

Clinical Informatics: A New Paradigm for Advances in BioMedical Informatics

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ABSTRACT

The medical informatics field is going through a rapid change. The current model used is one of patient to physician, with information technology as a value added segment. However, with rapid developments in hardware and software, innovations in the medical informatics field can take a quantum leap forward by changing its basic model of thinking. The evolving field of medical informatics is giving way to new developments in clinical informatics. With clinical informatics comes the natural progression to patient centered care, and patient access, to a plethora of online information. A new model is proposed of patient to information technology with the physician as the value added segment.

INTRODUCTION

Healthcare is a basic human necessity. Throughout human history, advances in medical care have allowed mankind to flourish. Advances in pharmaceuticals have all but eliminated some infectious diseases. Public health policy and immunizations have prevented the spread and eradication of multiple illnesses. The advances in medical imaging have changed basic medical care through daily use of x-rays, ultrasounds, CT-scans and MRI. New surgical suites, laparoscopic instruments and readily available imaging have revolutionized the surgical subspecialties. The push for evidence based medicine, peer-reviewed journals, and standard of care practices, have standardized many medical treatments. At the forefront of these and many other medical advances are technology, and the need to manage the overwhelming quantity of new medical information. The term electronic health (eHealth) and biomedical informatics are two terms that encompasses various modalities, including: research, medicine, medical technology, computer technology, clinical application, pharmaceuticals, and a vast array of online resources. Biomedical informatics is a broader term which encompasses eHealth. The rapid rate in which health information is becoming available is an evolutionary process that is constantly changing medicine. Informatics is quickly becoming an emerging field (An, Hayman, Panniers & Carty, 2007).

Medical informatics is therefore, a dynamic field of medical information, technology, and practical application, all combined in an attempt to improve health outcomes, lower healthcare costs, and educate healthcare providers and patients.

Many attempts have been made to define eHealth (Oh, Enkin & Jadad, 2005) and biomedical informatics. While the field is broad and currently ill defined, there are various nomenclatures used: Biomedical Informatics, Medical Informatics, Health Informatics, Health Information Technology (HIT), Public Health Informatics (Kukafka & Yasnoff, 2007), and Clinical Informatics (Shortliefte, 2007). In this budding new field, definition varies from institution to institution, company to company and hospital to hospital. Two definitions can be found online that demonstrate the differences:

The online Handbook of Medical Informatics presents this definition:

The domain of medical informatics is determined by the intersection of the terms "medicine" and "informatics" (or "health" and "information"). The first term indicates the area of research, the second one its methodology. Medical informatics has both applied and theoretical aspects; models are developed both in applications and in theoretical activities (Van Bommel, 2007).

One of the industry leaders presents his view in this manner:

The integrative discipline that arises from the synergistic application of computational, informational, cognitive, organizational, and other sciences whose primary focus is the acquisition, storage, and use of information in the health/biomedical domain (Hersh, 2007).

Both views hold an underlying theme, that of organizing current medical information and technology, thus applying it into clinical use.

The American Medical Informatics Association has set forth a broad and distinctive view:

Biomedical and health informatics has to do with all aspects of understanding and promoting the effective organization, analysis, management, and use of information in health care. While the field of biomedical and health informatics shares the general scope of these interests with some other health care specialties and disciplines, biomedical and health informatics has developed its own areas of emphasis and approaches that have set it apart from other disciplines and specialties (AMIA, 2007).

Their emphasis on the uniqueness and the development of a subspecialty has allowed the advancement and development of a national association, which in turn has led to government funding and educational advances.

TECHNOLOGY

The ubiquitous nature of the Internet has recently changed medicine. It is estimated that 137 million Americans, or 68% of the adult population use the Internet (Fox, 2005) and roughly 80%, or 95 million adult Americans, have searched for medical information online (Fox, 2007). The uniformity of standardized protocols has enabled resources and information to be shared. Electronic medical records have enabled a more continuous patient care philosophy. Imaging such as x-ray, ultrasound, ct scans, and MRI have improved patient care. New laboratory tests such as: HbA1c, urine studies, and endocrine hormones have helped to better understand the neuroendocrine systems and body function, thus allowing correct diagnoses and proper medical management. An understanding of biochemical pathways has given rise to the lucrative pharmaceutical industry, as well as new, and sometimes improved medications.

The Internet and various data repositories have given rise to a new trend in modern medicine: evidence-based medicine. Evidence based medicine is an attempt to combine the vast amounts of medical literature and information into a best practice approach to medical problems. A review of the medical literature and best practice techniques combine to allow healthcare providers a systematic approach to patient care.

Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research (Sackett, 1996).

Evidence-based medicine is changing the way physicians are trained today. New skills are required for physicians to understand evidence based medicine (EBMG, 1992). These skills require a knowledge of the medical literature and search functionality. Best practice methodologies are now based on the evidence presented in the medical literature. New websites, such as the Cochrane Database (<http://www.cochrane.org/>) and Dynamed (<http://www.ebscohost.com/dynamed/default.php>) are also allowing practitioners easy access to this new evidence based data.

The Cochrane website provides links and access to new evidence based reviews, updated Cochrane reviews, search by A-Z listings and group listings. They also provide an introduction to their purpose and goals.

In their introduction, found on their website (<http://www.cochrane.org/reviews/clibintro.htm>), they explain:

No one can keep up to date with the relevant evidence in their field of interest... Textbooks, editorials and reviews which have not been prepared systematically may be unreliable. Much evidence is unpublished, but unpublished evidence may be important. More easily accessible research reports tend to exaggerate the benefits of interventions...The Cochrane Library solves many of these problems...Cochrane Reviews are based on the best available information about healthcare interventions. They explore the evidence for and against the effectiveness and appropriateness of treatments (medications, surgery, education, etc) in specific circumstances (Cochrane, 2007).

The Cochrane database has become mainstream in research and education today. Their evidence based review system allows quick and easy access to information based on the highest level of evidence found in the literature, systematic reviews.

Dynamed is evidence based online resource. It was developed with the daily practitioner as the user. It combines useful evidence based information in a user friendly manner. An article by the American Academy of Family Physicians recently highlighted Dynamed and some of the most useful features (<http://www.ebscohost.com/dynamed/aafp.php>).

DynaMed meets the needs of the modern family physician through the following features:

- *Validity: DynaMed content is determined by systematic selection of the best available evidence.*
- *Relevance: Most of DynaMed's reviewers, authors and editors are family physicians involved in direct patient care; they ensure that the needs of the practicing physician are met.*
- *Convenience: It is easy to 'Jump to' the topic of interest, then follow the standard templates and outlines to the specific information of interest.*
- *Comprehensiveness: By synthesizing and integrating all the clinical knowledge in one outline, you do not need to read multiple search result items to get the whole story.*
- *Timeliness: DynaMed is updated daily, so is more current than any other clinical reference (DAMED 2007; Alper, 2003; Alper, White & Ge, 2005).*

Evidence based medicine is leading to best practice solutions, and resources such as Cochrane and Dynamed are enabling health care providers greater and wider access to these solutions.

TELEMEDICINE

Telemedicine is slowly being applied into clinical practice. It can be implemented through various media. The use of electronic media to exchange medical information between different locals can employ: videoconference sessions with video and audio, audio only or electronic data exchange, such as through the use of electronic medical records. The American Telemedicine Association has defined telemedicine in this manner:

Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve patients' health status. Closely associated with telemedicine is the term "telehealth," which is often used to encompass a broader definition of remote healthcare that does not always involve clinical services. Videoconferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education and nursing call centers are all considered part of telemedicine and telehealth (ATA, 2007).

Different techniques are used in telemedicine conferences. The traditional teleconference session is thought of as patient to physician. A new model proposed is that of physician to physician. The physician to physician model is currently employed by Project ECHO (<http://echo.unm.edu/>). Project ECHO allows patient monitoring, where rural

practitioners collaborate with specialist, thus allowing the rural practitioner complete care of the patient, with case management through a group of specialists.

Even though advances in technology have made telemedicine more appealing, physician acceptance is still the greatest hindrance (Hu & Chau, 1999). Regardless of the technique, telemedicine will play a large role in the future of healthcare.

CLINICAL INFORMATICS: TOOLS FOR THE PHYSICIAN

While the field of biomedical informatics is broad and diverse, clinical informatics focuses on direct patient involvement, with health information technology as a value added option. There are various websites that provide an array of services that can augment the physicians knowledge base, thereby improving patient care and education. Presented below are a few of the most useful medical websites for physicians and patients.

Search Engines

There are various search engines that provide access to the medical literature. Each offers different services. PubMed (<http://www.pubmedcentral.nih.gov/>) is a service provided by U.S. National Institutes of Health. It offers free access to digital archives of biomedical and life sciences journals. The search functionality is exhaustive and can be limited by numerous criteria. Abstracts are readily available and links to full articles are provided.

Medline (<http://www.nlm.nih.gov/medlineplus/>) is another medical literature search engine. It is a free service provided by the U.S. National Institutes of Health, U.S. National Library of Medicine, and other various government agencies and health-related organizations. Not only can you search medical literature, but it also offers: an illustrated medical encyclopedia, patient tutorials, health news, various health topics, information on drugs and supplements, physician directories and other resources. It is one of the most comprehensive online medical websites available today.

The popular search engines, such as, Google (<http://www.google.com>), Yahoo (<http://www.yahoo.com>), and Dogpile (<http://www.dogpile.com>) also offer quick and easy access to medical information for both physician and patient. These search engines offer access to some websites that are useful, and others that do not always provide reliable information. Search results include physician targeted websites, patient/consumer targeted websites, business related websites, information websites, and university websites. There are other websites that provide false, incomplete and incorrect information. Sifting through the multiple entries can be time consuming and even dangerous if the website provides incorrect information. While these websites are the most popular search engines, they do not always provide links to the most useful medical information.

Commercial Websites and Patient Information

There are numerous commercial websites available that provide health information. The most notable is WebMD (www.webmd.com), which is a comprehensive website enabling consumers direct access to medical information. This website includes sections on: *Health A-Z*, *Drugs and Treatments*, *Men's/Women's and Childrens Health*, a *Glossary*, *HealthCenters*, *Top Health Topics* and a *Symptom Checker*.

The *Symptom Checker* service is an advancement in direct patient driven healthcare. It enables patient education and provides a differential diagnosis based on user's symptoms. Patients can search for potential diagnoses. This service is not without controversy. Patient driven healthcare does not necessarily mean patients receive the correct diagnosis. The patient's diagnosis is only as valid as the program. Diagnosis, without treatment by a licensed practitioner, does not always lead to the correct treatment. While this service has a role in modern medicine, it is not without flaws and potential for abuse.

Other commercial websites are more practitioners based. One such website is MDCConsult (<http://www.mdconsult.com/>). MDCConsult is a popular site among licensed practitioners. It is a for-profit business website, offering multiple resources for both physicians and patients. Subscription is required. There are links to books/journals, patient information, drug information, guidelines, news and images of various medical modalities,

and not just dermatology. An introduction to their services is readily available <http://www.mdconsult.com/php/about/76722102-3/AboutMDC.html>. There are also new websites, such as SaludInformatics (<http://www.saludinformatics.com>), which offer a collection of links to online resources, which is maintained by physicians, for physicians.

The most complete non-subscription based online service focused on practitioners is eMedicine (<http://www.emedicine.com>). EMedicine is a free service with peer reviewed articles in a complete and easy to read format. It offers easy search capability. Registration requires only an email address. Articles are presented in standard format covering a wide range of topics. Various resource centers by topics, specialty browsing and continuing medical education credit are all offered free of charge. There are also eTools (<http://www.emedicine.com/etools/>), which include treatment algorithms, calculators, decision rules, diagrams, scores and reference tables. New sites are coming into existence all of the time like Salud Informatics (<http://www.saludinformatics.com>) which is dedicated to providing a common resource for health care professionals to easily access the wealth of online resources. Regardless of the company or website, clinical tools are improving physician knowledge and skills.

Professional Societies

There are various professional societies which offer access to online information, none as complete as the website by the American Academy of Family Physicians (<http://www.aafp.org>). It has resources links to information and online access to: American Family Physician, Family Practice Management, Familydoctor.org, AAFP News, AAFP Policies, and various journals, including American Family Physician, Annals of Family Medicine, a Family Practice Management. There are also resources for patients, including: patient information and handouts, current news and clinical recommendations. They also provide educational information for medical residents and medical students.

The recent rise in diabetes over the last few years has lead the American Diabetes Association to organize a website, Diabetes.org (<http://www.diabetes.org/>), with numerous links to resources, information and tools. With over 20 millions Americans with diabetes, and many not even knowing they have the diseases, there is a growing need for diabetes education, treatment and information (ADA, 2002). Diabetes care and costs are increasing at a rapid rate. By better understanding the disease process and helping educate people, the hope is to have healthier patients, reduced costs and improved health outcomes. One of the most useful tools on the website is the Personal Health Decisions (PHD) tool. The PHD calculator gathers information regarding personal health information, calculates risks based on the most current data, studies and outcomes. Information collected is based on personal history, medications, labs tests and lifestyle. All reports are presented is a graphical format, complete with pre and post medication and lifestyle modification assessment. The PHD calculator is the most comprehensive online diabetic tool available.

Educational Resources

While the field of medicine is a continuous journey in education, most U.S. medical schools now provide information online, including lecture notes, slides, resources and other educational materials. When it comes to education related to dermatology, there is one website that stand out, DermAtlas (<http://www.dermatlas.org>). This site is sponsored by Johns Hopkins University. It offers a complete search ready dermatology site, complete with search by words and/or homunculus. There are great pictures and lists of differential diagnoses with cross reference ready links. This free service is the most comprehensive dermatology website.

NEW PARADIGM

The medical informatics field was one that was born from utilizing information technology by one of adding value to the medical field. Previously listed are numerous websites and online resources that have enabled the physician/practitioner to expand their knowledge base and access information to improve patient care. This shift from physician with *all* knowledge, used to treat patients, has now changed. Evolution has occurred. Physicians now no longer have *all* knowledge, but they can have access to the most recent, complete and comprehensive knowledge base available. Evidence based medicine, telemedicine, and online resources now enable providers with internet

access to make decisions for patient care based best practice guidelines. Patients now also have access to medical literature, information regarding diagnosis and treatment. Patients have become empowered through the use of technology (Rohm & Rohm, 2002). Again, evolution is occurring. The medical field has always used the model of the relationship of patient to physician. The physician then used technology to enhance or “add value” to the patient/physician relationship. This could be expressed in the following model, see Figure 1.

Figure 1: Patient/Physician Relationship.

$$\begin{aligned}
 &\text{Patient} \quad + \quad \text{Physician} \quad + \quad \text{Information Technology} \\
 &\{ \text{The Patient/Physician Relationship} \} + \{ \text{Value Added} \}
 \end{aligned}$$

A proposed solution for the medical informatics field is a simple change in the current model. A change in the Patient/Physician Relationship is proposed by including the Information Technology directly in the relationship. Please note, the patient and physician are critical to the relationship. However, by making the physician as a “value added” portion of the proposed model, the model is expanded. The expansion allows for the use of information technology as a primary role first. By utilizing information technology first, the patient can input much more information about themselves and of their family. A new website dedicated to patient driven health records, HealthVault (<http://www.healthvault.com/>), is one such example of patient driven healthcare. Patients control their own health records and then share that information with the providers. A more complete picture can be developed for the physician by allowing the patients to seek care at multiple care sites, but one location for all health information. Thus, the physician’s time is used in a more efficient manner and can develop and further the Patient/Physician relationship. See Figure 2 for the proposed model that could be expressed in the following:

Figure 2: Patient/Information Technology/Physician Relationship.

$$\begin{aligned}
 &\text{Patient} \quad + \quad \text{Information Technology} \quad + \quad \text{Physician} \\
 &\{ \text{The Patient/Physician Relationship} \} + \{ \text{Value Added} \}
 \end{aligned}$$

The physician will always play an invaluable role in the relationship; however, patient can now access the plethora of new online medical information to educate themselves. Through the use of the various search engines, evidenced-based literature, patient handouts, professional and free websites, patients can now educate themselves. Patients can directly use the current technology to help manage their own health, then access a provider for help in making treatment decisions and prognosis (Rohm & Rohm, 2004), thus allowing the physician to be used as the value added option.

The new paradigm, with physician as a value added option, could in theory, better educate patients, thus allowing improvement in their own health. This would in turn; ease the burden on the healthcare community, freeing current resources, and refocus on those patients who need continued care.

CONCLUSION

Advances in medicine, combined with new technologies, have enabled the field of biomedical informatics to flourish. Provider access to patient information, evidence based medicine and online resources allow more informative and prepared physicians to deal with the rigors of modern medicine. Patients can also use the various online clinical resources to gain a better understanding of the disease process, diagnosis and prognosis. Educated patients can use their new found knowledge to gain a comprehensive view to their potential disease state and the various treatments. Providers can thus refocus their efforts in a more efficient and productive manner. Online clinical resources allow both provider and patient access to the most recent and evidence based information, thereby improving patient care and strengthening the provider-patient relationship. This exciting, new, emerging field of biomedical and clinical informatics is revolutionizing the way that medicine is practiced.

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