The Practice of Informatics

Forum Paper ■

Are Medical Informatics and Nursing Informatics Distinct Disciplines?

The 1999 ACMI Debate

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A b s t r a c t   The 1999 debate of the American College of Medical Informatics focused on the proposition that medical informatics and nursing informatics are distinctive disciplines that require their own core curricula, training programs, and professional identities. Proponents of this position emphasized that informatics training, technology applications, and professional identities are closely tied to the activities of the health professionals they serve and that, as nursing and medicine differ, so do the corresponding efforts in information science and technology. Opponents of the proposition asserted that informatics is built on a re-usable and widely applicable set of methods that are common to all health science disciplines, and that "medical informatics" continues to be a useful name for a composite core discipline that should be studied by all students, regardless of their health profession orientation.

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At the 1999 Annual Symposium of the American Medical Informatics Association, the American College of Medical Informatics presented its fourth biannual debate. Dr. Charles Friedman of the University of Pittsburgh organized the debate to focus on professional training and professional identities in informatics. As with previous ACMI debates,[1–3] the issues were intentionally polarized on a specific proposition:

> *Resolved:* Medical informatics and nursing informatics are distinctive disciplines that require their own core curricula, training programs, and professional identities.

This is a classical debate, the purpose of which was not to achieve consensus or to declare a winning or losing debating team, but rather to bring attention to contemporary views of the similarities and differences of the health-related disciplines involved in informatics training, research, and development. What follows is an edited transcript of that debate.

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Introductory Comments

Dr. Masys: I would like to introduce this event by reminding you that our debate topic is the proposition that "medical informatics and nursing informatics are distinctive disciplines that require their own core curricula, training programs, and professional identities." If we parse that sentence, there are some embedded questions. The first is the notion of a core curriculum. I wondered as I read the proposition whether we really know what the core knowledge of medical informatics is, to be able to put it into a curriculum. How would we know whether we needed distinctive curricula if we didn't have a sense of the bounds of a core curriculum in the first place. It seems to me that this is one unanswered question that could be explored in the debate.

The second is the issue of training programs. In reading the proposition I wondered how similar or different our current training programs are, and I hope we will hear a bit about that as well. And, last, there is the question of professional identity. In a fundamental sense, the notion of what constitutes one's professional identity is an interesting sociologic and socialization process, particularly as students gradually become professionals and practitioners.

It is important to realize that, although we have listed nursing and medical informatics as the issues to be discussed, in this case we take nursing as the surrogate for all the evolving subdisciplines of health-related informatics that are not traditionally and specifically medical. These include dentistry, psychology, allied health professions, and health sciences librarianship, which is in the overlap of knowledge management and clinical activities. We hope that you think of this debate not as "the doctors versus the nurses," but rather as a general issue that is more than "lumping" or "splitting" in our field.

I think we are asking some relatively deep questions: How much of the knowledge and methods of informatics is reusable across the topical domains that we address? How much is not reusable and necessarily defines a subspecialty? And is the socialization process that establishes one's professional identity in the health professions a "vestige of a prior civilization?" At what point in one's career does one say, "I am not primarily a doctor or a nurse or allied health professional; being an informatician is my primary job."? A number of us have had that epiphany during our careers. I suspect that a number of people in this audience have had that experience, and that more will have it in the future. When you have such a turn in your career, when you see that your major emphasis, your loyalties, your "instincts," your allegiance, and your professional skills are focused on knowledge management and informatics, then with what new group do you identify?

And last, we have to ask whether our field is sufficiently mature to be able to thrive in the face of what might be viewed as disciplinary splintering or compartmentalization. Many people outside the field of informatics either are completely without a clue as to what the word means, or they mistake it for technical support for personal computers and networks. To the extent that we have a nonunified view of what we do as professionals, I think we suffer and perpetuate an identity crisis.

Those who address both the explicit and the more general issues of the proposition are a very empowered group of debates. The affirmative team includes Patti Brennan, RN, PhD, who is Professor of Engineering and Nursing at the University of Wisconsin and also our AMIA President Elect. She is joined by Milton Corn, MD, who is Associate Director for Extramural Programs at the National Library of Medicine and Dean Emeritus of the Georgetown University School of Medicine.

For the negative, the team is made up of Judy Ozbolt, RN, PhD, who is Professor of Nursing and Informatics at Vanderbilt University, and Ted Shortliffe, MD, PhD, who is Professor of Medicine and Computer Science, Associate Dean for Information Resources and Technology at the Stanford University School of Medicine, and soon to be Chair of the Department of Medical Informatics at Columbia University.

Under our rules of engagement, each person will have the opportunity to present a prepared statement and rebut the prepared statement of one of the opposing team's members.

Statement in Support of the Proposition

Dr. Brennan: Resolved: Health informatics is fundamentally, at its core, disciplinary based. Of course! It is a fundamental principle of medical informatics that knowledge is inseparable from the strategies and structures used to represent it. Carol Friedman tells us that natural language processing requires decoding *both* syntax and semantics to convert text to computerized representations. Therefore, it is both essential to understand the base clinical disciplines that make up the various subfields of health informatics and impossible to construct a single, overarching field of health informatics that is anything but a concatenation of these subfields.

Nursing and medicine are fundamentally different disciplines. I offer definitions of each of the professions: Nursing is the diagnosis and treatment of human response; the informatics applications therefore should support the specialized knowledge and essential communications needed to accomplish this. Medicine is the practice concerned with the maintenance of health and the prevention, alleviation, or cure of disease; the informatics focus then becomes maintenance of health and management of disease.

Additional evidence of the unique, nonoverlapping nature of the subfields of health informatics arises from the nature of the clinical languages and clinical practices. Judy Ozbolt found that existing vocabularies are not adequate to represent all of nursing, but when she developed the 1999 Vocabulary Summit she involved 85 percent nurses. Sue Bakken discovered that the best-performing formal language still provide terms for only 70 percent of the concepts needed in nursing. In the practice arena, both medicine and nursing contribute uniquely to health care. One must be careful to note that proximity, while it does not preclude parallelism, does not presuppose parity.

Discipline shapes the human and informational networks we establish, ones that promote interconnections among the elements we view as essential to health and health care. The fundamental difference between these two fields jointly engaged in health care demands fundamentally different informatics tools.

Therefore, it is essential to examine the disciplines to understand the phenomena of concern and thereby gain guidance for the development of informatics applications. Since knowledge is inseparable from its structure, informatics must be anchored in the knowledge of the discipline. Health informatics from its inception has always been disciplinary. We look to the words of great mean in our field to confirm this observation. The eminent physician, Morris Collen, said years ago that medical informatics is the application of computers, communications, and systems to medicine. The esteemed doctors Greenes and Shortliffe say that medical informatics must support medical practice, and since medicine is a recognized and respected discipline, it defines for itself what medicine comprises.

The problem is not whether the disciplinary orientation of health informatics exists; it is the singularity of discipline around which *medical* informatics is organized. The migration of informatics to health care through the filter of medicine has left a legacy of elementalism attributable in part to the reductionism philosophy that undergirds the science and ap-

proaches to practice that characterize its (medicine's) contributions. Informatics applications are created in the image and likeliness of medicine—a valuable and important base, giving rise to the accepted gold standard for the "best" informatics applications, that is, those that articulate as close as possible to the nature of the clinical service. The culture of medicine is reproduced in the informatics tools we build and the vision of what we consider valid aspects of the systems (who the users are, what the purpose is, and what knowledge is needed for care). We are left with a legacy of systems built for the index discipline of medicine that now must be retrofitted for the distaff disciplines. Relevant knowledge is circumscribed by scientific rationale, and valid stakeholders are defined within a tight power hierarchy. Discipline-specific informatics needs that fall outside the realm of the index discipline of medicine become add-ons, modifications, and future enhancements whose developments and financing are illusive, not essential.

The future of health care, yea, even the health of the population rests on strong professions working together. Informatics is needed to translate knowledge into practice. Knause's work demonstrated that, in the intensive care unit, doctors and nurses must collaborate to improve care. Linda Aiken provided evidence that nursing organization contributes significantly and independently to producing key clinical outcomes. Clem McDonald's group showed that informatics applications that are targeted to the information needs of clinicians improve health care delivery and health outcomes. Gil Kupperman's research demonstrated how alerts directed to the specific concerns of physicians work to ensure that laboratory findings are properly integrated into care.

We need to prevent the collapse of health care as we know it by drawing on our disciplinary resources and organizing them in a unified effort. We need to prevent the collapse of health care as we know it through discipline-specific informatics initiatives that prepare specialists to engage in integration, not ones that prepare generalists to decompose into specialty applications developers.

How fitting that we debate these issues in this beautiful city, the seat of democracy in the free worlds. Our country's motto, "E pluribus unum"—from many, one—firmly demonstrates that quality futures result from strong linkages of clearly bounded units.

Health informatics, with its many disciplines, is good.

Rebuttal to Dr. Brennan's Statement

Dr. Ozbolt: Patti, I must point out that your own arguments deceive you. Even where they are accurate,

they are irrelevant. The issue is not whether medicine and nursing are separate disciplines. We know that they are complementary but distinct. The issue is whether medical informatics and nursing informatics represent separate disciplines. Of course they do not. If we were to build separate disciplines to provide the information that supports what doctors do and provide the information that supports what nurses do, no one would suffer more than the patient. But the physicians and the nurses, too, would be extremely frustrated. We need not have silos of information for medical practice and for nursing practice. Rather, medical informatics is structured not around what doctors do but around the practice of health care, the science of health care, and the basic sciences that support all our work. So the arguments about what doctors do and what nurses do as separate just do not apply here.

Statement Opposing the Proposition

Dr. Shortliffe: Our worthy opponents are supporting a resolution that claims that medical informatics and nursing informatics are distinctive disciplines that require their own core curricula, training programs, and professional identities. It strikes me that this claim is remarkably confused, in that it requires us to make a distinction that fails to take into account the evolution of the field of medical informatics and of the very professional organization (AMIA) that has brought us here today. It is not my intention to spend our time quibbling about naming conventions, but I do reflect with some anguish on the lengthy process that it took for the ''medical informatics'' name to be introduced, popularized, and finally accepted as the label for our shared discipline—and as a key component in the name of our organization. Let us avoid reopening that can of worms and instead reach a common understanding of both the ties that bind us in the field and the various ways in which individuals will emphasize different skill sets and application interests in defining their own niches in medical informatics.

I trust we would all agree that medical informatics is intrinsically entwined with the substance of biomedical science—including medical practice and nursing practice (as well as several other areas of endeavor). As Scott Blois pointed out years ago in his landmark book, *Information in Medicine*,[4] medical informatics determines and analyzes the structure of biomedical information and knowledge, whereas biomedical science is constrained by that structure. Inherently interdisciplinary, medical informatics melds the study of computer science, decision science, cognitive science, and other basic fields with analyses of biomedical information and knowledge, thereby addressing specifically the interface between these component sciences and biomedical science.

It is my view that medical informatics is best viewed as the name for a basic biomedical science—one that has a wide variety of potential areas of application. The analogy with other basic sciences is that medical informatics uses the results of past experience to understand, structure, and encode objective and subjective biomedical findings and thereby make them suitable for processing. This approach supports the integration of the findings and their analyses. In turn, the selective distribution of newly created knowledge can aid patient care, health planning, biomedical visualization, and basic biomedical research. Medical informatics is a science that contributes to the work of both physicians and nurses, as well as other health professionals, experts in population health, educators, and molecular biologists.

Medical informatics is, by its nature, an experimental science—one characterized by posing questions, designing experiments, performing analyses, and using the information gained to design new experiments. One goal is simply to search for new knowledge— hence my suggestion that it is best viewed as a basic research field. But the second goal is to use this knowledge for practical ends—application research. There is a continuity between these two endeavors. In medical informatics, there is an especially tight coupling between its application areas and the identification of basic research tasks that characterize the scientific underpinnings of the field (Figure 1).

We have names for the areas of application that are based on medical informatics principles and that help identify the fundamental research questions in the field. These include clinical medicine informatics, nursing informatics, dental informatics, veterinary informatics, imaging informatics, public health informatics, and bioinformatics. The first four of these are often lumped under the general term clinical informatics because they share a common focus on the care of patients. In general, medical informatics researchers derive their inspiration from one of these application areas, identifying fundamental methodologic issues that need to be addressed and testing them in system prototypes or, for more mature methods, in actual systems that are used in clinical or biomedical research settings.

One important implication of this viewpoint is that the core discipline is the same, regardless of the area of application that an individual is motivated to address (Figure 2).
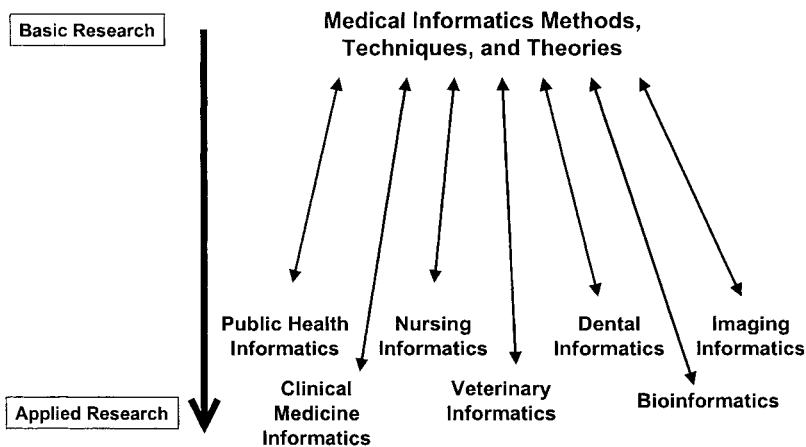
Figure 1 Medical informatics can perhaps best be viewed as the name of a basic research discipline that constitutes the methods, techniques, and theories that support a wide range of application domains. Medical informatics researchers typically choose to specialize in one of these application areas, although their basic contributions may well be relevant to other areas of application as well. Their applied contributions generally benefit a biomedical field, such as those shown as examples at the bottom.

This argues for unified medical informatics educational programs, ones that bring together students with a wide variety of applications interests, including nurses and physicians, working together on courses in the core curriculum. Elective courses and internships in areas of specific interest are, of course, important complements to the basic core exposures that students should receive, but given the need for teamwork and understanding in the field, it would be counterproductive and wasteful to separate trainees on the basis of the application area that may interest them. This may be especially true for nurses and physicians, since their unique perspectives are complementary and a unified viewpoint is often crucial in the development of effective and acceptable clinical systems.

So let us at last accept the notion that medical informatics is the name of our composite core discipline, one that must be embraced and studied by all serious students, regardless of their health professional orientation. Nursing informatics and clinical medicine informatics are important fields for the application of medical informatics concepts, just as are public health
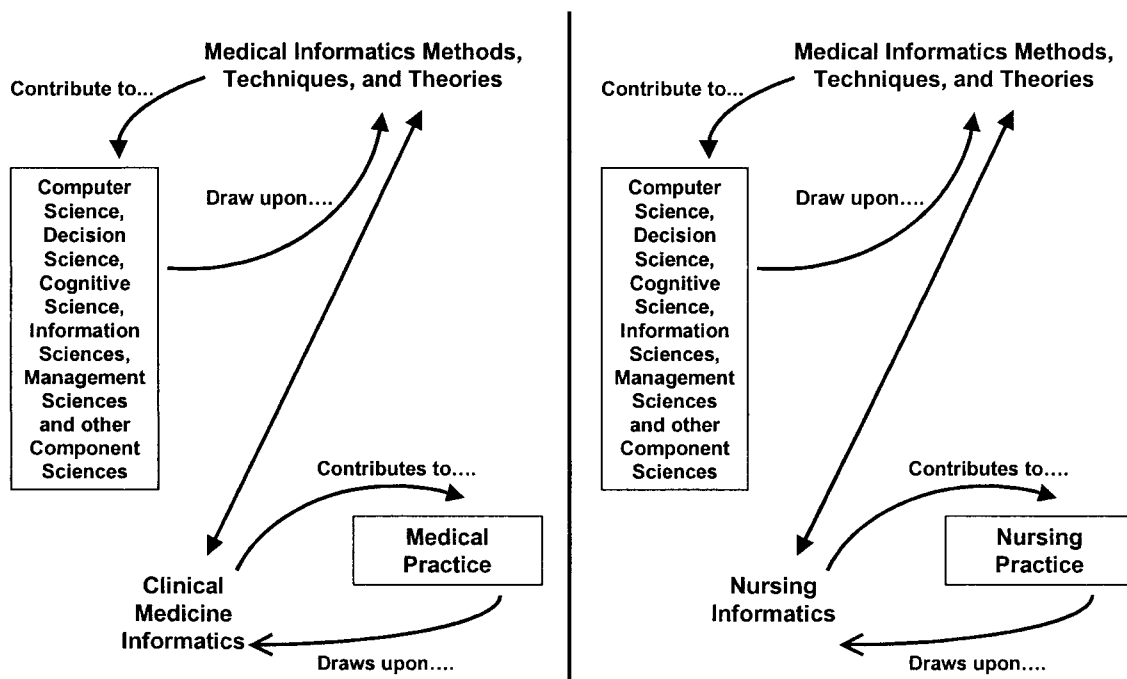
Figure 2 The application areas of medical informatics, such as clinical medicine informatics (*left*) and nursing informatics (*right*), help drive the core research agenda and are motivated by the needs of their application domains (e.g., medical practice and nursing practice, as shown here). Similarly, the interdisciplinary core of the field, unchanging regardless of application domain, both draws on and contributes to the component basic sciences, such as computer science, decision science, and cognitive science.

informatics, imaging informatics, and bioinformatics. Specialized courses in nursing informatics will always be important offerings for students of medical informatics who wish to specialize in the nursing area, and those who specialize in other applied informatics areas should, no doubt, learn basic concepts of nursing informatics as part of their broad introduction to the field. Separating the health profession students as they train to be medical informatics professionals would be misguided and counterproductive, driving an unnecessary wedge between two groups of experts who have much to offer each other and who share a core knowledge base in the component sciences, which include computer science, decision science, cognitive science, information science, and management science.

Rebuttal to Dr. Shortliffe's Statement

Dr. Brennan: Dr. Shortliffe, I thank you for emphasizing that the ties that bind us are conceptual and applied. But those ties must have something to hold on to. And I submit that what they hold on to are the knowledge bases of our disciplines. It is impossible to consider a curriculum that is devoid of content. And that content includes, in part, the substance of the science and the substance of the discipline. I submit that your claim that medical informatics is inherently interdisciplinary is, in fact, true; but again, to be interdisciplinary one must have disciplines to start. It is unclear whether "interdisciplinary" should be the consequence or the starting point. But it seems quite clear, given the evidence that we have about the inability of existing language structures to adequately capture the nursing language, and the amazing surprise and recognition from SNOMED International at the expansion of the flexibility of their vocabularies once nursing terms were entered, to attest to the need for starting, not stopping, at discipline. Now, I agree that the experimental science part of our field is quite important, and it is interesting to watch the development of different kinds of science as we introduce different kinds of scientists. Medical informatics, health informatics, and nursing informatics are both informed by and informing of their core disciplines, and the joy of being at the intersection of disciplinary fields is in part the dynamic exchange of knowledge and process.

We discussed the composite core that must be embraced and studied, and this I absolutely agree is true. But I fear that what we define as a composite core may in fact be heavily influenced by what we believe does the composing. The conductor who strays very far from the score begins to develop a new line of music. So we need to look: What is our core? And we need to look back at the core from which we came.

Statement in Support of the Proposition

Dr. Corn: I remind all that what we are talking about is not computer science, or informatics as a basic science, or the evolution of the field. We are talking about training and education. Such matters are not science, and as I make three simple arguments here, I ask each of you to use your own experience with training and education as a litmus test for the validity of what I am saying. The first argument is from an analogy with other health professions. It seems to me that the most important training period for all other health professions is the period spent applying basic information—applying tools—to a domain of some kind. What distinguishes a surgeon from a gynecologist is not the physiology course both took in the second year of medical school. It is the years spent in applying all that basic information to the field in which they are going to use it, to a real-world situation. Similar things could be said about a pediatric nurse and a coronary care unit nurse. If, in fact, an informatician were merely a servant to his tools, then he would indeed belong to the help desk and would come up when you ring the bell.

A single flavor of education may be feasible for those who fix tools. Informaticians, whom I consider to be specialists who *use* tools to manage information in some real-world field, in an extraordinarily complicated system such as medicine, must have, as an important part of their training, experience in applying tools to a specific domain. An informatician can no more be separated from the field in which he works than can a dancer be separated from the dance. I think the domain is essential, and I think the importance of the specialty training that each of us has had in our own training period emphasizes the validity of what Dr. Brennan has said.

My second argument stems from observation of existing informatics training programs. If there is, in fact, a universal Brand X training program from which a graduate can emerge equipped to move to every corner of the hospital, where is this program? I am familiar with many of the extant programs, at least the ones supported by the National Library of Medicine. Each of them thinks it is good and each of them *is* good. However, I can tell you that over the 15-year evolution of these programs, there has not been a trend toward a single set of courses, a single set of projects, or a single type or distribution of faculty among our programs. I think it is variation in domain

interests that is responsible for a large share of the differences in curricula. If a program director is particularly interested in clinical information management, then, I assure you, the courses that are offered, the projects that are assigned, and the faculty that is around to mentor are all likely to have clinical information as a central theme. Conversely, in a program attempting to produce computational biologists, the coursework, the mentors, and the projects would not be recognizable by the first one. Is one wrong and the other right? Of course not. These programs have *de facto* recognized the integral role of the domain when one is training a health professional at the very highest level. There may well be respect for nursing in a training program, but what is needed is interest in nursing.

Last, I would like to make not an argument but a plea to all of you to remember that when you were in training there was something to be said for role models and mentoring. The facts transmitted during the training period are important, the lectures are important, but I think, too, that the people who do the teaching have much to offer in addition to the specific material of the course work. I also think that students in a training program want and have a right to expect that a substantial number of the people who are showing them how, leading them, and pointing the way to what the future will be are people who have "walked the walk." Professional faculty should have a common language and some common previous training with their students. They should be able to tell the trainees something about what real problems need to be addressed in their future careers. Faculty should give guidance above and beyond the mere technical elements of informatics. Should not nursing informatics training be substantially about nursing information issues?

On those three grounds I would say that those who think that one program fits all are ignoring experience and are in error. As we look over what has actually developed, we must acknowledge that we have no such domain-independent training program. All the other health professions have, in fact, embraced the importance to training of the specific domain to which basic information is to be applied. Nursing informatics deserves the same model.

Rebuttal to Dr. Corn's Statement

Dr. Shortliffe: There are many comments that both Dr. Corn and Dr. Brennan have made to which I would like to respond. First is the suggestion that it is impossible to consider a curriculum that is devoid of content. Of course that is true. But I do think it is very important to distinguish between methodologic training (of a sort that a core curriculum will tend to bring to the trainees in a field) and the more applied courses in which people begin to learn the specific content that applies to a particular area of application. It is extremely important for us to distinguish in this discussion between a fundamental core that is largely methodologic, including techniques that are shared across all these various application domains, and specific application courses that people will indeed need to take as they specialize in their areas of preference or (for those who are from a health profession) areas that reflect their health professional training.

Milt asked us to draw on our personal experience with training and education, and I would like to do that. We have had experience, in our training program at Stanford University, bringing together people with a combination of backgrounds, including the different health professional fields, and treating them identically from the day they arrive. We see tremendous benefit to be gained by having them working on homework projects together in the middle of the night. They bring to bear on those kinds of projects the special perspectives that come from their health professional backgrounds. By observing our students in such side-by-side efforts, we have come to recognize the importance of the unique perspectives (and terminology, too) that someone may bring into our interdisciplinary training environment. It's important for people who may be physicians training in medical informatics to understand the nursing perspective on informatics and how nursing practice guides the perspective and the interests of nurses who are studying the core discipline. I learned this basic lesson as an intern, working with nurses on the wards in hospitals, where I appreciated the importance of that kind of communication and sharing in providing the optimal care of our patients.

Dr. Corn said that informaticians use tools to manage information. And I would say that's not quite right. That is what doctors do. That is what nurses do. Increasingly, informaticians are attempting to *develop* tools, often with novel characteristics, that will be usable by doctors and nurses and other health professionals—and molecular biologists, and geneticists, and epidemiologists. It is that ability to take knowledge of the application domain and apply it to the needs of people who are out there working in the biomedical fields; to bring it to bear in innovative, creative, and responsive design processes that reflect insights from the core discipline; to appreciate the way in which applications drive the work that is done by people in the field—it is this combination of abilities

that allows someone to say, "I am an informatician. I am also a physician." Or, as I hope Dr. Brennan would say, "I am an informatician, and I am also a nurse."

Statement Opposing the Proposition

Dr. Ozbolt: Medical informatics and nursing informatics are not separate disciplines. Rather, as Ted has shown, medical informatics is a tightly integrated discipline with a common core around which many interdependent functional areas revolve. Medical informatics and nursing informatics certainly do not require separate core curricula, training programs, or professional identities. The truth is quite the contrary.

The mission of medical informatics is to support biological and health sciences and the practice of health care in ways that improve knowledge, practice, and ultimately health itself. Neither the best knowledge nor the best care nor the best health occurs when disciplines act in isolation. Health is determined by a complex amalgam of genetics, environment, social and economic conditions, cognition, emotions, relationships, and behavior. Although all health professionals address all these factors to some degree, no one profession or practitioner can address all of them in depth.

The public, policy makers, providers, and payers agree that we must find ways to improve health outcomes while controlling costs. Yet costs continue to rise, and public health problems go unresolved. It will be ever thus—unless and until we stop trying to solve complex problems with the knowledge, abilities, and insights of disciplines acting singly.

Successful health care occurs when all the health care professions unite to create shared understanding and to devise appropriate, economical, and effective solutions that draw on the expertise of all. Effective health care requires an array of professional specialists to work together to create a unified approach in which the efforts of each are informed by and complementary to the efforts of the others.

Such unified care cannot occur when the information infrastructure consists of disciplinary information silos that offer only limited access to out-of-discipline care providers. Unified care requires a unified information infrastructure. To conceive, design, and build such an infrastructure, informaticians require vision and knowledge beyond the boundaries of individual health professions.

Informaticians must know not just the elements of medicine or nursing, but *how physicians and nurses collaborate* to provide patient care. The systems they cre-

ate must support this collaborative process, not the isolated exercise of discrete disciplines. The core curriculum for health informatics then must include analysis of the cognitive, psychomotor, interpersonal, and organizational processes of collaborative practice. This analysis is best understood in an interdisciplinary context, with key contributions from physicians, nurses, and social scientists. As students learn how to apply knowledge from computer science and engineering to the development of informatics applications to support collaborative practice, they and their products will benefit from the perspectives and critique of both nurses and physicians.

Because a unified information infrastructure to support collaborative practice requires interdisciplinary understanding, separate training programs in nursing informatics and medical informatics are ludicrous. Their graduates are not prepared to create adequate solutions to the challenges confronting health care providers. By the same token, separate disciplinary identities for medical informatics and nursing informatics are admissions of inadequate preparation.

The informaticians who can support health care in the new millennium will be trained in interdisciplinary programs to create shared information resources that are viewed from multiple perspectives and put to multiple uses that are not isolated but complementary. Learning to think about the information problems of health care in a way that embraces the various caregiving disciplines is critical. Only then can medical informaticians build the infrastructures to support collaborative care.

Rebuttal to Dr. Ozbolt's Statement

Dr. Corn: Let me follow that up with a reaction to Judy's comment about the ideal hypothetic core curriculum. I think that would be a wonderful curriculum, one that included knowledge, social responsibility, some information about the other disciplines, and something about how people collaborate. Why have none of the existing programs actually done that? Let me tell you what I found when I reviewed what our existing programs have done. Fifty percent had a course called "Introduction to Medicine." None had a course called "Introduction to Nursing" or "Introduction to (fill in the blank)" or any of the other professions that Dan mentioned as being proxies in this debate. Not one said anything about social interactions, and not a single program had a course in cognitive psychology. I was told later that one program does offer such courses but keeps it hidden. I am not suggesting that in some ideal world with a lot of re-

sources one might not develop a universal program to which all could go. But we would be foolish if we did not recognize that this has not been done. It seems unwise for us to postulate, as the model for what we are going to do in the future, universal training programs that have, in fact, not been created by anyone after 15 or more years.

I have a final comment about the basic concept that both Ted and Judy have mentioned—that informatics has a common core for everyone and that if there is, indeed, to be specialization afterwards, a few courses can be taken. I do not believe that. Those specialists whom I respect spent years training in their domains of interest. Ask yourselves what you would do if you developed an acute need for an informatician to address an information management problem on the hospital wards. I do not think you would be asking your average computational biologist to come over to help you. You would want someone who really had paid some dues on clinical information systems. Similarly, domain experience would be critical for informatics problems in other fields. The concept that all informaticians are tool builders for whom a course or two is sufficient to provide expertise in the domain of application seems wrong headed.

Closing Comments

Dr. Masys: I believe we have discovered an interesting proposition here. And that is that if we had to start today without any of the historical baggage of the informatics training programs that already exist and have long track records, what would we invent from scratch for the new millennium for informatics training? Would it look like the existing discipline-based programs, or would it look like a unified approach to all the disciplines, combined with subspecialization electives? I do not have the answer to that question, but would leave you with that as a thought piece for your travels home from this conference.

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