Clinical Informatics Study Guide

Text and Review

John T. Finnell
Brian E. Dixon
Editors

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Foreword

Information is not just necessary for delivering care, information arguably *IS* care. Although some clinicians, e.g., surgeons or physical therapists, do a lot with their hands, most of us clinicians work with our heads. We spend practically all of our time collecting, managing, processing, and transmitting information. This is a ubiquitous notion: Gonzalo Vecina Neto, the head of Brazil's National Health Regulatory Agency, has publicly stated, "There is no health without management, and there is no management without information." Amen to that!

In the 1960s, there was a well-known catchphrase "the medium is the message." First introduced in *Understanding Media: The Extensions of Man* by Marshall McLuhan, the notion was that the medium in which a message is conveyed has as much impact on individuals and society as its content. This is most evident in health care where managing patient care requires as much or more information from patients' health records as from patients directly. Information *IS* health care.

Most undergraduate medical education does not appreciate this. Medical students spend more formal didactic time memorizing Krebs' tricarboxylic acid cycle (and promptly forgetting it after the test) than being trained how to find, manage, and make sense of patient information and medical knowledge. They spend more time memorizing the names of the foramina in the skull than learning how to identify their patients' problems and their management. Heretofore, clinical information management was a skill students picked up indirectly through digging haphazardly through whatever chart or electronic health record (EHR) system is available. Forty years of EHR research and development yielded a lot of data about their potential capabilities and benefits, but realizing these benefits required informal approaches to attaining EHR implementation and management that were scattered and poorly organized, if extant at all. There is a huge gap between the possible benefits of EHRs and the benefits realized by clinicians and health systems to date, enhanced by the US government that, through the HITECH Act, has invested billions in EHR systems resulting in three-quarters of US hospitals and more than half of the physician practices now having an EHR. Optimized for managing health system logistics, these EHR systems have disappointed and often frustrated clinicians whose innate,

human capability to access and manage cogent patient information has not improved and indeed may have worsened after installing EHR systems.

As with any major infrastructure or cultural change, hiccoughs are likely to occur. So it is not unexpected that health systems and clinicians would struggle to rapidly replace their paper-based information management systems with electronic ones. Workflows optimized using paper-based records became dysfunctional with EHRs. Alleviating clinicians' frustrations with EHR systems and reaping the benefits of EHRs and other health information technologies cannot and will not happen spontaneously. They need shepherding. Someone has to be responsible for the information environment in which clinicians practice, someone with deep knowledge of both clinical medicine and health information technology. It was therefore timely, if not perhaps overdue, when the American Board of Medical Specialty (ABMS) formally established clinical informatics as a formal physician subspecialty in 2011.

Diagnostic radiologists and surgical pathologists do not usually provide direct patient care. Yet their clinical specialties are essential for other clinicians to make treatment decisions. Similarly, the clinical informaticist's role is not one of direct patient care but to provide the right information to the right clinicians at the right time in the right way for patients to receive the highest quality and safest care. To accomplish this, clinical informaticists must be broad generalists in both medicine and informatics. They must have a good understanding of the practice of medicine across all specialties and in all inpatient and outpatient practice venues. They must understand workflows of health care delivery, the messiness of clinical data which can be missing and even wrong, and how health care providers must tolerate the uncertainty that accompanies each decision made and each action taken. Similarly, clinical informaticists must understand how each datum is generated, stored, transmitted, and processed to yield useful information. They must have a sufficient depth of technical knowledge to help health systems make decisions about purchasing and implementing EHRs and other health information technologies. Finally, clinical informaticists must understand organizational behavior and management to allow health data and meta-data enhance efforts to improve the quality, safety, and efficiency of health care. Because information *IS* care!

Forty years of rapidly evolving health information and information technology has characterized the field of clinical informatics. The editors and authors of this textbook on clinical informatics have collated and organized that information into a compendium of the field that will both inform budding clinical informaticists while defining the knowledge gaps that need filling. It is a journey into a young and exciting field where change is constant and an uncertain path lies before us. We will certainly be "sailing the ship while we are building it," but the knowledge and wisdom in this book will light the way, illuminate the shoulders that current and future clinical informaticists will stand on to give our patients, our country, and our planet the high-value health systems they want, need, and deserve.

Indianapolis, IN, USA William M. Tierney, MD

Preface

Although the need for managing data and information in medicine is centuries old, the medical subspecialty of clinical informatics has officially been in existence since 2011. During the process to becoming a clinical subspecialty, as well as the years following recognition by the American Board of Medical Subspecialties, we repeatedly discussed with each other the need for a foundational text to specifically support the preparation of the emerging, new generation of clinical informatics leaders. As we taught this content to our graduate students, we struggled to find a single text that sufficiently covered the core content. We therefore embarked upon a journey to create this text with the intent that it will be a useful resource for trainees in clinical informatics fellowships, clinicians who desire to independently prepare for the board exam, as well as those ineligible for the physician board exam but nonetheless are seeking to understand or advance in the field of clinical informatics.

We are so very pleased to have assembled the group of authors represented in these pages. Each of them has contributed significantly to the advancement of the clinical informatics field within their own area of expertise either as a teacher, researcher, practitioner, advocate, or policymaker. They have dedicated many hours preparing and revising the content in this book, and we are honored to serve as editors for their content. We could not have created this text without their assistance in this journey.

How to Use This Book

This book is written to support the formal training required to become certified in clinical informatics. The content is structured to define or introduce key concepts with examples drawn from real-world experiences in order to impress upon the reader core clinical content. This book is not intended to provide comprehensive details on specific informatics systems or components, nor does it go into detail concerning foundational, theoretical concepts drawn from the sciences underlying informatics (e.g., computer science, information science, cognitive science).

The authors were instructed to guide readers through the core content, referencing or directing the reader to additional materials that will provide greater depth. While providing a roadmap for faculty who wish to then go deeper in courses designed for physician fellows or graduate students in a variety of clinically oriented informatics disciplines (e.g., nursing, pharmacy, radiology, public health). This book can also serve as a reference for those seeking to independently study for a certifying examination or periodically reference while in practice.

Structure of This Book

This book is divided into sections that group related chapters based on the major foci of the core content: (1) health care delivery, (2) clinical decision-making, (3) information systems, (4) leadership and managing teams, and (5) professionalism. The chapters do not need to be read or taught in order, although the suggested order is consistent with how we have structured our curricula over the years.

Clinical informatics focuses on the application of computers and information systems to the delivery of patient care and population health. We therefore begin this book with an overview of clinical informatics as a specialty within the larger field of medicine. Chapter 1 defines and describes the history of clinical informatics as a medical subspecialty. It further describes common roles for informaticians in a variety of clinical settings. This is followed in Chap. 2 by an overview of the US health care system. Understanding how health care is organized and delivered is fundamental to those in charge of capturing, storing, and making information accessible to the many clinical and allied health professionals that work in fragmented organizations and facilities throughout the health system. In Chap. 3, the reader will find an overview of the US health policy context, emphasizing laws and regulations that pertain to health care system data and information. It is important for clinical informaticians to understand federal and state laws surrounding health information in addition to the technologies that manage them.

In the next section of this book, we focus on clinical decision-making and the informatics tools, algorithms and systems that support decision-making in clinical contexts. In 2008, Charles Friedman postulated a "fundamental theorem" of biomedical informatics: "a person working in partnership with an information resource is 'better' than that same person unassisted." The theorem succinctly asserts two important themes found across numerous landmark articles: (1) humans are incapable of storing and processing all of the data and information necessary to deliver high quality care in all contexts, and (2) computers should not replace human decision-making. Chapter 4 reviews the complex process of making clinical decisions. To design effective electronic health record systems, one must understand how clinicians make decisions. In Chap. 5, we review how evidence-based knowledge is discovered and transformed into guidance for practicing clinicians. Chapter 6 discusses how CDS systems apply evidence-based knowledge and guidelines to support clinical decision-making processes. Decision-making processes occur in the context of complex clinical workflows. Therefore, in Chap. 7, we review tools

and models for analyzing and modifying clinical workflow. Finally, in Chap. 8, we present a more recent trend in clinical informatics – predictive analytics. Through analysis of larger volumes of data captured in electronic health records, analytics seeks to inform clinicians and health administrators about these key domains in health care delivery: cost, quality, and access.

In the next section, we describe key information systems found in health care settings and discuss the design, development, implementation, and evaluation of systems. Chapter 9 reviews the technical foundations upon which health information systems are built. Informatics leaders will need to make decisions not only about which systems support clinical decision-making but also how systems should be organized, connected, and supported. This chapter will arm clinical informatics leaders with the knowledge and tools necessary for making these kinds of decisions. In Chap. 10, readers will find an overview of the various information systems they will likely encounter and/or manage in their careers. Chapter 11 focuses on standards, technical building blocks that enable interoperability between systems. Supporting and selecting standards is an important role for informatics leaders, because otherwise the clinical information systems implemented will be silos of data unable to support the range of clinicians caring for patients.

The final two chapters of this section focus on the development and implementation of information systems. Chapter 12 describes information system life cycles as well as the governance and ongoing maintenance necessary to keep systems operational. Then in Chap. 13, we focus on the design and evaluation of end users' interactions with information systems. Engineering systems to meet users' needs is critical in health care, because the systems we implement are used in the delivery of care so mistakes in data entry, analysis, or decision support can result in serious adverse events.

In the fourth section of this book, we focus on a critical aspect of clinical informatics: leadership. Clinical informaticians will be looked to within their organizations as leaders: be it team leads for the implementation of information systems or as an executive leader as a Chief Medical Informatics Officer (CMIO). In Chap. 14, we provide a review of various leadership models and guidance on the dimensions of leadership. Chapter 15 covers a wide range of strategies for managing people, teams, and meetings. Then in Chap. 16, we discuss the principles of project management, which includes the tools and theories behind successfully driving both small and large system implementations as well as informatics performance improvement. Chapter 17 focuses on the strategic and financial planning necessary for informatics leaders, especially CMIOs or Directors of informatics departments which will have a budget. Then in Chap. 18, we focus on the management of change because inevitably the introduction of an information system, or the upgrade of a system, requires organizational or personal change. Research in informatics has repeatedly shown that effective management of this change is a critical determinant in the success of the system.

In the final section of this book, we go beyond the core domains of clinical informatics. The chapters in this section focus on related, "sister" branches of the larger field of biomedical informatics. Understanding these aspects of biomedical informatics is important for clinical leaders, because (1) clinical informaticians will

likely interact with specialists in these areas in the course of their daily activities, and (2) these areas are increasingly interconnected to the practice of clinical informatics. Chapter 19 focuses on consumer health informatics which supports the increasingly important function of patient engagement. New technologies and tools are available to put patient data and information into the hands of patients and their caregivers. Collaboratively, clinicians and patients can work to improve health and well-being while supporting patients' preferences in their care plans. Then in Chap. 20, we explore public health informatics. Population health is booming, and public health agencies have decades of experience analyzing population-level data and implementing interventions to improve the health of populations. Understanding the systems, methods, and challenges in public health agencies informs clinical informaticians' work while identifying community partners who can collaborate on improvements to health care delivery as well as outcomes.

There are a number of other related informatics disciplines we were unable to include in this book at this time. For example, translational biomedical informatics focuses on integrating data and knowledge from across the biomedical spectrum to support patient and population health. Such approaches will be necessary to make the goals of the US President's Precision Medicine initiative (https://www.whitehouse.gov/blog/2015/01/30/precision-medicine-initiative-data-driven-treatments-unique-your-own-body) a reality. We hope to include these additional areas of interest in the next edition of this book, by which time they will likely be recognized as core content and part of the clinical informatics board exam.

Structure of Each Chapter

Within each chapter, the reader will find a number of sections designed to support understanding of the core content in clinical informatics. Nearly all chapters begin with a clinical vignette, or story that illustrates at least one key lesson. The vignettes add context and depth and are drawn from real-world experiences of the authors. In addition to vignettes, we pushed authors to include illustrative figures, tables, and boxes to reinforce the main content of the chapter. Each chapter further highlights the core content covered in the chapter to demonstrate which sections of the board exam are contained in the chapter. Finally, chapters include discussion questions aimed at sparking dialogue in formal courses or fellowship programs.

Statement from the Editors

We hope that you derive both knowledge and enjoyment from this book. Clinical informatics is our passion, and we are delighted to share it with you. It is our hope that this book can support independent learners as well as many cohorts of clinical informatics fellows. It will take hundreds of clinical informatics specialists and

many thousands of informatics-savvy clinicians to design, develop, implement, and use advanced information systems to improve patient and population health around the world. We hope this book plays a role in making that vision a reality.

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Part I
Fundamentals

Chapter 1
Clinical Informatics: Emergence of a New Profession

Edward H. Shortliffe, Don Eugene Detmer, and Benson S. Munger

Introduction

The roots of the applied informatics discipline date to the 1960s, when hospitals and other health-related entities first began to adopt the data processing capabilities that were taking hold in other aspects of business and science. Since the funds required to adopt such methods were substantial – this was the era of expensive mainframe computers before time-sharing or personal computers had been introduced – it is not surprising that the principal uses of computers were in large hospitals and that the applications were motivated either by clinical care or business operations. Thus the beginnings of clinical informatics can be identified some 50 years ago and the expertise in the area has had a half-century to evolve and mature – while it has also tracked the remarkable changes in technology as well as in the delivery and financing of health care that have occurred during that same period.

As growing numbers of individuals began to work at the intersection of computing and medicine, sometimes obtaining formal training in both areas, it became clear that a new profession was emerging – one that focused less on research and more on the effective practice of applied clinical computing and information management. Many questions arose regarding such individuals – questions that were vigorously discussed by early in the first decade of the new century. How might

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mid-career individuals get training in the area? Was it really necessary for them to go back to graduate school full-time? Was there a role for informatics as an area of subspecialty training for physicians who wanted to devote major portions of their careers to work in the area? How could an individual demonstrate to employers (typically health systems, hospitals, or other health-related entities) that he or she was qualified for a formal position in clinical computing, focused on practice, strategic planning, and implementation rather than on research? Might there be a suitable way to get certified in the area without needing to return to school to get a formal graduate degree?

Although these questions were asked by individuals from a wide variety of health professional backgrounds, they became especially pertinent for physician informaticians, driven in part by the creation of chief medical information officer (CMIO) positions occurring within a culture of recognized medical specialties. In this chapter we summarize what happened to address and answer these questions, culminating in the creation of a formal subspecialty for board-certified physicians through the American Board of Medical Specialties (ABMS). With that new subspecialty now in place, the need for formal training options has become more urgent. This volume is intended to help in the education of individuals who are preparing for their clinical informatics board examinations or who wish to refresh their knowledge of the field from time to time after they have been certified. Although the focus is on physicians who are eligible for formal ABMS certification, there are many other kinds of professionals who work in clinical informatics and the book will be valuable for them as well. Later in this chapter, we discuss efforts to create alternate certification pathways for individuals who work in the area but are not eligible to take the ABMS board examination.

Although this volume is intended for practitioners and does not prepare individuals to become researchers in clinical informatics, it does convey a body of knowledge and experience that is useful to researchers in the field, since all informatics research is driven by a desire to address real-world problems from the areas of public health, clinical care, or biomedical research. Accordingly, although readers will notice references to the clinical subspecialty for physicians throughout, the book is intended for a wider audience as training and certification options broaden beyond those available for practicing physicians.

Clinical informatics is an applied sub-discipline of the field of *biomedical informatics*, which has been defined by the American Medical Informatics Association (AMIA) as "the interdisciplinary field that studies and pursues the effective uses of biomedical data, information, and knowledge for scientific inquiry, problem solving, and decision making, motivated by efforts to improve human health" [1]. The term *clinical informatics* refers to practice in health care settings where the concepts of informatics are applied to the care of both individuals and populations. With the advent of widespread use of electronic health records (EHRs), it is now possible to manage populations of patients routinely, thus bridging a gap between personal and population health that has existed for over a century. This is one of the transformative aspects of clinical informatics as a discipline.

In 2009, AMIA published two key papers that introduce the notion of a clinical subspecialty for informatics physicians [2, 3]. They emphasize that clinical informaticians use their knowledge of patient care, combined with their understanding of informatics concepts, methods, and tools:

- To assess information and knowledge needs of heath care professionals and patients;
- To characterize, evaluate, and refine clinical processes;
- To develop, implement, and refine clinical decision support systems;
- To lead or participate in the procurement, customization, development, implementation, management evaluation, and continuous improvement of clinical information systems.

This volume, then, introduces and summarizes those concepts, methods, and tools, offering case studies and illustrations of both effective approaches and those that have limited the success of the field to date.

History and Development of Clinical Informatics as a Medical Subspecialty

Clinical informatics developed over a period of decades as computing and computer systems entered hospitals and clinics — primarily for billing purposes but also for laboratory results management and, in particular, for results reporting. A first-generation of clinicians emerged who were sufficiently interested in computing and computer science that they undertook formal study in these disciplines and then worked as researchers or practitioners at the intersection of computing and clinical care. By the early 1970s, the U.S. National Library of Medicine had begun to fund both research and the training of researchers in the emerging discipline. National meetings engaging those sharing these interests emerged during the late 1960s and 1970s. It was the introduction of an annual Symposium on Computer Applications in Medical Care (SCAMC), beginning in 1977, that served as a particularly important catalyst to the creation of a national community that, in time, became known as the *medical informatics* community. By 1984, the American College of Medical Informatics (ACMI) formed as an honorific society in which peers elected future members based upon their contributions to the field. Building on a smaller professional society known as the American Association for Medical Systems and Informatics (AAMSI), AMIA was formed in the late 1980s through a formal merger of ACMI, AAMSI, and SCAMC. AMIA quickly became the professional home where both senior and junior informaticians, including those focused on clinical care, could present their work as well as find out what was current in the field. Such informatics specialists were not necessarily physicians, however. From the beginning, AMIA welcomed all health professionals, and other scientists (e.g., computer scientists, decision scientists, cognitive scientists, sociologists) with an interest in

the application of computing and communications technology in health and health care. The term *informatics* was still new in the 1980s, and many workers in applied settings such as hospitals referred to what they did as "health information technology" (HIT or *health IT*). The HIT and health IT designations are still common today and at times have led to confusion regarding the relationships between clinical informatics and health IT. There has also been confusion at the international level in that most other countries have come to refer to HIT as HICT or health ICT, explicitly mentioning "communications" in addition to "information." Today the U.S. HIT community has a large trade organization known as the Health Information Management Systems Society (HIMSS), whose annual conventions often attract clinical informaticians who want to interact with colleagues and track the newest technologies and products. AMIA, with its own annual informatics meeting, has complemented and cooperated with HIMSS while attracting a more scholarly audience, including both researchers and professionals who look beyond the technology to educational needs and the conceptual underpinnings of knowledge and information management in health care settings.

Defining the Characteristics of the Profession

Following the release of a professional code for informaticians in 2004 [4], AMIA held a Town Hall meeting during its annual symposium to discuss the matter of formal training and certification in clinical informatics, regardless of one's area of clinical expertise or even one's previous health professional training, if any. The goal was to approach clinical informatics as an integrative discipline across all of health care. Further, the AMIA Board decided to begin its formal efforts with just one of the health professions rather than to try to mount a certification effort across all disciplines at once. The decision meant that AMIA would first pursue certification for physicians and then, with insights and lessons from that effort, pursue interprofessional certification for other clinical informatics experts (see the discussion of this topic at the end of this chapter). It made sense to start with MDs because many existing clinical informatics subspecialists were also physicians, board-certified in one of the major clinical specialties (e.g., internal medicine, surgery, pediatrics, radiology) and because the notions of specialist and subspecialist, and the processes for their certification, were familiar and well defined. A subspecialty, in this context, is a field of narrower concentration for someone who is already certified as a specialist. For example, cardiology is a subspecialty of internal medicine. As was successfully argued, clinical informatics can be viewed as a relevant subspecialty for physicians trained and certified in any of the standard specialties — i.e., they may appropriately work in clinical informatics regardless of their primary training and practice.

Any new discipline within the medical profession, seeking to obtain support for formal specialty or subspecialty status from medicine as a whole, must first convince other medical specialists and subspecialists that the discipline is worthy of

such designation. Thus three critical sets of players were involved in addressing the challenge that faced AMIA:

- First, clinical informatics needed to be viewed formally as a separate discipline by other medical specialty groups. Such recognition is evident when a nationally recognized organization that represents the rising discipline is elected to formal membership in an organization such as the American Medical Association (AMA) or the Council of Medical Specialty Societies (CMSS).
- Next, the subspecialty needs to be recognized by the American Board of Medical Specialties (ABMS). ABMS is an umbrella organization for the certifying boards in all the various specialties and subspecialties of medicine; it formally recognizes specialties and subspecialties and also, through its constituent boards, creates and maintains the certification examinations that attest to the competence of medical subspecialists.
- Third, the Accreditation Council for Graduate Medical Education (ACGME) must be engaged since the ACGME exists in large part to review and accredit training programs capable of preparing candidates to sit eventually for the certification examinations of the constituent boards of the ABMS.

Accordingly, the President of AMIA approached the officers of CMSS to determine if they would consider making AMIA a member of CMSS. CMSS is an organization whose purpose is to provide a forum for collaboration among medical specialty organizations to influence policy, medical education and accreditation from a broad, cross-specialty perspective. Within a few months, AMIA had been elected to membership in CMSS and its President, Don Detmer, was elected to serve as its Treasurer. He went on to participate actively at meetings of the organization.

In the late summer of 2006, John Lumpkin, Vice-President of the Robert Wood Johnson Foundation (RWJF), partnered with Detmer to request an informal meeting with the presidents of a number of medical specialty societies to discuss the potential for creating a new clinical informatics subspecialty. The result of this meeting was an expression of genuine enthusiasm for pursuing its development, although it was recognized that a number of formal steps and approvals would be required before an ABMS-approved certifying examination could be created for the discipline.

By March 2007, RWJF had awarded AMIA a grant to develop two key documents essential for formally approaching ABMS for review and approval as a new subspecialty. Through that grant AMIA engaged Benson Munger, a former executive director of the American Board of Emergency Medicine, to help to guide the process. Separate task forces were appointed to address the core content of the field [2] and fellowship training requirements [3]. Reed Gardner (chair) and J. Marc Overhage (vice chair) were selected to lead the Core Content Task Force, while Charles Safran (chair) and Michael Shabot (vice-chair) assumed leadership of the Training Requirements Task Force. Over a number of months in 2007–2008, the task forces created documents that were reviewed and approved by the AMIA Board of Directors and, along with a descriptive piece by Detmer and Lumpkin [5], all three were published in the *Journal of the American Medical Informatics Association* (JAMIA) in 2009.

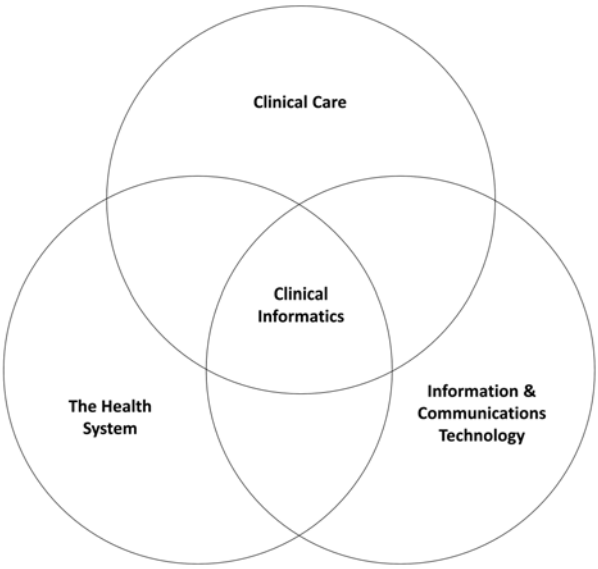

Fig. 1.1 Domains of clinical informatics (Reproduced from Ref. [2] with permission from the American Medical Informatics Association and the Journal of the American Medical Informatics Association)

A number of key concepts were critical at this early development stage. Clinical informatics is intrinsically an integrative discipline. This was acknowledged by appointing non-physician clinical informaticians to each AMIA task force, where they functioned as full members. There was representation from nursing, pharmacy, and dentistry. The groups also emphasized the concept of a learning healthcare system committed to the principles outlined in the IOM reports, *Crossing the Quality Chasm* (2001) and *Health Professions Education: A Bridge to Quality* (2003) [6, 7]. Equally important, the role of a clinical informatician was to take both a clinical view and a systems view, emphasizing that qualified subspecialists should be capable of leading organizations strategically as well as tactically with respect to all major aspects of integrating information and communications technology with information needs as they might evolve over time. A key visual was created to represent this perspective (Fig. 1.1).

Seeking Approval for the Clinical Subspecialty

The next step in the process was to identify one or more ABMS boards that would agree to propose the formal creation of a clinical informatics subspecialty. Leveraging his role on CMSS, Detmer began to approach the leaders of the various specialty societies, and in turn their cognizant boards, to discuss the possibility that they would handle the formal proposal process and, if successful, assume responsibility for the certifying board examinations that would follow. Although many Boards were supportive and expressed an interest, it was the American Board of Preventive Medicine (ABPM) that was most interested in submitting a formal

proposal and becoming the administrative board. As Detmer left his AMIA role in 2009, his successor, Edward Shortliffe, assumed the responsibility for working with the ABPM to finalize a plan. Meeting with their cognizant board committee, Shortliffe presented the case, supported by Munger and AMIA staff. ABPM would assume significant costs if they were to propose a new subspecialty that they would oversee, and they needed assurance both that there was a good chance the subspecialty would be approved by ABMS and that a significant number of individuals would be interested in sitting for the certifying exam when offered.

Verbal support from other boards was helpful in reassuring ABPM that there was enthusiasm within ABMS for the creation of the new subspecialty and AMIA gathered suitable data to help to demonstrate the potential demand for such a certifying exam. In addition, in mid-2009 at the meeting of AMIA's Academic Forum in Colorado, Shortliffe invited a senior leader from ACGME to meet with informatics program directors who, up until then, were most familiar with requirements for graduate (MS and PhD) education and generally had less familiarity with formal fellowships that would need to be accredited if trainees were to become board-eligible within the ABMS certification model. The interactions at that meeting were crucial, not only because informatics educators began to understand the ACGME accreditation model but because ACGME leaders began to realize that, if they were involved in accrediting informatics fellowships, they would encounter many issues that had not arisen previously. There were, for example, questions of whether masters' degrees would be required or optionally offered to clinical informatics fellows in training and how or whether that option would be assessed by ACGME. Most fellowships have both clinical and research requirements, but what was "clinical time" for a clinical informatics fellowship? Perhaps it could be a service component that affected clinical programs at the affiliated medical institution? Unlike most fellowships, it was unclear what a "direct patient care" component would be. Since fellows could come from a variety of clinical backgrounds and specialties, it was not reasonable to expect the informatics fellowship formally to provide a panoply of direct patient-care opportunities in every specialty. In fact, ACGME began to realize that the creation of a clinical informatics subspecialty would require them to rethink the definition of the term "clinical". Shortly after the Colorado meeting, ACGME leaders began a discussion of this question, leading to the formal adoption of a new, expanded definition that was approved by their board and placed on the ACGME web site in 2009 [8].

> The word "clinical" refers to the practice of medicine in which physicians assess patients (in person or virtually) or populations in order to diagnose, treat, and prevent disease using their expert judgment. It also refers to physicians who contribute to the care of patients by providing clinical decision support and information systems, laboratory, imaging, or related studies.

This new definition became an extremely important factor in the subsequent discussions with ABMS as the subspecialty proposal was being considered.

By the autumn of 2009, the leadership of the ABPM had approved a plan to propose the new subspecialty to ABMS. As is customary for new subspecialties, there was to be a 5-year "grandfathering" period during which active clinical informaticians who were also ABMS-certified physicians could apply to be deemed board