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Research and Education

University of Utah Medical Informatics Research and Training Program

Introduction

The Department of Medical Informatics at the University of Utah is currently a Clinical Department in the School of Medicine. The Department traces its beginnings to 1964 when it was established as the Department of Biophysics and Bioengineering in the School of Engineering at the University of Utah. In 1972, the Bioengineering Department was split into the Department of Bioengineering which stayed in the School of Engineering and the Department of Medical Biophysics and Computing which moved to the School of Medicine. In 1985 the Department was formally renamed Medical Informatics. Homer R. Warner, M.D., Ph.D. was the founding Chairman of the above named Departments and served as their Chair from 1964 until 1996 when Reed M. Gardner, Ph.D. was appointed Chairman of the Department. The University of Utah Department of Medical Informatics is nationally and internationally recognized for its contributions to clinical health information systems, computerized decision-making, evaluation of computerized patient care, and other areas of medical informatics research.

Current education and research opportunities range from basic to applied sciences, and encompass five broadly defined tracks leading to the Master of

Science (M.Sc.) and Doctorate of Philosophy (Ph.D.) degrees. The Department is one of 12 National Library of Medicine (NLM) Medical Informatics training sites in the United States. The NLM Training Grant in Medical Informatics provides one of the rich areas of support for pre-doctoral as well as post-doctoral students at the University of Utah. The Veterans Administration provides some funding for Medical Informatics Trainees. Intermountain Health Care (IHC), the not-for-profit health care organization which owns the LDS Hospital also provides funding for training as well as providing ready access to their clinical facilities for Medical Informatics Trainees.

The present article updates earlier publications about the Medical Informatics Training program at the University of Utah. Warner's review of the Graduate Program in Medical Informatics at the University of Utah in 1994 [1] was part of a broader International Medical Informatics Association (IMIA) Working Group 1 review of six health/medical informatics programs [2]. Two more recent publications have also outlined the strengths of the Medical Informatics program at the University of Utah [3] and a historical perspective of the type of students have been educated at the University of Utah, and where they currently are employed in the academic as well as

industrial workplace [4]. A detailed current description of the academic department is found on the World Wide Web (WWW) at the address indicated [5]. In addition to information about the Department there are instructions about how to apply to become a graduate student, details about faculty, faculty interests, research topics and course outlines and descriptions. Recently, the Abstracts from Master of Science Theses and Ph.D. Dissertations for students who have graduated since 1990 have also been made available at the same Web site [5].

In 1996, a major change in the number and type of students who were admitted to the academic program occurred. Prior to 1996, approximately 8 students were admitted each year, and those students were primarily engineering, computer scientists, and biologist. Since 1996, we have been admitting approximately 15 new students into the program each year, and about 70% of them have been physicians, typically with several years of residency training and several who were "Board" certified in medical fields such as Pediatrics, Internal Medicine, Surgery, Pathology.

Since the program's inception in 1964, there have been a total of 234 graduates. Of those 234, 138 have been awarded a MS degree and 96 have been awarded the PhD. Currently there are 64 graduate students enrolled.

Mission Statement Department of Medical Informatics

The mission of the Department of Medical Informatics at the University of Utah is to improve health care outcomes through the use of information systems (including health, economic, and satisfaction results for consumers and providers) in the private and public sectors of the health care industry [5]. To accomplish this mission, the Department assumes three major responsibilities:

1. Educates medical professionals, medical informaticists, and the health care community in the field of medical informatics;
2. Promotes and conducts research to broaden medical informatics knowledge; and
3. To serve the health informatics professionals and consumers by participating in relevant professional

societies, editorial boards, and continuing education programs, while maintaining medical informatics leadership in the community.

All of these responsibilities involve the active collaboration of faculty and students at the University of Utah, with the School of Medicine, University of Utah Medical Center, College of Nursing, Intermountain Health Care (IHC), LDS Hospital and other related hospitals and clinics, and the Department of Veterans Affairs, especially the Salt Lake VA Medical Center (VAMC).

A brief overview description of each of the five tracks is provided below. Table 1 outlines the Semester Credit Hours recommended for each student to complete a Master of Science Degree. Each student's actual course of study is established by a Faculty Advisory Committee. Each Masters student has a Chair of the Committee and two additional members. For the

Doctor of Philosophy student the Committee is composed of a Chair and four other members. The Chair of each of the Committees must be a member of the Medical Informatics Faculty.

Overview of Departmental Training Tracks

1. Health Information Systems

This track is designed to give students a clear understanding of the requirements, concepts, and methods to design, develop and evaluate health information systems (HIS). Emphasis is placed on implementation of clinical components of such systems and the integration of clinical systems with the more traditional administrative and financial health information systems. Students are provided both course work and practical project experience in working with an operational health

Table 1 - Spreadsheet of Course Offerings, Semester Credit Hours, and Faculty who teach the courses

Summary 2000-2001 Medical Informatics Curriculum 01. Sep 00

Course #	Course Title	Faculty Advisor--> Semester-->	TRACK-->		#1 Health Information Systems		#2 Medical Expert Systems		#3 Genetic Informatics		#4 Health Quality Assurance		#5 Medical Imaging	
			Pincett Fall	Spr	East Fall	Spr	Albright Fall	Spr	Weir/James Fall	Spr	Parker Fall	Spr		
5900	Applications Programming	Sorenson	3	3	3		3		3		3		3	
6000	Medical Informatics Core	Gardner	6		6		6		6		6		6	
6100	Applied Statistics (every 2nd yr)	Horn	2*		2*		2*		2*		2*		2*	
6110	Research Design	Neuhausen		2		2		2		2		2		2
6200	Health Information Sys/Admin	Pincett		3		3					3			3
6220	MI Vocabulary & Standards	Huff		3*		3*		3*		3*		3*		
6230	Networks & Communications	Bray/Sorenson		3*										3*
6300	Medical Decision-Making & Knowledge Engineering	East				4								
6350	Mathematical Modeling (2 Spring)	Clark												
6400	Health - Quality of Care	Weir/James									4			
6450	Primary Care/HIS	Shorr		2										
6460	WWW Design (3 Spring)	Sorenson/Bray												
6500	Genetic Epidemiology	Neuhausen						2						
7000	Graduate Seminar	Gardner	1	1	1	1	1	1	1	1	1	1	1	1
7010	Journal Club (PhD Required) (2Fall/Spr)	Sorenson												
IM7570	Research Ethics	Jacobsen	1		1		1		1		1		1	
	Total Required Hours-->		13	14	13	13	13	8	13	13	13	13	13	9
	As Outlined Total-->			27			26		21		26		22	
6970	MS Thesis Research-->			7		7		7		7		7		7
	As Outlined Total-->			34		33		28		33		29		29
	Minimum MS Total Required Hours			30		30		30		30		30		30
	Computer Programming Course/s													
RN6800	Database Design (4)		4		4		4		4		4		4	
EDPS6300	Statistics & Research Design Ed Psych (3)		3		3		3		3		3		3	

5900 -- is REQUIRED "OR" equivalent course or experience apply
6000 REQUIRED of ALL Medical Informatics Students
 Approximately 15 weeks of classes/semester
 One semester hour = 1 hour of classwork/week
 * = Courses that are taught every other year

information system. For example, students develop and test informatics concepts and strategies using the HELP clinical computing systems located at LDS Hospital and Primary Children's Medical Center. In addition, clinical computing at the University of Utah Medical Center, Veterans Administration Medical Center, and any of the 20 other Intermountain Health Care (IHC) Hospitals and more than 15 clinics serve as laboratories where students can design, develop, implement, and evaluate applications for health information systems.

Based on the fact that many of our Medical Informatics graduates have become Chief Information Officers (CIO) [3], we have joined a consortium of University Departments in a multidisciplinary Health Services Administration (HSA) program. The HSA program is coordinated through the Office of the Vice President for Health Sciences, the Vice President for Academic Affairs, and the Governor Scott M. Matheson Center for Health Care Studies. The HSA program prepares students for administrative positions in policy and planning in both the public and private sectors of health care. The HSA program allows training of our students in the business school (MBA program, accounting, economics), as well as in public administration, public health, pharmacy, social work, nursing, health education, and anthropology. In the normal University curriculum, many of these graduate level courses would not be available to Medical Informatics students.

2. Expert System

This track emphasizes the application of techniques from expert systems research and artificial intelligence to problems in medicine. The students have access to expert systems implementations on stand-alone workstations as well as integrated health care enterprise information systems. Tools developed support both symbolic and

mathematical techniques. Emphasis is placed on developing and evaluating practical tools that enhance the delivery of medical care and contribute to the objectives of medical education.

3. Bioinformatics

This track is designed to give students a thorough training in Bioinformatics, human genetics and statistics. The training is provided through practical work in the methods and software used in analysis of genetic data, and through training in a specific area of the student's choice. The current Genetic Epidemiology group has developed techniques for linking genealogical records with clinical health care records to provide insights into the familial and genetic linkages of diseases. This group found the first two Breast Cancer Genes and has recently found a Prostatic Cancer Gene. In addition to these forms of cancer, the group is working to provide linkages with a wide variety of human illnesses. A very active research group has provided a natural link for the Department of Medical Informatics to become even more active in Bioinformatics.

4. Healthcare Quality

This track emphasizes the application of expert systems and interactive learning modalities to facilitate institutional quality management and to maintain professional competence in the health care field. Students learn to apply computer skills to assist in the basic principles of: (a) quality management, including assessing and improving the effectiveness and efficiency of care; and (b) science information management, including identification of information needs, and retrieval and application of information to enhance the benefits of care.

Because of the Department's long standing affiliation with the LDS Hospital and Intermountain Health Care, the faculty and students have had a very close relationship with IHC's

Institute of Health Care Delivery Research. Dr. Brent C. James, a member of our faculty is the Director of this institute and has worked with our faculty and students to help them with Quality of Care projects.

5. Medical Imaging

This track emphasizes the applications of information processing in medical imaging. Students participate in the Medical Imaging Research Lab (MIRL) with students and faculty from several other departments. Research areas currently include digital X-ray imaging, magnetic resonance (MRI), and optical microscopy. A major activity of the imaging group is to provide high resolution MRI angiography of the brain and heart. These flow angiograms can be made without the injection of radiographic material. Mathematical methods for further improving images are an ongoing and exciting research topic for this talented group.

Faculty

The Department has a total of 37 faculty located at the University of Utah Health Sciences Center, LDS Hospital, Primary Children's Medical Center, Intermountain Health Care, in private industry, and at the University's Research Park. There are 12 Medical Doctors (MD), 17 who hold Doctorate Degrees (usually a Ph.D.), 3 who hold both an MD and Ph.D. Degree, and 5 who are Registered Nurses (RN) and also hold Doctorate Degrees. There are currently 14 who hold the rank of Professor, 14 who are Associate Professors, and 9 Assistant Professors.

By any measure that can be applied, the Department of Medical Informatics has a very outstanding faculty. In the current Faculty there are two members of the prestigious Institute of Medicine of the United States National Academy of Science (Homer R. Warner and Paul D. Clayton). Six members of the

faculty have been elected to the American College of Medical Informatics (ACMI) (Homer R. Warner, Reed M. Gardner, T. Allan Pryor, Paul D. Clayton, Mark H. Skolnick, Stanley M. Huff, and R. Scott Evans) for their outstanding contributions to the field of Medical Informatics. Public service of the faculty in a variety of capacities in the field of Medical Informatics has also been remarkable. For example, two members of the faculty have served as President of the American Medical Informatics Association (AMIA) (Reed M. Gardner, Paul D. Clayton). Three members of the faculty have served on the Board of Directors of AMIA (Homer R. Warner, Reed M. Gardner, Paul D. Clayton). Stanley M. Huff currently serves as Chairman of the HL7 standards group. Homer R. Warner and T. Allan Pryor have served as Editors of Computers and Biomedical Research since the Journal's inception. Reed M. Gardner has served as Editor-in-Chief - International Journal of Clinical Monitoring and Computing. In addition, the time of service of the faculty has been remarkably stable, there are 3 Emeritus faculty (Homer R. Warner, John W. Williamson, T. Allan Pryor) and those with the rank of Professor have an average faculty service of over 25 years.

In 1994 Richard and Carol Fay donated \$1.0 Million to established the Fay Presidential Chair of Medical Informatics at the University of Utah in honor of Dr. Homer R. Warner. In 1999, the Fay's donated an additional \$1.5 Million to fund a second Presidential Chair in Medical Informatics as well as funding for graduate student fellowships. As far as the author knows, these Presidential Chairs are the only such endowed Chairs in Medical Informatics in the United States.

The University of Utah also has faculty in the School of Nursing involved in Nursing Informatics. Because of the key function nurses

have in the health care delivery systems in the United States, the Department of Medical Informatics has established a close working relationship with the University of Utah College of Nursing Informatics program. Three Nursing Informatics faculty are Adjunct members of the Medical Informatics Department and five Medical Informatics faculty are Adjunct members of the College of Nursing Informatics program. This cooperative relationship allows for a collaborative sharing of faculty, courses, and students in research activities.

Honors and Awards

In 1998, in honor of the retirement of Homer R. Warner as Department Chairman, the Department established the Homer R. Warner Award. The cash award of \$1,000 is given each year to the most outstanding paper presented at the Fall American Medical Informatics Association meeting.

In 1983, the John D. Morgan Fellowship was established. This student fellowship, was established by a generous contribution by Dr. John D. Morgan, a former student and faculty member. The Fellowship is Awarded to an outstanding student completing their final year in a Master of Science or Doctor of Philosophy course of study.

Since 1997, the Bruce A. Houtchens Award, with a cash prize of \$1,000, has been presented to a University of Utah student who submits the most outstanding invited paper expressing their original ideas and research or development efforts in the area of health informatics or telemedicine. Students from the fields of Computer Science, Biomedical Engineering, Medical Informatics, Nursing and any other field of health care technology are invited to submit papers. Dr. Houtchens was a former member of the Faculty of Surgery at the University of Utah and the University of Texas at

Houston. He was completing his Master of Science Degree in Medical Informatics at the University of Utah at the time of his death. He and his wife, Dr. Maria Houtchens, now a Surgical Resident at Harvard University Hospital in Boston, were hiking in the hills north of the University when he suffered a fatal myocardial infarction. To honor Bruce's lifetime dedication to Medical Informatics and Telemedicine, Dr. Maria Houtchens established the Award in 1996.

International Partnership in Health Informatics Education (IΦE)

In the Spring of 1999, an International Partnership between the University of Utah, the University of Minnesota in the United States along with the University of Amsterdam, in the Netherlands, and the University of Heidelberg and the University of Applied Sciences Heilbronn, in Germany - our European colleagues, was established. The purpose of this activity was to begin addressing the international scope of Health Informatics. The IΦE partnership is designed to allow students and faculty from any of the Universities to visit, study and perform research at a partner University. Initially there have been exchanges of students to do short-term (3 to 5 month) research projects. In addition, each year a "Master Class," with faculty and students from each of the institutions, meets and discusses current topics. This past summer (August 2000) a group of 20 students and 10 faculty met at a church abbey in the medieval town of Bad Wimpfen (near Heilbronn and Heidelberg) and later at the Medical Informatics Europe 2000 conference in Hannover, Germany. The theme discussed at Bad Wimpfen was "Regional Sharing and Standardization of Patient Data." Master teachers from the University of Utah, University of

Amsterdam and the Technical University of Munich led the discussion. In addition, students made presentations on similar topics as well as on their own areas of research.

In addition to the formal international program described above, the Department has already trained 72 foreign students from Europe, Asia, South America, and the Middle East [3]. Most of these students have returned to their country of origin and are now providing Medical Informatics leadership in their home countries.

Areas of Research and Development

The Department of Medical Informatics at the University of Utah is internationally recognized for its contributions to computer applications in clinical care, medical education, and research. Although the earliest phases of the development of the research strengths of the Department were in understanding and developing physiological models, more recent activities have centered around operational clinical computing systems. Because of the breadth of current research, to give an overview of the Departmental activities, 10 research topic areas are outlined below. Each research topic area is provided with a paragraph or two describing the research and in addition a list of relevant references to provide more depth for those interested in a specific topic.

1. Clinical Systems Applications

The HELP (for Health Evaluation in Logical Processing) system has been the "centerpiece" of developments of the Department of Medical Informatics [6-8]. Initially installed at LDS Hospital, the system is now installed in several hospitals. The HELP system is a clinically oriented system which has become an integral part of the day-to-day operation at LDS Hospital. The

system is unique in that it gathers patient data in a coded format so that the decision support engine can operate on the data and provide interpretations, alerts, reminders and drive patient care protocols. The HELP system has provided a platform for development of a wide variety of clinically applicable tools for improvement of medical care. Evaluations of the acceptance, use and value of clinical computing have been enhanced by availability of the HELP system. Faculty and graduate students in the Department have been the major contributors to the development and operation of the HELP system. Having ready access to the HELP system has provided a major laboratory of Medical Informatics research and development.

Developmental plans are underway to replace the HELP system at LDS Hospital, Intermountain Health Care (IHC, the parent company which owns and operates LDS Hospital and 21 other hospitals) with a Patient Care Management System. This Patient Care Management System is based on a centralized and lifetime patient data repository. The new system is being designed to have all the capabilities of the HELP system, but will also provide a lifetime record, contain data integrated from multiple hospitals and clinics, and will have extensive Data Warehouses to enhance clinical research. Whereas the HELP system was developed on main-frame technology, the new system is based on client-server technology and will make extensive use of Web data entry and review capabilities.

The University of Utah is also developing an electronic patient record and plans are underway to explore the legal, political, ethical and technical issues that will allow sharing of records between IHC and the University of Utah [9]. Other departmental systems such as the "Stork-bytes" labor and delivery system are being developed using client-server technology but with tight integration with the lifetime data repository.

2. Critical Care Automation

One of the first developmental areas to which the HELP clinical computing system was applied was to critical care and the Intensive Care Units (ICU) [7]. The ICU system has grown from acquisition of blood pressure and other physiological signals to a complete electronic patient record system. Computerized modules that support patient care in the ICU are: a) a nursing information system that computerizes nursing charting with nurse observations documentation, medications ordered and given, procedures performed, etc; b) computerized respiratory care charting; c) medication monitoring and charting; d) laboratory system integration; e) blood gas result integration and interpretation; f) hemodynamic monitoring; h) total parenteral nutrition (TPN) ordering and management; i) severity of illness scoring; j) Medical Information Bus (MIB) data acquisition; k) infectious disease monitoring; l) ventilator protocol monitoring; m) laboratory alerts; and n) computerized "rounds" display and reporting system [10, 11].

The Department with its faculty and graduate students have been active in development and evaluation of techniques to enhance patient care in the ICU. For example, development and testing of the IEEE 1073 Medical Information Bus (MIB) standard has enabled the automatic, accurate, timely and representative collection of data from critically ill patients [12-16].

3. Clinical Decision-Support

One of the most exciting and productive activities of the Department has been the development, testing, and evaluation of clinical decision-support systems using the HELP system [7,17]. Since the initial design and implementation of the HELP system, its developers have used the system to explore computerized interventions into the medical decision making process. These interventions imply a computer-

directed interaction with physicians, nurses, and therapists involved in patient care. There are at least five different decision-support approaches that have been tested with the HELP system [17]. These include: a) Computerized *interpretation* of complex results, the Blood Gas interpretation program is an example [18]; b) *alerting* clinical staff to the important clinical data, Laboratory Alerting is an example [19]; c) *critiquing* of new orders and proposing changes to those orders, pharmacy and blood ordering are examples [20, 21]; d) *computerized protocols* which recommend changes in patient therapy, two excellent examples are in daily operation on the HELP system - the antibiotic assistant [22], and the use of ventilator protocols [23]; and e) applications that *summarize* patient care data are useful to assist in therapeutic interventions, the ICU rounds report is an example [11].

4. Evaluation of Clinical Computing Systems

Because of the maturity and widespread use of the HELP clinical information system, students, clinicians, and faculty have been able to evaluate the use of the system [24]. In 1995 the Computerized Patient Record Institute (CPRI) awarded the first Nicholas E. Davies Computerized Patient Record Recognition to the developers of the HELP system. A wide variety of evaluation strategies have been developed, tested and applied to the HELP system. These include evaluation of physician and nurse acceptance of the expert system [25] and also assessment of the value and clinical applicability of the system [26, 27]. In the next segment examples of quality improvement are outlined.

5. Using Computers to Improve Quality of Care & Reduce Errors in Medicine

With the recent publication of Institute of Medicine "To Err is Human" there has been an increased

focus on using computerized expert systems like the HELP system to improve patient care [28]. Extensive research by the students, faculty and staff of the Medical Informatics Department have provided important examples where computerized systems can improve the quality of care and reduce errors [19, 27, 29-36]. Publication of the successful results of using computerized expert systems to improve the quality of care in some of the most prestigious clinical journals has given medical credibility to use of clinical computing.

6. Vocabulary and Data Standards

One of the most complex tasks facing the field of medical informatics is the establishment of vocabulary and data standards. Without standards to exchange data we are continually having to "invent" methods and vocabulary. Such an activity is frustrating and inefficient. At a time when the value of clinical information systems are becoming recognized, a major deterrent to widespread use and integration of multiple clinical sites is the lack of standards. Extensive work by Dr. Stanley M. Huff of our faculty along with his faculty colleagues and students have added important knowledge and operationally effective methods to the development of standards and vocabulary [37-43]. Work by other faculty members and colleagues in developing Arden Syntax for sharing decision-support knowledge has also been an important contribution [44-46].

7. Genetic Epidemiology and Bioinformatics

The Genetic Epidemiology group in the Department of Medical Informatics has been active for several decades in studying the predisposition to disease. Recently many genes that predispose to common diseases such as breast cancer, prostate cancer, and melanoma have been localized and cloned. The current initiative to map and sequence

the human genome together with rapidly advancing molecular biology techniques, ensure that this field will continue its rapid expansion. The group at Utah is now working toward development of a Bioinformatics track using recent funding from the National Library of Medicine.

The principal activity of the Genetic Epidemiology group at Utah has been to collect genealogical records and look for families at high risk of certain diseases. Then using modern genetic technologies, the group has found two breast cancer genes (BRCA1 and BRCA2) as well as genes for prostate cancer [47-58].

8. Medical Imaging

The medical imaging track of the Department is directed by Dennis L. Parker, recently recognized by the University of Utah at its 2000 Commencement as a Distinguished Research Professor. Dr. Parker and his colleagues are holders of three United States Patents in the field of Magnetic Resonance Imaging (MRI). The seminal work of this team headed by Dr. Parker developed the field of neuro and cardiac angiography using MRI so that blood flow in the brain and heart can be determined without use of contrast material [59-63]. Exciting opportunities for graduate students in bioengineering, medical informatics and physics are available with the Medical Imaging group.

9. Public Policy Issues

The field of Medical Informatics has several Public Policy issues that must be dealt with as the field matures. Perhaps the most important issues still under active consideration and discussion is Patient Privacy. Dr. Paul D. Clayton, while a faculty member at Columbia University, made a broad study for the Institute of Medicine of privacy and confidentiality issues in the United States. The results of the work are published in the book "For the

Record: Protecting Electronic Health Information" [64, 65]. Current public policy and legislative activities in the United States use this excellent work as a model of how to protect patient records.

Clinical software systems are becoming ubiquitous. Although a growing literature documents how these systems can improve health care delivery, there is concern about patient safety using such systems. Dr. Randolph A. Miller and Dr. Reed M. Gardner formally addressed these issues when approached by the United States Food and Drug Administration (FDA) [66, 67]. Subsequently these investigators have set up Software Oversight Committees (SOC) in each of their institutions and are testing the validity of local oversight to minimize the impact of software errors in their institutions and those of two other similar institutions. Research results from using the "oversight" committees has proven positive. Several graduate students are involved in these studies.

10. Natural Language Understanding

Much of the patient's medical record is now in electronic form as "free text" from dictation and transcription services. Until recently, the text has only been available to clinical staff to "read" and ponder. However, there is a great need to have access to the data for computerized decision-support. Dr. Peter J. Haug, his students and medical colleagues have made excellent progress to unlocking this previously unavailable data for use in decision-support. To help resolve this problem, a medical language processing system called SymText, was developed by Spencer B. Koehler as a part of his Medical Informatics Doctoral Dissertation [68]. Subsequent use of the system has enhanced quality control, infectious disease monitoring, and allowed the development of protocols for pneumonia management in the

emergency room [67-76]. With the recent advent of "voice recognition" systems and their use by radiologists, data from X-ray interpretations can be used for real-time computerized decision-support.

The Future

The future of Medical Informatics at the University of Utah is bright. With access to the HELP system at Intermountain Health Care, research investigations into computerized decision-support will continue. Perhaps even more exciting is the development of the HELP system replacement, the Patient Care Management System under way at IHC along with the Clinical Workstation now being used in multiple outpatient clinics. Both the Patient Care Management System and the Clinical Workstation operate from a highly coded and enterprise wide integrated database. From this centralized database we will be able to carry out Enterprise wide research into outcomes research at even a greater depth than in the past, because we will have not only hospital records, but all the major parts of the patient record. The database is being designed with a Web front end to allow for data entry and review at any location and by patients as well as care givers.

Combining the Enterprise, Lifetime view of clinical data with the genealogical and genetic data will challenge our Medical Informatics faculty, students and investigators for decades to come. There will be ethical, technical, political, and intellectual challenges greater than any that we have seen in the past. As I have often told my students, "I wish I could turn my biological clock back 30 years so I could see the exciting developments that will occur!"

Finally, will Medical Informatics become a real discipline? Dr. Homer R. Warner our Emeritus Chairman

asked that question in 1995 [77]. Based on my 30 years of experience in the field of Medical Informatics at the University of Utah and based on the rate of change of medical knowledge acquisition, I can think of no more exciting field to be involved in. Certainly, Medical Informatics is already a real discipline!

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