Respiratory Care Management Information Systems

Richard M Ford RRT FAARC

Hospital-wide computerized information systems evolved from the need to capture patient information and perform billing and other financial functions. These systems, however, have fallen short of meeting the needs of respiratory care departments regarding work load assessment, productivity management, and the level of outcome reporting required to support programs such as patient-driven protocols. The respiratory care management information systems (RCMIS) of today offer many advantages over paper-based systems and hospital-wide computer systems. RCMIS are designed to facilitate functions specific to respiratory care, including assessing work demand, assigning and tracking resources, charting, billing, and reporting results. RCMIS incorporate mobile, point-of-care charting and are highly configurable to meet the specific needs of individual respiratory care departments. Important and substantial benefits can be realized with an RCMIS and mobile, wireless charting devices. The initial and ongoing costs of an RCMIS are justified by increased charge capture and reduced costs, by way of improved productivity and efficiency. It is not unusual to recover the total cost of an RCMIS within the first year of its operation. In addition, such systems can facilitate and monitor patient-care protocols and help to efficiently manage the vast amounts of information encountered during the practitioner's workday. Respiratory care departments that invest in RCMIS have an advantage in the provision of quality care and in reducing expenses. A centralized respiratory therapy department with an RCMIS is the most efficient and cost-effective way to monitor work demand and manage the hospital-wide allocation of respiratory care services. *Key words: computers, respiratory care, information management, medical records, patient records, data collection.* [Respir Care 2004;49(4):367–375. © 2004 Daedalus Enterprises]

Introduction: The Evolution of Information Systems

In today's medical centers, "IT" no longer refers to "inhalation therapy," but to "information technology." The introduction of the microcomputer in the 1970s and the proliferation of personal computers in the early 1980s

Richard M Ford RRT FAARC is affiliated with Respiratory Services, University of California, San Diego Medical Center, San Diego, California.

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Correspondence: Richard M Ford RRT FAARC, Respiratory Services, University of California, San Diego Medical Center, 200 West Arbor Drive, San Diego CA 92103–8771. E-mail: rmford@ucsd.edu.

greatly expanded use of computers in medicine.[1] Several different types of hospital information system were introduced to support the functions of admission, discharge, transfer, billing, budgeting, and financial management. Hospitals throughout the country have since expanded their hospital information systems to include the capture of clinical information through online patient charting and interfaces with other medical systems. Given the potential advantage for both patients and payers, national experts in health quality and patient safety advised that computerized physician-order-entry be adopted as a national safety standard.[2–4] Hospital information system manufacturers responded by developing both the electronic medical record and computerized physician-order-entry as features in new generations of software.

By 1980 it was recognized that by using a computer one respiratory therapist (RT) could do more work than several people doing calculations by hand.[5] At that time only a handful of respiratory care departments were substantially computerized. Pullen[5] reported computers being used as tools for managing vast amounts of clinical data from patients with respiratory illnesses. Information systems assist in the flow of care by making available key patient information such as laboratory values and outcomes of therapy and by performing calculations.[4] Early examples include Loma Linda University in Loma Linda, California, which used computers to automate the transfer of blood gas analyses from the laboratory into the medical record.[5] LDS Hospital in Salt Lake City, Utah, developed their own system, with the concept of "chart accurately and let the computer do the rest of the paperwork."[6] The University Hospital Health Science Center of the State University of New York at Stony Brook, Long Island, New York, was among the first hospitals in the country to interface their respiratory therapy with their hospital information system, including physician-order-entry and automated generation of orders for respiratory staff.[5] A handful of respiratory care departments began developing their own information systems and then manufacturers of respiratory care management information systems (RCMIS) emerged. The primary functions of those early commercially available RCMIS were charting and billing. RCMIS manufacturers also introduced bedside charting capability, using portable hand-held computers.

The advantages of hand-held computers used at the point of care in pulmonary medicine were reported as early as 1985, by Andrews et al[6] and Hess et al.[7] Their usefulness was demonstrated in the clinical setting, to capture bedside data and perform calculations so that immediate and timely information was available to caregivers. Hand-held computers have evolved and now range from highly portable miniature devices, such as the Palm hand-held, to more powerful but still small computers that run the Windows operating system (Fig. 1). RCMIS manufacturers have taken advantage of that new mobile technology.

Fig. 1. Notebook computer (P-1120, Fujitsu, Santa Clara, California) with touch-screen and integrated wireless local-area-network capability. This is one of several options for mobile charting devices.

RCMIS transmit data between the server and the hand-held device via radio-frequency (wireless) technology. Stoller et al[8] demonstrated that mobile workstations networked through a radio-frequency communication system have several advantages over non-radio-frequency devices, including faster fulfillment of respiratory therapy consult orders (7.8 vs 2.8 h) and less time spent organizing and assigning respiratory care work (81.6 vs 43.6 min).[8]

Entering patient data into a hand-held device during the patient-care visit improves medical documentation. Rather than entering data after the visit, based on memory or notes on paper, which may be incomplete, inaccurate, or misinterpreted, with a hand-held device the practitioner can perform data entry at the bedside and in conjunction with treatment. Not only is information captured more immediately, the hand-held device makes immediately available important information related to patient assessment, and information entered by the clinician can be transmitted to other devices and systems.[9] Portable charting devices are evolving to serve as "personal digital assistant," pager, cellular telephone, and e-mail and Internet access device, and range from the size of a cellular telephone to devices about the size of a standard sheet of paper. This technology brings the opportunity for improved communication and access to information for the bedside caregiver.

Although the development of respiratory care over the past 35 years paralleled the revolution in information technology, few manufacturers responded to the unique needs of respiratory care departments. Manufacturers of RCMIS remain limited (Table 1). Many manufacturers of hospital information systems now incorporate charting and billing for respiratory care; however, they typically do not facilitate work load assessment, productivity management, or

Table 1. Names and Manufacturers of Respiratory Care Management Information Systems

Product Name	Manufacturer	Location	RC Sites (No.)	Web Site
CliniVision MPC	Nellcor Puritan Bennett	Kanata, Ontario, Canada	106	Clinivision.com
MediLinks	MediServe Information Systems	Tempe, Arizona	>100	Mediserve.com
OPUS	Theronyx	Thousand Oaks, California	7	Theronyx.com

RC = respiratory care
MPC = mobile patient charting
OPUS = outcomes and performance utilization system

the level of outcome reporting required to support programs such as patient-driven protocols. RCMIS offer many advantages over paper-based systems and hospital-wide information systems. RCMIS are designed to facilitate essential functions in respiratory care services, including assessment of work demand, the ability to assign and track resources, charting, billing, and reporting of results. They incorporate the ability to perform point-of-care mobile charting and are highly configurable to meet the specific needs of individual respiratory care departments.

The Need for Automation

The clinical environment is very data-intensive. East identified 236 categories of data that are reviewed at the bedside for clinical decision-making.[1] Eddy stated, "it is simply unrealistic to think that individuals can synthesize in their head scores of evidence, accurately estimate the outcomes of different options, and accurately judge the desirability of those outcomes." He concluded that the complexity of medicine exceeds the inherent limitations of the unaided human mind.[10] Though East and Eddy describe the challenges to the human mind in processing the vast amounts of clinical information, many department directors identify similar challenges in managing respiratory services. Managed care, re-engineering, changes in reimbursement, and national health care reform are issues that have shifted the manager's focus to cost containment and the evaluation of programs such as patient-driven protocols, flexible staffing/budgeting, and reductions in fixed support staff. These challenges drive the need to capture, organize, and analyze data. A detailed, "real-time" knowledge of and ability to access patient outcomes and department performance is essential. An RCMIS allows the respiratory care team to do more with less, to better manage resources, to easily report clinical and financial outcomes, and to conveniently capture information that supports ongoing performance improvement.[11,12]

RCMIS Evaluation and Planning

Planning for an RCMIS can take several months, considering the complexity and the need to integrate it with other technology and systems within a medical center. The process should start with the formation of an RCMIS advisory team who can provide expert advice during system selection and support during system installation. The team should include respiratory care department leadership and staff as well as representatives from the departments of information services, telecommunications, finance, patient accounting, administration, medical records, nursing, and medical staff. If the system has the capability or potential to be utilized in other departments within the medical center, representatives from those departments should also be part of the team. Though not all members may be required to attend every meeting, they should remain engaged and informed and be available to discuss issues related to their subjects of responsibility or expertise.

The proposal should include a description of why the system is needed, the desirable system characteristics, costs, resources required, fiscal and clinical benefits, and training and implementation timelines. The desirable characteristics of an RCMIS differ among departments and depend on the scope of service, structure, and functions. When considering RCMIS acquisition, planners need to determine which characteristics (Table 2) are *essential* and which are desirable but not *essential*. Identifying those characteristics is important to define system requirements in the evaluation process and to determine cost.

Discussions with an RCMIS manufacturer's sales specialist can lead to the assumption that the system can do everything you need it to do, and more. However, though nearly anything may be *possible* when it comes to computers and software, it is important to develop a clear and unquestionable understanding of what the system can *actually* do. Is the system specifically designed to provide you with the desired feature, or is it something the manufacturer thinks can be done or is working on? Some features, such as hospital-information-system interfaces, connectivity with other systems and equipment, and speed and performance in the hospital network, are nearly impossible to demonstrate until all the hardware components are in place and you start using the system. A sizable investment of time and money would be required to test and validate RCMIS performance and functionality in your setting prior to a purchase commitment. Functionality can best be as-

Table 2. Characteristics and Options of Respiratory Care Management Information Systems

Interfaces
Admission, discharge, and transfer
Orders (inbound and outbound)
Results (inbound and outbound)
Billing
Equipment (ventilator and monitor output capture)
Other departments' information systems
Charting
Flow sheet or free text entry
Support for both keyboard and pen entry
Automatic fill-in of designated fields from connectivity with other systems and devices
User-configurable templates for patient, order, and activity
Drop-down selection lists
Field limits and warnings
Ability to designate required fields
Ability to add, edit, and annotate comments
Audit trails for all entries and changes
Option to carry forward field values from orders and prior activities
Automatically calculated or default field values
Decision-support branching-logic capabilities
Workflow
List orders due and order detail for practitioners
Determine work demand prior to and during shift
Configure (manual or automatic) work assignments
Indicate work that has been done and work that is past due
Route new patients and new orders to practitioners
Calculate productivity of department, shift, or practitioner
Reports
Workload assessment, identifying all orders due
Practitioner workday, work-list specific to the area being assigned
Charting of all activities performed
Billing per patient, area, procedure, for any specified period
Tools to extract any desired data for export or external report writers
Inventory control and equipment management
Procedure micro-costing
Other Features
Support point-of-care and wireless communications
Compliance with Health Insurance Portability and Accountability Act
Features that enable use beyond respiratory care
Support outcome reporting and quality improvement
Updates and upgrades to software and hardware

Table 3. Issues Related to Clinical Information System Manufacturer Support and Performance

Provision of off-site and on-site training
Implementation time lines and on-site support during implementation
Support during system configuration and development of user-defined reports
Frequency of updates and upgrades
Cost of updates and upgrades
Service and resources available at all times
Ongoing commitment to users through forums and user groups

sessed through ongoing demonstrations of the product, discussions and site visits with others who have utilized the product, and, if possible, a trial-run in a test setting. Talking with other system users who have an environment similar to your own is highly recommended. The advisory team can identify RCMIS users through manager networks and user groups, searching the literature for user publications, or directly through the manufacturer. Discussions with other users will assist in the evaluation of the system's ability to perform specific functions and allow you to assess the ease of implementation, required training, the need for a department-based information specialist, system reliability, and—most importantly—the level of manufacturer support. Table 3 lists issues related to RCMIS manufacturer performance.

All products, services, and support should be specified in the purchase contract. It is also possible for the contract to include the details of the payment schedule, based on the manufacturer's ability to phase in the desired options. In some cases manufacturers will be open to creative programs that share or minimize the institution's financial risk. Information system contracts can be complex and specify a variety of terms and conditions related to the licensing of the software, coverage of expenses related to user group meetings, liability and indemnity related to software use, hardware specifications to support software, ongoing levels of technical support and the associated annual costs, and the degree of current and future compliance with the Health Insurance Portability and Accountability Act (HIPAA).

Justifying an RCMIS

The acquisition and operation costs of an RCMIS are substantial barriers for medical centers. Despite the many benefits, the number of RCMIS installations in medical centers in the United States amounts to less than 250 (unpublished data from my 2003 survey of manufacturers). There are also a handful of centers that have developed their own systems, using the talents of personnel within the department or hospital. Internally designed systems can meet needs specific to the institution; however, developing an RCMIS can require several hundreds of hours of programmer time. In situations where acquisition of a commercially available system is not possible, in-house RCMIS development is an option to consider.[13] In a period when hospitals are experiencing substantial decline in the funding available for capital expenditures, the cost of an RCMIS creates many challenges. Systems such as MediLinks (MediServe, Tempe, Arizona) or Mobile Patient Charting-MPC (CliniVision, Kanata, Ontario, Canada) can be $150,000–$250,000 for a 400-bed institution.[13]

To secure approval for an RCMIS requires convincing decision-makers that the system will afford substantial savings.[11] The economic justification of an expenditure of this magnitude will require a cost/benefit analysis and should include a return-on-investment analysis.

The first step in the justification process is to determine the projected savings and revenue to be generated as a result of the investment. In justifying a traditional hospital information system, the chief information system officer will calculate (1) reductions in labor costs (from obviating manual tasks and improving clinician productivity), (2) reductions in supplies and equipment (from standardization and better inventory management), and (3) revenue enhancement (from, for example, fewer outstanding days of receivables and fewer losses and disallowed charges).[14] In preparing a return-on-investment analysis for an RCMIS, similar cost savings and revenue enhancements should be included. Use of RCMIS over the past 10 years, however, has demonstrated a unique advantage for respiratory care departments. The cost savings and revenue enhancement will differ among departments and depend on the analysis of the factors listed in Table 4.

Though difficult to quantify and not usually part of the return-on-investment analysis, side benefits of a hospital information system include a demonstrable improvement of the quality of patient care and improved employee satisfaction, which positively impact recruitment and employee retention.[15–17] The system's time savings for staff means that health care providers have more time at the bedside for patient care. The elimination of many manual steps reduces the potential for error, and the legibility of the chart documents produced by an RCMIS is far superior to manually-created documents. The work environment is improved through improved communication and information access.[14] Such benefits may be difficult to quantify but can be incorporated in the RCMIS proposal.

Table 4. Respiratory Care Management Information Systems Offer Cost-Savings and Revenue Enhancements

Lost-charge capture yields net gain
Labor savings from point-of-care charting
Labor savings from better tools to manage productivity
Labor savings from reductions in fixed resources
Reductions in department and hospital cost and full-time employees, secondary to facilitation of protocols
Cost avoidance linked to: compliance with the Health Insurance Portability and Accountability Act; quality improvement; benchmarking; computerized physician-order-entry; and electronic medical records (paper-based systems are more expensive and/or time/labor intensive)

The Cost of an RCMIS

The cost of an RCMIS depends on the desired system characteristics you define and on the pre-existing structures and systems in place at your institution. The key part of the analysis is to ensure that all elements of cost are identified and accurately estimated, including all hardware, software, staff, and facility preparation costs.

Hardware costs may include a server computer, desktop workstation computers, mobile workstations, antennas and related equipment for wireless networking, emergency power availability, uninterruptible power supplies, carts, stands, mobile batteries, data storage/backup devices, and the cost of future upgrades and maintenance. Most systems currently available are hardware-independent, so the RCMIS advisory team can select from among several types and sources of hardware.

Software costs include licensing and maintenance/upgrade expenses. This includes not only the cost of the RCMIS application but also the costs of the operating systems, computer-virus protection, remote access, report-writing software, and other applications required to support the RCMIS application. In addition to the initial acquisition cost for software, the ongoing monthly/annual support fees must be included. Annual support fees for systems are typically 10–25% of the purchase price of the software.

Staffing costs include the additional personnel required for configuring the system, attending off-site training provided by the manufacturer, on-site training, time spent developing user-defined reports, and the ongoing cost of personnel assigned to manage the RCMIS.

Implementation

The successful implementation of an information system in a hospital setting requires attention to user readiness. The amount of training and support required will partly depend on your staff's computer "self-efficacy"—their competency and comfort in using computers. Greater computer self-efficacy is associated with experience with a home personal computer, ability to use word processing, ability to use the Internet and e-mail, and with demographics such as age and level of education. There are tools to assess self-efficacy and they can be useful in preparing group and individual training, and for determining the need for practice technology, peer mentors, and other resources during implementation.[18,19] A successful transition from a paper-based system to an RCMIS largely depends on keeping staff involved in the evaluation process, engaging them in configuration decisions, providing training, and facilitating the time needed to learn and adapt to the new technology.

Implementation of an RCMIS actually starts weeks before the system arrives. Despite all the technical considerations, the most important aspect of implementing an RCMIS is getting staff involved in the planning and configuration of the system. What procedures need to be included? What data need to be charted? What fields should be table-driven entries? How often should data be transmitted? What reports would be helpful? These are just a few of the many questions that the RCMIS team will face during planning and implementation.

The institution's information systems department will also need to be involved to support network communications and system interfaces. Typically, the manufacturer will work with the information systems department and pre-test interfaces 2–3 weeks prior to the RCMIS "go live" date. Interface and network performance should be validated in a test environment before going live. The information systems department should also assist in issues related to network security and virus protection of desktop and mobile devices. Though interfaced systems may require substantial support from information systems staff for 30 days prior to implementation, the information systems support required substantially decreases after configuration and implementation.

Once the RCMIS software and interfaces are fully installed, a 24–48-hour period of both paper and electronic charting should be considered. Clinical charting and billing records must be compared and validated for accuracy. Once data integrity and accuracy is validated, staff can put away their patient cards, charting forms, and billing slips, and trade them in for hand-held computers. The change may not initially be welcomed by all staff, as some will prefer the paper system they worked with for years. In time, however, staff become more familiar with and accepting of computerized charting and the RCMIS. Early gains such as having more time at the bedside, fast access to information, improved workflow, and new tools to support clinical care will help convince practitioners of the value of the new system.

The RCMIS Experience at the University of California, San Diego

The RCMIS justification and implementation experience at the University of California, San Diego (UCSD), provides some insight for those considering an RCMIS. The UCSD medical center is a 420-bed academic medical center with a respiratory care department of 55 full-time employees (FTEs). A CliniVision system was installed in June of 1993. It was a major challenge to acquire this $180,000 RCMIS during the same period that consultants arrived and targeted the respiratory care department for a substantial reduction in operating expenses. The RCMIS was not justified on the basis of reducing lost charges, nor enhancing revenue capture, nor even improving productivity. Although those factors enhanced the "bottom line," the cost savings potential deemed most important was the system's utility in facilitating patient-driven protocols. Just 6 months prior to acquiring the RCMIS the department had implemented (on a single medical floor) a patient-driven protocol program for chest physiotherapy and small-volume nebulizers. The cost saving achieved by that trial program was estimated to exceed $150,000 annually, as routine treatments decreased from 7,000 per month to less than 4,000. The use of paper documentation to assign protocol activities to RTs, to monitor care plans, and to assess outcomes was difficult and time-consuming. It was realized that further cost reductions could be achieved by expanding the program to the other medical floors and phasing in additional protocols. The protocol program's surveillance objectives could be accomplished either by hiring additional staff or acquiring an RCMIS. The annual saving from the patient-driven protocol program was predicted to exceed $300,000, so the RCMIS was approved and acquired.

Integration of Protocols

A patient-driven protocol is a set of medical-staff-approved care plans that are driven by the patient's condition and response to therapy and that allow the RT to initiate, change, discontinue, or restart treatments and services. Patient-driven protocols are driven by patient-specific information and observations that require we collect, store, process, and retrieve large amounts of patient data. To provide protocol-driven care for the 100–150 patients that UCSD respiratory care has on service each day, the RCMIS was specifically configured to identify evaluations and treatments due, track indications for therapy, monitor patient response to therapy, investigate RT compliance with the protocol care plan, trend transitions to alternative therapy, identify patient outcomes, and quantify the impact of patient-driven protocols on department operations. Point-of-service charting was configured to serve as a "bedside coach" so that the charting fields prompt the practitioner to perform the essential steps in the protocol and capture the information that drives the care plan.

A major opportunity for health care cost-containment is in developing information systems that provide practitioners with better information and decision-support for effective resource management.[12,20–24] The use of point-of-care computers can reduce clinical costs.[20–24] Iregui et al[25] studied the impact on ventilator-weaning of using a hand-held-computer version of their existing protocol. They found that patient eligibility for a spontaneous breathing trial was identified much earlier and that intensive care unit (ICU) stay was significantly shorter. With 352 patients enrolled in their study, a computerized interactive

version of their weaning protocol eliminated a total of 264 ICU days, for a cost saving of $369,600.[25] At UCSD the RCMIS improved speed, accuracy, and information access, and provided essential feedback for managing patient-driven-protocol-related activities. The actual year-end reduction in respiratory care expenses associated with implementation of patient-driven protocols at UCSD exceeded $500,000.

Improved Productivity

Productivity improvements from implementing the RCMIS at UCSD were not unlike the productivity improvements found by other institutions that made the investment in information systems that provide for work load assessment, assignment, and reporting results. My discussions with CliniVision and MediServe users indicate productivity gains of 5–10% (unpublished data from my 2003 interviews with users). Improved productivity is an often-reported benefit of transitioning to a computerized information system.[6,19,26] At UCSD the RCMIS allowed us to identify significant variability in the day-to-day, shift-to-shift, and area-to-area demand for respiratory care services throughout the medical center. In such an environment it is important to maintain the ability to vary labor resources and cross-utilize staff to minimize idle time, maximize time spent with patients, and maintain a productive workforce. It became clear that having a centralized respiratory therapy department was the best way to monitor work demand and manage the hospital-wide allocation of respiratory care staff. The data identified when and where therapy was done, allowing for the objective determination of the cost of respiratory care per procedure and per nursing unit. It became evident that there was no other structure or skilled personnel that could perform respiratory care tasks at a lower respiratory care cost per nursing unit.

The RCMIS also automated the deployment of RTs to work areas, based on the number of patients and treatments. Time standards were configured for each procedure so that staff were assigned 440 min of care in an 8-hour shift and 660 min of care in a 12-hour shift. In addition, because the system operates via radio-frequency network and automatically routes incoming orders to the appropriate practitioner, it quickly informs RTs and supervisors of changes in work demand. Knowing where staff were needed at any given time of the day provided for mid-shift reallocation of staff and improved planning for the next shift.

Practitioners spend a substantial portion of the workday documenting patient care activities. RCMIS that provide point-of-care on-line charting and access to information can improve productivity (Table 5). Ford and Burns found an immediate 8–10% improvement in daily productivity with tools that provided for better assessment of work demand, improved ability to flex and re-allocate, and less time spent entering information into medical records. Total annual salary expenditures for the RT clinicians were about $1.8 million, so a 10% productivity improvement saved about $180,000. The decrease in salary expenses alone was enough to pay for the RCMIS within the first year of operation.[11]

Table 5. Respiratory Care Management Information Systems That Use Mobile Devices* Improve Productivity

Immediate bedside access to patient information
Concurrent access to the patient record for documenting patient care
Elimination of a separate process to perform billing
Reduction in time spent entering information (drop-down menus, automatic fill-in of certain fields, and electronic interface with medical instruments that transfer data to specific fields)

*"Mobile device" means a hand-held computer that goes with the clinician during work and accesses patient information in the respiratory care management information system via radiofrequency connection.

Improved Charge Capture

Systems that automate billing capture and electronically transfer patient charges to the finance department can increase charge revenue by 10–30% (unpublished data from my 2003 interviews with users of such systems). The amount of the charge revenue increase largely depends on the efficiency of the systems that are in place prior to RCMIS installation. At UCSD charge capture improved by 10% after our 1993 RCMIS installation. At UCSD's Thornton Hospital in La Jolla, California, charge capture improved by 300% after their 1997 RCMIS installation; that substantial increase was from transitioning from a decentralized to a centralized system of managing their respiratory care services and from refinements in the billing process, both of which were made possible by the RCMIS. Table 6 lists ways that RCMIS can improve billing capture. Although UCSD is largely reimbursed through capitated payment programs, a small percentage of gross charges are recovered based on billed services. At Thornton Hospital net revenue increased by $900,000 the first year after RCMIS installation—a substantial improvement, considering the hospital's marginal collection percentage. Improved charge capture justified the total expense of the RCMIS at Thornton Hospital within 60 days.

The RCMIS at UCSD improved productivity, enabled implementation and expansion of their protocol program, and decreased the actual operation budget by more than $700,000 in fiscal year 1993–1994. The 1997 Thornton Hospital RCMIS installation brought similar productivity gains, enabled protocol-program support, and improved

Table 6. Respiratory Care Management Information Systems Improve Charge Capture

Eliminates written charge slips/cards, in which errors and omissions can occur
Automates billing capture into the clinical charting
Because billing is automatic with clinical charting, 100% of patient charges have the required documentation, which eliminates denials associated with lack of documentation
The billing interface passes charges directly to the hospital patient accounting system, which eliminates rejections secondary to deferred or delayed entry
The manager can immediately adjust or correct billing files to resolve problems and minimize errors and rejected charges
The manager can quickly modify billing configurations to optimize charge capture when there is a change in regulations or payer requirements

actual annual net revenue capture by more than $900,000. These gains achieved at UCSD and Thornton Hospital may seem extraordinary, but my discussions with respiratory service administrators and directors and with user group forums for both CliniVision and MediServe indicate that most facilities have recovered their initial RCMIS investment within the first year.

Summary

Information technology can play an important role in the collection, analysis, and reporting of both clinical and operational data and can enable programs that may not otherwise be possible with limited resources. At UCSD information systems that support the provision of clinical services and automate previously manual processes provided the edge needed to succeed in re-engineering respiratory services. By automating the assessment of work demand and the assignment of work load, productivity can be improved. By configuring hand-held point-of-care computers as protocol "coaches," the practitioner can successfully implement protocol care plans. By capturing care plans and outcomes at the point of care, the surveillance needs of a protocol program can be met. By capturing data and automating reports, continuous quality improvement programs become data-driven. By working with programmers to design tools for data analysis, manual processes that previously took days can be automated and reduced to a few hours, and in some cases minutes. There is no doubt that information technology brings substantial benefit and savings if applied appropriately and can substantially increase the personal productivity of respiratory care staff and managers. Andrews et al, in discussing wireless point-of-care data entry, perhaps summed it up best: "If caregivers are to become effective managers of health care resources in a diverse clinical environment, they will need these tools to achieve efficient access to information to make well-informed decisions and to measure patient outcomes."[6] For UCSD, if it were not for the RCMIS acquired in 1993 and the resulting improvements in data access and operational enhancements directly attributed to the RCMIS, the respiratory care department at UCSD might no longer exist.[27]

Accurate information and its timely availability are critical for today's respiratory care department. Cost-effective care requires rapid identification of and response to the changing patterns of care delivery needs, in a concurrent rather than retrospective time frame. RCMIS manufacturers continue to invest in new tools to improve RCMIS performance and expand capabilities to include decision-support and branching logic. Respiratory care departments that invest in an RCMIS will have an advantage when it comes to the provision of quality care and reducing expenses.

REFERENCES

1. East TD. Computers in the ICU: panacea or plague? Respir Care 1992;37(2):170–180.
2. Morrissey J. An info-tech disconnect. Even as groups such as Leapfrog push IT as an answer to quality issues, doctors and executives say, 'not so fast'. Mod Healthc 2003;33(6):6–7,36–38,40.
3. Bates DW. Computer physician order entry. The Leapfrog Group, Washington DC. 2003.
4. Bates DW, Gawande AA. Improving safety with information technology. N Engl J Med 2003;348(25):2526–2534.
5. Pullen EE. Computers help provide better care. Respir Ther 1980; 10(4):25–27.
6. Andrews RD, Gardner RM, Metcalf SM, Simmons D. Computer charting: an evaluation of a respiratory care computer system. Respir Care 1985;30(8):695–707.
7. Hess D, Maxwell C, Agarwal NN, Silage DA. Applications of a handheld computer in critical care medicine. Respir Ther 1985;15(4): 25–28.
8. Stoller JK, Kester L, Orens DK, McCarthy K. Impact of a radio frequency management information system on the process and timing of providing respiratory care services. Respir Care 2002;47(8): 893–897.
9. Waegemann CP, Tessier C. Documentation goes wireless: a look at mobile health care computing devices. J Ahima 2002;73(8):36–39; quiz 41–42.
10. Eddy D. Practice policies: where do they come from? JAMA 1990; 263(9):1265,1269,1272.
11. Ford R, Burns DM. Data-driven cost containment in the patient-focused environment. AARC Times 1994;18(5):80–84.
12. Ruland CM. Developing a decision support system to meet nurse managers' information needs for effective resource management. Comput Nurs 2001;19(5):187–193.
13. Howard WR. Development of an affordable data collection, reporting, and analysis system. Respir Care 2003;48(2):131–137.
14. Williams B. How to do an ROI (return on investment). Healthc Inform 1990;7(2):30–32.
15. Manning J, McConnell EA. Technology assessment: a framework for generating questions useful in evaluating nursing information systems. Comput Nurs 1997;15(3):141–146.
16. Kahl K, Ivancin L, Fuhrmann M. Automated nursing documentation system provides a favorable return on investment. J Nurs Adm 1991; 21(11):44–51.

17. Baldwin FD. Making do with less: there's no quick fix for the nursing shortage, but technology can help. Healthc Inform 2002; 19(3):37–40.
18. Dillon TW, Lending D, Crews TR 2nd, Blankenship R. Nursing self-efficacy of an integrated clinical and administrative information system. Comput Inform Nurs 2003;21(4):198–205.
19. Dillon TW, McDowell D, Salimian F, Conklin D. Perceived ease of use and usefulness of bedside-computer systems. Comput Nurs 1998; 16(3):151–156.
20. Wallace CJ, Metcalf S, Zhang X, Kinder AT, Greenway L, Morris AH. Cost effective computerized decision support: tracking caregiver acceptance at the point of care. Proc Annu Symp Comput Appl Med Care 1995:810–813.
21. Morris AH. Computerized protocols and bedside decision support. Crit Care Clin 1999;15(3):523–545.
22. Morris AH. Developing and implementing computerized protocols for standardization of clinical decisions. Ann Intern Med 2000;132(5): 373–383.
23. Morris AH. Rational use of computerized protocols in the intensive care unit. Crit Care 2001;5(5):249–254.
24. Barton DM, Burns SM, Fahey SA. A microcomputer application for managing information used when weaning patients from mechanical ventilation. Comput Nurs 1992;10(2):65–71.
25. Iregui M, Ward S, Clinikscale D, Clayton D, Kollef MH. Use of a handheld computer by respiratory care practitioners to improve the efficiency of weaning patients from mechanical ventilation. Crit Care Med 2002;30(9):2038–2043.
26. Hammond J, Johnson HM, Varas R, Ward CG. A qualitative comparison of paper flow sheets vs a computer-based clinical information system. Chest 1991;99(1):155–157.
27. Burns D. When information is key to survival: breathing life into respiratory care. Healthc Inform 1994;11(5):24–26,28,30.

Discussion

Ward: As you mentioned, more and more ICUs are installing clinical information systems—comprehensive computerized systems that do everything. We have one in our ICU and I don't think it interfaces well with our RCMIS, so that's been a problem for us. Among the problems is that some of our ventilators do not communicate with our clinical information system. That's caused problems for research and with regard to presenting an organized and comprehensive flow sheet of what's going on, so if anyone out there is considering purchasing one of these systems, I recommend that you make sure that the RCMIS and the clinical information system interface well.

Ford: I agree, Nick. You must consider the system's ability to interface with clinical information systems and medical instruments. That can be a problem with vendor-specific systems, some of which are designed to interface only with their particular piece of equipment. I hope that's going to change, but we'll have to challenge the manufacturers to do it. I have the same connectivity issues in our ICU. We can interface with Puritan Bennett ventilators but not with other ventilators.

MacIntyre: These calculations we make for administrators of so-called cost savings and revenue enhancements can, I think, be a 2-edged sword. Specifically, with revenue enhancement you can increase charge capture, but at my institution each year the administrators negotiate discount rates with the third-party payers, and if we're increasing service volume or increasing charges dramatically, we just turn around and offer them a bigger discount, so the net flow of cash doesn't change all that much. So there's a problem with a simple argument that you're going to improve charge capture.

And the flip side is also true. We talk about cost savings, and I agree that you can save costs in terms of cutting down on people who are designed to do billing. We did that at Duke when we implemented a management information system. I think that's a legitimate cost savings. But I also think you have to be careful in terms of clinician FTE savings. You can calculate these various efficiencies very nicely, as you described, but the only way you really save money on FTEs is by getting rid of them. That can be a very scary thing to do, because there's a certain "critical mass" that I think you need to provide basic clinical respiratory services.

For instance, in my institution at night on the adult service I have 1 RT for general care, and I can't get rid of that RT. I need that RT there for emergencies and patient care. If I develop a system that shows there are savings to be made in the nighttime workload, because they have this wonderful computerized machinery, I can't translate that into actually removing a person from my staff. So calculating those cost savings can be problematic. You don't really save an FTE unless you eliminate an FTE.

Ford: Your points are very well made. It is very important for department managers to thoroughly understand their hospital's reimbursement environment before they decide on an approach to justifying or assessing the benefits of an RCMIS. As an example, I had to thoroughly understand our Thornton Hospital environment, which has totally different reimbursement considerations, so my approach to justifying RCMIS was totally different.

In regard to the FTE issue, I did have some early initial reductions as unnecessary care was eliminated through protocols; however, you'll note that I never stated that we had a net decrease in FTEs at UCSD over that period. In fact, in the past 10 years I've gone from about 42 FTEs to nearly 60 FTEs, and I justified those through this system. You get an improvement in productivity, which means you can better match service demand with available staff, but some of that improvement is actually from an increase

in the number of charges captured. That can provide a benefit if you're in a flexible budget environment. For example, if my units of service go from 3,000 to 6,000, my administrator lets me add staff. In terms of protocols, if you're doing less therapy, you can reduce the number of staff who perform those therapies.

But I also recognize you need to be careful not to overstate productivity gains in some situations. Thornton Hospital is a small community hospital where I have 1 or 2 people on per shift. I have minimum staffing thresholds for Thornton, so my administrator knows that, regardless of whether I have 1 or 4 or 5 ventilators in operation, I'm always going to have at least 1 person per shift. We've established these minimum thresholds at which the productivity equations are not used to forecast total staff needed. You have to reach that understanding with your administrator before making a commitment that you're going to be able to improve productivity.

Hess: You talked primarily about commercially available systems, but there is another option. That is, an institution can build its own system. For example, we did that using several RTs who have computer skills; we built it in Microsoft Access database management software and worked with our information technology people, and as a result we don't have a commercially available system at all. It's our own; we built it ourselves. We've talked at this conference about being able to configure the system—to modify it and so forth. You can do that with a homemade system, provided that you have a few people who have the skills and the labor of love in doing this.

Ford: I think you hit the nail on the head, Dean. In certain environments you may have the skills, resources, and motivation to build your own system. Certainly when Pullen,[1] in 1980, described the benefits of an RCMIS, prior to any manufacturers of commercial RCMIS, he was looking at facilities that had the talent, motivation, and resources to develop systems specifically for respiratory care. Today a handful of sites have developed their own systems. However, although it can be done, it remains a challenge to achieve the same benefits as the commercially available systems.

REFERENCE

1. Pullen EE. Computers help provide better care. Respir Ther 1980;10(4):25–27.

Stewart: One of the things you mentioned, which we also experienced in our organization, was that the RCMIS's "bedside clinical coach" function decreased the time associated with orientation of new RTs. What we used to see with 100 RTs was everybody using their own private language to describe something, which made it really difficult when you spent 6 to 10 weeks orienting a new employee. It's another important RCMIS advantage that orientation becomes more complete and more guided.

Giordano:* I don't want this discussion to end without saying that moves to reduce staff are always a good thing from a business standpoint, but I get the feeling sometimes when we talk about this, that we're thinking about the pie only being so big and we don't consider the unmet needs of the patients within institutions, and how—by not needing as much staff to do a certain sector of procedures and clinical interventions—this could free up staff to do some other things that would contribute to quicker resolution of the problem or shorter length of stay, which, in terms of the "macro" issues that face institutions, is very favorable from a business standpoint. So by increasing efficiency and decreasing the staff necessary for, lets say, aerosol therapy, that does not necessarily mean that that staff that was once needed for that cannot be redirected to do something that would help the institution or the department achieve its goals.

I know, for instance, that even though many hospitals have smoking-cessation programs, which I believe is the single most profound clinical intervention that could ever be done to treat pulmonary disease, that it's kind of a hit-and-miss situation in a lot of institutions. And this is a natural for RTs. By freeing them up from certain tasks we could then get them into using protocols and procedures that require the critical thinking and the true professional aspects of respiratory therapy. They don't always have to have equipment in their hands to make a difference.

Pierson:* Based on your knowledge of the systems, your experience with implementing them, and your familiarity with our whole health care system I'd like you to speculate on what we're going to see 5 years from now. Will we see hospital information systems get smarter and more encompassing so that they serve the needs of respiratory care departments, or will we see thousands of hospitals with specific RCMIS?

Ford: I think there are a couple things the future is going to bring, and hopefully the RCMIS manufacturers will respond to the needs of the respiratory care community. The introduction of RCMIS came at a terrible time in health care, in which decreased reimbursement and increased competition for capital dollars limited installation beyond 250 hospitals. In the years ahead all involved are going to have to look at the connectivity issues, because we want to chart only once and not be required to enter du-

* Sam P Giordano MBA RRT FAARC, Executive Director, American Association for Respiratory Care, Irving, Texas.

*David J Pierson MD FAARC, Editor in Chief, RESPIRATORY CARE Journal, Seattle, Washington.

plicate information into other systems. So the connectivity issues between ICU systems and other computerized information systems must be a priority for our vendors.

We're going to see also that these systems will universally support protocols. I think the information system vendors have gotten that message and understand how important it is to enhance protocol-driven care. They will take advantage of wireless portable devices, so we will have point-of-care charting that actually supports protocols.

Lastly, we talked about how expensive these systems are and that they need to be more affordable. Manufacturers could offer various levels of functionality, such as the with concept of a "MediServe Light" or a "CliniVision Light"—something for departments that don't need the $180,000–250,000 full-function system but just need the basics to provide workload management, charting, billing, and reporting. More advanced functions such as decision-support and interfaces with other hospital systems would cost more.

Nelson: You said you need to put your processes into the management system. Do processes drive the computerization, or does the computerization really drive an improvement in your process? I'm reminded of the case of when you have something that doesn't work: do you just try to cover it up, like painting polka dots on an Edsel? Which comes first, the chicken or the egg?

Ford: I think the processes come first. You already have processes in place, and the automation and computerization make those processes much more efficient and effective. Established processes become more data-driven, and you have improved access to information. You also have a new way of surveying, from a central location, what's happening in the various areas of the hospital. The RCMIS may drive new processes, but I think most adapt and configure computerized information systems to their environment, to increase the efficiency and effectiveness of existing processes.

Gardner: I've walked into 3 hospitals in the last week and there was a sign at the front door of every one that read, "Turn Your Cell Phone Off." How can we use wireless devices? How can clinicians use PDAs [personal digital assistants], especially in the ICUs, if everyone says turn them off?

Ford: The problem of radio-frequency devices interfering with medical instrumentation is important. Puritan Bennett updated their 840 ventilator to better shield it, following an incident related to radio-frequency interference. The early hand-held wireless devices used with information systems were known to possibly interfere with medical devices. In fact, CliniVision put a warning on the device screen that prompts the user to be at least 3 feet away from a medical device prior to radio-frequency transmission. We've also seen a decrease in the wattage of these devices over the years—as high as 2 watts during the early 1990s, compared to a quarter of a watt or less now—so the threat of interference with medical devices from wireless laptops and hand-held devices is far less, although we still have the policy in our hospital that there are no cell phones in patient care areas.

Volsko: I worked with MediServe in the early 1990s, during the advent of their spread-spectrum technology. At that time we used Bear 5 ventilators, which were affected by wireless devices. We missed bradycardias in the neonatal ICU if the RTs were charting within 50 feet of a cardiorespiratory monitor. They couldn't use the hand-held devices in the blood gas lab, because they would interfere with the Corning 178 calibration process. The therapists had to take the hand-held devices outside of the ICU to do their charting. So we had a lot of obstacles that we worked through. It's interesting to see how the technology has evolved, and it's nice to see the commitment of the vendors to address those problems and make the technological advances so that we can use this technology in respiratory care.