ORIGINAL ARTICLE

How e-learning creates new opportunities in hospital setting? Innovations in a low resource setting

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Background: E-learning and telemedicine have become common methods in changing and developing medical education and clinical processes. The purpose of this study was to describe the innovations of blending e-learning into the educational and medical processes of hospital services

Methods: The process of action research included plan, act, observation and reflection was followed. Implementation, which took 18 months, included purchasing and installing the required software and administration of new educational and medical processes. The result reflected in regional and national innovation councils among universities of medical sciences and minister of health and in Iran.

Results: Incorporation of e-learning into medical and educational processes resulted in practical innovations. The first was setting up an e-clinic, which was formed based on virtual and online communication between the hospital's clinic and distant rural health centers. It prevented from unnecessary referrals and created an accountable paradigm of medical education based on a triple consultation between family physicians (GPs), specialists and patients in rural and urban communities. Another innovations were the development of a joint clinic of diabetes and ophthalmology specialists, running online medical classes, online morning reports meetings and holding OSCE using virtual reality technology. Moreover, with the establishment of virtual reality technology, novel productions in medical education also emerged.

Conclusion: The results revealed that e-learning and telemedicine create novel opportunities in health systems toward accountable education and improving both equity and efficiency in health service provision.

Keywords: Distance learning, E-health, Hospital management, Virtual reality

كيف يخلق التعلم الإلكتروني فرصًا جديدة في إعدادات المستشفيات ؛ ابتكارات في منظمات ذات موارد منخفضة

الخلفية والهدف: أصبح التعليم الافتراضي والتطبيب عن بعد نهجا متفق عليه لتطوير التعليم الطبي والعمليات السريرية. الغرض من هذه الدراسة هو الإبلاغ عن نتائج دمج التعلم الإلكتروني في عمليات توفير الخدمات التعليمية والعلاجية في المشافي .

الطريقة: تضمنت عملية تنفيذ البحث الإجرائي أربع مراحل: التخطيط والتنفيذ والملاحظة و النقد. استغرق الأمر 18 شهرا لشراء وتثبيت البرامج وإجراء إجراءات تعليمية وعلاجية جديدة. وقد حولت النتائج في مجالس تطوير جامعات العلوم الطبية والابتكارات ووزارة الصحة.

النتائج: أدى دمج التعليم الافتراضي في عملية تقديم الخدمات التعليمية المستندة إلى المستشفى إلى خلق ابتكارات تطبيقية. الأول هو نشر عيادة افتراضية (E-Clinic) تعتمد على الاتصال الافتراضي بين العيادات الإلكترونية المتخصصة في المستشفيات والمراكز الصحية للمجتمعات الريفية والحضرية البعيدة . منع هذا الابتكار الإحالات غير الضرورية ، وعزز التدريب على الاستجابة من خلال التشاور الثلاثي بين الأخصائي المستقر في المستشفى ، طبيب الأسرة في مركز الصحة والمريض وأيضاً طلاب الطب الحاضرين في العيادات .وشملت الابتكارات الأخرى تنفيذ عيادة مشتركة ، ومحاضرات طبية عبر الإنترنت ، وتقارير صباحية على الإنترنت بمشاركة أساتذة إيرانيين يقيمون في الخارج ، واختبار OSCE مع تكنولوجيا الواقع الافتراضي. بالإضافة إلى ذلك ، مع نشر تقنية الواقع الافتراضي ، تم تطوير منتجات جديدة وخاصة في مجال التعليم الطبي.

الخلاصة: أظهرت نتائج هذه الدراسة أن التعليم الافتراضي والتطبيب عن بعد يخلقان فرصًا جديدة في النظام الصحي من أجل توفير التعليم المستجيب وتعزيز العدالة والكفاءة في توفير الرعاية الصحية.

الكلمات المفتاحية: التعليم عن بعد ، الصحة الإلكترونية ، إدارة المستشفيات ، الواقع الافتراضي

چگونه آموزش الکترونیک فرصت های جدید در ساختارهای بیمارستانی ایجاد می کند؛ نوآوری هایی در سازمان های با منابع کم

زمینه و هدف: آموزش مجازی و تله مدیسین به رویکردی مورد توافق در توسعه آموزش پزشکی و فرایندهای بالینی تبدیل شده است. هدف پژوهش حاضر، گزارش نتایج ادغام آموزش الکترونیک در فرایندهای ارایه خدمات آموزشی و درمانی بیمارستان می باشد.

روش: فرایند اجرای اقدام پژوهی شامل چهار مرحله ی برنامه ریزی، اجرا، مشاهده و انعکاس، مورد پیروی قرار گرفت. اجرا 18 ماه طول کشید که شامل خرید و نصب نرم افزارها و انجام فرایندهای جدید آموزشی و درمانی بود. نتایج در شوراهای تحول و نوآوری دانشگاه های علوم پزشکی و وزارت بهداشت ایران منعکس شد.

یافته ها: ادغام آموزش مجازی در فرایند ارائه خدمات آموزشی–درمانی بیمارستان منجر به ایجاد نوآوری های کاربردی گردید. نخست استقرار کلنیک مجازی (E-Clinic) بود که بر پایه ارتباط مجازی و آنلاین درمانگاه تخصصی بیمارستان و مراکز سلامت جامعه روستایی و شهری دور شکل گرفت. این نوآوری از ارجاعات غیر ضروری جلوگیری کرد و با ایجاد مشاوره سه گانه بین متخصص پزشکی مستقر در بیمارستان، پزشک خانواده مرکز سلامت و بیمار و همچنین حضور دانشجویان استاژر و انترن در محل کلنیک، باعث تقویت رویکرد آموزش پاسخگو گردید. سایر نوآوری ها شامل اجرای کلنیک مشترک (Joint Clinic)، برگزاری کلاس های پزشکی عمومی آنلاین، گزارش صبحگاهی آنلاین با حضور اساتید ایرانی مقیم خارج کشور و برگزاری آزمون OSCE با فناوری واقعیت مجازی بود. علاوه بر این ها، با استقرار فناوری واقعیت مجازی محصولات جدید و ویژه ای در حوزه آموزش پزشکی تولید شد.

نتیجه گیری: نتایج مطالعه نشان داد که آموزش مجازی و تله مدیسین فرصت های بدیعی در نظام سلامت و در راستای آموزش پاسخگو و تقویت عدالت و کارایی در ارایه مراقبت های سلامت ایجاد می کند.

واژه های کلیدی: آموزش از راه دور، سلامت الکترونیک، مدیریت بیمارستان، واقعیت مجازی

اسپتالوں میں الیکٹرانیک تعلیم سے کس طرح مواقع فراہم ہوتے ہیں، کم وسائل و ذرائع کے حامل طبی مراکز کا جائزہ

بیک گراونڈ: الیکٹرانیک یا ٹیلی میڈیسن آج کی دنیا میں میڈیکل تعلیم کا ایک موثر ذریعہ بن چکا ہے۔ ان تحقیق کا ھدف اسپتالوں میں میڈیکل خدمات فراہم کرنے والے عملے کو الیکٹرانیک ذریعے سے تعلیم دینے کے اثرات کا جائزہ لینا ہے۔

روش: اس تحقیق کو چار مرحلوں میں انجام دیا گیا، منصوبہ بندی، عمل درآمد ،مشاہدہ اور اس کے اثرات کا جائزہ یہ چار مرحلے تھے۔ کمپیوٹر ہارڈ ویر اور سافٹ ویر خرید کر نصب کرنے میں اٹھارہ مہینے لگ گئے، اس کے بعد میڈیکل تعلیم کا نیا سلسلہ شروع کیا گیا۔ایران کی وزارت صحت کو اس تحقیق کے نتیجوں سے آگاہ کیا گیا۔

نتیجے: اسپتالوں میں میڈیکل خدمات دینے والے عملے کو الیکٹرانیک ذریعے سے تعلیم دینے سے مفید اور عملی نتائج سامنے آئے ہیں،اسپتالوں میں ای کلینیکس قائم کی گئیں جو سوپر اسپیشیالیٹی اسپتالوں ، طبی مراکز اور دور دراز کے شہروں اور دیہی علاقوں کو کوریج دیتی ہیں۔ای کلینیکوں کی وجہ سے غیر ضروری ویزٹوں میں کمی آئي جبکہ اسپتال کے اسپیشلسٹ، فیملی ڈاکٹر کی تشخیص اور بیمارکی مرضی جان معالجاتی فیصلہ کیا گیا، اس فیصلے میں طبی عملے اور انٹرن ڈاکٹروں کو شامل کیا گیا جس کی وجہ سے میڈیکل طلباء کی تعلیم میں مثبت تبدیلیاں آئیں۔ اس کے علاوہ جوائنٹ کلینک بھی قائم کی گئي، آنلائیں میڈیکل کلاسیں لگائي گئیں، بیرون ملک ایرانی ڈاکٹروں کو صبح کی رپورٹ پیش کی گئي،اس کے علاوہ او ایس سی ای ٹسٹ بھی انجام دیا گیا۔اس کے علاوہ مختلف طریقوں سے الیکٹرانیک میڈیا سے فائدہ اٹھایا گیا۔

سفارش: اس تحقیق کے نتائج سے معلوم ہوتا ہے کہ الیکٹرانیک تعلیمی روش سے میڈیکل فیلڈ میں متعدد آسانیاں ہوئي ہیں اور مثبت تبدیلیاں آئي ہیں۔

کلیدی الفاظ: الیکٹرانیک تعلیم،الیکٹرانیک سہولتیں، ایرانی ڈاکٹر

INTRODUCTION

E-learning has become one of the main components of medical education and clinical service processes and changed many aspects of medical practice and education (1,2). In some developing countries, serious measures are being taken to integrate telemedicine and e-learning in order to compensate for probable inequities (3,4). Although e-learning can be defined and interpreted in different ways (5), the essence is to use the latest technologies, Information and communication technology (ICT), in the process of training and service delivery. E-learning in medical training is administered in ways such as electronic problem solving, simulation, virtual reality, web-conference, distance learning, electronic evaluation, online learning, electronic workbook and worksheet, electronic contents and cellphone-based learning (2,5-7). Using information technology (IT) in clinical services also uses common forms of telemedicine (8). Hospitals are the main settings in the establishment of telemedicine and tele-education. In Iran, hospital settings have two-fold importance, because medical education is incorporated with health care delivery processes (9). So, the development and strengthening of ICT technologies in hospital settings has great benefits, though there are some challenges with its implementation (10).

Although the list of ways to use e-learning is long, using them does not simply require implementing a predesigned process to accomplish the expected outcomes. Rather, it requires creativity and adaptation of processes according to the changing environment (2). Tele-health professionals emphasized on the reflection of exercises and lessons learned for developing deeper knowledge for future projects (11). Accordingly, this article describes the design and implementation of incorporating e-learning into training and clinical processes in Gonabad University of Medical Sciences (GUMS) in Iran.

METHODS

The action research process was followed to capture novel idea and its implementation. Action research, is a dynamic, revolutionary and participatory process which precedes the step of identifying and solving the problem (12) and has the capability to facilitate the changes and improvements of service provision (13). The cycled process included pan, act, observe, reflect, and iterate (14). The first step involved interviews with and creating focus groups of hospital managers and faculty in order to identify the current problems faced in the process of training and health service provision. Also, we tried to find the solutions to the identified problems based on the infrastructure of virtual and e-learning. Brainstorming and reviewing texts were the main means of this step. A narrative review of literature was applied in the PubMed. The implementation phase took eighteen months from December 2015 to June 2017. This step mainly included purchasing the equipment, providing the physical space and training the staff. The results reflected in regional and national innovation councils among universities of medical sciences and minister of health in Iran.

RESULTS

In this section we review the findings of the study separately for each step.

The first step (identifying problems): Limited expertise of faculty members, fragmentation of clinical services, insufficient local cases of patients for training students, long geographical distance between rural health centers and hospital specialists' clinic and difficulties in the referral system were recognized as the main problems.

The second step (planning): The solutions to the identified problems based on the infrastructure of virtual and electronic learning were identified. The main tasks to initiate prior to implementation were identifying local and foreign professors whose scientific perspective could be used through distance learning, as well as signing contracts with them and other creditable scientific centers, planning for purchasing required equipment and infrastructure for e-learning (Adobe connect web-conferencing software, digital cameras, etc.), installing the equipment, providing the physical space, scheduling the training of the staff and the doctors and getting permission from respective authorities. The third step (implementation): Adding e-learning to the process of educational and clinical services results in four innovations:

1. E-clinic:

The internal medicine clinic of two academic hospitals (22-Bahman and Bohlool) and the health center of Kakhk were equipped with web-conference and tele-medicine equipment, including laptops, digital cameras, ophthalmoscope, LCDs and microphones and other digital medical equipment which enabled transferring patients' symptoms. The GPs in the health centers were also trained. If the patients in the health center needed specialist consultations, GPs would start online communication with the e-clinic through the multimedia system and use the specialist's advice on how to manage treatment. Stager and intern students of medicine were also active in the e-clinic, holding a triple consultation between family physicians (GPs), specialists and patients, and would even give advice. The major achievements of the e-clinic were the availability of specialist services to disabled and vulnerable patients (such as pregnant women) and patients in rural and deprived areas, preventing multifold visits of patients by GPs and specialists, continuity of primary health care and clinical specialist services, immediate feedback from specialists to GPs working in rural or urban health centers. Also, medical students were able to play an active role at e-clinic, got to know problems faced by physicians and patients, increased the number and variety of cases, which improved their medical education, prevented unnecessary visits and referrals, increasing satisfaction of patients and reduced out of pocket costs (Figure 1).

2. Joint clinic of diabetes and ophthalmology:

Diabetic patients who had ophthalmological disorders were simultaneously examined by an internal specialist and ophthalmologist. The pictures of the eyes were then shared online using video-ophthalmoscope through a webinar system at GUMS and, ultimately, the best decision was made. Similar to the e-clinic, stager and interns students of medicine had active roles in the joint clinic, as well (figure 2).

Figure 1. E-clinic, an internal specialist with medical students receives the visual information and guides the family physician in rural health center

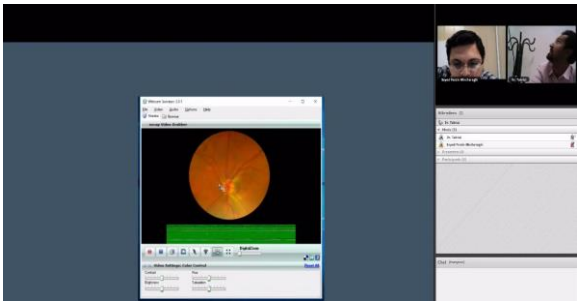

Figure 2. Joint clinic, a shared consultation between ophthalmologist and internal specialist is running about an ophthalmological disorder

3. Online morning report:

By using the webinar system at GUMS, the medical morning report sessions in the hospitals were shared with Iranian and foreign specialists and professors. The students and professors of the university were able to exchange and share their ideas concerning the management of patients with overseas professors during morning reports. Some consideration was also devoted to ethical and IT security issues (figure 3).

4. Distance learning classes with Iranian and foreign professors:

Subjects to the shortage in some medical specialties, out priority was to use educational services of professors from other countries (USA, Canada, etc.) and other Iranian medical universities and hospitals (Masih Daneshvari hospital, Imam Hossein hospital, and Loqman hospital in Tehran and Kerman University of Medical Sciences) via distance online classes. Most of the classes were held for medical and clinical laboratory students. Quality of education, satisfaction of medical students, reducing costs of education (less needed for the presence of invited professors) also resulted from the distance learning classes.

5. Virtual reality-based OSCE for clinical skills of internal medicine:

Through using the software and hardware of virtual reality, clinical diagnosis scenarios included simulated examination of a visit session between a physician and a patient, and a description of patient's history was recorded. Abnormal sounds, such as wheezing, were mixed with the video, and final processed video file were saved on cellphones equipped with a gyroscope and then installed on virtual reality headset. Students then faced the scenario in the permitted time using the virtual reality headsets, wrote down probable diagnoses and suggested treatments on their answer sheets. The same approach was adopted to evaluate stager students' examination skills in which the scenario of lung examination of a patient was carried out by virtual reality equipment. Through using the headset, students were asked to detect at least three mistakes that occurred during the course of patient examination for which they filled in respective answer sheets. After the exam, students were given a checklist concerning the efficiency and quality of the virtual reality OSCE in comparison with the common method of the exam; the results showed a positive attitude and satisfaction of the students (Figure 4).

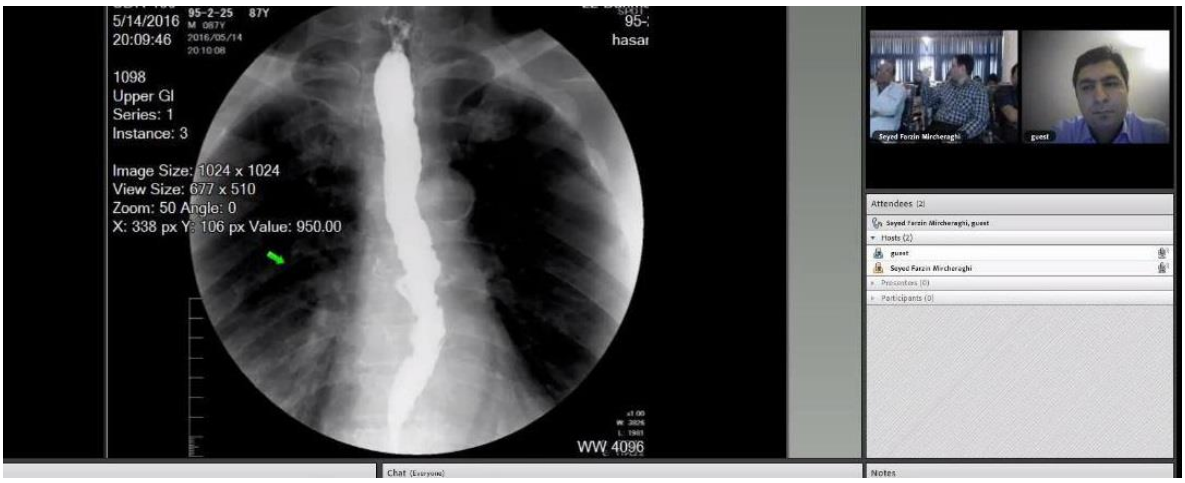

Figure 3. An Online morning report is running shared with foreign specialists (from Maryland)

Figure 4. The students are taking the virtual reality based OSCE for clinical skills of internal medicine based on a simulated consultation between physicians and patients

Figure 5. The production of medical electronic contents by virtual reality technology (MRI simulator)

6. The production of medical electronic contents by Virtual reality technology:

The equipment of virtual reality technology was located in the central skill laboratory of GUMS. Special cameras with 360° capabilities were the main tools. The idea was processed in the group, and then, with establishment of the cameras, the recording processes were done. The virtual tours from rural and urban health centers and the MRI simulator were the prime productions (Figure 5).

DISCUSSION

The present study used an action research approach to blend e-learning and electronic infrastructure into the process of providing improved medical education and clinical services. According to this study, holding the e-clinic is a door to a new era of medical education by providing live and practical triple-shared consultation. From an educational perspective, with each case, students and GPs benefit from practical advice given by specialist doctors as new learning experiences. Also, this telecommunication links community and academic hospitals in Iran, and alters hospital-based medical education by community-based education. From a medical care perspective, access to specialist outpatient care is available for rural populations. The Gezira Family Medicine Project (GFMP) in Sudan implemented ICT in three main areas: telemedicine, e-learning, and electronic medical records. The project evaluation showed that ICT implementation in primary care can help to achieve health sector goals from education to health care coverage (15). In another study carried out in Iran, family physicians reported that receiving feedback and comments from specialists resulted in the increase of their knowledge and skills in diagnosis (16). As physicians in rural communities, they face limitations in accessing continuing medical education, but in return, telemedicine and e-learning can compensate for these shortcomings (17). The establishment of the joint clinic of diabetes and ophthalmology improved the treatment processes of the patients. It also promoted the quality of medical education and opened a new era of virtual and accountable education and production of electronic educational materials. Paul Chan et al. (18) described the design, implementation, and evaluation of a tele-education system developed to improve diagnostic competency in retinopathy of prematurity (ROP) by ophthalmology residents in the United States. They concluded that tele-education is effective in improving diagnostic accuracy of ROP. In a boarder scope, the e-hospital project, as a trans-national project lead by the European commission, aimed to promote e-learning activities for adult patients (19).

By providing live webinar (online) classes and online morning reports for medical students that were presented by professors from other Iranian and foreign universities, we opened a window for using knowledge and experience of professors in every country and partnerships with other medical institutions with a low cost, especially minimizing travel expenses for teachers. In medical universities of Tanzania, an e-learning course was implemented to improve competency-based medical education in 2009. The project demonstrated that e-learning technologies could effectively be adopted to enhance educational processes (20).

Virtual reality is a new technology which could be used in different fields, particularly medicine and education (21). Simulation, with the help of virtual reality tools, could provide us with cost-effective educational and training methods. For instance, students could improve their skills without interacting with real-life patients whose lives could be threatened due to the students' lack of experience and practice (22). In this study, virtual reality technology was used in the production of educational materials and students' evaluation. The study by Lee et al, with the aim of comparing effect of the two methods of 3D simulation and using physical moulages and manikins, showed that the two

groups had the same results in OSCE, although the 3D simulation method was cheaper, easier and took less time and physical space (23). Also, in a study titled "Evaluation of virtual reality simulation in dentistry OSCE exam," Hung et al compared the "conventional simulators" and "virtual reality" in dentistry exams. The results of the study showed that the group working with virtual reality needed less time for learning. The same group performed significantly better in skills of the wall of the dental crown, though the marks for preparing the margins were no different between the two groups. The researchers claimed that the exam results of the virtual reality group were better in comparison with the conventional simulator group (24).

The results revealed that telemedicine and distance education as innovative combinations of IT and medicine have great potential to create novel opportunities for educational programs and provide clinical services to rural and deprived areas. Because of huge advantages of telemedicine and tele-education, medical universities in Iran and other countries should re-new their curriculums toward competency-based curricula. In a climate of increasing demands for new health care services and limitations on new resources, from cost-benefit and cost-effective perspectives, the establishment of telemedicine and tele-education in the health system could create value for money, especially in settings with limited resources. Despite the mentioned opportunities, e-learning has some constraints in some fields. For instance, physical examinations cannot be practiced in a virtual setting. Lack in IT skills of hospital staff is another challenge in generalizing e-learning. Therefore, e-learning should be considered as a complementary approach to the conventional process. Evidence from economic evaluation studies in the field of telemedicine and tele-education is also needed.

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