Role of Information and Communication Technologies in Medical Science and Research

Shriya Ambhaikar
Dali Medical University
Yunnan Province, China

ABSTRACT
Information and communication technologies are about to make a massive move into medical practice, not only in selected areas of 'high-tech' medicine, but throughout the field. Research in information technologies is needed in the areas of massive data collection related to patient, medical imaging, cancer detection, ERH, education and in training as well. We need to realize that every year that goes by there is more and more information added in medical science and there is a strong argument to be made that the greatest work is being done with the help of information technology. When we consider that this information is coming from all around the world, we need a way to get easy access and only reliable source is information technology. ICT will allow medical researchers to determine the effectiveness of a particular treatment for a given population or to discover the harmful side-effects of a drug.

Keywords
Information and communication Technology (ICT), Medical science, Computer technology, Artificial intelligence, Computer skills, Computer knowledge, Electronic Medical Record (ERH), Adverse Drug Event(ADE).

1. INTRODUCTION
With the development of technology medical Science growing more multifaceted and most clinical research focuses and relies on new approaches to provide better diagnosis and treatment which is effective and cost effective too. For effective implementation of medicals' medicines must achieve major gains in quality, it must be transformed, and information technology will play a key part, especially with respect to safety.

The Information Technology Association of America (ITAA) defines Information Technology (IT) as "the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware". Computers and IT/ICT are almost synonymous and together, they have connect the whole world in such a way that there is not a single part in the world or a single incident that we cannot know of and the wonderful part is that we don't even need to go out from our room. IT has brought the world to our fingertips and it won't be an exaggeration to say so [5].

Several countries have announced initiatives to modernize their health care systems with investments in health information and communication technology (ICT) even major corporate groups are spending money in medical science researches like Microsoft designed a site especially for health services. The main aim of these initiatives is to use technology to improve the health care system by reducing expenses, increasing patient safety and improving excellence of patient care. Improving health care is in priority nowadays in all countries. The role of information and communication technology in reducing and preventing medical errors is investigated, and recommendations are presented regarding the use of information technology for prevention and reduction of medical errors in medical science. But with these developments which provides significant benefits to patients and medical science these also raise to ethical and legal challenges in the protection of patient privacy and confidentiality.

The inundation of Information and Communication Technologies the terms data, information, and knowledge are often used similar. In a medical context, data are those primary facts and observations acquired in the course of providing services such as all the numeric values of various clinical tests [4]. Data contribute to and in some cases become information when they inform an assessment or action. In turn, information can be systematically organized and analyzed to produce knowledge, which is the accrue understanding of real-world objects and ideas. In this context, knowledge is the framework upon which individual base their decisions towards diagnosis, comparing the person-specific data and information with the science base of what is believed to be generally true about human health and disease.

These peculiarities are important because upheavals driven by information technology occur in the acquisition of data, in the methods for synthesizing data into information to inform decisions, and in the accrued knowledge base of medical science [6].

2. IMPROVING SAFETY WITH ICT
Nowadays, information technology has made possible to achieve "mass customization" the efficient and reliable production of goods and services which involves direct and indirect involvement either with monitoring of patient or clinical laboratory result. These measures are adopted according to the highly personalized needs of individual customers. ICT systems across the world are now improvise the standard of medical attention, caring, monitoring, promotion, disease prevention and optimized technique to cure chronic diseases[2]. To help achieve this, there is considerable scope for collecting, analysing and utilising information from patients about lifestyle (eg, exercise, work schedule, diet, smoking, eating habit, family history etc) without the involvement of clinicians. These systems can be used to collect information directly from the patient, for example, pre consultation interview (with the help of online facility). Computer-based questionnaires are also useful for collecting important data before the consultation. ICT helps in improving patient safety, these systems can also reduce human intervention, administrative cost and helps in improving facilities towards patient's treatment.

3. USAGE OF ICT IN MEDICAL SCIENCE

3.1 Different Ways that ICT Can Reduce Errors

Information technology can reduce the rate of errors in three ways:

i. By preventing errors and adverse effects.

ii. By facilitating a more rapid and effective response after an adverse event has occurred.

iii. By tracking and providing feedback about adverse events.

Data now show that information technology can reduce the frequency of errors of different types and probably the frequency of associated adverse event [3]. The main classes of strategies for preventing errors and adverse events include tools that can improve communication, make knowledge more readily accessible, require key pieces of information (such as the dose of a drug, timing, strength of dose etc), assist with calculations, perform checks in real time, assist with monitoring, and provide decision support.

3.2 Collecting Information and Assisting With Calculations

One of the major advantages of using computers for clinical tasks that is often overlooked is that it makes it possible to implement "forcing functions" features that restrict the way in which tasks may be performed. For example, prescriptions written on a computer can be forced to be legible and complete [7]. The usefulness of forcing functions may also apply to other types of information technology. For example, bar-coded patient-identification designed to prevent accidents, such as the medication of one patient of a procedure intended for another patient, function in this way. Similarly, many actions imply that another should be taken; these dependent actions have been termed "corollary orders" by Overhang. For example, prescribing bed rest for a patient would trigger the suggestion that the physician consider initiating prophylaxis against deep venous thrombosis[1]. This approach which essentially targets errors of omission has resulted in a change in behavior in 46 percent of cases in the intervention group, as compared with 22 percent of cases in the control group, with regard to a broad range of actions.

The use of computers can also reduce the frequency of errors of calculation, a common human failing. Such tools can be used on demand for example, by a nurse in the calculation of an infusion rate.

3.3 Screening and Monitoring

Screening and Monitoring is inherently boring and is not performed well by humans. Moreover, so many data are collected now that it can be hard to filter through them to detect problems[16]. However, if the screening and monitoring of information is computerized, applications can perform this task, looking for relations and trends and highlighting them, which can permit clinicians to intervene before an adverse outcome occurs. For example, "smart" monitors can look for and highlight signals that suggest the occurrence of de-compensation in a patient signals that a human observer would often fail to detect "Smart" Monitoring in an Intensive Care Unit.

A related approach that appears to be beneficial on the basis of early data is technology-enabled remote monitoring of intensive care. Such monitoring is especially attractive in the intensive care unit because there is a shortage of expert for these tasks. And these helps in reducing mortality rate by huge difference.

3.4 Decision Making

Information systems can assist in the flow of care in many important ways by providing key information on patients as laboratory values, by calculating weight-based doses of medications, or by red-flagging patients for whom an order for imaging with intravenous contrast material may be inappropriate.

A longer-term benefit will occur as more sophisticated tools — such as computerized algorithms, artificial neural networks, artificial intelligence and knowledge based diagnosis become integrated with the provision of health care. Artificial Neural-network decision aids allow many factors to be considered simultaneously in order to predict a specific outcome [8].

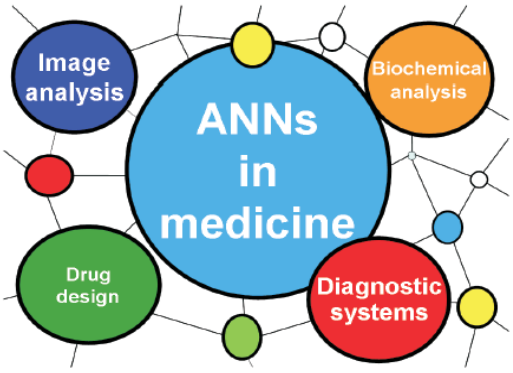

Fig.1 Overview of the main applications of artificial neural networks in medicine

Artificial intelligence aids in minimally invasive surgery advances using Therapeutic robots (therapeutic animal robots that have been developed to help Alzheimer's patients. Robotic pets help nurture brain function by delaying cognitive problems that in turn improves quality of life, and reduces the reliance on social services, allowing a person to stay in their home longer with less medical assistance).

Following figure shows the difference between AI based treatment vs Traditional treatment.

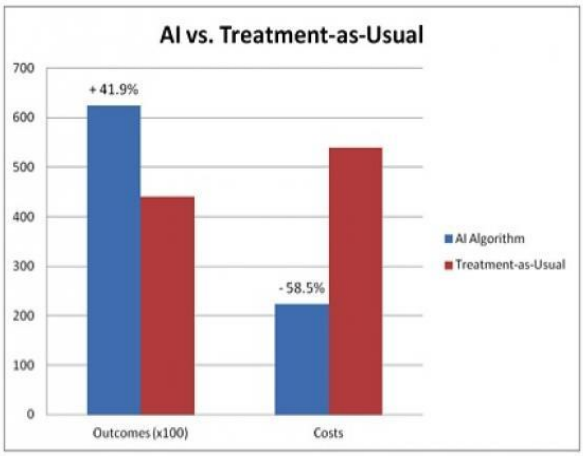

Fig. 2 AI vs Traditional Treatment

These tools have been developed in order to reduce diagnostic and treatment errors in numerous clinical settings, including the assessment of abdominal pain, cardiac pain, chest pain, and psychiatric emergencies and the interpretation of radiologic images and tissue specimens [11].

Controlled trials have demonstrated improvement in clinical accuracy with the use of such technical tools, including their use in the diagnosis of myocardial infarction, the detection of breast cancer on screening mammograms, finding of cervical neoplasia on Papanicolaou smears[14]. However, of these practices, only neural-network–assisted cervical screening has had substantial use.

3.5 Usage of iMED - Intelligent Medical Image Processing

MedIRA (Medical Image Recognition and Annotation) is an I2R Core project. The team develops a variety of medical image-based diagnosis systems with the objective to develop imaging technologies for assisting medical doctors in their clinical practices[15].

The MedIRA Knowledge-based Medical Image Analysis Platform can process CT (Computerized Tomography), MRI (Magnetic Resonance Image), Microscopic, eye retina and lens images, etc. Using image processing algorithms, statistical analysis and annotation tools, the platform provides CAD (Computer Aided Diagnosis) for the clinicians [9].

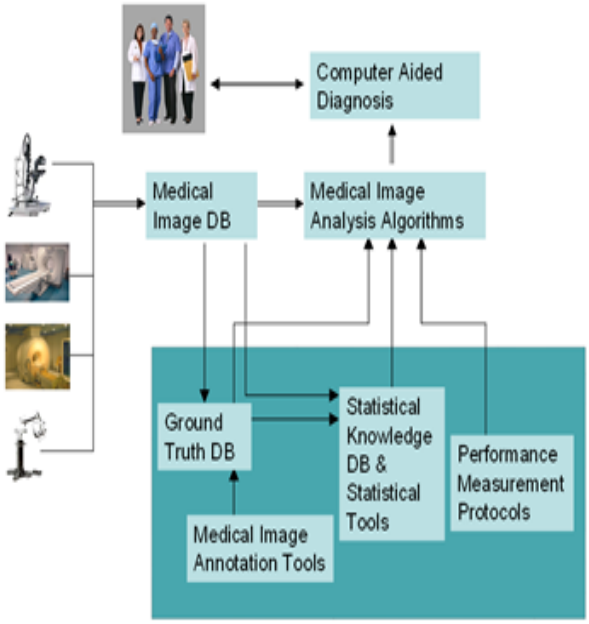

Fig. 3 MedIRA knowledge based medical image analysis platform

Some of the developmental projects and systems the project team is working on with hospitals and medical research centers include:

- Cataract Grading Using Lens Image
- Stroke Detection Using Brain CT Image
- Liver Segmentation Using Abdominal CT Image
- Head Injury Diagnosis Using Brain CT Image
- Malaria Detection Using Microscopic Image
- Breast Cancer Detection Using Microscopic Biopsy
- Glaucoma Diagnosis via Analysis of Morphological Features of the Optic Disk
- ARGALI: an Automatic Cup-to-disc Ratio Measurement System for Glaucoma

Some of the systems have shown promising experimental results.

3.6 Rapid Response and Tracking of Adverse Events

ICT tools can also be used with electronic medical records to identify, intervene early in, and track the frequency of adverse events a major gap in the current safety-related armamentarium to improve processes, it is important to be able to measure outcomes. ICT pioneered an approach for combing clinical data bases to detect signals that suggest the presence of an adverse drug event in hospitalized patients, such as the use of an antidote or life saving drug. Such tools may be useful both for the improvement of care and for research [10].

Electronic tools designed to identify a broad array of adverse events in a variety of settings seem promising. Often, these signals may permit earlier intercession**.**

3.7 Medication Safety and the Prevention of Errors

Medication safety nowadays has gaining worldwide attention and possibly been the most closely studied field in patient safety. ICT helps to reduce the rate of medication errors have engrossed all the methods through which effective result will generate. Medication errors have been found to result from the fact that clinicians have insufficient information about the patient and the drug. Other common factors include a failure to provide sufficient specificity in an order, illegible handwriting, miscalculation, and errors in medical transcription [12]. In one controlled trial involving inpatients, the implementation of a computerized application for order entry by physicians which improves communication, makes knowledge accessible, includes appropriate control on choices of drugs, routes, frequencies, and doses, helps with calculations, performs real-time checks, and assists with monitoring resulted in significant reduction in serious medication-related errors.

The use of computer based decision support in medical science can also result in major reductions in the rate of complications associated with various medicines and the rate of Hospital-acquired infection. Medication safety is an important problem in medical science as number of patient admitted are now suffering with Adverse Drug Events(ADE). And still the ratio of ADE patients is comparatively high as compare to other factors[13]. Hence, IT interventions are important in decreasing ADEs, but further research is required for each application as well as comparisons of different applications. Implementation of IT interventions must be involved in medical sciences which are carefully integrated with existing organizational culture and systems. After accomplishment, iterative assessment and refinement will be required to achieve maximum benefit.

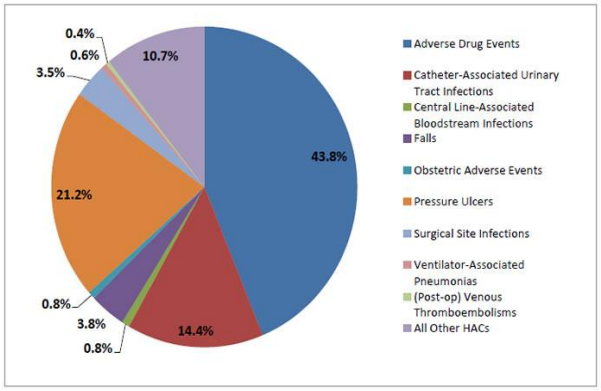

Fig. 4 ADE Vs Other factors

4. BARRIERS AND DIRECTIONS FOR IMPROVEMENT

Despite the substantial opportunities for improvement in patient safety, the development, testing, and adoption of information technology remain limited. Numerous barriers exist, although some approaches to overcoming them are at hand.

a. Financial Barriers

b. Lack of standardization

c. Lack of experts to handle ICT product

d. Cultural Barrier

e. Lack of research and development in medical science with respect to ICT.

5. CONCLUSION

The primary intricacy in modern medical science care is execution of proper treatment which is more crucial during critical position of patient as shown in fig.2. Providing reliable, efficient, individualized care requires a lot of professionalism of data handling related to patient and coordination will be achievable only with the increased use of information technology. Information and communication technology can significantly improves the wellbeing of patient by structuring actions, fetching errors, and bringing computer based patient-centered decision support to the point of care to allow necessary customization. New methods and technology that improve customization and gather and examine through ream of data to identify crucial changes in status and then notify key persons for appropriate action should prove to be especially important.

Even though IT solutions do have considerable potential to improve patient safety and medical science but there is currently a gap between the theoretical and experimental demonstrated benefits. Awareness must also be paid to socio-technical factors to maximize the likelihood of successful implementation and adoption of information and communication technology in the field of medical science.

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