DIGITAL MEDICINE

APR-JUN 2016 | VOLUME 2 | ISSUE 2

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Publisher

Spring Media Publishing Co. Ltd
Wolters Kluwer Health|Medknow Medical Research

Frequency

Quarterly

ISSN

2226-8561

Launch Date

September 30, 2015

Current Publication Date

June 30, 2016

Editorial Office

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Third Military Medicine University,
Chongqing 400038, China
Telephone: +86-23-68752211
Email: editor@digitmedicine.com

DIGITAL MEDICINE

APR-JUN 2016 | VOLUME 2 | ISSUE 2

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The future of digital medicine in the aging society

David Wortley FRSA*

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David Wortley is CEO and Founder of Gamification and Enabling Technologies Strategic Solutions (www.gaetss.com), a consultancy on the strategic use of Gamification and Enabling Technologies for the transformation of business and society. He is a recognized authority on the practical application of Gamification and Enabling Technologies to address global challenges in areas such as health, environment, and education. He is a serial technology innovator and has been a pioneer of emerging technologies for over 30 years. He is an expert advisor to the European Union and an accredited business mentor. His specialist expertise is in the commercialization of disruptive digital technologies. David is also a Founding Council Member of the International Society of Digital Medicine (ISDM).

David was the Founding Director of the Serious Games Institute (SGI) www.seriousgamesinstitute.co.uk at Coventry University and he was responsible for the development of the institute as a global thought leader on the application of immersive technologies (which include video games, virtual worlds, and social networking) to serious social and economic issues such as education, simulation, health, commerce, and climate change. Working with academics, regional development agencies, and leading computer games companies, David made the SGI is a focal point for games-based learning, simulation, and immersive three-dimensional (3D) virtual environments and an engine for innovation and social and economic regeneration. David is a respected (see http://davidwortley.com/testimonials.html) and sought-after international conference speaker and writer for global publications on Learning Technologies, Defence and Health applications. He has written numerous papers on technology and society (see http://www.davidwortley.com/articles.html), and he is a regular conference presenter (see http://www.davidwortley.com/conferences.html).

INTRODUCTION AND BACKGROUND

Global Health and sustainable improvements in the well-being of humans are seriously threatened by two societal phenomena.

The aging society

Across the globe, falling birth rates and increased life expectancies have led to significant increases in the percentage of citizens aged over 65 years compared to the younger working population. The increased life expectancies have, at least in part, been a result of improvements in health care, and the diagnosis and treatment of diseases and medical conditions that have traditionally caused premature death.

One of the results of this demographic shift is that the financial resources to support societal development and sustainability which largely come from taxation and other income generated by the activities of the working population will be in decline, i.e. a smaller number of workers will be supporting a larger number of citizens who are either retired or not working. This presents a challenge to the sustainability of public health care [Figure 1].

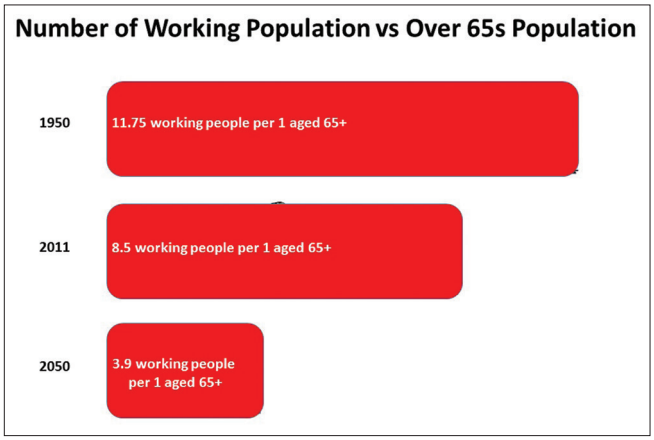

Figure 1: Aging Society Trends - A Global Village Journal Issue 10[1]

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The second impact of the aging society is the annual cost of health care per capita of older people being significantly greater than the cost per capita of younger people [Figure 2]. This increased cost is a direct result of greater life expectancy linked to increased vulnerability to conditions such as dementia and physical and mental frailty.

This phenomenon is exacerbated in the developed world by the disintegration of the family unit and local communities as increased citizen mobility has led to family members being placed in the care of public and private sector health-care providers rather than the traditional model of the caring family unit.

Impact of lifestyle and medical advances on causes of death

The above graph [Figure 3] illustrates the top 10 causes of death in the USA in 1900 v 2010 and shows that medical advances have all but eradicated many of the traditional causes of death from communicable diseases with a consequent growth in morbidity resulting from lifestyle choices and behaviors.

The issue with lifestyle-related conditions is the behaviors such as sedentary lifestyles and poor diets adopted early in life have a major and cumulative effect in later life resulting in diabetes and cardiovascular problems which require often expensive interventions and high levels of cost to public health services.

The role of digital technologies in medicine, health, and well-being

Digital technologies have undoubtedly had a major impact on medicine both in diagnostics and treatment. Modern digital scanning, artificial intelligence, big data analytics, human-computer interfaces, robotics, and 3D visualization technologies have all helped to not only increase our understanding of the physiology of the human body and enabled early detection of medical conditions but also they have contributed to increasingly more targeted and personalized interventions.

However, set against these positive benefits of digital medicine and health technologies is the impact of technologies which reduce the daily physical and cognitive challenges that have throughout history constantly exercised our bodies and minds and in the process, given us the active lifestyles needed to maintain health and well-being. Sedentary lifestyles at home and work coupled with the instant gratification of fast foods are leading to

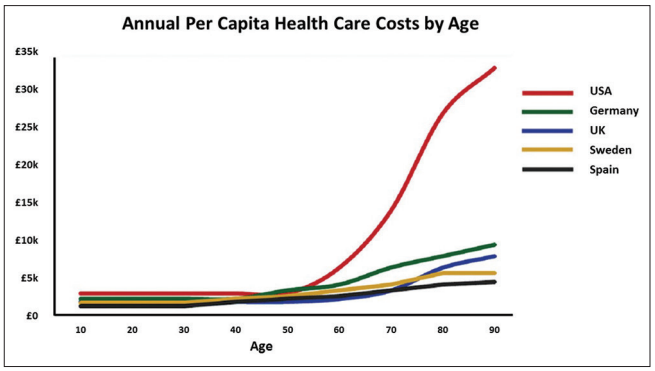

Figure 2: The annual cost of health care per capita[2]

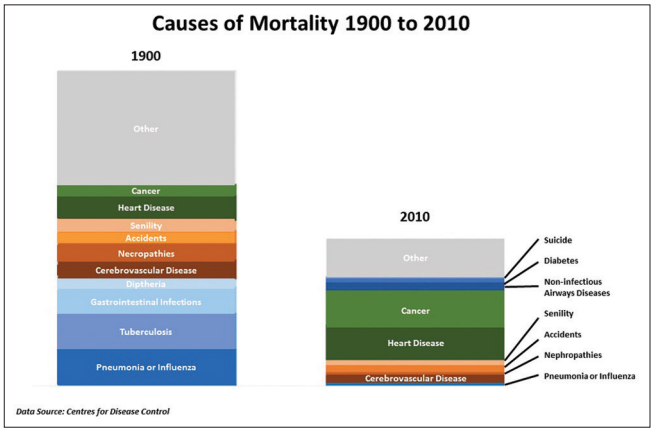

Figure 3: The top 10 causes of death in the USA in 1900 *versus* 2010[3]

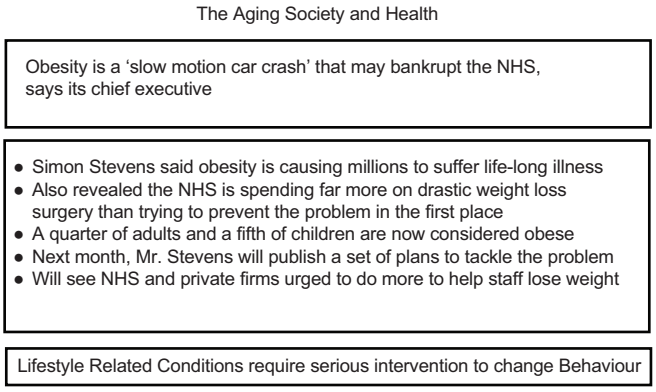

Figure 4: NHS Chief Executive Simon Stevens warning on obesity - UK Daily Mail 2015[4]

obesity epidemics in many different parts of the globe [Figure 4].

In these circumstances, I contend that it is important to leverage the power of technology to influence sustainable active and healthy lifestyles in which the citizen and communities are not only empowered but also accept more responsibility for personal health management through the use of consumer health and well-being technologies enabled by "gamification" (games

psychology and mechanics) and a new form of citizen health charter.

If future citizens are to have access to sustainable, effective, and ubiquitous healthcare, there needs to be a realization and understanding between citizens and health-care providers around personal responsibility for health management.

The digital technologies enabling preventative health care and personal health management

The future focus of digital technologies to address the dual challenges of the aging society and lifestyle behaviors will be based on the increasing consumerization, availability, connectedness, and functionality of disruptive and ubiquitous technologies such as wearable devices, sensors, artificial intelligence, cloud computing, big data analytics, and mobile devices that will monitor and in the case of chronic conditions, help to automatically moderate citizen health. The devices and the technology infrastructure to support them will be leveraged by the application of games psychology and mechanics to motivate, incentivize, and educate citizens to not only better manage lifestyle choices but also to share data anonymously with clinicians to contribute to a better understanding of optimal lifestyle choices and their impact on health.

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Access this article online	
Quick Response Code	Website: www.digitmedicine.com
	DOI: 10.4103/2226-8561.189502

How to cite this article: Wortley D. The future of digital medicine in the aging society. Digit Med 2016;2:43-5.

Founding Conference of the International Society of Digital Medicine: A small step makes a big stride

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Prof. Jianguo Sun is a doctor of medicine, professor of radiation oncology, and a doctoral supervisor. His research work focuses on improving the current radiotherapy planning system by using digital technology. He is also interested in early diagnosis, pathogenesis, and comprehensive treatment of breast cancer, with the major research interest in molecular markers of cancer stem cells and their role in tumor biotherapy. He is the deputy director of the Cancer Institute of People's Liberation Army (PLA), Xinqiao Hospital, Third Military Medical University. He researched on radiation oncology as a visiting scholar at Stanford University in the USA during 2013–2014. He is the vice chairperson of Chongqing Medical Association, the Youth Council of the Radiotherapy Branch of PLA Oncology Society, and also the Radiotherapy Committee of the Chinese Society of Integrated Traditional Chinese and Western Medicine. Being a council member of the International Society of Digital Medicine, he is specialized in combining digital medicine with traditional radiotherapy. He has four scientific projects supported by the Key Project of Natural Science Foundation of China, and several scientific projects supported by other sources, including the National Key Research and Development Plan of China. He won the first and second prizes of Chongqing Science and Technology Progress, and the second prize of Medical Achievements of PLA. He has published over seventy papers and compiled five monographs.

The Sixth Annual Academic Congress of Chinese Society of Digital Medicine held on June 18th in Nanjing also became the Founding Conference of International Society of Digital Medicine. More than 1000 participants from 28 countries and regions gathered together for academic exchange and collaboration in digital medicine (DM). Sponsored by the Chinese Society of Digital Medicine and hosted by the Nanjing Hospital affiliated to Nanjing Medical University, this 2-in-1 conference set the theme as "Promoting global development of digital medicine by international collaboration." The Chinese Society of Digital Medicine, among the 88 societies of the Chinese Medical Association, became the first one to establish an international society in its field.

The highlight of the conference began even before the opening ceremony. The symposium on establishing an International Society of Digital Medicine was held on June 17th as a round-table meeting of 78 DM scientists from 28 countries and regions, including China, the US, the UK, Canada, Australia, and South Africa. As representatives of worldwide DM scientists, the 78 participants discussed and voted and elected Prof. Shao-Xiang Zhang, the current president of the Chinese Society of Digital Medicine, as the president of the International Society of Digital Medicine. Eight professors were elected as vice presidents of the ISDM, including Prof. Joseph S. Alpert from the US, Prof. Jiming Kong from Canada, Prof. Uwe Spetzger from Germany, Prof. Paolo Milia from Italy, and Prof. Marc Thiriet from France. Moreover, the draft statute was passed by the council and began to take effect.

This conference provides worldwide DM scientists a forum for discussing a wide array of topics on the basic research and clinical applications of DM, ranging from three-dimensional (3D) printed body parts to virtual reality-based surgical simulation, to robot-assisted operation, to magnetic resonance imaging (MRI) guide-focused ultrasound surgery, and to 3D global health innovation platform. The "buffet" of DM had lasted for

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2 days. I was enormously impressed with the keynote speech delivered by Prof. Joseph S. Alpert on the electronic medical record and the one by Prof. Uwe Spetzger on the implantation of an individualized 3D-printed titanium cage for cervical fusion. DM scientists took this great opportunity to learn from their international colleagues.

DM is the science that uses the modern digital technology to explain medical phenomena, solve medical problems, and explore medical mechanisms, with the purpose of improving life quality. With medicine as its core, DM is an inter-discipline that combines modern medicine with new and high-digital technology and involves computer science, mathematics, informatics, electronics, mechanical engineering, and biomedical engineering. The essence of DM is to improve diagnosis and treatment by using high digital technology.[1]

This Sixth Annual Academic Congress is a unique one with special significance for the Chinese Society of Digital Medicine. Before then, the Chinese Society of Digital Medicine had successfully convened five annual academic meetings, since its establishment in May 2011, promoting the development of DM in China effectively. This meeting, with the theme of "promoting international collaboration," marks a new phase of the development of DM in China and worldwide as well. From then on, DM scientists from China and all over the world can take the International Society of Digital Medicine as a platform for regular academic exchange and collaboration, which will definitely enhance the progress of DM and accelerate digitalization of modern medicine.

For the Chinese Society of Digital Medicine, this Founding Conference of the International Society of Digital Medicine is a small step toward internationalization. However, it will be an important step that makes a big stride in the history of DM of the world.

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Quick Response Code

Website: www.digitmedicine.com

DOI: 10.4103/2226-8561.189503

How to cite this article: Sun J. Founding Conference of the International Society of Digital Medicine: A small step makes a big stride. Digit Med 2016;2:46-7.

REVIEW ARTICLE

The electronic medical record in 2016: Advantages and disadvantages

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ABSTRACT

The electronic medical record (EMR) is now nearly ubiquitous in the USA. This article will review the EMR system with respect to goals, utilization, advantages compared with hand written records, as well as problems and/or disadvantages of the EMR system.

Keywords: Electronic medical record, in-patient, out-patient, patient care

INTRODUCTION

What is an electronic medical record (EMR)?

Definition - An EMR is the legal patient record that is created in digital format in hospitals and ambulatory environments. EMRs may include a variety of personal and clinical information.

The EMR is almost universally used in health-care systems throughout the United States as a result of a federal government decision to financially reward systems using an EMR and to punish systems financially who are not using an EMR. A number of different providers offer large computerized systems to cover both in-patient and out-patient services. For the last 2 years, my hospital has been using one of the most popular and most expensive systems, the Epic EMR. All of the EMR systems in use now in the USA are highly sophisticated and will undoubtedly become more so in the future. The detailed objectives of the EMR system are as follows: Access detailed patient information, document patient progress, assist in chronic disease management, facilitate disease coding for billing and disease demographics, improve communication between health-care providers with information that is easily accessible and legible, provide health-care staff with decision support tools, create educational patient handouts, and help track health maintenance and preventive medical interventions. Moreover, of course, to do all of this in an environment that is secure and private.

HOW DO ELECTRONIC MEDICAL RECORD SYSTEMS WORK?

How does this computerized system work? The system sends clinical information to the health-care provider's EMR inbox with each patient visit carefully documented. It can take up to 6 months to train personnel how to use the system efficiently. However, once the health-care providers are fully trained, the system allows for a complete examination of the patient's clinical information in a relatively short time. Additional visits are quickly entered into the EMR database once providers become

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Access this article online

Quick Response Code

Website: www.digitmedicine.com

DOI: 10.4103/2226-8561.189504

How to cite this article: Alpert JS. The electronic medical record in 2016: Advantages and disadvantages. Digit Med 2016;2:48-51.

experienced. Patients have access to much of the information in their health record, and this can be helpful in ensuring adherence to a therapeutic program. However, patients can be confused by medical terminology, and explanations may require additional clinician time. Appointments and test requests are also clearly listed in the EMR, which benefits both clinicians and patients. The system can be programmed to provide reminders for disease management, annual screenings, or required immunizations. Finally, the system can provide accurate and rapid billing and collection information.

There are a number of organizational concerns when an EMR is utilized. For example, computer server crashes, security breaches, and off-site data storage can complicate the use of these systems. Patients complain that the system interferes with the more "hands on" physician–patient relationship by making visits more impersonal. In addition, there is an initial loss of productivity when the EMR system is put into place because of training and implementation.

POTENTIAL BENEFITS OF THE ELECTRONIC MEDICAL RECORD

What are the potential benefits that can be realized by using the EMR? First, the use of an EMR helps to reduce medical errors by utilizing computerized prescription entry, predicting drug interactions and displaying a warning for the health-care provider, assisting clinicians in reconciling patient medications, and most important, maintaining a detailed and legible medical record. Theoretically, EMR-guided visits should be shorter and better organized although increased time is required to write the electronic clinical note than with handwritten notes. Another major plus for the EMR is that patients can be seen sequentially by different providers with up-to-date information immediately available to all providers. This was often difficult when paper charts were being utilized. In addition, the EMR gives clinicians immediate access to patient medical information, as well as the ability to enter and store orders for prescriptions, tests, and other services in a computer-based system with orders and clinical notes easily stored. This saves a lot of storage space that was needed when paper records were the norm.

Other advantages include the fact that the system allows the patient to access their own medical information easily and from home. Moreover, EMRs include scheduling systems that can greatly improve hospital and clinic efficiency and provide more timely service for patients. Furthermore, the EMR system gives the health-care provider instant access to other clinicians' evaluations, as well as all diagnostic tests. From an academic point of view, the EMR is an excellent tool for "big data" research through the huge amount of clinical information that is stored in the database. Overall, the EMR is efficient, secure, and readily accessible to staff and to patients.

CHALLENGES IN USING AN ELECTRONIC MEDICAL RECORD

From the physician's point of view, the EMR can be useful but also presents some challenges. Benefits include legible orders, the volume of transcription material is reduced, and orders are rapidly routed. One large challenge involves getting a large medical staff trained in the use of the EMR. This is particularly a problem with older physicians who may not be very "computer savvy." The high cost of these systems is another challenge for hospitals and practices. It is often difficult to measure any financial benefit given the high cost of these systems. One study of cost–benefit of EMRs was done at the Samsung Hospital in Korea. The investigators there found that the EMR was cost–beneficial. An 8-year analysis of cost–benefit at this institution found that the net present value of the system was positive at $3617 (US dollars) with a benefit to cost ratio of 1.23.[1] However, it required 6.18 years of use to accrue this cost–benefit which was the result of cost reductions and additional revenue. The benefit was attributed to cost reductions and additional revenue. Finally, we are still dealing with early generations of EMRs which almost certainly will evolve in future versions.

THE ELECTRONIC MEDICAL RECORD AND MEDICAL ERROR

It is widely believed that EMRs will reduce physician error and increase patient safety by eliminating errors resulting from illegible handwriting. Medical documentation in the EHR is clear and legible and thus reduces confusion. There are fewer forms to fill out during a visit with fewer repetitive questions, for example, regarding past medical history. The EMRs alert system ensures that proper dosage and drug utilization are administered to patients. Park *et al.* noted that the EMR had the potential to improve patient adherence to prescribed drug therapy.[2]

POTENTIAL PROBLEMS WITH THE ELECTRONIC MEDICAL RECORD

Similar to all new technologies, there are some potential problems with the EMR. Hackers can easily gain access to

the system. Moreover, when a health-care system employs EMRs, this can lead to technical difficulties when there are problems with the computer system. Moreover, EMRs are expensive initially and during maintenance. Users need to be trained to use the EMR, and this requires considerable time and changes in system and work practices. EMR clinical notes require more time to create compared with handwritten notes. In addition, unfortunately, the different EMR systems do not communicate with each other so that information in one hospital may not transfer easily to another hospital using a different EMR system. EMR companies are working vigorously on this latter problem since the federal government in the US has mandated that the different EMR systems must be able to communicate with each other in the near future. Another problem is that the EMR encourages the use of the "copy and paste" syndrome as opposed to writing original observations. Other complaints that have been mentioned by EMR users include difficult to use programs, technical failures, the cost associated with training staff, lost passwords slowing access, and the fact that there are so many templates and not enough narrative notes. Finally, EMRs in their current form are not useful to psychiatrists and psychologists in that they fail to provide an adequate overview of the treatment process.[3]

THE ELECTRONIC MEDICAL RECORD AND RESEARCH

The EMR database can be a potentially huge asset for so-called "big data" research since detailed clinical information on literally thousands of patients is stored here enabling clinical scientists to investigate associations, prognosis, therapeutic outcomes, and many, many other clinical questions.[4] Some authorities have had ethical concerns about the use of EMRs such as the integrity, security, and privacy of the systems; equality of access; and the authenticity of the data stored therein.

PATIENTS AND ELECTRONIC MEDICAL RECORDS

A question that is frequently asked by the health-care systems about to employ an EMR is "How do patients react to this new form of medical record keeping?" Pyper *et al.* in the United Kingdom questioned 606 patients in the UK who responded to a questionnaire about the use of the EMR in their healthcare. The responses to the questions were as follows: "I want to have access to my health record:" 83% said yes. "I think it is a good idea to make health records electronic:" 79% said yes. However, 50% of patients were concerned about the security of their health information. Nevertheless, the overall response was quite positive.[5] In general, there are a number of aspects of EMRs that make them a positive intervention for patients. The EMR gives the patient a larger role in their care through increased patient knowledge and self-management. There is the potential for greater health-care provider–patient interaction, and this can potentially increase patient safety because of the improved communication between the physician, the patient, and other members of the health-care team. However, there are some disadvantages to patients interacting with EMRs including potential confusion when patients do not understand medical terms or reports. Moreover, the EMR has the ability to make the patient–doctor relationship more impersonal. In addition, as noted above, patients are often concerned about the confidentiality of their personal health information.[6]

PERSONAL OBSERVATIONS ON THE ELECTRONIC MEDICAL RECORD

I have now personally worked with the EPIC EMR for nearly 2 years. In general, I like the EMR system. It enables me to access laboratory and imaging reports instantaneously when I have the patient in front of me. I can also easily access clinical notes made by other physicians involved in the care of my patient. On the in-patient service, my team of residents and fellows and I frequently call up images of X-rays, computed tomography scans, echocardiograms, magnetic resonance imaging, and laboratory data on individual patients when we discuss evaluation and management. Instant access to this information is invaluable. However, it does take more time to complete the out-patient and in-patient notes because of the extensive template required for each patient entry. In addition, the clinical notes end up being very long because the computer adds in all the history, laboratory values, medicines, social history, family history, etc., in every note. The EPIC out-patient note also requires the physician to enter the diagnosis for the patient three times in the same clinical note.

FUTURE DIRECTIONS

There is no question that the EMR will continue to evolve and bring even more information to the clinician caring for a specific patient. Undoubtedly, in the near future, genetic information will also become a routine part of the patient's record. This will be extremely useful since it will provide the health-care provider with specific information concerning possible diagnoses, as well as important aspects of drug metabolism and sensitivities. Moreover, as noted above, the potential for "big data" clinical research

using collected patient clinical data is huge and exciting because of its potential to improve patient care.

CONCLUSIONS

It is my belief that the EMR is a permanent component of modern clinical medicine. It is a useful clinical tool and will improve patient care. We are still in the early stages of its use and development and so there remain problems to make these systems as good as they can be. The EMR is here to stay!!

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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ORIGINAL ARTICLE

Prevention and control of operating room fires: Knowledge of staff employed by selected hospitals of Isfahan University of Medical Sciences

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ABSTRACT

Background and Objectives: Patient safety in hospital is an essential professional indicator that should be noticed. The thread of fires is of the most potentially dangerous risk that could harm patients and personnel. Hence, we studied operating room staff knowledge about fires, its prevention, and control, based on their specialty and their job tenure. **Materials and Methods:** This is a descriptive-analytical cross-sectional study. A cluster sampling method was applied, and a quota was considered for each hospital. In each cluster, samples were selected through census method. Data were collected using a three-part questionnaire and analyzed using SPSS version 17 (SPSS, Inc, Chicago, IL, USA). **Results:** The mean of their knowledge level about fires and its prevention was 2.71 (0.67), and control was 2.62 (0.71). In 66% of cases, the level of knowledge about fires and its prevention, and in 70% of cases, the level of knowledge about methods of fire control have been below the average ($P < 0.05$). As staff age increases, their level of knowledge increases as well. Hospital they are employed by, their job tenure, and their profession can affect the level of knowledge ($P < 0.05$). **Discussion:** This study shows that the staff knowledge about fires, its prevention, and control has been lower than the average limit. Due to the sensitivity of the issue, in terms of susceptibility of the environment and medical equipment for ignition, and also the safety of staff and patients, it is necessary to make facilities for development of staff knowledge, to eliminate defects of staff training by managers, and also to consider standards.

Keywords: Fire, knowledge, operating room staff

INTRODUCTION

Operating room (OR) is considered as one of the most complex work environments in health-care services which is obvious in patients-related issues, treatment protocols, and using high-tech equipments[1] for a better adaptation with these improvements. Health-care systems requires an effective management to coordinate with these increasingly rapid changes to provide a better and safer service for both patients and staff.[2] The purpose of compliance with safety standards in the OR is to provide safety of all personnel working in this environment as well as safety of patients who are undergoing a surgical procedure.

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Access this article online

Quick Response Code

Website: www.digitmedicine.com

DOI: 10.4103/2226-8561.189506

How to cite this article: Jalali H, Asl EB, Mehr AM, Pourafzali SM, Ghasemi M. Prevention and control of operating room fires: Knowledge of staff employed by selected hospitals of Isfahan University of Medical Sciences. Digit Med 2016;2:52-6.

Providing safety in the OR can be achieved by a team work where everybody in this system shares responsibility. Therefore, the periodic revisions of the safety requirements are certainly necessary.[3] OR safety can be studied from several aspects, including infection control, protecting against fires, safety of staff and patients related to the physical environment, etc.[4] Among all the cases subjected to the safety issues in the OR, fires are the most important potential hazards which should be noticed.[5] In addition, safety issues associated with fires are also an ethical and legal issue, since any damage caused by fires to the patients or personnel, requires not only legal actions but also costs a lot to pay for damages, blood money (restitution), costs of personnel disability due to injuries, and reproviding damaged equipment.[6] Hospital Administrators in the United States of America have estimated that about 100 fires occur annually in their hospital OR where averagely 10–20 cases lead to severe injuries and 1–2 cases result in death.[7] In Iran, we have no published official statistics or referral source to identify OR fires, but it does not reduce or deny the possibility of risk. Fire requires specific conditions and specific elements to start, including flammable materials, fire or heat, and oxygen. Normally, if these three elements are kept separated from each other, it would not be dangerous. However, in the OR, the probability of any event is unpredictable. If for any reason, two of the three elements get close together, it might be combustible. Materials including sponges, towels for dressing, drape towels, plastic materials such as pipes and syringe provide the raw material for the fire. Using light sources which radiate high amount of energy and heat such as lasers, light sources, fiber optic devices, electrical equipment such as a microscope, endoscope, monitors, and hyperthermia units in an environment rich in oxygen and anesthetic gases such as Nitrous oxide can be also effective in completing the cycle of fire.[8] Unfortunately, the issue of safety for fires in the OR is not still a matter of discussion at the top of priorities.[9] That might be due to misconceptions of the authorities about the low probability of an incident such as fires in a hospital OR.[10] To prevent fires during surgery, every OR staff should take special responsibility. It requires knowledge of all staff and a well-organized teamwork.[11] Related studies have shown that the most hospital staff, especially in an OR, have little knowledge about fire prevention and control. In a study by Davoodiantalab *et al.* about staff knowledge in Shiraz Hospitals, it was found that approximately 50% of staff had no enough knowledge about fire control.[12] Safavi *et al.* have also assessed knowledge of staff in Gillian University Hospitals. Results of their study indicated that the highest deviation from standards of safety in the OR has been in the preparation stage. These factors of safety include assessment of ventilation and temperature, checking oxygen bar, inlet and outlet valves of anesthesia machine, and so on.[13] Based on all these evidence, if the OR personnel have enough knowledge about sources of fire, its prevention, and methods of control, further injuries and damages can be avoided. Therefore, this study was designed to assess knowledge of OR staff about sources of fires, its prevention, and control in selected hospitals affiliated to Isfahan University of Medical Sciences.

MATERIALS AND METHODS

This study is a descriptive, analytical design with a cross-sectional approach in which researchers evaluate the level of OR staff knowledge including OR technician, recovery nurse, anesthesia technician, nonspecialized personnel, surgeon, surgery resident, anesthesiologist, and anesthesiology resident, about fires, its prevention and methods of control in selected hospitals such as Ayatollah Kashani Hospital, Chamran Hospital, Alzahra Hospital, Feiz Hospital, and Imam Musa Kazim (AS) Hospital affiliated to the Isfahan University of Medical Sciences. A cluster sampling method was applied, and a quota was considered for each medical center. In each cluster, samples were selected through census method. Samples were included to the study if they were permanently employed in the OR, had at least 1 year of job tenure, and willingness to participate. All who were not eager to participate and failed to fill out the questionnaire and inexperienced ones such as undergraduate students and 1st year residents were excluded from the study. Data were collected by means of a three-part questionnaire with 28 closed questions, in which the first section includes gathering demographic variables; the second section evaluates personnel's knowledge about fire resources and its prevention; and the third section measures their knowledge about methods of fire control. This researcher-made questionnaire was designed based on citing numerous studies in this area and also previously used questionnaires as well as the reviews of experts in this field to be localized based on our condition. Scoring criteria for each question were based on four alternatives that respectively were: I am completely aware of (4), I am quite aware of (3), I have little knowledge (2), and I do not know (1). The validity of the instruments was proved by using content validity and several stages of editing by experts and professionals. To approve the reliability of scale, Cronbach's alpha coefficient was used. It was calculated and confirmed 0.89 during a pilot study on ten subjects. Questionnaires were filled out by subjects after signing the informed consent.

Data were analyzed using SPSS version 17 (SPSS, Inc, Chicago, IL, USA); descriptive statistics include mean, standard deviation, frequency distribution, and inferential statistics such as Chi-square, *t*-test, ANOVA, and Pearson correlation coefficient. All analysis was performed at the significance level of (0.05).

RESULTS

In this study, there were 257 cases of OR personnel employed in selected hospitals affiliated to Isfahan University of Medical Sciences participated. A total of 162 (63%) were female, and 78 (30.4%) were male, and the mean of age was 35.06 (8.01) years. The highest employment rate in 94 cases (36.6%) was for OR technician, and the lowest employment rate in seven cases (2.7%) was for anesthesiologist. The mean of job tenure was 10.76 (7.74) [Table 1].

Assessing the level of knowledge about fires, preventive strategies, and control showed that the mean of level of knowledge about fires and its prevention was 2.71 (0.67), and also the mean of level of knowledge about methods of fire control was 2.62 (0.71). Binomial test results also showed that in 66% of cases, level of knowledge about sources of fires and its prevention, and in 70% of cases, the level of knowledge of the methods of fire control has been below the average (value = 2.5). The difference was considered statistically significant ($P < 0.05$). Hence, in general, it can be concluded that the level of knowledge about fires, preventive strategies, and control was lower than the average in Isfahan hospitals [Table 2].

The study of influencing factors on the level of knowledge revealed that gender differences did not affect the level of staff knowledge ($P = 0.313$). In contrast, as age increases, the level of knowledge about fires and prevention (correlation = 0.093) and methods of control (correlation = 0.139) has been increased. ANOVA test showed that this relationship has been statistically significant ($P < 0.05$). ANOVA also indicated that factors such as hospitals they are employed by, job tenure, and their profession can be effective in their level of knowledge ($P < 0.05$). In other words, anesthesiologists had the highest level of knowledge in contrast with nonspecialized personnel in the OR. Comparing the level of personnel knowledge among hospitals also showed that Imam Musa Kazim (AS) hospital staff had the highest level of knowledge in contrast with the Ayatollah Kashani hospital staff. In addition, by increasing job tenure, the level of knowledge increases as well [Tables 3 and 4].

Table 1: Frequency distribution of demographic characteristics

Criteria*	Frequency (%)
Gender	
Female	162 (63)
Male	78 (30.4)
Age (year)	
20-30	79 (30.7)
31-40	95 (37)
41-50	44 (17.1)
>50	7 (2.7)
Hospital	
Chamran	36 (14)
Kashani	80 (31.1)
Alzahra	83 (32.3)
Feiz	47 (18.3)
Imam Musa Kazim (As)	11 (4.3)
Profession	
Surgeon	14 (5.4)
Surgery resident	36 (14)
Anesthesiologist	7 (2.7)
Anesthesiology resident	19 (7.4)
Operating room technicians	94 (36.6)
Anesthesia technician	46 (17.9)
Recovery nurse	28 (10.9)
Other	13 (5.1)
Job tenure (year)	10.76±7.74
>10	106 (41.2)
11-20	59 (23)
<20	26 (10.1)

*Some of the participants' data have not been fully completed

Table 2: Descriptive statistics of knowledge about fires, prevention, and control

Factors	Frequency (%)	Mean (SD)	*P**
Knowledge of fire resources and prevention			
≥2.5	66	2.71 (0.67)	0.000
>2.5	34		
Knowledge of fire control			
≥2.5	70	2.62 (0.71)	0.000
>2.5	30		

*Binominal test. SD: Standard deviation

DISCUSSION

Fires in the OR is one of the extremely dangerous events which can have catastrophic consequences.[14,15] Knowledge about fires, prevention, and control is essential for every hospital staff so that this event can be wisely managed.[16] As the results of this study show, staff knowledge about fires, prevention, and control is less than the average, which is consistent with other similar studies in our country. Mehdinia *et al.* designed a study to determine fires risk in Qom hospitals based on fire risk assessment engineering method to develop a program to enhance the safety of patients and staff. According to

Table 3: Comparing level of staff knowledge about fire resources and prevention based on variables

Variables	Mean (SD)	*P*
Gender		
Female	2.73 (0.69)	0.313
Male	2.64 (0.66)	
Age (year)	ρ=0.093	0.046
20-30	2.63 (0.69)	
31-40	2.73 (0.68)	
41-50	2.70 (0.67)	
>50	2.53 (0.55)	
Hospital		
Chamran	2.66 (0.80)	0.026
Kashani	2.58 (0.67)	
Alzahra	2.73 (0.70)	
Feiz	2.82 (0.47)	
Imam Musa Kazim (As)	3.22 (0.45)	
Profession		
Surgeon	2.72 (0.70)	0.000
Surgery resident	2.35 (0.56)	
Anesthesiologist	3.28 (0.48)	
Anesthesiology resident	2.84 (0.83)	
Operating room technicians	2.75 (0.67)	
Anesthesia technician	2.85 (0.54)	
Recovery nurse	2.67 (0.63)	
Other	1.60 (0.52)	
Job tenure (year)		
>10	2.60 (0.65)	0.017
11-20	2.94 (0.72)	
>20	2.72 (0.48)	

SD: Standard deviation

Table 4: Comparing level of staff knowledge about fire controlling methods based on variables

Variables	Mean (SD)	*P*
Gender		
Female	2.60 (0.73)	0.711
Male	2.64 (0.70)	
Age (year)	ρ=0.139	
20-30	2.52 (0.72)	0.037
31-40	2.64 (0.71)	
41-50	2.77 (0.71)	
>50	2.66 (0.46)	
Hospital		
Chamran	2.52 (0.73)	0.028
Kashani	2.61 (0.67)	
Alzahra	2.54 (0.80)	
Feiz	2.73 (0.56)	
Imam Musa Kazim (As)	3.23 (0.60)	
Profession		
Surgeon	2.54 (0.77)	0.000
Surgery resident	2.43 (0.64)	
Anesthesiologist	3.36 (0.46)	
Anesthesiology resident	2.89 (0.75)	
Operating room technicians	2.57 (0.71)	
Anesthesia technician	2.76 (0.66)	
Recovery nurse	2.63 (0.62)	
Other	1.52 (0.32)	
Job tenure (year)		
<10	2.55 (0.69)	0.048
11-20	2.66 (0.64)	
>20	2.79 (0.78)	

SD: Standard deviation

the results of their study, the risk of fires in all parts of hospital has been more than admissible level. In other words, the minimum acceptable safety for hospitals has not been provided. Accordingly, when the potential risk is high, knowledge deficit can worsen the situation. Hence, any occurrence of an accident such as fires may result in catastrophic and irreparable consequences such as people death, job interruption, high cost of repair and replacement of equipment, and also financial losses. Therefore, changes in system approach to improve safety are required.[6] In contrast with the previous study by Mehdinia *et al*., in a research of Mousavi *et al*. to determine the compliance with safety standards in hospitals affiliated to Tehran University of Medical Sciences, all the wards have been 84.9% safe which has been mostly for the physical environment. But still, the minimum safety has been for personnel who require refreshing and increasing knowledge.[17]

Regarding assessment of staff knowledge about fires, its prevention, and control, results of Bagheri *et al*. show that only 6.3% of staff had a good knowledge, 60.4% had an intermediate knowledge, and 33.3% had a poor knowledge. About 97.9% of hospital staff considered knowledge as a necessity.[18]

Davoodiantalab *et al*. found that regarding methods of fire prevention, 40.97% of the staff did not have knowledge, and 38.9% had poor knowledge. Regarding methods of fire control, 76% had no knowledge. They also found that staff knowledge is linked with their job tenure which is consistent with our results. But in contrast, they found that no significant relation is present between staff knowledge and their profession. As we indicated in our study, anesthesiologist had more knowledge than other OR staff. The overall results of their study show that staff knowledge about methods of fire control has been lower than their knowledge regarding fire prevention methods which is exactly consistent with our results.[12]

Shahbazi *et al*. in their study with similar objectives to us in Borujen hospitals found that 57.3% of staff had a fair knowledge, and 38.3% had poor knowledge about fires. All the participants have stated that so far they had no training courses about fire prevention and safety in OR. Based on their results, gender differences did not affect the level of staff knowledge which is consistent with the results

of this study. In addition, the lowest level of knowledge has been for nonspecialized personnel. However, in contrast with our result, the highest knowledge level has been for surgeon.[19] Bruley found that fire prevention in the OR can be possible by raising staff knowledge about potential hazards and effective teamwork.[11] Association of Operating Room Nurses guideline has specified that based on previous studies, all fires in the OR is 100% preventable. Staff knowledge is of the most issue for this purpose.[5] Beyea has determined steps to prevent and control fires in the OR. It includes (1) staff knowledge about methods of fire control, (2) fire control process optimization, and (3) reporting the incidence of fires in OR.[20]

According to the results of our study, unfortunately, staff knowledge about fires, its prevention, and control methods has been below the average. Therefore, it is highly recommended that the authorities include training programs about fire and safety or related workshops in their educational planning for hospitals. All the staff should be aware of their responsibility toward their profession, patients, equipment, and environment.

Acknowledgment

The authors express thanks and appreciation to the authorities of Ayatollah Kashani Hospital, Alzahra Hospital, Chamran Hospital, Feiz Hospital, and Imam Musa Kazim (AS) for their cooperation in this study. Special thanks to the nursing executives, OR supervisors, and all the OR personnel who participated and answered questions honestly.

Financial support and sponsorship

The authors would also like to acknowledge "Deputy of Research at School of Nursing and Midwifery" for supporting this research project. The research code for the proposal of this research is 293067.

Conflicts of interest

There are no conflicts of interest.

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ORIGINAL ARTICLE

Forecasting visitor accession trend of two prominent Indian Health Journal websites for the period 2015–2020 using time series analysis

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ABSTRACT

Objective: To determine the pattern and forecast visitor accession trend of two national academic journal website: Indian Journal of Community Medicine (IJCM) and Indian Journal of Public Health (IJPH) for the period 2015–2020. **Materials and Methods:** The visitor accession details (number of times journal issue accessed online) for the period 2000–2014 (15 years) were collected and recorded on Microsoft Excel sheet. Time series analysis was then applied on the dataset using different forecasting models to predict the future trend of accession and value of a real dataset using R software (version 3.1). **Results:** Both the Indian journals are managed by independent professional bodies, but IJCM journal website was made online in 2007, 3 years ahead of IJPH (2010), leading to a very high accession (a proxy indicator for volume of readership) of IJCM during this period ranging between 100,000 and 120,000 counts, and thereafter accession was noticed to be slightly higher for IJPH than IJCM. The time series sequence showed that both had similar pattern, i.e., first stage: they have initial slow rise; second stage: sudden increasing trend from 2007 to 2010 (IJCM); and 2010 to 2012 (IJPH), respectively; and third stage: Both have then a decreasing trend with superimposed seasonal fluctuations. Future predicted accession details of IJCM and IJPH for 2015–2020 by Holt-Winter fitting model suggest stagnation with online accession of journal issue ranging from 30,360 to 31,860 counts for IJPH and 20,997 to 25,581 counts for IJCM though the range of accession for IJCM (4584) was higher than IJPH (1500), thereby reflecting that IJPH will attain stagnation earlier then IJCM. Autoregressive integrated moving average model also reflected similar results. Ljung-Box test indicated that the model was found statistically correct (P = 0.825 for IJCM and P = 0.50 (IJPH), and there was no statistically significant difference between actual values and predicted values by model. For IJCM dataset, value of R^2 = 0.678 means that the model could explain 67.8% of the observed variation in the series, while it was able to explain 63.3% variations in IJPH series. **Conclusion:** To conclude within limitations, this study provides information on pattern and trend of visitor accession of public health journal website. The information unraveled from this study may further aids in planning, strengthening publication standards along with experimentation of innovative ideas to enhance visibility, global participation with a focus on retaining and enhancing journal user base.

Keywords: Autoregressive integrated moving average, behavior, cyclic, forecasting, online, prediction, public health, readers, regression, seasonal, smoothing technique, statistical modelling, trend, viewership

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Access this article online

Quick Response Code

Website: www.digitmedicine.com

DOI: 10.4103/2226-8561.189512

INTRODUCTION

In our day to day life, there occur many situations where analysis of past data is needed to make current decisions

How to cite this article: Dwivedi N, Sachdeva S. Forecasting visitor accession trend of two prominent Indian Health Journal websites for the period 2015-2020 using time series analysis. Digit Med 2016;2:57-63.

and to predict and forecast future events. The objective can be fulfilled using statistical techniques called time series analysis, wherein observations are collected at regular time intervals. These observations have an order in which they appear and found to be correlated.[1,2] Typically, a time series comprises four components (variations) and traditionally three approaches (models) for forecasting future values.[3,4] These variations are: (1) trend variation (long-term change in the mean); (2) seasonal variation (patterns occur in a fixed and known period e.g., quarter of a year, month etc.); (3) cyclic changes (pattern exists when the data exhibit rise and fall that are not of a fixed or known period); (4) irregular component (any fluctuations that are observed excluding the above mentioned variations from a time series). The models include regression-based methods, exponential smoothing methods, and autoregressive integrated moving average (ARIMA) models.

In the last decade, growth in web potential in research, academic learning, and commercial usage has increased explosively. The innovative ideas are being applied using statistical knowledge to bring out newer thought processes and products for various stakeholders. With this background a study was undertaken to determine trend, pattern, and forecast visitor accession of two national public health academic journal websites (1) Indian Journal of Community Medicine (IJCM) and (2) Indian Journal of Public Health (IJPH) for the period 2015–2020.

MATERIALS AND METHODS

Background information of two prominent National Public Health Journals is as follows.

Indian Journal of Community Medicine

The IJCM (ISSN = 0970-0218 [Print]; 1998-3581 [Electronic]) is the official organ of the Indian Association of Preventive and Social Medicine, a nonprofit professional body established in the year 1974. IJCM is an open access, peer-reviewed quarterly international publication in English language, indexed in large number of database and available in PubMed since 2008-09. IJCM is available online (www.ijcm.org.in) since September 15, 2007 including the availability and display of previous issues. The SCImago Journal Rank (SJR) of IJCM (2014) was 0.51 with 1.02 cites/document in last 2 years.

Indian Journal of Public Health

The IJPH (ISSN = 0019557X (Print); 2229-7693 (Electronic)] is the official organ of Indian Association of Public Health (IAPH), a nonprofit professional body established in the year 1956. IJPH is also open accessed, peer-reviewed, quarterly, international publication in English language, indexed in large number of database, and earliest records available in PUBMED dates back to year 1961. IJPH is available online (www.ijph.in) since 25th Sep 2010 including the availability and display of previous issues. The SJR of IJPH (2014) was 0.37 with 0.81 cites/document in last 2 years. Most of the previous issues were made available online after the appearance of website. Both the journals have been outsourced for printing and multi-media journal website management to the same private vendor and both apply graded article processing charges from authors.

Data collection

Journal hosting site routinely captures, stores, and displays anonymous accession details of manuscript/issue in a consolidated manner. The accession counts were culled out for 15 years period, i.e., January 2000–December 2014 to forecast the accession trend for the period 2015–2020. During this period, IJCM published volume number 25 (year 2000) to 39 (year 2014), whereas IJPH published volume number 44 (year 2000) to 58 (year 2014) with release of four-issues quarterly, i.e. January-March, April-June, July-September, and October-December per year leading to a total of 60 issues during this span by both the journals.

Publically available visitor accession data (a proxy indicator for volume of readership) was captured on July 1, 2015, recorded on Microsoft Excel sheet and displayed in Tables 1 and 2. There were no missing values but it is pertinent to mention that accession count indicates a cumulatively figure over time with one of the limitations being that it does not differentiate

Table 1: Accession counts of Indian Journal of Community Medicine journal website for the period 2000-2014

IJCM	Issue 1	Issue 2	Issue 3	Issue 4
2000	5054	5592	6759	7563
2001	7473	5745	6431	8034
2002	5003	6408	6382	9095
2003	5703	4796	5461	6371
2004	9053	12,726	12,748	11,106
2005	10,248	5608	30,199	12,923
2006	50,074	16,595	41,414	22,551
2007	85,199	110,347	122,450	89,163
2008	106,749	94,293	84,978	79,046
2009	85,141	103,742	102,600	91,903
2010	160,209	183,999	92,889	46,040
2011	44,234	49,264	37,449	31,611
2012	35,134	37,039	39,223	30,380
2013	33,798	26,454	54,656	29,215
2014	20,625	18,407	17,050	21,055

IJCM: Indian Journal of Community Medicine

Table 2: Accession counts of Indian Journal of Public Health journal website for the period 2000-2014

IJPH	Issue 1	Issue 2	Issue 3	Issue 4
2000	1346	756	812	1314
2001	1333	557	1157	1154
2002	854	1285	493	202
2003	1387	1661	814	907
2004	3009	2338	3301	2312
2005	3498	2694	6561	8603
2006	7348	2686	2170	1830
2007	8314	6350	3406	5790
2008	4936	2951	6548	24070
2009	4057	864	4718	17878
2010	44,389	27,542	35,110	43,192
2011	39,484	52,879	52,561	57,761
2012	118,951	49,707	35,073	37,888
2013	35,943	51,074	31,183	41,260
2014	37,994	22,571	20,140	20,737

IJPH: Indian Journal of Public Health

between new or repeat visitor as same reader can re-visit a number of times thereby increasing the accession status.

Different forecasting models were then utilized to predict the future trend of accession and value of a real data set using R software (version 3.1).

Statistical analysis

The following steps were followed during modeling and forecast analysis:[4-6]

1. Time series data were applied to determine the presence of basic features such as trends, seasonal behavior or both
2. Eliminate any trend or seasonal components, either by differencing or by fitting an appropriate model to the data. In our data set, both the components were present and were eliminated by using software command (Holt-Winters [H-Ws] and auto ARIMA)
3. Develop a forecasting model for the residuals. We used 20% of dataset for 'training' to find the parameters of the models, i.e., H-Ws and ARIMA[7]
4. Validate the performance of the model from the previous step. The objective of this step is to select a particular model to be used in forecasting. We have used the remaining 80% data set for "testing"
5. Check the difference between original time series and the forecasted values by model
6. To compare models, forecast accuracy was measured using mean absolute error (MAE), root mean square error (RMSE), and mean absolute percentage error (MAPE)

In this study, H-W model and ARIMAs models were applied.

Holt-Winter method

This method is also known as a triple exponential smoothing model and recommended when seasonality exists in the time series data.[7,8] It is based on three smoothing equations – one for the level, one for trend, and one for seasonality. In H-W method, there are three smoothing parameters α, β, and γ and range is 0–1.[9-12]

Autoregressive integrated moving average model

Auto regressive integrated moving average or ARIMA model has three parameters (*p, d, q*) and is often written as ARIMA (*p, d, q*),[13-15] where *P* determines the number of steps into the past needed to forecast the current value. The parameter *d* represents the levels of differencing the original time series is needed for it to become stationary. Parameter *q* is the order of moving average process.

Forecast accuracy measures

Suppose our data set is denoted by y_1..., y_T, and we split it into two sections: the training data (y_1..., y_N) and the test data (y_{N+1}..., y_T). To check the accuracy of forecasting method, we estimate the parameters using the training data and forecast the next *T-N* observations.[7] These forecasts can then be compared to the test data.

The forecast errors are the difference between the actual values in the test-set and the forecasts produced.[16] Thus, $e_t = y_t - y_{t|N}'$ for $t = N + 1$.....T. y = denotes the predicted values.

In this paper, we have used three popular measures of accuracy i.e.,

$$MAE = \text{mean}(|e_i|)$$

$$RMSE = \sqrt{\text{mean}(e_i^2)}$$

$$MAPE = \text{mean}(|p_i|) \text{ where } p_t = 100 e_t / y_t$$

RESULTS

Both the Indian journals are managed by independent professional bodies but IJCM journal website was made online in 2007, 3 years ahead of IJPH (2010), leading to a very high accession (~readership) of IJCM during this period ranging between 100,000 and 120,000 counts. A developmental phenomenon occurred for the first time with the spread and penetration of internet in country plateau with online appearance of IJPH journal and thereafter visitor accession was noticed to be slightly higher for IJPH than IJCM [Figure 1]. Average visitor accession per issue

for the period 2000–2014 of IJCM was 44,246.47 (issue 1), 45,401.0 (issue 2), 44,045.93 (issue 3), and 33,070.4 (issue 4), whereas it was 20,856.2; 15,061.0; 13,603.13; and 17,659.87 for IJPH, respectively. The time series analysis showed that both have similar pattern, i.e., first stage: they have initial slow rise; second stage: sudden increasing trend from 2007 to 2010 (IJCM) and 2010 to 2012 (IJPH), respectively; and third stage: both have then a decreasing trend with superimposed seasonal fluctuations.

Figures 2 and 3 show the auto-correlation function (ACF) and partial ACF plot showing dataset reaching a stationary level.

Figures 4 and 5 show that the observed actual values (black line) and the predicted model values (red line) matched reasonably well for both IJCM and IJPH dataset and there is consistency in the trend.

Figures 6 and 7 show the predicted accession details of IJCM and IJPH during 2015–2020 by H-W fitting model suggesting of stagnation and ranging from 30,360 to 31,860 counts for IJPH and 20,997 to 25,581 counts for IJCM though the range of accession for IJCM (4584) was higher than IJPH (1500) thereby reflecting that IJPH will attain stagnation earlier then IJCM.

Table 3 shows parameter (α) for H-Ws model which showed the influence of recent and later data on model. Alpha value ranges from 0 to 1 and the values nearer to 1 mean that the model is influenced more by later set of values rather than the recent values. IJCM (α =0.91) is influenced more by later data set, i.e., weightage given to 2014 values is less than the weightage given to 2013 value and so on. Whereas, IJPH (α =0.30) is highly influenced by recent data i.e., weightage given to 2014 value is more than weightage given to 2013 value and so on.

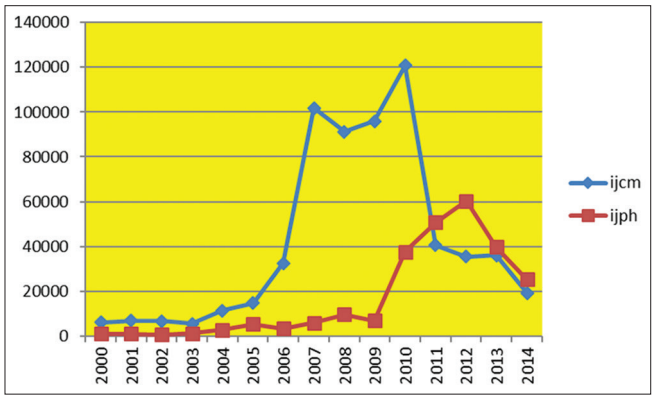

Figure 1: Line graph of accession details of Indian Journal of Community Medicine and Indian Journal of Public Health website, 2000–2014

Table 4 shows the best fitted ARIMA model parameter for both sets. Different combinations for ARIMA model on the training data set was tried and it was found that ARIMA (0,1,0) (1,1,0) model was the best fitted with lowest variance (IJCM = 8352, IJPH = 3144) and Akike information criterion (IJCM = 1290.59, IJPH = 1238.35).

Table 5 shows the comparison between H-Ws and best fitted ARIMA model using popular model error statistics

Table 3: Holt-Winter model parameter values for Indian Journal of Community Medicine and Indian Journal of Public Health dataset

Journal	α
IJCM	0.91
IJPH	0.30

IJPH: Indian Journal of Public Health, IJCM: Indian Journal of Community Medicine

Table 4: Autoregressive integrated moving average model parameter values for Indian Journal of Community Medicine and Indian Journal of Public Health dataset

	ARIMA model	Variance (σ2)	AIC
IJCM	(0,1,0) (1,1,0)	8352	1290.59
IJPH	(0,1,0) (1,1,0)	3144	1238.35

IJPH: Indian Journal of Public Health, IJCM: Indian Journal of Community Medicine, AIC: Akike information criterion

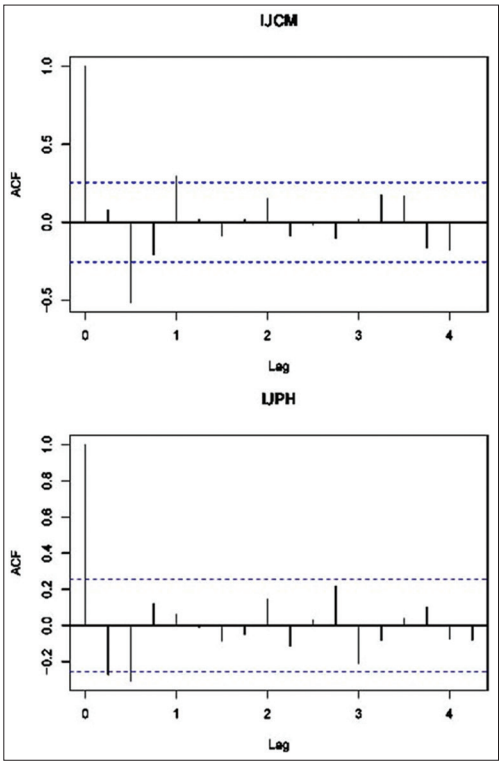

Figure 2: Auto-correlation function plots

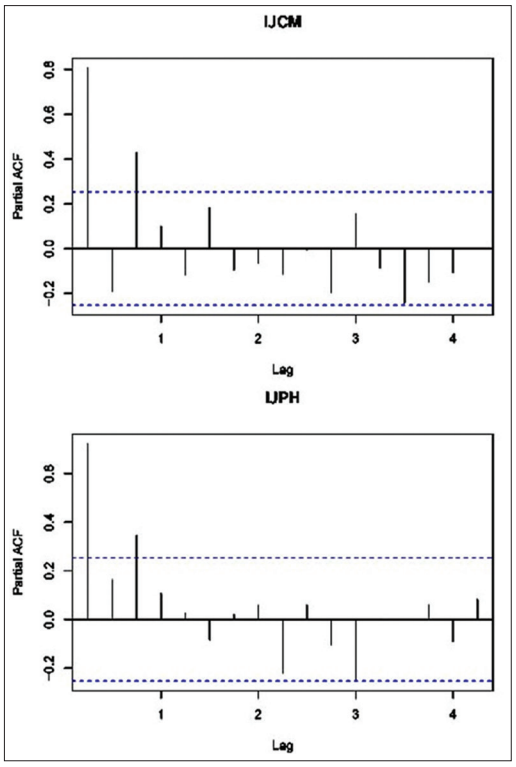

Figure 3: Partial auto-correlation function plots

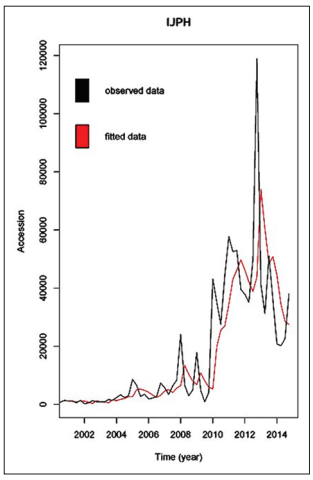

Figure 5: Holt-Winters model fitting (IJPH)

MAE, RMSE, and MAPE. This table shows that for H-W model all the three error measures were lower than ARIMA model, suggesting that H-W model was better measure for forecasting than ARIMA model in current data series.

In Table 6, Ljung-Box (modified Box-Pierce) test indicated that the model was found statistically correct ($P = 0.825$ for IJCM and $P = 0.50$ for IJPH, respectively). There was no statistically significant difference between actual values and predicted values by model. Although the time series model offers a number of different goodness of

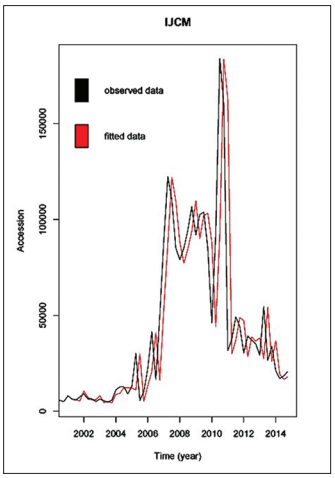

Figure 4: Holt-Winters model fitting (IJCM)

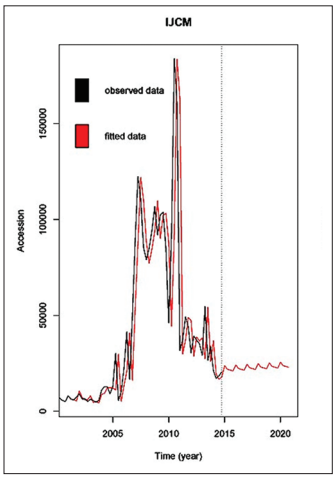

Figure 6: Future predicted value of Indian Journal of Community Medicine website accession

Table 5: Model forecast error statistics

	Estimation period		Validation period	
	H-W model	ARIMA model	H-W model	ARIMA model
IJCM				
RSME	717.70	892.81	454.65	592.05
MAE	548.33	627.21	585.62	612.91
MAPE	8.02	10.96	17.97	19.28
IJPH				
RSME	561.15	662.28	148.82	156.98
MAE	551.62	608.19	886.85	994.28
MAPE	8.41	10.07	3.34	5.28

H-W: Holt-Winter, IJPH: Indian Journal of Public Health, IJCM: Indian Journal of Community Medicine, RSME: Root mean squared error, MAE: Mean absolute error, MAPE: Mean absolute percentage error, ARIMA: Autoregressive integrated moving average

fit statistics, here stationary R^2 value was used and larger values of stationary R^2 (up to a maximum value of 1) indicate better fit. For IJCM dataset value of $R^2 = 0.678$ meaning that the model could explain 67.8% of the observed variation in the series and similarly for IJPH dataset, it was able to explain 63.3% variation.

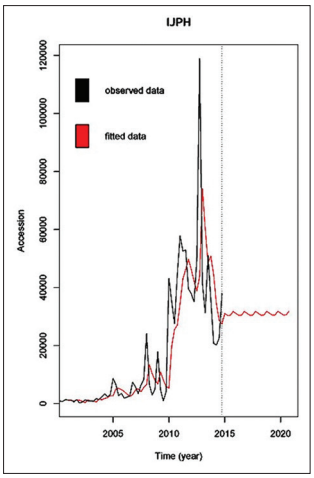

Figure 7: Future predicted value Indian Journal of Public Health website accession

Table 6: Model statistics for Indian Journal of Community Medicine and Indian Journal of Public Health accession dataset

Journal	Stationary R^2	Statistics	*P*
IJCM	0.678	11.571	0.82
IJPH	0.633	14.344	0.50

IJPH: Indian Journal of Public Health, IJCM: Indian Journal of Community Medicine

DISCUSSION

People may visit the website for different reasons (information, transaction, or navigation) and the actual reason for the observed behavior may be difficult to infer. Time series models are particularly useful when little is known about underlying process one is trying to predict. The accession of academic journal website primarily depends upon objective of reader/scholar, professional level of researcher, credibility and popularity of author(s), innovative concept/research/idea or critical learning offered by a particular article/manuscript/document published by a journal.

Based on our analysis, it is concluded that the accession of these historically trusted popular Indian journal websites will stagnate during 2015–2020. The myriad reasons could be maturity of readers, high publication standard of journals leading to nonattraction of majority of mediocre academicians/researchers/scholars/readers, mushrooming of similar but multiple journal publishing houses, and general disinterest, etc. Another common reason personally observed, experienced, and noticed by authors is that there is substantial delay in communicating the decision with regard to acceptance or rejection of manuscript once the review process is initiated. This delay as calculated by author is a median of 6 months with the range of 3–15 calendar months (not shown in table) leading to frustration, despair, and anger toward journal administration. Time to publication is yet another parameter that needs urgent early attention by the esteem journal colleagues. These delay including noncommunication by the journal management members over the past few years have led to the emergence of bunch of other journal publishing housing in the country who are also committed to quality but ensuring timely and early decision making.

With increase access to internet, requirement of mandatory research publication for professional advancement, availability of research training environment, funding options, and positive research environment in the country there is large spurt of online submission of publication documents/articles which also probably burden the limited capacity of editorial board to communicate in reasonable time-frame in recent years. However, there could be other administrative and technical factors leading to delay. It is conceded with a pinch of salt that submitting authors may also be responsible for the delays. Therefore, effective and early communication between primary journal stakeholders (author, editor, and reviewers) may play a pivotal role in healthy development of journal in future.

Usefulness of this study may be applicable in planning and most important being toward increasing publication standards to a next higher level along with experimentation of innovative ideas to increase visibility, participation, enhancing, and retaining user base. Significant advise, use, and reporting by these journals on the lines of strengthening the reporting of observational studies in epidemiology and consolidated standards of reporting trials guidelines[17] may attract more global readers with higher citation, impact and credibility.

Probably, this is the first ever study carried out on Indian public health journal website with the application of time series analysis, and within limitations, a straight forward answer cannot be offered to a complex yet evolving phenomenon. Therefore, for healthy growth of journals and publishing authors (elite *vs.* mediocre) in our country, quality checks and balance will continue to dominate in near future. In the light of above discussion, journal management could consider increasing the annual frequency of publications from 4 (quarterly) to 6 (bi-monthly) or 12 (monthly) issues to retain and expand user base (authors/readers) without compromising the quality.

In a digital era with increasing internet penetration in country has the time arrived to phase out print version of journal? This decision may not be easy and would require introspection, discussion with stakeholders, and articulation of roadmap. Future research direction could include in-depth online readership behavior analysis and insight by systematically applying newer tools and technology (web-analytics, metrics) to these academic journal websites.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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ORIGINAL ARTICLE

Preclinical medical students' usage of electronic devices in lectures: A cross-sectional study

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ABSTRACT

Background and Objectives: Electronic devices such as laptops, tablets, and smartphones are commonly used in clinical clerkships, problem-based learning, and practicals. However, there is limited literature on electronic device usage in medical lectures. This study aimed to (1) assess preclinical medical students' pattern and reason for electronic device usage in lectures and (2) assess the effect of lecture content and student factors on device usage. **Materials and Methods:** This was a cross-sectional study from the year 1 to 3 medical students of the Li Ka Shing Faculty of Medicine, The University of Hong Kong. The data was collected through self-administrated questionnaires. The questionnaire was distributed twice to the same cohort of students, once after their basic medical science lectures, another after humanities lectures. Categorical variables were compared by Chi-squared test or Fisher's exact test; continuous variables were compared by Mann–Whitney U-test or Kruskal–Wallis H-test. **Results:** Five hundred and seventy-nine valid questionnaires were collected. Students spent more time on electronic devices for learning in science lectures when compared with humanities lectures ($P < 0.001$). In contrast, students spent more time for nonlearning purposes in humanities lectures ($P < 0.001$). In science lectures, the mode of admission to medical school ($P < 0.05$) and year of study ($P < 0.001$) were factors affecting the device usage. **Conclusions:** Lecture content, mode of admission, and year of study have a significant impact on the electronic device usage in preclinical medical lectures. Appropriate interventions are necessary to help the students make better use of their devices and decrease the time spent on nonlearning purposes, particularly in humanities lectures.

Keywords: Lectures, smartphones, undergraduate medical education

INTRODUCTION

Electronic devices including laptops, tablets, and smartphones are gaining popularity in society and are commonly used in tertiary education.[1,2] Usage of electronic devices and e-learning resources is also widely accepted in medical education. Multiple studies and programs have been performed to assess or implement electronic device usage in medical education. Areas covered include clinical clerkship teaching,[3,4] clinical skills learning,[5,6] problem-based learning,[7] practicals,[8,9]

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Access this article online

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Website: www.digitmedicine.com

DOI: 10.4103/2226-8561.189521

How to cite this article: Hui RW, Leung SS, Cheung TL, Chu EW, Fong JC, Lau IH, *et al.* Preclinical medical students' usage of electronic devices in lectures: A cross-sectional study. Digit Med 2016;2:64-71.

and the teaching of specific specialties such as surgery and pathology.[10,11] Most of the published literature on device usage in medical education are based on clinical years or postgraduate medical teaching, and there is limited literature about electronic device usage in lectures in the preclinical stage.

The pattern of usage has also been studied. Studies have suggested the usage of electronic devices for note-taking[12] and to search for academic resources.[4] The use of handheld devices for accessing electronic databases such as "UpToDate" and "Best Practice" is also increasingly popular.[13] Newer innovations such as usage of social media[14,15] and interactive information sharing for lectures[16] have been proposed. However, concerns have also been raised about electronic devices being a distraction and how students may use electronic devices for nonlearning purposes.[2,7,17,18] Students may multitask on their electronic devices and could be disturbed by other activities.[1] Other challenges raised include superficial learning and not knowing how to appropriately use the resources.[17] There are also concerns that the heavy reliance on these electronic resources may lead to information overload and omission of important core knowledge.[13]

The literature elicits that electronic devices have shown benefits in medical education and received generally positive comments from students. However, arguments have been made against the usage of electronic devices. The usage rate of electronic devices in medical education is high and electronic devices are widely accepted tools for medical lectures. Yet, the data on device usage in preclinical medical students are limited. This study will provide an understanding of the electronic device usage pattern of preclinical medical students in lectures. The objectives of the study are (1) to identify the pattern and reason of electronic device usage in preclinical medical lectures and (2) to identify whether lecture content (basic medical science *versus* humanities) and student factors will affect electronic device usage in preclinical medical students.

MATERIALS AND METHODS

Study population

The sample population encompassed year 1–3 undergraduate Bachelor of Medicine and Bachelor of Surgery (MBBS) students of the Li Ka Shing Faculty of Medicine, The University of Hong Kong (HKU) in the 2014–2015 academic year. There are two modes of admissions into the HKU MBBS curriculum – Joint University Programmes Admissions System (JUPAS) and non-JUPAS. JUPAS refers to students who have completed secondary education in local schools. Non-JUPAS admission encompasses degree holders, students from overseas schools, and students from international schools (schools in Hong Kong that adopt international curriculum rather than the local Hong Kong curriculum).

The HKU MBBS curriculum is system-based and problem-based. It is horizontally integrated, with system-based blocks in the year 1–3. Problem-based learning occupies about 25% of the timetable in that period, while students also need to attend lectures and practicals. The MBBS curriculum is also vertically integrated with early clinical exposure starting from year 1 and later revisit of basic sciences. Since classes from year 4 to 6 mostly take place in clinical settings, the first 3 years are called the preclinical years in this study (despite the fact that clinical exposure starts from year 1).

Procedure

The data was collected in the form of a self-administered questionnaire filled in by the students. The questionnaires were distributed to students immediately after their lectures. Students were invited to fill in the questionnaires referring to their electronic device usage in the lecture they just finished. The questionnaire was distributed twice to each of the three cohorts of students (i.e., year 1–3), once after their basic medical science lectures (such as anatomy, biochemistry, microbiology, physiology, or pharmacology) and another after humanities lectures (such as medical ethics or humanities). Each of the lectures lasted for approximately 60 min.

The questionnaire used in this study was adopted and edited from a previous study by Chan *et al*.[7] The questionnaire encompassed three parts: (1) background information of students (year of study, mode of admission to medical school), (2) type of lecture that was just conducted (basic medical science or medical humanities), and (3) pattern and reason of electronic device usage in lecture.

Statistical analysis

Data were analyzed using the SPSS version 21 (SPSS Inc, Chicago, IL). Descriptive statistics were expressed as number (percentage). Categorical variables were compared by Chi-squared test or Fisher's exact test; continuous variables were compared by Mann–Whitney U-test or Kruskal–Wallis H-test.

Ethical considerations

Participation was voluntary and written consent was obtained. No identifiable information was collected. The study was approved by the Institutional Review Board of the HKU/Hospital Authority Hong Kong West Cluster (IRB reference number: UW 14-617).

RESULTS

In total, 579 valid questionnaires were analyzed. Three hundred and eighty-nine questionnaires were completed in basic medical science lectures, and 190 questionnaires were completed in humanities lectures. It was noted that the number of questionnaires collected in humanities lectures was smaller than that in basic medical science. This could be due to the lower attendance rate in humanities lectures, hence the smaller number of respondents. A summary of the data is given in Table 1.

Time spent on electronic devices

In the questionnaires, the students reported the time they spent on their electronic devices for learning and nonlearning purposes. Each lecture lasted for an hour, so the time range that they spent was 0–60 min. Students could multitask and simultaneously perform learning and nonlearning tasks, therefore they were allowed to fill in a maximum time of 60 min for learning and 60 min for nonlearning. Students with no usage of electronic devices at all were marked as 0 min for both categories.

Basic medical science lectures

In basic medical science lectures, year of study had no significant effect on the time spent on electronic devices for learning purposes (χ^2 [2, N = 389] = 1.14, P = 0.565). In contrast, the year of study was significantly associated with the time of device usage for nonlearning purposes (χ^2 [2, N = 389] = 17.85, P < 0.001). Follow-up pairwise comparison showed that there were significant differences in time spent between year 1 and year 2 students (P < 0.001) and between year 1 and year 3 students (P < 0.05). The time spent on nonlearning purposes in year 1 students was greater than the time in year 2 and 3 students, respectively.

Table 1: Demographics of respondents

	Basic medical science lectures (n=389)	Humanities lectures (n=190)
Year of study (%)		
Year 1	159 (40.87)	46 (24.21)
Year 2	110 (28.28)	57 (30.00)
Year 3	120 (30.85)	87 (45.79)
Mode of admission to medical school (%)		
JUPAS	270 (69.41)	127 (66.84)
Non-JUPAS	119 (30.59)	63 (33.16)

JUPAS refers to students admitted to medical school through Hong Kong local secondary schools. Non-JUPAS admission encompasses all other routes of admission (international schools, overseas schools, degree holders). JUPAS: Joint University Programmes Admissions System

The effect of mode of admission (JUPAS and non-JUPAS) was also analyzed. The time spent on learning purposes was significantly greater in non-JUPAS students than in JUPAS students (U = 18074.50, P < 0.05). Mode of admission had no significant effect on the time spent on nonlearning purposes (U = 15551.00, P = 0.600).

Humanities lectures

In humanities lectures, the year of study and mode of admission both had no significant effect on the electronic device usage time.

Comparing basic medical science and humanities lectures

Comparing science and humanities lectures, students spent significantly more time on their electronic devices for learning purposes in science lectures (U = 26450, P < 0.001). On the other hand, students spent significantly more time on nonlearning purposes in humanities lectures (U = 47867.50, P < 0.001).

Reason for usage

In the questionnaire section on the reason for usage, students were allowed to select more than one option as students may multitask and use electronic devices for different purposes in the same lecture.

In basic medical science lectures, 299 (76.86%) respondents reported the usage of electronic devices. Of the students who used electronic devices, 196 (65.56%) used devices for viewing lecture materials, 178 (59.53%) for taking notes, 144 (48.16%) for researching, 47 (15.72%) for reading reference materials, and seven (2.34%) for recording the lecture content [Figure 1]. For nonlearning purposes, 151 (50.50%) used electronic devices to access social media, 47 (15.71%) for extracurricular activities, 99 (33.11%) for accessing E-mails, 141 (47.16%) for instant messaging, 54 (18.06%) for entertainment, and 34 (11.37%) for reading the news [Figure 2].

In humanities lectures, 151 (79.47%) respondents reported the usage of electronic devices. Of the students who used electronic devices, 66 (43.71%) used devices for viewing lecture materials, 42 (27.82%) for taking notes, 37 (24.50%) for researching, and 15 (9.93%) for

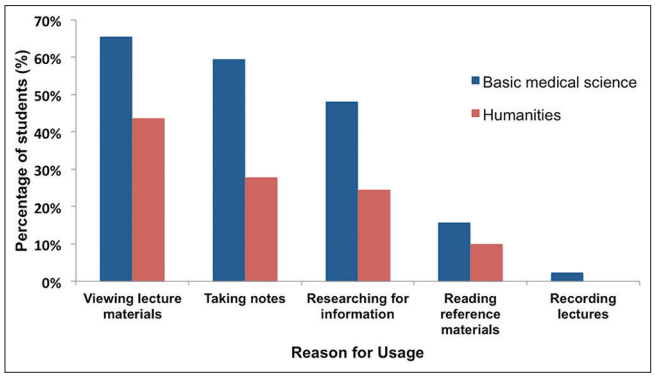

Figure 1: Reasons for the usage of electronic devices for learning purposes

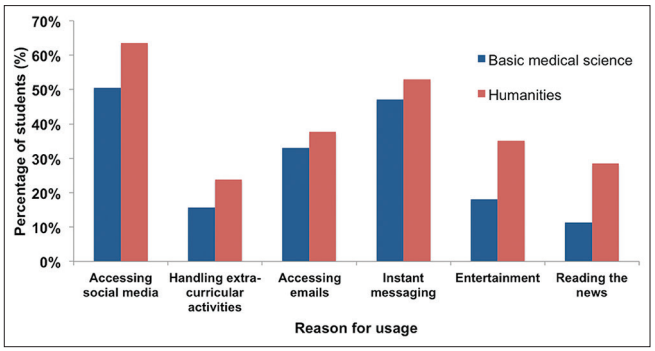

Figure 2: Reasons for the usage of electronic devices for nonlearning purposes

reading reference materials [Figure 1]. For nonlearning purposes, 96 (63.58%) used their electronic devices to access social media, 36 (23.84%) for extracurricular activities, 57 (37.75%) for accessing E-mails, 80 (52.98%) for instant messaging, 53 (35.10%) for entertainment, and 43 (28.48%) for reading the news [Figure 2].

Reasons for nonusage

In basic medical science lectures, 90 (23.14%) respondents reported they did not use electronic devices. Among the students who did not use electronic devices, over half (52.2%) of them believed that usage of electronic devices did not facilitate their learning, and almost one-third (31.1%) thought electronic devices were a source of distraction. Ten percent reported a preference of using printed notes over electronic devices.

Similarly in humanities lecture, 39 (20.53%) respondents did not use electronic devices. Among these respondents, 24 (61.54%) did not think the usage of electronic devices facilitate learning, while 12 (30.77%) thought it was a distraction.

DISCUSSION

Results showed that preclinical medical students spent more time on their electronic devices for learning purposes in basic medical science lectures when compared with medical humanities lectures. On the other hand, more time was spent on nonlearning purposes in humanities lectures. This implies that preclinical medical students were less focused on the lecture content in humanities lectures when compared with science lectures. Medical students' criticism and skepticism against medical humanities teaching have been documented globally. In particular, medical students have suggested humanities teaching to be simplistic, uninteresting,[19] and irrelevant to clinical practice.[20] The differences in device usage patterns between humanities and science lectures may be attributable to students' negative attitude toward humanities lectures. Since we did not assess students' views toward medical humanities, we were unable to draw any associations between learning attitudes and device usage. Nevertheless, the results from this study clearly demonstrated a disparity in device usage and attentiveness between science and humanities lectures. Further studies to assess how lecture content affect electronic device usage are warranted.

Students admitted through the non-JUPAS scheme spent significantly more time on learning using their electronic devices than JUPAS students during basic science lectures. JUPAS students are admitted to medical school from local schools whereas non-JUPAS students are admitted from international schools or overseas schools. English is a second language to the majority of Hong Kong students, and the exposure to English is less in local secondary schools when compared with international schools.[21] Hence, non-JUPAS students are likely to have higher English ability than their JUPAS counterparts. Non-JUPAS students' language ability may enable them to make better use of electronic resources, which are mostly in English. Language could be a major contributing factor to the difference in electronic device usage observed in JUPAS and non-JUPAS students.

In basic medical science lectures, the year of study also had a significant effect on the time of usage for nonlearning purposes. Year 1 medical students spent significantly more time on nonlearning purposes on their electronic devices when compared with year 2 and 3 students. A previous study demonstrated that medical student seniority was associated with differences in concentration levels in class. The authors proposed that students being taught by different lecturers in different years may contribute to the disparity in attention levels.[22] Our data revealed that aside

from attentiveness in lectures, medical students' year of study has an effect on electronic device usage as well.

Overall, the usage rate of electronic devices in lectures was high. The usage rate was 76.86% in basic medical science lectures and 79.47% in humanities lectures. Certain students did not use electronic devices in the lectures, and the most common reason was they thought the devices did not facilitate their learning. Personal factors such as a preference for hand-written notes also contributed to the students' views on electronic devices in learning.

It was noted that many students used their electronic devices for multiple tasks and some students used their devices simultaneously for learning and nonlearning purposes. Multitasking on electronic devices is prevalent and has been reported in the literature.[2] However, the actual effect of multitasking on learning has not been quantified. Further studies are needed to look into the pattern of multitasking on electronic devices and whether multitasking has any effect on learning efficiency.

In this study, students were required to retrospectively report their electronic device usage pattern during the lectures; therefore, recall bias could be present. Students may also be less willing to volunteer about their usage of electronic devices for nonlearning purposes due to social desirability bias. However, we administered the questionnaires immediately after the lectures and also did not collect any identifiable information; therefore, the recall and social desirability bias should be limited. The questionnaires were distributed to students after their lectures; therefore, the subjects did not include the absentees. It was observed that the attendance to humanities lectures was lower than in basic medical science lectures. The number of absentees could be related to students' attitude to the lecture type and could lead to selection bias. Future studies should aim to send out electronic questionnaires to all students, allowing collection of comprehensive data that includes absentees as well.

CONCLUSIONS

This study shows that lecture content has a significant impact on the duration and purpose of electronic device usage in preclinical medical lectures. Students spend more time on their devices for learning purposes in basic medical science lectures and more time on nonlearning purposes in humanities lectures. Mode of admission to medical school and the year of study have an effect on electronic device usage in basic medical science lectures. Appropriate interventions may be necessary to decrease the amount of time students spend on electronic devices for nonlearning purposes.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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APPENDIX – QUESTIONNAIRE USED IN THE STUDY

Medical Students' Usage of Mobile Devices Questionnaire

Please answers the following questions according to the instructions

Please put a tick in the appropriate boxes

Please note that MOBILE DEVICES includes laptop or notebook computers, smartphones (e.g. iPhone, Galaxy Note, etc.), tablets (e.g. iPad, iPad mini, Galaxy Tab, etc.), and ebook readers, (e.g. Kindle, NOOK, etc.), etc.

1. What is your gender?
- Male
- Female

2. What is your year of study?
- MBBS I
- MBBS II
- MBBS III

3. Through which of the following did you enroll into this program?
- JUPAS
- Non-JUPAS (Previous education level: Secondary/Bachelor/Master/Doctoral)

4. Please specify the number of mobile devices you own:

_____

5. To which of the following categories does the lecture you have just attended belong?
- Medical Humanities

6. Did you use any mobile device (s) in the lecture you just attended?
- Yes
- No

(If yes, please proceed to question 8; if no, please proceed to question 7)

7. Why did you not use a mobile device in the class you just attended?
- Mobile devices do not facilitate my learning
- Mobile devices distracts me
- The lecturer did not allow the use of mobile device
- Others (Please specify:_____)

(Please proceed to question 12)

8. Please indicate the device (s) you used in class:
(You can choose more than 1 option)
- Laptop
- Smartphone
- Tablet
- Ebook reader
- Others (Please specify:_____)

9. What did you use your device for? (You can choose more than 1 option)
- Learning purposes
- Viewing lecture materials

- Taking notes
- Searching for information relevant to the lecture content
- Viewing reference material, e.g. ebooks, journals
- Others (Please specify:_____)
- Non-learning purposes
- Social Media (e.g. Facebook)
- Handling extracurricular activities matters
- E-mail
- Instant messaging
- Entertainment (e.g. YouTube, gaming)
- Reading the news
- Others (Please specify:_____)

10. Approximately how much time did you use your mobile devices for learning purposes in the lecture?

_____minutes

11. Approximately how much time did you use your mobile devices for nonlearning purposes in the lecture?

_____minutes

12. To what extent do you agree with the following statement?

"Mobile device (s) facilitate your learning during lectures."

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

13. To what extent do you agree with the following statement?

"Mobile devices should not be used for noneducational purposes during lecture."

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

14. To what extent do you agree with the following statement?

"Use of mobile device (s) during lectures should be regulated."

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

End of questionnaire. Thank you for taking part in this research study.

Please hand in this questionnaire together with the consent form to any of our teammates.

ORIGINAL ARTICLE

Motor cortex activation during motor imagery of the upper limbs in stroke patients

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ABSTRACT

Objective: The objective of this study was to analyze the functional brain activation in acute stroke patients during motor execution (ME) and motor imagery (MI) and to discuss the association between damaged brain structure and impaired brain function in stroke patients. **Methods:** The functional magnetic resonance imaging technique was used to observe activation of the brain during ME/MI of the upper limbs in 12 acute stroke patients (with the left brain damage) and 12 healthy controls. **Results:** During ME, the stroke patients appeared to be activated more strongly than the healthy controls in the ipsilateral primary motor areas. The MI of the affected hand in the stroke patients was not significantly different from that of the healthy hand. The nonmotor areas, the angular gyrus, and the fusiform gyrus were also activated during ME/MI. **Conclusion:** Structural damage in the brain is associated with the activation of brain function in acute stroke patients. Ipsilateral inhibition is reduced in stroke patients during ME and the damaged brain needs to recruit more brain areas to complete the desired action due to motion difficulties resulting from brain damage. The participation of nonmotor brain areas in ME/MI indicates that cortical reorganization may contribute to the restoration of motor function following stroke. MI can be used to improve injured brain areas, helping with the rehabilitation of stroke patients.

Keywords: Functional magnetic resonance imaging, motor execution, motor imagery, stroke

INTRODUCTION

Motor deficits are one of the main and often most debilitating deficits after brain damage. Stroke is a major cause of morbidity and invalidity in the modern society.[1] Patients who survive a stroke usually recover some of the functionalities that is compromised by the stroke within 3 months. Physical therapy is often used to treat these stroke-related motor deficits. The theory of cortical plasticity postulates that[2] continuous training can recover the lost motor function when part of the brain cortex is damaged and motor dysfunction occurs. In recent years, motion imaging technology has been considered an important new procedure in the rehabilitation of this disorder.[3]

Motor imagery (MI) can be defined as the internal reactivation of a first-person motor program which is governed by the principles of central motor control without any overt motor output.[4,5] MI activates the sensorimotor system without obvious movement and has the same neural mechanisms with motor execution (ME).[6-10] An increasing number of clinical studies have shown that MI rehabilitation is suitable for stroke patients, especially for those who have a great difficulty in moving their bodies.[5,11-13]

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Access this article online

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Website: www.digitmedicine.com

DOI: 10.4103/2226-8561.189523

How to cite this article: Wang L, Zhang J, Zhang Y, Sang L, Yan R, Liu C, Qiu M. Motor cortex activation during motor imagery of the upper limbs in stroke patients. Digit Med 2016;2:72-9.

Despite many studies have investigated the use of MI in rehabilitation, the neural mechanisms of exercise in the treatment of stroke patients are not very clear. These mechanisms could have important implications for treating stroke patients who have been treated with MI. We have previously explored the relationship between activated brain areas and age during simple finger ME/MI by the functional magnetic resonance imaging (fMRI).[14] However, the results are simply for the healthy controls, and the brain activation mechanisms during the ME/MI of the upper limbs in stroke patients are unclear. Therefore, this study continues to use fMRI to explore the activated brain network during ME/MI in healthy human controls and patients recovered from stroke (stroke within 3 months).

METHODS

Subjects

Twelve patients (7 males; a mean age of 53.17 years [Supplementary Table 1]) with first-ever subcortical stroke were prospectively recruited. The criteria for selecting patients included initial disease occurrence and obvious hemiplegia due to cerebral infarction or cerebral hemorrhage. The specific inclusion criteria included the duration of motor dysfunction ≥1 month; the extension of the ipsilateral wrist >10; the extension between the thumb, the metacarpophalangeal joint, and the interphalangeal joint of at least two fingers >10; and that extension can be repeated three times/min. Exclusion criteria included a persistent language deficit, significant renal or liver disease, carotid artery stenosis/occlusion, neglect/inattention, treatment with selective serotonin reuptake inhibitors or benzodiazepines, a large area of infarction or massive bleeding, and bilateral hemisphere damage. Twelve age-matched controls (6 males; a mean age of 56.67 years [Supplementary Table 2]) were recruited through a local advertisement. The controls had no history of medical disorders and were not taking regular medication. All the controls were right-handed. Written consent was obtained from each participant, and the protocol was approved by the Ethics Committee of the Third Military Medical University. For each participant, mental status was assessed by the Mini–Mental State Examination, MI performance was evaluated by the Movement Imagery Questionnaire-Revised, Second Edition, and those controls who were unable to adequately perform MI were excluded from the study.

Experimental design

All the controls experienced four sequential runs in this order: Unaffected left-hand ME; left-hand MI; affected right-hand ME; and then right-hand MI. The ME procedure was to press the thumb and index finger together at a frequency of 1 Hz. As the patient group had finger movement problems in the affected hand, they were asked to try their best to pinch between the thumb and index finger, and the actual pinching frequency was below 1 Hz. The MI procedure was to imagine the same movements without actually performing them. A diagram of an idealized experiment is illustrated in Figure 1. Each run included 5 blocks, each lasting for 1 min. Within each block, a 10 s instruction period preceded a 30 s resting baseline period, followed by a 30 s ME (MI) period. During the ME run, the screen presented a picture of the corresponding finger movement at a frequency of 1 Hz. During the MI session, the screen presented an arrowhead; the left arrow directed the participant's attention to the left hand, while the right arrow directed the participant to the right hand. During the rest period, black cross picture on the center of the screen reminded the participants to place their hands on the sides of their bodies and breathe quietly. The stimulus presentation and behavior recordings were conducted with E-prime software (company and location). A Data Glove (5DT) was used to monitor the participants' behavior during the whole process of the experiment. If the participants did not perform in accordance with the requirements during ME or they had obvious finger movement during MI, the experiment would be stopped. Before the fMRI experiment, the participants received task training twice, for 1 h each time.

Data acquisition

The data were collected on a 3.0T MRI scanner (Trio, Siemens Medical Erlangen, Germany). All fMRI scans were performed using a T2*-weighted gradient echo sequence, a standard birdcage radio-frequency coil, and the following parameters: Repetition time (T_R) = 2000 ms, echo time (T_E) = 30 ms, flip angle = 90°, 64 × 64 voxel matrix, field of view (FoV) = 220 mm, 27 contiguous axial slices acquired in interleaved order, and thickness = 4.0 mm. High-resolution T1-weighted structural images were also obtained, using the three-dimensional gradient-echo technique pulse sequence, under these parameters: T_R = 1900 ms, T_E = 2.52 ms, TI = 1100 ms, flip angle = 15, 256 × 256 voxel matrix, FoV = 240 mm, 176 contiguous axial slices, and thickness = 1.0 mm. During the scan, the participants were asked to lie on the scanner and keep quiet and still.

Data preprocessing

The SPM8 software (http://fil.ion.ucl.ac.uk.spm/) was used to analyze the data. All the original images were

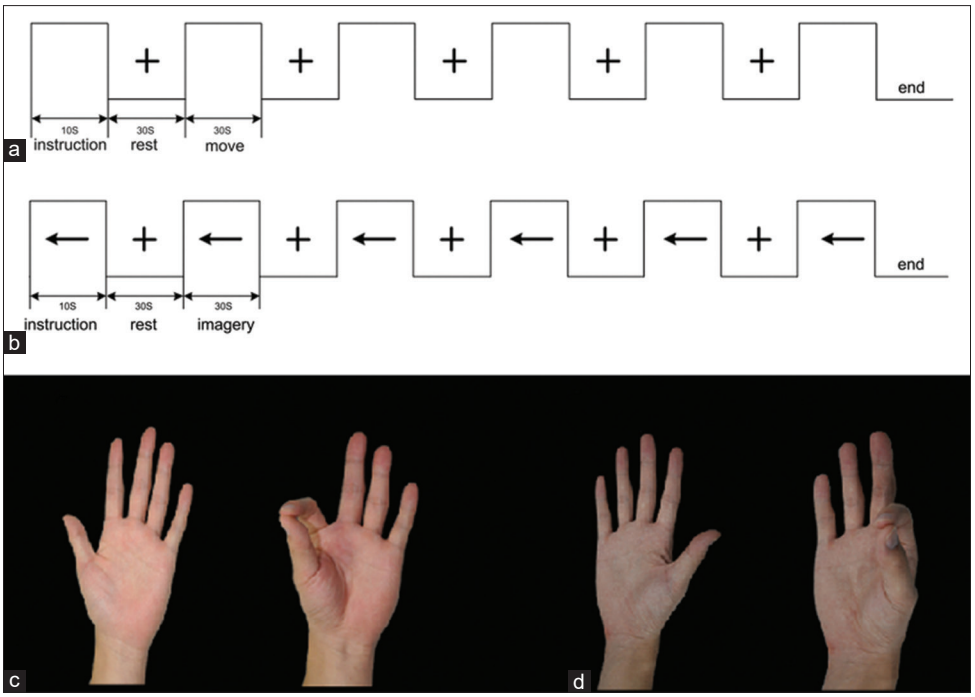

Figure 1: Example diagram of the experiment (a) motor execution (b) motor imagery. Each participant underwent four 5-min runs. Each run included five identical 60-s blocks, and the 60-s blocks comprised a 30-s rest period and 30 s of motor execution (or motor imagery). (c and d) image showing how to perform motor execution with the right hand (c) and the left hand (d)

reoriented and realigned, and those whose head motion was >0.5 mm or rotation was >0.5° were excluded from the following analysis. All functional volumes were realigned to the first functional volume, and then all realigned images were normalized into a standard stereotaxic space using an echo planar imaging template delivered with SPM and spatially smoothed using a Gaussian kernel with an FWHM of 6 mm.

Statistical analysis

After conducting the data preprocessing, the modeling analysis of the individual data showed the specific activation of brain function during ME/MI. The SPM-8 analysis software separately performed the single-sample *t*-test for the two groups' brain function results during the ME/MI. To detect the differences in brain activation between ME/MI and the rest period, we also performed a one-sample *t*-test-group analysis. In addition, we used gender and motion imagination score as covariates to perform the covariance statistical analysis. The SPM(t)s were thresholded at $P < 0.01$ (false discovery rate correction), voxels ≥20.

Interestingly, the BOLD signal was different between the young and old groups while they were performing the same task. As a result, we conducted a two-sample *t*-test ($P < 0.001$, uncorrected) to (1) compare the left- and right-hand ME between the old group and the young group and (2) compare the left- and right-hand MI between the old group and the young group.

RESULTS

Motor execution between the control and patient groups

The activation pattern was found to be extremely similar during ME under the visual guidance between the groups. The main activated brain areas comprised the bilateral premotor cortex (PMC) and the supplementary motor area (SMA), the primary motor cortex (M1), the cerebellum, the thalamus, the superior and inferior parietal lobe, the fusiform lobe, the superior frontal lobe, the putamen, and the superior temporal lobe [Figure 2a, b, e, f, and Tables 1, 2].

The two-sample group analysis [Figure 3a, b and Table 3] indicated that there were differences in the activated brain areas during ME between the two groups, despite their similarities. Due to ME with the affected hand or the unaffected hand, the stroke patients had a stronger activation in the brain than the control group, mainly in the ipsilateral precentral gyrus, the postcentral gyrus, the SMA, the frontal gyrus, the parietal gyrus, and the angular gyrus. In addition to the ipsilateral activated brain areas, we observed brain activation in contralateral motor areas such as the precentral gyrus, the SMA, and the parietal

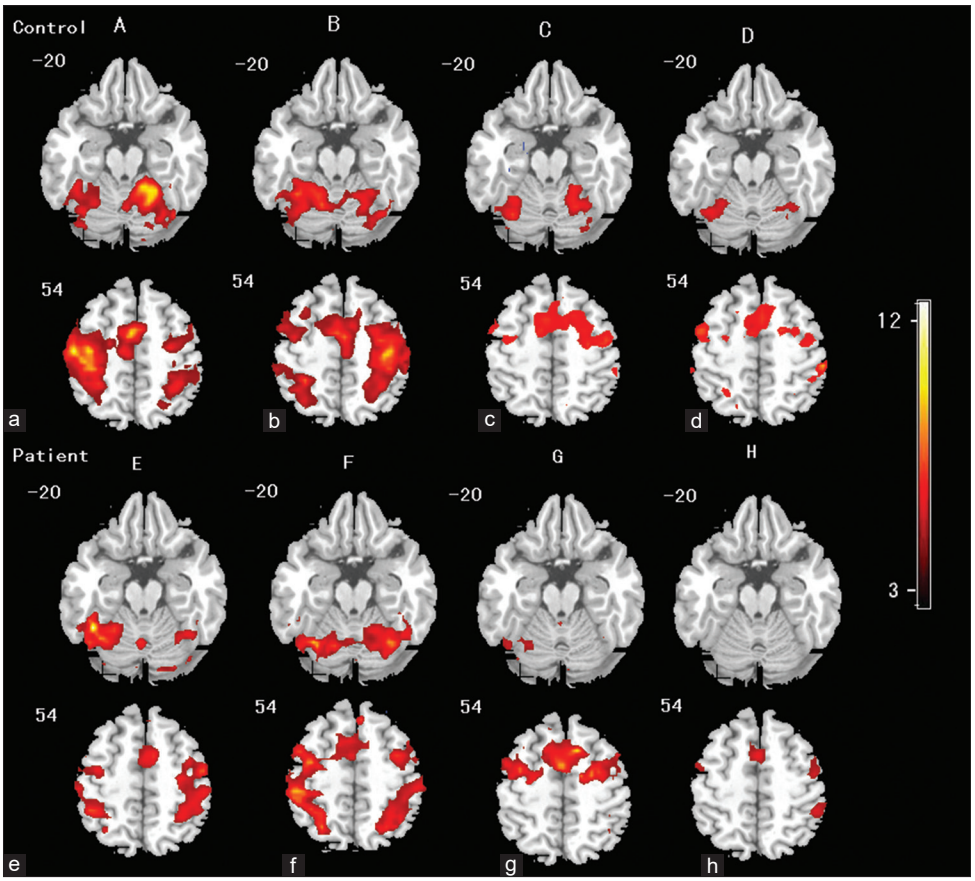

Figure 2: The activation of brain function in the control and patient groups under different conditions: (a) control left-hand motor execution; (b) control right-hand motor execution; (c) control left-hand motor imaging; (d) control right-hand motor imaging (e) patient left-hand motor execution; (f) patient right-hand motor execution; (g) patient left-hand motor imaging; and (h) patient right-hand motor imaging. All the voxels were significant at $P < 0.01$, corrected for false discovery rate of the whole brain

Table 1: The activated brain areas during motor execution and motor imagery of both hands in the control group

Control anatomic site	Side	ME_left			*t*	Voxels	ME_right			*t*	Voxels
		x	y	z			x	y	z		
PMC	Left	−58	−21	41	8.36	829	−36	−21	60	10.25	891
PMC	Right	38	−20	42	12.67	976	40	−5	45	8.32	760
M1	Left	−33	−12	60	7.22	67	−36	−26	64	10.25	123
M1	Right	42	−15	56	13.87	129	58	−15	28	5.62	33
SMA	Left	−6	−3	58	8.78	266	−6	−6	57	15.69	295
SMA	Right	6	3	57	11.37	497	6	3	61	10.63	353
Cerebellum	Left	−22	−51	−24	12.26	628	−25	−50	−24	6.68	448
Cerebellum	Right	35	−70	−18	6.87	310	25	−60	−15	10.76	496
		MI_left					ME_right				
PMC	Left	−58	5	12	6.59	971	−32	−5	58	6.77	672
PMC	Right	50	6	48	8.18	627	46	−3	51	5.62	670
M1	Left	−48	−12	40	2.65	49	−50	−9	43	4.17	34
M1	Right	50	−8	46	5.87	15	51	−9	50	3.99	34
SMA	Left	−6	−3	70	5.40	398	−8	0	57	5.91	319
SMA	Right	6	0	63	5.83	490	9	6	65	5.28	367
Cerebellum	Left	−20	−58	−21	5.40	525	−20	−58	−21	4.90	100
Cerebellum	Right	30	−54	−21	6.35	258	26	−52	−20	5.12	264

PMC: Premotor cortex, SMA: Supplementary motor area, ME: Motor execution, MI: Motor imagery

Table 2: The activated brain areas during motor execution and motor imagery of both hands in the patient group

Patient anatomic site	Side	ME_left			*t*	Voxels	ME_right			*t*	Voxels
		x	y	z			x	y	z		
PMC	Left	−52	−3	50	5.76	685	−39	−18	63	6.54	708
PMC	Right	40	0	−17	8.05	510	51	3	46	7.36	944
M1	Left	−60	−20	42	5.88	100	−36	−24	50	5.56	79
M1	Right	36	−21	48	8.28	86	60	−12	32	7.45	100
SMA	Left	−3	−2	57	8.90	312	−3	−3	57	6.41	312
SMA	Right	5	−3	56	10.49	284	5	−3	58	7.86	379
Cerebellum	Left	−21	−50	−28	6.56	187	21	−60	−21	9.87	483
Cerebellum	Right	35	−74	−20	7.40	295	15	−70	−19	8.86	342
		MI_left					ME_right				
PMC	Left	−43	−6	40	5.14	688	−42	−10	46	4.68	461
PMC	Right	30	0	50	8.13	560	51	3	45	3.85	189
M1	Left	−48	−9	45	3.78	22	−45	−9	48	4.96	25
M1	Right	60	−15	27	6.24	5	60	−13	27	3.49	6
SMA	Left	−5	−3	63	5.49	395	−6	9	48	5.19	241
SMA	Right	6	−3	66	5.90	390	8	−3	66	4.44	232
Cerebellum	Left	−21	−57	−24	6.56	177	−24	−58	−23	2.27	10
Cerebellum	Right	35	−63	−24	7.40	219	30	−60	−21	2.80	36

PMC: Premotor cortex, SMA: Supplementary motor area, ME: Motor execution, MI: Motor imagery

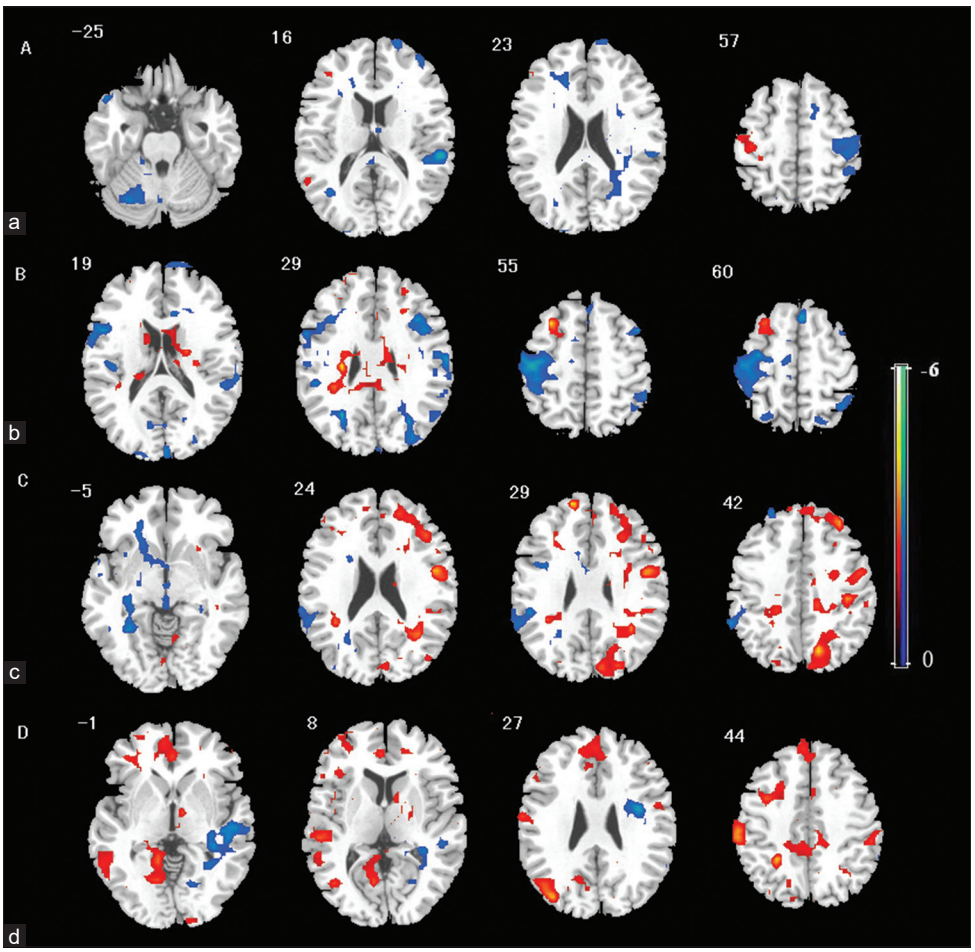

Figure 3: The two-sample t-test group results of the differential contrasts between the healthy control and patient groups (a) left-hand motor execution; (b) right-hand motor execution; (c) left-hand motor imagery; and (d) right-hand motor imagery. Stronger activation for the control group *versus* the patient group is shown in red and for the patient group *versus* the control group in blue

gyrus, which was stronger than that of the control group during motor execution in the patients' affected hands. The ME in the unaffected hands of stroke patients demonstrated no difference in brain activation in relation to the control group.

Motor imagery between the control and patient groups

For a whole-brain analysis examining the BOLD response to the MI, brain regions were found to be similarly activated in both the two groups [Figure 2c, d, g, h and Tables 1, 2]. As shown in Figure 2c and d, increased activation was found in M1, the SMA and PMC, the cerebellum, the frontal lobe, the parietal gyrus, and the parietal gyrus.

In our study, we mainly focused on the difference in MI between the two groups, which is shown in two-sample *t*-test group results [Figure 3c, d and Table 4]. During the movement imagination of the y hand (left hand), the ipsilateral brain activation in the patient group was significantly lower than that in the healthy group, particularly in the left precentral gyrus, the postcentral gyrus, the frontal gyrus, and the parietal gyrus. The contralateral, uninjured, and right parietal gyrus in the patient group showed a stronger activation. During the MI of the affected hand, the activation in the patient group was significantly weaker than that in the healthy group, including the uninjured, ipsilateral areas of the brain such as the postcentral gyrus, the frontal gyrus, the SMA, and the cerebellum. On the contralateral side, the activation in the parietal gyrus and frontal gyrus was also weaker than that in the healthy controls.

Table 3: Areas differentially activated during motor execution in the control *versus* the patient group

Anatomic site	Side	Left hand (unaffected)			*t*	Voxels
		x	y	z		
Control-patient						
Precentral	Right	45	−21	63	3.71	36
Postcentral	Left	−45	−30	54	−3.21	48
Precentral	Left	−36	−20	54	−2.66	36
Cerebellum	Right	27	−69	−27	−2.93	30
Lingual	Right	21	−75	−9	−5.61	104
		Right hand (affected)				
Precentral	Left	−63	−15	27	−3.32	50
Precentral	Right	42	−18	57	−3.79	128
Postcentral	Left	−63	−30	21	−3.41	25
Postcentral	Right	45	−21	54	−4.23	196
Frontal_mid	Left	−42	12	30	−5.15	47
Frontal_inf_oper	Right	57	9	33	−3.43	36
Parietal_inf	Left	−33	−78	42	−3.64	60
Lingual	Left	−6	−96	6	−4.53	98
Fusiform	Left	−21	−81	−9	−3.79	28

Table 4: Areas differentially activated during motor imagery in the control *versus* the patient group

Anatomic site	Side	Left hand (unaffected)			*t*	Voxels
		x	y	z		
Control-patient						
Postcentral	Left	−45	−6	36	2.87	49
Precentral	Left	−51	−3	24	3.93	55
Parietal_sup	Left	−36	−25	30	3.88	28
Parietal_inf	Left	−39	−27	36	4.89	26
Frontal_mid	Left	−33	39	42	3.81	50
Cerebellum	Left	−21	−45	−27	3.41	74
		Right hand (affected)				
Frontal_sup_medial	Left	0	48	33	3.12	32
Frontal_sup_medial	Right	6	48	42	3.10	23
Lingual	Right	21	−57	−12	4.05	94
Cerebellum	Right	12	−48	−3	3.13	26

DISCUSSION

The present study used fMRI to investigate the neural mechanisms underlying ME and MI in stroke patients. First, we found that brain activation in the ipsilateral primary motor areas of the stroke patient group appeared to be greater than that in the control group during ME, particularly in the precentral gyrus, the postcentral gyrus, the SMA, and the cerebellum. This finding indicates that ipsilateral inhibition is reduced in stroke patients during ME. Second, regardless of whether the MI was of the affected hand or the unaffected hand, the ipsilateral brain activation of the patient group was weaker than that of the healthy group, while the contralateral activation was greater than that of the healthy group. This suggests that despite the disease in the patient group, the brain activation pattern is better than the control group during MI, the contralateral brain is more easily activated, and the ipsilateral brain regions are more easily inhibited. In addition, the MI of the affected hand in the stroke patients was not significantly different from that of the unaffected hand, which implies that MI may be used to improve injured brain areas, activate brain areas, and help with the rehabilitation of stroke patients. Third, these results indicate that the damage to brain structure is related to the brain function activation in stroke patients.

Motor execution

During ME, the main motor brain regions had a stronger activation in the patient group than in the controls, which was consistent with the other findings.[15,16] In patients, the attempt to overtly move the left (paretic) wrist recruited the same areas plus a number of additional regions. These included, in particular, the anterior premotor and prefrontal cortices and the extended parietal cortices. In

general, activation was more bilateral in patients, including activation of the ipsilateral pre- and primary-motor cortices.[16,17] In this study, the ME of the unaffected hand in the patient group showed no significant difference in activation from the control group. In contrast, contralateral brain areas such as the precentral gyrus, the SMA, and the parietal gyrus presented a stronger activation in the patient group than in the control group during ME of the affected hand. These results demonstrate that the attempt to move the fingers activates the motor system of the brain, even just minimal movement. This finding verifies that practice-related improvements in movement performance provide a model for the rehabilitation of patients following stroke. This is similar to the results of other studies. In the unaffected hemisphere, sensorimotor cortex activation was found to be increased in stroke patients when compared with the controls. In partially recovered stroke patients, an intriguing finding related to the movement of the affected hand is the enhanced activation of the contralesional motor network, including the primary sensorimotor cortex.[16-18]

During ME of the unaffected hand or affected hand, ipsilateral brain areas showed a stronger activation in the patient group *versus* the control group. This indicates that ipsilateral inhibition was reduced, which was consistent with the laterality. In the major motor areas, the laterality index in the healthy controls was significantly higher than that in the patient group. This is also consistent with the result of Sharma *et al*.[19] that the hemispheric balance of BA4 activation was significantly less lateralized in stroke patients than in controls.

Motor imagery

In this study, the ME and MI brain activation in both groups were very similar, with large overlapping regions, such as M1, the PMC, and the SMA, which is consistent with the other findings. Previous studies have reported that the same neural networks are activated when movements are mentally practiced, such as during physical practice of the same skills.[20-22] MI in our study activated a network of cortical areas [Table 4], which is highly consistent with the previous reports that the lateral and medial premotor cortices and the inferior and superior parietal cortices were activated during MI of simple movements.[23-26]

In this study, during MI, the ipsilateral brain activation in the patient group was weaker than that in the healthy group, while the contralateral activation was stronger in the patient group than in the healthy group, regardless of whether the unaffected hand or the affected hand was imagined. This suggests that despite their disease, the brain activation patterns in the patient group during MI were better than those in the healthy controls, and it is thus more likely to activate the contralateral brain and inhibit the ipsilateral brain regions. In addition, there was no significant difference in brain activation in the patient group during MI of the unaffected hand *versus* the affected hand. Hence, we can conclude that during ME, there is a difference between the unaffected hand and affected hand of the stroke patients, but there is no difference in the brain areas activated by MI. Thus, MI can be used for rehabilitation of stroke patients and may be particularly suitable for stroke patients with early dyskinesia or passive treatment problems. It has been suggested that stroke patients with mental practice can improve motor function in the affected upper limb.[27]

It has been reported that a stroke patient can improve the ability to mentally imagine finger movements, taking advantage of the previously idle ventral visual processing stream to imagine finger movements. In particular, the recovery of motor function after a stroke is accompanied by a redistribution of activity within a network of parallel-acting cortical motor areas[28] and a reinforcement of the spared area adjacent to the lesion.[29] Our results also confirm that nonprimary motor areas, the lingual and fusiform gyri, are active during MI and ME in the patient group and thus play a role in remodeling brain function.

This study indicates that MI can activate brain regions associated with actual ME; thus, MI is expected to enhance neurorehabilitation following stroke. Our data further demonstrate that MI therapy may be beneficial at all stages after stroke. However, our study has some limitations. First, the patient groups are early stroke patients. Second, although we used fMRI technology and discovered that MI can stimulate the brain network, the elasticity function of the brain can remodel the brain function of stroke patients, restoring some motor function, and we did not trace the rehabilitation effect of MI in treating stroke patients. Our next study will expand the research sample size and longitudinally track the additional therapeutic effect of new MI with the traditional treatment methods to further study the neural mechanisms underlying MI for the rehabilitation of stroke patients and help their clinical treatment.

CONCLUSION

During ME of the unaffected hand, contralateral activation shows no significant difference between the two groups;

during ME of the affected hand, the contralateral activation is greater in the patient group than in the control group, and many nonmotor brain areas are activated. This finding indicates that the damaged brain needs to recruit more brain areas to complete the desired action due to motion difficulties resulting from brain damage, confirming the previous view of remodeling brain function. During MI, brain areas show relatively greater activation in the patient group than in the control group, which verifies our previous hypotheses that to achieve the same level as healthy patients, stroke patients may need more and stronger brain activation on the affected side. Because of the remodeling function of the brain, nonmotor brain regions may be involved in the process of MI or ME in stroke patients and play a remodeling role.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Patient demographics and lesion details

Subject	Age (years)	Gender	MMSE	MIQ-RS	Lesion chronicity (days)	Type of stroke	Affected neocortical
1	63	Men	28	28	61	Hemorrhagic	Putamen
2	51	Women	22	30	70	Ischemic	Pons, thalamus
3	52	Men	27	29	60	Hemorrhagic	Basal ganglia
4	68	Men	26	30	65	Ischemic	Thalamus
5	45	Men	29	36	60	Hemorrhagic	Thalamus
6	46	Men	27	32	60	Hemorrhagic	Occipital lobe
7	62	Women	19	35	70	Ischemic	Putamen, thalamus, insula
8	77	Men	21	28	47	Ischemic	Temporal
9	73	Women	28	34	80	Ischemic	Insula, frontal lobe
10	41	Women	26	36	67	Ischemic	Insula, frontal lobe
11	64	Women	26	30	58	Ischemic	Insula, caudate, basal ganglia
12	38	Men	26	36	76	Ischemic	Insula, basal ganglia

MIQ-RS: Movement Imagery Questionnaire-Revised, Second Edition, MMSE: Mini-mental state examination

Supplementary Table 2: The basic data of the controls

Subject	Age	Gender	MIQ-RS	MMSE
1	66	Women	36	26
2	30	Women	34	27
3	62	Men	32	28
4	67	Men	29	25
5	52	Men	38	29
6	52	Men	36	30
7	32	Women	32	27
8	35	Women	32	29
9	60	Men	28	27
10	60	Women	36	30
11	62	Men	28	29
12	60	Women	30	30

MIQ-RS: Movement Imagery Questionnaire-Revised, Second Edition, MMSE: Mini-mental state examination

Significance of establishing the International Society of Digital Medicine

Dear Editor,

After the first meeting of the International Society of Digital Medicine (ISDM), I want to express my ideas and feelings about it. The idea of ISDM gives great opportunity to promote communication and collaboration in an international manner, which brings the outstanding academicians and businesspeople together. It is promising, synergic, and enthusiastic. The objectives of the Society are to hold the International Congress on Digital Medicine (ICDM), to operate a permanent website to serve as a medium for discussion, debate, and the preparation of ICDM, to arrange international workshops and symposia, and to form relationships and cooperate with other governmental and nongovernmental organizations in its academic field. These objectives are carefully selected, motivating and making the members excited about. As the first action to put these objectives into application, I decided to write this letter. I believe this society, ISDM, will accomplish magnificent successes, with the international cooperation of both academicians and businesspeople, in the science and business areas. First of all, all together, in the leadership of ISDM, we should spend efforts to promote the Journal of Digital Medicine as one of the outstanding journals. Due to the increasing number of researches and will to publish scientific articles in the scientific society, we should do nothing more than attracting the attention of the authors. As one of the founder members of the ISDM, I invite all our members to contribute to the success of our journal, develop multinational scientific projects, and discover business areas that ISDM should contribute. In short, I invite all members into action. Now, it is show time for ISDM.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Access this article online	
Quick Response Code	Website: www.digitmedicine.com
	DOI: 10.4103/2226-8561.189524

How to cite this article: Gürsel G. Significance of establishing the International Society of Digital Medicine. Digit Med 2016;2:80.

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