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REMOTE CLINICAL TEACHING

THE CLINICAL TEACHER

A remote access mixed reality teaching ward round

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Abstract

Background: Heterogeneous access to clinical learning opportunities and inconsistency in teaching is a common source of dissatisfaction among medical students. This was exacerbated during the COVID-19 pandemic, with limited exposure to patients for clinical teaching.

Methods: We conducted a proof-of-concept study at a London teaching hospital using mixed reality (MR) technology (HoloLens2™) to deliver a remote access teaching ward round.

Results: Students unanimously agreed that use of this technology was enjoyable and provided teaching that was otherwise inaccessible. The majority of participants gave positive feedback on the MR (holographic) content used (n = 8 out of 11) and agreed they could interact with and have their questions answered by the clinician leading the ward round (n = 9). Quantitative and free text feedback from students, patients and faculty members demonstrated that this is a feasible, acceptable and effective method for delivery of clinical education.

Discussion: We have used this technology in a novel way to transform the delivery of medical education and enable consistent access to high-quality teaching. This can now be integrated across the curriculum and will include remote access to specialist clinics and surgery. A library of bespoke MR educational resources will be created for future generations of medical students and doctors to use on an international scale.

1 | INTRODUCTION

Centralisation of health care has resulted in many hospitals offering access to only certain clinical specialties. Since it is not feasible to rotate all medical students through each hospital, this can lead to inconsistency in clinical exposure. This was exacerbated during the COVID-19 pandemic with most institutions using online platforms to deliver education, often without exposure to real patients.[1]

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There is a broad evidence base for the application of extended reality (XR) technology in medical education including simulation-based surgical training,[2] teaching anatomy[3] and telementoring.[4]

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XR technology includes virtual reality (VR), augmented reality (AR) and mixed reality (MR). VR involves a completely digital environment. AR is a real-world environment enhanced by digital information (e.g. holograms). MR enables users to interact with spatially registered virtual holograms placed in the real environment. Multiple devices can be digitally linked allowing individuals to interact with the visualised environment simultaneously through remote telepresence.[5]

A literature review of AR and MR in health care education found that beyond live-streaming surgical operations, studies did not involve real patients in an authentic context, with only two including patient data.[6]

We believe we are the first to describe the use of MR technology (HoloLens2™) to deliver a live-streamed, remote access, interactive teaching ward round for medical students. We have evaluated the feasibility, acceptability and effectiveness of this technology for educational purposes from the perspectives of students, faculty members and patients.

2 | METHODS

In June 2020, fourth-year students at Imperial College School of Medicine participated in a teaching ward round involving HoloLens2 ™ technology. We recruited patients from a teaching hospital in London. We based the teaching on learning outcomes from the undergraduate curriculum. Participation was voluntary and we obtained consent from all participants. Ethical approval was granted by Imperial College London.

Our objectives for this study were to explore whether MR technology is:

- feasible for the delivery of an interactive teaching ward round remotely accessed by medical students
- acceptable to patients, students and faculty members
- effective for interaction between students, patients and clinicians

The HoloLens2™ is a commercially available head-mounted MR device developed by Microsoft Corporation (Redmond, WA, USA), currently costing $3500.00 (US Dollars) per headset. The headset

FIGURE 1 Clinician wearing the HoloLens2 ™ device to live stream the teaching ward round.

provides true heads-up display functionality with the ability to place interactive objects within the user's field of vision, while delivering live bidirectional audiovisual communication. Multiple users are able to interact via the Microsoft Dynamic 365 Remote Assist application, which uses Microsoft Teams, a communication platform combining chat, video, file storage and application integration. The HoloLens2™ has been used for the delivery of clinical care,[7] but thus far not for the delivery of live bedside teaching.

The ward round commenced with an introduction to HoloLens2 ™ technology, rules of engagement and learning objectives. During the ward round, the clinician wore a HoloLens2™ device (Figure 1) to live stream the clinical environment. Students were able to see and hear the patient, and interact with the clinician via voice and instant messaging. Students could ask questions, elicit clinical signs and discuss learning points. Patient-specific MR content such as radiographic images, laboratory results and medication charts placed in the user's field of view provided a multifaceted educational experience. We met information security and governance requirements for handling patient data by using an institutional Wi-Fi network and restricted user accounts protected with multifactor authentication.

The ward round lasted 1 hour, was led by a physician trained in using HoloLens2 ™ technology and involved the clinical review of two patients. The first patient consultation allowed students to take a medical history and formulate a differential diagnosis. The second patient consultation involved the interpretation of investigations (radiographic images superimposed on the students' field of vision as holograms, which they could annotate) and develop a management plan. The ward round concluded with key learning points and an opportunity for students to ask further questions.

We then asked students to provide feedback using an anonymous questionnaire consisting of Likert-type scale responses evaluating the feasibility, acceptability and effectiveness of MR technology for teaching ward rounds (Figure 2). Free text responses were included for further feedback and suggestions for improvements. Patients

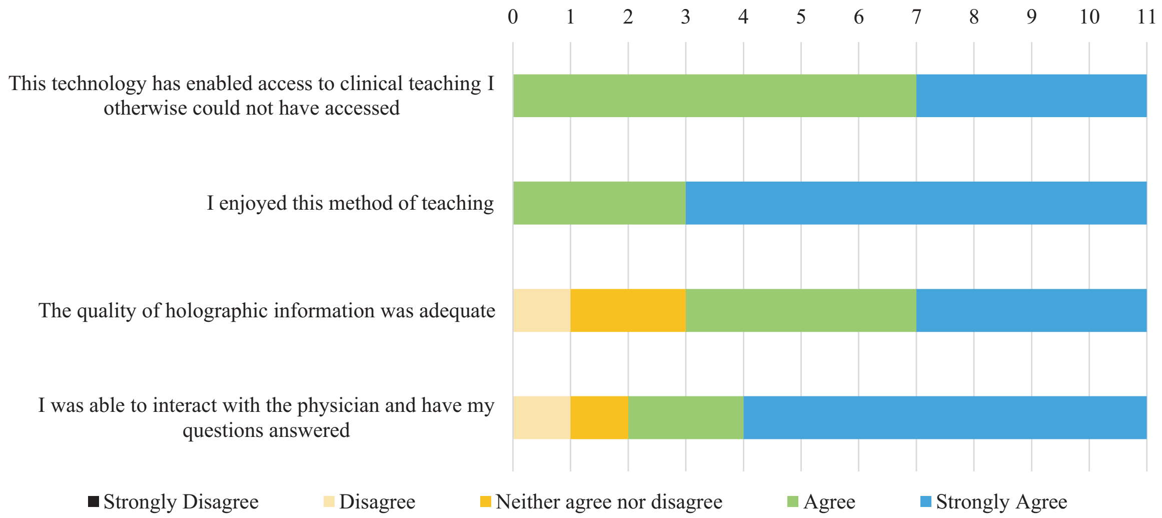

FIGURE 2 Post-Ward Round Questionnaire Percentage Responses (n = 11).

and faculty members involved also provided free text feedback regarding their experience.

3 | RESULTS

Eleven medical students (nine females and two males) and two patients (one male and one female) participated in the ward round. This was facilitated by two faculty members; a physician leading the ward round wearing the HoloLens2 TM device and another clinician running the technology. All 15 participants (students, patients and faculty members) provided feedback on the session.

3.1 | Feasibility

All students (n = 11) agreed that MR technology enabled access to clinical teaching that was otherwise not feasible secondary to the COVID-19 pandemic, and more widely, due to variable access to specialist teaching for students. Students described how the technology enabled learning from 'unique patients in other sites and wards who you would not usually have access to' and 'patients with rare diseases who we would not usually be able to see'. Faculty members commented on the ease with which multiple students could benefit from the clinical experience, which would have not been physically feasible in the usual clinical environment.

MR technology enabled access to clinical teaching that was otherwise not feasible secondary to the COVID-19 pandemic.

3.2 | Acceptability

All students agreed that they found the MR ward round to be an enjoyable learning modality. The majority (n = 8) agreed that the quality of the holographic content used in the ward round was adequate. One student disagreed and felt that 'an improvement in lighting' was required and 'the image quality was not always great'.

All students agreed that they found the MR ward round to be an enjoyable learning modality.

Students also elaborated on the benefits of remote MR ward rounds compared to traditional face to face ward rounds. They described how 'it's hard to hear or see things on normal ward rounds as there are so many people and they are so busy… it allows us to see everything on one screen'. Patients involved felt the experience was 'thoroughly enjoyable', were 'extremely happy to provide some help for doctors in training' and 'would definitely volunteer again'. The patient–physician interaction was still maintained despite the use of a headset, with one patient stating 'it felt personal and like a normal consultation' and 'I enjoyed watching you navigate with the holograms during the session'.

3.3 | Effectiveness

The majority (n = 9) of students agreed that they could interact with the clinician and have their questions answered. Students also highlighted their preference for interacting with the clinician remotely including, 'this encourages us to get involved and have a discussion which is not always possible on a normal ward round' and 'we could all contribute if we wanted to without the pressure we might get if picked on'. One student felt that the interaction with the physician was 'difficult… when multiple voices' were speaking at the same time and that 'background noise' was disruptive.

4 | DISCUSSION

This proof-of-concept study aimed to explore the application of MR technology to deliver an interactive, remote access teaching ward round. Quantitative and free text feedback from students, faculty members and patients deemed this educational innovation to be feasible, acceptable and effective. Moreover, their feedback highlighted how learning design enabled by this technology could potentially improve an existing method of teaching (i.e. the traditional ward round) and facilitate new ways of interacting between teachers, students and patients.

Learning design enabled by this technology could potentially improve an existing method of teaching.

Technology is thought to support learning in several ways, including through active group participation, frequent feedback and connection to world experts.[8] This can be linked to connectivism, the notion that connecting learners to each other enables collaborative learning.[9] Furthermore, multimedia learning theory proposes deeper learning when information is presented through multiple modalities.[10]

Ensuring students have a similar clinical experience has proven challenging in the past. We can now provide consistent and equal access to learning opportunities irrespective of where medical students are placed for their training. MR technology can also be integrated across the medical school curriculum, using holographic technology to enable access to specialist ward rounds, clinics and surgery. This may range from small group tutorials, to an entire year group of medical students. In addition, these educational opportunities could be recorded to create a library of bespoke MR resources for on-demand use on an international scale. This would further support student-centred learning by conferring the flexibility to learn anytime and anywhere, according to students' own pace.

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Limitations of this study include that it took place at the end of the academic year and therefore resulted in a small sample size of study participants (n = 11). Furthermore, while free text comments provide some insight into why students agreed or disagreed with statements in our questionnaire, formal thematic analysis of qualitative data could provide more in depth explanations and is important future work.

Some students reported difficulty interacting when multiple participants attempted to speak simultaneously. Possible solutions for this include the use of the 'raise hand' function on Microsoft Teams if someone wishes to speak. Given that this session took place in an authentic, busy clinical environment, some students also reported difficulty with 'background noise'. This can be mitigated by informing those in the area that teaching is taking place. Other improvements include ensuring better lighting and higher resolution of images to improve the quality of holographic content.

Further research is required to develop a pedagogical framework for MR teaching ward rounds and to explore the impact of this technology on student learning as compared to traditional teaching methods (e.g. in-person ward rounds).

5 | CONCLUSION

Our results support the feasibility, acceptability and effectiveness of using MR technology to deliver a remote access, interactive teaching ward round. We propose that this technology could be implemented by institutions worldwide to enable consistent and equal access to learning opportunities. Further work is required to assess the additional value MR technology brings to students' learning compared to traditional teaching methods.

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None

DECLARATION OF INTEREST

Philip Pratt is Chief Scientific Officer of Medical iSight. James Kinross and Guy Martin are on the Scientific Advisory Board of Medical iSight. The authors alone are responsible for the content of the article and no funding was received.

ETHICAL APPROVAL

Ethical approval was granted by Imperial College London on 20/05/2020 (reference number: EERP1920-069).

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