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REVIEW ARTICLE

"Apps, Phones and Tabs" the Role of Technology in Bedside Teaching

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Abstract: Bedside teaching is a mainstay of medical education. The development of clinical and practical skills, the use of patient centered care and the team approach cannot be underestimated, although bedside teaching has seen a decline over the recent period. This is possibly due to a combination of patient embarrassment, the pressure placed on doctors to maximize patient treatment time and shorten their stay in hospital, and the recognized effect on training by the European Working Time Directive.

Technology has strongly influenced the development of medicine over the ages, and since the introduction of mobile technology, it has advanced dramatically over the last two decades. The ease of access to a worldwide source of medical opinion has meant that education for both doctors and patients can be hand held and ever present, including at the bedside, with smartphones and tablet computers now an integral part of modern day life.

This review will focus on the potential role and ability of the app to modernise a traditional teaching method, both for the junior doctor and medical student and for the impact on patient education.

Keywords: Bedside teaching, App, Mobile technology, Education.

INTRODUCTION

Bedside teaching is a mainstay of medical education. It has been a part of student and doctor training since the early days of hospital care. The development of clinical and practical skills, the use of patient centered care and the team approach cannot be underestimated, although bedside teaching has seen a decline over the recent period.

Technology has strongly influenced the development of medicine over the ages, and since the introduction of mobile technology, it has advanced dramatically over the last two decades. The ease of access to a worldwide source of medical opinion has meant that education for both doctors and patients can be hand held and ever present, including at the bedside, with smartphones and tablet computers now an integral part of modern day life.

BEDSIDE TEACHING; EDUCATING THE PATIENT AND DOCTOR

Bedside teaching is a well-established traditional method of educating medical students and junior doctors. Unlike other professions, there is an obligation that doctors 'are prepared to contribute to teaching and training doctors and students' as set out in the GMC Good Medical Practice guidance [1].

Studies have suggested that this method of teaching may be on the decline in modern medical education. One study indicated that only 17% was performed at the bedside [2]. This has been attributed to patient barriers such as embarrassment and humiliation [3].

Great value however has been placed upon bedside teaching including the development of practical skills, re-enforcing the concept of delivering patient centered care and encouraging team building between colleagues and patients. The student is introduced to the art of professionalism, humanism and the conversion of academic knowledge

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into clinical acumen [4]. One study demonstrated that patients found the experience positive, allowing them to express their feelings about their condition [3].

TECHNOLOGY; MOBILE, HANDHELD, WORLDWIDE, ALL HOUR ACCESS

Advancing technology has always influenced the evolution of modern medicine. There has been a belief that diagnosis and treatment of disease could one day be possible using a handheld applicator, a feeling most characterized by the 'tricorder' described in the popular 1960's cult TV series Star Trek [5]. Although this is still science fiction for the most part, the rapid development of technology allowed the hand held computer to become a symbol of the current day, with smartphones, hand held tablets and personal digital assistant use accepted as normal. In particular, smartphone and tablet devices have started to change the working day of the healthcare professional both as a personal and professional device. These devices make use of applications (more commonly known as 'apps'), which are software platforms that may be downloaded to a target smart device. At their conception, apps served to improve productivity and information retrieval (*e.g.* email access, calendars, weather updates). Apple's introduction of the iPhone in 2007 (Apple Inc, Cupertino, CA, USA) is arguably thought of as the birth of the smartphone, and since this time both itself and rival companies have created a massive market worldwide for mobile technology.

With growing demand and blossoming popularity the app market has rapidly grown to a £15 billion industry [6]. A browse through the virtual store today reveals a myriad of downloadable apps covering a variety of domains; social, entertainment, consumerism, and health to name but a few.

Health apps can be divided into several categories depending upon their target audience. Mosa *et al*. [7] defined these as apps for healthcare professionals, for medical and nursing students and for patients.

Across this spectrum they are targets towards patient care and monitoring, generic layperson health advice, as well as a portable reference device, for research and education.

One study [8], based on the Italian android system, showed an average download of 3,000 for the top 500 medical based applications with 53% aimed at medical professionals although 19% of these came under the medical tool or reference category. Of the 45% designed for personal health, a similar percent (16%) were aimed at body welfare or woman affairs, such as fertility and pregnancy recording.

It should also be noted that prior to the portable access to the web, the internet itself created a mass market for educational websites, both those verified and non-verified by the health profession. In fact, it is not uncommon for doctors to direct patients to verified websites to gain more knowledge on specific diagnosis and treatments.

MERGING THE TWO FIELDS

The merging of medicine and internet technology has created new terms for this developing field.

eHealth has arisen as a paradigm involving the concepts of health, technology, and commerce, with commerce and technology as tools in the service of health [9].

From eHealth, a further term mHealth, has been generated. The Global Observatory for eHealth (GOe) of the World Health Organization (WHO) defines mHealth or mobile health as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" [10].

In August 2010, only four months after the public release of the popular Apple tablet the iPad (Apple Inc, Cupertino, CA, USA), three medical schools put the new technology to the test [11]. Upon starting medical school not only were new students issued with a white coat at the induction ceremony, but also an iPad, complete with digital versions of all the recommended textbooks for their first year. The reflections from their innovative new project make an interesting read;

They were able to deliver the curriculum electronically; students were able to pre-download all lecture slides directly onto the iPad prior to attending tutorials. This alone saved Yale University $100,000 in one year on photocopying and distributing notes in the paper format.

Using apps such as iAnnotate allowed students to then annotate the presentation slides directly onto the document, and save the updated version. Furthermore, all notes could be saved into the virtual file hosting service - Dropbox. This synchronizes documents with other devices using cloud storage, making them accessible online or through an

alternative computing device. Students found this useful for study in situations where they did not have access to their iPad but had internet access.

This modality of downloading documents meant that the medical schools could instantaneously alert students to updated versions of the issued notes. This reinforced the concept of modern physicians keeping themselves up to date.

Not only were recommended textbooks available on the tablet device but they promoted a more interactive format. Zoom capabilities allow students to magnify high quality images and diagrams. With the swipe of a finger students could also watch videos and listen to audio files within these reference books. Previously physical copies would sometimes include a compact disc (CD) with this multimedia. Again students were able to save their personal annotations to these texts.

The iPad allowed the student to carry with them all of their textbooks, notes and lectures from the entire year, weighing in at a mere 500g, and access at the touch of a mini slim line screen. They could make use of this on the ward and on ward rounds.

Tutors also noted the improved ability of the students' ability to critically appraise. In this trial period seminars were held allowing students to discuss how they used the iPad to facilitate their learning. They were able to evaluate the quality of apps, describing their merits and limitations, and suggest potential development of the technology [11].

APPS FOR BEDSIDE TEACHING

There are a plethora of apps targeted towards medical student education. Some focus exclusively on a single topic, such as anatomy, physiology, or pharmacology. Others serve as revision tools, including podcasts [12, 13] and flashcards, or clinical scenarios.

Examples of apps which have practical applications at the bedside, are next described.

A search for 'anatomy' in the Apple Store generates a list of 876 apps. It is an understatement to suggest that many are available, and this alone highlights the popularity of this modality of learning. Some focus on specific topics such as muscles, the skeleton or are region specific whilst others are all encompassing of the body. It can almost be overwhelming in knowing where to start with so many options.

An important app to note, a familiar name to all healthcare professions is Gray's anatomy [14]. Here the renowned classical anatomical book first published in 1858 has been brought into the 21st century with complete text and all 1247 illustrations in high definition magnification. Whilst at the bedside a teacher or student may familiarise themselves with an anatomical drawing of a structure to reinforce and integrate basic sciences in the applied clinical scenario.

Other apps are designed to function as anatomy related quizzes or mock exams. Here the student can tailor quizzes on regional anatomy to consolidate what was learnt in a bedside tutorial.

Three hundred and twenty seven apps may be found under the search term 'radiology.' Again there is wide variety, some purely to educate, some to test knowledge [15]. With many examples of various imaging techniques, a radiograph may be quickly accessed by a tutor in conjunction with a patient scenario. After examining a patient's respiratory system a tutor may search for an appropriate radiograph to further assess the student's knowledge or demonstrate visually the corresponding clinical finding. Consequently, no longer does the group have to leave the bedside of the patient to view imaging, something that may disrupt the flow of the session.

The versatility of apps is demonstrated by the use of the audio function of the phone/tablet device. A key example of this is the design of many apps dedicated to heart sounds. No longer does the tutor have to recreate the classical 'whoosh' of aortic stenosis, but can use the app to play recorded heart sounds.

Other apps have been created and claim to accurately image the optic disk [16], inner ear [17], skin lesions [18], as well as record spirometry [19] and record Electrocardiograms (ECG) of the heart [20]. They are also being created to aid in pharmacy management [21].

SimMon [22] and SimMonitor [23] are examples of apps that allow a tutor to recreate live patient observations. An iPad can be placed at the bedside of either a patient or actor and set up to illustrate fictitious observations such as heart rate, respiratory rate, oxygen saturations and ECG tracing. If connected *via* Bluetooth or Wi-Fi to a smart phone the tutor can manipulate the figures from the foot of the bed. This app can facilitate the teaching of resuscitation and critical care where observations may be tailored to a particular scenario depending upon a student's interventions; for the better or worse!

Simulator patients exist for teaching in the simulated classroom however this use of an application on a tablet or phone with a real patient on a ward may help to make the situation feel less orchestrated and artificial for the student.

There have also been trials with surgical apps including use in a simulated laparoscopic scenario [24]. For the surgical trainee there are apps for recording surgical logbooks, as well as feedback and assessment apps.

The Objective Structured Clinical Examination (OSCE) is a relatively modern format of examination in medicine taking the form of a circuit of multiple stations focusing on various skills such as clinical examination, practical skills, communication skills and interpretation of results. OSCE Trainer [25] is an app providing check lists of 63 mock OSCE stations allowing examiners to mark a student's progress through a station and delivers graphical feedback of results. Pairs of students may also use this as a revision aid in preparation for exams. For example one can mark off all the components of an abdominal examination, from candidate introduction and hand washing to auscultation and then evaluate their performance from the checklist.

OSCE Timer [26] is a useful app allowing an examiner create an OSCE with exact timings. The number of stations can be entered, time limit per station, time for switchover and warnings for time remaining. This allows tailoring for various centers in accordance with the examining body guidance, or again for students to practice prior to exams.

The use of patient encounter logs has been used worldwide, both as a recording tool, and as a device to analyse both student exposure to patients and disease as well as a way of improving medical education [27 - 31].

A small study [32] into the use of six apps at the bedside showed 'Bedside teaching was enhanced by professional illustrations and animations depicting anatomy and pathophysiology. Impromptu teaching was facilitated, as resources were conveniently available on a student's smartphone or tablet. The ability to annotate and modify images and subsequently email to patients was an extraordinary improvement in provider-patient communication. Universal limitations included small smartphone screens and the novelty of new technology.' The apps here included medically orientated drawing applications [32].

Other studies have shown a majority of junior doctors and medical students owning 1-5 medically orientated apps, with 25 minute use over a 24 hour period [33]. The use of technology is not unique to the new doctors and undergraduates with a study of medical providers showing 56% of them use apps in their clinical practice [34]. Especially with the current drive towards an evidence based medicine method of teaching and clinical practice [35, 36]. They also may allow a reduction in medical error, particularly in regard to prescribing error [37, 38].

Apps have also allowed the switch from 2D to 3D, with comments on the use of audiences own smartphone and tablet being used to supplement poster and talk presentations [39, 40]. Likewise, a frequent provision of delegate apps for those attending major medical conferences has developed.

Another way to break down the increasing range of medical based apps is to divide them into categories included apps that connect to and act as an extension of a medical device (*e.g.*, remotely displaying data from a bedside monitor), apps that transform a mobile platform into a traditionally regulated medical device (*e.g.*, an iPhone as a stethoscope), and apps that allow the user to enter patient-specific information and, using formulae or processing algorithms, output a patient-specific result. This latter group includes formulation of BMI and Glasgow Coma Scale numbers [41].

Although the thought of access to a massive and instant source of information is theoretically great, it must be noted that this should not replace traditional teaching methods. Knowing information is only a click away also has created new challenges including those found across the app community involving slow and poor connection and download speeds, usability issues and troublesome input mechanisms [42].

Other cited issues include; 'App overload,' a stressful scenario, with most apps having a fragmentation of useful information on any one topic [43], the potential source of infection that these personal mobile applications may carry [44 - 46], and security of information, especially as there is a move to electronic patient records [47 - 49].

APPS FOR PATIENT EDUCATION

An important role of the physician is to educate the patient about their condition and empower them to manage their own health. It may be easy for the doctor to advice a patient to lose weight but a lot harder for the patient to find support outside of the hospital environment. Apps may provide a useful medium in bridging this gap, particularly with surveys showing 31% of mobile phone users have accessed health information and 19% of smartphone users having installed a health management app [50].

A variety of apps offer a calorie counting capability where patients can easily track their daily calorie intake. Calorie Counter & Diet Tracker by myfitnesspal.com [51] overs a facility where patients can scan in a barcode to the app database of over three million foods to track their calorie consumption.

With the same device a patient may count calorie intake and also the number burnt using GPS capabilities. When out for a walk, run or bike ride one can turn on the device, submit data about height and weight and the app tracks the route taken and calculates the distance covered and calories burnt. These results may also be uploaded to social media and networking site such as Facebook and Twitter. This brings an interesting link to the impact that a community support may impact positively on a person's weight loss.

It's perhaps unsurprising to find health apps that support patients to stop smoking. NHS choices [52] has developed an app that allows a patient to track how long they have gone without smoking (to the minute) and interestingly how much money this has saved them! Here the NHS based app delivers a daily message to patients to support smoking cessation and links to their helpline. The NHS also offers a Drinks tracker allowing patients to easily and accurately monitor and moderate their unit intake. Many other apps published by various companies are available, but it is reassuring for the healthcare professional and the patient that these apps have been approved by a recognised body.

Apps have been developed for specific chronic conditions. Many exist for diabetic patients to monitor their glucose levels and dietary intake [53].

MyAsthma [54] is an app developed by GlaxoSmithKline PLC that allows patients to enter details about their asthma and manage their chronic condition. Tips about triggers are tailored to the patient and even weather updates on pollen counts may be generated. It is not alone in asthma based apps, although care should be taken in advising these to patients as they are generally generic, and may lack appropriate information or use unsafe calculation tools [55].

Calendar facilities can help patients track their condition and health questionnaires can indicate if new treatment regimes are improving their health. This can be used on the ward and in the outpatient setting to benefit the patient and responsible consultant.

Patient based apps will continue to progress with time. It is suggested that one route to assist bedside aid are the use of patient electronic diaries to help streamline nursing care, particularly in recording and reporting post-operative pain [56].

DISCUSSION

With the impressive range of apps available it can be rather daunting knowing where to start. As with the internet the user must be cautious in sourcing and referencing of information. The quality of apps is also varied.

As with any market, the app world has both good and bad products. There is a worldwide consensus that medical advice can be both given and used inappropriately, and without some form of regulation the massive number of medically based apps allows misuse of the field.

Supported by a finding that the development of mHealth apps has a commercial and economic motivation more than a research motivation [57].

The United States of America department of Food and Drug Administration has had increased involvement in reviewing medical device software, but as a consequence of the rapidly expanding field has potentially allowed a bottlenecking effect of future applications, albeit for a point of patient safety [58].

NHS Choices launched an online 'health apps library' to the public in March 2013 [52]. Apps are reviewed by a clinical assurance team - consisting of doctors, nurses and safety specialists to log trustworthy apps to help patients manage their health. Apps are reviewed to ensure that they are relevant to people living in England, have trustworthy references and comply with the Data Protection Act so that sensitive patient information is stored correctly. Developers must submit their app for assessment by the team and by clinicians, whereby it is either approved and published or rejected. Once approved the app is under regular review.

The price of apps also plays an important factor. Some textbooks may actually be more expensive to purchase electronically than physically due to the enhancement with the multimedia applications. This may deter potential buyers; for example, it is well accepted with in the music industry that the digital format of a track is cheaper than a physical copy.

With a growing population of older patients the modern app industry may exclude a key percentage of the patient

(and medical!) population. Elderly patients traditionally do not have the same affinity with advancing technology as the younger generations. With the older population often having many comorbidities and polypharmacy, this new way of delivering healthcare is unlikely to benefit this population group.

Few senior doctors have formal qualifications in teaching methods [59]. Anecdotal evidence highlights the difficulties encountered by junior doctor when asked to teach medical students [60].

Desirable teacher traits have been described and to be perceived as 'ideal' it has been shown that teachers need to adapt their behaviour to the trainee's learning needs [61]. They ought to be inspiring, supportive and actively involve students [62]. Jeffree and Clarke present 'ten tips for teaching in the theatre tearoom' and describe the need for actively engaging the learner. This applies to both children and adults - learning is best when the student actively engages with the subject [63].

When using a tablet a tutor can quickly access pre-prepared materials at the drop of a hat, with little need for any preparation. All too often bedside teaching is delivered on an ad-hoc basis. This may combat the difficulties faced by doctors of balancing growing time pressures with the expectations of producing high quality tutorials at short notice. The use of apps at the bedside can allow a teacher to become more versatile, and access a broad spectrum of teaching aids. Cloud sharing platforms also allow tutors to email documents to students easily which may compliment a tutorial and negate the need for students to carry notebooks on the ward - encouraging more active participation than furiously writing down all the tutor has to say.

CONCLUSION

Bedside teaching creates an interactive environment for students to learn whilst emphasising the culture of patient-centered care. With this teaching method in decline it is important to consider the ways in which this technique can be revitalised. The use of a tablet or smartphone with various applications can rejuvenate this style of teaching to benefit both the student and the patient, with a multitude of medical references readily available. Multimedia, including visual and audio format also complements the various types of learning styles that students and patients may have. Care is needed though to select which apps are used ensuring they are accredited.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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REFERENCES

[1] Teaching, training, supporting and assessing, Available from: www.gmc-uk.org/guidance/good_medical_practice/teaching_training.asp

[2] Crumlish CM, Yialamas MA, McMahon GT. Quantification of bedside teaching by an academic hospitalist group. J Hosp Med 2009; 4(5): 304-7.
[http://dx.doi.org/10.1002/jhm.540] [PMID: 19504491]

[3] Majdan JF, Berg KT, Schultz KL, Schaeffer A, Berg D. Patient perceptions of bedside teaching rounds. Med Educ 2013; 47(11): 1124-5.
[http://dx.doi.org/10.1111/medu.12336] [PMID: 24117572]

[4] Gonzalo JD, Heist BS, Duffy BL, *et al.* The value of bedside rounds: a multicenter qualitative study. Teach Learn Med 2013; 25(4): 326-33.
[http://dx.doi.org/10.1080/10401334.2013.830514] [PMID: 24112202]

[5] Memory Alpha, Starfleet Tricorder, http://en.memory-alpha.org/wiki/Starfleet_tricorder

[6] Wall Street Journal. Available from: www.wsj.com/news/articles/SB10001424127887323293704578334401534217878

[7] Mosa AS, Yoo I, Sheets L. A systematic review of healthcare applications for smartphones. BMC Med Inform Decis Mak 2012; 12: 67.
[http://dx.doi.org/10.1186/1472-6947-12-67] [PMID: 22781312]

[8] Obiodu V, Obiodu E. An Empirical Review of the Top 500 Medical Apps in a European Android Market. J MTM 2012; 1(4): 22-37. v
[http://dx.doi.org/10.7309/jmtm.74]

[9] Oh H, Rizo C, Enkin M, Jadad A. What is eHealth (3): a systematic review of published definitions. J Med Internet Res 2005; 7(1): e1.
[http://dx.doi.org/10.2196/jmir.7.1.e1] [PMID: 15829471]

[10] World Health Organization mHealth: New Horizons for Health through Mobile Technologies: Based on the Findings of the Second Global Survey on eHealth (Global Observatory for eHealth Series, Volume 3). 2013-05-23

[11] Wiechmann W, Schwartz ML, Korenkiewicz J. "The Whole World In Their Hands: iPad Experiences From Three Medical Schools" Podcast. Available from: http://www.medicaleducationipad.com

[12] Mostyn A, Jenkinson CM, McCormick D, Meade O, Lymn JS. An exploration of student experiences of using biology podcasts in nursing training. BMC Med Educ 2013; 13: 12.
[http://dx.doi.org/10.1186/1472-6920-13-12] [PMID: 23360078]

[13] Meade O, Bowskill D, Lymn JS. Pharmacology podcasts: a qualitative study of non-medical prescribing students use, perceptions and impact on learning. BMC Med Educ 2011; 11: 2.
[http://dx.doi.org/10.1186/1472-6920-11-2] [PMID: 21223547]

[14] Gray's Anatomy for Students for iPad, Available from: https://itunes.apple.com/us/app/grays-anatomy-for-students/id429405125

[15] Székely A, Talanow R, Bágyi P. Smartphones, tablets and mobile applications for radiology. Eur J Radiol 2013; 82(5): 829-36.
[http://dx.doi.org/10.1016/j.ejrad.2012.11.034] [PMID: 23312700]

[16] Available from: https://www.d-eyecare.com/en_US/product#features

[17] Available from: https://www.cellscope.com/clinicians

[18] Skin Vision, Available from: https://skinvision.com/

[19] Larson EC, Goel M, Redfield M, Boriello G, Rosenfeld M, Patel SN. Tracking lung function on any phone. In: Proceedings of the 3rd ACM Symposium on Computing for Development (ACM DEV '13). ACM, New York, NY, USA, 2013, Article 29, 2 pages.
[http://dx.doi.org/10.1145/2442882.2442917]

[20] Available from: https://www.alivecor.com/en/

[21] Aungst TD. Medical applications for pharmacists using mobile devices. Ann Pharmacother 2013; 47(7-8): 1088-95.
[http://dx.doi.org/10.1345/aph.1S035] [PMID: 23821609]

[22] iTunes Preview, Available from: https://itunes.apple.com/us/app/simmon/id364731597

[23] SimMonitor, Available from: http://appshopper.com/medical/simmonitor

[24] Bahsoun AN, Malik MM, Ahmed K, El-Hage O, Jaye P, Dasgupta P. Tablet based simulation provides a new solution to accessing laparoscopic skills training. J Surg Educ 2013; 70(1): 161-3.
[http://dx.doi.org/10.1016/j.jsurg.2012.08.008] [PMID: 23337687]

[25] OSCE Trainer, Available from: http://www.appbrain.com/app/osce-trainer/edu.one2onemedicine.oscetrainer

[26] Appcort, Available from: http://appfinder.lisisoft.com/app/osce-timer.html

[27] Pipas CF, Carney PA, Eliassen MS, *et al.* Development of a handheld computer documentation system to enhance an integrated primary care clerkship. Acad Med 2002; 77(7): 600-9.
[http://dx.doi.org/10.1097/00001888-200207000-00004] [PMID: 12114137]

[28] Kurth RJ, Silenzio V, Irigoyen MM. Use of personal digital assistants to enhance educational evaluation in a primary care clerkship. Med Teach 2002; 24(5): 488-90.
[http://dx.doi.org/10.1080/0142159021000012513] [PMID: 12450468]

[29] Bertling CJ, Simpson DE, Hayes AM, Torre D, Brown DL, Schubot DB. Personal digital assistants herald new approaches to teaching and evaluation in medical education. WMJ 2003; 102(2): 46-50.
[PMID: 12754909]

[30] Ho K, Lauscher HN, Broudo M, *et al.* The impact of a personal digital assistant (PDA) case log in a medical student clerkship. Teach Learn Med 2009; 21(4): 318-26.
[http://dx.doi.org/10.1080/10401330903228554] [PMID: 20183359]

[31] Blaya JA, Fraser HS, Holt B. E-health technologies show promise in developing countries. Health Aff (Millwood) 2010; 29(2): 244-51.
[http://dx.doi.org/10.1377/hlthaff.2009.0894] [PMID: 20348068]

[32] Markman TM, Sampognaro PJ, Mitchell SL, *et al.* Medical student appraisal: applications for bedside patient education. Appl Clin Inform 2013; 4(2): 201-11. Apr 24
[http://dx.doi.org/10.4338/ACI-2013-01-R-0007]

[33] Payne KB, Wharrad H, Watts K. Smartphone and medical related App use among medical students and junior doctors in the United Kingdom (UK): a regional survey. BMC Med Inform Decis Mak 2012; 12: 121.
[http://dx.doi.org/10.1186/1472-6947-12-121] [PMID: 23110712]

[34] Franko OI, Tirrell TF. Smartphone app use among medical providers in ACGME training programs. J Med Syst 2012; 36(5): 3135-9.
[http://dx.doi.org/10.1007/s10916-011-9798-7] [PMID: 22052129]

[35] Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isnt. BMJ 1996; 312(7023): 71-2.
[http://dx.doi.org/10.1136/bmj.312.7023.71] [PMID: 8555924]

[36] Soma DB, Homme JH, Jacobson RM. Using tablet computers to teach evidence-based medicine to pediatrics residents: a prospective study. Acad Pediatr 2013; 13(6): 546-50.

[http://dx.doi.org/10.1016/j.acap.2013.05.028] [PMID: 24238681]

[37] Prgomet M, Georgiou A, Westbrook JI. The impact of mobile handheld technology on hospital physicians work practices and patient care: a systematic review. J Am Med Inform Assoc 2009; 16(6): 792-801.
[http://dx.doi.org/10.1197/jamia.M3215] [PMID: 19717793]

[38] Lindquist AM, Johansson PE, Petersson GI, Saveman BI, Nilsson GC. The use of the Personal Digital Assistant (PDA) among personnel and students in health care: a review. J Med Internet Res 2008; 10(4): e31.
[http://dx.doi.org/10.2196/jmir.1038] [PMID: 18957381]

[39] Hutchins BI. Embed dynamic content in your poster. Sci Signal 2013; 6(260): tr1.
[http://dx.doi.org/10.1126/scisignal.2003623] [PMID: 23362241]

[40] Atherton S, Javed M, Webster S, Hemington-Gorse S. Use of a mobile device app: a potential new tool for poster presentations and surgical education. J Vis Commun Med 2013; 36(1-2): 6-10.
[http://dx.doi.org/10.3109/17453054.2013.790794] [PMID: 23641759]

[41] FDA. Draft Guidance for Industry and Food and Drug Administration Staff Mobile Medical Applications available at http://www.fda.gov/downloads/Medical Devices/DeviceRegulationandGuidance/GuidanceDocuments/UCM263366.pdf. 2011.

[42] Lobo D, Kaskalogly K, Kim CY, Herbert S. Web usability guidelines for smartphones: A synergic approach. Int J Inf Electron Eng 2011; 13: 33-7.

[43] van Velsen L, Beaujean DJ, van Gemert-Pijnen JE. Why mobile health app overload drives us crazy, and how to restore the sanity. BMC Med Inform Decis Mak 2013; 13: 23.
[http://dx.doi.org/10.1186/1472-6947-13-23] [PMID: 23399513]

[44] Albrecht UV, von Jan U, Sedlacek L, Groos S, Suerbaum S, Vonberg RP. Standardized, App-based disinfection of iPads in a clinical and nonclinical setting: comparative analysis. J Med Internet Res 2013; 15(8): e176.
[http://dx.doi.org/10.2196/jmir.2643] [PMID: 23945468]

[45] Gould D. Commentary: Ulger F *et al.* (2009). Are we aware how contaminated our mobile phones with nosocomial pathogens? Nurs Crit Care 2009; 14(4): 213-4.
[http://dx.doi.org/10.1111/j.1478-5153.2009.00345.x] [PMID: 19531040]

[46] Akinyemi KO, Atapu AD, Adetona OO, Coker AO. The potential role of mobile phones in the spread of bacterial infections. J Infect Dev Ctries 2009; 3(8): 628-32.
[http://dx.doi.org/10.3855/jidc.556] [PMID: 19801807]

[47] Lin B, Vassar JA. Mobile healthcare computing devices for enterprise-wide patient data delivery. IJMC 2004; 4: 343-53.
[http://dx.doi.org/10.1504/IJMC.2004.005855]

[48] Bønes E, Hasvold P, Henriksen E, Strandenaes T. Risk analysis of information security in a mobile instant messaging and presence system for healthcare. Int J Med Inform 2007; 76(9): 677-87.
[http://dx.doi.org/10.1016/j.ijmedinf.2006.06.002] [PMID: 16931132]

[49] Kharrazi H, Chisholm R, VanNasdale D, Thompson B. Mobile personal health records: an evaluation of features and functionality. Int J Med Inform 2012; 81(9): 579-93.
[http://dx.doi.org/10.1016/j.ijmedinf.2012.04.007] [PMID: 22809779]

[50] Mobile health 2012. Washington, D.C: Pew Research Center's Internet & American Life Project 2012.

[51] Lose Weight with MyFitnessPal, Available from: http://www.myfitnesspal.com/

[52] NHS Choices - Healthy apps library, Available from: http://apps.nhs.uk/about/NHS

[53] Klonoff DC. The current status of mHealth for diabetes: will it be the next big thing? J Diabetes Sci Technol 2013; 7(3): 749-58.
[http://dx.doi.org/10.1177/193229681300700321] [PMID: 23759409]

[54] NHS Choices - Healthy apps library, Available from: http://www.myasthma.com

[55] Huckvale K, Car M, Morrison C, Car J. Apps for asthma self-management: a systematic assessment of content and tools. BMC Med 2012; 10: 144.
[http://dx.doi.org/10.1186/1741-7015-10-144] [PMID: 23171675]

[56] Hardwick ME, Pulido PA, Adelson WS. The use of handheld technology in nursing research and practice. Orthop Nurs 2007; 26(4): 251-5.
[http://dx.doi.org/10.1097/01.NOR.0000284655.62377.d9] [PMID: 17882103]

[57] Martínez-Pérez B, de la Torre-Díez I, López-Coronado M. Mobile health applications for the most prevalent conditions by the World Health Organization: review and analysis. J Med Internet Res 2013; 15(6): e120.
[http://dx.doi.org/10.2196/jmir.2600] [PMID: 23770578]

[58] U.S. Department Of Health and Human Services, Food and Drug Administration, Center for Devices and Radiological Health and Center for Biologics Evaluation and Research. General Principles of Software Validation; Final Guidance for Industry and FDA Staff General Principles of Software Validation; Final Guidance for Industry and FDA Staff Center for Devices and Radiological Health 2012. [Retrieved 2 June]

[59] Wilson DH. Education and training of preregistration house officers: the consultants viewpoint. BMJ 1993; 306(6871): 194-6.
[http://dx.doi.org/10.1136/bmj.306.6871.194] [PMID: 8443488]

[60] Jackson P. Learning to teach. BMJ 2009; 339: b4554.
[http://dx.doi.org/10.1136/bmj.b4554]

[61] Boor K, Teunissen PW, Scherpbier AJ, van der Vleuten CP, van de Lande J, Scheele F. Residents perceptions of the ideal clinical teachera qualitative study. Eur J Obstet Gynecol Reprod Biol 2008; 140(2): 152-7.
[http://dx.doi.org/10.1016/j.ejogrb.2008.03.010] [PMID: 18455863]

[62] Sutkin G, Wagner E, Harris I, Schiffer R. What makes a good clinical teacher in medicine? A review of the literature. Acad Med 2008; 83(5): 452-66.
[http://dx.doi.org/10.1097/ACM.0b013e31816bee61] [PMID: 18448899]

[63] Jeffree RL, Clarke RM. Ten tips for teaching in the theatre tearoom: shifting the focus from teaching to learning. World J Surg 2010; 34(11): 2518-23.
[http://dx.doi.org/10.1007/s00268-010-0719-6] [PMID: 20652699]