15
Computer Charting: An Evaluation of a Respiratory Care Computer System

Robert D. Andrews, Reed M. Gardner, Sandy M. Metcalf, and Deon Simmons

Introduction

In efforts to increase the efficiency of medical care delivery, institutions are turning to computers as useful tools for processing and storing medical, financial, and administrative information. It has been reported that 25% to 35% of a health professional's time is spent doing paperwork [1–3], and although many hospital departments have computerized information systems, the clinical information in the patient's chart remains essentially unchanged [4–6]. This clinical information includes patient history, observations, medications, and progress notes used in diagnosis and treatment. The documentation of most procedures in respiratory care (RC) is similar in content. We report the usefulness of a computer-charting system in documenting and processing clinical information.

An Optimal System

The efficiency of any system is measured by the "useful" work completed compared to the energy required. The most efficient RC computer system would have the following characteristics:

- No repetition of work or reporting
- Easy access for entry and review
- Accurate and descriptive documentation
- Automatic performance of many functions from a single input (i.e., billing, reporting, checking for errors, alerting, and gathering of management statistics)
- Exact correlation between charting and billing
- Integration of RC information with that of other hospital departments
- Availability of information for diagnostic and research purposes

- Easy implementation
- Reliability (no downtime)
- Inexpensive equipment that pays for itself

Perhaps the best proof of a computer's usefulness is the degree to which people want to use it because it helps them do their jobs, not simply because its use is mandatory.

Institutional Background

LDS Hospital

LDS Hospital, a major referral center with 520 beds and 5 (4 adult, 1 newborn) intensive care units (ICUs), has been a leader in the development of computer applications in medicine. A highly developed hospital information system (HIS), known as HELP, integrates all patient information [7,8]. A Tandem "nonstop" computer system (Tandem, Cupertino CA) is connected to more than 300 terminals and 95 printers. It is highly reliable and has little downtime (0.2%) [9] because of its redundant processing and storage of data [10]. The computer has an integrated central billing system. The functions of order entry, reporting, data entry, and alerting are well developed for most departments. At least four terminals are available on every nursing division (each of which handles 48 patients), as is a printer. The ICUs have a terminal at each bedside.

Respiratory Care Department

Respiratory care presented several unique problems for computer implementation. By 1982 only about a dozen RC departments in the country had reached a level of substantial computerization; an equal number of departments had tried, but failed [11]. At LDS Hospital we introduced computer charting as an improvement on the written patient chart and to meet the clinical, financial, and management needs of RC.

The RC service is highly mobile. Therapists do not have a permanent workstation, as work is performed at the bedside and throughout the hospital. Therefore, entering computer information required having access to terminals in many locations or recording information on paper for later computer entry in the RC department. Thus, the logistics problems of where the data could be reviewed and how it could be entered in the patient's chart had to be solved.

Patient records vary in quality and detail because from one-third to one-half of them are in narrative which makes information difficult to collect and process [5,12–14]. Unlike computerized systems in clinical laboratories that process large amounts of numeric data, computerized RC information systems require a reporting "vocabulary" with a wide range of descriptions.

To be automated, patient records had to be converted from a narrative format to the computer's predefined vocabulary [6].

The RC computer system was developed from a very simple concept: "Chart accurately and let the computer do the rest of the paperwork." The system was designed to maximize the efficiency of documenting procedures and thereby improve the evaluation of medical care. In addition, documentation was required for hospital accreditation [15] and for verification that a procedure had been performed. The charting of clinical procedures was also used in nonmedical functions, such as management statistics and billing. Because the functions were integrated into the HIS, they became byproducts of the documentation process [16]. As paperwork was reduced, a higher percentage of the therapist's time could be spent doing the most useful work, patient care.

Respiratory care documentation has traditionally been written into the patient's chart using specific forms—those for notes, assessments, and ventilator monitoring—with each section organized chronologically. Documentation has allowed later review so that patient care can be assessed and changed if necessary. These processes of data entry, organization, storage, and review are very similar to the operation of a computer. To permit the computer to be used for patient charting, three programming functions of the HIS were instrumental: (1) One program allowed creation of questionnaires, to be used for data entry. This program also permitted the capture of billing information. (2) Another program allowed the creation of vocabulary used in charting by assigning the medical terminology to codes that were more easily stored in the computer's files. (3) A general reporting language was used to program the reports and statistics.

Description of the RC System

The RC computer system is a subsystem of the HIS; it depends on the central computer and uses nursing division terminals for data entry and review. It avoids duplication by using existing hardware and by using information from other hospital departments, such as admission, discharge, and transfer (ADT) information. The HIS controls and processes the flow of all patient information (Figure 15.1). RC charting is entered at the nursing divisions, is stored in patient data files and can be reviewed at any nursing division terminal. A 24-hour management report provides individual and departmental productivity records, and an alert report is used for both management and patient care monitoring. Permanent copies of all RC charting are automatically processed for delivery to Medical Records after a patient has been discharged. The HIS is integrated with a billing computer system that processes financial transactions and provides the hospital with productivity reports. Thus, all reporting and billing are extracted directly from the computerized clinical charting.

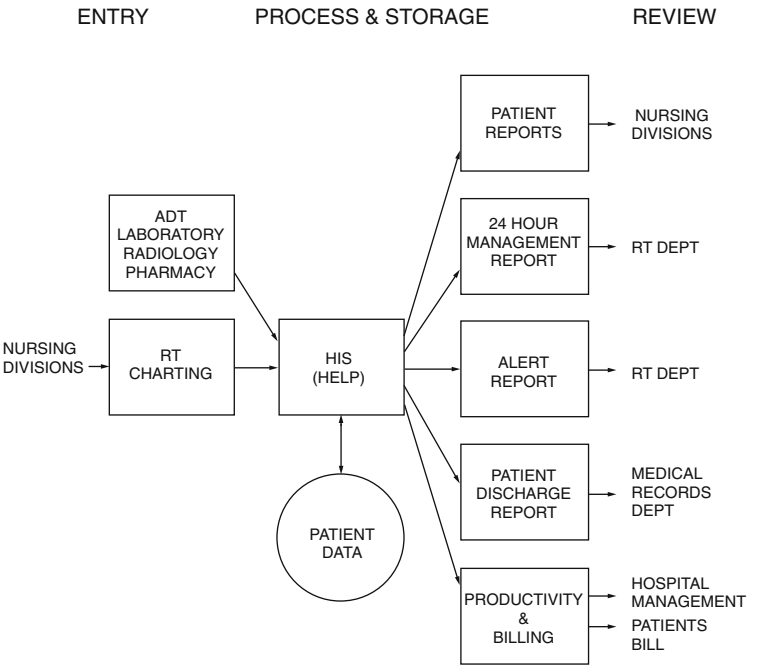

Figure 15.1. The RC computer system uses the hospital information system (HIS) for the processing of medical information.

Currently the RC department is not fully computerized—order entry, workload allocation, and newborn nursery charting are still done manually. The charting of ventilator data was recently implemented, because bedside terminals are now available in the ICUs where ventilators are used. Approximately 90% of RC charting and charge capture is now computerized.

Charting

The charting process is initiated by selecting the "Respiratory Therapy Charting" option on the computer terminal at the nursing station. Entries are made by selecting multiple-choice items from the menu, by number entry, or by typing in free text (Figure 15.2). The questionnaire-entry format follows a logical sequence that corresponds with the department's charting requirements. Entries can include the charting of more than one procedure at a time, which allows procedures that are frequently done together to be charted without redundant questions and multiple data entries. To speed the process, only questions pertinent to the specific procedure are asked.

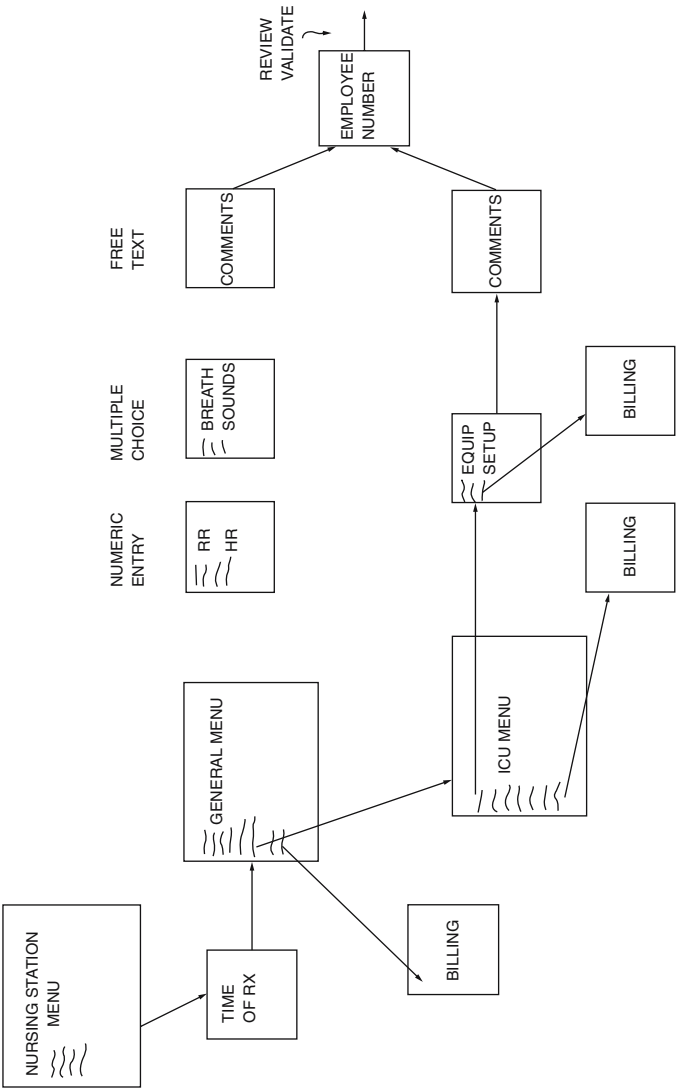

FIGURE 15.2. Computer charting uses menu selection for entering results of RC procedures.

Follow-up questions are also specific to certain entries; this results in a highly variable pathway that allows flexibility yet decreases the time required for data entry. The only questions to which answers are mandatory are those pertaining to medical-legal or billing issues; most questions can be left unanswered, allowing the therapist to chart only that which is necessary. The therapist is responsible for complete and accurate charting. A procedure attempted but not completed is also documented in order to verify that an attempt was made and to explain why it was not done. All entries require an employee identification number, which serves as an electronic "signature."

Review of Charting

The review of charting is available by using a review option on any hospital terminal. This option is on the same menu for review of laboratory, blood gas, and radiology results. Because results can be reviewed from any terminal, it is not necessary to be on a particular ward to obtain a patient's chart. The report is a text report (Figure 15.3) that resembles written entries (Figure 15.4).

Automatic Routine Reporting

Every morning at 03:00 a program automatically generates three routine reports for the RC department: (1) a complete printout of RC charting on patients discharged the previous day, (2) a 24-hour management report, and (3) an alert report. These three reports are the only hard-copy printouts that are automatically generated routinely by the RC system. This early morning use of the computer is efficient and provides information that can be assessed by supervisors at the beginning of the day.

The 24-hour management report lists the work that has been charted for that period by each therapist (Figure 15.5). The report identifies the patient, work units, and duration of each procedure. It is a record of each therapist's

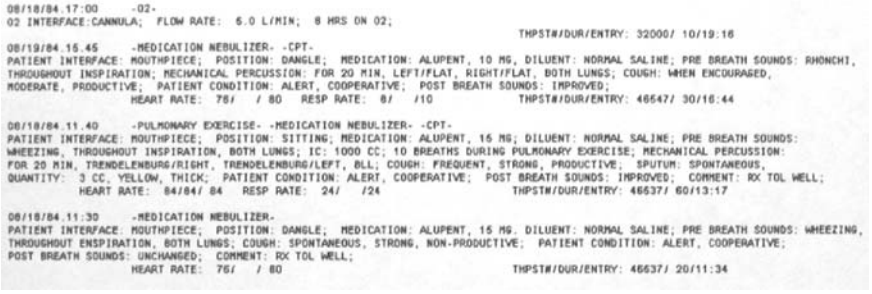

Figure 15.3. An example of computer charting.

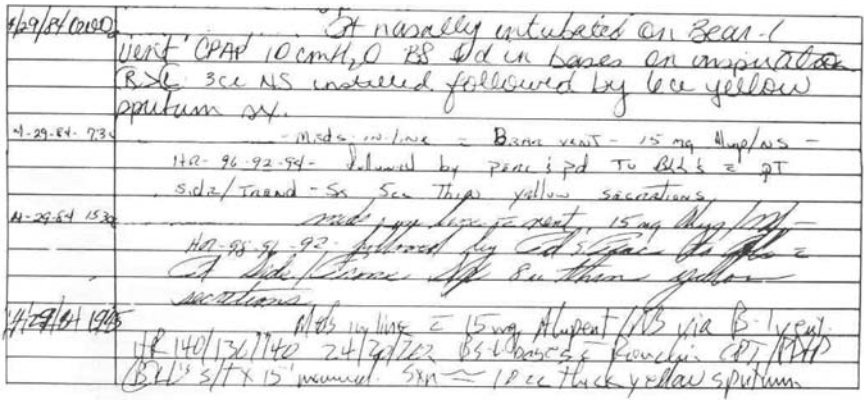

FIGURE 15.4. An example of manual charting.

productivity. Supervisors review the report to confirm that assigned procedures were completed, so that missed procedures or missed charting can be identified and corrected. The management report also provides a department summary, listing a breakdown of total procedures performed and the reasons when treatments were not completed (Figure 15.6). The 24-hour

RESPIRATORY CARE THERAPIST REPORT 17 AUG 1984

24 HOUR MANAGEMENT REPORT

THERAPIST # 46482 LINDA STANCHFIELD AUG 17, 1984 00:00 - AUG 17, 1984 23:59

DATE	TIME	ROOM	PATIENT	TREATMENTS	RVU'S	UNITS	DUR	PC	TA	CT	ENTRY
08-17	12:00	E609	PATIENT, A	MEDICATION NEBULIZER	23.24	1	30		164	4.6	16:00
08-17	12:00	E609	PATIENT, A	NEBULIZER MONITORING	2.39	1	10		128	1.6	14:17
				HPN EQUIPMENT SET UP	20.61						
				ON O2	67						
08-17	08:00	E609	PATIENT, A	MEDICATION NEBULIZER	23.24	1	20		209	3.6	11:46
08-17	07:30	E609	PATIENT, A	NEBULIZER MONITORING	16.73	7	10		402	1.6	14:21
08-17	07:30	E609	PATIENT, A	O2	4.69	7	10		398	1.6	14:15
08-17	07:00	E610	PATIENT, B	NEBULIZER MONITORING	18.12	8	10		419	1.6	14:08
				ON O2	5.36						
08-17	13:45	W623	PATIENT, C	PULMONARY EXERCISE	15.04	1	20		33	3.6	14:33
				MEDICATION NEBULIZER	23.24						
08-17	09:30	W623	PATIENT, C	PULMONARY EXERCISE	15.04	1	20		284	2.6	14:32
				MEDICATION NEBULIZER	23.24						
08-17	13:30	DSCH	PATIENT, D	MEDICATION NEBULIZER	0	0	5		83	1.6	14:57
				** NOT DONE **	0						
08-17	12:00	DSCH	PATIENT, D	MEDICATION NEBULIZER	0	0	5		191	1.6	14:55
				** NOT DONE ** NOT ON UNIT	0						
08-17	07:40	DSCH	PATIENT, D	MEDICATION NEBULIZER	23.24	1	20		225	1.6	11:44
08-17	07:00	E514	PATIENT, E	O2	5.36	8	10		423	1.6	14:12
08-17	12:30	E512	PATIENT, F	IPPB	27.34	1	35		108	4.6	14:49
				CPT	24.61						
08-17	10:30	E512	PATIENT, F	IPPB	27.34	1	35		224	4.6	14:45
				CPT	24.61						
08-17	08:30	E512	PATIENT, F	IPPB	27.34	1	20		366	4.6	14:41
08-17	07:30	W629	PATIENT, G	NEBULIZER MONITORING	18.12	8	10		405	2.6	14:23
				ON O2	5.36						
08-17	07:30	E516	PATIENT, H	NEBULIZER MONITORING	18.12	8	10		408	1.6	14:27
08-17	07:15	W638	PATIENT, I	MEDICATION NEBULIZER	23.24	1	20		416	2.6	14:29
				POINTS: 14.0 TOTALS: 419.19			300	0		46.0	
				AVERAGES:					270.2	2.6	

FIGURE 15.5. The 24-hour management report provides a record of all procedures documented by each therapist.

RESPIRATORY CARE DEPARTMENT REPORT 17 AUG 1984
24 HOUR MANAGEMENT REPORT

RUN AT 03 31 18 AUG 84
RUN TIME 24 MIN

TOTALS

AVE POINTS	11.8	POINTS	318.3	ENTRIES	446	AVE ENTRIES	16.6
AVE RVU'S	354.79	RVU'S:	9579.43	ENTRY TIME:	796	AVE TIME:	1.8
RVU / DUR	1.36	THERAPISTS DUR:	7021	AVE TURNAROUND TIME	100.7		
THERAPISTS	.27	CHARGES	8014.76	%RVU'S COMPLETED	97.6	% CHARGES COMPLETED	98.4

TREATMENT TOTALS

TREATMENTS COMPLETED	TOTAL (INITIAL)	RVU'S	CHARGES
PULMONARY EXERCISE:	87 (14)	1538.08	814.70
MEDICATION NEBULIZER:	85 (12)	2008.20	941.80
IPPB:	16 (1)	508.52	204.60
CPT:	53 (3)	1353.53	1066.00
INTERMITTENT NEBULIZER:	1 (1)	35.54	14.00
ASSESSMENT:	38 (17)	935.18	176.70
02:	1600 HRS	1206.00	3600.00
NEBULIZER MONITORING:	313 HRS	748.07	287.96
SUCTION:	2	27.34	13.00
HYPERBARIC CHAMBER:	150 MIN	266.50	201.00
INTERHOSPITAL TRANSPORT:	60 MIN	60.00	66.00
MED NEBULIZER –IN LINE:	30	246.00	120.00
INTRAHOSPITAL TRANSPORT:	240 MIN	240.00	264.00
THORACIC DEMO:	1	61.52	35.00
USN EQUIPMENT SET UP:	3	41.01	30.00
HPN EQUIPMENT SET UP:	7	143.57	70.00
02 EQUIPMENT SET UP:	11	160.37	110.00
STANDBY:	20 MIN	20.00	0
		9579.43	8014.76

REASONS TREATMENTS NOT DONE			
NOT ON UNIT:	1	23.24	10.90
ASLEEP:	1	15.04	7.90
RECEIVING OTHER CARE:	1	15.04	7.90
NAUSEATED:	1	24.61	20.00
DUE TO WORKLOAD:	3	45.12	23.70
REFUSED CARE:	2	30.08	15.80
ADVISED NOT TO GIVE:	1	24.61	20.00
UNABLE TO COMPLETE:	1	15.04	7.90
OTHER:	2	38.28	18.80
	13	231.06	132.90

Figure 15.6. The 24-hour management report also provides a departmental summary of procedures performed and the reasons when procedures were not completed.

report provides management data extracted directly from patient charting and forms the basis for long-term individual and departmental reports.

The alert report (Figure 15.7) is used to monitor for both management and medical errors. The listing for Patient B is an example of a management alert to an overcharge resulting from double charting. If hourly therapy, such as oxygen, is documented for more than 24 hours in a single day, an alert is printed so that the charting and billing can be corrected. A medical alert might indicate a need for closer patient assessment. If a patient is on continuous oxygen therapy for a prolonged period of time and has never had a blood gas test, an alert is printed. Alert capability will be expanded to include the monitoring of medical necessity protocols [17,18].

Billing

Billing is an automatic byproduct of the computer charting of a completed procedure. An example of a therapist's chart is shown in Figure 15.3. This

```
4N84    PATIENT, A
    *** NO BLOOD GAS IN LAST 4 DAYS ***
4N89    PATIENT, B
    $$$ 2 DAYS AGO > 24 HRS 02 CHARGES / DAY $$$
    *** CONTINUOUS 02 DISCONTINUED OR INTERRUPTED YESTERDAY ***
4N89    PATIENT, C
    *** NO BLOOD GASES ***
```

Figure 15.7. Alert report identifies possible errors and oversights in computer charting and patient care.

documentation of oxygen therapy results in a bill for 8 hours of oxygen. The next treatment shows medications-nebulizer therapy and chest physical therapy (CPT), which are billed. Everything is charted for clinical reasons, and the program automatically bills when appropriate. Treatments ordered but not done are reported in the chart but are not billed. Thus, billing accuracy depends on the therapist's charting accuracy. Mistakes can still occur, such as charting the wrong patient or charting the same procedure twice.

These errors can be found easily by therapists as they review the charting or by supervisors as they review the 24-hour management report, and the errors can be easily corrected by supervisory personnel. Billing accuracy is not merely of concern to the hospital and patient, but also determines RC productivity, which is used to justify the staffing requirements of the RC department. The 24-hour management report determines the individual therapist's productivity as well as that of the RC department as a whole.

Evaluation Methods

The RC computer system was evaluated in four ways: (1) therapists' appraisal, (2) observation of work patterns, (3) audit of the quality and content of charting, and (4) productivity analysis. The evaluation was made before computer charting (PRE) and after computer charting (POST).

Therapists' Appraisal

Questionnaires were distributed to the therapists (63 PRE and 55 POST) to be filled out anonymously 2 months before and 2 months after the establishment of computer charting (March 1984). The questionnaires were used to determine therapists' expectations, problems, suggestions, and preferences.

Work Patterns

PRE and POST individual work patterns were compared. After 2 months of computer charting, an inquiry of head nurses and ward clerks was made to obtain feedback on possible interference or congestion at nursing station terminals. The department managers of both Billing and Medical Records were also interviewed.

Quality and Content of Charting

We compared the quality and content of computer charting against manual documentation by auditing medications-nebulizer therapy, one of the most common RC procedures. Guided by departmental standards for this treatment, we checked documentation for inclusion of (1) therapist signature, (2) medications delivered, (3) comments (patient's condition, effects of therapy, and adverse reactions), (4) changes in breath sounds, (5) heart rate before and after treatment, (6) sputum production, (7) cough effort, and (8) patient position. Chart legibility was also evaluated. For this study, patients' charts were selected at random before and after implementation of computer charting. Five hundred manually charted procedures (performed on 22 patients by 49 therapists) were evaluated for content and quality and compared to 500 computer-charted procedures (performed on 29 patients by 51 therapists). The only item that was a mandatory entry on the computer was "therapist signature."

Productivity

PRE and POST statistics of work volume and productivity were compared for all procedures preformed by the RC department during a 6-month period (February through July 1984). Four PRE pay periods (the 8 weeks preceding computer implementation) were compared to the first 8 pay periods (167 weeks) of POST data. Hospital data on productivity and work volume were generated from procedures billed; RC department data were generated from the supervisors' accounts of completed work assignments. These two sources were evaluated with regard to changes in productivity and work volume. An unpaired t test was used for comparison of PRE and POST data.

Results of Evaluation

Therapists' Appraisal

Questionnaires returned by the therapists (49 PRE and 50 POST) indicated job position, location, and shift worked. Virtually all therapists were famil-

iar with the use of computer terminals for reviewing information (96% had used a hospital terminal before), and it took only about 3 days for most of them to feel comfortable doing computer charting. Results of the questionnaires are presented in Table 15.1. Of the 50 therapists who returned the POST survey, 32 (64%) favored computer charting, compared to 10 (20%) who preferred manual charting.

Work Patterns

Computer charting reduced a four-step process (charting the procedure, filling out a charge slip, processing the charge slip and transferring it to billing, and posting the charges into the computer) to only one step—computer charting the procedure. The secretary's job was changed from that of processing charges to auditing billing mistakes and making sure that all printouts of discharged patients were delivered to Medical. Records. Shift supervisors generally had about 30 minutes added to their workload as a result of reviewing the 24-hour management report. Entering billing charges in the Kardex system was eliminated, which, according to estimates from the Industrial Engineering Department, saved each therapist 10 minutes a day. Many therapists felt that charting was faster using the computer.

Other departments affected by the computer were Nursing, Billing, and Medical Records. Access to nursing station terminals was not found to be a major problem. Occasionally problems resulted if a therapist entered several procedures at once and deprived others of access to the terminal. Because computer charting completely bypassed the Billing Department, posting RC charges was eliminated; this saved the Billing Department about 30 minutes per day. The Medical Records Department agreed to put the patient reports onto the patient's chart; this added about 30 minutes of work per day in this department. The net result of RC computer charting on other departments was one of redistribution of effort, with no major overall change.

Quality and Content of Charting

Computer charting was found to be more complete than manual charting in every case except the documentation of medication, which remained the same (Figure 15.8). Both the manual and computer charts had four instances (0.8%) in which the medication was not specified. Legibility and signature were both 100% on the computer. Figures 15.3 and 15.4 illustrate the difference in legibility between computer and manual charting. It was noted that not only was there an improvement in meeting the department's requirements for charting, but often the requirements were exceeded. Computer charting was found to be more informative, concise, and compact.

Table 15.1. Results of survey completed anonymously by therapists two months before and two months after computer charting was established.

1. Approximately how many minutes do you spend in charting a treatment?

	<2 min	2–5 min	6–10 min	>10 min	No response
PRE	2 (4%)	27 (55%)	19 (39%)	1 (2%)	
POST	11 (22%)	30 (60%)	7 (14%)	1 (2%)	1 (2%)

2. (POST) How does computer charting time compare to charting manually?

Faster	About the same	Longer	No response
18 (36%)	21 (42%)	9 (18%)	2 (4%)

3. (POST) To do the same amount of work for your job, how much time has the computer saved or added?

	# Responses	Total minutes
Min/shift the computer has saved	16	414
Min/shift the computer has added	9	345

4. How many times during a shift do you use a hospital terminal?

	<2 min	2–5 min	6–10 min	>10 min	No response
PRE	3 (6%)	10 (20%)	19 (39%)	14 (29%)	3 (6%)
POST	2 (4%)	6 (12%)	13 (26%)	28 (56%)	1 (2%)

5. (POST) For the following aspects, how do you feel computer charting compares to manual charting?

	Much better	Better	About the same	Worse	Much worse	No response
Quality of time spent:	7 (14%)	21 (42%)	16 (32%)	2 (4%)	2 (4%)	2 (4%)
Ease of entering:	12 (24%)	19 (38%)	12 (24%)	5 (10%)		2 (4%)
Ease of review:	8 (16%)	17 (34%)	8 (16%)	14 (28%)	1 (2%)	2 (4%)
Accuracy:	12 (24%)	14 (28%)	13 (26%)	8 (16%)	1 (2%)	2 (4%)
Productivity:	13 (26%)	24 (48%)	9 (18%)	2 (4%)		2 (4%)

6. How often do you have trouble getting access to a terminal on the ward?

	Very rarely	Occasionally	Often	Almost always	No response
PRE	17 (35%)	27 (55%)	2 (4%)		3 (6%)
POST	23 (46%)	22 (44%)	2 (4%)	1 (2%)	2 (4%)

7. (PRE) How often do you have trouble getting access to a patient's chart?

Very rarely	Occasionally	Often	Almost always
9 (19%)	31 (63%)	7 (14%)	2 (4%)

8. Do you feel computer charting will make your job any easier?

	Yes	No	No response
PRE	17 (35%)	20 (41%)	12 (24%)
POST	29 (58%)	9 (18%)	12 (24%)

9. (POST) Which do you prefer, computer charting or manual charting?

Computer charting	Manual charting	No response
32 (64%)	10 (20%)	8 (16%)

10. (POST) What difference, if any, do you feel computer charting has made in the quality of patient care?

Better	No change	Worse	No response
16 (32%)	30 (60%)	2 (4%)	2 (4%)

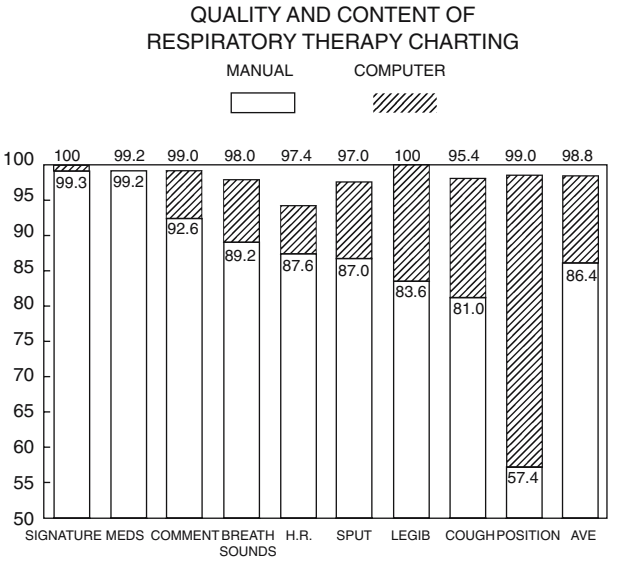

Figure 15.8. Percentages of acceptable charting from an audit of 500 procedures of manual charting and 500 procedures of computer charting. Numbers atop bars are percentages of acceptable computer charts; numbers in bars are percentages of acceptable manual charts.

Productivity

Productivity data are presented in Table 15.2. Significant ($p \leq 0.03$) increases after computer charting was instituted are shown for both productivity and work volume. Hospital data calculated from billed procedures showed that productivity increased 18.2%; RC records showed that productivity (average workload completed per therapist) increased an average of 13.7%. Hospital data showed that work volume increased 20.9%, while RC department records showed that it increased 16.4%. The number of employees who worked during both periods was not significantly different (51.23 PRE vs. 52.40 POST).

Discussion

Implementation of the computer-charting system was trouble free, and therapists learned the system quickly. Therapists' response was very positive. The preference for using the system was not only very high, but higher than anticipated. Whereas only 35% (17/49) of those who returned the PRE questionnaire felt computer charting would make their job easier, 64% (32/50) of those who returned the POST questionnaire expressed a prefer-

ence for computer charting. About one third of the responding therapists reported that computer charting was faster (Table 15.1, items 2 and 3); however, 56% of therapists returning the POST survey felt that their charting time was better spent and 74% felt productivity was better (Table 15.1, item 5), indicating that the computer may have been helpful in ways other than speed of charting.

The computerized clinical records were more descriptive, legible, and complete than were the manual reports (Figure 15.8). Overall, computer charting was found to be 12.4% more complete than manual charting. The only item in the study that did not show a significant improvement was medication documentation, which has now been made a mandatory entry on the computer. This will ensure 100% compliance and is justified because the delivery of medication is the primary objective of medications-nebulizer therapy.

Because computer charting can be programmed so that a therapist must reply to a question in order to proceed through the entry process, an

Table 15.2. Productivity and work-unit data for the 8 weeks preceding and the 16 weeks following the implementation of computer charting.

Pay period (2 weeks)		Hospital data (procedures billed)		RC department data (supervisors' accounts)	
PRE	FTE	Productivity	Work Units	Productivity	Work Units
1	49.96	93	221,869	87	206,834
2	50.40	95	229,005	88	211,680
3	49.88	91	217,955	91	215,482
4	54.68	86	226,560	98	255,902
Average	51.23	91.3	223,847	91.0	222,475
POST					
5	48.82	118	275,346	92	213,832
6	51.05	109	267,750	98	237,383
7	54.44	103	268,834	103	267,845
8	50.62	107	260,645	107	258,162
9	50.55	112	271,524	112	271,524
10	50.91	103	250,040	106	258,114
11	54.88	105	277,183	104	273,302
12	57.92	106	294,009	106	291,916
Average	52.40	107.9	270,666	103.5	259,010
P	NS	0.0002	0.00004	0.0054	0.0300
% Increase	2.3	18.2	20.9	13.7	16.4

FTE = full-time equivalent therapists paid during pay period.
Productivity = the % of work completed compared to the amount of work expected to be completed for the number of FTEs.
Work units = the number of minutes spent doing productive work (determined by hospital Industrial Engineering). One work unit = one productive minute of work.
P = P value from unpaired *t* test of PRE and POST results.
NS = not significant.

argument can be made that the answering of all questions should be mandatory, assuring 100% compliance. Although mandatory entry seems to be the ideal solution, it has the disadvantage of not allowing the therapist to exercise discretion over what is charted. Mandatory entry may force the reporting of irrelevant or incorrect information. Certainly information is better left unreported than reported incorrectly. The ultimate responsibility for complete charting is the therapist's. Computer documentation significantly improved charting without forcing the outcome.

Every procedure allows the entry of comments in a free-text format; therefore, a procedure can be documented entirely on comments and still be complete. However, free-text entries are not so useful as structured data (selections that are stored in the computer in coded format). As an example, if patients receiving a certain bronchodilator were to be monitored for changes in breath sounds, the computer could be programmed easily to find the data if the information was structured. If the information was free text, accurate retrieval and monitoring would not be possible. Currently, structured data accounts for more than 95% of RC charting.

An argument can be made that too much information is charted, resulting in "information overload," whereby irrelevant information reduces the impact of relevant information on decision making [8,9–22]. Just what information is the most useful is a question that will require further study.

Evaluation of productivity was hampered by the fact that all accounting methods and charges had been changed 8 weeks prior to computer implementation. Unfortunately, this limited the amount of useful PRE data to only four pay periods.

Because the RC department maintains a nearly constant work force, fluctuations in work volume affect the productivity of the department. The results in Table 15.2 show that there were increases in productivity, according to both hospital and departmental calculation, after computer implementation (18.2% and 13.7%, respectively). Work volume also increased (20.9% and 16.4%, respectively), while the number of therapists did not increase significantly.

There were three possible reasons for the apparent improvement in productivity: (1) The work volume increased, requiring the therapists to work more efficiently. (2) The computer assured that work charted was charged for, and this accuracy increased the work volume. This explanation assumes that in the PRE period, some work was done but not accounted for. We were unable from the data available to make a quantitative assessment of this factor. Nevertheless, the computer assures concordance of clinical and financial record keeping and minimizes lost charges. (3) Computer charting helped the therapists do their job more efficiently and thus allowed them to handle heavier workloads. The manual Kardex system was replaced, saving 10 minutes per therapist per shift. The therapist survey showed that 74% of the therapists thought computer charting allowed them to be

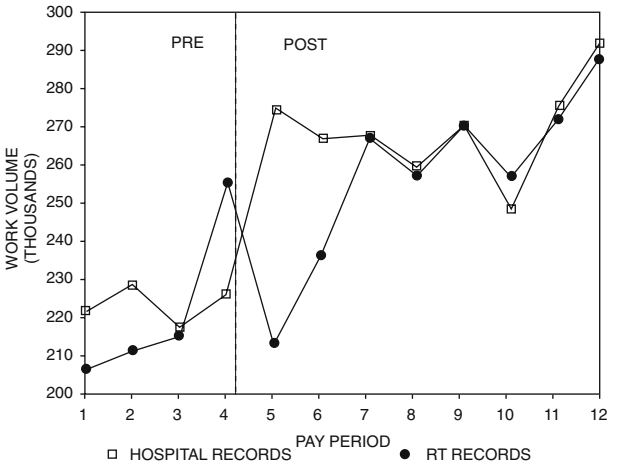

Figure 15.9. Comparison of work volume from hospital records and work volume from departmental records. Computer charting started at point marked by dotted line (March 1984).

more productive, but they also indicated that the timesavings was not very substantial.

We conclude that all three factors mentioned above, or a combination of them, could have been responsible for the increase in productivity, although it remains unclear to what extent each factor may have been responsible. One fact was clear: during the period when therapists were busier and 18% more productive, they were using the computer. Computer charting did not decrease productivity.

Figure 15.9 shows that after Pay Period 6, about 6 weeks after implementation of computer charting, procedures billed and procedures assigned became highly correlated ($r = 0.96$ for Pay Periods 7 though 12). These results confirmed that computer charting provided a high degree of confidence that every item billed was documented as being performed. The poor correlation for Pay Periods 5 and 6 can be partially explained. Computer charting processes billing information immediately, whereas manual charting processes billing at least a day later. Pay Period 5, the first after conversion to computer charting, reflected the billing of all procedures during that pay period, plus the carryover billing of some procedures completed in the previous pay period hence, hospital billing records and RC records differed in the work volume reported. Also, the 24-hour management report was not implemented until Pay Period 6, so errors may have gone unnoticed before that date.

Information that is stored in the computer is used in ways that are impractical with manual methods. The alert program provides automatic

quality assurance by routinely searching all current patients' records for possible needs for corrective. The facet of computerized charting with the greatest potential for development is in the expansion of the automatic monitoring of patient care. Information could be incorporated into assessment protocols that automatically monitor the efficacy of treatments. Patients' assessments could be reviewed so that care could be optimized. The medical staff could be provided computer-generated reminders for use in treatment assessment [22], The information charted could also be useful for other departments. For example, a program monitoring infectious disease could take into consideration a change in breath sounds in a patient suspected of having a pulmonary infection. RC charting is now incorporated into computerized ICU-rounds reports and patient-summary reports. These reports extract the most recent and useful data and display them in a concise format for optimal use [6,9,21].

The RC computer system is efficient because it has streamlined the process of documentation while extracting the most "useful" information. Without having to provide costly cumulative paper reports, the RC system provides better access for entry and review. Overall, computer charting is preferred by therapists over manual charting, making their job easier while improving the quality of information charted. Computer charting has added a high degree of confidence that there will be good correlation of clinical, administrative, and financial records. The computerization of charting RC procedures demonstrates the advantages of using clinical information for the benefit of the therapist, the department, the hospital, and the patient.

References

[1] R.A. Jydstrup and M.J. Gross, Cost of information handling in hospitals, Health Serv Res 1 (1966) 253–271.
[2] K. Jacobwitzk, L. Strodtman, T. Lomas, and T. Turax, Microcomputer-based data management system for nursing assessment of the diabetic patient, in: *Proceedings of the 5th Annual Symposium on Computers in Medical Care* (1981), pp. 755–759.
[3] M.F. Collen, L.S. Davis, E.E. Van Brunt, and J.F. Terdiman, Functional goals and problems in large-scale patient record management and automated screening, Fed Proc 33 (1974) 2376–2379.
[4] J.D. Bronzino, C*omputer Applications for Patient Care* (Addison-Wesley, Menlo Park CA, 1983).
[5] S.L. Mertz, S.R. Ash, and J. Farrell, The CNS in the ICU: A bedside notation system for nurses, in: *Proceedings of the 6th Annual Symposium on Computers in Medical Care* (1982), pp. 577–581.
[6] G.O. Barnett, The application of computer-based medical-record systems in ambulatory practice, New England Journal of Medicine 310 (1984) 1643–1650.
[7] T.A. Pryor, R.M. Gardner, P.D. Clayton, and H.R. Warner, The HELP system, Journal Medical Systemic 7 (1983) 87–102.

[8] B.R. Warner, *Computer Assisted Medical Decision Making* (Academic Press, New York, 1979).
[9] R.M. Gardner, B.J. West, T.A. Pryor, et al., Computer-based ICU data acquisition as an aid to clinical decision making, Crit Care Med 10 (1982) 823–830.
[10] O. Serlin, Fault tolerant systems in commercial applications, Computer 17 (1984) 19–30.
[11] G. Jeromin, Computerization: Are we ready? Respiratory Care 27 (1982) 797–798.
[12] L.E. Garrett, W.W. Stead, W.E. Hammond, C.J. McDonald, and M. Buecher, A method of handling subjective and physical data; experience with two systems, in: *Proceedings of the 6th Annual Symposium on Computers in Medical Care* (1982), pp. 232–235.
[13] R.D. Zielstorff, J.L. Roglieri, K. Marble, et al., Experience with a computer-based medical record for nurse practitioners in ambulatory care, Comput Biomed Res 10 (1977) 61–73.
[14] M.F. Collen, Patient data acquisition, Med Instrum 12 (1978) 222–225.
[15] Joint Commission on Accreditation of Hospitals, Accreditation manual for hospitals, 1982 edition (American Hospital Association, Chicago).
[16] D.J. Mishelevich, A.L. Robinson, C. Rogers, M.E. DuPriest, and E.I. Mize, Respiratory therapy as a component of an integrated hospital information system: The Parkland On-line Information System (POIS), Respiratory Care 27 (1982) 846–854.
[17] Blue Cross and Blue Shield Association, Medical necessity guidelines: Respiratory care (inpatient) (Chicago, September 1982).
[18] ACCP-NHLBI, National conference on oxygen therapy, Chest 86 (1984) 234–247.
[19] M.R. Grier, The need for data in making nursing decisions, in: H.H. Werley and M.R. Grier, editors, *Nursing Information Systems* (Springer, New York, 1981), pp. 15–31.
[20] W.R. Ayers, The potentials and limitations of computers in medical practice: Update—Computers in Medicine 1 (1983) 35–39.
[21] K.E. Bradshaw, R.M. Gardner, T.P. Clemmer, J.F. Orme, F. Thomas, and B.J. West, Physician decision-making: Evaluation of data used in a computerized ICU, Int J Clin Monitor and Comput 1 (1984) 81–41.
[22] C.J. McDonald, Protocol-based computer reminders, the quality of care and the non-perfectibility of man, New England Journal of Medicine 295 (1976) 1351–1355.
[23] G.O. Barnett, R. Winickoff, J.L. Dorsey, M.M. Morgan, and R.S. Lurie, Quality assurance through automated monitoring and concurrent feedback using a computer-based medical information system, Medical Care 16 (1978) 962–970.