solution?
Acta Orthopaedica 92 (2), November 2020
Orthopaedic training in the United Kingdom has changed little from the Halstedian apprenticeship model of graduated responsibility, with the mantra "see one, do one, teach one". Whilst still relevant in surgical teaching, the current and ongoing disruption to surgical training secondary to the coronavirus disease 2019 (COVID-19) outbreak highlights the need for alternative methods of experiential surgical learning, which allow for the development of the knowledge, skills, and attitudes of orthopaedic surgeons, to be sought.

Virtual Reality and Physical Models in Undergraduate Orthopaedic Education: A Modified Randomised Crossover Trial
Orthopedic Research and Reviews 11 (12), August 2020
Both VR and physical models represent valuable educational adjuncts for the undergraduate medical curriculum. Both have demonstrated improvements in immediate and long-term knowledge retention of key orthopaedic concepts.

Development of a structured virtual reality curriculum for laparoscopic appendicectomy
The American Journal of Surgery 219 (4), April 2020
Many of the LAP Mentor basic psychomotor skills tasks and all component tasks of the laparoscopic appendicectomy module are able to distinguish novices from experts. Our analysis has informed the evidence-based construction of a novel VR curriculum for laparoscopic appendicectomy.

Virtually Competent: A Comparative Analysis of Virtual Reality and Dry-Lab Robotic Simulation Training
Journal of Endourology 34 (3), March 2020
Both VR and dry-lab simulation were effective in improving robotic surgical skill but were not equal. For more advanced skill training, dry-lab training was found to be superior to VR simulation. Dry-lab training offers specific benefits to robotic surgical training and should remain a principal component of the simulation curriculum.

Virtual reality training improves trainee performance in total hip arthroplasty: a randomized controlled trial
The Bone & Joint Journal 101-B (12), December 2019
Procedural knowledge and psychomotor skills for THA learned in VR were transferred to cadaveric performance. Basic preparatory materials had limited value for trainees learning a new technique. VR training advanced trainees further up the learning curve, enabling highly precise component orientation and more efficient surgery. VR could augment traditional surgical training to improve how surgeons learn complex open procedures.

Effect of Face-to-Face vs Virtual Reality Training on Cardiopulmonary Resuscitation Quality: A Randomized Clinical Trial
JAMA Cardiology 5 (3), November 2019
In this randomized noninferiority trial, VR training resulted in comparable chest compression rate but inferior compression depth compared with face-to-face training. Given the potential of VR training to reach a larger target population, further development is needed to achieve the compression depth and overall CPR skills acquired by face-to-face training.

Use of a Virtual Reality Device for Basic Life Support Training
Simulation in Healthcare 14 (5), October 2019 Our study suggests that virtual reality is an enjoyable method by which to teach basic life support. Although concerns over the accuracy of the tracking system and the small sample size weaken our conclusions regarding its ability to assess performance, our exploratory data are of value to educators, researchers, and policy makers.

Prospective Cohort Study of Haptic Virtual Reality Laparoscopic Appendicectomy Learning Curve Trajectory
Journal of Laparoendoscopic & Advanced Surgical Techniques 29 (9), September 2019
Learning curve trajectory can be measured, influenced, and accelerated significantly; a pronounced left-shift effect, with translational potential for enhanced shorter training time and improved patient safety.

Performance on a Virtual Reality DHS Simulator Correlates with Performance in the Operating Theatre
Surgical Technology International, July 2018
There is no significant difference between performance on a VR DHS simulator and the operating theatre. This suggests that the simulator is excellent for training in this component of the DHS procedure, but further work is needed to assess whether training on the simulator can improve performance in the operating theatre.

The Validation of a Novel Robot-Assisted Radical Prostatectomy Virtual Reality Module
Journal of Surgical Education 75 (3), May–June 2018
Surgeons found this full procedural VR training module to be a realistic, feasible and acceptable component for a robotic surgical training programme. Construct validity was proven between expert and novice surgeons. Novice surgeons have shown a significant learning curve over 5.5 hours of training, suggesting this module could be used in a surgical curriculum for acquisition of technical skills.

Effectiveness of Immersive Virtual Reality in Surgical Training – A Randomized Control Trial
Journal of Oral and Maxillofacial Surgery 76 (5), May 2018
The study group participants showed significantly greater perceived self-confidence levels compared with those in the control group ($P = .034$; $\alpha = 0.05$). Novices in the first year of their training showed the greatest improvement in their confidence compared with those in their second and third year.

Augmented reality: implementation and effectiveness

AR supported rehabilitation and wellbeing

Uses of augmented reality in surgical consent and patient education - A systematic review
PLOS Digital Health 4(4), April 2025
The evidence presented suggests patients tend to prefer information regarding their condition and surgery using AR enhanced resources and their understanding may be improved as a result.

Augmented reality and radiology: visual enhancement or monopolized mirage
BJR Open 6 (1), January 2024
AR shows great potential in radiology, especially with intervention and education. Further work on tracking and registration is required. Research and development costs can be prohibitive and risk monopolization, but providing a reliable consumer base and increasing collaboration radiology can safeguard against this.

3D Virtual Models and Augmented Reality for Robot-Assisted Partial Nephrectomy
In: Robotic Surgery for Renal Cancer. Management of Urology, January 2023
In this chapter we will explore the universe of 3D guided surgery, starting from the realization of the 3D models to their application in surgical planning and navigation.

Augmented reality can improve accuracy in identifying botulinum toxin injection sites
European Medical Journal 6 (1), January 2022
Facial botulinum toxin injection is a skill developed with experience. Inaccurate injections of the toxin can cause local complications as well as patient distress. Trainees typically learn to perform facial injections following detailed study of medical anatomy diagrams. However, anatomy diagram depictions of a 'standard' face may not be generalisable to the varied facial anatomy of real patients. Augmented reality (AR) technology may provide a more individualised approach.

Running App "Zombies, Run!" Users' Engagement with Physical Activity: A Qualitative Study
Games for Health Journal 10 (6), December 2021
This study identified a number of factors that users found attractive in an AR running exergame, particularly narrative. Our findings suggest that ZR may engage people in exercise by modifying their perception of PA through a story line or narrative, dissociating the players from the effort of exertion. AR narrative-based apps may be an effective way of engaging people with health-related behaviors or habit-forming activities.

The Acceptability and Impact of the Xploro Digital Therapeutic Platform to Inform and Prepare Children for Planned Procedures in a Hospital: Before and After Evaluation Study
Journal of Medical Internet Research 22 (8), August 2020
This study has shown that the DTx platform, Xploro, has a positive impact on children attending a hospital for a procedure by reducing levels of procedural anxiety. The children and parents in the intervention group described Xploro as improving their experiences and being easy and fun to use.

Training the workforce using AR

Exploring the Use of an Augmented Reality Device Learning Tool for Multidisciplinary Staff Training on Domestic Abuse and Sexual Violence: Postintervention Qualitative Evaluation
JMIR Formative Research 9, March 2025
Thematic analysis described the [device] as a "realistic," "adjustable" tool that "creates a safe learning environment." Participants suggested it could be useful in "pre-exposure preparation" by "improving communication" and allowing different approaches to be trialed in a safe environment. The use of survivor scripts was described as a useful tool to "bring the survivor into the learning space" in a safe way. Participants identified the HP as a suitable tool for workers inside and outside health care, including social sectors such as law enforcement (32%).

Extended and augmented reality in vascular surgery: Opportunities and challenges
Seminars in Vascular Surgery 37 (3), September 2024
Extended reality has brought new opportunities for medical imaging visualization and analysis. Various applications have been proposed for surgical practice, as well as education and training. The aim of this review was to summarize current applications of extended reality and augmented reality in

vascular surgery, highlighting potential benefits, pitfalls, limitations, and perspectives on improvement.

Augmented Reality in Medical Education: A Mixed Methods Feasibility Study
Cureus 15 (3), March 2023
The purpose of this mixed-methods feasibility study was to evaluate the applicability and acceptability of AR in undergraduate and early postgraduate medical education. Thematic analysis revealed four key themes: visual conceptualization for learning, accessibility, varied immersion, and future application. Remote simulation for the management of airways in critical care was found to be acceptable and afforded a high level of enjoyment and value.

The Integration of Smart Goggles into Perianesthesia Nursing Practice
Journal of Perianesthesia Nursing 38 (10, February 2023
The benefits of transforming something practical that nurses and other healthcare workers use regularly, like goggles, is that the innovative aspects can potentially be more easily integrated into existing practice. A hands-free tool that can enhance a nurse's perception can also promote greater awareness of patient safety issues, particularly if a nurse is handling multiple patients at once.

Use of augmented reality in surgical simulation training during covid-19
BMJ 376, January 2022
Covid allowed us to run remote supervised operative sessions with a high fidelity surgical training platform. The laparoscopic simulator used a native application and a cloud based learning system. This augmented reality solution allowed us to increase accessibility by minimising cost while improving ability, building muscle memory and technical skill.

The web of clinical data, bioengineering, augmented reality and robotic in vascular surgery
Frontiers in Surgery 9, October 2022
About augmented reality, recently, this technology has been successfully helping surgeons during image-guided integration of surgical navigation with virtual planning simultaneously with the real patient anatomy.

Augmented Reality–Assisted Design of Local Flaps: A New Practical and Educational Tool in the Field of Plastic Surgery
Annals of Plastic Surgery 89 (4), October 2022
In this article, we describe the utilization of AR to design effectively and accurately surgical flap markings just with the help of an AR-compatible mobile phone and a low-cost application. We believe that, due to its ease of use, AR will play a pivotal role to the education and the training in the field of plastic surgery and burns, and other surgical specialties alike.

Augmented Reality and Plastic Surgery Training: A Qualitative Study
Cureus 13 (10) October 2021
Though this study includes a small sample size, its findings suggest that AR platforms may offer a uniquely interactive remote educational experience in surgical training. Strategies and suggestions for its use are discussed, as well as broader considerations in using technology in surgical education.

Undergraduate surgical education during COVID-19: could augmented reality provide a solution?
British Journal of Surgery 108 (3), March 2021
AR provides a live representation of a real-world environment into which additional computer-generated elements are integrated. To maximize student learning opportunities, the mixed reality optical display capabilities of the Hololens headset

were used to supplement a ‘surgeon’s-eye’ live feed with additional imaging, clinical videos, and anatomical diagrams.

The Use of Augmented Reality to Raise Awareness of the Differences Between Osteoarthritis and Rheumatoid Arthritis
In: Biomedical Visualisation. Advances in Experimental Medicine and Biology, vol. 1262, July 2020
In total 11 adult participants tested the application taking part in a pretest and posttest which aim to measure the usability of the application and the acquisition of knowledge on OA and RA. A T-test was performed to assess the effectiveness of the application from the pretest and posttest questionnaire outcomes. Overall results were encouraging reporting a very significant acquisition of knowledge and a highly satisfactory user experience.

Evaluation of Child-Friendly Augmented Reality Tool for Patient-Centered Education in Radiology and Bone Reconstruction
In: Biomedical Visualisation. Advances in Experimental Medicine and Biology, vol. 1171, December 2019
This study shows the great potential of using digital technologies, and more particularly augmented information, in engaging future generations in science from a young age. Creation of educational materials using digital technologies, and evaluating its effectiveness, highlights the great scope novel technology could have in anatomical education and training.

Training and Transfer Effect of FluoroSim, an Augmented Reality Fluoroscopic Simulator for Dynamic Hip Screw Guidewire Insertion: A Single-Blinded Randomized Controlled Trial
The Journal of Bone and Joint Surgery 101 (17), September 2019
FluoroSim has demonstrated validity and training effect. It has the potential to be approved for possible use on patients in the operating room to help surgeons with the operation.

Consequently, operating time, accuracy of TAD, and surgical outcomes may all be improved.

Mixed or extended reality (XR)

Extended Reality-Enhanced Mental Health Consultation Training: Quantitative Evaluation Study
JMIR Medical Education 11, April 2025
Our findings show, for the first time, that XR can be used to provide an effective, standardized, and reproducible tool for trainees to develop their mental health consultation skills. We suggest that XR could provide a solution to overcoming the current resource challenges associated with equipping current and future health care professionals, which are likely to be exacerbated by workforce expansion plans.

A novel training session: mixed reality evisceration surgery webinar
Eye 39(2), October 2024
This study has demonstrated that utilisation of mixed reality with conventional teaching methods can provide a useful initial learning experience which may facilitate effective further learning of the evisceration surgery in a wet-lab or patient setting.

Effect of Mixed Reality on Delivery of Emergency Medical Care in a Simulated Environment: A Pilot Randomized Crossover Trial
JAMA Network Open 6 (8), August 2023
This study found that the use of MR technology reduced error, improved teamwork, and enhanced practitioner confidence when used to support the delivery of simulated emergency medical care.

The impact of extended reality on surgery: a scoping review
International Orthopaedics 47, January 2023
The growth of XR-assisted surgery is driven by advances in hardware and software. Whilst augmented virtuality and mixed reality are underexplored, the use of VR is growing especially in the fields of surgical training and pre-operative planning.

Mixed Reality Platforms in Telehealth Delivery: Scoping Review
JMIR Biomedical Engineering 8, 2023
This review constitutes a recent overview of the evolving digital AR and VR in various clinical applications using the telehealth setup. This combination of telehealth with AR, VR, and MR allows for remote facilitation of clinical expertise and further development of home-based treatment. This review explores the rapidly growing suite of technologies available to users within the digital health sector and examines the opportunities and challenges they present.

Clinical applications of extended reality
In: Extended Reality for Healthcare Systems. Recent Advances in Contemporary Research, 2023
Extended reality (XR) is a transformative healthcare technology that is still being explored and exploited to assess its true potential for the healthcare sector. Some of the established clinical applications of XR such as mental well-being, management of mental health issues, pain management, and physiotherapy and rehabilitation have been extensively covered in this chapter.

Extended reality for development of clinical skills
In: Extended Reality for Healthcare Systems. Recent Advances in Contemporary Research, 2023
Immersive technologies have changed the face of education delivery in the medical sector. Extended reality (XR) offers a range of benefits for clinical education with its ability to provide diverse environments that are free of risks and come at much lower costs. As a result, the learning experience is scalable, accessible, and cost-effective.

Economic impact of XR adoption on healthcare services
In: Extended Reality for Healthcare Systems. Recent Advances in Contemporary Research, 2023
This chapter provides insights into the “value for money” aspects of XR and the economic implications of its adoption, with case studies to support claims regarding real-world impact. The benefits of VR and cost–benefit analysis of XR adoption is spread across several verticals such as training, service delivery, and infrastructure costs to cover the different aspects of XR adoption in a comprehensive manner.

Are extended reality interventions effective in helping autistic children to enhance their social skills? A systematic review
Review Journal of Autism and Developmental Disorders 10 (4), April 2022
Five electronic databases were systematically searched and seventeen studies were identified. The majority targeted social-emotional reciprocity and were of relatively low quality. There was insufficient evidence to determine whether effects were generalisable, sustained or important to autistic people.

International Mixed Reality Immersive Experience: Approach via Surgical Grand Rounds
Journal of the American College of Surgeons 234 (1), January 2022
Almost all of the participants in the mixed reality international grand rounds felt the immersive XR experiences-allowing visualization of clinical findings, imaging, and laboratory results at the patient's bedside-were superior to a traditional grand rounds format, and that it could be a valuable tool for surgical teaching and telerounding.

Supporting laparoscopic general surgery training with digital technology: The United Kingdom and Ireland paradigm
BMC Surgery 21 (123), March 2021
This review aims to critically evaluate key issues in laparoscopic general surgical training and the digital technology such as virtual and augmented reality, telementoring and automated workflow analysis and surgical skills assessment.

Use of the HoloLens2 Mixed Reality Headset for Protecting Health Care Workers During the COVID-19 Pandemic: Prospective, Observational Evaluation
Journal of Medical Internet Research 22 (8), August 2020
The deployment of the HoloLens2 led to a 51.5% reduction in time exposed to harm for staff looking after COVID-19 patients (3.32 vs 1.63 hours/day/staff member; P=.002), and an 83.1% reduction in the amount of PPE used (178 vs 30 items/round/day; P=.02).

Educating the workforce and role development

Evaluation of a virtual placement for mental health nursing students: a pilot study Abstract only*
The Journal of Mental Health Training, Education, and Practice 18 (5), October 2023
High levels of approval of the innovation were recorded among both students and staff. Students were pleased to be taught by clinical experts, though some found it difficult to study at home and some found the hours long. High satisfaction levels may reflect the pandemic context: the placement reduced social isolation and the sense of education being interrupted. Participating students were in their final year of study, and the placement took place in the second year of the pandemic, so mutual familiarity and well-developed information technology skills may have made the innovation more acceptable.

Artificial intelligence in nursing education 1: strengths and weaknesses Abstract only*
Nursing Times 19 (10), September 2023
Sophisticated digital tools, such as ChatGPT, have surpassed previous forms of AI and are now being used by students and educators in universities worldwide. Nurse educators could use these tools to support student learning, engagement and assessment. However, there are some drawbacks of which nurse educators and students should be aware, so they understand how to use AI tools appropriately in professional practice.

The Role of Immersive Virtual Reality and Augmented Reality in Medical Communication: A Scoping Review
Journal of Patient Experience 10, June 2023
This scoping review identified a gap in literature surrounding VR/AR usage and their effects on medical communication. The body of evidence is not only small in quantity but also superficial, particularly in the case of AR. Although there is unanimously positive sentiment toward the role of immersive VR and AR in improving medical communication, it is difficult to definitively conclude that their use is viable in current clinical applications, without more robust evidence. The apparent motion sickness and reliability limitations are also hurdles to overcome before widespread clinical adoption.

Virtual Interactive Surgical Skills Classroom: A Parallel-group, Non-inferiority, Adjudicator-blinded, Randomised Controlled Trial (VIRTUAL)
Journal of Surgical Education 79 (3), May–June 2022
VCT provides greater accessibility and resource efficiency compared to FFT, with similar educational benefit. VCT has the potential to improve global availability and accessibility of surgical skills training.

Digital health must be better integrated into medical education
BMJ 376, March 2022
Digital health must be better integrated into our medical education and developed throughout the curriculum. As digital natives, medical students should be consulted on the design of digital health education, and we should push for better training within our medical schools. We must be equipped with the technological, legal, and ethical skills to prepare for a digital future and to ultimately provide the best care for our patients.

Trends in the Use of Augmented Reality, Virtual Reality, and Mixed Reality in Surgical Research: a Global Bibliometric and Visualized Analysis
Indian Journal of Surgery 84, February 2022
The trends detected in the present analysis suggest that the number of global publications pertaining to the use of AR, VR, and MR techniques in surgical research is likely to increase in the coming years. Particular attention should be paid to emerging trends in related fields including MR, extended reality, head-mounted displays, navigation, and holographic images.

Digital Teaching in Medical Education: Scientific Literature Landscape Review
JMIR Medical Education 8 (1), January-March 2022
The literature received worldwide contributions with the most productive countries being the United States and United Kingdom. Some studies have shown that digital teaching could increase learning satisfaction, knowledge gain, and even cost-effectiveness. More studies were conducted on trainees than on undergraduate students.

Virtual and Augmented Reality Applications in Medicine: Analysis of the Scientific Literature
Journal of Medical Internet Research 23 (2), February 2021
The conducted bibliometric analysis unequivocally reveals the versatile emerging applications of VR and AR in medicine. With the further maturation of the technology and improved accessibility in countries where VR and AR research is strong, we expect it to have a marked impact on clinical practice and in the life of patients.

Preparing dental students for independent practice: a scoping review of methods and trends in undergraduate clinical skills teaching in the UK and Ireland
British Dental Journal 230, January 2021
Contemporary clinical dental skills teaching produces new graduates who possess excellent theoretical knowledge, are prepared and confident in basic clinical skills, but are lacking in experience of complex treatments which may result in a reduced preparedness for independent practice.

The role of virtual reality in the changing landscape of surgical training
The Journal of Laryngology & Otology 134 (10), October 2020
In the post coronavirus disease 2019 educational landscape, virtual, augmented and mixed reality technology may prove invaluable in the training of the next generation of surgeons.

Workforce and service user perspectives

Carers and professionals' views on using virtual reality in dementia care: A qualitative study
Dementia 24 (1), August 2024
Overall, participants had a positive attitude toward VR and made several suggestions for its future use to enable enjoyable and immersive experiences. Examples included suggestions to

personalise VR content to accommodate heterogenous profiles and stages of dementia, co-developing protocols to address health risks and side effects and further investigating shared experiences of VR with caregivers.

Public attitudes towards the use of novel technologies in their future healthcare: a UK survey
BMC Medical Informatics and Decision Making 23 (1), February 2023
This study examined UK public attitudes and opinions towards NHTs being used to address common chronic conditions. Responses suggest that the UK public is generally open to technological innovation in their future care but acceptability of a specific NHT is likely to vary.

Involving autism stakeholders in identifying priorities for interventions based on augmented reality
Disability and Rehabilitation: Assistive Technology 19 (3), September 2022
This study used qualitative evidence and thematic analysis to identify the main design guidelines. A semi-structured interview was administered to a total of twenty participants representing four stakeholder categories: ASD, clinicians, therapists and caregivers. Interviews focussed on three dimensions related to user, technology and environment since they represent a complex system within which the individual using technology is situated.

Assessing the attitude of surgical trainees towards virtual reality simulation: A national cross-sectional questionnaire study
Scottish Medical Journal 67 (3), May 2022
Virtual reality surgical simulation in surgical training is beginning to emerge as a genuine high-fidelity, low-risk solution to the lack of surgical case volume trainees are currently experiencing. The survey was disseminated within the United Kingdom through social media and email correspondence, in co-operation with national surgical organisations. 91 trainees responded from a variety of clinical specialities.

Younger Adolescents' Perceptions of Physical Activity, Exergaming, and Virtual Reality: Qualitative Intervention Development Study
JMIR Serious Games 7 (2), April-June 2019
Key elements that should be incorporated into a VR game for health intervention were identified and described. These also included the use of rewards, novelty and enjoyment in immersive game play, multiplayer options, and real-world elements, as well as continual updates and new challenge levels. The use of VR to promote PA in adolescents is promising, but some barriers were raised.

Diversity, inclusion, and ethics

Implementing a virtual reality-based intervention to support the wellbeing of mental health staff in the workplace: A mixed-methods pilot study
Journal of Workplace Behavioral Health 1-15, July 2024
Participants were enthusiastic about increasing access to the intervention. A small minority highlighted implementation issues, including headset comfort and difficulty adjusting psychologically to VR. Findings indicate that the VR intervention was feasible and acceptable to support the wellbeing of mental health staff in the workplace.

Virtual reality relaxation for mental health staff in complex care services: A feasibility and acceptability study
Mental Health and Prevention 33, March 2024
This study provides support for the growing body of evidence that VR relaxation is helpful and beneficial for the wellbeing of staff in the workplace, especially healthcare professionals and

other key workers who have highly stressful jobs. The positive findings indicate that there is scope to increase the availability of VR-based staff support interventions in mental health settings.

Virtual reality and immersive technologies to promote workplace wellbeing: a systematic review
Journal of Mental Health 33 (2), March 2023
Although methodological limitations mean caution should be taken when generalising findings to broader worker-populations or technologies, this review provides optimism for the use of immersive technologies, particularly VR, to promote workplace wellbeing. These technologies can be feasible, acceptable, and effective interventions that help mitigate the mental health impacts of isolating and unfamiliar working environments, and for those with highly stressful work demands.

Walk in their shoes – immersive 360-degree VR experience of diversity and inclusivity in the NHS
International Journal of Healthcare Simulation 2 (Supplement 1), 2022
Doctors within the NHS from black, Asian, and minority ethnic (BAME), and International Graduate backgrounds face differential attainment in their progression in the NHS and share differing experiences. It has been reported by the GMC that higher rates of complains against International Graduates may reflect the lack of induction and social integration within the NHS culture. Virtual Reality (VR) provides an immersive platform, with viewers able to involve themselves in realistic scenarios remotely. We utilised 360-degree VR to produce a realistic scenario on the differing experience of a BAME, International Graduated Doctor on their first day in the NHS.

Virtual reality champion debriefing training
International Journal of Healthcare Simulation 2 (Supplement 1), 2022
A full-day digital debriefing champion training was developed. This incorporated a session on VR technology, background of the TIDES project, and the importance of debriefing in patient safety and outcomes. This was followed by an introduction of a modified TALK debriefing model [2] and essential debriefing skills training. Participants watched a series of VR videos of 3 characters, focusing on discrimination occurrences for BAME staff occurring during the COVID-19 pandemic (e.g. lack of personal protective equipment availability during night shifts). The champions then participated in a demonstration of a modified TALK debriefing model, after which they practiced leading a debriefing of one of the VR videos themselves.

Co-production for service improvement: Developing a training programme for mental health professionals to enhance medication adherence in Black, Asian and Minority Ethnic Service Users
Health Expectations 22 (4), June 2019
The need to educate students rather than trained professionals was emphasized, and they suggested that educational content should be packaged in a contemporary manner (a virtual reality experience). Findings indicated that education should focus upon understanding the impact of taking prescribed antipsychotic medication on both SUs and carers.