



A UK perspective on smartphone use amongst doctors within the surgical profession



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HIGHLIGHTS

- Doctors use their own mobile devices to support their work due to limitations in time and space.
- Of those surveyed >90% owned a smartphone.
- 80% owning smartphones were willing to use their own device within the workplace in a 'BYOD' manner.
- >50% of smartphone users own medical apps and >85% use the Internet to access medical information.
- It may be valuable to further develop software that recognises this potential of mobile access.

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ABSTRACT

Introduction: Hospitals are increasingly looking for mobile solutions to meet their information technology needs. Medical professionals are using personal mobile devices to support their work, because of limitations in both time and space. Our aims were to assess smartphone use amongst UK surgical doctors, the prevalence of medical app use and online activity.

Methods: A thirteen-item questionnaire was derived to identify the proportion of surgical doctors of all grades using smartphones within the workplace. The following factors were evaluated: use of medical apps; use of online medical resources and if users were willing to use their own smartphone for clinical use.

Results: A total of 341 participants were surveyed with a complete response rate: 93.5% of which owned a smartphone, with 54.2% of those owning medical apps and 86.2% using their device to access online medical resources.

Junior doctors were more likely to use medical apps over their senior colleagues ($p = 0.001$) as well as access the Internet on their smartphone for medical information ($p < 0.001$).

Overall, 79.3% stated that they would be willing to use their smartphone for clinical use, which was found not to be dependent on seniority ($p = 0.922$).

Conclusion: Online resources contribute significantly to clinical activities with the majority of smartphone users willing to use their own device. The information gathered from this study can aid developers to create software dedicated to the smartphone operating systems in greatest use and to potentially increase the use of a bring your own device (BYOD) scheme.

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1. Introduction

In 2008, the Apple iPhone 3G (Apple Inc., USA) was released along with a dedicated application ('App') store, which allowed self-contained programs designed to fulfil a particular purpose to

be downloaded to a device. This technology was subsequently applied to other mobile operating systems.

In November 2012, the UK's Department of Health issued a mandate setting out objectives for the National Health Service (NHS) Commissioning Board to make progress in four key areas, including the use of technology [1].

An increased uptake of smartphones has allowed the use of Internet accessible devices to aid information retrieval within the workplace. The use of information technology (IT) within health-care has become ubiquitous [2].

Hospitals are increasingly looking for mobile solutions to aid both clinical care and research [3]. As a result, a gradual shift in the focus of mobile healthcare has taken place in hospitals. This has been partly due to a greater proportion of medical professionals considering use of mobile devices to support their work because of limitations in time and space [4]. A possible solution to this issue is to make use of those that already own smartphones in a 'bring your own device' (BYOD) scheme, which has adopted by numerous industries, including local councils in the UK [5].

Several reviews have highlighted the roles of smartphone technology within the hospital workplace in addition to flexible communication via multiple modalities such as voice calls, short message services (SMS) texts and e-mail [6–8]. These include: portability; rapid access to online information; use of medical mobile applications and multimedia resources as reference/decision-aiding tools and potential access to patient records.

Due to the limited availability of desktop workstations to access patient records, request further investigations and access reference tools, a solution is required to ensure that this information can be accessed promptly on the go. Improved efficiency was observed amongst resident physicians in the US following the introduction of Apple iPads into the workplace to access medical records [9].

Our study chose to focus on the use of smartphone technology amongst doctors working within surgical specialties in the UK. Our aims were to identify the prevalence of smartphone ownership, medical app use and relevant online activities; and in addition if smartphone users would be happy to use their own device for clinical use. An additional aim was to identify if there was any scope for future app development.

2. Materials and methods

A thirteen-item questionnaire (Fig. 1) was derived based on the authors' experiences and critical appraisal of the current medical literature regarding smartphone use [10–12]. Pre-testing of the questionnaire was performed locally within the authors' own departments to determine suitability and comprehension of the questions.

The study identified the following factors:

- Demographics
- Smartphone ownership
- Medical apps owned
- Frequency of app use
- Use of internet search engines and websites accessed for medical use
- Whether there was any scope for app development
- Whether the participant would be happy to use their smartphone in a BYOD manner

2.1. Participant selection

Participants included training and non-training grade doctors of ascending level (from Foundation Year doctors; Core Trainees and

Age	Gender		Male / Female
Current position	FY1 Core Trainee Trust Grade SASG/Associate specialist Consultant Other (Please state):		FY2 Specialty Trainee
Current specialty			
Do you own a Smartphone/Tablet? If so, what?	Yes/No	iPhone / iPad / Blackberry / Android / Windows Other:	
Do you own any medical apps that aid with work?	Yes/No	If so, which ones?	
Do you have a favourite work-related app? (Name)			
How often do you use any of the medical apps?	Daily / Weekly / Rarely / Never		
Do you use an internet search engine on your smartphone or tablet to access relevant medical information?	Yes / No		
How often do you use an internet search engine to access medical information?	Daily / Weekly / Rarely / Never		
Are there any specific websites that you use to access medical information?	Google or other search engine / eMedicine / UpToDate / Wikipedia / NICE/patient.co.uk / Hospital intranet Other:		
Are there any medical apps that you would like to use that aren't currently available?			
If you were required to use a smartphone for hospital based work - would you be happy to use your own?	Yes / No		

Fig. 1. Questionnaire: A survey to assess smartphone use amongst surgical doctors.

Trust Grade doctors; Clinical Research Fellows, Specialty Trainees and Staff & Associate Specialist Grades (SASG) to Consultancy) working within surgical specialties. The questionnaire was distributed by hand to individuals at a national meeting and at nine regional meetings in three deaneries (Yorkshire & Humber, Mersey & East Midlands).

Survey distribution was carried out by the authors approaching individual delegates during breaks in the designated refreshments area with the questionnaire. Questionnaires were collected immediately upon completion and placed into a document wallet. The study was performed over a 6-month period (June 2013 to November 2013). The questionnaires were delivered in paper form and collected after completion to ensure an optimal response rate. All participants were made aware that completion of the questionnaires was voluntary and that completion was taken as consent to participate within the study. No incentives were offered to the participants. Participants were asked whether they had previously participated in the survey prior to completing a form to avoid duplication.

Although a proportion of the foundation doctors were not currently on a surgical firm, they had all worked within a surgical team within the previous 12 months. We chose to include this group, as their role was likely to be very similar despite the change in specialty. Surgical nurse specialists were also approached with the questionnaire.

Ages were categorised in four groups: Under 30, 30–39, 40–49 and Over 49.

Doctors were also grouped according seniority with Consultants and Staff & Associate Specialist Grades categorised as Senior and all other grades classed as Junior.

Due to the vast range of apps listed by the participants, apps were classified according to function as deemed by two independent researchers after mutual agreement (RKP & AES). The categories that they were divided into were as follows: drug reference guides; clinical calculators; reference guides/handbooks; portfolio/logbooks; journals; revision; other/miscellaneous (if they could not be classified into the above categories). Apps with multiple functions were classified according to their primary function.

Suggestions for app development were cross-referenced with existing app databases, as deemed by the two independent researchers as above.

Statistical analysis was performed using SPSS Statistics 20 for Mac (IBM, USA).

Pearson's chi-squared test was used to evaluate levels of independence. A p value of ≤ 0.05 was considered significant and thus reject the null hypothesis.

3. Results

A total of 341 unique responses were received, with all health professionals approached agreeing to participate. The median age of the participants was 32 years (range 23–65) with a male predominance (231/341; 67.7%). Over 95% (326/341) of those questioned were doctors (Table 1) and the predominant specialty was general surgery in 46.0% (157/341) (Table 2).

In total 319 participants (93.5%) owned a smartphone with the iPhone being the most common device used (214/319; 67.1%) (Fig. 2).

Of those who owned a smartphone, 173/319 (54.2%) downloaded medical apps with 70.5% (122/173) of these using their apps either daily and weekly (Fig. 3).

The most commonly used medical apps were British National Formulary (BNF) (70/173; 40.5%), eLogbook (30/173; 17.3%) and MedCalc (27/173; 15.6%). Amongst the total number of apps owned, reference guides/handbooks (95/333; 28.5%) were the most common type of app downloaded, followed by drug reference guides (77/333; 23.1%), and clinical calculators (71/333; 21.3%). However, when looking specifically at senior doctors, the most common type of app utilised was clinical calculators followed by reference guides/handbooks and then drug reference guides.

Internet search engines were used to access medical information by 86.2% (275/319) of smartphone owners with 42.2% (116/275) of these participants accessing this information daily (Fig. 4).

The most commonly accessed websites were Google or other search engines (211/275; 76.7%), followed by the National Institute for Health and Clinical Excellence (NICE) (100/275; 36.4%) and Wikipedia (91/275; 33.1%).

When questioned whether there were any apps that participants would like to use that were not currently available, 91.8%

(313/341) did not make any suggestions, with 18.5% (63/341) specifically commenting that they were unsure what apps were available or suggesting apps that were already available.

Of the 319 smartphone users, 253 (79.3%) stated that they would be happy to use their smartphone for hospital based work.

Although no significant association was found between gender and owning medical related apps ($p = 0.376$), a significantly greater proportion of males were observed to access the Internet on their smartphone for medical information (89.4% vs 78.4%; $p = 0.009$). Gender was not noted to be an influential factor in whether participants were willing to use their own smartphone for clinical use ($p = 0.077$).

Only 15 (4.4%) responses were received from surgical nurse specialists and therefore we are unable to make any conclusions based on this limited number. A greater proportion of junior doctors when compared to their senior colleagues owned medical apps (61.7% vs 40.5%; $p = 0.001$). Juniors were also more likely to access medical information via the Internet on their smartphone (90.9% vs 75.0%; $p < 0.001$). However no significant difference was observed between junior and senior clinicians regarding willingness to use their smartphone for hospital based work (79.1% vs 78.7%; $p = 0.922$). These findings were also mirrored when comparing age groups.

4. Discussion

All of the individuals approached agreed to participate in the survey and therefore the results are likely to be representative of doctors working within the surgical specialty. Although a greater proportion of younger and more junior doctors were surveyed, this is representative of the structure of a surgical firm, where there is a pyramidal structure in hierarchy. A greater proportion of the participants were male, which is again representative of those working within a surgical specialty, where approximately only a quarter of trainees are women [13].

Devices 4 (D4) Limited carried out a survey of health professionals in the UK in 2010, where they used an online questionnaire to identify mobile phone usage [14]. They received 474 valid responses, of which only 161 were doctors. Of their total responses, 81% used a smartphone, however only 30% of doctors used work related software apps. Our study identified a higher proportion that owned smartphones and used work related apps, which is likely due to a greater uptake in smartphone use, due to increased availability and decreased cost, as well as a vast increase in the number of work-related apps available [15,16]. Due to the method in which the survey was delivered, the response rate was not quantified and there was also likely to be a selection bias due to health professionals with an interest in technology being more likely to complete an online survey.

Our results for the proportion of doctors owning smartphones and using medical related apps are similar to the American surgical cohort in Franko and Tirrell's 2012 study in that over 90% of

Table 1
Table demonstrating the grade/level of participants.

Current grade	Level	Number of participants	Percentage of participants
Foundation year	Junior	99	29.0%
Core Trainee		21	6.2%
Trust grade		14	4.1%
Clinical Research Fellow		14	4.1%
Specialty Trainee		87	25.5%
Staff & Associate Specialist Grade (SASG)	Senior	9	2.6%
Consultant		82	24.0%
Surgical nurse specialist	N/A	15	4.4%
Total		341	100%

Table 2

Table demonstrating the current specialty of participants. (Note that some of the foundation doctors surveyed were working within a non-surgical specialty at the time of the survey, but had all worked within a surgical specialty within the previous 12 months.)

Current specialty	Number of participants	Percentage of participants
General surgery	157	46.0%
Vascular surgery	14	4.1%
Urology	71	20.8%
Ear Nose & Throat (ENT)	20	5.9%
Plastic surgery	6	1.8%
Trauma & Orthopaedics	13	3.8%
Paediatric Surgery	3	0.9%
Neurosurgery	14	4.1%
Transplant surgery	3	0.9%
Other non-surgical specialties	40	11.7%
Total	341	100%

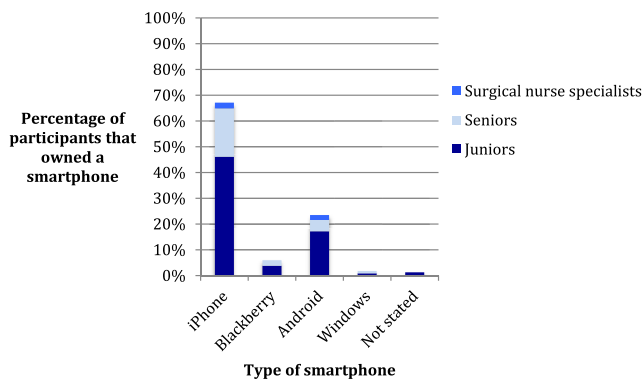


Fig. 2. Bar chart illustrating the type of smartphone owned by the participants.

participants owned a smartphone and approximately half owned medical related apps [11]. Their study used an e-mailed survey delivered to American doctors across 27 specialties. Although they received 3306 responses; only 844 worked within surgery and other surgical subspecialties. Although they found a trend towards decreasing app use with increased training level, this was not deemed significant.

As this study was also carried out online, it unfortunately suffers from the same selection bias as D4's study. Although a large group was surveyed, the targeted doctors worked within a variety of specialties and thus combining the results made it difficult to draw conclusions that were applicable to individual specialties.

As expected, younger/junior doctors were significantly more likely to use medical apps over their older/senior colleagues ($p \leq 0.01$). Over 85% used an Internet search engine to access medical information either daily or weekly, suggesting that online

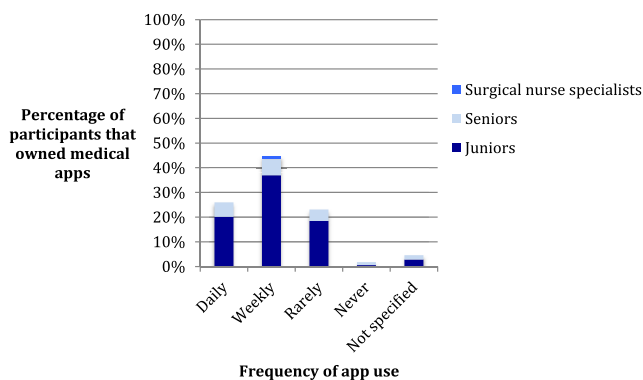


Fig. 3. Bar chart illustrating the frequency of use amongst those owning medical apps.

resources significantly contribute to clinical activities. The majority of users did not visit specific websites for medical information and chose to use a search engine to identify relevant information.

A proportion of doctors (18.5%) made suggestions for apps that were already in existence or specifically commented about their uncertainty over the catalogue available. In Wallace *et al's* study, 47% of the participants agreed with the statement, 'I feel as though I don't know enough about what is out there to effectively use my smartphone,' which would support our finding of participants lack of knowledge over available apps [7].

It is worth being vigilant when using medical apps, as inaccuracies have been identified, which may compromise their safety and value [17–19].

Due to concerns over the validity of information, Apple has requested app developers to provide reference sources for the information relayed, but it is currently unclear whether the parties policing this are merely looking to remove plagiarism and what medical qualifications they possess [20]. It should also be considered that app content may not be valid in the country of practice.

The UK's Medicines and Healthcare products Regulatory Agency (MHRA) in March 2014 published guidance on medical device stand-alone software including apps [21]. This stated what actually constituted a medical device, including software making recommendations based on patient entered data, and if complex calculations are carried out which replaces the clinician's own calculations.

The NHS Choices Health Apps Library was released in March 2013, with the aim of providing a source for apps that have been reviewed to ensure 'that they are relevant to people living in the UK, comply with data protection laws and comply with trusted sources of information' [22]. However the apps listed are targeted at patients and are unlikely to be used within the workplace.

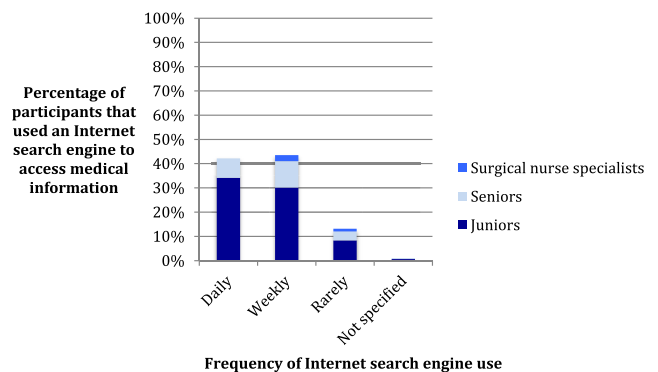


Fig. 4. Bar chart illustrating the frequency of Internet use amongst those using their smartphones to access medical information.

Given the complexity of formally regulating the thousands of medical apps available, peer review as that carried out by iMedicalApps and Medical App Journal can provide evaluation. iMedicalApps is an online resource that has been regarded as an evidence-based trusted website by the Cochrane Collaboration [23]. Although both of these are valuable resources, their primary audience is the American market and therefore may not be applicable to doctors working within the UK. The US company Haptique™ attempted to develop an “App Certification Program”, but this was suspended due to the complex nature of carrying out such a substantial task [24].

4.1. Smartphone use within the workplace

Prgomet *et al's* (2009) systematic review demonstrated the beneficial role of handheld technology within a hospital setting, particularly where there may be a deficiency in the availability of desktop workstations [25]. These benefits include rapid response to diagnostic results, the prevention of medication errors and improvement of data management and accessibility. They also demonstrated that the wireless transmission of investigatory patient data to the relevant physicians handheld device was feasible for diagnosis and could expedite treatment by allowing earlier notification, resource preparation and mobilisation of staff.

Several hospitals in the UK have responded to the requirement of information on the go and have created their own apps with trust policies and management advice in line with national guidelines. An example of this includes Rx Guidelines which enables access to local guidelines including local antibiotic prescribing policies [26].

The majority of respondents owned smartphones and were willing to use them for clinical use. Over 90% of smartphone users owned either an iPhone or an Android device. This information will enable trusts to develop software specific to the most commonly used smartphone operating systems.

However there are currently several concerns with the use of smartphones in a BYOD manner, including public perception; social use within the workplace; information security and protection; and validity of resources available [27,28]. Almost 80% of those surveyed stated that they would be happy to use their smartphone for clinical use, however there were some concerns stated by a few of those surveyed.

Several of the participants, particularly the junior doctors commented that they were concerned about using smartphones within the workplace for fear of appearing rude in front of senior colleagues and patients, as they may incorrectly think that they are using their smartphones for social use. Therefore this stigma associated with smartphone use must also be broken to ensure that they can be used in a professional manner. Another concern raised was access of online material on smartphones within hospitals being difficult due to poor signal quality. Many hospitals now have free access to Wi-Fi, which would enable access to important online resources, as well as preventing access to sites deemed inappropriate.

In addition to misuse of smartphone technology within the workplace, opponents also cite that they may pose a distraction within certain areas such as within theatres and local policies may need to be implemented to govern use [29,30]. Although there are concerns whether these devices pose an additional risk of potentially pathogenic bacteria, this may be reduced by introducing comprehensive guidelines with regards to decontamination similar to that of medical equipment [31].

Wallace *et al's* study examining the attitudes of medical students and resident doctors in Canada to the use of mobile computing devices in medical education acknowledged several challenges including: superficial learning (i.e. failure to internalise

knowledge); concerns over the validity of resources; distraction within the clinical environment; concerns about information privacy if required to access patient information and blurring of personal/professional boundaries (i.e. personal use) [7]. However with careful planning and instigation of policies governing use, these concerns can be overcome. The most difficult of which will be the policing of BYODs for personal use within the workplace and truly overcoming this would require trusts to provide employees with their own devices, which would be very costly.

4.2. Study limitations

Our total number of participants was only 341, which is lower than that of Franko's and Tirell's American study, however despite this, we feel that our results are more representative of the survey population due to the high response rate and the lack of a selection bias inherent in an e-mailed survey. A possible bias of our study participants was the use of national and regional meetings to recruit participants. Those attending these meetings are likely to have a keen interest in medical research and therefore may be more willing to participate in research studies.

Although, junior doctors were significantly more likely to use medical related apps, the cohort of junior doctors was larger than that of the senior doctors. We acknowledge that junior doctors, particularly foundation doctors may utilise smartphones in a different manner to more senior colleagues particularly due to requirement for ward-based duties. However as they form an essential part of the surgical team, we chose to include their responses in our study. We chose to exclude medical students from the survey as it was felt that the use of medical apps in this demographic would be for studying and primary learning, rather than to aid patient care whilst working on the wards.

The majority of the participants worked within a general surgical specialty and although general surgery is one of the two most commonly subscribed to specialties along with trauma & orthopaedics, the study may not be truly representative of some of the other subspecialties.

Although the questionnaire was designed to evaluate Internet use specific to smartphones, the question asked did not directly enquire as to whether this use was limited to a smartphone. The results have suggested a lack of knowledge over the current catalogue of medical related smartphone apps, however this was not definitively evaluated by the study.

5. Conclusion

Greater than 90% of those surveyed owned a smartphone, with 80% of those willing to use their own device within the workplace in a BYOD manner.

With over 50% of smartphone users owning medical apps and over 85% using the Internet to access medical information, this would suggest that online resources contribute significantly to clinical activities. With several trusts in the UK recognising this current practice, it may be valuable to further develop software that recognises the potential of mobile access to information that is validated.

The information gathered from this study can aid developers to create software dedicated to the platforms in greatest use, to potentially increase the use of a BYOD scheme.

The majority of participants did not have any relevant suggestions for app development, which may suggest that there is an uncertainty over the catalogue available. Given concerns voiced in both our study and the work of others questioning the reliability of available resources, a possible solution would be the creation of a UK based app directory to outline availability with verification of

performance and validity. However given the complexity of this regulation, peer review specific to the UK may have to suffice.

Conflict of interest statement

All authors declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no the relationships or activities that could appear to have influenced the submitted work.

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Ethical approval

Not applicable.

Consent

Not applicable.

Author contribution

Rikesh K Patel (RKP), Adele E Sayers (AES), Jonathan Armitage (JA) & Iain Andrew Hunter (IAH) were responsible for study conception and design. RKP, AES, Nina Louise Patrick (NLP) & Kaylie Hughes (KH) were responsible for acquisition of data. RKP & AES were responsible for analysis and interpretation of data. RKP, AES & IAH were responsible for drafting the article. All authors were responsible for final approval of the version to be published.

Guarantor

Rikesh Patel, Adele Sayers & Iain Andrew Hunter.

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