

The Unprecedented Role of Computers in Improvement and Transformation of Public Health: An Emerging Priority

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Introduction

With usage beyond comprehension and preference beyond inscription, computers are one of the greatest inventions of humans. Owing to high precision, speed, accuracy, regular updating of information and presence of world wide web of knowledge of current and historical concepts, computers do play an indispensable part in the lives of about 1 billion people, who have been reported to be using them daily throughout the world.⁽¹⁾

With a history of public health professionals being the first users of information technology (IT),⁽²⁾ this article has been written with the objectives to assess the role of computers in public health and to emphasize their present need in health care and future scope in India.

Role of Computers

There was a time when there was minimal role of technology in public health and physicians only were the sole caretakers and saviors of people.⁽³⁾ Nowadays, technology is at its peak and there is a boom in the availability of the computers to an extent that nearly 500 million computers are available throughout the world.⁽⁴⁾

No field today is uninfluenced by computers, and so is public health, which has benefitted through the pioneering concept of public health informatics i.e.,

systematic application of information, computer science, and technology to public health practice, research, and learning, which eventually facilitates transmission of data from healthcare staff to local health agencies, then to state health agencies and finally to National Center of Disease Control leading to formation of Public Health Information Network (PHIN).⁽⁵⁾

Presently, computers play a crucial role by providing care in all aspects of health. Apart from the formation and maintenance of patient's records, they play a judicious role in public health surveillance. On one hand, computers are the key functionaries of health management information system and on the other hand, they are key handlers of geographic information system, electronic medical records, bioengineering, education, and research. They are also being used in statistical analysis of various data and hence, play an innovative role in leveraging the quality standards of public health professionals and workers.⁽⁶⁾

The detailed description and use of computers in each of the abovementioned applications is being presented as below.

Disease Surveillance

Disease surveillance projects are computer-based surveillance systems, which are used for rapid transmission and analysis of morbidity data. These are used to monitor the progress of ongoing disease control programs at national level. Initiated in the United States (US) in 1992 and in India in 2004, these aimed to detect early warning signals of impending outbreaks and help initiate an effective response in a timely manner.

In these projects, weekly reports are prepared by reporting units (using computers) on every Monday,

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which includes data of the previous week beginning from Sunday and ending on Saturday. These data are transmitted by state health department computers to central surveillance units through electronic mail (e-mail) facility (MINET) for rapid analysis and display of maps and demographic and epidemiological characteristics of diseases for prevention of outbreaks.

Presently, more than 90% districts all over India report such weekly data through e-mail or portal on www.idsp.nic.in. These weekly data are analyzed by District Surveillance Units (DSU) and State Surveillance Units (SSU) for disease trends, and whenever there is a rising trend of illnesses, it is investigated by the Rapid Response Teams (RRT) to diagnose and control the outbreak.

IT network connecting 776 sites in states/district headquarters and premier institutes has been established with the help of National Informatics Centre (NIC) and Indian Space Research Organization (ISRO) for data entry, training, video conferencing, and outbreak discussion. Recruitment of 301 epidemiologists, 60 microbiologists, and 23 entomologists has been completed till 2012.

On an average, 20-30 outbreaks are reported every week by the States. A total of 553, 799, 990, and 1675 outbreaks were reported in the year 2008, 2009, 2010, and 2011, respectively. In 2012, 335 outbreaks have been reported till 1st April. Apart from this, media scanning and verification cell established in July 2008 at National Center for Disease Control, New Delhi detects and shares media alerts with the concerned states/districts for verification and response. A total of 1758 media alerts related to diarrheal diseases, food poisoning, and vector-borne diseases were reported from July 2008 to March 2012.

Apart from this, various emerging and re-emerging infectious diseases, like influenza, and biological warfare, which poses a threat to global health, are being rapidly contained with the help of disease surveillance projects spreading throughout the country with the help of computers.⁽⁷⁻¹¹⁾

Telemedicine

The World Health Organization (WHO) defines telemedicine as "The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities."⁽¹²⁾

In a country like ours, with population of 1.21 billion residing in over 3.2 million square km area hindered by varied landscapes like mountain, deserts, plains, and the far-flung and hilly areas and lack of investment for healthcare and inadequate medical facilities in rural areas, adaptation of telemedicine technology offers one of the best options for delivering healthcare for rural and geographically distant population spread across India.

Telemedicine system consists of telemedicine platform (computer/laptop/palmtop/personal digital assistant/mobile), telemedicine software (for capturing of images/video) at both patient's and doctor's end along with availability of communication media, which can be terrestrial or mobile connectivity. Most commonly, telemedicine allows real-time live video communication between patient and specialist but at times, when health providers are not available, images and videos can be stored and forwarded to them.

Telemedicine has reduced distance and the extra strain for rural population to travel to super specialty hospitals in the cities. Apart from saving time, it has also reduced the cost of treatment and prognosis due to access to standard treatment. Critical care monitoring, where it is not possible to transfer the patient, can also be done with the help of telemedicine. It also helps in remote training of medical students/paramedical staff by experts in the field, provides updated health information to health care workers and patients, decreases response time for the management of an epidemic/outbreak or a disaster, and helps in transmission of medical images for diagnosis, exchanging health services, or live education via videoconference.

National Task Force on Telemedicine was constituted in September 2005. Presently, Satellite Telemedicine Network is working in India through Indian Satellite System (INSAT) in 439 nodes across the country through 17 Mobile vans. Telemedicine services are being used in various reputed institutes all over India (Post Graduate Institute of Medical Education and Research, Chandigarh; Christian Medical College, Vellore; Apollo Corporate Group of Hospitals; Sir Ganga Ram Hospital; Tata Memorial Hospital, Mumbai; Fortis healthcare Network; and Escort Heart Institute, New Delhi) for teliagnosis, teleconsultation, telefollow ups, expert's opinion, public awareness programs, guest lectures, teleconferences, national workshops, clinical society meetings, live surgeries, and tele-education. The Central Government Health Scheme has successfully networked all its dispensaries across 24 cities.

GB Pant Hospital, INHS Dhanvantari at Port Blair, Andaman Island, and Bishop Richardson Hospital at Car Nicobar along with ISRO Gramasat Network at 8 Islands

effectively used telemedicine during post-tsunami disaster relief work. Also, telemedicine connectivity is provided between the Temple Board Hospital at Pampa (at foothills of Sabarimala shrine in Kerala) and Amrita Institute of Medical Sciences, Kochi and Trivandrum Medical College Hospital.⁽¹³⁻¹⁶⁾

Health Management Information System (HMIS)

HMIS is the key component of any health program and is defined as a tool that helps in gathering, aggregating, analyzing, and using the information generated for taking actions to improve performance of health systems.⁽¹⁷⁾

Web-based HMIS helps in easy aggregation of data, reduces workload on field staff, strengthens decentralization, and hence, improves the planning ability by formulating 18 national, 52 state/district, 51 facility, and 18 community indicators.⁽¹⁸⁾

At the national level, it is primarily a tool of policy- and strategy-making. At the state and district level, it helps in program monitoring and management. At the sub-district level (block, primary health centre, and sub-centre), it facilitates effective registering and collation of data, provision of data analysis tools, generation of reports, and development of indicators for comparison.

All India Institute of Medical Sciences (AIIMS), New Delhi runs a Comprehensive Rural Health Services Project (CRHSP) at Ballabgarh, which has been using computerized HMIS since 1988. The HMIS at Ballabgarh is currently in its third version, which uses generic and open source software. According to a study conducted to evaluate the effectiveness of a computerized HMIS in rural health system in India, it was found that more than 95% of data was accurate.⁽¹⁹⁾ Health workers acknowledge the usefulness of HMIS in service delivery, data storage, generation of work plans, and reports. For program managers, it provides a better tool for monitoring, supervision, and data management. The initial cost incurred in computerization of two Primary Health Centers of CRHSP was estimated to be Indian National Rupee (INR) 1674, 217. Equivalent annual incremental cost of capital items was estimated to be INR 198, 017. The annual savings is around INR 894, 283, and there have been no major hardware problems in the use of computerized HMIS.⁽¹⁹⁾

U.S. President Emergency Plan for AIDS Relief (PEPFAR) supports HMIS activity that was built on existing data and information. This activity headed by a technical group, which coordinates the program across U.S. government agencies and the multilateral organization

UNAID – global funds to fight AIDS, Tuberculosis, Malaria – WHO, and World Bank.⁽¹⁹⁾

Geographic Information System (GIS)

GIS is a computer-based information system that is used to digitally represent and analyze the geographic features present on the Earth's surface and the events (non-spatial attributes linked to the geography under study) that are taking place on it. GIS has been defined as "automated systems of software and hardware for the capture, storage, retrieval, analysis, and display of spatial & non-spatial data."⁽²⁰⁾

GIS looks into social factors, biodiversity, engineering, land use, and environmental considerations as a whole by using many aspects such as cartography, statistical analysis, and database technology. Sources of geographical data are digital maps, surveys using global positioning system, routine health information system data, census data, survey data, and data from other sectors.

With the help of GIS, we can find out geographical distribution and variation of diseases; analyze spatial and temporal trends; map populations at risk and stratify risk factors; document healthcare needs of a community and assess resource allocations; forecast epidemics; identify gaps in immunizations; plan and target interventions; monitor diseases and interventions over time; manage patient care environments, materials, supplies, and human resources; monitor the utilization of health centers; route health workers, equipments, and supplies to service locations; publish health information using maps on the internet; and locate the nearest health facility.

Apart from this, we can easily draw maps and visualize spatial distributions, edit and alter existing data, accurately measure distances and areas, and overlay maps of different areas. GIS has also been used for control of dracunculiasis, schistosomiasis, and onchocerciasis. In India, GIS is being used in National Vector Borne Disease Control Program, Integrated Disease Surveillance Project, National Leprosy Eradication Program and National Rural Health Mission.⁽²¹⁾

Electronic Medical Records

Paper-based medical record system had many weaknesses including illegible handwriting, incomplete data, unsafe and non-confidential, and poor availability whereas use of Electronic Medical Records (EMR) is a secure and confidential method of keeping records. With an aim to modernize the health system by inculcating and promoting the use of health information technology,

it helps in collecting complete information about individual patients including registration, clinical record, laboratory, and imaging.⁽²²⁾

In recent years, computerization of patient records has increased at a high rate, and this trend is likely to continue. Mother and Child Tracking System (MCTS) is one of the most recent examples of use of Electronic Health Record System implemented as part of the Janani Suraksha Yojna Scheme for providing incentives to mothers who deliver in hospitals.⁽²³⁾

EMR also allows tracking of patients requiring follow up e.g., human immunodeficiency virus (HIV)-infected patients. It also allows management of diseases requiring long treatments e.g., multidrug-resistant tuberculosis (MDR-TB) or extensively drug-resistant tuberculosis (XDR-TB). Apart from this, it also helps clinicians and public health professionals and workers to provide comprehensive care to individuals because of the strong search and record-keeping ability of this system.^(24,25)

Bioengineering

Bioengineering is a discipline that advances knowledge in engineering, biology, and medicine and improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice. It is helpful in designing computer systems to monitor patients.⁽²³⁾

Bioengineering is a relatively new engineering discipline when compared to the long-standing traditions of other fields of engineering. It uses traditional engineering skills and tools to analyze and solve problems in biology and medicine. The difference between bioengineering and biomedical engineering is that bioengineering is a more global term which encompasses biomedical engineering and is applied to all life sciences and medicine whereas biomedical focuses primarily on medicine and healthcare.

Bioengineering is used in computerized analyzer for blood sample analysis and in ambulances for use in rural areas. Medical imaging systems and rehabilitative tools such as prosthetics, artificial limbs, etc. also make use of bioengineering for the welfare of public health.

Large-scale disasters that displace populations and strain the existing healthcare infrastructure, such as the 2004 Indian Ocean tsunami and the 2010 earthquake in Haiti, have two well-defined stages: the crisis during the event, and the slower, more devastating catastrophe that puts the lives of millions of people at risk. Local

government response is often focused on the former, with little attention to the latter. Crisis management in remote settings is particularly complicated. In this perspective, we argue in favor of improved management of large-scale disasters through investment in biomedical engineering (WHO, 2011).^(3,26,27)

An important application of bioengineering is analysis and to provide cost effective solutions to the problems of human health. It plays an essential role in healthcare delivery system and is employed by multidisciplinary clinical and research teams. Unfortunately, middle- and low-income countries have few bioengineering departments conducting active research because of lack of technical capacity and resources.

Public Health Informatics

It has been defined as the systematic application of information and computer science and technology to public health practice, research, and learning. Public health informatics is a branch and profession that applies mathematics, engineering, information science, and related social sciences (e.g., decision analysis) for analysis and management of important public health problems and processes. It is one of the branches of the larger field known as biomedical or health informatics.

Public health informatics supports public health decisions by providing timely, relevant, and high-quality information. Public health informatics professionals work to disperse advice on public health goals faster, better, or at a lower cost by using computer science and IT.⁽²⁸⁾

Conclusions

Nowadays, computers are available at much cheaper and affordable prices. Their use has increased efficiency and reduced human errors. Apart from providing regular updated information and streamlining medical education and health care, computers do play an indispensable role in administration and management via regular and timely updates and through availability of its world wide web. Better health surveillance systems would help decision makers to detect and control emerging and endemic health problems.

On one hand, where computers have replaced millions of employees, their excessive usage threatens the security and confidentiality of records. The immense capabilities of computers can suddenly stop and leave their users helpless until they find technical support to fix problems like spywares/viruses/Trojans, etc. From a public health point of view, computers not only endanger the health of people with fatigue, stress, body aches, and carpal – tunnel

syndromes but also pollute the environment by releasing harmful levels of lead and mercury during their manufacturing and disposal procedures. Another disadvantage is the enormous cost of the computers, their software, and the maintenance required.

Since it is all about technology and proper knowledge is required for operating them, many Indians still do not prefer using it. Also, many doctors are not fully convinced and familiar with e-medicine. There is a lack of confidence in patients about the outcome of e-medicine. Even after making such a financial investment, providing access to space, and deploying geostationary satellites, computers cannot replace humans and their psychomotor skills.

Recommendations

Financial investments are required to develop and maintain computers at all workplaces, especially in rural areas, which comprises 68% of the total population.⁽¹³⁾ For implementing all of the abovementioned technologies, availability of trained manpower is essential. Technical constraints, including connectivity, bandwidth provision, and reliability, also need to be taken care of along with availability of health professionals for correct diagnosis and treatment.

Cost consideration and affordability need to be taken into account for the development and implementation of national plan for e-health along with its integration into the health system. People residing in rural and remote areas need to be made aware of the existence of such e-services in their areas; their ethical and social issues also need to be addressed.

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