K.C. Lun

School of Biological Sciences
Nanyang Technological University
Singapore

Research and Education

New Challenges for Health Informatics

Abstract: In March 2001, the International Medical Informatics Association organized a workshop entitled "Challenges in Medical Informatics" in Madrid, Spain. It invited twenty members of the medical* informatics community to discuss current issues relating to the academic standing of the field. The broad objectives of the workshop were (a) to review the relevance of medical informatics as an academic discipline in today's setting and (b) to examine its impact by the new world economy. One of the issues discussed was to find an appropriate response to the growing emergence of bioinformatics in the age of genomic discovery and molecular medicine. With the exciting discoveries in molecular medicine coming hot on the heels of the first draft of the mapping of the human genome and the availability of high-throughput measurement of gene expressions using microarray techniques, bioinformatics has, in recent years, gained prominence in life sciences research and development. As the next phase of research will see the applications of genomic and proteomic data in the clinical management and treatment of patients, it is inevitable that bioinformatics and health informatics will converge, presenting an exciting new challenge for our field. The terms "biomedical informatics" and "clinical bioinformatics" have been used to describe this convergence.

Another exciting challenge for health informatics comes from the spectre of global bioterrorism. Following the September 11, 2001 terrorist attacks in the USA and the spate of anthrax outbreaks there and elsewhere, there has been an urgent need to review current methods of disease surveillance. Current research in "preventive bioterrorism" focuses on the use of prodromal (warning) symptoms to predict serious infectious disease outbreaks. The health informatics challenge, in this case, is to develop a wide area network of health information systems to achieve real-time reporting of prodromal symptoms from sentinel stations and to deploy data-mining and decision analytical techniques for the outbreak predictions.

The third challenge to be covered in this presentation relates to the deployment of networked virtual reality for remote tele-rehabilitation of patients with cognitive and physical impairments. While the benefits of deploying telemedicinal principles for remote medical rehabilitation of patients are clear, the costs and use of virtual reality pose a real challenge. Some solutions are proposed in this paper.

1. Introduction

In March 2001, twenty individuals from the health* informatics community were invited by the International Medical Informatics Association (www.imia.org) to participate in a workshop entitled, "Challenges in Medical Informatics" in Madrid, Spain. The broad objectives of the workshop were (a) to review the relevance of medical informatics as an academic discipline in today's setting and (b) to examine its impact by the new world economy. Among the many issues that were discussed was the challenge posed by the recent rise in prominence of bioinformatics following the efforts to map the human genome and subsequent deluge of genomic and proteomic data coming out of molecular biology laboratories around the world. Papers presented at the workshop have now been published in the January 2002 issue of Methods of Information in Medicine [1]. The challenge from bioinformatics is just one of several exciting areas for health informatics to find new niches in the wake of recent trends for the applications of info-communication technologies in health and healthcare delivery.

2. The Challenge from Life Sciences

With the exciting discoveries in molecular medicine coming hot on the heels of the first draft of the mapping of the human genome [2] and the availability of high-throughput

* in this paper, the terms health informatics and medical informatics are synonymous

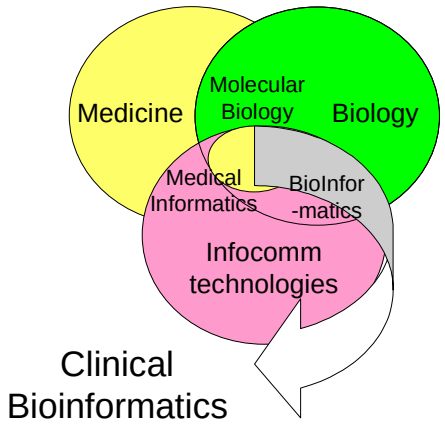

Fig. 1. The relevance of biomedical informatics.

measurement of gene expressions using microarray techniques [3], bioinformatics has, in recent years, gained prominence in life sciences research and development. As the next phase of research will see the applications of genomic and proteomic information, culled from nucleotide and protein databases, in the clinical management of patients, it is inevitable that bioinformatics and health informatics will converge, presenting an exciting new challenge for our field. The terms "biomedical informatics" and "clinical bioinformatics" have been used to describe this convergence [4,5,6]

Bioinformatics deals with the data- and image-processing and information tools and techniques in biology that are instrumental in translating molecular/genetic information into biological processes/pathway knowledge. It therefore makes sense that if we couple bioinformatics with the tools and techniques that deal with clinical information (e.g. computerized patient records, clinical decision systems, image- and signal-processing), we have the means to correlate essentially genotypic information with expressed phenotypic information [7]. While bioinformatics enables us to understand the fundamental knowledge about biological processes, the inclusion of clinical information in biomedical informatics opens the gateway to genetic risk profiling of patients, new paradigms in disease diagnoses and prognoses and novel approaches to drug discovery based on the correlation of genetic and molecular knowledge of diseases with clinical information of their patients.

Bridging the gulf between bioinformatics and medical informatics requires a meeting of the following challenges:

- Co-operation between biologists working in the basic sciences and clinicians in the medical sciences. This is already taking place in large research institutions throughout the world. It is also necessary to bring together bioinformaticians who deal essentially in the life sciences domain with medical informaticians who work essentially in the health and medical domains. This could be achieved by having joint activities between the organizations of these two professional groups such as the International Medical Informatics Association (www.imia.org) and the International Society of Computational Biology (www.iscb.org).
- The linking of genomic information with clinical information can be facilitated through new architectures in the design of computerized patient records. However, even today, there are still not many healthcare institutions with fully operational CPRs. Even if these are available, the legal requirements for patient data protection have to be in place. These issues are formidable but not insurmountable. They can be resolved with time.
- Standardization issues, which are already challenging in health informatics, will have to be extended to cover bioinformatics. Already, the need to standardize bioinformatics concepts and representations are challenging, to say the least.

3. The Challenge from bioterrorism

Another promising area of research in health informatics has been spawned from the spectre of global terrorism. Following the September 11, 2001 tragedies in the USA and the spate of anthrax outbreaks there and elsewhere, there has been an urgent need to review current methods for disease surveillance [8]. 'Bioterrorism' has been defined by some as "the use or threat to use disease-spreading microorganisms or toxins as weapons for revenge, politics or support of a cause or the advancement of a criminal enterprise" [9,10]. From the epidemiological standpoint, bioterrorist acts can be overt or covert. Overt attacks such as deployment of chemical agents have immediate manifestations and can elicit immediate response from civil defence and military personnel. Biological attacks, on the other hand, are covert and will not be immediately manifested because of the incubation period between exposure and the onset of illness. Hence for covert bioterrorist attacks, the existing method of disease surveillance that relies on positive diagnoses of specific diseases will not be effective. Current research in "preventive bioterrorism" focuses on the use of syndromes i.e. signs and symptoms as possible early-warning alerts on the disease radar screen to detect possible covert acts of bioterrorism. The health informatics challenge, in this case, is to develop a wide area network of health information systems to achieve real-time reporting of prodromal (or warning) symptoms that are associated with serious infectious diseases.

One such project that has been submitted for research funding in Singapore involves the setting up of a sentinel network linking government polyclinics and participating general practice clinics. To be deployed over a

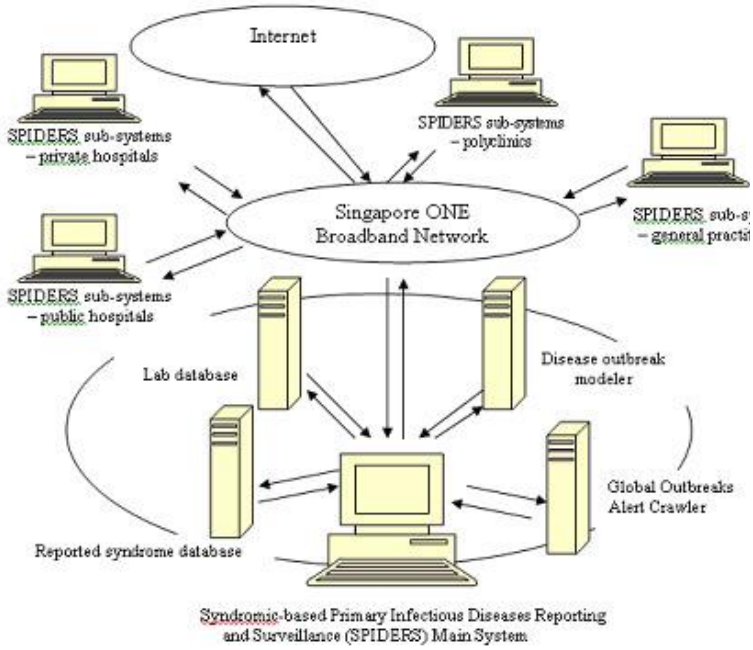

Fig. 2. Proposed Syndrome-based Primary Infectious Diseases Epidemiologic Reporting and Surveillance (SPIDERS) System.

secure, virtual private network using the Singapore ONE broad-band infrastructure as the supporting network backbone, the Syndromic-based Primary Infectious Diseases Epidemiologic Reporting System (SPIDERS) will be a web-based information system that (a) supports nation-wide, real-time reporting of syndromic data, (b) alerts on possible disease outbreaks based on historical experience or ongoing investigations, (c) provides geographical and statistical information on outbreaks, (d) deploys Web-based agents to track occurrences of disease outbreaks reported on the Internet and (e) links to Web-based information on epidemiological diseases, disease outbreaks and biological and chemical agents as weapons of destruction.

The heart of SPIDERS will be an inference engine that will employ data-mining and AI techniques to predict disease outbreaks based on incoming real-time syndromic data collected from the sentinel stations.

4. The Challenge from deployment of V.R. for tele-rehabilitation

The third promising area of health informatics research is to examine the use of telemedicine for home-based tele-rehabilitation of patients. The practice of telemedicine is not new. Recent publications on telemedicine have described the potential virtual reality (VR) technology may provide for treating patients with cognitive or psychological impairments [11,12,13]. Yet there has been few breakthroughs in the development of commercial telemedicine systems that deploy VR technology. The reasons are obvious. The side-effects from the use of virtual reality are already very challenging, even for normal persons. Spatial disorientation, nausea, loss of balance are common complaints. Thus, to deploy VR techniques in the rehabilitation of patients with cognitive deficiencies would be additionally challenging, especially when many of such patients are in the elderly age groups. In addition, the costs of the VR and ICT hardware, such as data gloves, motion and position sensors and high-end microcomputers with large memory, high-speed processors and graphics accelerators, have been barriers to the production of affordable commercial systems.

In Singapore, we have now found a solution to the problem of deploying VR techniques for remote tele-rehabilitation for cognitive and physical impairments. A dataglove is used to record finger/joint flexure of the patient's hand and a position tracking system records a patient's motor performance while manipulating 'real world' objects. The data is sent to the workstation of a remotely located therapist where a virtual reality application visually recreates the 'real world' task being performed by the patient. The therapist can view the scene from any possible position/ orientation, unlike a video which displays only one viewpoint. Storage of all data provides a complete record of patient progress and allows playback and detailed analysis. A video/voice link provides real time communication between the therapist and the remotely-located patient. Details of this work can be found in a research paper to be published [14].

5. Conclusion

The three areas of research that have been highlighted in this paper are just some of the emerging fields that build on the tools and techniques of health informatics. Once again, their multidisciplinary nature underpins health informatics as a discipline that addresses a very broad range of health and health care topics. Projects in biomedical informatics, for example, require health informaticians to collaborate with scientists working in

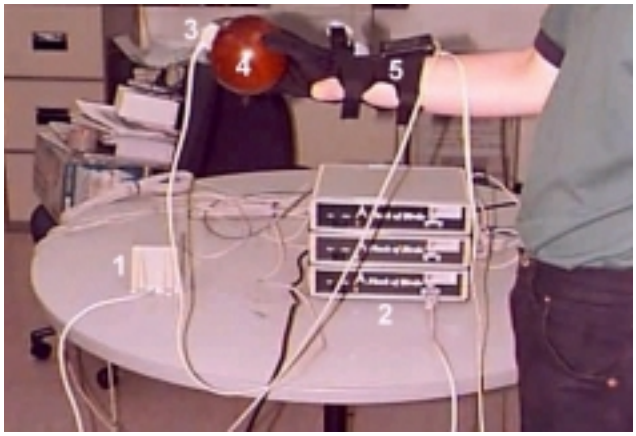

Fig. 3. Main components for motor performance monitoring with patient handling 'real world' object.

Fig. 4. Screen-shot from the therapist's application showing VR views.

basic biology, those in syndromic disease surveillance require collaboration with medical epidemiologists while those in remote tele-rehabilitation require input from rehabilitation therapists. Nevertheless, these projects fall within the domain of health informatics so long as, according to Haux [15], they "cover computational and informational aspects of processes and structures in medicine and health care".

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Address of the author:
K C Lun
Professor and Vice Dean (Academic)
School of Biological Sciences
Nanyang Technological University
Singapore
and
President, International Medical Informatics Association
School of Biological Sciences, NTU
1 Nanyang Walk, Block 5 Level 3
Singapore 637616
Tel: +65 67903726
Fax: +65 68968032
E-mail: kclun@ntu.edu.sg