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Biomedical Informatics and Computing: A Paradigm Shift

Ann Séror, MBA, Ph.D., eResearch Collaboratory, Quebec City, PQ, Canada
Email: annseror@eresearchcollaboratory.com

Abstract

The objective of this review is to consider how emerging computing paradigms will shape research and service delivery in medicine and the health sciences.[1] *Recent literature has recognized the critical roles of nanocomputing as well as large scale health information infrastructures to integrate genetics, proteomics and clinical medicine.* [2] *Particular focus is on the human body as a scientific laboratory and the contributions of quantitative and qualitative methodologies to research on individual medicine and public health.*

Research in medicine and the health sciences is in the process of a profound paradigm shift [3] - transformed by both large and small scale health information infrastructures. Large, system level infrastructures include the *computational grid* initiated in the 1990s and more recently, *cloud computing*. [4] The grid is defined as a distributed computing network providing direct access to computing power and software with "coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations". [5] Grid technologies and virtualization contribute to the development of cloud computing, offering access to infrastructure, platforms and software as services through resource leasing. Clouds, like computational grids, vary by ownership and access control in service markets.[6] While large scale grid and cloud computing infrastructures make vast scientific databases accessible,[4,7] nano- computing – including cellular and molecular computing devices - are creating sensor and effector capabilities for *in vivo* data collection, diagnostics, disease management and drug delivery.[8] These concurrent developments transform the relationship between computing and science. Not only is computing an increasingly critical component of science, but it is also changing the definition of the scientific laboratory.[9,10] as well as the design of research methodologies [11]for integration of multi-level studies.[12,13]

This paradigm shift at the system level of analysis is motivated by the ***conceptualization of the human body as model and laboratory for individualized medicine as well as public health.*** [14] *–with redefinition of boundaries among the human body and its extensions such as computer devices and networks.* [15] Consistent with Foucault, Levin and Solomon [14] identify six parameters for analysis of the body in the history of medicine: 1- abstraction-concreteness, 2- exteriority-interiority, 3- quality-causality, 4- state-process, 5- analysis-holism, 6- isolation-integration. Levin and Solomon suggest that *the human body is more than a biological organism, more than a physical substance – that it is also, in short, a discursive formation.* However, these authors have not explored the human body as an information system interconnected with a larger population and extended ecology. Sensor and effector technologies configured in a body area network (BAN) further redefine the human body within the a population ecology as an individually scalable laboratory. (Tissue analysis is restored to its individual context from Pasteur's laboratory.)

One of the consequences of this shift is ***reconsideration of validity in observational and case studies with respect to randomized controlled trials (RCT).***[13,16]and the statistical definition of certainty in quantitative analysis [17]

Figure 1: L. Laurent-Gsell. Pasteur's Laboratory. (circa 1885)
Photothèque des musées de la ville de Paris. Source : http://www.sb-roscoff.fr/CyCell/Page81.htm

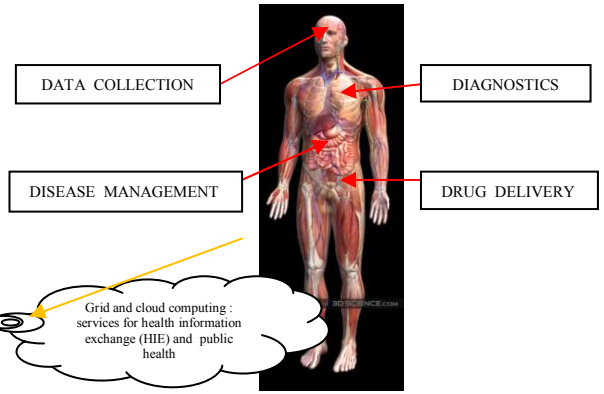

Figure 2 : Body Area Network : A Laboratory Paradigm.

This review concludes that very large as well as nano-scale health information infrastructures will be integrated to create individualized laboratories, diagnostics and treatment services as well as regional and global public health networks for data collection, analysis, surveillance, experimentation and simulation.

Without laboratories men of science are soldiers without arms.
- Louis Pasteur (1822-95)

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