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Public Health Informatics: Potential and Challenges for Better Life in Rural Communities

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***Abstract*—**Public health informatics (PHI) which has seen successful implementation in the developed world, become the buzzword in the developing countries in providing improved healthcare with enhanced access. In rural areas especially, where a huge gap exists between demand and supply of healthcare facilities, PHI is being seen as a major solution. There are factors such as growing network infrastructure and the technological adoption by the health fraternity which provide support to these claims. Public health informatics has opportunities in healthcare by providing opportunities to diagnose patients, provide intra-operative assistance and consultation from a remote site. It also has certain barriers in the awareness, adaptation, network infrastructure, funding and policy related areas. There are certain medico-legal aspects involving all the stakeholders which need to be standardized to enable a working system. This paper aims to analyze the potential and challenges of Public health informatics services in rural communities.

***Keywords*—**PHI, e-health, Public health.

I. Introduction

ACCORDING to the World Health Organization (WHO) (2006) [16] and other pertinent literature, in 21st century, the major problems of healthcare system globally have to do with the quality, safety, effectiveness, cost and accessibility/equity. Regardless of economic and social status, all citizens are seeking for safe, high quality and effective healthcare services at a reasonable cost. In reality this is not satisfactory due to twofold reasons: (i) the scarce resources such as the limited number of doctors or funding and (ii) high level of specialization and division of labor due to the size and complexity of healthcare coupled with the necessity to keep up with rapid advances in medical knowledge, technology, effective management and coordination. Thus, communications play a key role to deliver high quality services. However, this is not the reality today because the system is poorly organized, managed and coordinated which seriously degrade the quality of healthcare. The efficiency of services is low, resources are not rationally utilized, and patient outcomes are not satisfactory because processes are not based on best-practices and standard pathways. The public health is also degraded because continuity of care cannot be achieved. Other problems include ineffectiveness, under-utilization (not receive sufficient care), overuse (receive unnecessary services) and highly variable provision of healthcare services (changes from one place to another is clear indication that not all services rely on best scientific knowledge) [4], [16], [17].

Effective health practice requires timely, accurate, and authoritative information from a wide variety of sources. Not surprisingly, health professionals have been among the earliest adopters of computers and other information technologies and numerous individually useful computerized information and surveillance systems have been developed [5], [6]. The area of health informatics applies information science methods to analyze and understand health care information, to progress from raw data to knowledge, for improved problem solving, decision-making and care delivery. The power of information technology to improve health status both of individuals and of populations is claiming unprecedented attention nationally and internationally as society deals with the effects of recent economic, environmental and policy change. We need to utilize a more systematic and informed approach to the application of information science and technology in order to take full advantage of its potential to enhance and facilitate public health activities.

II. What Is Public Health Informatics?

Public health has become a tool to ensure health and overall development of a nation. It is a term commonly used by health care providers, academicians, policy makers and other stake holders. The first accepted definition of public health states, “Public health is the science and the art of preventing disease, prolonging life and organized community effort for sanitation of the environment, control of communicable infections, education of individual in personal hygiene, organization of medical and nursing services for early diagnosis and preventive treatment of diseases and the development of social machinery to ensure everyone a standard of living adequate for the maintenance of health” [1]. Simultaneously, Health/Medical informatics science which is defined as “ The integrative discipline that arises from the synergistic application of computational, informational, cognitive, organizational and science whose primary focus is the acquisition, storage and use of information, in the health/biomedical domain”[2].

Public health informatics is the systematic application of information and technology to public health practices and

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research. The scope of public health information infrastructure includes the conceptualization, design, development, deployment refinement, maintenance and evaluation of communication, surveillance and information systems relevant to public health. Effective public health practice requires timely, accurate and authoritative information from a wide variety of sources. It requires the application of knowledge from numerous disciplines and its practice must incorporate traditional knowledge that can create a sustainable health model for the rural communities

Public health information has been variously described as the "foundation" for better health, as the "glue" holding the health system together, and as the "oil" keeping the health system running [10]. There is however a broad consensus that a strong health information system (HIS) is an integral part of the health system, the operational boundaries of which include:

… all resources, organizations and actors that are involved in the regulation, financing, and provision of actions whose primary intent is to protect, promote or improve health [11,15].

However, the Public health information field is complex. On the demand side, there are different users and uses of information – people and patients, communities, service providers, program managers, policy-makers, providers of funds, global agencies and organizations. All need information on a range of health-measurement areas including mortality and morbidity rates; disease outbreaks; determinants of health (such as nutrition, environment, and socioeconomic status); access, coverage and quality of services; costs and expenditures; and equity. On the supply side, various tools and methods are available including vital registration and census systems; household, facility and district surveys; routine clinic-based data; disease surveillance systems; national health accounts and modeling.

III. Some Issues in Public Health Informatics

The Public health informatics field encompasses a broad range of themes, both in terms of technical issues as well as with respect to the medical context the methods are set in.

Current research therefore covers a wide array of topics, including:

A. Data Acquisition

Capturing and recording medical data in electronic form is a major bottleneck in applying computers in healthcare. Medical data include things that are not easily recorded or precisely defined. From the viewpoint of designing intelligent systems that reason about medical data, this constitutes a formidable challenge.

B. Medical Vocabularies

Obviously, data has to be somehow represented in coded and machine-readable form if it is to be made properly used of in a computer system. Important parts of the body of medical knowledge are nomenclatures and ontology's for accurately describing, cataloguing and classifying elements in the finding-disease continuum. Such systems are commonly referred to as controlled medical terminologies (CMTs).

C. Electronic Medical Records

Electronic Medical Record [12] is the electronic record of the specific health-related event for a person; whilst Electronic Health Record is the electronic record for a person of all health-related events before birth till death (womb-to-tomb health record!). These terms describe systems that provide a "structured, digitized and fully accessible record."[14] An electronic medical record (EMR) to be searchable and its information content harvested, its content should be encoded using some kind of controlled medical terminologies (CMT). Furthermore, once the content of a medical record is in place, there is still the issue of how to structure the content internally and how to tailor suitable views of an EMR's content for various user groups.

Advantages of digitalization of an individual's patient's health/medical record are:

i. it helps in reduction of error in medical care,
ii. it is easy to maintain for a long period,
iii. it has low maintenance costs,
iv. it is easy to access from any corner of the world if linked to the world wide web,
v. it improves efficiency of health care, and
vi. it helps in research.

D. Decision Support Systems

The study of decision support systems in the area of health care is health informatics, or medical informatics, which focuses on information processing in the health care environment, on methodologies to develop information systems for health care and medicine, and on evaluation and understanding of the changes brought by these systems and technology in the health care environment. Computer programs that help clinicians make clinical decisions, typically can be divided into three groups:

i. Tools for information management,
ii. Tools for focusing attention and
iii. Tools for patient-specific consultation.

Ways to build, maintain, and evaluate such decision support systems (DSSs) are of interest to develop.

E. Deployment Barrier

Systems that may prove successful in research settings often do not make it into clinical use. Barriers of deployment may be of technical, operational, organizational and legal nature and the identification of these and ways to overcome them are active research issues in medical informatics.

F. Confidentiality Issues

Medical information is often sensitive and with a potential for misuse if obtained by malevolent third-parties. The challenges that sound management of confidential data representation have not gone unnoticed in the medical informatics community.

IV. The Potential of Public Health Informatics

The broadened scope of application of public health informatics lies in:

A. Disease Surveillance

This methodology is taken up by the governments and medical committees at times of epidemics where specialists get a chance to predict, observe, and minimize the ill effects of the epidemic. Direct case reports are created using the public health informatics applications.

B. Disaster and Disease Management

The public health informatics facilities come extremely in use in the cases of natural disasters such as earthquakes, floods etc. where medical facilities cannot be quickly set-up. In such cases a simple health informatics facility will help specialists without reaching the disaster struck areas for diagnosis. Specialist's consultation is provided and recommendations for specialists are made. This also helps in reducing the cost of transportations of medical facilities and doctors.

C. Remote Consultation

This application of PHI is required in providing consultation in remote areas where full-blown facilities have not been set-up. This is extremely critical for rural areas where medical institutions believe that it is not profitable enough to set-up units which provide all medical facilities. Only consultation is provided and recommendations for specialists are made.

D. Second Opinion

Public health informatics applications come in use here when the patients are already diagnosed with a particular disease and the primary doctor wants to confirm the same by seeking the opinion from a specialist in another region. The patient can him/herself take a second opinion from the specialist if he/she is unsure about the diagnosis provided by the primary doctor without having to go to the secondary specialists facility.

E. Webcam Procedures

This public health informatics facility is used in cases where the specialist doctor is unable to perform medical procedures due to his/her inability to be at the concerned location. The specialist can guide his/her sub-ordinate doctors in performing the procedure as well as in diagnosis.

F. Home Care

This facility is used by patients by logging in directly to the hospital/institute public health informatics unit and getting feedback and diagnosed.

G. Medical Education and Public Awareness

PHI applications can be used for spreading general awareness to the public especially in times of epidemic without the need for the specialist doctor to be present in the concerned location. This facility helps a lot in reaching out to large masses and early information dispersal.

H. Computer-Based Information Processing Tools

Now-a-days, health care professionals usually have to deal with much higher amounts of data as compared to the health care professionals in 1980s. The computer-based tools of hospitals/medical centers in the meantime encompass hundreds of computer-based application components, thousands of workstations and other terminals and up to a hundred servers (larger computer systems that offer services and functionality to other computer systems), which usually belong to a network. Here main focus will be on the computer-supported parts of health information systems, as the lines of development are the most interesting. In many of the health care settings, we are aware that the electronic patient record has already become the leading record, no more the paper-based one. So, there is a highly redundant co-existence of paper and computer-based information processing, often causing higher costs and higher efforts for health care professionals to access and to use data [8].

I. Local To Worldwide Information System

For the first time, we are really having the chance to broadly explore patient-centered information processing in 'Public health information systems'. Patient-centered information processing was our aim from the beginning on, not institution-centered processing, which may lead to sub-optimal results with respect to quality and costs of patient care. The development from local to regional and global architectures fortunately correlates with the intentions of many health care authorities to improve quality and efficiency of care through disease oriented, not institution-oriented care strategies. Such departmental, hospital and health care systems were having specific information system architectures and infrastructures. Until today, many of us feel that public health care professionals as users accept the necessity of computer-based health information systems and see their benefits, but they are not really content. Besides the reason that computer-based information processing tools are still improvable, especially with respect to the ease of use and the ease of data input, the increasing amounts of data in medicine and public health care may also be one of the reasons for this unsatisfactory situation [8].

J. From Health Care Professionals to Patients and Consumers

At the beginning, computer-supported health information systems were primarily intended to support health care professionals, mainly physicians, as well as administrative staff in hospitals. Later, there was a focus also on nurses. Since several years, we recognize that health information systems now will also directly support rural patients, their relatives and all people with health questions and problems—often denoted as rural health consumers.

K. From Using Data Only for Patient Care to Research

Another shift was given in the use of data in such information systems. Even until the last decade, there was an almost exclusive use of PHI data for patient care and administrative purposes, with some use for quality

management and controlling. Now we are having the ability to extend the possibility of using data, primarily used for patient care, also for health care planning and, above all, for clinical research. This possibility will have a continuous influence to medical statistics and epidemiology, in terms of probably different study designs and methods for data analysis.

L. Inclusion of New Technologies

Another continuing process in this evolution was the increase of functionality in computer supported health information systems. Today, we can observe new extensions by the use of so-called enabling technologies for health monitoring. These technologies enable us to continuously monitor the health status of patients with unobtrusive, noninvasive technologies, e.g. as wearable devices. Such wearable devices may range from micro sensors, integrated in textiles, through consumer electronics, embedded in fashionable clothes and computerized watches, to belt worn personal computers with head mounted display. With appropriate sensors data can be measured continuously, not only at discrete points in time, and without manual intervention. With the help of such sensors and with ubiquitously available computing facilities, local (pre-) processing is possible as well as a later, maybe wireless transfer to monitoring centers, at least in terms of reporting on exceptional conditions of a patient and in raising alarms in case of critical situations. Here, we can identify new possibilities of organizing care and treatment in a way that might be more convenient for our daily life and may support us to keep living in our social environments. It may be suitable and affordable for aging societies [8].

V. What are the Challenges for Public Health Informatics in Future?

One major goal of public health informatics is ensuring the capacity to assess community problems in a comprehensive manner through the development of integrated nationwide public health data systems. Another major challenge for public health informatics is facilitating the improved exchange of information between public health and clinical care.

The problems of "PC in a kiosk" based healthcare is fraught with infrastructure problems like lack of electricity, maintenance issues in heat and dust of tropical climate, moral and ethical issues in providing quality care, knowledge gaps of users, supply of medicines and other healthcare products to the last mile and unproven clinical efficacy [18].

The models driven by private service providers (either independently or in public-private partnership) have been limited in their impact by overarching issues of acceptability, affordability and financial feasibility [9]. The predominant focus so far has been on symptomatic reactive care whereas ignoring the need of preventive care in resource poor settings. Moreover, there is little support for cognitive limitations of users at grassroots level, who operate in variable local healthcare infrastructure and are limited in abilities for local data management [7]. Lack of definitive user identification and transparency of business transactions especially in "fee for service" models make it difficult to run a sustainable program that could build trust and make communities self-reliant. Despite success of small pilot projects, linguistic, cultural and geographical spread of diverse population has made scaling up difficult. Furthermore, in a country where 42% of the population lives below poverty line [3], it is not sufficient just to make services available for a cost, but also needs to invoke active community participation to reduce the burden of preventable problems. The implementation of such projects also needs to be infused with sense of service and incentives to work with marginalized groups. Empowerment of grassroots intermediaries to involve their communities has been identified as the key factor that fosters local ownership in the backdrop of availability of culturally appropriate content and services that respond to needs of the poor [13].

The challenges faced by the novice discipline of public health informatics to grow for the benefits of the rural population emerge out of some public health governance issues and some technical issue related with e-health.

A. Need for Institutional and (Inter-) National PHI-Strategies

It is obvious that strategic information management has now to be considered as an important task in the continuing process of maintaining and improving health information systems, in order to improve health care. It has to be implemented not only in health care institutions such as hospitals, institutional information management strategies will have to be accompanied by regional, national and international strategies. Strategic information management should now consider the developments mentioned previously: on the global access to PHI, the extended PHI users including health consumers, the extended use of data including research, the new types of data and the health monitoring opportunities. Conflicts will arise and will have to be solved. There will be promises and perils. We have to find a balance to preserve privacy and to get the necessary support by ubiquitous computing resources for our health and quality of life [8].

B. Need for Education in Health and Biomedical Informatics

Another immediate consequence is the need for appropriate education in health informatics or biomedical informatics. Because of the mentioned progress in informatics, including the described developments in health information systems, educational courses and even programs are needed, in order to have well-educated health care professionals or even health informatics/medical informatics specialists, with sufficient knowledge and skills to systematically process data, information and knowledge in medicine and health care.

C. Need for Research in Health and Biomedical informatics

Health information systems are in a phase of rapid development, with many questions being still unsolved in terms of architecture, functionality and management. These new types of systems are urgently needed for reorganizing health care in an aging society; there is a significant need for research in various areas of health and biomedical informatics.

D. Need for Improving Communication Skills and the Patient-Doctor Relationship

Communication skills are fundamental to a successful health informatics strategy. Public Health informatics is a technological science and a socio-cultural field of study. General practitioners and practice staff must acknowledge that data collection and retrieval involves a relationship between the patient, practitioner and the computer/device. This relationship is fluid and the practitioner must be conscious of the use of the computer 'taking over' the consultation. There is a three way relationship between the doctor-patient-computer, however, the doctor-patient relationship remains paramount, and the practitioner needs to be able to facilitate and use the computer to enhance the relationship.

Health informatics incorporates both basic and advanced professional knowledge and skills.

Basic knowledge and skills include:

i. Basic computer literacy skills
ii. Knowledge of appropriate and reliable websites for patient information
iii. Understanding of the role of the electronic health record in health practice.
iv. Advanced knowledge and skills include:
v. Knowledge of evidence based practice search strategies, e.g. PubMed and Cochrane
vi. Knowledge of appropriate e-medicine websites for professional 'just in' time information, e.g. E-Medicine, Harrison's Online, Dermnet
ii. Understanding of infrastructure set up, e.g. server system, security and data recovery
ii. Telehealth including teleconsults, email consultations and
ix. Higher level electronic health record skills involving using templates for application of medical summaries, medication lists, care plans and health assessments.

E. Need for Improving Population Health and the General Practice

Health informatics has a key role in assisting general practice in improving population health strategies. General practices that have an information management strategy in place and staff who promote clean data protocols can use informatics principles to retrieve population health statistics from their own practice. Health informatics strategies in the form of recalls and reminders can also assist general practices to engage in population health activities such as Pap tests and preventive health activities.

F. Professional and Ethical Role

General practice and medical technology is continuously evolving and general practitioners and practice staff need to engage in continual skill development. Mastering medical computer skills is independent of medical experience and knowledge. General practitioners, regardless of age, should acknowledge that health informatics can complement and coexist with traditional general practice. Change management is a key concept in assisting uptake in increasing usage of the electronic health records in health practice.

G. Organization and Legal Dimensions

Health informatics is different from practice management. Health informatics encompasses some elements of practice management and also has defined activities in the area of patient information and professional medical information processes. General practices require a long term view of system security and privacy, including virus protection, server firewall set up, encryption of patient information through emails or system networks, data recovery plan and back up procedures. The electronic health record is a patient record and, like the paper based, is a legal document. General practitioners need to ensure appropriate data quality and up-to-date record keeping is key health informatics strategy [8].

VI. Conclusion

Knowledge of information and technology will increase rapidly in the coming years. In this scenario, the public health infrastructure must be strengthened to avoid more complexities in the health delivery services in rural areas. The confluence of improved information systems and technologies, new challenges to the public health system, and changes in the medical care system presents a unique opportunity, not only to improve the efficiency and effectiveness of public health practice, but to transform fundamentally some aspects of public health practice itself. We believe the new and evolving discipline of public health informatics is the key to systematically and scientifically exploiting this opportunity to the benefit of the public's health. The suggestions in this paper will only be possible if the inclusion of rural area is taken into consideration. Tapping the human resources in villages and creating friendly health models alone will help in sustaining the public health information infrastructure in these areas. The public health information system projects in the rural areas must focus on improving the efficiency of traditional public health practice. Acceptance for health services is always seen in the rural areas and this gateway can be a stepping stone to other welfare programmes for the rural communities.

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