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The Future of Biomedical Informatics: A Perspective from Academia

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Abstract. Academic biomedical informatics has achieved great successes through research contributions over several decades, now reflected in a thriving commercial marketplace for electronic health records and other informatics tools. That very success, coupled with changes in the ability of governments to support research at past levels, is forcing a reconsideration of the directions and emphases for faculty members in informatics academic units. This paper discusses those forces and proposes areas of emphasis that will strengthen the academic discipline as it evolves in the years ahead. The focus is on the role of academic informaticians as practitioners of informatics, as researchers, and as educators.

Keywords. Biomedical informatics, academic research, informatics education, clinical practice of informatics

Introduction

Those of us who have spent decades working and studying as informaticians may be lulled into believing that this "young discipline" is still stretching its legs and learning to walk. The events of the last decade make it clear, however, that our field has matured substantially, marked both by the aging and, alas, the retirement of many of the individuals who pioneered informatics research (and applications) in their youth, and also by the greater acceptance and economic importance of the systems and methods that we have developed in the last half century. Work that began largely in academic laboratories and university hospitals has now nurtured a health information technology (HIT) industry that has grown remarkably and is influencing healthcare systems, institutions, governments, and health policy makers globally.

The growing maturity of the field and the establishment of a prosperous industry are forcing the academic informatics units to rethink their roles and priorities as our discipline anticipates future directions and opportunities. In this paper I will briefly summarize some of the resulting questions, the tensions that exist, and the priorities for academic informaticians as we look to the future. I will argue that the future is bright, but that our successes will be dependent on our ability to understand the evolution of academic informatics and to reinvent ourselves accordingly.

For purposes of this discussion I will refer to our discipline as "biomedical informatics" (BMI)—increasingly the accepted name for the core science. I fully recognize, however, that there are disciplinary, regional, and international differences in the terminology that people choose to use. Thus the discussion here should be viewed as equally relevant for "health informatics" (applied informatics research and practice in the clinical setting and in population health), "medical informatics" (the former name for BMI, but increasingly being used to emphasize applied patient-care

and disease-oriented informatics, with a focus on physicians), and "bioinformatics" (the application of BMI in areas of molecular biology and genomics/proteomics). The predominant view of these terms in the US, with a definition of BMI and the interrelationships among the subfields, was recently published by AMIA in the *Journal of the American Medical Informatics Association* [1].

1. The evolution of academic informatics

Academic units in informatics have always been distinctive when compared with either engineering or clinical departments in universities. The first ones began in the late 1960s, generally in medical schools, and usually with highly applied motives that drove the basic research agendas of their faculty members. Many of the early innovators were clinicians, often self-taught in computer science, who were driven by a desire to address needs and problems that they observed in the healthcare setting. Many built clinical systems for use in their institutional hospitals or clinics, leveraging existing methods from the computing industry while attracting research funds to tackle the novel problems they encountered in health care.

Although many units developed close ties with their affiliated computer science departments or engineering schools, they tended to maintain a primary home in the biomedical and health setting and adopted much of the culture of academic medicine. Other health science faculty members were often puzzled by these informatics entities, unsure what kind of research they performed and what it meant for an informatics scholar to develop "new knowledge"–the currency of academic prestige and promotion in such settings. Yet the informaticians clearly had expertise that was needed and they built systems that addressed important clinical and health problems. Furthermore, they tended to bring in grant funding that helped the school and its reputation, and some also worked as clinicians and were recognized as colleagues for that work as well.

By the year 2000, roughly 25% of US medical schools had established formal academic units in BMI, either as divisions within departments, as full-fledged departments, or as research centers. There was similar growth in the number of academic programs in Europe. Most focused their educational activities on graduate students, although a few schools were successful in achieving early forays into the medical school curricula. Nursing schools had been much more successful in incorporating informatics into their nursing curricula. Faculty members tended to have formal training in informatics or computer science, often with PhDs or other doctorates. Graduates of the programs were finding a growing market for their skills, both in newly formed academic programs and in industry.

Many of the academic programs combined research and education with significant responsibilities for building, implementing, maintaining, and enhancing the clinical systems in their academic health center (the "practice" of informatics). Thus we have tended to see informatics units adopt the traditional "3-legged" set of responsibilities for academic medicine: research, education, and practice. In the larger departments, faculty members often differentiated to emphasize one of these three areas, although all members generally maintained some role in education and training.

During the last decade, however, several major changes have occurred. First, the institutional willingness to create new academic BMI programs has increased, with several departments or divisions being formed every year–seriously straining the ability of the other programs to produce the graduates who can fill the faculty positions that

are now available. At least two forces have generated this demand for new programs: (1) a growing realization that life-science and clinical research increasingly depends on the availability of talented and effective informatics collaborators given the data/knowledge-management imperatives and the analytical challenges in an era of increasingly "big data" from both genomic and clinical sources; and (2) a growing awareness that informatics scientists are dealing with issues that are intrinsic to the future of both biomedical research and clinical practice. Indeed, some institutional leaders have openly opined that their school's research funding base could be eroded if they fail to take informatics more seriously as a key component of their scholarly portfolio.

But there have been myriad other changes affecting informatics in the last decade as well. The burgeoning commitment to HIT, by governments and healthcare institutions, stands as testimony to the effectiveness of past informatics research, now implemented in commercial products, with a resulting influence on patients, healthy individuals, and national economies. With the growth and acceptance of the industry, institutions are turning to new vendor-supplied electronic health record (EHR) and computerized provider-order-entry (CPOE) systems, leading to the gradual disappearance of locally built systems in the academic health centers. This has influenced the role of the practitioners in the academic informatics units, since they now are more likely to be involved in implementing or maintaining/enhancing a commercial product than in building and installing systems that result from the research projects in their own unit.

Another change in the last decade has been growth in the public awareness of health information management issues and challenges, and especially societal concerns about individual privacy and the confidentiality of personal health data. No longer is the work of informaticians and the HIT industry invisible to the public; they see the systems, they hear about the cost and privacy issues, and they also increasingly experience the personal use of the technology through patient portals into EHR systems. It is accordingly now easier for informaticians to explain what they do when chatting with neighbors!

2. Looking to the Future

What, then, are the implications for academic informatics as it continues to evolve? We can begin to anticipate the kinds of changes that are likely, and potentially necessary, based on current trends and incompatibilities between the historical positioning of our programs and what is likely to occur in the future.

I will assess that future along the three principal dimensions that have defined the professional activities of informaticians in academic settings: practice, research, and education.

2.1. The practice of informatics

Many people who work in the informatics field are motivated and rewarded by the implementation and maintenance of working systems that change the landscape positively for both clinicians and patients. When these individuals work in academic units, they correspond to clinical faculty in traditional medical school departments,

being assessed by their practice expertise and their ability to teach and to serve as role models for students with similar professional aspirations.

Although institutions are continuing to reach out to their informatics faculty to provide necessary expertise in clinical practice settings, it is increasingly uncommon for such faculty to work with systems that they or their colleagues built themselves. Many complain about the unwillingness of the vendor who supplies their systems to "open them up" for integration of research products coming from the academic side. It remains to be seen whether new architectures will arise that change this trend, which is heavily entrenched [2]. Furthermore, the major HIT vendors place heavy emphasis on product development and sales/implementation, and they tend not to support research laboratories of the sort we have come to expect from the major computer software vendors, such as IBM, Microsoft, HP, Google, and, historically in the US, the Bell telephone system (Bell Labs).

Thus academic informaticians who work as practitioners are increasingly serving as knowledgeable implementers and maintainers of vendor-supplied systems over whose design and features they have little control. They may provide security/privacy expertise, business intelligence oversight, or assistance with standards and vocabulary systems. They may even serve as their institutional chief medical information officer (CMIO) or chief nursing information officer (CNIO). But the systems they support are no longer their own, as they often were in the early days of our field.

I accordingly believe that the role of the academic informatician as an innovative informatics practitioner will be limited in the years to come. The graduates of our educational programs will often seek careers in such clinical environments, and we will continue to need practitioners to serve as adjunct faculty who teach our students and serve as role models for those whose career aspirations are in the practice arena. However, the research and scholarly outlets for faculty members in practice settings will be severely constrained, focusing largely on evaluations or on small incremental system improvements that are implemented within the constraints of the commercial product with which they work.

2.2. Research in informatics

Given the practical and economic success of past informatics research contributions, these should be halcyon days for those who want to continue to push the frontiers of informatics research. Although I firmly believe that this will (and should) be a growth area for our field, and that academic informatics research will prosper in the years ahead, we need to recognize that there are significant barriers that we must tackle directly in order to achieve what is possible.

One problem is the lack of understanding of the research content of informatics by those who are enjoying the very products that have emerged from our research laboratories. The current HITECH initiative in the US, which provides incentives for practitioners to implement EHRs in both hospitals and ambulatory settings, is investing billions of dollars in the technology but none on research to enhance it in the future [3]. Furthermore, there is remarkably little recognition, by lawmakers or the media, that the EHRs of today are the products of decades of international government-sponsored informatics research. My own visits to legislators and their staffs have, for example, demonstrated a striking ignorance regarding the National Library of Medicine and its role as a supporter of the kinds of research that produced the EHRs of today [4].

We accordingly have a major challenge in the education of the public and, in particular, health policy leaders. There is strong support for HIT, with increasing investment and acceptance as I mentioned earlier, but HIT's link to fundamental and applied informatics research is poorly understood. The lesson for our community is that we must emerge from our academic units and research labs in order to play a more active and visible educational and policy role. The challenges start within our own institutions, where health-science school leaders need to understand the nature, importance, and promise of ongoing informatics research. There are still too many schools in which the informatics program is viewed as a technology support unit rather than a vibrant part of the intellectual and research environment. But we also need to move beyond our own institutions, in ways that will differ from country to country, depending on the political realities and the ways in which science policy decisions and investments are made. But in every country, an enhanced understanding of informatics and its research challenges by practitioners will be key. I'll say more about this below.

A second problem relates to the nature of the industry with which we interface. Our colleagues in the computer science community typically have rich relationships with industry, often with research funding from companies and active collaborations with corporate researchers. At a time when governments are struggling to maintain research funding due to other fiscal challenges and priorities, the role of collaborative research with industry is especially important. Given the previously mentioned challenges related to the implementation of commercial systems in academic medical centers, the ability of informatics researchers to influence future products is likely to depend on relationships with industry and opportunities to influence product development and enhancement. It is suboptimal to rely solely on publications as a vehicle for bringing research results to the attention of our colleagues in industry.

As mentioned, however, the current HIT industry has devoted remarkably little energy or funding to producing corporate research programs. Some would call this short-sighted, given the suboptimal characteristics of essentially all commercial products, which accordingly suggests that there is a need for further research and innovation. These observations accordingly suggest that both industry and academic informatics need to seek common ground and relationships that will enhance both products and the health of the discipline going forward.

2.3. Informatics education

The demand for individuals trained in informatics is rapidly growing and is creating pressure both for institutions that cannot find the skilled labor that they need and for academic informatics units that cannot easily increase the number of graduates that they produce. Informatics education is accordingly a growth area that needs to be taken seriously by all academic programs, with the creation of innovative training opportunities across a broad spectrum of backgrounds and needs.

Traditional graduate training in informatics will continue to be core element in the strategy. With the creation of new academic units, there is a need for mid-career individuals who have both the academic credentials and the personal characteristics that are needed to provide the leadership for a new program that will perform both research and education in the field. In the US we have a significant shortage of such individuals, and I suspect the situation is similar in Europe. This has led to compromises in the selection of leaders for new programs, sometimes resulting in the

recruitment of individuals from other disciplines who are attracted secondarily to informatics despite their lack of formal training in the area.

We have also seen the development of training programs that are offered online, often conferring a certificate rather than a degree, and focusing on individuals who are employed full time while they are seeking to acquire additional skills in informatics. Because many of the trainees in such programs are already health professionals, they are subsequently in an excellent position to bring the informatics concepts and skills that they have acquired to practical settings. Short-term certificate programs and even online master's degree programs seem likely to increase in light of the demand for their graduates.

Related to the certificate programs is the increasing interest in informatics tutorials or intensive continuing education sessions by health professionals, often at professional meetings in their primary decision. These are providing an excellent opportunity for informatics faculty to provide targeted training and orientation to the field, but the experience is very different from teaching graduate students and requires careful adaptation of content and emphasis in order to appeal to such health professionals.

Increasingly important is the recognition that informatics needs to be part of the primary training of health professionals. As mentioned earlier, nursing programs have tended to involve some informatics training for some years, but with the exception of exposure to probabilistic decision making and test interpretation, most medical schools have remarkably little informatics in their curricula. Recent calls to rectify this situation [5,6] are having some impact, and informatics faculty need to be prepared to participate in such training at their home institutions.

3. Conclusion

The future of academic informatics is bright, but will evolve in ways that will distinguish such programs from those that created the discipline over the last half-century. I have argued that there will be fewer opportunities for informatics faculty to pursue scholarly interests as informatics practitioners in clinical settings but that there should be a corresponding increase in the opportunities for targeted research programs and collaborations with industry. In the area of education, however, the demand is burgeoning and informatics faculty will have a great deal to offer that will help to transform the understanding of the discipline by the public and key decision makers.

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