

RESEARCH ARTICLES

The Current State of Pharmacy Informatics Education in Professional Programs at US Colleges of Pharmacy

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Objectives. Pharmacy practice is changing in response to several clarion reports published by the Institute of Medicine (IOM) documenting preventable medication errors. This paper seeks to assess the current curricula of US colleges of pharmacy to determine the readiness of new pharmacist graduates to do the pharmacy informatics work necessary to implement a safer, more information-rich medication use system.

Methods. Data were collected from course titles and descriptions published on the public Internet web sites of the 89 US colleges of pharmacy recognized as regular institutional members of the American Association of Colleges of Pharmacy (AACCP).

Results. Of the 88 colleges of pharmacy included, 73 (83%) maintained updated curricula on their web sites. Of the 73 pharmacy curricula studied, only 24 (33%) included courses in pharmacy informatics.

Conclusions. In the United States, colleges of pharmacy are formally training only a small portion of their pharmacy students in pharmacy informatics while informatics knowledge is desperately needed to improve medication use practices.

Keywords: pharmacy informatics, curricula, information, technology, curriculum

INTRODUCTION

The field of medical or healthcare informatics has emerged as an important discipline as computer use in healthcare and biomedical research has become commonplace. Shortliffe defines medical informatics as “the scientific field that deals with biomedical information, data, and knowledge – their storage, retrieval, and optimal use for problem-solving and decision-making.”¹ Given this broad definition, one can conceive of a subspecialty of medical informatics tightly focused on the optimal use of drug information for problem-solving, decision-making, and promoting safe pharmaceutical care. This subspecialty is the field of *pharmacy informatics*. The use of the term *pharmacy informatics* is not widespread. In fact, a MEDLINE search for *pharmacy informatics* currently returns zero citations and a note indicating that the phrase was not found.² The objective of this study is to assess current curricular approaches to pharmacy informatics being adopted in our nation’s colleges of pharmacy.

Pharmacy informatics is a nascent but growing sub-discipline. As recently as the year 2003, pharmacy infor-

matics has been described in the medical literature as a “new role for pharmacists.”³ However, studies of computer use and the implications of information technology for pharmacy practice go back at least 20 years. Kirking et al published a study in 1994 indicating that the pharmacy computer systems of that era may have positively impacted pharmacist patient care; however, the benefits of computer system use were neither dramatic nor uniformly achieved.⁴ Amazingly, as early as 1985, Brodie and Smith wrote in the *American Journal of Pharmaceutical Education* with regard to pharmacy curriculum models, “What is needed desperately is a new philosophical and conceptual basis for pharmacy education consistent with the emerging technology and the needs of a technological society.”⁵ Nevertheless, these same authors listed computer science as an adjunct area of pharmacist preparation, along with sociology, communication theory, health economics, and ecology. The idea of pharmacy informatics as a field was therefore only foreshadowed in this early work.

In 1999, Troiano published an excellent primer on pharmacy information systems written for information technology professionals.⁶ Troiano documented the many developments in both hospital and outpatient pharmacy information systems throughout the 1990s that helped make these systems more useful and common. Core pharmacy informatics concepts and tasks are described includ-

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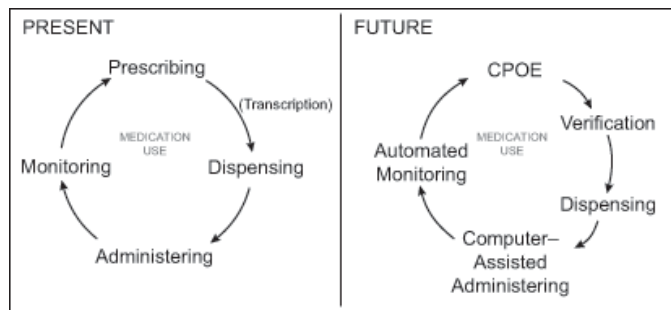


Figure 1. Present and future medication use cycles.

ing order entry into the pharmacy information system, online order verification by pharmacists supported with computerized warnings for drug allergies, inappropriate doses, and drug-drug interactions, computer-supported medication supply and distribution, automated label generation, and computerized pharmacy billing. Implementing, managing, programming, modifying, and upgrading these pharmacy information systems is work that must be done in large part by pharmacists as they are the ones best equipped to understand the myriad issues involved in all areas of the medication use cycle (Figure 1). Nevertheless, one might assume from this discussion that only a small number of specialist pharmacists are needed to handle such pharmacy informatics tasks. What is the impetus, then, to dramatically improve pharmacy informatics education for all pharmacy students?

The Institute of Medicine (IOM) report published in 2000 entitled, *To Err is Human: Building a Safer Health System*, documented that as many as 7,000 Americans die each year due to medication use errors.⁷ Pharmacy educators and the students they teach need to be aware that this report focused attention on safe medication handling and administration practices. In fact, the IOM made explicit statements regarding medication safety, calling on healthcare organizations to “implement proven medication safety practices” to reduce reliance on memory, standardize terminology, and utilize constraints, forcing functions, protocols, and checklists. The IOM also recommended minimizing data handoffs and requirements to enter the same data more than once.^{7(p183)} These suggested improvements are intended to dramatically change the medication use cycle from its present, error-prone state to a safer, future state. The IOM’s recommendations rely heavily upon the application of existing information technology to the present medication-use cycle.

One such application is computerized physician order entry (CPOE). For the purposes of this paper, CPOE is defined to include both inpatient orders and the electronic ordering of outpatient prescriptions often referred to as *e-prescribing*. CPOE systems allow physi-

cians and other caregivers to input orders directly into a computer, thereby eliminating problems with handwriting legibility and order transcription. Furthermore, the power and promise of CPOE is truly realized when the system is used to direct the ordering physician to make good clinical decisions and appropriate choices based on the facts in the individual patient’s electronic health record combined with documented, scientific medical evidence. This added content and system functionality is referred to generally as clinical decision support (CDS). For example, using CPOE with CDS it is often possible to eliminate dosing errors by limiting users only to appropriate, predefined dosing choices.⁸ However, the task of maintaining the drug order entry portion of a CPOE system is formidable. CPOE systems require continual updates for new drugs entering the market, new therapeutic indications, new warnings, formulary changes, and other issues. Pharmacists and hospital pharmacy departments may naturally be the ones tasked with these CPOE maintenance functions.

As mentioned above, for CPOE to reach its full potential it must be coupled with a patient information system.⁹ The scope of patient information systems is currently shifting from local, hospital, or provider-based systems to more comprehensive and widely available electronic health records (EHR) that can be used in both inpatient and outpatient settings. EHR systems are intended to serve as both current and historical records of patient health and medical interventions. Therefore, these systems are laden with enormous amounts of data that must be intelligently interpreted by all healthcare providers including pharmacists. Future systems are likely to include more technical, customizable, advanced search and data reporting functionalities, but their value will depend entirely on their expert use. Will pharmacists have the necessary skills to create their own macros to enhance efficiency, generate customized views and reports, properly query underlying EHR databases, and appropriately search and filter volumes of information in order to quickly identify key issues for decision-making?

It is heartening to recognize that most professional pharmacy curricula currently include studies in the analysis of medical research and literature along with coursework in finding and understanding published drug information. However, the overwhelming number of drug-related studies published each year and the proliferation of drug information sources require colleges of pharmacy to adjust their curricula in order to cover important work being conducted in many areas of medical informatics. Specifically, new pharmacists will need to have the skills to critically analyze meta-analyses of

Table 1. Results of Internet Survey* of Pharmacy Informatics Education in Professional Programs at US Colleges of Pharmacy

	Schools Included in the Study	Schools With Curricula Published Online	Schools Offering Pharmacy Informatics Courses	Schools Requiring Studies in Pharmacy Informatics
Exact numeric counts	88	73	24	12
Percent of total (n=88)	N/A	83	27	14
Percent of schools with curricula published online (n=73)	N/A	N/A	33	16

*Data collected during July and August of 2004.

multiple random controlled trials as well as training to find and interpret electronic clinical guidelines detailing best practices for treating many medical problems.

Although the PharmD degree does not lead all pharmacy practitioners into careers as researchers, many pharmacists currently participate in clinical drug trials and other types of medical research.¹⁰ In the coming, data-driven, information-rich healthcare environment envisioned by today's leaders, the opportunity for compiling useful medical and drug data for analysis and publication will be almost limitless.¹¹

If properly trained in data gathering, handling, and statistical analysis, future pharmacists can help the nation achieve its goal of using documented clinical evidence to justify most, if not all, drug therapy decisions. The push toward achieving safer and more effective medication use through evidence-based medicine (EBM) will require thoughtful, well-conducted research.

Now that the "Decade of Health Information Technology"¹¹ has arrived, implementing information technology tools that lead to a safer medication-use system in the United States will be necessary. New pharmacists entering professional practice will need to understand and have the capabilities to update and maintain CPOE systems; utilize, query, and report on EHR data; find and intelligently analyze new types of electronic medical literature; and conduct computerized drug utilization reviews and unique medical research projects using potentially complex, technically sophisticated software tools.

METHODS

The criteria for inclusion in this review of particular colleges of pharmacy and their respective pharmacy informatics curricula are straightforward. Eighty-nine pharmacy colleges recognized as regular members of the American Association of Colleges of Pharmacy (AACCP) were included.¹² All have professional pharmacy programs leading to the doctor of pharmacy (PharmD) degree that have been granted either full or candidate accreditation status by the American Council on Pharmaceutical Education (ACPE). Of these, only 1 college of pharmacy had to be excluded for lack of a public Internet web site.

The search for the University of Puerto Rico College of Pharmacy web site was conducted both in English and Spanish to no avail. The University of Puerto Rico College of Pharmacy was excluded on this basis.

For this study, the following pharmacy informatics curriculum search strategy was developed. Each college of pharmacy web site was carefully inspected to reveal the presence or absence of published online curriculum information. Where it was found, curriculum information, generally consisting of listings of course numbers and titles, was then searched for the word *informatics* using the "Find" function of the *Internet Explorer* browser software (Microsoft, Redmond, Wash). The same curriculum information was then carefully read to reveal courses that may have been related to pharmacy informatics but titled or described using different terminology. Finally, pharmacy school web sites were separately searched in a manual fashion for listings or descriptions of elective courses offered in the field of pharmacy informatics.

This study specifically did not include any analysis of the university course catalogs. The intent of the study was to ascertain scholastic activity directed from within US colleges of pharmacy and not whether other avenues for informatics study were available to pharmacy students. A further aim was to limit the study to the curriculum information most likely to be viewed by prospective pharmacy students. This study also excluded any postgraduate training or postgraduate residencies in pharmacy informatics, although the existence of such programs was confirmed.¹³

RESULTS

Of the 88 college of pharmacy public Internet web sites examined, 73 (83%) had updated, curriculum information. Several pharmacy school web sites not counted above indicated that curriculum information was generally available but had been removed from public viewing until such a time that an updated curriculum could be electronically published.

Study results are summarized in Table 1. Of the 73 college of pharmacy curricula examined, only 24 (33%)

Table 2. Highest Ranked Colleges of Pharmacy in the United States

University of California San Francisco
University of Texas at Austin
University of Kentucky
University of Michigan at Ann Arbor
Purdue University at West Lafayette
University of Minnesota
Ohio State University
University of Arizona
University of Florida
University of Maryland at Baltimore
University of North Carolina at Chapel Hill
University of Tennessee at Memphis

U.S. News & World Report's Survey of Pharmacy Schools from 2002¹⁴

included any courses in pharmacy informatics. Furthermore, only half of the schools currently teaching pharmacy informatics are requiring pharmacy informatics study before the PharmD degree is conferred. A relatively low percentage of colleges of pharmacy whose curricula were published online (16%) required coursework in pharmacy informatics.

These data can be analyzed for evidence of whether the thought leaders in pharmacy education at the nation's premier pharmacy schools have been quicker to embrace pharmacy informatics than their colleagues at other schools. According to *U.S. News & World Report's* survey of American professional pharmacy programs, the 12 schools listed in Table 2 are the highest rated by academic deans of colleges of pharmacy.¹⁴

Of these 12 highly regarded PharmD programs, less than half (5/12 or 42%) currently offer formalized curriculum in pharmacy informatics. Even fewer of these elite pharmacy schools (2/12 or 17%) make studies in pharmacy informatics a requirement for graduation with a doctor of pharmacy degree. These numbers are similar to the overall picture for the adoption of pharmacy informatics curricula in the United States.

For the 24 schools currently engaged in formal pharmacy informatics teaching, the actual pharmacy informatics course titles vary widely (Table 3).

DISCUSSION

Despite the well-publicized documentation of an unacceptable rate of harmful medication errors in our current healthcare system and the expressed need for information systems to help prevent them, US colleges of pharmacy have yet to require the teaching of pharmacy informatics principles to the majority of their professional pharmacy students. On the contrary, only a small

Table 3. Course Titles in Pharmacy Informatics at US Colleges of Pharmacy

Advanced Computer Applications in Healthcare (E)
Application of Informatics in Healthcare (R)
Bioinformatics (E)
Biomedical Informatics (R)
Computer Applications in Pharmacy (E)
Computers in Pharmacy (E)
Computing Applications (E)
Drug Information and Informatics (R)
Evidence Based Medicine (R)
Healthcare Informatics (E)
Hospital Pharmacy Practice Management (E)
Informatics (R)
Informatics for Pharmacists and other Health Professionals (E)
Informatics in Healthcare and Drug Literature Evaluation (R)
Information Systems in Healthcare (E)
Introduction to Health Informatics (E)
Introduction to Pharmacy Informatics (R)
Pharmacoinformatics (E)
Pharmacy Automated Systems, Drug Information Systems and Drug Literature Evaluation (R)
Pharmacy Bioinformatics (R)
Pharmacy Computer Systems (E)
Pharmacy Informatics (R or E)
Principles of the Human Genome, Pharmacogenomics and Bioinformatics (E)

R = a required course; E = an elective course

fraction of pharmacy students are guaranteed to receive formal instruction in courses primarily dedicated to pharmacy informatics within their professional academic programs at this time.

While many colleges of pharmacy informally address pharmacy informatics in courses on drug information, pharmaceutical research, and medical literature evaluation, or perhaps even in biostatistics courses, the dramatic changes in pharmacy practice and the medication-use cycle presaged by quickly developing information technology initiatives in American health care will require a higher level of pharmacist information gathering and handling skills than in the past.

This study indicates that even in the top-rated colleges of pharmacy in the United States, the adoption of pharmacy informatics training is only beginning to take place. However, America's top-rated college of pharmacy at the University of California San Francisco requires a pharmacy informatics course with content that includes database design and applications, pharmacy components of the EHR, and discussions of the privacy and security of healthcare data. (Pharmacy Year 1 Spring Courses. University of California San Francisco College of

Pharmacy. Available at: <http://pharmacy.ucsf.edu/pharmd/curr/core/y1q3/> Accessed August 21, 2004.)

Unfortunately, pharmacists and others have coined too many competing terms for pharmacy informatics including *pharmacoinformatics*, *drug informatics*, *medication informatics*, and even *health system informatics*. As evidence of this, most of today's current courses in pharmacy informatics are titled differently. The data show that the informatics courses offered by 24 pharmacy schools had 23 different titles. This may be evidence of the nascent state of pharmacy informatics as a subdiscipline and the lack of consensus on how best to approach this material. The current jumble of terms and course titles is unnecessary and confusing. The term *pharmacy informatics* stems from the name of the profession of pharmacy itself and rightly encompasses the refinements and distinctions drawn by its competing terms. The term *nursing informatics* appears to be widely used.² The pharmacy profession should follow the nursing profession's lead and settle on the term *pharmacy informatics* to describe this growing area promoting the application of information technology tools to the medication-use cycle and the optimal use of patient and drug information in combination to solve clinical problems and document results.

Further study of pharmacy informatics programmatic and curriculum development is clearly warranted. As a follow up to the current study, a systematic survey of existing pharmacy informatics course syllabi would be beneficial. Perhaps the beginning of a consensus about the key concepts and important features of a pharmacy informatics curriculum could be produced. This would provide a basis for more colleges of pharmacy to institute formal pharmacy informatics instruction.

CONCLUSIONS

Presently, only a small fraction of US pharmacy students are receiving in-depth exposure to the principles and practice of pharmacy informatics as a subdiscipline of medical informatics. Pharmacy educators have yet to embrace the term *pharmacy informatics*, let alone develop a standardized pharmacy informatics curriculum. Meanwhile, the healthcare industry is anxiously seeking to utilize information technology to improve the safety and quality of care. Technologies like CPOE, computerized IV pumps, and barcoding have begun dramatically changing pharmacy practice in the inpatient and outpatient settings. How well the profession of pharmacy adapts to these new information tools and techniques will in part be determined by how quickly and effectively US colleges of pharmacy begin to educate professional pharmacy students in pharmacy informatics.

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