Introduction to medical informatics pdf

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Supplementary material articles from The Western Journal of Medicine are provided here courtesy of BMJ Publishing GroupPage 2Get a printable copy (PDF file) of the entire article (627K). p775-a Supplementary Material Articles from The Western Journal of Medicine are given here courtesy of BMJ Publishing Group Whose physiology literally means the logic of life, and pathology is the logic of the disease, so is the health informatics logic of health care. It is the study of how clinical knowledge is created, shaped, shared and applied. It is the rational study of how we think about healthcare, and the way treatments are defined, selected and developed. Ultimately, it is the study of how we organize ourselves, both patients and professionals, to create and run health organizations. With such a crucial role, the study of computer science is just as fundamental to medical practice and the delivery of healthcare in this century as anatomy or pathology was in the past. Health informatics is thus as much about computers as cardiology is about stethoscopes (Coiera 1995). Instead of drugs, X-ray machines or surgical instruments, the tools for computer science are more likely to be clinical guidelines, decision support systems, formal health languages, electronic records or communication systems such as social media. However, these tools are only a means to an end, which is the delivery of the best possible healthcare. Although the name health informatics only came into use around 1973 (Protti 1995), it is a study that is as old as the health care system itself. It was born on the day a clinician first wrote down some impressions about the patient's illness, and used these to learn how to treat his next patient. Computer science has grown significantly as a clinical discipline in recent years driven, partly no doubt, by advances in computer technology. What has fundamentally changed now is our ability to describe and manipulate health knowledge on a very abstract level, and to store large amounts of raw data. We now also have access to rich communication systems to support the healthcare process. We can formally say that health informatics is the study of information and communication processes and systems in health care. Health informatics is particularly focused on: Understanding the basic nature of these information and communication processes, and describing the principles that shape them, Developing measures that can improve existing information and communication processes, Developing methods and principles that allow such actions to be designed, evaluate the impact of these actions on the way individuals or organizations work, or on the outcome of the work. Specific subspecialities of health informatics include clinical informatics, which focuses on the use of information in support of patient care and bioinformatics, which focuses on the use of genomic and other biological information. The rise of health Perhaps the biggest change in clinical thinking over the past two centuries has been the rise of the scientific method. Since acceptance, it has become the lens through which we see the world, controlling everything from the way we see disease and fighting it. It is now hard to imagine how controversial the introduction of theory and experimental method in medicine once was. Then it was strongly opposed by empiricists, who believed that observation, rather than theoretical presumption, was the only basis for rational practice. From this perspective, it is almost eerie to hear again the old empiricists' argument that healthcare is an art, and not a place for unnecessary speculation or formalization. This time, empiricists are fighting against those who want to develop formal theoretical methods to regulate the municipal practice in health care. Words such as quality and safety, clinical auditing, clinical guidelines, indicators, performance measures, health rationing and evidence-based practices now define the new intellectual battlefield. While the advance of science pushes clinical knowledge down to a fine-grained molecular and genetic level, it is events at the other end of the scale that force us to change the most. First, the health care company has become so large that it now uses more national resource than any country is willing to bear. Despite sometimes heroic efforts to control this growth in resource consumption, health budgets continue to expand. It is therefore a social and economic imperative to transform healthcare and minimize the drain on social resources. The structure of clinical practice also comes under pressure from within. The scientific method, long the backbone of medicine, is now in some ways threatened. The reason for this is not that experimental science is not able to answer our questions about the nature of the disease and its treatment. Rather, it's almost too good at work. As clinical research ploughs forward in laboratories and clinics around the world, like any major information-generating machine, healthcare professionals are inundated with their results. So much research is now published every week that it can literally take decades for the results of clinical trials to translate into changes in clinical practice. So, health professionals find themselves practicing with constantly limiting resources and unable, even if they had time, to keep up to date on knowledge of best practices hidden in literature. As a consequence, the scientific basis for clinical practice trails far behind it by clinical research. Consumers are struggling even more, and have to contend with conflicting messages and information they find online, such as in social media. Two hundred years ago, enlightened doctors understood that empirism needed to be replaced by a more formal and testable way of characterizing disease and treatment. The tool they used then was the scientific method. Today we are in Situation. Now the requirement is that we replace the organisational processes and structures that force the arbitrary selection of treatments with those that can be formalised, tested and applied rationally. Modern health services have also moved away from seeing disease in isolation, to understanding that disease occurs at a complex system level. Infection is not only the result of the invasion of a pathogenic organism, but the complex interaction between a person's immune system, bacterial flora, nutritional status, environmental and genetic endowments. By seeing things at the system level, we are getting closer to understanding what it really means to get sick and how this condition can be reversed. We must now make the same conceptual leap and start to see the major knowledge systems that involved the provision of healthcare. These systems produce our knowledge, tools, languages and methods. Thus, a new treatment is never created and tested in intellectual isolation. It is important as part of a larger knowledge system, since it happens in the context of previous treatments and insights, as well as the context of a society's resources and needs. Furthermore, our work is not completed when we scientifically prove that a treatment works. We must try to spread this new knowledge and help others understand, apply, and adapt it. These are the challenges for health care. Can we put together rational structures for the way clinical evidence is gathered, communicated and applied to routine care? Can we develop organizational processes and structures that minimize the resources we use, the harm we create, and maximize the benefits delivered? And finally, what tools and methods need to be developed to help achieve these goals in a way that is convenient, testable and in line with the basic goal of healthcare - relief of disease? The role of health informatics is to develop a system science for healthcare that provides a rational basis for answering these questions, as well as creating the tools to achieve these goals. The scale of computer science is thus enormous. It finds application in the design of clinical decision support systems for practitioners, consumer decision aids and electronic healthcare, in the development of computer tools for research, and in the study of the very essence of healthcare - its corpus of knowledge. Nevertheless, the modern discipline of health informatics is still relatively young. Many other health care groups are also addressing the issues raised here and not always in a coordinated way. In fact, these groups are not always even aware that their efforts are connected, nor that their concerns are those of computer science. The science of what works I want to let you in on a secret. There are really only three questions that matter in computer science. At the beginning of some new computer science endeavors, you just need to ask: 1 – What is the problem that we are trying to solve? 2 – How will we know when we have 3 - Is technology the best solution, or are there easier options? If you make sure that these questions are asked, you will be seen as a wise indeed. If you know enough to answer them, you can be held up as a computer science guru. Reading this at the very beginning of the computer science journey, you may be surprised by the triviality of these questions. Re-reading them at the end of the journey through this book, you can now understand why little else matters, and also understand how rare it is for these questions to be asked in the real world - and what the almost inevitable consequences of not asking them are. With this framing, we need to understand three things about every computer science intervention- its possibility, its practicality and its desirability. The opportunity reflects the science of computer science – what in theory can be achieved? Practicality addresses the potential for successful development of a system or the introduction of a new process – what can actually be done given the limitations of the real world? Desirability looks at the basic motivation to use a given process or technology. These criteria are proposed because we must develop a framework for judging the claims of new technology and those who seek to profit from them. Just as there is a long-standing, sometimes troubled, symbiosis between the pharmaceutical industry and medicine, there is a newer and thus less researched relationship between healthcare and the computing and telecommunications industries. Clinicians should judge the claims of these newcomers in the same cautious way as they investigate allegations of a new drug and perhaps more, given that clinicians are far more knowledgeable about pharmacology than they are about computer science and telecommunications. Overview of the book The first goal of this book is to present a unifying set of basic computer science principles that affect everything from the delivery of care to a single patient to the design of the entire health care system. The next goal is to present the breadth of issues that concern computer science, show how they are related, and to encourage research to understand the common principles that connect them. The book is organized into a number of parts that revolve around the two distinct but interwoven strands of information and communication systems. While the unique character of each string is explored individually, there is also an emphasis on understanding the rich way they can interact and complement each other. Part 1 – Basic concepts in computer science This first part of the book provides an intuitive understanding of the basic theoretical concepts needed to understand computer science – the notions of what constitutes a model, what one means by information, and what defines a system. Each concept is used to develop an understanding of the basic nature of information and communication systems. A recurring theme in the book, first articulated here, is the need to restrictions imposed on us when we create a model of the world, or use it to design a technology. Understanding these limitations defines the final limits of computer science, regardless of the technology one might want to apply in its service. Part 2 - Computer Science Skills Build on the concepts in Part 1, the second part of the book looks at the practical lessons that can be drawn from computer science to guide daily clinical activity. Each clinical action, every choice of treatment and examination, is shaped by available information and how effectively this information is communicated. Five basic clinical computer science skills are explored, each with its own individual chapter: Communication is effectively based on understanding cognitive models of information processing, and is constantly challenged by the limits of human attention, and the imperfection of models; Structuring information, with a particular focus on the patient record, turns out to depend on the task at hand, the channel used to communicate the message, and the agent who will receive the message; Questioning others to find information is essential in clinical practice to fill the ever-present gaps in the individual's knowledge; Searching for knowledge describes the broader strategic process of knowing where to ask questions, evaluating answers and refining questions in light of past actions, and occurring in many different environments, from when the patient is interviewed and examined, to when treatment options are canvassed; Making decisions occurs when all available information needed is put together using the other computer science skills, and attempts to come up with the best option to solve a problem like choosing a treatment, based both on evidence from science, as well as the desires and needs of individuals. Part 3 – Information systems in health care The chapters in this section provide the technical core on which all other parts depend. We introduce clinical information systems and their role in supporting the model, measuring and managing cycle. Secondly, it is shown that it is not always necessary to completely formalize this cycle, especially when flexibility in decision-making is required. Therefore, many information processes are left in an unstructured or informal state, and more likely to be supported by communication processes. The electronic health record is introduced next time, and is the first major technical system to be discussed in the book. The benefits and limitations of existing paper-based systems are compared to their electronic counterparts. Since the electronic patient record feeds so many different clinical systems, later topics such as decision support, protocol-based care, population monitoring and clinical auditing are also introduced here. The next two chapters cover the basic computer science topics on how to design, evaluate and then implement working technological systems in sociotechnical organisations. It is often a conundrum that well-designed systems do not deliver the benefits expected. The evaluation chapter introduces the concept of information value, and uses it to explain the value chain that starts with information creation and extends to the optimal benefit of its use. Understanding where a system is meant to deliver value along this chain becomes a recurring motif in later chapters This topic expands in the chapter of implementation, which sees system implementation as one of appropriate technologies in complex adaptive organizations. The unexpected results of technology can sometimes only be explained by going back and taking such a broader system view. System security is deeply linked to design and implementation decisions, and the potential disadvantages of information and communication technology are explored next time, given how closely related the concepts are in these chapters. The final chapter of this section takes a different systemic perspective on clinical systems and the value of information, this time coming from economics. While evaluation methods tell us a lot about the value of information, economics brings its own equally valid insights. After completing this section, one should be able to move on to any of the other parts in any order, as each explores a more specialized subject area. Part 4 – Policy and protocol-based systems In this section, the various forms and use of clinical guidelines, care plans and protocols are introduced. The various roles that computer-based protocol systems can play in clinical practice are outlined in the second chapter. These cover both traditional passive support where protocols are kept as a reference, and active systems where the computer uses the protocol to assist in the delivery of care. For example, protocols incorporated into the electronic record can generate clinical alerts, or make treatment recommendations. The growing evidence base in favor of such technologies is also summarized, stressing that the benefits are more likely to be easily demonstrated in the process rather than clinical outcome improvements. The third chapter reviews the process of protocol creation, dissemination and application, and explores how computer science can create tools to assist at each of these stages. Part 5 – Communication systems Although interpersonal communication skills are fundamental to patient care, the communication process has not been well supported technologically for a long time. Now, with the widespread availability of communication systems that support mobility, voicemail, electronic mail and social media, new opportunities are emerging. The chapters in this section introduce the basic types of communication services and explain the different benefits of each. The next chapter is probably the most technical of the book, covering information and communication networks, and health-specific networks such as health information exchange. It's the place. this text where interoperability standards are covered in detail, as well as topics related to how information is accessed across networks, including privacy and consent. Social media is a different class of communication system and their importance is emphasized with a discreet chapter devoted to them. The chapter introduces basic concepts from social networking theory, social determination of health, and then explores how social media is being exploited across the spectrum of healthcare. The final chapter of this section examines clinical communication from the perspective of telemedicine and m-health technology. The potential of such systems for different areas of health care is described, along with the accumulating evidence basis for their success, again using the value chain as a way to understand sometimes unexpected negative results. Part 6 – Language, coding and classification If the data in electronic patient records systems are to be analyzed, they must be available in a normal way. This is usually thwarted by the variations in health terminology used by various individuals, institutions and nations. To solve the problem, large dictionaries have been created with standardized clinical terms. The chapters in this section introduce the basic ideas of clinical concepts, concepts, codes and classifications, and demonstrate their various uses. The inherent benefits and limitations of using different terms and codes are discussed in the second chapter. The final chapter looks at some more advanced problems in coding, which describes the theoretical limitations of coding. It introduces natural language processing and text extraction methods, and explains how the statistical approach to language management is complementary, and sometimes preferred, to the more formal semantic approaches using your clinical terminologies and ontologies. Part 7 – Clinical decision support and Analytics Clinical decision support systems (CDSS) are historically one of the most powerful classes of computer science intervention at our disposal. These computer programs range from systems that only present data to help a human make a decision, some generating questions or alerts when a clinician's decision looks problematic, through systems with the ability to make decisions entirely on their own. In the first chapter, the focus is on the various programs for CDSS, especially to see how clear successes can be identified. The next chapter takes a more technological focus, looking at the computational reasoning processes that underpin CDSS. The final chapter of this section looks at how CDSS knowledge is created, through machine learning, data analytical and computational discovery methods. Part 8 – Specialized applications for health informatics The latest chapters of the book explore some of the specialized ways in which decision-making technologies are used in clinical practice. They find application in creating intelligent patient or autonomic therapeutic devices such as self-adjusting patient ventilators. Together with communication technology, CDSS are important components of public health and biosurgery systems. In the field of bioinformatics, human genomic and metabolic knowledge is utilized using computer techniques, and reframes many classes of clinical decision-making as questions of genetics. When such bioinformatics knowledge is used in clinical practice is often described as personal or precision medicine, and this topic is covered in its own chapter. The book concludes, not on a minor topic, but on one of the most transformative both for computer science as well as health care delivery - the emergence of consumer ownership and engagement in the process of care, and the role that computer science must play in making this necessity a reality. In 1995, a 100,000 was published in 1995. Medical computer science. In 1999, an article was published in the British Medical Journal 310. In 1995 he was exposed in 1995. The synergism of health / medical informatics revisited. Methods of information in medicine 34(5): 441-445. 