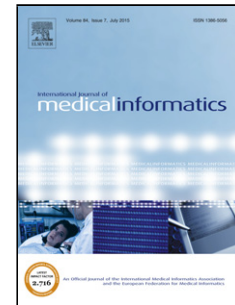


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## Exploring mobile working in healthcare: clinical perspectives on transitioning to a mobile first culture of work

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### **Objectives**

This study investigated the views of healthcare professionals (HCPs) as end-users of mobile technologies to inform the requirements for a successful move towards a mobile first culture of work within secondary care. Many HCPs already used mobile devices to support their day-to-day practice and so transitioning to an organisational led mobile way of working is both needed and timely.

### **Materials and Methods**

In-depth focus groups and interviews at a UK academic hospital were conducted with HCPs (nurses, doctors, and allied health professionals). The interviews elicited views from HCPs

about the use of mobile technologies in their clinical work and discussed their experiences of previous technology deployments.

## Results

Thirty-four HCPs participated. Three themes were identified: integrating mobile working in hospital care; addressing data governance and accountability for mobile working; and handling the pace of change. The acceptance of mobile working is determined by whether it enhances, rather than hinders clinical practice whilst holding end-user's confidence; measuring the impact of the administrative burden on workload, changes to professional accountability and safeguarding patient data are serious issues that need consideration; and the pace of change needs to work for all stakeholders.

## Discussion and Conclusions

The benefits of adopting mobile technologies are well recognised, however, technical and policy related factors identified by professional end-users require answers in order to successfully integrate mobile working into current practice. Adopting a mobile first approach to work is timely and achievable, but can only be delivered on a foundation of positive end-user engagement and strong organisational leadership.

### Keywords:

Readiness to change; mobile working; patient safety; implementation; disruptive technology

## SUMMARY TABLE

What was already known on the topic:

- Mobile technology has the potential to transform the way in which healthcare is delivered and provide solutions to many key quality and safety challenges

- The use of mobile technology is ubiquitous amongst healthcare staff, but organisations have thus far largely failed to deploy large-scale evidence-based solutions

What this study added to our knowledge:

- Transitioning to a mobile-first culture of work within healthcare an achievable goal
- Changing organisational culture, measuring the impact of new technologies, improving the skills and capabilities of staff, and addressing concerns about data quality and security are crucial for success
- Organisations must engage end-users right from the very outset of any new technology project to ensure that it meets their needs and supports the delivery of high-quality care

## 1 - INTRODUCTION

Mobile technology has become increasingly important for healthcare delivery. Healthcare Professionals' (HCPs) use of mobile devices to support their practice has become a norm[1–3]. Mobility in the clinical environment is key, and mobile technologies can aid in information provision and communication, support clinical workflows and facilitate better personalised care for patients[4–11].

The interest in mobile technologies in the UK National Health Service is increasing due to a revitalised initiative for digital and health IT acceleration[12–14]. This follows the National Programme for IT (NPfT) in the early 2000s which aimed, but ultimately failed to join information systems and data for enabling improvements in care provision[13] largely due to the lack of HCP engagement. This failure demonstrated the importance of involving clinicians early on in any plans that changed the way of working or for adopting new

technologies. Due to the ubiquity of mobile technology, focus has shifted from understanding its suitability in healthcare contexts[1,3,15,16] to how to transition fully to a mobile way of working.

Recent studies have found smartphones to be the preferred mode of communication compared to traditional means[17,18]; with growing use among HCPs[15,19]. Smartphones are deemed more efficient, less distracting than conventional pagers and provide a better quality of information transfer[16]. However, unintended consequences of mobile working have also been highlighted[4] such as notification fatigue, interruptions to clinical duties and concerns about the security of patient data[4,20–22].

Further investigation of the opportunities and challenges to successfully integrate mobile technologies into routine work is required. In order to facilitate a mobile technology enabled healthcare system, there must be alignment between health IT infrastructure and organisational and professional readiness[12,23–26]. Health IT implementation is challenging due to socio-technical and cultural factors in healthcare organisations[26,27]; digital and mobile technologies meanwhile bring their own complications despite intending to elevate the quality and safety of healthcare. It is also important to evaluate any new technology that will impact upon those who do the work[22,28].

While research has seen widening acceptance of mobile technologies for clinical practice, most to date have been conducted on small scale deployments with a focus on specific technologies designed for narrow contexts that often fail to elicit the broader views of a wide range of professionals[1,23]. As there is a push to a universal adoption of mobile working there is a need to anticipate wider socio-technical issues, identify HCPs' attitudes towards changing practices and rigorously evaluate the impact of technology on broader aspects of clinical practice, workflow, and patient outcomes[1,6,7,11,29,30]. With usage being reported to be increasing exponentially[15,18], little is known more generally about how different

HCPs experience using mobile technologies for providing care and their readiness to change completely to a mobile way of working. It is therefore appropriate to investigate readiness and adoption through the actors involved, the context, and system rather than simply focusing on the evaluation of a specific technology or product.

Where previous implementation research has typically examined mobile technology adoption in specific contexts, this study focuses on HCPs perspectives about how to support a whole organisation transition to a mobile first culture of work. This study aimed to scope the experiences, attitudes, and behaviours of HCPs about using mobile technologies in the hospital setting, characterise how they perceive the change and define key points to address for successful roll-out of mobile technologies and change to a mobile first culture of work in all aspects.

## **2 - MATERIALS AND METHODS**

### **2.1 - Recruitment procedure and setting**

Focus groups and semi-structured interviews were conducted with different healthcare professionals (HCPs) within a self-contained medical unit at a UK Academic Health Sciences Centre. The interview schedule was informed by the 'Seven success factors for accelerating change' framework by Allcock et al [26] as summarised in *Table 1*. This framework posits that several factors can determine successful change and was chosen as a guide for the question schedule because of its appropriateness to the UK context, and to help explore the barriers and facilitators to implementation relating to the whole system. While the framework does not focus on technology per se, it provides a robust framework upon which to identify the key opportunities and challenges for mobile working and lends itself to investigating change from a systems perspective, rather than the evaluation of technology itself.

Questions followed the specific interview schedule (*Online Appendix 1*) and aimed to elicit

HCPs' views on adopting mobile working and their experiences of previous digital technology deployments

1. Committed and respected leadership that engages staff
2. A culture hospitable to, and supportive of, change
3. Management practices that ensure execution and implementation
4. Capabilities and skills to identify and solve problems
5. Data and analytics that measure and communicate impact
6. Resources and support for change
7. An enabling environment which supports and drives change.

**Table 1: The 7 success factors for accelerating change in the NHS[26]**

Participants were purposively sampled to obtain a broad range of HCPs. In total 34 participants were recruited comprising 6 doctors, 6 senior nurses (Band 6 and above), 13 junior nurses (Band 5 and below), 3 Healthcare Assistants, 4 Allied Health Professionals (physiotherapist, pharmacist, speech and language therapist, and a theatre co-ordinator) and 2 administration staff. Institutional review was conducted by the Imperial Joint Research Compliance Office (JRCO) and approval for the study was obtained as part of a larger digital quality improvement and service evaluation project within the associated NHS Trust.

## **2.2 - Analysis**

The analysis applied an iterative deductive to inductive approach[31,32]. Transcripts were coded deductively according to an initial thematic framework based on Allcock[26]. The framework was revised as new codes were identified until no new categories of codes emerged from the data. Two researchers independently coded and indexed 10% of the transcripts and differences in coding were discussed and consensus reached. The remaining transcripts were coded using the revised coding framework. Recurring responses across cases were deemed salient and the extracted data were summarised under each code and

then mapped onto categories and key emerging themes. Themes that reflected HCPs' readiness to adopt a mobile way of working were discussed, defined and agreed by both researchers, and notable quotes selected that represented these themes. Key emerging themes were identified that related to readiness to change to a mobile way of working at the local level.

### **3 - RESULTS**

Three core themes were identified which report the experiences of clinical staff in relation to mobile working:

1. Integrating mobile working in hospital care
2. Addressing data governance and accountability for mobile working
3. Handling the pace of change.

The development of these core themes is summarised in *Figure 1*.

#### **3.1 - Integrating mobile working in hospital care**

Participants' experiences of information technology defined the context of how they perceived the deployment and use of mobile technologies. They recognised both the utility and current limitations of mobile technologies, and the need to balance priorities and practicalities to match clinical and operational needs.

##### *3.1.1 - Utility of a mobile way of working*

The move to paperless mobile working was met with varied views about its potential benefits and pitfalls; however, the majority saw it as a positive step:



*Going from paper notes and documentation to electronic, I think that's gone really well and I think people are realising that it's a much more efficient way of working. So, I think taking it another step, I think people would be ready for it. (Nurse)*

While communication technologies and practices from previous generations such as bleep systems remain ubiquitous, HCPs were already using mobile devices and applications to make communicating with other staff easier:

*People are definitely ready to use the smartphone to do the jobs that they are already using the smartphone to do (Doctor)*

### 3.1.2 - Perceived cultural and workflow limitations of mobile working

Not all end-users were positive with some reserving judgment about the potential benefits of using mobile devices for clinical task management and communication. Some were wary of the potential increase in administrative burden:

*I think one of the things we've talked about is whether it [mobile working] will actually increase our workload... (Doctor)*

For some respondents using a mobile device to communicate with colleagues may be more cumbersome than speaking with colleagues face-to-face:

*If the nurses need to get you to do something, you're like ten metres away down the hallway, and they'll speak to you... rather than going, "Oh, we'll put this in the thing [mobile technology]". (Doctor)*

The preference for communicating using mobile technologies was not universal. Some HCPs saw it as a facilitator for fast exchange of information, but some nurses viewed using mobile devices during clinical care as being seen to be unprofessional:

*If the manager or someone sees you on your mobile it looks like [unprofessional], do you know what I mean? (Nurse)*

There was also a hesitance to use mobile devices during the direct care because of how patients may perceive this work behaviour:

*The patients actually give feedback to us, most of the nurses are spending more time talking to us [other staff] than with the patients, ... then we have to explain to that patient, 'We are using the computer instead of using paper documentations' because they are not aware of all the technology coming to NHS sites. (Nurse)*

### 3.1.3 - Changes should be purposeful and high quality

Any new way of working that is disruptive should match clinical practice needs and improve the delivery of care. An eagerness by organisations to adopt novel technologies may lead to solutions that lack meaning or purpose with technology adopted for the sake of it, rather than to solve a specific problem:

*We have people who just want to digitise everything they touch and turn it into an app which is ... sort of ... understandable, but unrealistic. But it's very, very difficult so, yeah, we know what it costs [technology companies], that's the kind of time motivation and investment it requires to build something that works, so I think people are quickly frustrated by*

*the fact that they can't just do that. Or to stick a PDF on a phone and call it an app and think that the job is done. (Doctor)*

### **3.2 - Addressing data governance and accountability for mobile working**

Participants explained that capturing, storing, and using patient and clinician data should be done precisely, securely, honestly, and meaningfully.

#### *3.2.1 - Data provision and security*

The vast amounts of data and the ease at which it could be captured through mobile devices was welcomed by health professionals. Hand-in-hand with capturing data however is the obligation to safeguard it and protect patients.. Participants stated this was a real concern to them:

*If I've got that on a handheld device I've got to then ensure the security of that device or some kind of encryption so if I lost it on the street nobody would have access into patient information. (AHP)*

#### *3.2.2 - Transparency leads to accountability*

In the context of delineating accountability of care delivery, transparency was expressed as a key factor to protect both data and people:

*I think it's just having that reassurance about how data is kept safe and being completely transparent about how the system works and what it's going to be used for, who has access to it, how they have access to it and I think if you can address those concerns then I think it [mobile working] should therefore be successful. (Doctor)*

Uncertainty about how much data is needed and for what purposes it is collected required clarification for many participants. The move to a mobile way of working raised questions about what was deemed auditable, whether monitoring all communications was necessary and whether there would be punitive outcomes for any oversights:

*Does the fact that that's in writing – that you were told to do that, and you're like, "But I had a verbal conversation that negated that" – where are you, legally, in that? (AHP)*

Understanding how mobile technologies are perceived by patients and the public was also highlighted by some participants. It is crucial that all relevant stakeholders are consulted in advance about the use of new mobile technologies to ensure their concerns are addressed:

*Getting feedback from patients and members of the public as to what their concerns would be around this type of technology and then addressing those would probably sort that issue out entirely. (Doctor)*

### **3.3 - Handling the pace of change**

Participants highlighted the tension between maintaining standards in practice and catching-up to new ways of working. This was continuously challenging amidst competing priorities of work and minimal resources.

#### **3.3.1 - Organisational culture of innovation**

Organisations that frequently implement novel technologies are perceived to be innovative and this supports staff to adjust quicker for to new technologies and ready for change:

*Our Trust is always changing. We've had a number of big particularly IT changes around first EDC, that's Electronic Discharge, then with [EPR] electronic prescribing administration so I think we are ready. (AHP)*

Participants highlighted that they sometimes felt that changes to ways of working were often implemented too fast and any proposed long-term benefits felt too distant; organisations must recognise and counteract the effects of innovation fatigue:

*I'm just also a little bit wary that – yeah, there's a lot of different new technologies and new platforms coming out, and if we're just introducing one more new thing for people to master, then I sort of feel like we haven't entirely got [EPR system] working to its potential. (Doctor)*

Some participants stated that there needs to be a positive attitudinal change for upgrading to new technologies:

*Everything is moving at a very fast pace and therefore we need to upgrade ourselves to what technology is all about. (Nurse)*

### 3.3.2 - Change is met with resistance as adjusting to change takes time and effort

The acceptability of mobile working may be increasing to align with changing practice. However, participants' experiences of previous digital implementations such as electronic health records (EHR) indicated that any changes are complex and lengthy, and staff want a seamless transition:

*The people on the ground and the people who are using these tools are keen and ready... but we know that everything will probably take longer than it is hoped for, planned for." (Doctor)*

The adoption and implementation of new technologies may increase workload for staff in the short-term, particularly when implementation is poor or resources are taken away; inevitably change is often met with resistance from end-users.

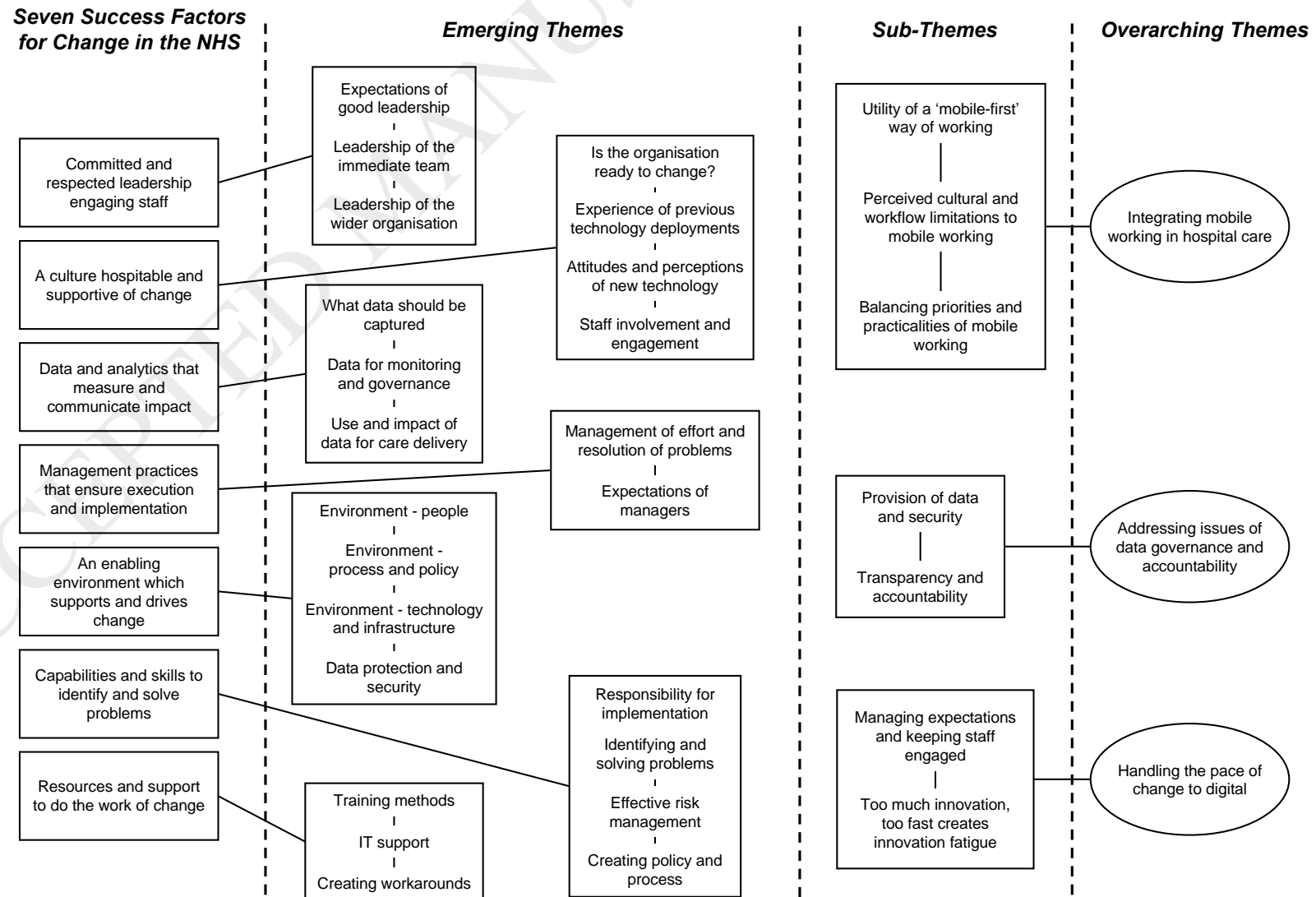
*I think that the necessary learning curve, teething – whatever that comes with change, makes people very, very resistant to it. (Doctor)*

### 3.3.3 - Change for the sake of change should be avoided

Not all staff were positive about the rapid pace of change. Some raised concerns and are likely to challenge any new deployments if they are perceived to be burdensome or unnecessary:

*I don't think that all the changes that are brought in are necessarily in response to direct problems that are faced by Trusts. So, it's not often, "Here's a new change, here's a new innovation, everyone's backing it and let's all get on board" and everyone is, "Well that is a problem" ...there's a lot of innovation for the sake of innovation that's backing a new idea for the sake of looking trendy and, "Aren't we doing new things? (Doctor)*

**Figure 1 – thematic map showing the development and identification of final core themes**



#### 4 - DISCUSSION

Being able to easily and effectively co-ordinate care requires better solutions that fit within the structure of the hospital setting[12,13,26]; mobile technologies have been positioned as a potential solution. This study has undertaken a novel examination of the system-wide adoption of mobile first working in a large healthcare organisation. Before any technological change is implemented in healthcare, end-user engagement in the process is essential[22,26]. This study aimed to delineate end-user's perspectives about adopting a mobile first culture of work in secondary care with three principle themes identified: integrating mobile working in hospital care; addressing data governance and accountability for mobile working; and handling the pace of change.

The hospital in which the study took place had recently changed to a paperless model of working and it is viewed as a forward-thinking organisation by the participating HCPs. The recent change to a new EHR system had been well implemented and received, but nonetheless participants recalled various challenges that require addressing prior to future technological roll-outs. These included needing adequate resources to support staff to adopt novel innovations and the need for active communication from leadership and organisational engagement with end-users. Specific issues relating to mobile technologies were also raised about usability and administrative burden, as well as ensuring information governance policies were well considered and accountability clearly demarcated. Consequently, all professionals maintained that changing to a mobile way of working should fit within existing capacities but also enhance clinical practices. The findings indicated that there was qualified support from frontline staff for the introduction of mobile working. While nurses were positive about the potential of mobile working in most aspects of their work, they were reluctant to use mobile devices during care because of fear of this being perceived as unprofessional. Patient views were important for professionals who were aware that using mobile devices



may project the wrong image. This will require a cultural change in which mobile working is assimilated into normal practice hand-in-hand patient education and engagement.

In this study perceptions about device and data security persisted and are consistent with other research highlighting the importance of effectively securing patient data[1,15,23,25,28,33]. Yet this did not deter HCPs from using personal devices for work due to the trade-off with the benefits provided by smartphones and applications. The current practice of many clinicians is to use personal devices and unsecured applications because there are no comparable officially sanctioned resources available. Clinicians often have to resort to various short-cuts, an example of which is the use of mobile messaging applications to facilitate inter-professional communication. Issues of cybersecurity will require a local and national policy response with responsibility shared between staff and organisations at all levels of healthcare[25,33]. The process for training staff on appropriate device use, data protection and security has been least studied and requires addressing in future research. The related issue of patient consent to share data between clinicians on widely used communication platforms is also an unsolved problem. Organisations will need to focus on regulatory and policy changes in the immediate future - such as compliance with GDPR (General Data Protection Regulations) in Europe - and address how issues of patient consent and device use need to be incorporated into daily practice.

The opportunity for additional administrative oversight that mobile technology can offer was welcomed by some. AHPs viewed the benefits in mobile device use through making data capture easier for audit and feedback. Electronic recording such as time stamping, read-receipts and push notifications, as well as being able to view communications to check on colleagues' progress of clinical tasks were considered useful. Whilst doctors were happy to use devices for care co-ordination, they reserved judgement about the benefits and impact of mobile working on workload and improvement in care, emphasising the importance for prospective evaluation. This view came from their experience of the status quo regarding the

saturation of alerts, bleeps, and other electronic documentation they were committed to. Furthermore, doctors highlighted concerns about potential increase in distractions because of the increased connectivity of mobile working which has previously been identified[4]. An added concern for some HCPs was whether increased data capture would result in additional compliance monitoring and administrative burden; some expressed that a culture of constant monitoring requires scrutiny to establish its efficacy, utility and appropriateness. The easing of these concerns should be the responsibility of organisations and leaders driving change and can only be done through the continuous iterative evaluation of new technology[13,29]. Central to this will be the need for organisational policies to be transparent about what data would be collected, for what purposes and how it would be used[19,34].

Healthcare systems also need to address the pace of change when rolling out changes to working. Organisations need to understand that changes should be meaningful and introduced incrementally. End-user resistance to change is a likely outcome if mobile working does not improve current practice. Any change that requires HCPs to dedicate time, effort and resources is futile if it does not ultimately support or enhance healthcare delivery; this was particularly true when new technologies overlap. To what extent innovation fatigue impacts on care delivery in forward thinking organisations will require prospective investigation[13] together with sensible planning and the reduction of unnecessary workload to effectively manage priorities[22]. There also needs to be a shift from only holding HCPs accountable for quality assurance and safety, to raising accountability of all agents involved in introducing change including implementers and leaders.

This was a novel investigation of end-user's views about changing to mobile working in the context of their previous experiences of using new technologies at work. Our analysis goes beyond assessing individuals' assessment of the ease of use and utility of mobile working - as that posited by classical models such as the Technology Acceptance Model[35] - using

the lens of the 7 success factors framework to guide discussions identify additional characteristics important for implementation through an inductive approach. The analysis highlighted areas that need to be addressed and will inform how transitioning to mobile working can be successfully implemented. The study was limited to a single hospital which in itself has a progressive digital agenda and digitally literate staff. Views of leaders, implementers and other decision-makers were not elicited to compare views. Many participants' views were informed by a single, large-scale EPR roll-out, so it would be appropriate to replicate this with HCPs in organisations without frequent digital change; conduct interviews with patients to understand the validity of staff concerns regarding the professionalism of using smartphones at the bedside; and elicit perspectives of IT professionals within hospitals to align perspectives and understand whether end-user's requirements are possible to implement. While not the focus of the study presented, future research could investigate the theoretical aspects of adoption and acceptance of technologies.

## **5 - CONCLUSIONS**

These findings suggest that transitioning to a mobile way of working can be challenging as staff learn to navigate new systems, adapt to novel ways of working and cope with innovation fatigue. Meanwhile, resources and capabilities to solve the technical, cultural and policy barriers to innovative change are often inadequate. This study showed that even without all the factors for success present organisations can still successfully deliver change and transition to a mobile first culture of work. Cultural change, measuring impact and improving skills and capabilities are crucial to the process of deploying novel technologies and instigating new ways of working. Adopting a mobile first approach to work in secondary care is timely and achievable, but can only be delivered on a foundation of positive end-user engagement and strong organisational leadership.

**AUTHOR CONTRIBUTIONS**

GM conceived the study. Interviews and focus groups were conducted by NS. Analysis was performed by NS and GM. NS and GM drafted the manuscript which was critically reviewed by SAA, SA, DK, and AD. All authors approved the final version of the manuscript. AD is the guarantor of the study.

**AUTHOR STATEMENT - CONSENT / ETHICAL REVIEW**

This study was reviewed by the Imperial Joint Research Compliance Office and approval was obtained as part of a wider digital quality improvement and service evaluation project. Informed consent was obtained from all participants,

**STATEMENT OF COMPETING INTERESTS**

The authors declare no competing interests or conflicts.

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## REFERENCES

- [1] K. Illiger, M. Hupka, U. von Jan, D. Wichelhaus, U.-V. Albrecht, Mobile technologies: expectancy, usage, and acceptance of clinical staff and patients at a university medical center., *JMIR MHealth UHealth*. 2 (2014) e42. doi:10.2196/mhealth.3799.
- [2] J. Wise, Disruptive technologies making cancer care more patient centred., *Br. Med. J.* 359 (2017) j5608. doi:10.1136/BMJ.J5608.
- [3] M.J. Johnston, D. King, S. Arora, N. Behar, T. Athanasiou, N. Sevdalis, A. Darzi, Smartphones let surgeons know WhatsApp: an analysis of communication in emergency surgical teams, *Am. J. Surg.* 209 (2015) 45–51. doi:10.1016/j.amjsurg.2014.08.030.
- [4] K. Tran, D. Morra, V. Lo, S.D. Quan, H. Abrams, R.C. Wu, Medical students and personal smartphones in the clinical environment: the impact on confidentiality of personal health information and professionalism, *J. Med. Internet Res.* 16 (2014) e132. doi:10.2196/jmir.3138.
- [5] D. Blumenthal, Stimulating the adoption of health information technology, *N. Engl. J. Med.* 360 (2009) 477–9. doi:10.1056/NEJMp1002530.
- [6] L.M. McElroy, D.P. Ladner, J.L. Holl, L. McElroy, The role of technology in clinician- to-clinician communication, *BMJ Qual. Saf.* 22 (2013) 981–983. doi:10.1136/bmjqs-2013-002191.
- [7] C. Nguyen, L. McElroy, M. Abecassis, J. Holl, D. Ladner, The use of technology for urgent clinician to clinician communications: A systematic review of the literature, *Int. J. Med. Inform.* 84 (2015) 101–110. doi:10.1016/J.IJMEDINF.2014.11.003.
- [8] G. Putzer, Y. Park, Are physicians likely to adopt emerging mobile technologies? Attitudes and innovation factors affecting smartphone use in the Southeastern United States., *Perspect. Heal. Inf. Manag.* 9 (2012) 1b.

- [9] C.L. Ventola, Mobile devices and apps for health care professionals: uses and benefits., *Pharmacol. Ther.* 39 (2014) 356–64.
- [10] K. Senior, Smart phones: new clinical tools in oncology?, *Lancet Oncol.* 12 (2011) 429–30. doi:10.1016/S1470-2045(11)70116-4.
- [11] F. Ehrler, R. Wipfli, D. Teodoro, E. Sarrey, M. Walesa, C. Lovis, Challenges in the implementation of a mobile application in clinical practice: case study in the context of an application that manages the daily interventions of nurses., *JMIR MHealth UHealth.* 1 (2013) e7. doi:10.2196/mhealth.2344.
- [12] R.M. Wachter, Hospitalists inpatient notes - hospitalists and digital medicine - overcoming the productivity paradox, *Ann. Intern. Med.* 165 (2016) HO2. doi:10.7326/M16-1367.
- [13] H.S. Sood, K. McNeil, How is health information technology changing the way we deliver NHS hospital care?, *Futur. Hosp. J.* 4 (2017) 117–120. doi:10.7861/futurehosp.4-2-117.
- [14] A. Sheikh, T. Cornford, N. Barber, A. Avery, A. Takian, V. Lichtner, D. Petrakaki, S. Crowe, K. Marsden, A. Robertson, Z. Morrison, E. Klecun, R. Prescott, C. Quinn, Y. Jani, M. Ficociello, K. Voutsina, J. Paton, B. Fernando, A. Jacklin, K. Cresswell, Implementation and adoption of nationwide electronic health records in secondary care in England: final qualitative results from prospective national evaluation in “early adopter” hospitals., *Br. Med. J.* 343 (2011) d6054. doi:10.1136/BMJ.D6054.
- [15] M. Mobasheri, D. King, M. Johnston, S. Gautama, S. Purkayastha, A. Darzi, The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study, *BMJ Innov.* 00 (2015) 1–8. doi:10.1136/bmjinnov-2015-000062.
- [16] B. Patel, M. Johnston, N. Cookson, D. King, S. Arora, A. Darzi, Interprofessional

- communication of clinicians using a mobile phone app: A randomized crossover trial using simulated patients, *J. Med. Internet Res.* 18 (2016) e79. doi:10.2196/jmir.4854.
- [17] R.C. Wu, D. Morra, S. Quan, S. Lai, S. Zanjani, H. Abrams, P.G. Rossos, The use of smartphones for clinical communication on internal medicine wards, *J. Hosp. Med.* 5 (2010) 553–559. doi:10.1002/jhm.775.
- [18] R. Wu, V. Lo, D. Morra, E. Appel, T. Arany, B. Curiale, J. Ryan, S. Quan, A smartphone-enabled communication system to improve hospital communication: usage and perceptions of medical trainees and nurses on general internal medicine wards, *J. Hosp. Med.* 10 (2015) 83–89. doi:10.1002/jhm.2278.
- [19] R.K. Patel, A.E. Sayers, N.L. Patrick, K. Hughes, J. Armitage, I.A. Hunter, A UK perspective on smartphone use amongst doctors within the surgical profession, *Ann. Med. Surg.* 4 (2015) 107–112. doi:10.1016/j.amsu.2015.03.004.
- [20] J. Bian, C.L. Bennett, D.A. Fisher, M. Ribeiro, J. Lipscomb, W. Jennings, B. Dorn, E. Rollins, Unintended consequences of health information technology: evidence from veterans affairs colorectal cancer oncology watch Intervention, *J. Clin. Oncol.* 30 (2012) 3947–3952. doi:10.1200/JCO.2011.39.7448.
- [21] R. Wu, K. Tran, V. Lo, K. O'Leary, D. Morra, S. Quan, L. Perrier, Effects of clinical communication interventions in hospitals: a systematic review of information and communication technology adoptions for improved communication between clinicians., *Int. J. Med. Inform.* 81 (2012) 723–32. doi:10.1016/j.ijmedinf.2012.05.014.
- [22] C.A. Sinsky, M.R. Privitera, Creating a “Manageable Cockpit” for Clinicians, *JAMA Intern. Med.* 178 (2018) 741–742. doi:10.1001/jamainternmed.2018.0575.
- [23] M. Lennon, M. Bouamrane, A. Devlin, S. O'Connor, C. O'Donnell, U. Chetty, R. Agbakoba, A. Bikker, E. Grieve, T. Finch, N. Watson, S. Wyke, F. Mair, Readiness for delivering digital health at scale: lessons from a longitudinal qualitative evaluation of a

- national digital health innovation program in the United Kingdom, *J. Med. Internet Res.* 19 (2017). doi:10.2196/jmir.6900.
- [24] H.S. Sood, M. Maruthappu, B. Keogh, A future vision for the NHS: the case for change, *Lancet*. 384 (2014) 1551–1552. doi:10.1016/S0140-6736(14)61948-6.
- [25] S.P. Bhavnani, K. Parakh, A. Atreja, R. Druz, G.N. Graham, S.S. Hayek, H.M. Krumholz, T.M. Maddox, M.D. Majmudar, J.S. Rumsfeld, B.R. Shah, 2017 Roadmap for Innovation - ACC Health Policy Statement on Healthcare Transformation in the Era of Digital Health, Big Data, and Precision Health: A Report of the American College of Cardiology Task Force on Health Policy Statements and Systems of Care, *J. Am. Coll. Cardiol.* 70 (2017) 2696–2718. doi:10.1016/J.JACC.2017.10.018.
- [26] C. Allcock, F. Dormon, R. Taunt, J. Dixon, Constructive comfort: accelerating change in the NHS, 2015. [http://www.knowledge.hscni.net/Content/Uploads/file/Constructive comfort - accelerating change in the NHS.pdf](http://www.knowledge.hscni.net/Content/Uploads/file/Constructive%20comfort%20-%20accelerating%20change%20in%20the%20NHS.pdf).
- [27] H.S. E. Russo, D.F. Sittig, D.R. Murphy, Challenges in patient safety improvement research in the era of electronic health records, *Healthcare*. 4 (2016) 285–290. doi:10.1016/J.HJDSI.2016.06.005.
- [28] I. Junglas, C. Abraham, B. Ives, Mobile technology at the frontlines of patient care: Understanding fit and human drives in utilization decisions and performance, *Decis. Support Syst.* 46 (2009) 634–647. doi:10.1016/j.dss.2008.11.012.
- [29] S.P. Bhavnani, J. Narula, P.P. Sengupta, Mobile technology and the digitization of healthcare, *Eur. Heart J.* 37 (2016) 1428–1438. doi:10.1093/eurheartj/ehv770.
- [30] N. Shah, E. Castro-Sanchez, E. Charani, L.N. Drumright, A.H. Holmes, Towards changing healthcare workers' behaviour: A qualitative study exploring non-compliance through appraisals of infection prevention and control practices, *J. Hosp. Infect.* 90 (2015) 126–134. doi:10.1016/j.jhin.2015.01.023.
- [31] C. Pope, S. Ziebland, N. Mays, Qualitative research in health care. Analysing



- qualitative data., Br. Med. J. 320 (2000) 114–6.
- [32] E. Bradley, L. Curry, K. Devers, Qualitative data analysis for health services research: developing taxonomy, themes, and theory, Health Serv. Res. 42 (2007) 1758–1772. doi:10.1111/j.1475-6773.2006.00684.x.
- [33] G. Martin, J. Kinross, C. Hankin, Effective cybersecurity is fundamental to patient safety, Br. Med. J. 357 (2017) 1–2. doi:10.1136/bmj.j2375.
- [34] C. de Grood, A. Raissi, Y. Kwon, M.J. Santana, Adoption of e-health technology by physicians: a scoping review., J. Multidiscip. Healthc. 9 (2016) 335–44. doi:10.2147/JMDH.S103881.
- [35] F. Davis, R. Bagozzi, P. Warshaw, User acceptance of computer technology: a comparison of two theoretical models, Manage. Sci. 35 (1989) 982–1003.