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Management and Analysis of Biological and Clinical Data: How Computer Science May Support Biomedical and Clinical Research

Pierangelo Veltri[a]

[a]*Bioinformatics Laboratory Surgical and Medical Science Department*
University Magna Graecia of Catanzaro, Italy

Abstract

The use of computer based solutions for data management in biology and clinical science has contributed to improve life-quality and also to gather research results in shorter time. Indeed, new algorithms and high performance computation have been using in proteomics and genomics studies for curing chronic diseases (e.g.,, drug designing) as well as supporting clinicians both in diagnosis (e.g., images-based diagnosis) and patient curing (e.g., computer based information analysis on information gathered from patient).

In this paper we survey on examples of computer based techniques applied in both biology and clinical contexts. The reported applications are also results of experiences in real case applications at University Medical School of Catanzaro and also part of experiences of the National project Staywell SH 2.0 involving many research centers and companies aiming to study and improve citizen wellness.

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Keywords: EPR Electronic Patient Record; Data management; Informative System;

1. Introduction

Life science actors include clinicians, biologists, biomedical engineers, bioinformaticians and many other interested in life-science related topics, and of course patients and (more in general) citizens. Information related to life science includes disease protocols, treatments and rules for early disease detection. Recently, many governments are investing in largely diffusion of knowledge regarding health related topics, starting from making available records on chronic diseases treatments, protocols and results (follow up), trying to boost researchers in finding always more accurate and efficient strategies for chronic disease treatment. Having strategies for containment or prevention of diseases is one of the main targets for improving life quality and also to reduce huge costs related to health management. Making data available from health structures, following the direction of the Open Data paradigm, may allow the distribution of knowledge in terms of disease treatments or early detection; it has been proved that having early

* Corresponding author. Tel.: +39-0961-3694149 ; fax: +39-0961-3694092
E-mail address: veltri@unicz.it

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disease identification is often the best way to treat chronic or rare diseases. Governments play crucial role in trying to diffuse knowledge on disease treatments and drugs follow up.

Management of Health Care structures is focusing on appropriateness of care measurement by using computer based methodologies to model the whole process of admission, permanence hospitalization period, resignation and controls of patients, considering both clinical and economic aspects. This challenge is very relevant for health structures (both public and private ones), which must optimize services and monitor expenses in order to obtain refunds for the services offered to patients. Moreover, keeping expenses under control and making them more objective could make the financial distribution of resources among structures (or operative units) much easier, helping decision makers for resource planning. The requirements of using digital format for clinical information has been thus assuming not only the relevance of gathering improvements in quality of service and information diffusion and portability, but also in terms of economical monitor and flow analysis. The clinical infrastructure has to include thus patients and medical actors, as well as relevant information and their flows, such as invoices, employees turnover, dismissing documentations with performed studies, human and automatic procedures, diagnoses and clinical histories, patients moves and transfers among structures and so on. Information related to the aspects need to be appropriately and efficiently acquired, coded, processed, persisted, organized and retrieved. Such objectives could be achieved by using existing standards for data management and computer based information systems, i.e. systems for automatic management of information. It is also undoubtful that IC technologies improve the possibility of applying interventions for patient treatments and monitoring as well as reduce the time of disease detections. This can be simply proved both referencing to more and more accurate diagnostic techniques (e.g., image diagnostic) as well as accurate and high-performance patient status monitoring (e.g. Telemedicine and controls). By using digital and inter-operable systems it should be possible having benefits from both quality of services and cost savings.

We here focus on role of computer science based strategies for managing and querying life-science-related data, focusing on *omics* data and on information related to patient treatment. Indeed, today there is an always increasing necessity of managing and analyzing omics data to extra information useful for disease treatment and prevention (Cannataro et al 2007; Indolfi et al. 2009). Omics data includes genomics, proteomics, and interactomics, and respectively refer to the study of the genome, proteome and interactome of an organism. Omics data is also increasing due to the availability of novel, high-throughput platforms for the investigation of the cell machinery, such as mass spectrometry, microarray, next generation sequencing, that are producing an overwhelming amount of experimental omics data. The increased availability of omics data also poses new challenges for its integration and correlation with clinical information to improve procedures and processes in health informatics (PRIN Gendata2020).

Indeed, omics data produced by laboratories may be used for improving clinical procedures and patient treatments. In both cases, i.e. omics data management and clinical data management and integration, computer science techniques are required to efficiently: managing data, integrating data, querying data, and making available knowledge to main actors of life science.

The paper presents some experiences of applying computer based know-how on both omics and patient/citizen-oriented information management. We present experiences on omics data manipulation to extract (unveil) information from (i) mass spectrometry data, by using data manipulation techniques as well as time series based techniques; and from (ii) microRNA data by using ad hoc designed plug ins, and ontology based techniques (Cannataro et al 2007; Indolfi et al. 2009). Also, we present application of bioinformatics technologies for supporting clinicians while treating patients both in an (i) offline cases, allowing early disease detections as well as supporting diagnosis validations and (ii) on-line cases where injuries treatments can be improved by using computer aided techniques. An example in hemodynamic surgery room is reported. In the first case we discuss the advantages of using computer based solutions for monitoring and managing clinical data, as well as to support screening on large population. In the latter we discuss how computer science research may aid in studying solutions to support physicians (Amato et al. 2009; Guzzi et al 2010).

2. Experiences of software tools developed for patient-bed use

Here we report on experiences of software tools developed starting from requirements and necessities we gathered from University School Hospital. We started from a mechanism of control data flow related to requirements of patient flow control and report about an Electronic Patient Record system (EPR) for monitoring data in surgery room and