# Conference Summary: Computers in Respiratory Care

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**Computers and data mangement in respiratory care reflect the larger practices of hospital information systems: the diversity of conference topics provides evidence. Respiratory care computing has shown a steady, slow progression from writing programs that calculate shunt equations to departmental management systems. Wider acceptance and utilization have been stifled by costs, both initial and on-going. Several authors pointed out the savings that were realized from information systems exceeded the costs of implementation and maintenance. The most significant finding from one of the presentations was that no other structure or skilled personnel could provide respiratory care more efficiently or cost-effectively than respiratory therapists. Online information resources have increased, in forms ranging from peer-reviewed journals to corporate-sponsored advertising posing as authoritative treatment regimens. Practitioners and patients need to know how to use these resources as well as how to judge the value of information they present. Departments are using computers for training on a schedule that is more convenient for the staff, providing information in a timely manner and potentially in more useful formats. Portable devices, such as personal digital assistants (PDAs) have improved the ability not only to share data to dispersed locations, but also to collect data at the point of care, thus greatly improving data capture. Ventilators are changing from simple automated bellows to complex systems collecting numerous respiratory parameters and offering feedback to improve ventilation. Clinical databases routinely collect information from a wide variety of resources and can be used for analysis to improve patient outcomes. What could possibly go wrong?** *Key words: computers, data collection, information management, training techniques, personal digital assistant, PDA, handheld computer, patient data privacy, medical errors.* [Respir Care 2004;49(5):531–536. 

## Introduction

I would like to thank the American Respiratory Care Foundation for sponsoring this conference and for allowing me the privilege of presenting the conference summary. We have spent 2 days at a conference entitled "Computers in Respiratory Care." In retrospect it seems to have been misnamed, since we have been talking very little about computers and more about information management. This is probably a reflection of the acceptance and omnipresence of computers that has occurred since the last RESPIRATORY CARE Journal Conference on computers, 20 years ago. At that time computers were comparatively rare and the conference tried to prepare us for the coming of automation. Now that they are here, this conference discussed how to use them more effectively.

## Computerization in Respiratory Care

Karen Stewart started the conference with a review of the effects of computers on respiratory care. In her hospital, computerized physician order-entry reduced errors by 55%. The Health Insurance Portability and Accountability Act (HIPAA) has made privacy of patient health information everyone's concern. HIPAA's initial main objective was to ensure that health care coverage could follow a person from one employer and provider to another without loss of coverage. Over the course of attempts to improve and clarify HIPAA, the health information privacy provisions were added. The HIPAA regulations dictate fines and imprisonment for disclosing any of a patient's health-related information, and health-related information is very broadly defined and can include written and spoken communications, e-mail messages, Web site access, and photographs.

Karen sees the next major goal of computerization to be fully integrating information from every source at the point of care, so that we spend less time searching for patient information and more time on patient care. That will require the elimination of existing information "silos" that confine information to particular groups or departments. She concluded with a quote that bears repeating in regard to the National Health Information Infrastructure: ". . . push information and knowledge to the point. . . that the right decisions can be made at the right time."

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The discussion that followed Karen's presentation included clarification of the relationship between health care institutions and software and hardware vendors and service providers. HIPAA regulations cover anyone who has information access, including technicians who do system repairs. Vendors must be auditable and there must be a *business associate agreement* between the vendor and the health care institution.

## Respiratory Care Management Information Systems

In his presentation Rick Ford told us about the path his institution followed to select and develop a computerized respiratory care management system. A respiratory care department can either use the hospital's information system or develop its own system within and specifically for the department. Hospital information systems have limited abilities because they are not designed specifically for managing respiratory care departments, whereas systems designed and implemented for a specific respiratory care department are easily configurable but must be configured to interface easily and accurately with the hospital-wide information system. In Rick's department they designed their own system, and he said that the key to success was creating an advisory team that included staff from the departments of respiratory care, nursing, finance, and information technology at the beginning of the project. Obtaining funding for such a project requires understanding the institution's strategic plan: know the administration's "pain points" and address them. Justifying a computerized management system generally relates to the effect on the financial "bottom line." Improving charge capture should be way down the list of reasons to automate, even though the system in Rick's department paid for itself in about 2 months by capturing charges that had previously been missed.

Another key requirement is having good time standard information, policies, procedures, and protocols. If you don't have those, create them before attempting to install a computerized management system. The American Association for Respiratory Care's Uniform Reporting Manual and Clinical Practice Guidelines provide good starting points. At Rick's institution implementing the management system did not allow them to reduce the number of staff, but it did improve staff utilization and allocation. Rick warned that ongoing support costs for such systems may be as high as 25% of the initial purchase cost.

Rick provided several observations about the University of California San Diego's (UCSD) experience in implementing a respiratory care management system. His department efficiency increased both by the installation of the system and by reverting to a centralized department model. Their data demonstrated that there was no other structure or skilled personnel who could perform respiratory care tasks at a lower cost.[1] He even surmised that had there not been data available that supported the value of the system the respiratory care depart-

ment at UCSD might no longer exist. Finally, he pointed out that many hospitals recoup the initial cost of such a system within the first year.

The discussion after Rick's presentation centered on which comes first: the respiratory care management information system or good clinical processes. In the absence of good processes all that is accomplished is automating poor processes. He was also quick to point out that benefits may not be realized as rapidly as they were in his institution.

### Computer-Aided Decision-Making in Respiratory Care

Reed Gardner provided an update of the report he delivered at the first RESPIRATORY CARE Journal conference on computers 20 years ago, regarding computerized clinical decision-support. The critical element for computerized clinical decision-support is an integrated clinical database but those have yet to be widely implemented. He showed a pyramid of accomplishments in the process of designing and implementing a decision-support system, which illustrated the difficulties involved. A decade may be required to collect adequate data, several years to determine the quality of the data, months to determine the data-presentation method, weeks to determine the clinical-decision-support rules to enter into the system, and less than a minute for the computer to render its advice. One large obstacle is agreeing on the decision rules. Determining who is the ultimate authority on a clinical question is usually an 80% social or political (and only 20% technical) decision. Now that numerous devices generate data (from infusion pumps to ventilators to radiology systems), Reed stressed the importance of a standard nomenclature for data exchange so that a term used by one system is understood by other systems.

Computerized decision-support is known to be valuable in both monetary terms and with regard to mortality/morbidity, which led to a discussion of why computerized decision-support is not universally implemented. As expected, the answer relates to finances, since designing and implementing a computerized decision-support system involves a large expenditure of time and money. Reed cited an example from his experience at LDS Hospital; there, savings from an "antibiotic assistant" computerized decision-support system were so obvious that the study was not even completed before the system was fully implemented. The discussion also raised the issue of Food and Drug Administration oversight of decision-support software. At present such oversight is required only in limited, specific cases, such as the software used by blood banks.

### Information Retrieval in Respiratory Care

Dean Hess gave us pointers on how to become information retrieval experts. He expressed the increasing need to have access to current information to support effective practice. Practicing evidence-based medicine requires convenient access to the ever-expanding body of medical literature. Though more information is becoming available online, there is not yet a vetting mechanism for the quality of that information, though several organizations, such as the Health On the Net Foundation,[2] have published guidelines and standards by which to assess health information found on the Internet. To perform effective information searches we need to be able to assess the authority, complementarity, confidentiality, attribution, justifiability, authorship, and sponsorship of information. The Health On the Net Foundation applies its "code of conduct" for medical and health Web sites and acts as a clearinghouse for sites that meet the criteria of that code.

With the wide variety of databases and Internet resources available, a searcher needs to realize that a search strategy that works in one search engine may not work in another. Search engines use proprietary strategies that optimize results for their intended users. A general-purpose search engine, such as Google, may rank and present results in a different order than a search engine designed specifically for medical information, such as Ovid. Becoming proficient at search strategies is mostly a trial-and-error process. The most effective strategy is to try the obvious first. If you are looking for information on a specific device, start at the manufacturer's Web site.

Dean pointed out during his discussion that sometimes our patients may have more information than we do regarding their diseases, partly because they have a vested interest. The discussion also addressed online continuing medical education. It was pointed out that many continuing medical education programs are sponsored by companies, though the sponsorship is not always readily apparent.

### Respiratory System Simulations and Modeling

The "cool toys" lecture was presented by Neil MacIntyre. He provided us with a stimulating catalog of simulators used in clinical education. Simulators are of 2 types: anatomic models and physiologic models. They range in sophistication from spring-and-bellows test lungs to quarter-million-dollar mannequins. Anatomic simulation models started as text-based computer programs that presented a condition to which the user entered a response. Computer graphics were later added to show reactions to treatment. The current state of the art is a computer-controlled mannequin that can present a whole spectrum of clinical problems. Neil also showed a bronchoscopy-training simulator that can demonstrate various anatomical situations and allows simulated biopsy. Physiologic models, such as the lung simulators made by Ingmar and Hans Rudolph, provide training on mechanics and ventilator interactions.

Neil spoke of an absence of data regarding whether computer models affect outcomes. Beginning in World

War II, the airplane industry drastically reduced the number of flight accidents by training pilots with flight simulators. The medical industry has not yet developed and implemented widespread simulator training. Although outcome data are not yet available, current medical simulators can provide a better understanding of pathophysiology.

### Education, Teleconferencing, and Distance Learning in Respiratory Care

Keith Hopper started off by lamenting his diminished exposure to the rich vocabulary of respiratory therapy and how he has missed it—so much so that he is considering naming his next cat "Parenchyma." In his presentation on distance learning and teleconferencing he reminded us that technology is expensive, fragile, and stupid. Our obsession with technology is easily demonstrated by the cellular telephone, which now turns up everywhere from restaurants to theaters to funerals to public restrooms. But Keith said that new technologies have actually had little impact on the education process. Neither radio, telephone, nor television brought the radical changes educators predicted. However, Keith believes the Internet may be different. In 2002 he found that 1,680 institutions were offering over 54,000 Internet-based courses.

Distance learning requires more than putting a camera in front of a lecturer. In distance learning, visual feedback from the audience is eliminated, students may not be able to readily communicate with the instructor, and nuances that would be detected in person could be lost. Distance learning has also had a high student attrition rate. In the case of respiratory therapist (RT) education this may be explained by the fact that to be an RT is to *do*, and distance learning does not allow the *doing* part. Keith warned against respiratory care developing a "matchbook training program" stigma. The perceived value of the profession may be diminished if online education is believed to be of low quality, partly because of gimmicks such as "life-learning credits." Keith enjoined the American Association for Respiratory Care to consider developing "super courses" that would help ensure a high standard of education.

### Computers in Patient Education and Monitoring

The term "e-health" describes the use of computerized information and communication technologies in health care, patient education and monitoring, medical informatics, public health, and business aspects of health care. In his presentation Thom Belda pointed out the problems that patients face when looking for information on the Internet. There is a need to improve the opportunity for patients to find accurate health information, to improve the use of multi-media to match patients' needs, and to improve the flow of information between the patient and the provider. Electronic access to health care providers is far from a new concept. For example, a 1924 article in *Popular Mechanics* (5 years before the advent of television) described an effort by Bell Laboratories to develop a "radio doctor" to extend health care to remote areas.

In the discussion following Thom's presentation the authority and reliability of health information on the Internet was brought up again. The National Cancer Institute's Web site concerning how to evaluate Internet health information[3] was cited as a resource to help assess the accuracy and quality of health-related Web sites. There is still a need for a more comprehensive Web-information evaluation process, similar to *Consumer Reports*' evaluations of consumer goods. Thom's review found that commercial Web sites tended to provide poorer quality information about diseases and tended not to include information about prevention.

Just as it limits people's access to health care, economics can limit access to Internet health information. Access to online services is related to income, although there are many sources of free Internet access, such as public libraries. One problem with public access is the potential lack of privacy of information that may be stored on the system after a user logs out. It was also brought up that a structure needs to be developed for reimbursement of chronic disease management. Patient satisfaction increases when they can monitor their own progress. Telemedicine improves patient compliance but lowers physician satisfaction, in part because of the lack of reimbursement for online care. Several programs are being developed to include online services in a reimbursement plan.

### Staff Training and Computers in Respiratory Care

Staff education is usually the first thing to be cut in tough economic times, according to Dave Walker, whose presentation to this conference provided several ideas to overcome that administrative short-sightedness. The first idea echoed Rick Ford's point that you must understand the institution's "pain points" and strategic plan and show administrators how staff training fits in with the hospital's needs. Inadequate training was blamed in half of the 98,000 patient deaths in 1997 that were due to medication errors. One technique is for the staff educators to diversify, which may include training staff in new subjects and expanding the educator's audience to include other health care providers, patients, patient's families, and the community at large.

The knowledge base for respiratory care is continually changing and requires education to distribute those changes. One key to the success of RT training is to provide it at the "golden moment"—that moment at which the RT is most receptive to learning, which is not normally during mandatory weekly staff training sessions. Access to training information should be inexpensive, convenient, and consistent. The system for updating staff training materials must allow for rapid changes and a continuous process of improvement. The staff training system should

be designed to meet the various levels of knowledge among the department's staff. Dave pointed out that 70% of high-tech industry companies have adopted computerized and Web-based training to keep their workforces up to date amid rapid change. He concluded with a demonstration of a personal digital assistant (PDA) application with video and audio to show how staff training can be extended to the bedside.

### Portable Applications and Devices

Terry Volsko demonstrated how PDAs provide a convenient tool for data collection and dispersion at the point of care or point of need, which decreases the time required for record-keeping, increases data and revenue capture, improves workflow, and improves follow-up. Converting one application alone to run on a PDA saved her department about 7 hours per week.

Though PDAs have become more sophisticated recently, they are generally used only for data collection, not data analysis. Many of the medicine-oriented PDA applications are references such as pocket guides for pharmacology and critical care and battlefield guides for medics. PDAs can (more reliably than index card files) maintain logs of procedures that each staff member is capable of performing and how many he or she has done.

Sophisticated PDA programs can be written, but they tend to be department-specific, written by a local PDA champion. Adding to the problem of exchanging programs is the variety of interfaces used to connect to clinical databases and the different terms used by different groups. Another problem is that PDAs can easily be lost or misappropriated.

Success in developing a PDA-based system requires finding a person who has a vested interest in the success of the system, evaluating the utility of the PDA application and the processes it will be used for, and training the users. Unfortunately, in most cases PDAs show up and then people start looking for applications to run on them, which recalls the age-old adage, "If you only have a hammer, every problem looks like a nail." One last consideration from a user standpoint is "separation-anxiety." When Terry Volsko changed jobs she had to turn in her PDA, and giving up such a useful tool was difficult.

### Computer Control of Mechanical Ventilation

Rob Chatburn's contribution to this conference provided us with the greatest opportunity to stretch our knowledge. "Fuzzy-logic" and "neural networks" are not yet everyday concepts for RTs thinking about mechanical ventilation but they are being incorporated into current and future ventilators. Rob presented 6 levels of ventilator control, ranging from simple (eg, set-point systems, in which the RT dials in a set of ventilation parameters and the ventilator delivers them) to the most advanced—the "neural network," which can provide the clinician with suggestions for ventilator-setting changes, observe the patient's reactions to ventilator-setting changes, and update its own control protocol. Each additional advance in the sophistication of the ventilator-control software removes the RT further from directly affecting the delivered values—to the point that a future ventilator system, using adaptive technology, might be able to start ventilating a patient without any operator assistance.

The second portion of Rob's presentation addressed the interface between the ventilator and the clinician. There are 2 general functions the ventilator must provide: controlling input and monitoring status. According to his observations, all current ventilators suffer from poor operator-interface design and inconsistent nomenclature, and from being too small, too cluttered, or poorly organized. He tasked manufacturers to utilize findings from the field of *usability engineering* to improve ventilators' user interfaces. He also encouraged RTs not to simply accept all the design aspects that manufacturers give us. Improved interfaces can lead to more efficient operation and easier learning.

Neil MacIntyre began a lively discussion after Rob's presentation. Neil said that the only values we need to run a ventilator are $P_{O_2}$, pH, plateau pressure, and fraction of inspired oxygen ($F_{IO_2}$), though he also pointed out that even among pulmonologists there is not complete agreement on that point, so how can criteria be established? Dave Pierson reminded us that all the alarms and waveforms are secondary and that we should start with a simple step—asking the patient how he or she feels.

### Using Computers for Intensive Care Research

In his presentation on using computers for intensive care research Nick Ward pointed out that gathering patient data is fraught with risks of error. Manually entered data are subject to various types of error, including transcription errors, omissions, and entry for the incorrect patient. Automated data collection may provide accurate numbers but cannot be used to judge data quality. Clinical databases have to be properly implemented to provide useful data to evaluate clinical outcomes. As an example Nick showed a study from his institution, in which clinicians were requested to give the reason for ordering an arterial blood gas test. In 92% of the cases no reason was entered. It was thought that most of the staff were following a "path of least resistance" in ordering the test and that they had no vested interest in the success of the test.

The 3 primary problems with data collection, storage, and retrieval are:

- Garbage in, garbage out: if the data are suspect, the conclusions derived from it are also suspect.
- Nothing in, nothing out: in some cases the data needed

to correctly answer a question has not been collected.

- Data in, data lost: proper care must be taken to ensure that data are properly backed up.

### Problems and Issues With Computers in Health Care

The final talk, mine, addressed the problems that can arise in using computers in health care. Before any computer is connected to a network, either by wires or wirelessly, the user must know what the computer is doing, why it is doing it, and what it is using for protection.

The most common problems with computers are related to viruses, worms, and other harmful code, which are often spread by way of software functions that are enabled but not needed. Some programs and operating systems are delivered with certain functions turned on that increase the risk from harmful code. System setup should include turning off those functions.

Computer algorithms should be understood if they are being used for clinical-decision-support. It is not necessary to know an actual formula, such as the equation for a reference value for forced expiratory volume, but it is necessary to know where to find the information when a question arises or a new version is released.

Antivirus software must be installed *and* kept current. New versions of viruses are constantly being written that can bypass their predecessor's signatures. Using outdated virus-protection software provides a false sense of security and helps spread problems. A simple virus, such as W32.Blaster should have been stopped before it even entered a hospital network, but Nick Ward revealed that his staff was allowed to read e-mail from external accounts on computers connected to the hospital network, thus bypassing the hospital's software firewalls and infecting over 1,000 computers. It took the equivalent of a man-year to repair all the systems.

The conference ended as it began, on the issue of privacy. In the words of several Internet pundits, "You have no privacy: get over it." HIPAA specifies who may view protected health information, but consumers often unknowingly sign waivers that release their health information when they apply for homeowner's insurance, a credit card, an auto loan, or even a bank account. Not only should we be good stewards of our patients' data, we should also know how to protect our own once we leave work.

### Summary

The most surprising message of the conference was provided when Rick Ford showed that at UCSD there was no other structure or skilled personnel who could perform respiratory care tasks more efficiently or cost-effectively than the respiratory care department. Their respiratory care management information system proved what we have known for years: that only RTs can provide the best respiratory care.

We need to maintain a patient-centric viewpoint. We need to make sure that *we*, not the computer or ventilator or other device, are treating the patient.

A commonly mentioned requirement was to know your institution's strategic plan and general direction; if you do not, you will be unable to effect changes.

We have a long way to go to implement the state of the art in computing. Many facilities are just now discovering relational databases. Computerization has been slow to come to the bedside, despite that it could reduce medical errors and bring substantial cost savings. Our progress since the first RESPIRATORY CARE Journal Conference on computers has not kept up with the dizzying pace of the "dot.com" and "dot.bomb" era. In the early days of respiratory care, RTs were hardware wizards. We could grab a handful of valves, some tubing, and a couple of water bottles and create anything. I would like to challenge RTs today to become software wizards and share that knowledge to help us catch up.

We need to agree on a common terminology. New acronyms sprout in our field faster than mushrooms in Seattle. Manufacturers invent new terms to try to obtain a marketing advantage, even if another manufacturer has a very similar feature under a different moniker. Whether an existing terminology is modified to include respiratory care or another source is found, we won't be able to completely share outcomes and ideas until we all speak the same language.

We were unable to cover everything during this short conference. Several key topics that will be left for the next gathering are information dissemination, technology transfer, and software management. How will publications react to the speed with which research can be shared over the Internet? Will printed journals become quaint antiquities? How can we let others know about computer programs that we are using that may help them? What is the proper way to write a program? Does it need to be in a computer language or is a spreadsheet adequate, and at what point is it too big?

Thanks again to the American Respiratory Care Foundation for sponsoring the conference. I'd like to close with this thought attributed to Isaac Asimov: "The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' (I found it!), but 'That's funny. . . . '"

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