


Smartphone use in virtual student teaching and virtual ward rounds during and after the COVID-19 pandemic?

Asif Raza ^{1,2,3}, Subhabrata Mukherjee,¹ Vikash Patel,¹ Naila Kamal,⁴ Ewa Lichtarowicz-Krynska^{5,6}

► Supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bmjinnov-2020-000576>).

¹Urology, London North West University Healthcare NHS Trust, Harrow, UK

²Medicine and Surgery, Plymouth University Peninsula Schools of Medicine and Dentistry, Plymouth, UK

³Medicine and Surgery, Imperial College London Faculty of Medicine, London, UK

⁴Obstetrics and Gynaecology, London North West University Healthcare NHS Trust, Harrow, UK

⁵Paediatrics, London North West University Healthcare NHS Trust, Harrow, UK

⁶River Island Academy Centre for Paediatrics and Child Health, Imperial College London Faculty of Medicine, London, UK

Correspondence to

Professor Asif Raza, Urology, London Northwest University Healthcare NHS Trust, London, UK; asifraza@nhs.net

Received 19 October 2020

Accepted 8 May 2021

Published Online First

16 July 2021



© Author(s) (or their employer(s)) 2021. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Raza A, Mukherjee S, Patel V, et al. *BMJ Innov* 2021;**7**:614–618.

INTRODUCTION

There have been exponential increases in telemedicine,^{1,2} mobile health platforms (mhealth)^{3–5} and virtual clinics during the COVID-19 pandemic.⁶ Up to 87% of doctors routinely use their smartphones for work-related tasks.⁷

The necessity for certain patients or staff, such as higher risk Black, Asian and Minority Ethnic staff or patients, to shield or isolate during the first wave of COVID-19, highlighted limitations in communication platforms between staff, and between doctors and patients. This may have contributed to higher patient morbidity and mortality particularly in care homes.⁸ Medical student teaching also suffered due to restricted hospital access during the height of the pandemic.⁹

We describe the novel use of a smartphone using Microsoft Teams (MST) for virtual ward rounds as well as virtual student teaching and assess practicality, user friendliness and cost effectiveness of a smartphone in these settings.

METHOD

The smartphone was evaluated by staff and students, using mannequins, in mock clinical scenarios before use in patient ward rounds. The most appropriate accessories and smartphone brackets supplied with the harnesses were selected after trial and error (figure 1).

Devices were connected to staff only hospital Wi-Fi and registered on a dedicated network via Media Access Control (MAC) address and WPA2 encrypted Wi-Fi password. Device access was password protected and users could only use

Summary box

What are the new findings?

- The smartphone is the most cost effective, user friendly and practical device to deploy at scale for non-augmented reality virtual ward rounds and for teaching students compared to other currently available smart devices.
- The smartphone can be used to securely stream two-way video and audio for patient interaction including live sharing and scrolling of radiology images, letters and pathology results through the NHS approved Microsoft teams platform.
- The smartphone can be used for staff in isolation or shielding to participate in virtual ward rounds and support front line staff with clinical advice and administrative support if required. Students who are on remote sites or shielding can also continue learning.

a personal National Health Service (NHS) email address to log on to MST.

Patient bedside curtains were drawn and written consent obtained before the ward round team (WRT) initiated a live stream with the office-based team (OBT). Teachers also initiated a live stream with students during mock clinical scenarios (online supplemental figure 1).

The OBT could then share their Personal Computer (PC) screen content, for example, blood results, patient letters or simultaneously scroll through Picture Archiving and Communications System (PACS) images with the WRT (online supplemental figure 2).

Summary box

How might it impact on healthcare in the future?

- ▶ The use of a smartphone with a ward round team (WRT) and office-based team (OBT) will help improve ward round efficiency as the OBT can perform administrative and support duties whilst the ward-based team focus on direct non-administrative patient focussed care.
- ▶ Students as well as other staff being able to see Picture Archiving and Communications System (PACS) images and results streamed from the OBT while they are on ward rounds may help improve learning through real-time interaction with the OBT.
- ▶ The widespread adoption of an OBT and ward-round team model will reduce the number of staff required to be physically on the ward potentially reducing the rate of hospital acquired nosocomial infections as well as transmission of COVID-19. It will mean less staff are needed to review a patient with COVID-19 or other patients in isolation as the rest of the team can be based remotely decreasing Personal Protective Equipment (PPE) requirements and improving both patient and staff safety.

A questionnaire was completed post streaming by the device user, recipients of the stream and patients.

RESULTS

Most users found smartphones were practical for use in a ward setting due to device familiarity and good audio and video feed (online supplemental table 1).

The smartphone screen was large enough to allow a clear view of all information being streamed. The main concern for a minority of stream recipients (students and doctors) was image quality degradation by excessive device movement irrespective of whether this was hands free, hand held, chest or head mounted and occasional dropped calls due to poor network coverage.

No patients objected to being live streamed during the virtual ward round.

DISCUSSION

With increasing use of augmented reality devices such as the Microsoft HoloLens 2 in clinical settings¹⁰ and medical student teaching we wished to evaluate a HoloLens 2 for virtual ward rounds and teaching during the pandemic. Due to a long waiting list we were unable to acquire a test device. Local Trust funding was not available to purchase a HoloLens 2 at £3349 each however our Digital services teams were able to rapidly supply and deploy hospital smartphones, costing approximately £300 per handset, during the pandemic. Harnesses and attachments (£15 per set) were purchased from online retailers. The combined cost of a smartphone and harness was 90% cheaper than a HoloLens 2.

The use of personal smartphones could have significantly reduced costs further however we could not use these for the evaluation due to concerns around security breaches and patient privacy. However Microsoft advised that future roll out of the M365 platform would improve personal smartphone security through advanced Microsoft Enterprise Mobility security functionality allowing additional options of control and compliance, set by the local Trust, for personal devices use during patient care.

The development of a growing number of augmented reality apps that can be used on iPhone Operating System (IOS) or Android smartphones, including Microsoft Dynamics 365 remote tool will decrease costs further when advanced augmented reality features or a completely hands-free option with the HoloLens 2 are unnecessary.

Before being allowed to use a smartphone for virtual teaching and virtual ward rounds we had to overcome further barriers including obtaining local approval from the Digital services, Information Governance, Legal and Infection control teams.

A Data Protection Impact Assessment (DPIA) had to be submitted to and approved by Digital Services. We could only use MST to live stream as the Information Commissioner's Office (UK) who enforce General Data Protection Regulations¹¹ and NHS Digital had approved MST with 256-bit Advanced Encryption Standard for routine use by clinicians.

During patient interactions students, not able to be on a ward, were only allowed to view the live stream on a hospital PC and not their own personal smartphones. Students signed a newly created declaration that if unsupervised by staff while viewing the stream they would not record or take pictures of stream content from the hospital PC on their personal devices.

The absence of agreed guidelines between the Hospital and local University, on remote viewing of live streams by students shielding or not able to be on site, alienated an important but small group during the pandemic.

A standard operating procedure (SOP), including a bring your own device policy for staff and students, based on only using MST after signing in with personal NHS email accounts, was approved after the pilot by Digital services. An SOP including a pictorial guide on how to use the devices on MST as well as different ways of using the smartphone has been written (figure 1, online supplemental figures 1; 2) and this along with an instruction video for staff will be uploaded to the Trust Intranet to supplement written guidance and guide staff on how to perform virtual teaching or virtual ward rounds.

Concerns from the Infection Control team included spread of infection from smartphones or devices during virtual ward rounds as well as chest harness disinfection.

1



Chest mount with clip attaches to harness.

4



Side view - smartphone attached to the harness (screen should face the wearer).

2



Smartphone holder – the screw should be attached to the bottom of the phone clip and not in the middle.

5



Front view - smartphone attached to the harness (screen should face the wearer).

3



Once the phone holder is attached to the harness it should be secured with the screw shown.

6



Alternate mounts for smartphone. Chest lanyard (Left) Head mount (Right)

Figure 1 How to assemble chest harness for smartphone.

Staff smartphones can be colonised with methicillin resistant staphylococcus aureus (MRSA) and Vancomycin Resistant Enterococcus (VRE).^{12–14} However, smartphone and tablet touchscreens are associated with lower infection levels than standard touchpad keyboards in hospitals.¹⁵ Decontamination methods include antibacterial screens (silver coated), alcohol-based wipes (70% isopropyl alcohol), Clinell wipes and Ultraviolet light.^{16–18} Harnesses were worn under sterile gowns to minimise exposure to contaminants but must be cleaned after use as per Trust local guidelines.

Despite the risk of device contamination, performing virtual ward rounds and reducing non-essential staff numbers on wards may reduce nosocomial infection risk including COVID-19 transmission. Up to 1.4 million patients are affected annually by non-COVID-19 hospital acquired nosocomial infections causing increased morbidity and mortality particularly in the elderly and frail.¹⁹ Up to 20%–70% of patient files and charts harbour infection due to frequent handling by staff.^{20–22} COVID-19 spreads by droplet transmission, poor hand hygiene and contact between staff and patients²³ and up to 80% of staff may be asymptomatic carriers of COVID-19²⁴ risking nosocomial spread from staff to patients.^{25–28}

Virtual ward rounds using a double telepresence robot (iPad on a trolley),²⁹ Microsoft HoloLens 2¹⁰ and laptops carried onto the ward.³⁰ have reduced staff numbers required on wards. The adoption of an office-based medical team (OBT) and WRT, in our practice, reduced ward round staff numbers by 50%.

Other benefits include students being able to see PACS images and results streamed from the OBT, while they are on ward rounds, which may aid learning through real-time interaction with the OBT (figure 1). The use of smartphones and chest harnesses allows the device wearer to carry out tasks or examinations while simultaneously streaming to the OBT or students and possibly reduce nosocomial infection rates due to less crowding of students and staff around often limited desktop workspaces on wards and offices.

Limitations in our study included the inability to save patient interactions which could be used as part of patient records or as future teaching resources, small number of study participants, use of older model hospital sim-free smartphones with lower screen resolution, smaller screen size and shorter battery life than current models.

Network coverage was patchy in parts of the hospital leading to poor streaming quality and occasional dropped calls. Our local trust was conducting a network survey during the study with plans to install multiple wireless access points in areas with poor network coverage.

Further research is required on whether virtual ward rounds will improve ward round efficiency, allow better experiential learning for junior staff performing ward rounds without Consultants being physically

present, better student teaching and whether the adoption of office and WRTs using a smartphone for secure streaming will reduce the risk of nosocomial infection transmission.

CONCLUSION

The smartphone is the cheapest, most user friendly and simplest device to deploy at scale in a health-care setting. It will allow students and staff in remote sites, isolating or shielding to continue to learn and participate in patient care. Smarter use of smartphones during and after the COVID-19 pandemic may help reduce morbidity and mortality by reducing nosocomial infections.

However for the benefits to be realised clinician engagement of a new model of remote based virtual teaching and management of patients is essential.

Twitter Asif Raza @ar_urology

Acknowledgements Mr Conrad Jaggwe Technical Lead and Facilities officer, Postgraduate Medical Education Dept, London Northwest Healthcare University NHS Trust for his technical assistance when using smartphones in a teaching simulation room, the Digital services team for providing the smartphones for evaluation, the Education fellows, Urology trainees and Medical students who assisted in testing and assessing devices during mock and real-life patient interactions, Miss Carmela Popanes (Urology Nurse Specialist) as well as the patients who participated.

Contributors AR devised the original idea for the study, devised and wrote the protocol, researched data for the article, wrote the article and led virtual ward rounds and virtual teaching. SM helped piloting virtual ward rounds and referencing for the article, VP piloted virtual ward rounds and production of figures and table. NK advised on protocol amendments. EL-K helped with protocol development and revisions, article content and virtual teaching scenarios.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval Ethics approval was obtained for the study and all participants gave informed consent.

Provenance and peer review Not commissioned; externally peer reviewed.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

ORCID iD

Asif Raza <http://orcid.org/0000-0001-7069-2792>

REFERENCES

- 1 Monaghesh E, Hajizadeh A. The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence. *BioMed Central Public Health* 2020;20:1193.

- 2 Wilson K. Mobile cell phone technology puts the future of health care in our hands. *Canadian Medical Association Journal* 2018;190:E378–9.
- 3 Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. *Pharmacy and Therapeutics* 2014;39:356–64.
- 4 Wu M, Luo J. Wearable technology applications in healthcare: a literature review. *online Journal of nursing informatics*, 2019. Available: <https://www.himss.org/resources/wearable-technology-applications-healthcare-literature-review> [Accessed 27 Sep 2020].
- 5 Yang Q, Van Stee SK. The comparative effectiveness of mobile phone interventions in improving health outcomes: meta-analytic review. *J Medical Internet Research Mhealth Uhealth* 2019;7:e11244.
- 6 Gilbert AW, Billany JCT, Adam R, *et al.* Rapid implementation of virtual clinics due to COVID-19: report and early evaluation of a quality improvement initiative. *British Medical Journal Open Quality* 2020;9:e000985.
- 7 Chase J. Healthcare Professionals: The iPad and other drugs. Medical Marketing & Media. Available: <https://www.mmm-online.com/home/channel/features/healthcare-professionals-the-ipad-and-other-drugs/> [Accessed 27 Sep 2020].
- 8 Burki T. England and Wales see 20 000 excess deaths in care homes. *Lancet* 2020;395:1602.
- 9 Remtulla R. The present and future applications of technology in adapting medical education amidst the COVID-19 pandemic. *J Medical Internet Research Medical Education* 2020;6:e20190.
- 10 Cafferkey JJ, Hampson DOP, Ross C. Using HoloLens™ to reduce staff exposure to aerosol generating procedures during a global pandemic. *medRxiv* 2020 <https://www.medrxiv.org/content/10.1101/2020.05.24.20107193v1>
- 11 McCall B. What does the GDPR mean for the medical community? *Lancet* 2018;391:1249–50.
- 12 Simmonds R, Lee D, Hayhurst E. Mobile phones as fomites for potential pathogens in hospitals: microbiome analysis reveals hidden contaminants. *J Hospital Infection* 2020;104:207–13.
- 13 Bhardwaj N, Khatri M, Bhardwaj SK, *et al.* A review on mobile phones as bacterial reservoirs in healthcare environments and potential device decontamination approaches. *Environmental Research* 2020;186:109569.
- 14 Malhotra S, Wlodarczyk J, Kuo C, *et al.* Shining a light on the pathogenicity of health care providers' mobile phones: use of a novel ultraviolet-C wave disinfection device. *American J Infect Control* 2020;48:1370–4.
- 15 Pal P, Roy A, Moore G, *et al.* Keypad mobile phones are associated with a significant increased risk of microbial contamination compared to touch screen phones. *J Infection Prevention* 2013;14:65–8.
- 16 Inagaki H, Saito A, Sugiyama H, *et al.* Rapid inactivation of SARS-CoV-2 with deep-UV led irradiation. *Emerging Microbes & Infections* 2020;9:1744–7.
- 17 Panigrahi SK, Pathak VK, Kumar MM, *et al.* Covid-19 and mobile phone hygiene in healthcare settings. *British Medical Journal Global Health* 2020;5:e002505.
- 18 Mark D, Leonard C, Breen H, *et al.* Mobile phones in clinical practice: reducing the risk of bacterial contamination. *International Journal of Clinical Practice* 2014;68:1060–4.
- 19 Luangsanatip N, Hongsuwan M, Limmathurotsakul D, *et al.* Comparative efficacy of interventions to promote hand hygiene in hospital: systematic review and network meta-analysis. *British Medical Journal* 2015;351:h3728.
- 20 Cheng VCC, Chau PH, Lee WM, *et al.* Hand-touch contact assessment of high-touch and mutual-touch surfaces among healthcare workers, patients, and visitors. *J Hosp Infect* 2015;90:220–5.
- 21 Panhotra BR, Saxena AK, Al-Mulhim AS. Contamination of patients' files in intensive care units: an indication of strict handwashing after entering case notes. *American Journal of Infection Control* 2005;33:398–401.
- 22 Teng SO, Lee WS, Ou T-Y. Bacterial contamination of patients' medical charts in a surgical ward and the intensive care unit: impact on nosocomial infections. *J Microbiology, Immunology and Infection* 2009;42:86–91.
- 23 Wong SCY, Kwong RT-S, Wu TC, *et al.* Risk of nosocomial transmission of coronavirus disease 2019: an experience in a general ward setting in Hong Kong. *J Hosp Infect* 2020;105:119–27.
- 24 Evans S, Agnew E, Vynnycky E, *et al.* The impact of testing and infection prevention and control strategies on within-hospital transmission dynamics of COVID-19 in English hospitals. *Phil. Trans. R. Soc. B* 2021;376:20200268 <https://www.medrxiv.org/content/10.1101/2020.05.12.20095562v2>
- 25 Meredith LW, Hamilton WL, Warne B, *et al.* Rapid implementation of SARS-CoV-2 sequencing to investigate cases of health-care associated COVID-19: a prospective genomic surveillance study. *Lancet Infect Dis* 2020;20:1263–71.
- 26 Arons MM, Hatfield KM, Reddy SC, *et al.* Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. *N Engl J Med Overseas Ed* 2020;382:2081–90.
- 27 Rivett L, Sridhar S, Sparkes D, *et al.* Screening of healthcare workers for SARS-CoV-2 highlights the role of asymptomatic carriage in COVID-19 transmission. *Elife* 2020;9:e58728.
- 28 Treibel TA, Manisty C, Burton M, *et al.* COVID-19: PCR screening of asymptomatic health-care workers at London Hospital. *Lancet* 2020;395:1608–10.
- 29 Croghan SM, Carroll P, Reade S. Robot assisted surgical ward rounds: virtually always there. *J Innovation in Health Informatics* 2018;25:41–56.
- 30 Schwamm LH, Estrada J, Erskine A, *et al.* Virtual care: new models of caring for our patients and workforce. *Lancet Digit Health* 2020;2:e282–5.