ORIGINAL ARTICLE

The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study

Mohammad H Mobasheri,1 Dominic King,2 Maximilian Johnston,2 Sanjay Gautama,3 Sanjay Purkayastha,1 Ara Darzi2

ABSTRACT

Background Much interest has arisen around the use of smartphones, tablet devices and related apps in the healthcare context. It has been suggested that increasing numbers of healthcare professionals are using these technologies in the workplace. We have performed an up-to-date UK-based, multicentre, cross-sectional survey study exploring the ownership rates and uses of these technologies among doctors and nurses, specifically focusing on the clinical environment.

Methods After initial piloting, all doctors (n=2107) and nurses (n=4069) at 5 hospital sites were invited to complete a 36-item (nurses) or 38-item (doctors) survey. Exploratory descriptive statistics were calculated and the $\chi^2$ test was used to compare differences in categorical data between groups. Statistical significance was taken at a level of $p<0.05$.

Results 98.9% of doctors and 95.1% of nurses owned a smartphone, while 73.5% and 64.7% owned a tablet device, respectively. Also, 92.6% of the doctors and 53.2% of nurses found their smartphone to be ‘very useful’ or ‘useful’ in helping them to perform their clinical duties, while 89.6% of doctors and 67.1% of nurses owning medical apps were using these as part of their clinical practice. Doctors and nurses were using short-message-script messaging (64.7% and 13.8%, respectively), app-based messaging (33.1% and 5.7%), and picture messaging (46.0% and 7.4%) ($p=0.0001$ for all modalities) to send patient-related clinical information to their colleagues. Therefore, 71.6% of doctors and 37.2% of nurses wanted a secure means of sending such information.

Conclusions Compared to earlier studies, we have demonstrated much higher smartphone ownership among doctors and nurses, who perceive these devices to be useful when performing their clinical duties. Large numbers of staff are sending patient related clinical information using smartphone messaging modalities. Care must be taken by doctors and nurses to ensure that no identifiable patient data is transmitted in this way, and healthcare organisations must develop strategies and policies to support the safe and secure use of these technologies by front-line staff.

INTRODUCTION

Since the release of the earliest commercially available handsets in 1983, mobile phone technology has evolved at an unprecedented rate.1 Miniaturisation coupled with advances in sensors, batteries and computing technologies heralded the release of the first set of smartphones in 2007 and tablet computers a year later. Both devices are capable of running stand-alone software applications referred to as apps. This has elevated the roles of these devices far beyond simple telephonic communication.2

Seventy-two per cent of the UK population now owns a smartphone and 23% own a tablet computer.3 In the USA, ownership rates are 65% and 48%, respectively.4 These technologies have revolutionised the ways that ordinary citizens live their lives, but much interest has also arisen around their use in the healthcare industry. Mobile health (mHealth) is defined as the delivery of healthcare through the use of portable communication devices.5 There are currently >90 000 mHealth apps available and it is predicted that by 2017, 3.4 billion people worldwide will own a smartphone and half will be using mHealth apps.6

A large proportion of such apps are targeted at the lay users and promote healthy living or empower patients to...
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manage disease conditions; there are, however, also an increasing number of apps designed specifically for healthcare professional use in the clinical environment to enhance efficiency around work-related tasks.

The unparalleled ubiquity, portability and connectivity of mobile communication devices help healthcare professionals to access health-related content at almost any time and place.""". Trusted healthcare organisations, such as the National Institute for Health and Care Excellence (NICE) in the UK, have made many of their guidelines for doctors available in app form to facilitate decision-making.8 Despite the enthusiasm for digital health there are pitfalls and several studies have demonstrated the potential for certain apps to cause patient harm.9-11 Furthermore, the use of mobile devices in the clinical arena poses specific security and privacy challenges12 that must be addressed in order to mitigate the risks of inadvertently breaching highly sensitive and confidential patient-identifiable data.

Healthcare organisations are increasingly looking at strategies and guidance on how smartphones and tablets can be used to enhance healthcare delivery, but there is scant reliable evidence on the prevalence and modes of current use. The aim of this study was to perform an up-to-date prospective survey of doctors and nurses at a large London-based National Health Service (NHS) Trust so as to explore the ways that front-line staff are using smartphones, tablet devices and mHealth apps in the clinical environment.

METHODS

Study design

A cross-sectional survey study was conducted. The study was a service evaluation and so formal ethical approval was not sought or required.

Participants

The study was performed at a large London-based NHS Trust consisting of five individual hospital sites. All doctors (n=2107) and nurses (n=4069) employed by the NHS Trust were invited to participate.

Measures

Electronic surveys were constructed using an online survey-building tool (Qualtrics). A list of relevant categories and questions was generated by reviewing previously published surveys exploring smartphone and medical app use in similar populations.13-16 Inclusion of categories and questions into the constructed survey was through a process of debate and consensus among the research team. The survey was piloted in paper form with a small sample of doctors and nurses independent of the study cohort, to ensure face validity. In response to feedback, several iterations of the survey were produced to ensure appropriate wording and content.

The final nurse survey consisted of 36 items, and the doctor survey was composed of 38 items (doctors were asked additional questions regarding the 'prescription' of medical apps to their patients). Items were divided into six main categories; (1) demographics (5 items), (2) tablet device ownership (4 items), (3) smartphone ownership (3 items), (4) smartphone use in the workplace (9 items), (5) medical app ownership and use in the workplace (14 items) and (6) other (3 items). A mixture of question types were utilised, including dichotomous, nominal polytomous, ordinal polytomous (predominantly 5-point Likert scales) and open-ended questions.

Distribution process

Prior to distribution, surveys were reviewed by the NHS Trust’s information governance and information technology (IT) teams for approval. The email addresses of all doctors and nurses employed by the Trust were obtained from the organisation’s governance department. An email invitation to complete the survey was sent to each staff member at the start of January 2015, followed by three reminder emails sent at 3–4 week's intervals, thereafter. The survey was closed on the 31 March 2015, and the results of any partially completed responses were recorded at this stage. All survey responses were entirely anonymised.

Statistical analyses

Data were analysed using SPSS for Mac (V22, Chicago, Illinois, USA) and Graphpad QuickCalcs (San Diego, California, USA). Exploratory descriptive statistics were calculated for relevant survey items. The χ2 test was used to compare differences in categorical data between the doctor and nurse groups. Statistical significance was taken at a level of p<0.05.

RESULTS

Response rates

Email invitations were sent to 2107 doctors and 4069 nurses. Four hundred and sixty doctors (21.8%) opened the email invitation and 287 of them (62.4%) completed the survey, either partially (n=38) or completely (n=249). Seven hundred and ten nurses (17.4%) opened the invitation email, and 564 of them (79.4%) completed the survey (partial n=95, complete n=469).

Demographics

Respondent demographics are shown in table 1.

Smartphone and tablet ownership

In the doctor group, 98.9% (n=281/284) and 73.5% (n=211/287) owned a smartphone and tablet device, respectively, while the corresponding figures in the nurse group were 95.1% (n=528/555) and 64.7% (n=363/561), respectively. Ownership of both smartphones (p=0.005) and tablet devices (p=0.009) was significantly higher among doctors. The iPhone was the most commonly owned smartphone handset in...
both groups (doctors 75.6%, nurses 58.4%) followed by Android-based handsets (doctors 21.5%, nurses 41.6%). In the case of tablets, the iPad and iPad mini were the most commonly owned platforms (doctors 83.7%, nurses 76.7%) followed by Android-based devices (doctors 12.0%, nurses 23.8%).

Smartphone use at work
When asked how useful they find their smartphone in helping them to perform their day-to-day clinical duties, 92.6% (n=252/272) of doctors and 53.2% (n=271/509) of nurses stated ‘very useful’ or ‘useful’, and this difference was significant (p=0.0001). Figure 1 shows the various features of smartphones that staff were using in this regard.

Perceptions regarding the use of smartphones in clinical practice
When presented with a list of adjectives, both doctors and nurses chose positive terms such as helpful, brilliant and essential more frequently than negative terms such as unnecessary, complicated and terrible (figure 2).

Medical app ownership and use
Medical apps were owned by 78.3% (n=202/258) of doctors and 34.8% (n=173/497) of nurses, and this difference was significant (p=0.0001). Of those owning medical apps, a significantly greater number of doctors (n=181/202, 89.6%), compared to nurses (n=116/173, 67.1%), used these apps as part of their clinical practice while at work (p=0.0001). Of those owning medical apps and using these at work, 41.3% (n=74/179) of doctors used the apps weekly and 33.0% (n=59/179) used daily, while in the nurses group 42.0% (n=47/112) used the apps weekly and 22.3% (n=25/112) used daily. Examples of utilised medical apps included drug formularies, medical calculators, disease diagnosis and management, reference and education, procedure documentation, and drug preparation and administration apps.

Recommendation of mHealth apps
Some 9.7% (25/257) of doctors had recommended mHealth apps for use by their patients. Figure 3 highlights reasons for non-recommendation.

Transmission of patient-related clinical information over smartphones
Respondents were asked if they had ever sent patient-related clinical information over their smartphones using short-message-script (SMS), app-based messaging (eg, WhatsApp), and picture messaging (using their smartphone camera). In the doctor group, 64.7% (n=176/272) had used SMS, 33.1% (n=90) had used app-based messaging and 46.0% (n=125) had used their smartphone camera and picture messaging (eg, to send a photograph of a wound or X-ray to a colleague for an opinion). The corresponding figures in the nurse group were 13.8% (n=70/509), 5.7% (n=29) and 7.4% (n=38), respectively (figure 4). Doctors were significantly more likely to send patient-related clinical information using these methods (p=0.0001 for all three methods).

Some 93.8% (n=255/272) of doctors used their smartphone while at work for communication purposes compared with 28.5% (n=145/509) of nurses (p=0.0001). In the doctor group, 50.2% (n=128/255) were using their smartphone in place of a traditional bleep.

Table 1 The demographics of surveyed (a) doctors, and (b) nurses: in terms of age, gender, specialty and level of training or grade

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Nurses (n)</th>
<th>Doctors (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical nurse</td>
<td>132</td>
<td>92</td>
</tr>
<tr>
<td>Surgical nurse</td>
<td>57</td>
<td>53</td>
</tr>
<tr>
<td>ITU nurse</td>
<td>49</td>
<td>34</td>
</tr>
<tr>
<td>Theatre nurse</td>
<td>35</td>
<td>22</td>
</tr>
<tr>
<td>A&amp;E nurse</td>
<td>31</td>
<td>20</td>
</tr>
<tr>
<td>Paediatric nurse</td>
<td>28</td>
<td>16</td>
</tr>
<tr>
<td>O&amp;G nurse</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>Midwife</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Recovery nurse</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Renal dialysis</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Psychiatry nurse</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>Level of training</td>
<td></td>
</tr>
<tr>
<td>Band 2</td>
<td>FY1</td>
<td>8</td>
</tr>
<tr>
<td>Band 3</td>
<td>FY2</td>
<td>17</td>
</tr>
<tr>
<td>Band 4</td>
<td>Core training</td>
<td>28</td>
</tr>
<tr>
<td>Band 5</td>
<td>Registrar</td>
<td>106</td>
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<tr>
<td>Band 6</td>
<td>Consultant</td>
<td>128</td>
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<tr>
<td>Band 7</td>
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<td>14</td>
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<tr>
<td>Band 8</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

FY, foundation year; ITU, intensive treatment unit; O&G, obstetric and gynaecology.

Some 93.8% (n=255/272) of doctors used their smartphone while at work for communication purposes compared with 28.5% (n=145/509) of nurses (p=0.0001). In the doctor group, 50.2% (n=128/255) were using their smartphone in place of a traditional bleep.

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Some 27.5% (n=71/258) of doctors and 3.6% (n=70/509) of nurses believed that they still had patient-related clinical information on their
smartphones, and this difference was statistically significant (p=0.0001).

A large proportion of doctors, 71.6% (n=71/258), and 37.2% (n=176/473) of nurses expressed a desire for a secure messaging app to allow transmission of patient-related information to colleagues in a secure way, and this difference was again statistically significant (p=0.0001).

**Own device versus trust-issued device**
In the event that smartphone use became an integral part of the hospital IT infrastructure significantly

**Figure 1** A graph showing the percentage of surveyed staff using various features of their smartphones to help them to perform their clinical duties. The difference between doctor and nurse groups is significant for all features used (p=0.0001).

**Figure 2** A graph showing the percentages of surveyed staff selecting terms related to their perceptions of smartphone use in clinical practice.
more doctors than nurses preferred to use their own device rather than a trust-issued handset (58.5%, n=147/251 vs 21.1%, n=100/473; p=0.0001).

**Satisfaction with the survey**

When asked if the survey had adequately explored the ways in which they use their smartphones and medical apps at work, 72.4% (n=518/717) of participants ‘strongly agreed’ or ‘agreed’, while 23.3% (n=167) ‘neither agreed nor disagreed’. Just 4.3% (n=32) ‘disagreed’ or ‘strongly disagreed’ with the statement.

**DISCUSSION**

Previously published surveys have demonstrated that 74.8–83.5% of UK doctors own a smartphone, and 36.8% are in possession of a tablet device. A slightly higher rate of 85% US doctors have been shown to possess a smartphone, with 56% using medical apps in their clinical practice. These surveys were published more than 2 years ago; a relatively long time frame in the rapidly evolving mHealth sector, during which smartphone and tablet technologies have continued to evolve and advance. Ownership and use of these technologies among nursing staff has been poorly explored in the literature to date with only a single published survey, limited by its small sample size (n=82).

In this work, we have performed an up-to-date pan-specialty, pan-grade survey study of both doctors and nurses at a large NHS Trust, spanning five separate hospital sites, to explore how the ownership and use of smartphones, tablet devices, and medical apps has changed since earlier published surveys, specifically focusing on the clinical environment.

The results demonstrate a large increase in the proportion of doctors owning smartphones (nearly 100%) and tablet devices (approximately 75%). A large percentage of nurses are also carrying these technologies (95% and 65%, respectively). The percentage of front-line staff using medical apps in their clinical practice (90% of doctors and 67% of nurses owning such apps) has also increased, demonstrating a growing demand among doctors and nurses for medical apps that enable them to perform work-related tasks more efficiently.

Interestingly, while the majority of surveyed doctors are using medical apps, very few have recommended them to their patients. A lack of awareness and uncertainties around the evidence base, safety and efficacy are important barriers identified through this survey. If the recommendation of apps is to become commonplace, clinical staff must be able to readily identify higher quality, trust-worthy apps. Currently this is a very challenging process due to the sheer number of mHealth apps available and the absence of robust app certification strategies.

The majority of surveyed staff perceived the clinical use of smartphones and medical apps in a positive light (figure 2), with more than 90% of doctors and half of the nurses identifying their smartphone as either ‘useful’ or ‘very useful’ in helping them to perform their daily clinical duties. Aside from medical app use, staff also found a host of other smartphone features to be of benefit in performing their clinical duties (figure 2). The use of messaging modalities (SMS, picture messaging and/or app-based messaging) is worthy of further discussion.

It is apparent that large proportions of doctors are using messaging services to convey patient-related
Figure 4  (A) A graph showing the percentages of surveyed doctors and nurses sending patient-related clinical information over their smartphones using various messaging modalities. Significantly, more doctors sent patient-related clinical information over all three messaging modalities (p=0.0001); (B) A graph showing the frequency with which surveyed doctors and nurses sent patient-related clinical information over their smartphones using various messaging modalities. Compared with nurses, a greater percentage of doctors sent patient-related clinical information on a daily basis using all three modalities, but significance was only reached with short-message-script (SMS; p=0.014).
clinical information to colleagues. Nearly two thirds of doctors have used SMS messaging, close to half have used picture messaging (eg, to send photographs of patient wounds or x-rays) and over a third have used app-based messaging to send patient related clinical information. Similar use is demonstrated among nurses, although the proportions are significantly lower. Owing to a lack of data encryption and necessary security modules, the transmission of information through these modalities is currently not secure. Staff clearly find these means of communication to be very useful in their clinical practice, but must take care that any clinical information they are sending does not constitute patient identifiable data, which could potentially lead to the inadvertent disclosure of highly sensitive and confidential information, particularly in the event that handsets are lost, stolen, or viewed by unauthorised users (it should be emphasised that our study did not explore the sending of patient identifiable data specifically).

It is not surprising that 70% of surveyed doctors and 37% of nurses expressed the desire for a secure means of sending patient information to colleagues over their smartphones. While fully secure messaging services for smartphones have recently come into fruition in the USA, similar platforms are not currently available in the UK. Until such time, it is imperative that NHS organisations educate staff on the dangers of sending patient information using unsecure smartphone modalities.

Doctors and nurses must also be aware that the mHealth apps market is currently under-regulated and that defective apps are capable of causing patient harm. Both staff and healthcare organisations should be encouraged to risk assess the medical apps prior to their use in order to mitigate such dangers. A recent paper by Lewis and Wyatt provides a useful framework for assessing risk in this regard, and standards are available to help NHS organisations manage the clinical risks associated with the deployment and use of Health IT systems. The creation of internal app stores by NHS Trusts may be a useful means of promoting the use of appropriately vetted apps among the employees.

Going forward, NHS organisations must ensure that their IT infrastructures (such as Wi-Fi provision) and policies (such as ‘bring your own devices’ policies) are updated to support the safe and secure use of smartphones and medical apps by front-line staff who have adopted these technologies in the work place in large numbers.

Limitations

Several limitations were identified in this study.

First, a relatively low response rate was noted. A large proportion of staff failed to open email invitations. This may partly be explained by inaccuracies in staff listings. While the NHS Trust’s governance department could guarantee lists were up-to-date with current staff, they could not give assurances that all the names of the previous staff had been removed. Consequently, response rates may have been higher than those quoted.

Second, the survey was only performed at a single NHS Trust. While this represents a limitation, it should be noted that the investigated Trust consists of five individual hospital sites of varying size, with a mix of teaching and non-teaching units, increasing the generalisability of results.

Third, several survey questions asked if staff had sent ‘patient-related clinical information’ over their smartphones. While this term is not synonymous with ‘patient-identifiable data’, it was purposefully chosen in response to feedback obtained during initial survey piloting. The pilot cohort of doctors and nurses feared answering such questions truthfully, in spite of assurances that responses were fully anonymised, due to a sense of self-incrimination.

Finally, although the survey had not been validated prior to its use, validity was assessed in the survey by asking respondents to what extent they agreed that the survey had adequately explored their uses of smartphones and medical apps at work. Only a very small minority disagreed (4.3%) with this statement, providing evidence of face and content validity.

CONCLUSION

The findings from this study demonstrate that smartphones have become increasingly popular among healthcare professionals who perceive them to be an excellent tool in supporting healthcare delivery. The results provide strong evidence that healthcare organisations need to develop policies to support the safe and secure use of digital technologies in the workplace and that strategies are needed to secure further innovations in digital health.

Correction notice This article has been corrected since it was published Online First. Text changes have been made on pages 1 and 3.

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Contributors MHM, DK, MJ, SG, SP and AD contributed to the study conception and design. MHM and DK contributed to analysis and interpretation of the data and drafted the manuscript. SG, SP and AD contributed to critical revision.

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REFERENCES


5 Whittaker R. Issues in mHealth: findings from key informant interviews. *J Med Internet Res* 2012;14:e129.


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