Review Article

Concerns about usage of smartphones in operating room and critical care scenario

ABSTRACT

Smartphones and tablets have taken a central place in the lives of health care professionals. Their use has dramatically improved the communication and has become an important learning tool as the medical information can be assessed online at anytime. In critical care settings, use of smartphone facilitates quick passage of information through E-mail messaging and getting feedback from the concerned physician quickly, thereby reducing medical errors. However, in addition to the benefits offered, these devices have become a significant source of nosocomial infections, distraction for medical professionals and interfere with medical equipments. They may also put privacy and security of patients at stake. The benefits could be severely undermined if abuse and over use are not kept in check. This review article focuses on various applications of smartphones in healthcare practices, drawback of the use of these devices and the recommendations regarding the safe use of these devices.

Key words: Distraction; healthcare; mobile applications; nosocomal infections; smartphone

Introduction

The widespread adoption of the internet and the rapid evolution of networks and devices have changed the way public servants work. They have improved the ability to communicate, collaborate and share information and expertise. Smartphones are becoming part and parcel of our everyday lives. They serve as a means to quickly fulfil tasks at home as well as at our workplaces. These devices have penetrated the market in every industrial sector and professional field. Smartphones are defined by Telecommunication Industry Association in 2010 "as a mobile device that offers the most advanced computing ability and connectivity available today, having intelligence similar to personal computer while offering the capabilities of mobile phones, running robust operating system (OS) software that provides platform for third party application, having more processing power and memory, multiple connections, such as Wi-Fi and Bluetooth, Multimedia applications, such as photos, music and videos and GPS functions." Examples of smartphones include Apple I phone 3G, 3GS, 4 and 4S, Google, Android based devices like Samsung Galaxy, HTC one V, Blackberry, Microsoft Windows etc., and the list is endless.

Mobile phones have become the integral part of physician's life. They are being used for personal and professional scheduling, accessing medical information, drug information and E-mails. There is a common practice to use mobiles and personal digital assistants (PDAs) by surgeons in operation theatres for professional purposes. Mobile cameras are being used for taking photographs intra operatively and to play live and recorded music during surgeries. There are

Access this article online	
Website: www.saudija.org	Quick Response Code
DOI: 10.4103/1658-354X.169483	

How to cite this article: Attri JP, Khetarpal R, Chatrath V, Kaur J. Concerns about usage of smartphones in operating room and critical care scenario. Saudi J Anaesth 2016;10:87-94.

Attri JP, Khetarpal R, Chatrath V, Kaur J

Department of Anesthesia, Government Medical College, Amritsar, Punjab, India

Address for correspondence: Dr. Joginder Pal Attri, Department of Anesthesia, Government Medical College, Amritsar - 143 001, Punjab, India. E-mail: jpattri12@yahoo.co.in

plenty of medical applications on Apple, Blackberry and Android phones to help facilitate physicians and patient communication, to place notifications and to let relatives watch the surgery from the waiting areas. The widespread adoption of mobile devices, even in low resource settings, promises to make vital signs monitoring available anywhere and at low cost. Not only this, these powerful devices provide intelligent interpretations or immediate transmission of information. There are six major smartphones (OS) platforms: Symbian OS, Palm OS, Window phones, Blackberry, IOS and Android.

In 2011, Dolan[1] reported that there were about 9000 medical health and fitness applications available for I phone alone. Search the term "medical" on I phone application store and 5012 applications are available. Smartphones software applications are becoming increasingly popular for both healthcare consumers and providers. A smartphone application is defined as a software application that runs on a smartphone or other portable devices. Smartphone applications are compact software programmes that perform specific tasks for the mobile users. There are two types of smartphone applications. The native application is that which must be installed on the device or arrives preinstalled. The web application is that which resides on a server and is accessed via the internet.

Various disease diagnostic applications are available like Johns Hopkin antibiotic guide, up to date etc. Drug reference applications that provide dosing guidelines, access to data on all pharmaceuticals that are sold in Sweden, Food and Drug Administration drug approval etc., drug doses for children and adult (drug dose net). Medical calculator applications like MedCalc which provides medical formulas calculators, uBurnlite to calculate percentage burn of body surface area. Soft forces antibiotic doses calculator is useful for treatment of patients with renal failure.

Uses of Mobile Applications in Hospital Scenario

Medical education applications include surgery notebook which keep a log of surgical cases and procedures.

Smartphone downloaded with resuscitation algorithms have the potential to improve performance in emergency scenarios. Then there are medical training applications like CPR[2] which is an application for CPR training based on both American Heart Association and European resuscitation council guidelines. iResus[3] application which provide access to UK's resuscitation guidelines algorithms. HINI swine flu update is a news reader application for swine flu outbreaks. "Recently during direct laryngoscopy for an elective case, the laryngoscope's light bulb unexpectedly failed. A flashlight smartphone app was immediately activated on the attender's smartphone and used as an alternative light source without interrupting the laryngoscope. The attender held the smartphone to the right of the resident's head so that the view of the patient's larynx was not interrupted. Due to wide angle of the flashlight, the larynx was well viewed and tracheal intubation was easily performed.[4]"

Mobile technology helps lower costs by facilitating the delivery of care and by providing the connectivity of people and healthcare providers. Easy access to reference materials, lab tests and medical records is possible with these applications. I Wander app for Android devices is used for Alzheimer's disease or dementia patients. It makes use of GPS function of smartphones to track location of patients. Social media sites help patients to cope up better with diseases like diabetes. Patient share their experiences about hypoglycemic events, insulin pumps etc. Portable electrocardiography (ECG) systems for high risk cardiac patients use smartphones attached to heart monitor to transmit heart rhythm data to health providers. ECG waveforms are analysed and those requiring special interventions are notified. An application that converts I phone into a device capable of monitoring pulse oximetry and other vital signs is also available.

3G network and the iPad have enabled the anesthesiologists to browse the Internet for journals and e-books even in their working hours. There are various literature search application like PubSearch which help to search medical literature from PubMed, disease association which is a search interface for case reports and review of reported case in PubMed/Medline, The United States National Library of Medicine, the world's largest library[5] has collection in the form of more than 7 million books, journals, technical reports, manuscripts, microfilms, photographs and images on medicine and related sciences, including some of the world's oldest and rarest works.

There are interactive blogs, allowing visitors to leave comments and even message. E.g., anesthesia today, anesthesia, pain, Intensive Care Unit, the Indian Anesthetists Forum and for the Anesthesia Consultant Blog etc. Difficult airway videos are accessible on U tube which could be of great help. Similarly PPTs are available on slide world.

The use of mobile devices for medical imaging is rapidly growing, with many traditional imaging techniques being challenged.[6] With improved image quality and rapidly declining cost, mobile health (m health) imaging has the potential to change the future of medical image capture.

Smartphone applications are used for visualisation and navigation by orthopedicians. When smartphone are connected to arthroscope,[7] live videos for accurate alignment of joint replacement implants are displayed. They are used for references regarding drug interactions and preoperative guidelines. Some apps even allow surgeons to perform simulated surgeries. They are helpful in calming preoperative jitters in children by keeping them engaged in games on smartphones. They are useful for anesthesia providers who have to watch many cases at 1-time even when they are in different locations covering many operating rooms (ORs) at 1-time.

These facilities at point of care are available at anytime from anywhere, thereby facilitating the practice of evidence based medicine at the point of care. Clinicians can educate patients regarding prophylactic measures as well as management on smartphones. Disease diagnostic applications to access the diagnosis and treatment information are now available on smartphone. Visual acuity tests are very conveniently done by ophthalmologists using smartphone application e.g., I phone has eye chart applications which include Snellen's eye chart. Eight smartphone based medical calculator applications are available namely Epocrates, Med Math, MedCalc, medical calculator, calculate archimedes, uBurn Lite, soft forces antibiotic dosage calculator and Paedes ED, most commonly used being Med Math and MedCalc.[8]

Airstip OB is designed for obstetricians to access their electronic medical records (EMRs), real-time and historical waveforms, fetal strips and maternal contractions patterns. Smartphone application facilitates CMEs and medical training. A real-time clinical alarm monitoring system was developed by Van Eltonger *et al*. (2010) to monitor Intensive Care Unit patients by smartphones, by displaying alarms with the vital signs at the moment of the alarm colour coded by the severity of the problems. Borbelota, a smartphone based mobile tele health system was developed in Brazil for nurses in isolated areas for primary health care centres to use during patient's home care visits. These nurses could complete registration of patients and work out a visit schedule and store data on web server. m health component of e health delivers medical and health care services through mobile devices. WHO has recently defined m health as "medical and public health practice supported by mobile devices such as mobile phones, patient monitoring devices, PDAs and other wireless devices." Bluetooth technology is also one of the very useful applications of smartphone for short distance wireless data transmission. Many medical devices like glucometer, thermometer has this functionality.[8]

Bedside computing is possible now. It is a database, reference books, patient tracking help, data planner, computer book, magazine, calculator and much more in one mobile device. Information and consultation required for our work is available at all times and everywhere within seconds. It is especially useful for the medical students and trainees. Just feed in patient's weight, sex, age, you get all the drug dosages, ventilator settings, drug information within seconds. With WhatsApp you don't even need to open your mail in case you want to take someone's opinion. X-rays and images can be sent and consultation is obtained in a very short interval of time.

Smartphones facilitate learning, treatment and communication by capturing interesting diagnostic images or recording procedures. Short messages service is also a valuable asset for surgeons to discuss management of interesting and difficult cases with their fellow colleagues.

Notifications and alerts play an important role in clinical daily routine. Failure to adequately communicate a critical value is a potential cause of adverse events. Medical devices and monitors rely on acoustic alerting which are prone to alert fatigue[9] and need medical staff to be physically present around within the range. By utilizing automated telephony server notifications are delivered quickly anytime and anywhere, thus allowing immediate feedback and corrective actions.[10]

Patient application also includes cardio mobile and pulmonary rehabilitations. MediMath is I phone medical calculator and general reference. It has inbuilt formulae for just about everything as well as quick references like facial and body dermatomes.

Medication: Software is available for current iOS and Android devices to perform double-checking of medications with barcode labelling.

Concerns Related to Mobile Use in Hospital Scenario

Nosocominal infections are dreaded problems in the medical centres. As early as 1861, Semmel Weis[11] observed that bacteria are transmitted to patients by contaminated hands of health personnel. Hospital ORs are ought to have the highest hygiene standards. The same high hygiene requirements also hold true for the personnel working there and equipments used by them. Mobile phones are used in closed contact with the body and as for most nonmedical electronic equipments, there are no cleaning guidelines available that meet hospital standards and the hygiene risk

involved in using mobile phone in the OR has not yet been determined. In a study following hand disinfections, 40 anesthesiologists working in OR were asked to use their personal in hospital mobile phone for a short phone call.[12] After use of cell phone, bacterial contamination of physician hands was found in 38/40 physicians. After repeating the same with fixed phones, 33/40 physicians showed bacterial contamination. It concluded that use of mobile phones may have serious hygiene consequences, because unlike fixed phones, mobile phones are often used in OR close to patients. There are no recommendations for cleaning mobile phones to meet hospital standards. Cell phones manufacturers even warn explicitly against using cleaning agents. So potential benefits from using a phone in general and mobile phone in particular in Intensive Care Unit must be weighed against the risk of unperceived contamination and infection. Brady *et al*.,[13] Hassoun *et al*.,[14] Braddy and Blair[15] showed that mobile devices used in health care settings could entail a high level of contamination. Ogg expressed concern over hospital staff using cellular phones in the OR and believed that bacteria laden devices could possibly cross contaminate the practitioner's hand.[16] A study was conducted in Ireland to test the bacteria carrying potentials of cell phones showed that of 70% of cell phones tested for bacteria that could cause infection, 96% were contaminated and 15% had bacteria known to cause health care associated infections.

Distractions

Learning is difficult in Intensive Care Unit if one is distracted. Functional magnetic resonance imaging shows that when people learn without distraction,[17] the hippocampus is involved in the processing and sharing information. When people learn a task while multitasking, the hippocampus is not engaged, instead, the striatum is activated[18] (the striatum supports habitual task performance). Thus, when information is obtained under multitasking conditions, the flexible application of knowledge associated with creativity and adaptive problem solving may be less likely to occur. If attention is switched between tasks, there is measurable cost in response time and decision accuracy. Adding phone conversation to other tasks like driving result in distraction and longer reaction time and degrade situational awareness, thereby decreasing ability to identify and respond to hazards. Allocation of attention to a range of tasks simultaneously is a key characteristic of anaesthetic practice. There is multilevel concept of "distributed situational awareness."[19] In anesthesia where anesthetist would not be able to tell blood pressure of a patient, but would know correctly that there was no problem. Intra operative teaching increases the cognitive work load and decreases vigilance,[20] with anesthesiologist being less likely to notice a new alarm and respond accordingly.

Experienced anesthesiologists are skilled at multitasking while maintaining situational awareness, but there are limits. Limited reading may not decrease vigilance during low task load, but text based activities are more interactive and more distracting especially for trainees with less experience. Vigilance is defined as "a state of readiness to detect and respond to small changes occurring at random intervals in the environment."[21,22] Vigilance is a crucial component of human performance in work environment including military surveillance, air traffic control, cockpit monitoring and anesthesia etc. Hence vigilance is used as a motto of American Society of Anesthesiologists. The British statesman Philip Stanhope, 4th earl of Chesterfield offered the following advice to his son "there is time enough for everything in the course of the day, if you do but one thing at once, but there is not time enough in a year, if you will do two things at a time."[23]

Mobile phones are source of distractions for the operating team, anesthetists as well as the staff working in OR. It has been compared very well to "sterile cockpit rules" in aviation to reduce the number of accidents created by extraneous conversations or nonflying related tasks that were being performed by pilots during taxi, take-off or approach to landing.[7] The sterile cockpit means that no tasks are to be undertaken by the flight crew during the critical phases of taxi, take-off and landing in any operation below 10,000 feet above ground level other than flight and cruising. Similarly distractions in the form of mobile phone degrade the performance of the entire team and introduces error that wouldn't otherwise occur. Sterile cockpit rule apply to the entire crew, not just the pilot. Only about 2-3% of people can actually multitask, most of us have a measurable decrease in performance if we try to do too many things. A sterile cockpit environment should be established during critical phases of the operation such as critical dissection and when opening implants. At least one surgical stimulation study showed that when you introduce a controlled level of distraction into the simultaneous by performed tasks, the performance really decreases the most for laparoscopy, less for robotic surgery and least for standard open surgery. Smartphones are detrimental to cognitive performance. Their use increases reaction time, reduces focus and lowers performance of tasks needing mental concentration and decision making. Parker pope established that cellular phones impact attentiveness and cause intentional blindness. Users become so engrossed in their cellular phones that even though they may be looking at their surroundings, nothing actually register. In

healthcare, even a small mistake can prove fatal. Halamka reviewed a case where a medical resident forgot to stop an anticoagulant medication for a postoperative patient.[17] The medical resident was distracted by a text message she received on her smartphone and she forgot her primary task. Westbrook *et al*. found that each interception to medical care workflow at an Australian hospital was associated with 12.1% increase in procedural failures and a 12.7% increase in clinical error. Smith *et al*. reported that 55.6% of 439 perfusionists admitted that they used cell phone while Cardiopulmonary bypass and 7.3% admitted that it had a negative impact on their performance. Cain established that accessory social media via smartphone while performing work related tasks was more problematic than accessing social media via computer as smartphone was portable and hence constant source of disruptions.[24] McBride's analysis indicated that cellular phone users were so engrossed in this activity that they were often unaware of their own misuses and might not realise that they were distracted.[25] Reduced visual field or diverted attention caused by cell phones during medical procedures might result in health care provider not recognising potential complications. Noise created from ringing of mobile phone may cause distraction especially while performing laryngoscopy, endotracheal intubation or during crucial steps of surgery.

Interference with the Medical Equipments

Lots of concerns have been raised regarding the interference of the vital apparatus in operating theatre (OT) and Intensive Care Unit caused by smartphones. This is due to the electromagnetic radiation produced by them. They should be kept at a safe distance from medical equipment and medical equipment should have the ability to resist EMR. Another issue is noise from ringing of mobile phones during work. Most interference related to disturbance of signal is on cardiac monitor.[26] Other effects were found on pacemakers with inappropriate inhibition or atrial over sensing or misinterpretation of the mobile phone signal as atrial activity with synchronous fast pacing of the ventricle, documented in both permanent and temporary systems. Interference with pacemaker occurred only with mobile phone at a distance of up to 10 cm from the equipment. Safest option is "1 m rule" purposed by Irnich and Tobisch which suggested restriction of mobile phones use to >1 m from the equipment.[26] In Europe, Asia and Middle East, phones operate predominantly in 1800 MHz band. Mobile phones operating at 1800 MHz appear to cause nonsignificant EMI and need to be closer to medical equipment to affect it.[27] Introduction of Bluetooth technology often cause further less inference.[28] With technological advancement, newer equipment is becoming less sensitive to interference as manufactures are adopting increasingly stringent standards for screening. Hietanen *et al*. found no evidence of equipment failure.[29,30]

Risk of interference of different types of communication devices

Risks of interference	Types of communication system
High	Analogue emergency service radios
	PBRs and PMR 446, e.g., porters' and maintenance staff radio (two way radio)
Medium/low	Mobile phones
	TETRA system
	Laptop computers, palmtops and gaming devices fitted with GPRS and or 3G
	HIPERLAN
Low	Cordless telephones (including DECT) and computer radio network system except HIPERLAN and GPRS e.g., RLAN system and Bluetooth

Mobile phones are included in the medium risk category. PBR: Private business radio; TETRA: Terrestrial trunked radio; HIPERLAN: High performance radio local area networks; DECT: Digital European cordless technology; RLAN: Radio local area network

Further Guidance for Staff

- The use of mobile phones in safety critical patient areas (category 3) should be restricted to matters relating to clinical management or Trust business, and must always be used with extreme caution and not within 1 m of life support medical devices.
- Staff personal mobile phones should be switched off when on duty in clinical patient areas (category 2) and safety critical patient areas (category 3). Exceptions to this are at the discretion of the clinical manager, e.g., there may be exceptional circumstances that will require a member of staff to have access to their phone at all times.
- Staff should advise patients who are leaving the ward to use their phone, or to smoke, that mobiles phone should nor be used within 1 m of active infusion pumps and monitors.

Ethical and Legal Concerns

Mobile phones with a camera facility can constitute a considerable risk. Their risks can be identified as possible breach of medical confidentiality, intrusion into patient's private life, possible contravention of data protection act 1998 and breach of patient confidentiality. Possible risk of safety and welfare of children in contravention of the children act 2007 and can be a cause of nuisance to staff and other patients.

Swot

Health care organisations perform analyses of the strengths, weakness, opportunities and threats.[23]

Strengths

1. Convenient: Information at your fingertips.
2. Designed and maintained by medical professionals.
3. Regularly updated with new health care related data.
4. Easy to use.
5. Allows health care professionals to connect to consumers/patients directly.

Opportunities

1. Standardized/digitized format for storing data.
2. Allows health care professionals to communicate at a global level.

Weakness

1. Need to be tech savvy.
2. Need to own a smartphone.

Threats

1. Compromise patient privacy and security: Unsure who else has access to his information beside the doctor and hospital.
2. Users might access it across multiple devices, which poses data privacy risks.
3. Source of distraction-alerts, beeps, reminders can be distracting.
4. Interrupts continuous communication with the patient.

Guidelines Regarding Use of Smartphones[23]

1. Taking into considerations that such devices can be a contamination risk, it is recommended to use sterile bags to store smartphones when entering patient care and other sensitive zones.
2. Use of gloves while interacting with patients. Use of new gloves after using a smart device in patient care and other sensitive zones.
3. Use of sanitising wipes and or hand sanitizers at regular intervals, especially before dealing with patients.
4. Store personal devices out of reach and encourage use of organisation provided devices that contain preinstalled job specific functions and apps.
5. Create no cellular/no smartphone zones in sensitive areas like Intensive Care Unit, OT and critical care units.
6. Regulate kind of ring tones, alert tones used by health care professionals.
7. Regulate access to social networking sites.
8. Establish cellular/smartphone restricted zones as well as cellular/smartphone friendly zones.
9. Create specific hot spots where personal devices may be used during breaks.
10. Prior permission to be obtained before taking photos and videos at work. All must adhere to organisational ethics and conflict of interest policies.
11. Ensure high security computing networks with regulated used of outside devices.
12. Policies of sharing work related information on social network.
13. Generate warning messages to indicate any possible breach in security.
14. Ensure high security Wi-Fi connections, set up hardware and software firewall.
15. Encourage employees to regularly change passwords. Block websites with low security.

Usage policies if crafted well can be used to maximize work efficiency and facilitate improved communication and services. For the purpose of this policy all areas within the trust will fall within the following three categories:[30]

Category 1: Nonclinical areas/low risk patient areas (e.g., ward day rooms, clinic waiting areas, corridors, reception areas), where mobile phones can be used by staff, patients and visitors alike.

Category 2: Clinical patient areas (e.g., general wards and departments) where mobile phones can be used by staff, patients and visitors, but may be subject to local restrictions if their use is deemed to be affecting patient care, dignity or confidentiality.

Category 3: Safety critical patient areas (e.g., Intensive Care/Coronary Care Units, OTs etc.) where the use of mobile phones by patients and visitors are prohibited, but may be used by clinical staff with extreme caution particularly Intensive Care Units if within 1 m of sensitive medical devices associated with life support. Patients and visitors mobile phones must be switched off in these areas.

Conclusion

Smartphone are now increasing being used by healthcare professionals, facilitating the use of applications at clinics, in patients wards, outpatient departments, Intensive Care Units, laboratories etc. Their use has enabled the communication and collaboration among different health care professionals, their staff and patients (Biomed Central.com).

However, smartphone based healthcare has limitations in the form of limited battery life, potentially erroneous data

input, screen size, computer viruses including spyware, EMI with medical equipment, loss/theft, breech of privacy and security and potentially inefficient patient/physician interactions. However, wide adoption of smartphones by general population ensures better m health and mobile telemedicine services through patients oriented applications e.g., patient education, disease self-management and remote monitoring of patients.

There is frequent use of smartphone by anesthetist in the OT and Intensive care units. There is no evidence to support blanket ban on use of smartphone in OTs. Phones, laptops in close proximity to drugs and patients increase clutter and untidiness of work area and increase contamination. Smartphone impair short-term memory, vigilance and other aspects of cognitive performance. Human attention span is limited. Noise, interruptions and emotional arousal are bad for vigilance and performance and should be employed with great cautions.[22]

The use of cameras on mobile phones is strictly prohibited in all categories in order to preserve patient confidentiality and human rights.

From this article it is clear that smartphones and mobile devices have become an integral part of physician's life and have significantly improved the quality of medical care. They present both opportunities and challenges. They compromise security and privacy, quality of patient care and efficiency and are sources of distraction. We will have to adopt a more sensible, evidence base balanced policy towards mobile phone usage in our clinical practice. The potential to both positively and negative impact on anesthetist's performance and should be employed with great caution.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Dolan B. Report: 13K iPhone Consumer Health Apps in 2012. Available from: http://www.mobihealthnews.com/13368/report-13k-iphone-consumer-health-apps-in-2012. [Downloaded on 2015 Jan 25].
2. Chakrabarti R, Perera CM. Setting the framework for intelligent apps. J Mob Technol Med 2014;3:1.
3. Low D, Clark N, Soar J, Padkin A, Stoneham A, Perkins GD, *et al.* A randomised control trial to determine if use of the iResus© application on a smart phone improves the performance of an advanced life support provider in a simulated medical emergency. Anesthesia 2011;66:255-62.
4. Avidan A, Shaylor R, Levin PD. Smartphone assisted laryngoscopy: A new technique to overcome light failure in a laryngoscope. Anesth Analg 2013;117:1262-3.
5. Johnson E. Internet resources for the anaesthesiologist. Indian J Anaesth 2012;56:219-26.
6. Chakrabarti R, Perera C. Smartphone medical imaging: Applications and future considerations. J Mob Technol Med 2014;3:1.
7. Schafer MF. Distraction in the operating room threatens patient's safety. Do cell phones and tablets affect communication and concentration? American Academy of Orthopaedic Surgeons, May 2012. Available from: http://www.aaos.org/news/aaosnow/may12/clinical5.asp. [Downloaded on 2015 Jan 25].
8. Mosa ASM, Yoo I, Sheets L. A systemic review of healthcare applications for smartphones. BMC Med Inform Decis Mak 2012;12:67. Available from: http://www.biomedicalcentral.com/1472-6947/12/67. [Downloaded on 2015 Jan 25].
9. Riedmann D, Jung M, Hackl WO, Stühlinger W, van der Sijs H, Ammenwerth E. Development of a context model to prioritize drug safety alerts in CPOE systems. BMC Med Inform Decis Mak 2011;11:35.
10. Majeed RW, Stöhr MR, Röhrig R. Proactive authenticated notifications for health practitioners: Two way human computer interaction through phone. Stud Health Technol Inform 2012;180:388-92.
11. Ulger F, Esen S, Dilek A, Yanik K, Gunaydin M, Leblebicioglu H. Are we aware how contaminated our mobile phones with nosocomial pathogens? Ann Clin Microbiol Antimicrob 2009;8:7.
12. Jeske HC, Tiefenthaler W, Hohlrieder M, Hinterberger G, Benzer A. Bacterial contamination of anaesthetists' hands by personal mobile phone and fixed phone use in the operating theatre. Anesthesia 2007;62:904-6.
13. Brady RR, Fraser SF, Dunlop MG, Paterson-Brown S, Gibb AP. Bacterial contamination of mobile communication devices in the operative environment. J Hosp Infect 2007;66:397-8.
14. Hassoun A, Vellozzi EM, Smith MA. Colonisation of personal digital assistance carried by healthcare professionals. Infect Control Hosp Epidemiol 2004;25:1000-1.
15. Braddy CM, Blair JE. Colonisation of personal digital assistance carried by healthcare settings. Am J Infect Control 2005;33:230-2.
16. Al-Abdalall AH. Isolation and identification of microbes associated with mobile phones in Dammam in eastern Saudi Arabia. J Family Community Med 2010;17:11-4.
17. Gill PS, Kamath A, Gill TS. Distraction: An assessment of smartphone usage in health care work settings. Risk Manag Healthc Policy 2012;5:105-14.
18. Poldrack RA, Foerde K. Category learning and the memory systems debate. Neurosci Biobehav Rev 2008;32:197-205.
19. Levine LE, Waite BM, Bowman LL. Electronic media use, reading, and academic distractibility in college youth. Cyberpsychol Behav 2007;10:560-6.
20. Fioratou E, Flin R, Glavin R, Patey R. Beyond monitoring: Distributed situation awareness in Anesthesia. Br J Anaesth 2010;105:83-90.
21. Weinger MB, Reddy SB, Slagle JM. Multiple measures of anesthesia workload during teaching and nonteaching cases. Anesth Analg 2004;98:1419-25.
22. Weinger MB. Vigilance, boredom, and sleepiness. J Clin Monit Comput 1999;15:549-52.
23. Jorm CM, O'Sullivan G. Laptops and smartphones in the operating theatre – How does our knowledge of vigilance, multi-tasking and anaesthetist performance help us in our approach to this new distraction? Anaesth Intensive Care 2012;40:71-8.
24. Cain J. Social media in health care: The case for organizational policy and employee education. Am J Health Syst Pharm 2011;68:1036-40.
25. McBride DL. The distracted nurse. J Pediatr Nurs 2012;27:275-6.
26. Tri JL, Hayes DL, Smith TT, Severson RP. Cellular phone interference with external cardiopulmonary monitoring devices. Mayo Clin Proc 2001;76:11-5.

27. Irnich WE, Tobisch R. Mobile phones in hospitals. Biomed Instrum Technol 1999;33:28-34.
28. Saraf S. Use of mobile phone in operating room. J Med Phys 2009;34:101-2.
29. Hietanen M, Sibakov V, Hällfors S, von Nandelstadh P. Safe use of mobile phones in hospitals. Health Phys 2000;79 5 Suppl:S77-84.
30. Wigmore J, Gemmell M. Policy on the use of mobile communication equipment in patient areas. University Hospital Bristol NHS Foundation Trust. Available from: http://www.uhbristol.nhs.uk/media/1529656/uhbristolmobilephonepolicy.pdf. [Downloaded on 2015 Jan 25].