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## REVIEW ARTICLE

### ICT IN HEALTH INFORMATICS

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#### ABSTRACT

Health informatics is the study and application of methods to improve the management of patient data, clinical knowledge, population data, and other information relevant to patient care and community health. It is a young science, which emerged in the decades after the invention of the digital computer in 1940s. Mechanical computing in medicine had a much earlier origin, in the 19th century. Health informatics is found at the intersection of healthcare and technology. It is where skills in both health and computer sciences come together in an effort to improve medical arena and patient outcomes. Professionals in this field draw on expertise from both disciplines to put technology to its best use in patient care, clinical and research settings. The study reflects the multidisciplinary nature of medical informatics, which interacts with various fields, including the clinical sciences, the public health sciences as well as cognitive, computing, and information sciences and services.

**Key words:** Patient data, Clinical knowledge, Healthcare and Community health

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#### INTRODUCTION

Information and communication technologies (ICT) are being widely used in healthcare management systems. Rapid advancements in ICT in the last decade or so provide solutions to the problems in healthcare management systems. These include a wide spectrum of issues such as patient safety, dietary management, telemedicine, digital imaging, and document management etc. (Aqil Burney *et al.*, 2010). Substantial global and national commitments will be required for current healthcare systems and health professional practices to become learning care systems utilizing information and communications technology (ICT) empowered by informatics (December, 2010). Improving the secure availability and use of pertinent health information allows individuals to take ownership of their health, partner with their health care providers and others on care preferences and decisions, and reach their health and quality of life goals (Federal Health IT Strategic Plan 2015-2020). Health information technology (HIT) is "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (Brailer, 2004). Health informatics also called health care informatics, health care informatics, medical informatics, nursing informatics, clinical informatics, or biomedical

informatics. It is a multidisciplinary field (Nadri *et al.*, 2017) that uses health information technology (HIT) to improve health care via any combination of higher quality, higher efficiency (spurring lower cost and thus greater availability) and new opportunities. Health information technology (HIT) is information technology applied to health and health care. It supports health information management across computerized systems and the secure exchange of health information between consumers, providers, payers, and quality monitors ([https://en.wikipedia.org/wiki/Health\\_information\\_technology](https://en.wikipedia.org/wiki/Health_information_technology)) Computerized systems involved in patient care have led to a number of changes. Such changes have led to improvements in electronic health records which are now capable of sharing medical information among multiple healthcare stake holders (Zahabi *et al.*, 2015) thereby, supporting the flow of patient information through various modalities of care. An individual can take many steps to improve his or her health, including lifestyle and wellness choices, actively managing his or her health care, and receiving necessary immunizations, preventive care, and long-term services and supports. Engaged individuals are more likely to be proactive in practicing wellness, prevention, and disease management behaviours (Mosen *et al.*, 2007). Technology transfer and capacity building in healthcare systems is required in the developing countries. Apart from financial constraints the other important thing is the reforms in healthcare policy and a social change which is more difficult to overcome as compared to financial crisis. The usage of different types of technologies like mobile phones, internet and related technologies in developing countries can be very effectively used to provide health services at low cost. The penetration can also help in provisioning of health care

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services in remote rural areas where, otherwise, health care facilities are patchy (Aqil Burney *et al.*, 2010).

### Definition of ICT

ICTs can be defined as technologies that provide access to information through telecommunications, and includes networks, the Internet, wireless, mobile devices and other communications-related technology. e-health can be defined as the use of ICTs for health (but this might also cover non-ICT policies that act as enablers, e. g. national standards for patient identifiers, or legislation for data privacy, etc) WHO definition. m-health can be defined as the provision of health services and information via mobile technologies such as mobile phones WHO definition ([http://www.who.int/pmnch/knowledge/publications/ict\\_mhealth.pdf](http://www.who.int/pmnch/knowledge/publications/ict_mhealth.pdf)).

### Emerging technologies

**Telemedicine:** Recently lot of stress is being made on the field of telemedicine (Bashshur, 1995) which is a merger of advanced telecommunication and computer technologies. Telemedicine is the use of information and communication technologies to provide and support healthcare services at distant locations. Telemedicine can give a new model for interaction with the patients or other important entities such as hospitals, pharmacies, physicians and governmental agencies. On the other side very advanced telemedicine technologies (Crump and Pfeil, 1995) are on the way such as Tele surgery where robotic instruments will perform the surgery on the basis of the audio and visual data received by the surgeon present at a remote or a distant location where there it is impossible to move a patient immediately (Guthart and Salisbury, 2000 and Aqil Burney *et al.*, 2010).

**E Health:** E Health (also written e-health) is a relatively recent healthcare practice supported by electronic processes and communication, dating back to at least 1999. Usage of the term varies. A study in 2005 found 51 unique definitions. Some argue that it is interchangeable with health informatics with a broad definition covering electronic/digital processes in health while others use it in the narrower sense of healthcare practice using the Internet. It can also include health applications and links on mobile phones, referred to as mHealth or m-Health. Since about 2011, the increasing recognition of the need for better cyber-security and regulation may result in the need for these specialized resources to develop safer eHealth solutions that can withstand these growing threats.

**Electronic health record:** Emerging electronic health record models present numerous challenges to health care systems, physicians, and regulators. This article provides explanation of some of the reasons driving the development of the electronic health record, describes two national electronic health record models (currently developing in the United States and Australia) and one distributed, personal model. The US and Australian models are contrasted in their different architectures ("pull" versus "push") and their different approaches to patient autonomy, privacy, and confidentiality (Tracy D Gunter *et al.*, 2005).

**Computerized physician order entry:** A means of requesting diagnostic tests and treatments electronically and receiving the results.

**E Prescribing:** Electronic prescribing or e-prescribing (e-Rx) is the computer-based electronic generation, transmission and filling of a medical prescription, taking the place of paper and faxed prescriptions. E-prescribing allows a physician, pharmacist, nurse practitioner, or physician assistant to electronically transmit a new prescription or renewal authorization to a community or mail-order pharmacy. It outlines the ability to send error-free, accurate, and understandable prescriptions electronically from the healthcare provider to the pharmacy. E-prescribing is meant to reduce the risks associated with traditional prescription script writing. It is also one of the major reasons for the push for electronic medical records. By sharing medical prescription information, e-prescribing seeks to connect the patient's team of healthcare providers to facilitate knowledgeable decision making (<http://www.medrunner.ca/learn-more/eprescribing>).

**Clinical decision support system:** A clinical decision support system (CDSS) is a health information technology system that is designed to provide physicians and other health professionals with clinical decision support (CDS), that is, assistance with clinical decision-making tasks. A working definition has been proposed by Robert Hayward of the Centre for Health Evidence: "Clinical decision support systems link health observations with health knowledge to influence health choices by clinicians for improved health care". CDSSs constitute a major topic in artificial intelligence in medicine (Moja *et al.*, 2014 and <http://www.exploris.info/Cardio-Explorer/>)

**Consumer health informatics:** Consumer health informatics (CHI) is a sub-branch of health informatics that helps bridge the gap between patients and health resources. It is defined by the American Medical Informatics Association as "the field devoted to informatics from multiple consumer or patient views". The Consumer Health Informatics Working Group (CHIWG) of the International Medical Informatics Association (IMIA) define it as "the use of modern computers and telecommunications to support consumers in obtaining information, analyzing unique health care needs and helping them make decisions about their own health" (<http://www.imia-medinfo.org/new2/node/137>)

**Medical research using grids:** Grid technology provides the opportunity to fulfil the increasing requirements of medical research and health care on information technology (IT). In health care the documentation needs grow due to DRGs (Diagnoses Related Groups). The progress in genome research makes personalized medicine possible. Electronic health records for the management of the patient data disseminate quickly. Most of the medical data e. g. data vital signs or images for diagnosis are available in digital form and should be used by different institutions. Medical databases are being created e. g. for oncology and should be accessible worldwide for authorized persons. These require an IT infrastructure which supports the secure collaboration between institutions ([https://link.springer.com/chapter/10.1007/978-0-387-78417-5\\_5](https://link.springer.com/chapter/10.1007/978-0-387-78417-5_5))

**Health informatics / healthcare information systems:** also often refer to software solutions for appointment scheduling, patient data management, work schedule management and other administrative tasks surrounding health.

**m-Health :** The term eHealth refers to the use of modern information and communication technologies (ICT) to meet needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers (eHealth EU Ministerial Declaration, 22<sup>nd</sup> May 2003). Advancements in information and communication technologies have paved way for provision of cost-effective e-services to the people around the globe. The combination of such wireless technologies with e-health is known as m-health. In general terms, m- health can be defined as mobile computing, medical sensor, and communications technologies for healthcare. (Istepanian, 2004).The applications include the use of cell phones and other communication devices to gather health data, delivery of healthcare information to doctors, researchers, and patients. It also includes real-time and direct provision of health services. It can help improve clinical outcomes, and contribute to better public health monitoring and education. Several platforms have been proposed to provide easy to use and cost effective solutions for seamless remote patient doctor interaction over a cellular network (Holopainen, 2008; Park and Jayaraman, 2003; Jovanov *et al.*, 2005 and Warren, 2003) m-Health systems are created as a synergy of emerging mobile medical computing, medical sensor technologies, and communication technologies (Istepanian, 2004 and Aqil Burney *et al.*, 2010).

**Video conference:** Another important technology is the use of video conferencing, allow clinicians/surgeons and physicians to interact with a distant patients due to time factor in a real time and give his/her expert advice and even interact with the patient. The video conferencing also help the physician to interact with different experts at the same time and make a decision. The modern technology provide the ways to not only store digital images such as MRI, X-Rays and Radiographs but to transmit them effectively and efficiently using tele-radiology (Gitlin ,1994)to the consultants which saves precious time and without any significant loss of data (Aqil Burney *et al.*, 2010).

**Cyber medicine:** Cyber medicine is the use of the Internet to deliver medical services, such as medical consultations and drug prescriptions. It is the successor to telemedicine, wherein doctors would consult and treat patients remotely via telephone or fax. Cyber medicine is already being used in small projects where images are transmitted from a primary care setting to a medical specialist, who comments on the case and suggests which intervention might benefit the patient. A field that lends itself to this approach is dermatology, where images of an eruption are communicated to a hospital specialist who determines if referral is necessary. The field has also expanded to include online "ask the doctor" services that allow patients direct, paid access to consultations (with varying degrees of depth) with medical professionals.

**Bar Code Technology:** Barcode technology (Roger, 2001) in healthcare management has involved applications at the point of care. Bar code technology specifically in health management improves the security, safety and quality of healthcare. The right treatment is not the only issue but to make sure that the right treatment is given to right patient at right time (Aqil Burney *et al.*, 2010).

**Radio-Frequency Identification:** Radio-frequency identification tracks patients throughout the hospital, and links lab and medication tracking through a wireless communications system. The technology, once common may

serve as an alternative to bar coding (Wang *et al.*, 2005 and Aqil Burney *et al.*, 2010).

**Clinical Decision Support System:** Clinical Decision Support System (CDSS) provides doctors, nurses and other paramedical staff with real-time diagnostic of the patients as well as treatment recommendations. (<http://www.openclinical.org/dss.html> and Aqil Burney *et al.*, 2010).

**Picture Archiving and Communication System:** A picture archiving and communication system (PACS) is an electronic and ideally filmless information system for acquiring, sorting, transporting, storing, and electronically displaying medical images. (Beard *et al.*, 1990; Becker *et al.*, 1994 and Aqil Burney *et al.*, 2010).

**Benefits of Health Informatics for Patients:** Worldwide use of computer technology in medicine began in the early 1950s with the rise of the computers (<http://healthinformatics.uic.edu/history-of-health-informatics>). In 1949, Gustav Wagner established the first professional organization for informatics in Germany (<http://www.nyuinformatics.org/education/degree-programs>). The HIT will improve individual patient care, but it will also bring many public health benefits including: Early detection of infectious disease outbreaks around the country; improved tracking of chronic disease management; Evaluation of health care based on value enabled by the collection of de-identified price and quality information that can be compared. The health information sharing between patients and providers helps to improve diagnosis, promotes self-care, and patients also know more information about their health. Today's modern medicine requires doctors to be constantly aware of new developments, new medications, and new procedures. With the influx of patients into the medical system, it is more essential than ever that the health care industry keep up. Health informatics is the combination of informational science, health care and computer technology. There are many benefits to using health informatics. Through the use of computers, the Internet and various medical databases, doctors can better learn how to treat patients more effectively. The data retrieved by the use of health informatics provides statistical information that can have a profound effect on how medicine is distributed, surgeries are performed, and how healing is tracked. It also helps hospitals better track patients' past records so they can be treated faster in the future.

The use of health informatics has opened up the doors for clinics to be more capable of treating patients in a more efficient manner, and helps these clinics refine their current process to make it more streamlined. Medical software and record keeping programs are constantly being upgraded, and new programs are provided to help keep more accurate and detailed records of patients. This can also help to speed up the check-in process for patients when they arrive at a hospital or doctor's office. Hand held portable devices are now also being used so that nurses and doctors can easily move throughout a large hospital or clinic, while still being able to access information at the touch of a button. Health informatics are also used at dentist offices so oral surgeons and dentists can coordinate patient treatment. This integration has provided medical professionals with an easy to use, fast method of accessing patient's past medical history. New technology can be an integral part of medicine, and health informatics is no exception. Through detailed patient medical records, clinics and hospitals have access to much more information, and can

retrieve this information quicker than ever before. The development and combination of computer and medical science has opened the doors for medical specialists, and given patients a better chance at getting the best treatment possible (<https://healthinformatics.uic.edu/resources/articles/benefits-of-health-informatics-for-patients/>). Computational health informatics is a branch of computer science that deals specifically with computational techniques that are relevant in healthcare. Computational health informatics is a branch of health informatics. Computer scientists working in computational health informatics and health scientists working in medical health informatics combine to develop the next generation of healthcare technologies ([https://en.wikipedia.org/wiki/Health\\_informatics](https://en.wikipedia.org/wiki/Health_informatics)).

**Impact of ICT on aspects of health care:** ICT has an impact on many aspects of health care. The most important are: accessibility to health care by citizens, its economy, quality of care and education.

**Accessibility:** The ICT has an impact on accessibility to health care services. The main goal is to provide access to the health services for the citizen at any time and any place and especially for the patients from rural areas and small towns. E Health can cope with the deficit of medical staff in developing and the developed countries.

**Economy:** The continuously rising costs are the main problem of the contemporary health service in many countries. These costs may not be acceptable both for developing and developed countries. eHealth can decrease the costs of health care by decentralizing the care - enabling medical services at a lower level where they are cheaper (e. g. regional hospital instead of university hospital), or by avoiding patient transport to the hospital when it is not necessary.

**Quality of care:** The imaging techniques described earlier (CT, MRI) contributed significantly to better quality of care. The primary use of imaging is diagnostics (Greenes *et al.*, 2001). The other uses are assessment of patient status in terms of response to treatment and prognosis. CT is often used for surgery or radiotherapy planning. Images can also provide real time guidance during surgical procedures. Images enable remote viewing; interpretation and consultation thus are the means of communication. Imaging plays an important role in education, training and research. The link between good quality images and quality of care is evident.

**Education:** ICT has an impact on education of both patients and medical staff. There are many web sites aiming at prevention of civilization diseases (diabetes, hypertension, cardiac failure, cancer). They can also support groups of patients suffering from the same disease (e. g. cancer patients). The most challenging factor in e-learning in medicine is lack or limitation of interpersonal contact, which is crucial in training future physicians.

## Conclusion

The ICT has an impact on accessibility to health care services. The main goal is to provide access to the health services for the citizen at any time and any place and especially for the patients from rural areas and small towns. ICT has an impact on education of both patients and medical staff. There are many web sites aiming at prevention of civilization diseases (diabetes, hypertension, cardiac failure and cancer). They can

also support groups of patients suffering from some diseases. Only continued application and reflective practice, evaluative research and refinement will result in success across the wide variety of settings needing improvements in health outcomes. ICT may help healthcare professionals and community health workers to carry out their work in a better way particularly in remote areas. Emerging technologies like Telemedicine, Video conference, Cyber medicine, Bar Code Technology, Radio-Frequency Identification, Radio-Frequency Identification and eHealth offers a way for improvement of the standard of healthcare particularly in the developing world.

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