Education, Research and Professionalism in Health and Biomedical Informatics: Myths, Realities and Proposals for the Future

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Abstract

This article proposes a definition of the field of Health and Biomedical Informatics, in line with recent international developments. According to the authors, there are several myths or misconception concerning the future development of this scientific and professional discipline. We describe the current situation of Health and Biomedical Informatics at an international level, include specific analysis for the two countries where the authors have worked (Spain and Australia) and finally propose a series of recommendations to improve it.

All this analysis is carried out in three areas: education, research, and professionalism (characterisation and development of the profession). Defining the body of knowledge of the discipline itself is an initial step that must be made and taken as soon as possible.

Keywords

Education, research, professionalism, biomedical informatics, health informatics

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1 Introduction

Biomedical and Health Informatics (BMHI)[1] has been defined as "the scientific field that deals with biomedical information, data and knowledge – their storage, retrieval and optimal use for problem solving and decision making [1]."

Other definitions as in [2, 3, 4] and [5] emphasize even more the optimal use of information in the domain of biomedicine. For these authors, and this would be the approach taken in this text, informatics is the science of information. Information is defined as "data + meaning". Thus, biomedical informatics would be information science applied or studied in the context of biomedicine.

In several places, some people tend to associate the term "informatics" with any activity at any level that is related to the use of computers. In our opinion, this very general sense devalues the academic discipline and hinders the recognition of its professionals. Clearly defining Health and Biomedical Informatics is an essential step to allow progress on practical issues such as: education, research, development of a professional career or consolidating an international community.

A key feature of this definition is that if we accept that biomedical informaticians study biomedical information (data and its meaning), then, professionals of this discipline should understand the context or biomedical domain (biology, medicine, pharmacy, nursing ...). This is because in this area the relevant concepts (eg a gene, fibrosis) are very difficult to relate with formal representations. Bernstam et al. uses the example of a Bank to support this idea. In this domain, the "semantic gap" between the data (numbers) and associated information (account balances) is very limited, i.e. there is a fairly direct relationship between data and information. In biomedicine, on the contrary, this "semantic gap" is very pronounced. Biomedical data are not often directly associated with a concept and the complexity of human beings and the pro-

[1]We are taking this name because it has been used in the recently published article for educational recommendations from IMIA (International Medical Informatics Association). Reference: [6]

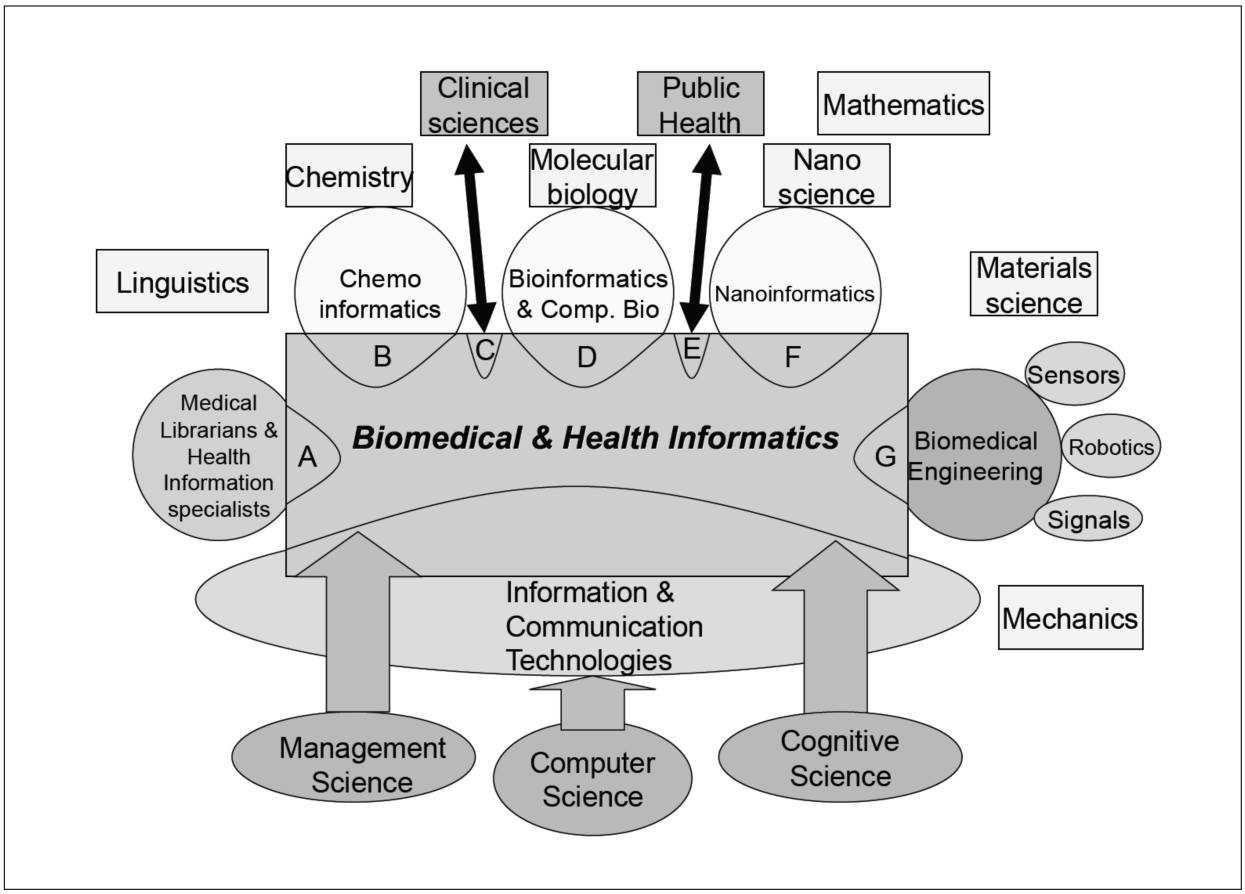

Figure 1: Disciplines overlapping with BMHI: A - Medical Information Science, B - Medical Chemoinformatics C – Medical (Clinical) informatics, D - Medical (translational) Bioinformatics, E - Public Health Informatics, F - Medical Nanoinformatics G - Devices and medical image processing.

cesses involved in biomedicine are not easily reducible to computer systems and conventional data processing. According to [2], humans can be considered as "systems" that have developed by evolution, and this makes its subsystems (organs) difficult to separate. This makes two individuals react differently to the same events (a drug), as opposed to other systems, like an airplane. Although very complex, airplanes respond to a design, so the parts are separable and respond equivalently to the environment.

This definition allows BMHI to be distinguished from other sometimes overlapping disciplines. Biomedical engineering, for example, tries to solve biomedical problems using engineering methods. Although these solutions may include, in some cases, the development of computer programs, the focus is on the problem to be solved, and not on specific aspects of data representation or information processing.

It is true that health and biomedical informatics do not yet have their own professional identity. The field is very heterogeneous. The same can be said of the profiles of people working in this field. It is also a multidisciplinary field with multiple areas of overlap with other disciplines, as shown in Figure 1, originally published in the educational recommendations of IMIA [7].

However, there is a body of knowledge in the BMHI discipline itself, which must be known to practitioners. Defining this body of knowledge can contribute to the establishment of educational programs at various levels (Master, PhD) to train the future professionals. It is also necessary to know in order to undertake tasks and participate in and promote innovative research projects. Finally, it would advance the professionalism, understood as the development of a profession with its own entrance requirements, competencies, certification, code of ethics or professional career. This idea is graphically represented in Figure 2.

Although it is not the aim of this paper and is beyond its scope to develop, an indication of the body of knowledge characteristics of BMHI should be provided. Since the emphasis is on data processing and on the generation of meaning in the domain of biomedicine, the key aspects to consider are related to the design and development of theories, models and methods to solve problems related to information architecture, retrieval, performance or analysis. Obviously, with the progress of the different health technologies (imaging, laboratory, medical records) in recent decades, the amount of data to handle is so large that Information and Communication Technology plays an im-

portant role in supporting these processes of information. We must emphasize again that it is the information and not the underlying technologies which represent the primary focus of BMHI.

Returning to the body of knowledge characteristic of BMHI, its aim is knowing what information is needed and how it can be managed to solve a particular problem in biomedicine. From this perspective, all aspects of databases (to store and retrieve data), algorithms (data processing), artificial intelligence (to generate meaning from data and existing data), ontologies (to represent and integrate data), visualization techniques (presenting data and information generated) or aspects of usability (human factors relevant to access to information) clearly represent core components of the body of knowledge and abilities of BMHI. In the biomedical context, this can be related to digital health records, clinical documentation, decision making support, interpretation of medical images and signals, etc. It is also important to study the history of the discipline, which dates back to more than 60 years; the successes and failures, their schools of thought, institutions, and main experts and leaders in the field. Only from the study of these can we avoid "reinventing the wheel" and making mistakes that have been previously made. We will be able to follow the experience of "success stories" and the methods that have proven useful in the international context.

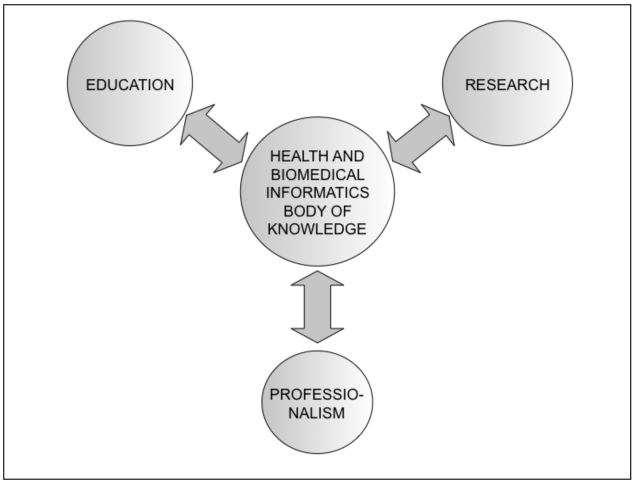

Figure 2: The definition of BMHI body of knowledge can advance issues related to education, research and development of the profession.

Some authors have even proposed sub-disciplines within BMHI. This depends on the specific domain in which data is handled and its meaning. For instance, bioinformatics (data from molecular and cellular level) [8], medical Imaging (tissues and organs level), clinical or medical Informatics (patients individual data), public health informatics (population-level data) [9] or the nascent nanoinformatics (submolecular or atomic level). Some BMHI education programs are based on this definition [10, 11].

2 Myths in Research and Education in Health and Biomedical Informatics

A myth is defined as "a set of beliefs and idealized images that are formed around a phenomenon and become a model or prototype". When analyzing the status of Education and Research in BMHI, and compared with the situation in other fields, there are clear differences and it is likely that the following myths or misconceptions are at the basis of some existing problems. Below, we discuss these myths, which, though seemingly innocent, are hindering the development of the discipline and thus should be discussed and answered.

Myth 1. Health and Biomedical Informatics is just the community resulting from the sum of the informaticians, plus physicians, plus pharmacists, plus nurses, plus other health professionals...

This idea denies the existence and the need to know the specific body of knowledge of the BMHI discipline itself. A corollary of this myth would be then that specific *education* in the area would not be needed. However, it is well established in many countries that a professional group trained specifically in BMHI is increasingly necessary, although there are different training routes to access this education.

Myth 2. Health and Biomedical Informatics does not involve research, it is just developing or adapting tools.

This way of thinking hinders the consideration of BMHI as a scientific discipline. There is a tendency for those responsible for implementing systems in health centers to regard all information systems as "commodities" that can simply be bought off the market and implemented. This may be true in some cases of hardware or communications systems, but systems should be much closer to the specific needs of a clinical service or a Research Unit. This myth also represents a barrier to the development of *research* projects by experts in BMHI. This requires innovative solutions to be explored, and collaboration with clinicians and biomedical researchers.

Myth 3. Developing information technology projects in this environment is similar to other fields of activity (banking, insurance,...)

By this criterion, any informatician, without experience in the biomedical and health domain, would be able to direct and lead BMHI projects. This myth, in our opinion, is at the basis of some of the projects that have not succeeded. This is due to a lack of understanding and communication difficulties between informaticians and clinicians. The *development of the profession* of BMHI would accredit professionals who have the skills to lead

these projects, with specific knowledge domain and ability to communicate effectively with both technologists and the clinicians.

So we could summarize our common position against these myths as it follows: BMHI is informatics, as such, BMHI needs the knowledge of informatics. But also since it is applied to health and biomedicine its practitioners should have a good knowledge of the concepts that apply to biomedicine and also about the organization of healthcare. Research in this field enriches the specific body of knowledge of the discipline and contributes to advance innovation in response to specific needs. Without knowledge of and experience in biomedicine informaticians may fail in BMHI projects.

3 Current Status of Health and Biomedical Informatics internationally

3.1 Education

A thorough review of the many educational programs that are provided internationally at different levels (undergraduate, postgraduate, continuing medical education) is required. This section highlights some references that should be taken into account.

With regards to the education of professionals in BMHI, it must be stated that the National Institutes of Health (NIH) of USA are financing, for more than 20 years, different graduate programs (Master and PhD) in Biomedical Informatics. These programs are offered at the most prestigious universities across the country (the number can vary from year to year, but usually close to 20). Similar programs exist in Germany, UK, Ireland, Canada and Norway, among others. It must also be pointed out that the Hospital Italiano de Buenos Aires (HIBA), has a program of residency in Biomedical Informatics.

The U.S. Department of Health has recently awarded grants totaling $144 million U.S. for training human resources and research in Health Informatics. This program is included in the framework of the "American Recovery and Reinvestment Act" (ARRA), which spend U.S. $2,000 million to promote the meaningful use of digital patient medical records in the U.S. Of these 144 million, 84 million was allocated to universities and consortia of "colleges" with the goal of training 50,000 new professionals in health informatics in the coming years.

There are also many examples in which undergraduate education of health professionals (e.g. medicine) includes a core subject and linking one or more subjects with BMHI. The aim is to equip the future health with the skills for basic biomedical information management [12].

Regarding Continuing Education in Informatics, health professionals should give importance to the AMIA 10x10 program of the American Medical Informatics Association[2], which aims to train 10,000 people through mixed courses (face-on line) about 10 weeks duration and are taught in collaboration with leading universities and hospitals in the U.S. [13, 14]. HIBA has developed a Spanish version of the course AMIA 10x10, at the University of Oregon, and has already run it several times with great success [15].

3.2 Research

The European Commission, through its Programme - ICT for Health has been funding research in areas related to BMHI for over 20 years. The V Framework Programme (2001) began to define a specific area known as BMHI, which has had its development in the Sixth Framework Programme (2003-2007), mobilizing more than 100 million Euros. Currently, during the Seventh Framework Programme, the projects included in the VPH Program (Virtual Physiological Human) continue to develop aspects of biomedical informatics.

In the U.S., the NIH Roadmap, which marks its priority areas of research includes computational biomedicine and the programs developed by the NIH included the creation of 7 NCBCs (National Centers for Biomedical Computing) and 60 CTSA (Clinical and Translational Research Awards). The former are engaged in research in BMHI, while the latter are entities that perform clinical trials, but must include at least one group with expertise in BMHI.

Of the $144 million provided for the Health Informatics program by the U.S., government via the ARR Act, 60 million was allocated to four research projects that address strategic issues for the development of this area: security, decision support decisions of patients and clinicians, secondary use of medical records and network infrastructure and application architectures.

3.3 Professionalism

In addition to the significant efforts being undertaken by the British National Health Service (NHS) and other scientific societies, such as COACH (Canada Health Informatics Association)[16] to advance the characterization of the profession of BMHI and the establishment of a career, with different access requirements and promotion, we should also point out here the recent advances achieved by AMIA for the standardization of educational programs and professional certification. AMIA has now been accepted in the Council of Medical Societies of America and is currently immersed in an ambitious project to

[2] American Medical Informatics Association. AMIA 10x10 program. Available at: http://www.amia.org /education /10x10-courses. Date Accessed: June 2011

ensure that clinical informatics is recognized as a medical subspecialty, which could be accessed from any major medical specialty. The specialty which has agreed to pilot the process is the one on Preventive Medicine and Public Health. AMIA estimates that the project will be completed by 2013, including the creation of a "Council" of examiners who will certify the adequacy of educational programs and two access routes to the subspecialty based professional practice or in education [17].

4 Current Situation of Education and Research in Health and Biomedical Informatics in Spain

4.1 Education

The situation can clearly be improved. At present, the university is not generating the profile of graduates required by companies and institutions in the sector. At the graduate level, very few educational programs are related to BMHI. There are some studies that offer a Master in Bioinformatics or in Biomedical Engineering, but not with the BMHI approach explained in the introduction of this article.

At the undergraduate level the study recently carried out by the COMBIOMED Research Network (http://combiomed.isciii.es) and the Spanish Health Informatics Society (http://www.seis.es) showed that there are enormous needs at the Spanish medical schools (including those newly created) in terms of training future doctors in skills and knowledge for managing information. Core subjects hardly exist in BMHI and in some cases, if offered, are optional, and deliver content on very basic office applications and literature searches. There are some honorable exceptions, such as in Barcelona. Universities like UB or UPF include core subjects of BMHI in the degree program. However, it is especially worrying that most new medical schools do not adequately address these needs, which have been recognized by both the White Paper of Medicine, coordinated by ANECA, and the leading international associations of medical education [12].

With regard to the third domain of education in BMHI, the continuous education of professionals, the situation is not very positive. There are few on-line training programs and very few initiatives of classroom training.

4.2 Research

The situation in Spain with regards to research on BMHI, measured in terms of classical, internationally accepted indicators (number of communications to international conferences, number of publications in peer-reviewed scientific journals, return on research projects funded by the Commission Union), could be defined as paradoxical. This adjective refers to the fact that there are very few groups (low quantity), although they are very competitive at an international level (high quality). One might therefore ask whether the level reached in the international arena is due to personal efforts rather than well-founded political support. One might also ask what the sustainability of these few groups with international projection is.

Another worrying indicator is the fact that Spain is one of the few countries in Europe that has not hosted any major international conference in BMHI (MEDINFO or MIE).

Finally, we must say that the involvement of IT staff from Spanish medical centers in research projects and presenting results at conferences or international journals is almost anecdotal, again with some honorable exceptions such as, Coruna or Granada.

4.3 Professionalism

Practically no steps have been taken towards the recognition of the profession of BMHI in Spain. A generally well-informed discussion on these points has not yet taken place. Currently we can only mention the actions by some regional health services, involving the creation of specific professional scales (at various levels).

5 Current Situation of Education and Research in Health and Biomedical Informatics in Australia

5.1 Education

In the past decade, the trend has been for Australian undergraduate and postgraduate health informatics degrees to close due to lack of demand. Currently there are around 10 university providers of BMHI degrees, including majors in information technology or information systems degrees [18]. In addition, diverse elective subjects are offered in a number of undergraduate and postgraduate degrees in ICT and in health sciences at many universities; this activity is very changeable and efforts to map it are difficult. Offering short courses for continuing professional development is increasingly of interest to professional associations and Registered Training Organisations (RTOs), both public and private, in the vocational education and training (VET) sector. International providers are able to meet the needs of some Australians, either through intensive programs requiring block attendance offshore, or through open and distance learning.

Some clinical health professional organisations in Australia have developed competency statements for general practice [19] and nursing [20], for example – although it is not clear how these are being implemented or audited in accredited curricula. A national project funded by the Australian Learning and Teaching Council is encouraging

the development of ehealth capability in students who are enrolled in entry-level clinical health professional degrees: http://clinicalinformaticseducation.pbworks.com.

There is as yet no Australian national framework for accrediting health informatics curricula. However a national Australasian Health Informatics Education Council [21] has been formed to advance this, under the auspices of the Australasian College of Health Informatics (ACHI), the Health Informatics Society of Australia (HISA), Health Level 7 (HL7) Australia, the Health Information Management Association of Australia (HIMAA) and the Australian Computer Society (ACS), with Commonwealth government observers.

5.2 Research

The Commonwealth government research body CSIRO supports the Australian eHealth Research Centre [22]. Several Australian universities have academic research units in health informatics and related fields, for example:

- Bond University http://www.bond.edu.au/research/research-at-bond/university-research-centres/centre-for-health-informatics/
- Deakin University http://www.deakin.edu.au/buslaw/infosys/research/healthinfo/
- Edith Cowan University http://www.ecu.edu.au/faculties/computing-health-and-science/research-activity/research-centres/ehealth-research-group
- Monash University http://www.mihsr.monash.org/e-health/
- University of Melbourne http://www .healthinformatics.unimelb.edu.au/
- University of New South Wales http://www.chi.unsw.edu.au/
- University of Queensland http://www.uq.edu.au/coh/

A study of Australian health informatics publications in PubMed 1970-2005 showed a consistent increase in line with world trends [23]. National competitive grant funding for health informatics research in Australia has increased from $300 000 to $8 million during the period 2000-2010 [24].

5.3 Professionalism

A recent study of the Australian health informatics workforce [25] concluded that there are over 10,000 people in this workforce now, many with non-formal education or none in health informatics, and that this number represents a workforce shortage in some settings and a prospective shortfall in others. Concerns about the supply of expert informaticians are becoming more acute as Australia proceeds to implement system-wide health and ehealth reforms nationally [26, 27].

The only national process for gaining professional credentials as a health informatician is to apply for full membership or fellowship of the Australasian College of Health Informatics [28].

6 Proposals for the Development of Education and Research in Biomedical Informatics and Health

6.1 Education

As we have seen, we can distinguish at least three different levels with regard to education in Health and Biomedical Informatics. Each of them should initiate efforts to better prepare current and future professionals:

- Knowledge of biomedical informatics, needs to spread and be explained to to all the medical schools and other health careers.
- Training Specialists in Biomedical Informatics (graduate programs such as Masters, Ph.D., Residency). It should follow the recommendations published by IMIA (International Medical Informatics Association).
- Continuing Medical Education of professionals. It could be done adapting the AMIA 10x10 program model of the American Medical Informatics Association)

Also we should pay special attention to innovative teaching methods that are being applied successfully in this field such as workshops, summer schools, online resources, Web 2.0, multidisciplinary working groups, problem-solving oriented training [29, 30, 31].

6.2 Research

Some actions that could be considered are:

- Designing training modules and specific research methodology for professional BMHI.
- Urging more attention to be paid to this discipline by research funding agencies, trying to ensure their presence in the Research & Development plans.
- Creating awareness in CIOs of hospitals on the importance of leading activities and participating in research projects.

6.3 Professionalism

To follow the path already undertaken by British or American colleagues, it would be necessary to create a working group to analyze the possibility of Biomedical and Health Informatics being recognised as a profession. You might even think of creating a model program RMI "Resident Medical Informatician." This involves talks with the ministries of health and education and contacts with the Board of Medical Specialties. However, the road to be traveled to make this a feasible possibility is very long. To cite one example, AMIA has had to demonstrate to the Board of Medical Specialties U.S. that they could meet a number of requirements for assessing the application. Among them were: having a code of ethics, having a body of peer-reviewed scientific communication (the magazine JAMIA), educational programs, rules, definitions of competencies, establishing a Scientific Society (AMIA) that runs annual meetings catering to a professional population of sufficient size and have an "Academy" ("American College of Medical Informatics").

7 Disclaimer

The opinions expressed in this article are the sole responsibility of their authors and should not be associated with the institutions with which they are linked.

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