Perspectives on informatics in the health sciences for information professionals

The emergence of informatics as a discipline is a relatively recent phenomenon even if the conceptual foundation has been around for quite some time. It was only in 1983 that Gorn formally defined informatics as the combination of computer science and information science.

Official descriptions of academic disciplines are defined by the National Center for Education Statistics (NCES) through the Classification of Instructional Programs (CIP) system. In this classification, informatics is described as

> *"a program that focuses on computer systems from a user-centered perspective and studies the structure, behavior and interactions of natural and artificial systems that store, process and communicate information. Includes instruction in information sciences, human computer interaction, information system analysis and design, telecommunications structure and information architecture and management"* (National Center for Educational Statistics, 2010).

How this plays out in actual practice varies. For example, the University of Washington School of Information defines informatics as "…conceptual and practical, academic and professional, and focused on the human and humanistic dimensions of the design and use of information systems" (University of Washington Information School, 2016, para. 2). At the University of California at Irvine, the department of Informatics put this a bit more succinctly as the "study (of) interactions among information technologies and people" (University of California Irvine, 2016, para. 3).

What is common among the varying definitions of informatics is that informatics is neither IT nor information science. Information technology professionals focus on the implementation and management of technology. They manage data and the infrastructure necessary to use data but they are not inherently concerned with what the data means or how it is specifically used in the practice of a profession. Information scientists tend to focus on the nature of information and how it is classified, categorized, and preserved.

Informaticists, on the other hand, are more concerned with how data is used, what it means, and how it helps in the practice of a profession. None of these three fields completely excludes the other and there are many areas of intersection; however, their focuses are different. Ideally, informaticists work together with IT professionals and information scientists to improve the use of technology to help the practitioner understand their information and create knowledge that helps them achieve their goals and outcomes.

The development of informatics in the health care sector

With the increasing prevalence of mainframe computing systems in the late 1960s, hospitals and health care providers started considering how computers could improve the practice of medicine and health care (Barnett, 1968). However, the early hopes for the development of computerized systems that could improve clinical practice in medicine where naïve and beset with unrealistic expectations (Barnett, 1987). However, with rapid increases in the capability of computers by the 1980s the promise of clinical information systems started to become a reality. It is in this period that we see the formation of conceptual models for how clinical information systems are differentiated from the administrative systems (such as financial and human resource applications) that were the primary applications of the day.

Blum (1986) was one of the first people to document the difference in approach between administrative systems and clinical information systems. With his model of the differences marking data, information, and knowledge (Figure 1), he set the stage for understanding the issues of informatics in a clinical practice setting.

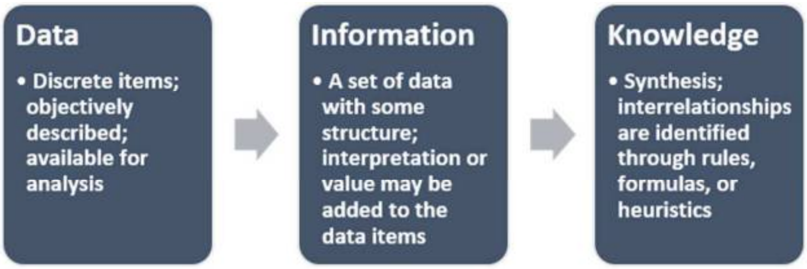

Figure 1- Blum's hierarchy of data to knowledge

Based on this data hierarchy, the primary outcome of a clinical information system is not simply information, as is the case in most administrative systems, but rather the ability of the people using the system to gain knowledge from the system. As clinical systems took hold, the idea of ”wisdom” as a fourth level, attributed to Nelson and Joos (1989), is the final link that allows for knowledge to be applied in practice.

Understanding the Data, Information, Knowledge, Wisdom (DIKW) framework

Nonetheless, the foci of an individual informaticist may span the range of from data to wisdom. This makes sense when you consider what data, information, knowledge, and wisdom can potentially represent. Each of these types of item can be used to create meaningful action in practice.

In an informatics context, data plays a critical role in building the foundation for improving practice. Data elements such as client demographics, problems that a patient might report, statistics on medical or health services delivered, case reports of illness, as well as client reports of health status are all examples of basic data.

Information emerges from such data. For example, data on the number of hospital beds occupied provides, when rolled up, a summary that can be used to understand other operations in the hospital such as whether additional admits are possible or that patients should be referred to nearby facilities. Data about case reports of illness in the general population can provide public health officials with information about where major outbreaks of disease may occur. Additionally, data from medical services billing can be analyzed in combination with demographic data to understand the distribution of health problems within a region or the financial burden of health care on population segments.

Knowledge is derived from information and data. A primary example of this is determining what outcomes result from various treatments. By analyzing the problems patients report and the various outcomes they have after treatment, best practices can be developed for addressing the individual problems patients may report.

The difference between knowledge and wisdom can be a bit difficult to conceptualize. However, wisdom is typified by the application of knowledge in practice. A prime example of this is understanding how an approach should vary depending on individual circumstances. As an example, while a particular course of treatment may be the same regardless of the recipient's age, wisdom is demonstrated in the care provider by how they adapt their approach in discussing a particular treatment protocol with a teenager as opposed to how they would do that with a senior. The same can be said for how a public health official would understand the differences in approach when discussing the implications of a foodborne disease outbreak with the general public, representatives from the food industry, legislators, or other health professionals.

Ultimately, the data, information, knowledge, wisdom continuum is the foundation of informatics practice in the health professions.

Types of informatics in the health professions

As discussed earlier, there is no consistent definition of informatics, even in the health professions. This has led to the use of a myriad of terms, such as medical informatics and health informatics, without a universally consistent understanding of exactly what is being discussed.

To help address this, AMIA (the American Medical Informatics Association) has been working on formal definitions for various aspects of informatics in the health professions. Within this framework, the continuum of informatics from basic research to applied research and practice is addressed formally.

At the highest level, the field is differentiated into biomedical (applied research and practice) and medical (basic research) informatics. However, the organization of subfields is neither clearly defined nor hierarchical. Best represented as a matrix (Figure 2), the relationships between various aspects of informatics in the health sciences is complex and still somewhat subject to interpretation.

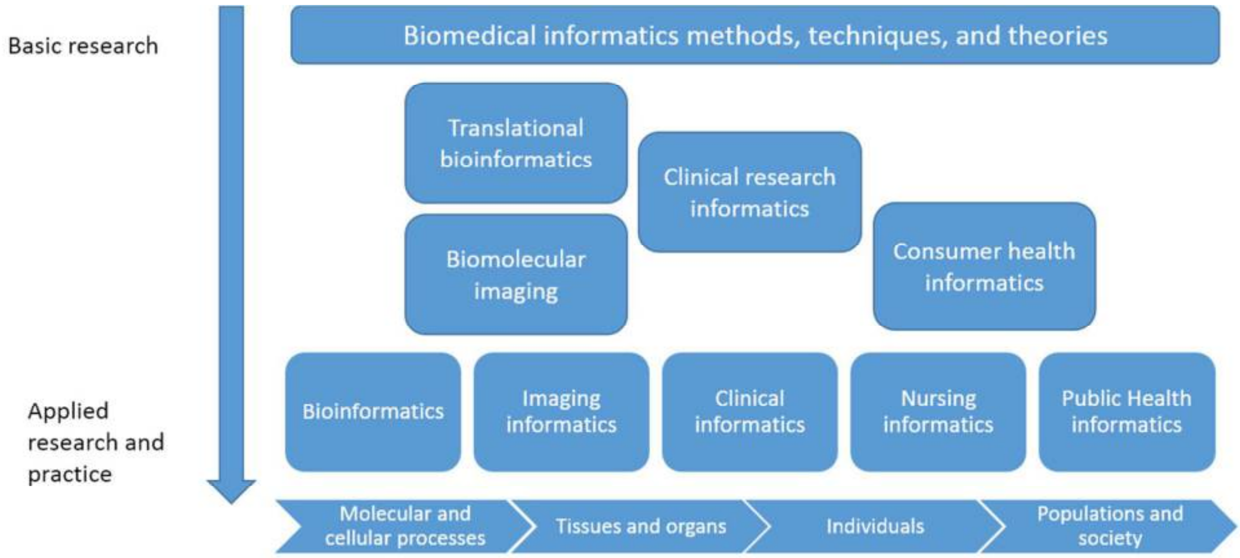

Figure 2- Informatics in the health sciences relationship matrix (adapted from "What is biomedical informatics?", AMIA, 2012)

Perhaps the most important aspect of this matrix is that the boundaries between areas are not fixed but instead are fluid. Given the underlying, interdisciplinary nature of informatics this is not surprising. While having a general idea of the basic disciplinary alignment of an informatics project is useful, getting too bogged down finagling over specific disciplinary boundaries may not be the most productive use of researchers' effort.

Semantic tools and informatics

An area where there is a clear intersection between informatics and information science is in the use of semantic tools to facilitate the work of analysis. Semantic tools are used in informatics to help convert data into information. This is primary done through controlled vocabularies, taxonomies and ontologies, reference terminologies, and interoperability standards.

In the area of controlled vocabularies, the most well-known is ICD, the International Classification of Disease. Administered by the World Health Organization, ICD is now in its 10th edition and has been extended with modifications for clinical practice contexts. This version is referred to as ICD-10-CM and it is the standard used in health information systems to code diagnoses, symptoms, and procedures related to patient care.

RxNorm provides a standardized vocabulary for clinical drugs and is used in pharmacy management and drug interaction systems to normalize terminology between systems that do not use the same terminology. This is necessary because drugs may have a brand name, a generic name in the United States, and a different generic name in other parts of the world. Consider the brand name drug Sominex (used to treat insomnia) whose generic equivalent name is diphenhydramine in the United States but is promethazine in the United Kingdom.

Taxonomies and ontologies are used to define terms and inter-relationships among them. One of the most commonly used is The Omaha System, a public domain ontology for describing patient care. It consists of three interrelated components: the Problem Classification scheme, which is used to assess the patient's health issues; the Intervention Scheme, which provides a standardized method of describing a care plan and the required services for that plan; and a Problem Rating Scale for Outcomes, which is a methodology for evaluating the progress of the client in meeting their treatment goals via an outcomes rating matrix.

In informatics, reference terminologies also play a big role in standardizing data across systems. Two of the most important are SNOMED-CT (Systematized Nomenclature of Medicine Clinical Terms) and LOINC (Logical Observation Identifiers Names and Codes).

SNOMED-CT is an extensive clinical terminology system. Rather than relying on provider notes that may be subject to the vagaries of natural language, SNOMED-CT provides a system for capturing and linking clinical concepts. Each concept is organized hierarchically from general to detailed and is assigned a numeric code. Every concept has at least one human readable description (a fully specified name or FSN). A concept may have additional, associated descriptions which represent clinical synonyms and relationships can be defined between related concepts.

Conceptually similar to SNOMED-CT, LOINC provides a universal code system for tests, measurements, and observations in the clinical environment. When used in combination with SNOMED-CT, it provides a formal mechanism for describing conditions and context associated with specific clinical concepts. For example, LOINC code 66157-9 is related to diabetes and specifically about whether diabetes occurred solely during pregnancy. It has three standardized answers: no (1), yes (2), or don't know (3). The advantage here is the same as with SNOMED-CT – the medical record uses a standard code to represent a condition and a status and is not subject to the interpretation of natural language notes.

Finally, interoperability standards are critical to informatics just as they are in bibliographic systems. While the technical standards for the exchange, integration, sharing, and retrieval of electronic health information differ from those in libraries and information agencies, the necessity and complexities are similar. Health Level 7 (HL7) is the most commonly used framework and set of standards to exchange, integrate, share, and retrieve electronic health information.

Some challenges in informatics

Interpretation of data is often clouded by worldview. Medical doctors, nurses, pharmacists, and other health professionals may view the same set of data differently. The challenge for the informaticist is to find a commonality among varying worldviews.

One of the major threats to the proper interpretation of data includes semantic equivalence. For example, all of these terms are used to describe the condition where are person has elevated blood glucose levels: diabetes, diabetes mellitus, elevated blood sugar, high glucose, "the sugars". In addition to the differences between health professionals, patients also have diverse and divergent vocabularies and perspectives.

In addition, semantic gaps occur when data does not fully encapsulate the context in which it exists. For example, it simply is not enough to know that a blood glucose level is elevated. The users of the data also need to know the context. For example, what the person's typical readings are, whether they ate or drank before taking the blood level test, or if they are taking any medications that might affect their blood glucose level reading, just to name a few contextual factors.

It is for these reasons that informatics is a complex and challenging field. The role of the inforaticist is to transform data to knowledge and information. Therefore, much of the work in informatics is focused on bringing order to the interpretation and use of clinical and other types of health-related data. Certainly, these are areas where the skills of information professionals can be applied.

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Resources

Health Level 7 (HL7) – http://www.hl7.org/

ICD-10 codes (open access version) - http://eicd10.com/

LOINC - http://loinc.org/

Omaha System - http://www.omahasystem.org/

RxNorm - http://www.nlm.nih.gov/research/umls/rxnorm/overview.html.

SNOMED CT - http://www.ihtsdo.org/snomed-ct