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Evolution of Interdisciplinarity in Medical Informatics in Europe: Patterns from Intertwining Histories

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Abstract. The IMIA History project book we are co-editing with colleagues from the IMIA History Working Group includes histories of early contributions to medical and healthcare informatics, as described by a sample of pioneers and experts, detailing how their own ideas developed from their work on various topics in the field at the beginnings of their contributions to the field. Its contents serve as a preliminary guide for meta-analyses of how the different contributors state their personal interdisciplinary origins from today's perspectives. In this short article we provide a brief preview of how an analysis of disciplinary characteristics from individual histories can begin to shed light on processes of interdisciplinary evolution of medical informatics in Europe.

Keywords. Interdisciplinarity, History, Medical and Healthcare Informatics

1. Introduction

The history of science illustrates how the development of different disciplines and domains of study has almost invariably given rise to various "boundary sciences" or interdisciplinary fields in order to deal with problems through new approaches that draw from methods and threads of inquiry and experimentation from several existing disciplines. Such inter-weavings usually prove to be quite productive, yielding interesting new scientific discoveries or important technological and practical advances. A web of inter-relations between various domains frequently takes place, revealing sometimes-unforeseen links between apparently unrelated fields.

Usually, the very name of a new interdisciplinary domain tells us about its origin, specifying the "parent domains" whose intersection or blending has created the new discipline, as in biochemistry, psychopharmacology, and bioinformatics, among many others. This is also the case with medical informatics, which results from the intersection and interweaving of two very large fields of practice and study – medicine (relying on the biomedical and life sciences applied to healthcare) and informatics (relying on computer and mathematical sciences applied to information technology). Its name

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reflects its nature as an interdisciplinary field, or, as van Bemmel stated: “medical informatics is interdisciplinary *avant-la lettre*” [1].

Studies on interdisciplinarity analyze various aspects of the links between concepts, knowledge and data structures or methods involved in the rise of a new domain. Such meta-analyses require a study and insight into the origins of the connections, which are not always presented clearly enough in the literature largely produced by authors from the existing disciplines. An incursion into a domain's history can cast some rays of light, revealing the roots of subsequent studies, which had strong follow-up and became substantive subfields of the new field.

2. Materials and Methods

We have recently carried out such a study, examining the roots of interdisciplinarity in medical informatics [3,4], based on 54 stories from European scientists who started their careers before 1980, or the early stage in medical informatics history, and which has been called its “pioneering period” [5]. The breakdown by length of experience in the field as measured from their year of university graduation consisted of 14 from 1960 and earlier, 20 from the 1961-1970 period, and 20 from 1970 to 1980. By gender, 48 were male and 6 were female.

We were interested in analyzing this date to uncover relations between the first professional background discipline of a pioneering investigator, through their professional affiliation, type of occupation or professional milieu within which the early medical informatics topics were approached (academic/university, healthcare organization, industry, other institution) and the medical informatics topics or approaches, both initial and subsequently developed.

3. Results

3.1. Professional Origins

Our study showed that 48 or about 81% of this sample of European pioneers in medical informatics had some kind of background involving technology or the exact sciences while 27 or 50% had backgrounds in medicine or the life sciences; with an overlap of 30% representing those who had a double specialization. Among the scientific or technical backgrounds, the most common were mathematics/statistics (19 persons), physics (13 total, but 10 of whom also had mathematics/statistics backgrounds also) and engineering (14 of which 7 involved computer science) but also chemistry/biochemistry (4) and biophysics (4). The biomedical profiles were predominantly in traditional medical specialties (20), while other fields included nursing (2), public health/epidemiology (2), dentistry (1) and psychology (1).

A obvious question that arises from this distribution of backgrounds is: “why is there such a high percentage of those coming from scientific and technical fields?” One might speculate that this might arise from an asymmetry that is observed in most interdisciplinary domains, including medical informatics, where one field provides the object of study (in this case biomedicine), while the others provide methods of analysis and interpretation (informatics). It has often been observed that those working in information technology as researchers and scientists were able to foresee the great potential of computing technologies for various applications before the application-domain specialists come to fully realize and embrace it. The altruistic goals of medicine and nursing, and the desire to uncover the mysteries of life have led to a proliferation of several interdisciplinary fields, including medical informatics. Multidisciplinary teams have arisen, bringing together specialists from various fields trying to solve the complex problems that cross the boundaries between the more formal analytic disciplines, new technologies, and the field of medical and healthcare practices. But, to support effective collaboration and integration, specialization in a single domain is rarely enough. It is not a surprise that many researchers have felt the need for a double specialization. This has happened in both directions – medical and healthcare practitioners involving themselves in informatics and/or mathematics/statistics, while mathematicians, statisticians, engineers and computer scientists have in turn focused on biomedicine.

3.2. Occupational Backgrounds and Experiences

Most early medical informatics practitioners in our European sample (over 75%) were mainly academics who started their work within various departments of universities, with over 20% of them being from university hospitals; while others came from industry, non-academic hospitals or public health or research units.

It is interesting to note that we have found a large number (over 25%) involved in governmental activities or pan-European organizations. Indeed, the potential of information technology to be part of the process of improving healthcare activities often appear to have drawn the attention of official or governmental institutions (ministries or other healthcare authorities) from the earliest days of medical informatics.

The most frequent research activities involved coordinating or participating in various projects or acting as experts. Given the preponderance of academic affiliations, education and training was omnipresent, contributing significantly to the development of the field.

3.3. Subfields and Topics

One of the most interesting aspects of this first overview study drawing on histories of how experts developed their interests and contributions to the field has to do with the evolution of key problems addressed or topics defined: how the ideas evolved, what challenges presented themselves, and how they were overcome. Such inquiries are important since they better disclose the essence of those connections which motivate and build the effective interdependences and webs of interdisciplinarity. One can understand interdisciplinarity more fully as going beyond being just the passive application of methods from one field in a study to answer a direct question about some concept or object from another field. A simple statistical analysis of some clinical data can hardly be considered an interdisciplinary study. The substance of interdisciplinarity is a bilateral relationship between people from different disciplines who actively work together to ask new types of questions, with the goal of uncovering new features of a subject or object of study which can drive the development of new methods in order to reach a deeper understanding of the phenomenon being investigated. Such an approach was highlighted earlier by van Bemmel in his detailed personal story [6], tracing the evolution of ideas in medical informatics as they changed over the course of his career.

In the present overview we use the four research challenge subfields or areas in medical informatics proposed by Kuhn et al. [6]: bioinformatics and systems biology, biomedical engineering and informatics, health informatics and individual healthcare, and public health informatics. As expected, since studies on bioinformatics and systems biology had barely started during the pre-1980 pioneering period we are examining, they represented only 5% in our sample, while studies on health informatics and individual healthcare are most plentiful, representing almost 45% of the total during this period. Studies in biomedical engineering and those on public health informatics had almost equal shares of approximately 25%., representing the disciplines that existed before informatics came to be defined as a separate field in its own right.

As discussed by Altman and colleagues recently [8], these subfields or areas of medical informatics interconnect at several levels and it is sometimes difficult to place studies in one specific group vs. another; so we have developed a number of criteria in order to do so, as discussed in more in detail in [3]. A better overall picture can be obtained by using a more granular, or refined breakdown of the areas or topics of study. The most frequently covered major topic out of a total of 65 was health information systems (28, or almost 20%), of which 14, or half, dealt with hospital information systems, with the others being clinical/laboratory or national information systems, The topic of data bases, most often associated with data processing or statistical analyses accounted for 15%, decision support systems including expert systems, AI and ontologies accounted for 10%, while electronic health records were the topic of another 10%. Remaining topics involved security and protection, standards and technological assessment, processing biological signals, medical imaging, modeling and simulation of pharmacological or biophysical phenomena, healthcare management and organizational impact, ethical issues and qualitative assessment studies, nursing informatics, clinical guidelines and telemedicine. Each were covered by a relatively small percentage of the persons involved in this sample from the early period of medical informatics research in Europe.

4. Discussion

Our study is preliminary, yielding just initial quantitative results, which, nevertheless point to how we can proceed with further more detailed follow-up studies. An important consideration is that personal narratives in free style do not lend themselves to the extraction of very precise data. Secondly, the professional backgrounds considered are very general and based on academic degrees or specializations, which does not characterize the important group of self-taught people, especially those who were self-instructed in the use of computers, which makes actual numbers of those with double specializations likely to be even higher than what is reported here. Since the boundaries between topics are not crisply defined; with some types of investigations distributed over several topics, the assignment of a study to a topic is not straightforward. Nevertheless, despite these limitations, the overall results are already quite suggestive about the patterns of backgrounds and interests of individuals, and their intertwinings, and correspond to the experiences of the authors in what they have observed over the years.

Some topics have persisted over time, remaining most relevant, or “hot”, either due to their generality, complexity and potential impact (artificial intelligence applications, the digital patient) or strongly determined by “external factors” (large healthcare information systems, requiring socio-economic and political involvement), or both (EHR systems). Some topics have faded – such as biological signal analysis, where research has mostly migrated to specialized biomedical disciplines, or, once mature, to industrial/commercial development. Beyond the period covered by this analysis, totally new topics have arisen – having mostly to do with the internet, social media, privacy and security, patient empowerment, big data and, most recently, data science. These, while building on earlier methodologies and studies of the social impact of computers and information, have to confront completely new challenges of scale, complexity, and density of interactions in the evolving human-machine ecologies of today.

5. Conclusion

We can see from the histories or essays submitted to the IMIA history book that they give the reader selected glimpses of individual professional studies, investigations, and practices, which, taken together, allows us to begin to begin to discern a map for tracing the ideas and practices of medical informatics history. A thorough analysis of the stories specific to various periods in medical informatics history, which will require careful definition and study, would yield a dynamic map representing "medical informatics in evolution" – a necessary enterprise which looks forward to more complete investigations and the involvement of new generations of biomedical and health informatics professionals.

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