AHRQ

RESEARCH IN ACTION

Agency for Healthcare Research and Quality • www.ahrq.gov

Issue #6 *June 2002*

Medical Informatics for Better and Safer Health Care

New health care technologies, medications, treatments, and procedures are being developed rapidly, and clinicians are expected to incorporate them into their daily practices. Clinicians are also expected to assimilate both old and new knowledge, apply that knowledge to their patients, remember each patient's individual health status and background, and communicate quickly with patients, hospitals, and other providers. In the past, meeting these expectations has often been difficult because systems to organize, store, and retrieve medical and patient information had not been developed. But today, computer systems exist that can help clinicians meet each of these challenges.

Medical informatics deals with all aspects of understanding and promoting the effective organization, analysis, management, and use of information in health care.[1] For over 30 years, the Agency for Healthcare Research and Quality (AHRQ) has supported research on informatics. Computer systems and applications, many of which are still being used today, were developed and tested through AHRQ-funded research. AHRQ has funded numerous studies on medical informatics, detailed elsewhere.[2] This report describes only a select few of the computer systems that are relevant to the problems clinicians face, such as improving the quality of patient care and patient safety, preventing medical errors, reducing costs, helping patients manage their conditions, and minimizing the impact of a new enemy—bioterrorism.

Background

Traditionally, the process of organizing, storing, integrating, and retrieving medical and patient information has been paper based. But paper-based systems are inefficient for managing enormous amounts of medical and patient information that can affect patient care. For example:

- The conventional medical record may be illegible because it is hand written[3] and poorly organized, making it difficult for physicians to locate the information they need about past medical tests and their results.[4]
- Patients who visit more than one health care provider have several medical records, which often are not shared with other physicians, laboratories, and hospitals.

Making a Difference

- **Computer systems improve quality of care…Page 2**
- **Computer systems improve medication management and reduce costs…Page 5**
- **Computers enhance patient self-management of chronic disease…Page 6**
- **Computers can help protect against bioterrorism and detect disease agents…Page 8**
- **Research to improve patient safety continues…Page 9**

Authors: Barbara L. Kass-Bartelmes, M.P.H., C.H.E.S., Eduardo Ortiz, M.D., M.P.H.

Managing Editor: Margaret K. Rutherford

Design and Production: Joel Boches

Suggested citation: Kass-Bartelmes BL, Ortiz E, Rutherford MK. Using informatics for better and safer health care. Rockville (MD): Agency for Healthcare Research and Quality; 2002. Research in Action Issue 6. AHRQ Pub. No. 02-0031.

Patient information then becomes fragmented, which can cause delays, disruptions, or errors in patient care.[5]

- Over the past 40 years, medical information has grown at an astonishing rate. For example, MEDLINE®, a database that contains references to articles in the biomedical literature and is maintained by the National Library of Medicine, added more than 460,000 references over the past year. This makes it virtually impossible for physicians to keep up with the large amount of information that results from clinical trials and other studies,[6] information that they could be using to guide their medical decisions. In addition, retrieving and understanding the information pose another set of problems.[7] As a result, patients sometimes do not receive care that is based on the best and most currently available evidence, such as the use of aspirin therapy to prevent strokes and heart attacks[8] and preventive therapies (for example, the pneumonia and flu vaccines).[9]
- Physicians must learn and retain a tremendous amount of information about antibiotics and the organisms they treat, including which bacteria are susceptible or resistant to the antibiotic, what dose the patients should receive and how frequently they should receive it, how long the patients need to take the antibiotic, side effects of the antibiotic, and interactions with other medications or food.[10] As much as 50 percent of antibiotic prescribing is inappropriate, leading to resistant bacteria, adverse drug reactions, and increased costs.[11] In addition, although medications may have worked well in tightly controlled clinical trials, physicians also need to keep informed about their effectiveness when they are used regularly in "real" clinical practice.[12]
- Studies have shown that patients who understand their conditions and are involved with their doctors in making health care decisions are better able to deal with their illnesses. However, patients often do not have access to accurate and reliable information or are not able to retrieve, understand, and use this information to meet their individual needs.[13]
- Patients with chronic diseases such as diabetes or congestive heart failure often have to monitor their blood glucose level, weight, blood pressure, and medication regimens in their homes. Many times they must wait until their next scheduled visit to share this information with their physician, and they often forget to bring their daily measurements with them when they see their providers. When changes in a patient's blood glucose level or blood pressure are not detected in a timely manner, the patient's health can deteriorate, leading to poorer health outcomes and more costly use of health care services.[14]
- Finally, the events of September 11, 2001, and their aftermath have put the United States on alert and propelled us toward developing additional computer systems that can collect, analyze, coordinate, and distribute health information. Specifically, physicians and public health workers need to be able to respond quickly and effectively to bioterrorism—the threat that disease agents such as anthrax or smallpox will be released into our environment and infect large numbers of people. In addition, when mass disasters occur, the resulting casualties and chaos require a system that can coordinate health and support services.[15]

Computer systems improve quality of care and reduce costs

COSTAR (Computer Stored Ambulatory Record)

The COSTAR system creates and stores an electronic patient record that includes information from the medical history, physical examinations, laboratory reports, diagnoses, and treatments.[7] Developed in 1968 at Massachusetts General Hospital[2] and still in use today,[16] COSTAR helped to improve quality of care by reminding physicians of guidelines in clinical practice.[3] Not following guidelines can lead to complications. For example, rheumatic fever (which can later cause damage to the valves of the heart) can result from an untreated strep infection.[17]

In an AHRQ-funded study within a primary care internal medicine clinic, 13 guidelines were incorporated into the COSTAR program to remind physicians to perform specific screening and preventive measures (Table 1). As a result, physician practice improved significantly for 10 of these 13 health maintenance measures between 1992 and 1993, and 7 out of 10 continued to show significant improvement in 1997.[7]

RMRS (Regenstrief Medical Record System)

The RMRS helped Wishard Memorial Hospital in Indianapolis improve preventive patient care and save money. This system stores over 30 years of patient data from emergency department visits, hospital stays, clinic visits, lab test results, and imaging studies. It generates flow sheets and reminders, and captures physician orders.[5]

Two AHRQ-funded studies showed that computer-generated reminders increased preventive care measures. Between April 1983 and January 1984, physicians and hospital house staff at Wishard Memorial Hospital's General Medicine Clinic received computer reminders during patients' clinic visits and/or monthly performance reports generated after the clinic visits for patients whom the computer identified as needing certain preventive care, such as colon cancer and tuberculosis screening, pneumonia vaccination, medication for high blood pressure, antidepressants, Pap smears, or mammography.[9] When compared to physicians who did not receive performance feedback reports or computer reminders, physicians who did receive such reports or reminders:

- Ordered more preventive care measures.
- Had a rate of pneumococcal vaccination that was 4 to 7 times higher.
- Increased their compliance for colon cancer screening by 50 to 133 percent.
- Increased their compliance rate from 10 to 15 percent overall.[9]

A study funded in 2001 by AHRQ showed that physicians who received RMRS computer-generated reminders had higher ordering rates for four preventive therapies than physicians who did not (Table 2).[8]

Another AHRQ-funded study indicated that automatically showing clinicians their patients' previous test results reduced duplicate testing by 16.8 percent and test costs by 13 percent. Over 16 weeks, during patient clinic visits, the results of some patients' past tests would appear on a computer screen. Physicians who received this computer

Table 1. Changes in compliance rates for computerized guidelines 1 year and 5 years after implementation of a computerized health maintenance reporting system for patients seen in an ambulatory care practice clinic

Preventive/ screening measure	Compliance rate		
	1992 (baseline)	1993	1997
	Percent		
Cholesterol	72	88	89
Pap smear	64	69	75
Mammogram	63	66	70
Breast exam	77	81	72
Breast exam instructions	8	38	41
Testicular exam	48	59	67
Rectal exam	38	72	67
Fecal occult blood	78	74	60
Flu vaccine	69	67	63
Pneumovax	58	65	55
Measles	19	24	12
Tetanus	7	18	23
Rubella	4	19	14

Source: Morgan MM, Goodson J, Barnett GO. Long-term changes in compliance with clinical guidelines through computer-based reminders. Proc AMIA Symp 1998; 493-7.

Table 2. Percent of hospitalizations during which a physician ordered therapy for a patient eligible to receive preventive therapy, May 1997 through October 1998

Therapy	Computer reminder	No computer reminder
Pneumococcal vaccine	35.8	0.8
Influenza vaccine	51.4	1.0
Subcutaneous heparin	32.2	18.9
Aspirin at discharge	36.4	27.6

Source: Dexter PR, Perkins S, Overhage JM, et al. A computerized reminder system to increase the use of preventive care for hospitalized patients. N Engl J Med 2001; 345(13):965-70.

display ordered, on average, 8.5 percent less tests for patients than physicians who did not receive this information. The result was an average decrease of 13 percent in charges for laboratory tests (Table 3).[4]

Additional AHRQ-sponsored research revealed that the RMRS saved $3 million annually on inpatient tests and medications. When physicians ordered a test or medication on the computer system, the computer displayed the cost of the test and whether it had been ordered previously, made medication recommendations, gave warnings about dangerous drug interactions, and showed the patient's active orders, allergies, diagnoses, vital signs, and test results. Total charges were less when physicians had access to this information than when they did not (Table 4).[18]

The RMRS also improved access to patient records by emergency departments, helping to reduce fragmentation of patient information.[5] AHRQ and the National Library of Medicine funded the initial development of the Indianapolis Network for Patient Care (INPC).[19] The network includes an active surveillance component that incorporates patient data from 11 hospitals in the Indianapolis metropolitan area.[19] Using INPC, Wishard Memorial Hospital linked its RMRS patient database with two other hospital emergency departments.[5] When patients were seen in the emergency departments of the other hospitals, the computer system matched their data with Wishard's patient data based on name, date of birth, sex, and other information.[5] When a match was found, the computer system then printed a patient report that contained a medical history, past hospitalizations and clinic visits, immunizations, and laboratory results.[5] At one of the hospitals, simply

Table 3. Test ordering rates and charges over 13 weeks for patient clinic visits with and without computerized display of past test results.

	Per 1,000 visits without computerized display		Per 1,000 visits with computerized display	
Test	Number of tests	Charge	Number of tests	Charge
Total	553	$13,994	510	$12,171
Electrolyte analysis	232	$4,988	214	$4,596
Blood count	145	$1,959	135	$1,817
Chest x-ray	69	$3,493	59	$3,014
Electrocardiogram	40	$1,799	26	$1,167
Urinalysis	32	$ 275	36	$ 310
Leukocytes	25	$ 272	22	$ 244
Urine culture	8	$ 163	13	$ 263
Upper gastrointestinal	7	$1,045	5	$ 760

Source: Tierney WM, McDonald CJ, Martin DK, et al. Computerized display of past test results. Ann Intern Med 1987; 107(4):569-74.

Table 4. Differences between hospital charges from April 1990 through October 1991 for inpatients with and without computerized display of test and medication information

Type of charge	Average charge per admission			
	With computerized display	Without computerized display	Difference	Percent reduction
Total	$6,077	$6,964	$887	12.7
Bed	$2,283	$2,551	$268	11.9
Tests	$1,621	$1,852	$231	12.5
Medications	$1,001	$1,181	$180	15.3

Source: Tierney WM, Miller ME, Overhage M, et al. Physician inpatient order writing on microcomputer workstations. JAMA 1993; 269(3):379-83.

providing this printed report saved $26.00 in patient costs per encounter.[5] The cost of providing the patient report was estimated at 20¢.[5]

Computer systems improve medication management and reduce costs

HELP (Health Evaluation through Logical Processing)

The HELP system was developed at LDS Hospital in Salt Lake City, Utah, with AHRQ support. This integration of clinical informatics with the business of health care delivery provides a model for the Nation. HELP is currently distributed commercially by 3M Company. The HELP system provides decision support programs such as the automated antibiotic consultant, which helps physicians select the best antibiotic for patients.[2] The computer-assisted decision support programs in the HELP system allow physicians to directly order antibiotics at bedside terminals, resulting in improved drug selection and reductions in adverse drug events and costs.

In one AHRQ-funded study, the automated antibiotic consultant program recommended the appropriate medication regimen for hospitalized patients 94 percent of the time, compared with the 77-percent success rate for physicians. The average cost for 1 day of therapy selected by the antibiotic consultant was $41.08 per patient, compared to $51.93 for the antibiotics prescribed by physicians. The majority of physicians who used the antibiotic consultant said they would recommend it to other physicians (88 percent), felt that it helped them select the proper antibiotics (85 percent), and believed that it improved patient care (81 percent).[10]

LDS Hospital researchers showed that from 1988 through 1994, the computerized decision support system helped physicians use antibiotics more effectively and appropriately, reduced costs and adverse drug events due to antibiotic therapy, and decreased antibiotic use overall (Table 5). Even though more patients received antibiotics, the price of acquiring antibiotics for the hospital increased, and the number of Medicare patients admitted to LDS Hospital increased, by 1994 the percent of total medication dollars spent on antibiotics had decreased.[11]

Another study showed that from 1994 to 1998, 91.4 percent of the patients hospitalized in the LDS Hospital intensive care unit received at least one course of antibiotics. Over this time period, however, the overall length of stay, incidence of adverse drug events, and mortality rates decreased (Table 6) and the antibiotic decision support program helped to control development of antibiotic-resistant bacteria. For example, the inappropriate prescribing of vancomycin (the antibiotic that is effective against Staph aureus bacteria) decreased.[20]

ARAMIS (Arthritis, Rheumatism and Aging Medical Information System)

Developed in 1975-76 at Stanford University School of Medicine with funding from AHRQ (then the National Center for Health Services Research), the ARAMIS

Table 5. Changes in antibiotic use, adverse events, mortality rates, and costs between 1985 and 1994 resulting from computerized antibiotic decision support program, LDS Hospital

Statistic	Baseline (year)	1994
Average number of antibiotic doses per patient	19 (1985)	5.3
Patients who received antibiotics within 2 hours prior to surgery	40% (1985)	99.1%
Rate of adverse drug events due to antibiotics	26.9% (1989)	18.8%
Mortality rate from antibiotics	3.65% (1988)	2.65%
Total medication dollars spent on antibiotics	24.8% (1988)	12.9%
Patients receiving antibiotics	31.8% (1988)	53.1%

Source: Pestotnik SL, Classen DC, Evans RS, et al. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. Ann Intern Med 1996; 124(10):884-90.

Table 6. Impact of computerized antibiotic decision support program on length of stay, mortality, and adverse drug events, LDS Hospital

Statistic	1994	1998
Intensive care unit length of stay	3.63 days	2.80 days
Total hospital length of stay	10.28 days	8.84 days
In-hospital mortality rate	8.7%	5.2%
Rate of adverse drug events	1.22%	0.04%

Source: Burke JP, Pestotnik SL. Antibiotic use and microbial resistance in intensive care units: impact of computer-assisted decision support. J Chemother 1999; 11(6):530-5.

database includes about 17,000 patients with arthritis as well as older adults without arthritis. These patients are followed for life, and researchers are continuing to conduct studies on their diseases, care practices, medical and surgical treatments, and costs.[12] The ARAMIS Post-Marketing System (ARAMIS-PMS) follows, studies, and evaluates the effectiveness, toxicity, and value of therapies for rheumatic disease once these therapies are in use by the general public.[12] Specifically, these studies examine whether or not a drug works outside of clinical trials, identify additional toxicities, assess patient satisfaction, and investigate cost-effectiveness.[12] For example, the ARAMIS-PMS used ARAMIS data to help evaluate the relationship of nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen and gastrointestinal (GI) complications such as upper or lower GI bleeding, gastritis, ulcers, and gastric outlet obstructions.[21,23] These studies found that the risk of being hospitalized was greater for patients taking NSAIDs than for patients who did not take NSAIDs.[21,23] Another study showed that 81 percent of patients hospitalized for GI complications who had been taking an H_2 antagonist (a medication to prevent GI symptoms) such as cimetidine, ranitidine, or famotidine (Tagamet, Zantac, and Pepcid) or antacids, had no apparent signs or symptoms prior to being admitted.[21,22]

Computers enhance self-management of chronic disease

CHESS (Comprehensive Health Enhancement Support System)

Developed at the University of Wisconsin-Madison, CHESS is a system designed to be used on a personal computer in patients' homes, especially patients suffering from a life-threatening disease such as breast cancer, HIV infection, heart disease, Alzheimer's disease, or alcoholism.[13] An AHRQ study of HIV patients who used CHESS showed that they had fewer hospitalizations and a higher quality of life than patients who received only standard medical treatment.[13] The CHESS computer tools for AIDS patients include:

- Answers to commonly asked questions.
- A library of full-text articles.
- Descriptions of health services, how to find a provider, and consumer tips.

- A referral system to national information and support services.
- Tools to assess the patient's lifestyle and risk factors, and advice on how to reduce risk.
- A tool that helps patients make decisions.
- An action plan to help patients carry out their decisions.
- Online discussion groups for sharing information and support.
- The option to ask questions of experts and receive confidential responses.
- True stories from patients with similar problems.[13]

The AHRQ-funded study that evaluated the HIV/AIDS module of CHESS showed that, compared to patients who received standard care, patients who used the CHESS program for 2 to 5 months had:

- Better mental capacity.
- A more active lifestyle.
- Lower levels of negative emotion.
- Better social support.
- More involvement in their health care.[13]

Although CHESS patients and patients who received standard care had the same number of visits to their physicians and the emergency department, CHESS patients were better prepared with questions for their providers during their visits so their visits were 15 percent shorter. They also had 47 percent more telephone calls with their providers because they felt more comfortable about calling. Patients who received only standard care had 50 percent more hospitalizations than the CHESS patients. When CHESS patients were hospitalized, their hospital stays were 39 percent shorter. During the time of the CHESS study, hospitalization costs for AIDS patients averaged $1,485 per day. While using the CHESS program, participants lowered their hospitalization costs by $728 per month. After the CHESS program was removed, participants continued to average a reduction of $222 per month in hospitalization costs.[13]

SBIR (Small Business Innovative Research) informatics development

Through the SBIR program, 2.5 percent of a Federal agency's extramural budget is set aside for small business research and development of products that can be commercialized for public benefit.[24] Through this funding, AHRQ has sponsored the SBIR research program "Developing Tools to Enhance Quality and Patient Safety Through Informatics."[25] Contracts awarded under this program include proposals for developing tools that patients can use at home to monitor their health, methods for electronic sharing of patient medical records, Internet-based communications between patients and providers, handheld devices for patients and providers, and decision support applications for patient self-care, patient safety, and chronic disease management.[25] Several of these programs have developed prototypes of devices that have the potential to improve patient self-care and self-monitoring.

For example, the Diabetes Assistance Self-care Program for Youth (DASPY), funded through AHRQ's SBIR program, is an Internet-based program designed to help young patients with Type 1 diabetes control their blood glucose and medication regimens. AHRQ-funded research showed that these young patients preferred using an electronic program rather than a paper-based program (Table 7). Using a handheld device, patients entered the date and times they checked their blood glucose and took insulin.[26] The device alerted patients that their blood sugar was too low or too high. It was programmed to ask the patients questions at the end of the day about their consumption of carbohydrates and how they felt physically. Patients transmitted data from the DASPY device to their physicians every 2 days. Patients reported that the electronic log was more fun to use, made it easier to send information to their physician, and was less likely to be lost than the usual paper log.[26]

AHRQ funded the development of a weight scale and a glucose monitor that automatically capture, store, and transmit patient data electronically using a wireless network. This allows patients to send important medical information without having to manually input data. Therefore, physicians can immediately detect changes in the patient's condition. The device can also be programmed to alert both the patient and the physician if the patient's weight or blood sugar levels exceed an established threshold, leading to faster and better treatment than simply waiting until the next scheduled appointment, which could be months away.[27]

Two other studies that AHRQ is funding involve medical devices that use wireless Internet technology to monitor blood pressure and pulse oximetry.[14] Pulse oximetry, a

measurement of the amount of oxygen in arterial blood,[28] is often used in patients with congestive heart failure to determine how well the heart is working to provide oxygen.[14] Because patients with congestive heart failure often retain fluid, blood pressure measurements also help indicate how well the heart is functioning. A rise in blood pressure is often associated with a rise in fluid retention. Once the devices take a blood pressure or pulse oximetry measurement, the readings are automatically sent via e-mail to a central computer.[14] If the patient's measurement exceeds preset limits, the computer system alerts the health care provider via voice mail, pager, facsimile, or e-mail.[14] By making this communication between the patient and the provider automatic, changes in the patient's health status can be detected quickly.[14] The health care provider can also give feedback or instructions by sending the patient messages that appear on the medical device.[14] This technology allows the devices to be used either in the home or while traveling by taking advantage of cellular technology—the same technology that is used for cell phones.[14]

One advantage of wireless medical devices is that they can be located in any room in the house. For example, the weight scale can be kept in the bathroom, where most patients weigh themselves. The devices can be located anywhere as long as they are within 35 feet of the telemedicine patient station, which can then relay the patient's information to the providers.[27]

AHRQ research to fight bioterrorism and improve patient safety continues

AHRQ had already begun funding research to deal with bioterrorism issues prior to September 11. It continues to fund research that investigates the effectiveness of information technology in fighting bioterrorism. In addition, AHRQ is currently funding many projects that investigate how technology can help improve patient safety.

Informatics to help identify bioterrorist attacks

Clinicians now need to be able to detect organisms such as ebola, anthrax, plague, tularemia, glanders, and smallpox when treating patients who are acutely ill, especially those who have fever.[15] The organisms that cause these diseases can be spread through the air and have the ability to infect many people simultaneously.[15] Diseases such as anthrax respond best to early treatment and must therefore be detected quickly.[15] Research projects have focused on helping hospitals and health care systems respond to bioterrorism emergencies, improve communication among various health systems, and train health care providers.[29] While most of these projects are still ongoing, some of their

Table 7. Preferences among patients ages 6-20 with Type 1 diabetes in using an electronic log compared to a paper log

Question	Electronic*	Paper*
Which log was more fun to use?	79%	17%
Which log was easier to remember to use?	58%	33%
Which log was easier for sending information to your doctor?	71%	25%
Which log is more likely to be misplaced or lost?	17%	83%
Which log would be easier to carry around?	58%	42%
Which log would encourage you to log your blood sugar and other information more often?	62%	33%
Which log would you prefer to use in the future?	67%	33%

***Note:** Totals may not add to 100% because of missing data.

Source: Sharma S. Web-based tool for diabetes self-care. Final report. Watertown (MA): New England Research Institutes; 2001. Contract No. 290-00-0025. Sponsored by the Agency for Healthcare Research and Quality.

results are already helping clinicians and public health workers respond to bioterrorism and other disaster threats.

In order to help clinicians detect these diseases faster, AHRQ is funding continuing medical education (CME) training through the University of Alabama at Birmingham (UAB).[30] Along with researchers at the Research Triangle Institute, researchers at UAB have developed online training modules for anthrax, smallpox, botulism, tularemia, viral hemorrhagic fever, and plague.[30] As of April 2002, UAB had awarded 883 continuing education credits.[31] The UAB CME Web site can be accessed at <http://www.bioterrorism.uab.edu/>.

AHRQ-sponsored researchers at the University of Pittsburgh have demonstrated that early detection of infectious disease is possible using the Real-time Outbreak and Disease Surveillance (RODS) computer system.[15] Several studies using data from emergency department visits, such as laboratory test results and patient demographic information, showed that the RODS computer system detected acute respiratory illnesses and influenza far more quickly than standard methods of detection.[15] The RODS computer system provides descriptions of symptoms that precede the physical presentation of diseases such as botulism, encephalitis, respiratory diseases, hemorrhagic diseases, diarrheal diseases, and viruses.[19] When patients begin exhibiting symptoms of one of these types of diseases more frequently than is considered normal, a notification system is engaged.[19] Physicians who have public health, emergency, and infectious disease training monitor this system and report suspicious events to the public health departments.[19]

An AHRQ project at Children's Hospital in Boston is developing computer systems that collect and analyze emergency department data, incorporate an online diagnosis and treatment manual, and use a decision support system specifically designed to detect diseases early.[19] To help clinicians identify the diseases that result from bioterrorism, the Massachusetts Institute of Technology has created a Web-based decision support tool that links patient symptoms and signs with a database of potential organisms and a treatment manual.[19]

Continuing its support of the Regenstrief Institute at Indiana University, AHRQ is funding a project that uses the Indianapolis Network for Patient Care to collect patient data such as lab results, clinic notes, chief complaint, diagnoses, procedures, immunizations, allergies, medications, and test results. When the system identifies cases of a reportable condition, it copies the patient information to the county and State health departments. It also sends e-mail summaries to public health officers and investigators.[19]

For additional information on AHRQ's continuing research on bioterrorism, see AHRQ Publication No. 02-P018 at <http://www.ahrq.gov/news/focus/bioterror.htm>.

Patient safety programs that use medical informatics

AHRQ is continuing to sponsor research promoting the use of informatics to ensure patient safety. Projects funded under the Clinical Informatics and Patient Safety (CLIPS) research program are examining how informatics can improve decisionmaking and patient safety while reducing errors and maintaining patient confidentiality.[32]

- *Improving Primary Care Patient Safety with Handheld Decision Support Systems;* Grant No. R18 HS11820. This project will examine the acceptance of, benefits of, and barriers to the use of stand-alone, handheld decision support systems (DSSs) in an ambulatory setting to improve prescribing patterns in order to prevent medication errors. It will also study the clinical impact and cost-effectiveness of point-of-care, handheld ambulatory DSSs on medical errors. A suite of decision support tools will be implemented in a number of ambulatory clinics, and the investigators will assess the extent to which potential or perceived barriers influence their use.
- *Impact of Personal Digital Assistant Devices on Medication Errors;* Grant No. R18 HS11808. This study will assess the impact of personal digital assistants (PDAs) on reducing medication errors in primary care office-based practices. Researchers will also measure the occurrence of potential preventable medication-related errors, assess physicians' attitudes toward the PDAs, and identify barriers perceived by physicians to PDA use in practice and successful strategies to overcome these barriers.
- *Using Handheld Technology to Reduce Errors in Attention-Deficit Hyperactivity Disorder Care;* Grant No. R18 HS11859. This project will use a real-time point-of-care handheld computerized decision support module called DS-ADHD to reduce medical errors in the treatment of attention-deficit/hyperactivity disorder

(ADHD) in children. They will address two important types of errors that occur in the management of ADHD: failure to detect comorbid conditions and failure to respond to adverse effects of ADHD medications.

- *Mining Complex Clinical Data for Patient Safety Research*; Grant No. R18 HS11806. Researchers are developing an infrastructure to support automated surveillance of errors by using a natural language processor called MedLEE to code the information contained in patients' electronic medical records to detect and characterize medical errors. Using a clinical repository with 10 years of data on approximately 2 million patients, they will incorporate the system into a hospital's current events surveillance program and assess its impact on error detection.
- *Informatics Tools to Reduce Warfarin Errors;* Grant No. R18 HS11804. This project will create clinical informatics tools specifically designed to reduce the incidence of warfarin dosing errors in hospitalized patients who are taking this medication for the first time. Researchers will modify a program that predicts warfarin dosing requirements along with a program that identifies potential drug-drug interactions. The investigators will also evaluate the feasibility of using these informatics tools in routine hospital practice. In addition, they plan to make them widely available at no cost for public use.
- *Using Prospective Minimum Data Set Data to Enhance Resident Safety*; Grant No. R18 HS11869. This research project will determine whether preventable adverse outcomes for the frail elderly population in long-term care settings can be avoided by using computers to alert nursing and other staff to the likelihood that a problem such as falls, pressure ulcers, and urinary tract infections will occur. They will also identify resident-specific risk factors that are likely to cause an adverse outcome and target these risk factors for preventive interventions.
- *Impact of Electronic Prescribing on Medication Errors;* Grant No. R18 HS11868. This study will assess the baseline medication error rate in an urban pediatric emergency department and clinic. Researchers will also examine the effect of handheld electronic prescription writing on prescribing practices and medication error rates.
- *Identifying and Reducing Errors with Surgical Simulation*; Grant No. R18 HS11866. This research project will use state-of-the-art simulation tools to train otolaryngology physicians. Through the use of these simulation tools, physicians will be able to practice surgical procedures without exposing patients to the potential risk of having their surgery performed by an inexperienced surgeon. Data from the program will be collected into a central database and used for outcomes analysis. Technical errors and "near misses" will be identified, quantified, and analyzed. This information will be used to improve physician training and to monitor ongoing performance.
- *Pharmacist Technology for Nursing Home Resident Safety;* Grant No. R18 HS11835. This study will use the Geriatric Risk Assessment Minimum Data Set Med Guide (GRAM), a clinical tool to alert medication prescribers and nursing staff to information that can reduce the threat to patient safety associated with adverse drug events in nursing homes. The GRAM software helps evaluate the complex medication regimens of older patients, incorporates patient assessment data for monitoring medication therapy, and facilitates inclusion of recommendations in the care plan to prevent medication-related problems. Researchers will examine the extent to which the GRAM clinical tool reduces the incidence of delirium, falls, and hospitalizations due to adverse drug events and will determine the impact the GRAM software has on the efficiency, productivity, workload, and job satisfaction of pharmacists and nursing facility staff.
- *Linking User Error to Lab and Field Study of Medical Informatics;* Grant No. R18 HS11816. This project will explore the relationship among human, machine, and environmental factors associated with the operation of infusion devices in clinical settings. The project will identify and characterize properties of infusion devices, environmental conditions, and problems in operator cognition that promote "user error."
- *HIV Treatment Error Reduction Using a Genotype Database;* Grant No. R18 HS11800. This project will implement and evaluate an automated computerized decision support system. The system will integrate patient-specific HIV genotype information with corresponding medication data within an electronic

medical record system to improve antiretroviral drug selection, reduce prescribing errors, prevent the development of drug resistance, and improve overall quality of care.

Conclusion

Medical informatics is one of many important components necessary to improve the quality of health care in the United States. Research funded by AHRQ over the past 30 years has given clinicians solutions to many problems they face in patient care. It has covered a wide range of topics, including the electronic medical record system, access to current information, clinical reminders, clinical decision support, electronic communication, patient education and self-management of chronic disease, and methods for identifying a bioterrorist attack. AHRQ remains committed to supporting research in medical informatics, including continued support of new and innovative technologies, information/knowledge management, improved communication between patients and providers, shared decisionmaking, identifying and overcoming barriers to the use of computers in health care, and new challenges posed by the threat of bioterrorism.

For more information

For further information on medical informatics at the Agency for Healthcare Research and Quality, please contact Eduardo Ortiz, M.D., M.P.H., at 301-594-6236 or eortiz@ahrq.gov.

AHRQ-Funded Research on Medical Informatics

- *Demonstrating Computer Support Impact on AIDS Patients*, University of Wisconsin-Madison: This study examined the effects of CHESS (Comprehensive Health Enhancement Support System, a patient-centered, computer-based support system) on the health care costs and quality of care of HIV-infected men and women.
- *Effect of Computer Feedback on Physician Test Ordering*, Indiana University: This project tested the effect of patient-specific computer feedback on physicians' test-ordering practices.
- *Variance in Medical Decisions: Causes and Cures*, Indiana University: This study examined the effects of three informational interventions (newsletters, reports comparing an individual physician with his or her peers, and personal contact by faculty members) in terms of changes in physicians' medical decisions.
- *Assessment of Technology Use Via a Computerized Ordering System*, Indiana University: This study developed a microcomputer network for ordering by physicians of all tests and treatments on the inpatient medicine service.
- *Computerized National Chronic Disease Databank System*, Stanford University: This project established a pilot rheumatic disease computer data bank network (Arthritis, Rheumatism and Aging Medical Information System, or ARAMIS) that pooled clinical data between institutions and institutional studies, allowed rapid access to large quantities of clinical data, and provided computer consultation and clinical decision procedures based on these data.
- *Assessment of Technology in Chronic Disease*, Stanford University: This project utilized ARAMIS, a successful national chronic disease data bank system, to develop a systematic technology assessment program in rheumatic disease.
- *Clinical Applications of an Expert System*, LDS Hospital: This project developed an antibiotic consultant for the Health Evaluation through Logical Processing (HELP) hospital information system.
- *Evaluation of a Computerized Infectious Disease Monitor*, LDS Hospital: This study demonstrated the effectiveness of using a computerized infectious disease monitor to minimize the inappropriate use of prophylactic antibiotics, optimize the use of therapeutic antibiotics, and detect the presence of nosocomial infections.
- *Hospital Computer Project*, Massachusetts General Hospital: This research project developed the Computer Stored Ambulatory Record (COSTAR), a totally integrated computer-based information system that supported all the medical care, financial, and administrative needs of an ambulatory care organization.
- *Computer-Based Access to Guidelines for Clinical Care,* Massachusetts General Hospital: This study developed, implemented, and evaluated a computer-based system that provided physicians and nurses access to clinical guidelines of care for the purpose of learning and consultation.
- *Bioterrorism: Automated Decision Support and Clinical Data Collection*, Boston Children's Hospital: This project is developing a prototype database and Web site to facilitate clinician reporting of trends reflecting possible bioterrorist events.
- *Using Information Technology to Improve Clinical Preparedness for Bioterrorism*, MPC Corporation-University of Pittsburgh/Carnegie Mellon University: This project is developing the Real-time Outbreak and Disease Surveillance (RODS) system to provide early warning of infectious disease outbreaks possibly caused by an act of bioterrorism.
- *Innovative Approaches to Training Clinicians for Bioterrorist Attacks: Online Modules*, University of Alabama-Birmingham: This project has developed interactive Web-based training modules to teach health professionals how to address varied biological agents, including anthrax, smallpox, botulism, tularemia, viral hemorrhagic fever, and plague.

References

*1. American Medical Informatics Association. Frequently Asked Questions. Web site: <http://www.amia.org/about/faqs/f7.html>. Accessed May 13, 2002.

*2. Fitzmaurice JM, Adams K, Eisenberg JM. Three decades of research on computer applications in health care: medical informatics support at the Agency for Healthcare Research and Quality. J Am Med Inform Assoc 2002; 9(2):144-60.

3. Barnett GO, Winickoff R, Dorsey JL, et al. Quality assurance through automated monitoring and concurrent feedback using a computer-based medical information system. Med Care 1978; 16(11):962-70.

*4. Tierney WM, McDonald CJ, Martin DK, et al. Computerized display of past test results. Ann Intern Med 1987; 107(4):569-74.

5. Overhage JM, Dexter PR, Perkins SM, et al. A randomized controlled trial of clinical information shared from another institution. Ann Emerg Med 2002; 39(1):14-23.

*6. Cimino C, Barnett GO, Blewett DR, et al. Interactive query workstation: standardizing access to computer-based medical resources. Computer Methods Programs Biomed 1991; 35:293-99.

7. Morgan MM, Goodson J, Barnett GO. Long-term changes in compliance with clinical guidelines through computer-based reminders. Proc AMIA Symp 1998; 493-7.

*8. Dexter PR, Perkins S, Overhage JM, et al. A computerized reminder system to increase the use of preventive care for hospitalized patients. N Engl J Med 2001; 345(13):965-70.

*9. Tierney WM, Hui SL, McDonald CJ. Delayed feedback of physician performance versus immediate reminders to perform preventive care. Med Care 1986; 24(8):659-66.

*10. Evans RS, Classen DC, Pestotnik SL, et al. Improving empiric antibiotic selection using computer decision support. Arch Intern Med 1994; 154(8):878-84.

11. Pestotnik SL, Classen DC, Evans RS, et al. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. Ann Intern Med 1996; 124(10):884-90.

12. Singh G. Arthritis, Rheumatism and Aging Medical Information System Post-Marketing Surveillance Program. J Rheumatol 2001; 28(5):1174-9.

*13. Gustafson DH, Hawkins R, Boberg E, et al. Impact of a patient-centered, computer-based health information/support system. Am J Prev Med 1999; 16(1):1-9.

*14. Havey G. Wireless Internet medical monitoring devices. Final report. Fridley (MN): Advanced Medical Electronics Corp.; 2001. Contract No: 290-00-0028. Sponsored by the Agency for Healthcare Research and Quality.

*15. Teich JM, Wagner MM, Mackenzie CF, et al. The informatics response in disaster, terrorism, and war. J Am Med Inform Assoc 2002; 9(2):97-104.

16. Rabbani U, Morgan M, Barnett O. A COSTAR interface using WWW technology. Proc AMIA Symp 1998; 703-7.

17. Web MD. Rheumatic fever. Web site: <http://my.webmd.com/content/article/1680.53609>. Accessed April 1, 2002.

*18. Tierney WM, Miller ME, Overhage M, et al. Physician inpatient order writing on microcomputer workstations. JAMA 1993; 269(3):379-83.

*19. Lober WB, Karras BT, Wagner MM, et al. Roundtable on bioterrorism detection: information system-based surveillance. J Am Med Inform Assoc 2002; 9(2): 105-15.

20. Burke JP, Pestotnik SL. Antibiotic use and microbial resistance in intensive care units: impact of computer-assisted decision support. J Chemother 1999; 11(6): 530-5.

21. Singh G, Ramey DR. NSAID induced gastrointestinal complications: the ARAMIS perspective—1997. J Rheumatol 1998; 25 Suppl 51:8-16.

22. Singh G, Triadafilopoulos G. Epidemiology of NSAID induced gastrointestinal complications. J Rheumatol 1999; 26 Suppl 26:18-24.

23. Singh G. Gastrointestinal complications of prescription and over-the-counter nonsteroidal anti-inflammatory drugs: a view from the ARAMIS database. Am J Ther 2000; 7(2):115-21.

**** AHRQ-funded/sponsored research***

24. National Institutes of Health, Office of Extramural Research, Small Business Funding Opportunities. Web site: <http://grants1.nih.gov/grants/funding/sbir.htm#sbir>. Accessed April 29, 2002.

*25. Small Business Innovative Research Program, Phase 1. Request for Proposals. Agency for Healthcare Research and Quality, Rockville, MD. Web site: <http://www.ahrq.gov/fund/rfp000006.htm>. Current as of July 2000.

*26. Sharma S. Web-based tool for diabetes self-care. Final report. Watertown (MA): New England Research Institutes; 2001. Contract No. 290-00-0025. Sponsored by the Agency for Healthcare Research and Quality.

*27. Gibson P. Automatic wireless data collection from medical devices. Final report. Fridley (MN): Advanced Medical Electronics Corp., 2001. Contract No. 290-00-0029. Sponsored by the Agency for Healthcare Research and Quality.

28. Dorland's Illustrated Medical Dictionary. 28th Ed. W.B. Saunders Company. Philadelphia, 1994.

*29. Agency for Healthcare Research and Quality. AHRQ research relevant to bioterrorism preparedness. Rockville (MD); 2002. AHRQ Publication No. 02-P018. Web site: <http://www.ahrq.gov/news/focus/bioterror.htm>. Current as of March 2002.

*30. Agency for Healthcare Research and Quality. Responding to bioterrorism: AHRQ helps clinicians, health systems, and policymakers. Rockville (MD); 2001. Web site: <http://www.ahrq.gov/research/bioterr.htm>. Current as of Oct. 2001.

*31. Terndrup T, Tresler M. Researchers, University of Alabama-Birmingham. E-mail correspondence to Barbara Kass-Bartelmes, Agency for Healthcare Research and Quality. April 10, 2002.

*32. Agency for Healthcare Research and Quality. AHRQ issues request for applications on clinical informatics and patient safety research. Press release. Rockville (MD): 2001. Web site: <http://www.ahrq.gov/news/press/pr2001/clipspr.htm>. Press release date Feb. 23, 2001.

**** AHRQ-funded/sponsored research***

Previous issues of *Research in Action* are available for free from the AHRQ Publications Clearinghouse: 1-800-358-9295. Please specify the AHRQ publication number when you call.

Issue	Title	Publication Number
5	Expanding Patient-Centered Care to Empower Patients and Assist Providers	AHRQ 02-0024
4	Managing Osteoarthritis: Helping the Elderly Maintain Function and Mobility	AHRQ 02-0023
3	Preventing Disability in the Elderly With Chronic Disease	AHRQ 02-0018
2	Improving Care for Diabetes Patients Through Intensive Therapy and a Team Approach	AHRQ 02-0005
1	Reducing and Preventing Adverse Drug Events To Decrease Hospital Costs	AHRQ 01-0020

U.S. Department of Health and Human Services

Public Health Service
Agency for Healthcare Research and Quality
2101 East Jefferson Street, Suite 501
Rockville, Maryland 20852

Official Business
Penalty for Private Use $300

PRSRT STD
POSTAGE & FEES PAID
PHS/AHRQ
Permit No. G-282

www.ahrq.gov

AHRQ Pub. No. 02-0031
June 2002