Nurses are now using computers for entering clinical data in the ICUs at Latter Day Saints Hospital. These authors studied the effects on time spent in direct patient care.

COMPUTER-BASED DATA ENTRY FOR NURSES IN THE ICU

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In an effort to provide the best possible medical care to critically ill patients, intensive care units (ICUs) have been established in health care delivery systems throughout the world. Computers have been used increasingly in ICUs to aid in the acquisition, communication, presentation, and interpretation of patients' data [1–3].

At Latter Day Saints Hospital, efforts have been made over the past 15 years to improve the quality of care in the ICUs through the use of computers [1,2]. Quantitative physiologic data, information on medications and intravenous therapy, laboratory results, and demographic data have been integrated into the computerized patient database for use in making decisions. An ICU Rounds Report has facilitated the decision-making process by consolidating data from many different sources and making the information rapidly available to physicians.

A study of decision making by physicians in ICUs showed that laboratory findings made up an average of 41% of the data reviewed during daily teaching rounds and an average of 48% of the data reviewed at the bedside [4]. As a result, efforts were made to increase the speed and ease of retrieval of laboratory data. The heavy use of laboratory data in decision making by physicians also provided the impetus for the development of a computerized alerting system to warn of life-threatening events that could be detected on the basis of a patient's laboratory test results [5].

Bedside terminals were installed and nursing care plans and charting were computerized in the ICUs in an effort to improve the acquisition of data, the content and legibility of documentation, and the efficiency of the charting process, so that nurses could spend more of their time in direct patient care. As a result of the computing system, the number and quality of nursing care plans increased and the content and quality of charting improved [6].

In the study reported here, we used work sampling to measure the time spent by ICU nurses in all activities related to patient care before and after implementation of computer-based charting.

ABSTRACT

Efforts are being made to improve the efficiency and quality of care in intensive care units (ICUs) at Latter Day Saints Hospital. The ICUs have been computerized, and the collection, storage, and presentation of patients' data have been improved. Nurses use computers for entering clinical data and plans for nursing care, and the effects of these changes on the work patterns of nurses in the ICU have been evaluated.

Contrary to our expectation, our studies showed a decrease in the proportion of time that nurses spent in direct patient care (from 49.1% to 43.2%) and an increase in the proportion they spent entering clinical data (from 18.2% to 24.2%) after computerization. These changes, however, were attributed to a decrease in the severity of patients' illnesses, rather than the availability of the computer. There was no measurable difference in the proportion of time spent at other nursing activities.

[KEYWORDS: *evaluation, computerized nurse charting, work sampling, ICU*]

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The Image Bank/Kay Chernush

METHODS

Study Design

The study was conducted in the thoracic ICU. The patients in this ICU made up a homogeneous group, in that most were admitted after coronary artery bypass grafting. The average length of stay in the ICU was 3 days, and patients who had major complications after surgery were routinely transferred to the shock-trauma and respiratory ICU. The head nurse of the thoracic ICU was receptive to the study and helped in carrying it out.

The study was performed in two phases, one before and one after installation of the computer-based charting system. The ICU was already partially computerized before implementation of computer-based charting. For several years, the computer had been used for automatic acquisition of such data as blood pressure, heart rate, and temperature. Computer technicians entered the names of drugs given and some of the physiologic data collected by nurses. However, the information entered by computer technicians did not include many of the procedures that the nurses performed.

With the implementation of computer-based nurses' charting, computer technicians were no longer used to enter data on nursing, and nurses became responsible for entering chart data on each of their assigned patients. In addition, the computerized charts became much more complete, including all nursing procedures (interventions) involved in daily patient care. Plans for nursing care were computerized at the same time, and terminals were installed at each bedside. In conjunction with the computerized nurses' charting system, calculation of patient "acuity scores" based on charting data was also automated. This score reflected the severity of illness and was used by the hospital to determine staffing needs.

The work sampling technique used in the study was originally developed by Tippett [7] in an attempt to speed up and simplify traditional time-study analyses. Unlike time-study analysis, in which an individual worker is observed continuously over a predetermined period, the work sampling technique involves numerous observations of multiple workers at random intervals. This technique yields more reliable results than a time-study analysis, because the individual workers are not aware of when they are being observed. In addition, the large number of observations of multiple workers tends to cancel out individual differences and provide a reliable average result. The work sampling design used in this study was based on other applications of work sampling in health care found in the medical literature [8–10].

The Pilot and Work Sampling Studies

With the assistance of the head nurse of the ICU, the job description for an ICU nurse was analyzed to determine a nurse's daily activities. These activities were then grouped into the 10 categories shown in Table 1.

To give a preliminary view of the distribution of nursing activities and to serve as a reference when the actual work sampling study was performed, a pilot study using traditional time-study techniques was performed. We reasoned that the results would either increase our confidence in the findings of the work sampling study (if they were similar) or raise questions about the validity of the work sampling technique (if the results differed greatly).

In the pilot study, an observer

THE 10 CATEGORIES OF NURSING ACTIVITY

Table 1

1. **Patient Care:** anything done to the patient—for example, giving medication, turning the patient, setting up intravenous lines, fixing bandages, and bathing the patient. Also includes watching the monitors at the central station.
2. **Charting:** anything involving the charting of nursing activities, whether on paper or by computer. Also includes correcting or looking for errors in the chart and calling out computer reports.
3. **Oral Communication:** talking about a patient or other work-related subjects. Talking could be with doctors, nurses, computer technicians, patients, families, laboratories, the blood bank, a clerk, etc.
4. **Obtaining Supplies:** going to get anything for a patient in or out of the unit. Includes obtaining intravenous lines, preparing medications, and getting pillows, bandages, equipment needed for a procedure, or any other supplies needed for patient care.
5. **Planning Nursing Care:** filling out the nursing care plan at a computer terminal (distinguished from time spent at computer-based charting or data review).
6. **Reporting:** time spent giving a report to a nurse who is coming on duty.
7. **Transferring Patients:** filling out forms for the transfer of a patient.
8. **Data Review:** reviewing data at a computer terminal—for example, reviewing laboratory test results (distinguished from time spent at computer-based charting or care plans).
9. **Checking Medication Schedules:** checking the computer-generated drug schedule against that on the Kardex file.
10. **Non-nursing Activities:** activities unrelated to patient care, such as making personal telephone calls, socializing, and taking breaks.

with a stopwatch recorded the time spent by a nurse, while caring for a patient, in performing activities in each of the 10 categories in Table 1 during the 24-hour period immediately following the patient's return from the operating room. The experiment was carried out on four different occasions with four different pairs of nurses and patients. The percentage of time spent at each activity was calculated for each of the nurse-patient pairs.

After the pilot study, the work sampling study was conducted in two phases. Phase 1 (before computer-based charting) was conducted from 5 a.m. on January 30, 1985, until 5 a.m. on February 6, 1985. At that time, nurses were using the conventional paper chart for most charting (although computer technicians later entered some of the information on the paper chart into the computer). Phase 2 (after the beginning of computer-based nurses' charting) was conducted from 5 a.m. on February 23, 1986, until 5 a.m. on March 2, 1986, approximately six months after computer-based charting was implemented.

During each phase of the work sampling study, observations of nursing activities were made approximately every 15 minutes, 24 hours a day for a 7-day period. Observations were made at random during each 15-minute period. One observer was used for each of three shifts, and each observer made observations on all nurses working in the ICU during that shift. Observers were drawn from among ward clerks and computer technicians who were employed by the hospital and were familiar with the thoracic ICU. A ward clerk was used as an observer during the day shift (7:30 a.m. to 3:30 p.m.), and computer technicians were used as observers during the evening shift (3:30 p.m. to 7:30 p.m.) and night shift (7:30 p.m. to 7:30 a.m.). Training for the observers included a thorough explanation of the procedure and of the definitions of the 10 categories of nursing activity, and several short trial observation periods to acquaint observers with the work sampling technique and answer any questions that might arise.

Data collected during the two phases of the study were analyzed by dividing the number of observations in each category by the total number of observations made (7775 in Phase 1 and 8050 in Phase 2) to determine the proportion of nursing time spent at each type of activity. Data were grouped according to time of collection (with day defined as 7 a.m. to 7 p.m. and night defined as 7 p.m. to 7 a.m.) and individual observer. Data collected by each observer were analyzed to identify any interobserver differences in the recording of data. No statistically significant differences between observers were found.

Data were also collected on the numbers of patients, the nurses' staffing levels, and patient acuity during the two phases of the study. Patient acuity is a gross

measure of the severity of illness and can be used in comparing different populations of patients [11].

RESULTS

During the pilot study, an average of 48.3% of nursing time was spent in direct patient care, 18.7% in paper charting, 13.9% in non-nursing activities, 6.6% in oral communication, 6.8% in locating supplies, 2.9% in reporting to a nurse coming on duty, 0.2% in scheduling medications, 1.2% in reviewing data at a computer terminal, 0.8% in preparing and updating plans for nursing care, and 0.6% in doing the paperwork necessary to transfer a patient to another unit in the hospital.

The results of Phase 1 of the work sampling study were comparable to those of the pilot study. The results of Phases 1 and 2 are summarized in Figure 1 and Table 2. The percentage of nursing time spent at each type of activity during the daytime, nighttime, and

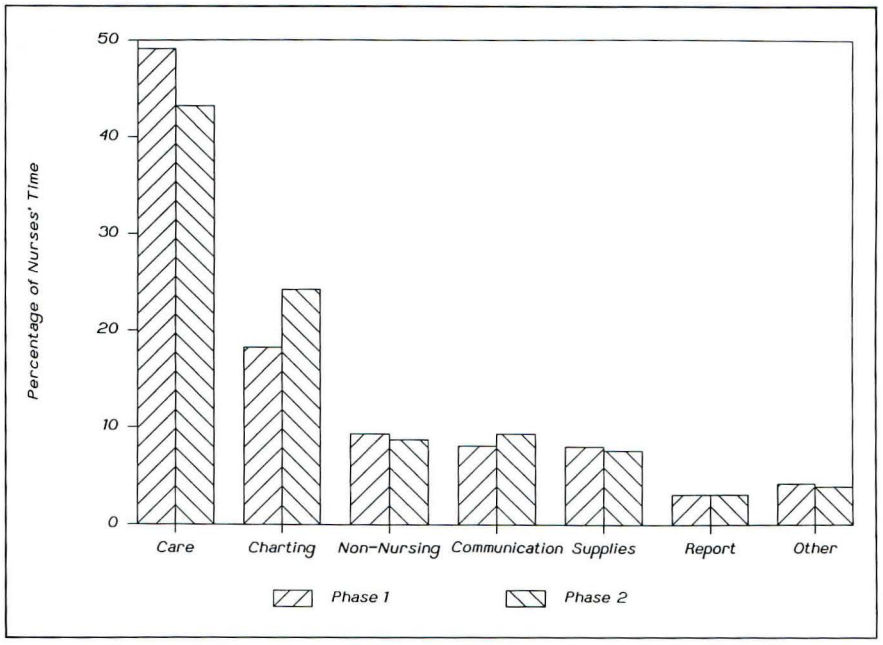

Figure 1. Results of Phases 1 and 2 of the work sampling study, conducted before and after implementation of computer-based charting. The study showed a decrease in the percentage of time spent in patient care and an increase in the percentage spent in charting after installation of the computing system.

PERCENTAGE OF TIME SPENT AT VARIOUS ACTIVITIES DURING THE TWO PHASES OF THE WORK SAMPLING STUDY

Table 2

	Phase 1			Phase 2		
Activity	**Day***	**Night†**	**Total**	**Day***	**Night†**	**Total**
Patient care	52.6	45.3	49.1	45.3	41.1	43.2
Charting	15.4	21.2	18.2	24.3	24.1	24.2
Non-nursing	4.9	14.1	9.3	6.3	11.3	8.7
Oral communication	9.3	6.7	8.1	10.4	8.2	9.3
Obtaining supplies	8.8	7.1	8.0	7.5	7.6	7.6
Reporting	4.2	1.9	3.1	2.9	3.4	3.1
Other:						
Data review	2.1	1.1	1.6	0.8	1.3	1.1
Drug scheduling	1.1	1.8	1.4	0.7	1.5	1.1
Nursing care plan	0.6	0.6	0.6	0.4	1.4	0.8
Transfer	1.0	0.2	0.6	1.4	0.1	0.9
Total for other	4.8	3.7	4.2	3.3	4.3	3.9

*7 a.m. to 7 p.m.
†7 p.m. to 7 a.m.

AVERAGE NUMBER OF PATIENTS IN THE THORACIC ICU DURING THE TWO PHASES OF THE WORK SAMPLING STUDY

Table 3

	Day*	Night†	Total	Difference‡
Phase 1	10.93	12.21	11.57	+1.28
Phase 2	11.50	12.46	11.98	+0.96
Difference‡	+0.57	+0.25	+0.41	

*7 a.m. to 7 p.m.
†7 p.m. to 7 a.m.
‡None of these differences were statistically significant (Student's t-test).

AVERAGE SCORE FOR PATIENT ACUITY (HOURS OF NURSING CARE PER PATIENT) DURING THE TWO PHASES OF THE WORK SAMPLING STUDY

Table 4

	Day	Night	Total	Difference
Phase 1	10.42	9.34	9.88	−1.08*
Phase 2	8.94	8.33	8.63	−0.62
Difference	−1.48†	−1.01†	−1.25†	

* $P < 0.05$ by Student's t-test.
† $P < 0.01$ by Student's t-test.

both was calculated for the two phases of the study.

The average number of patients in the ICU during Phase 1 of the study was 11.57 (Table 3). The average acuity (hours of nursing care required per patient) per shift was 9.88 (Table 4), with an average of 7.90 nurses working each shift (Table 5).

During Phase 2, patient care made up 43.2% of all nursing activities (Table 2). The average number of patients in the thoracic ICU was 11.98 (Table 3), with an average acuity per shift of 8.63 hours per patient (Table 4). Patient acuity decreased from 8.94 hours per patient during the day to 8.33 hours per patient at night (Table 4), and the average number of nurses working on each shift was 7.24 (Table 5).

There were no significant differences between the numbers of patients or between the numbers of nurses in the ICU in the daytime as compared with the nighttime or in Phase 1 as compared with Phase 2. There were significant differences between the levels of patient acuity measured in Phase 1 and Phase 2 and in the daytime and nighttime in Phase 1 (Table 4).

Ratios of the proportion of time spent in direct patient care were calculated for night versus day and Phase 2 versus Phase 1 (Table 6). These ratios were compared with corresponding ratios of patient acuity during the same periods. Because there were no significant differences in the numbers of nurses or the numbers of patients, ratios of time spent in direct patient care were not adjusted for these factors.

The largest differences between the two phases of the work sampling study (before and after implementation of computer-based charting) were in the time spent in direct patient care and in the time spent charting. There was a 5.9% decrease (from 49.1% to 43.2%, $P < 0.001$ by Student's t-test) in the total proportion of time spent in direct patient care from Phase 1 to Phase 2, and there were also decreases from day to night (from 52.6% to 45.3% in Phase 1 and from 45.3% to 41.1% in Phase 2). There was a 6.0% increase (from 18.2% to 24.2%, $P < 0.001$) in the time spent charting in Phase 2 as compared with Phase 1.

DISCUSSION

In both types of comparison (Phase 1 vs. Phase 2 and day vs. night), decreases in the proportion of time spent in direct patient care were matched by corresponding decreases in patient acuity, a measure of the severity of illness [11]. The patient acuity score consisted of a constant factor, for activities such as charting, reporting, rounds, oral communication, and changing intravenous tubing, and a nursing intervention factor, for other nursing activities. Although the acuity score is based in part on the number and type of nursing interventions in the patient care process, it was the best measure that we had available and we had

no reason to doubt its accuracy as a measure of severity of illness. Ratios of the changes in patient care and the changes in patient acuity were nearly identical (0.88 vs. 0.86, Table 6), and showed that time spent in patient care changed proportionately with the severity of illness as measured by patient acuity. Therefore, we suggest that the amount of time nurses spent in direct patient care was determined by patients' needs, and was not influenced by the nature of the charting system in use (paper vs. computer-based).

The nurses' highest priority was to meet the patients' needs for direct care. When those needs were high, less time was spent in other nursing activities, such as charting. When there was less need for direct patient care, nurses used the extra time to chart, update plans for care and teaching, and perform other tasks. This could account for the increased time spent in charting in Phase 2 of the study and for the increase between day and night (from 15.4% to 21.2%, $P<0.001$ by Student's t-test) during Phase 1.

A computer-based charting system should, by its nature, facilitate the acquisition of data, remind nurses of information to chart, and make data readily available for review (on the terminal and as reports), communication, and decision making. Studies have shown that the quality and contents of nursing care plans and charting are increased by computerization [6]. Despite these advantages, however, we have not observed any time savings as a result of the computerized charting system.

The lack of time savings may be due to several factors. First, the computer-based charting system is not yet comprehensive. For example, nurses are now required to chart patients' histories and assessments on paper. Work is under way to complete the computer-based charting system so that all patient charting can be done by computer. Second, nurses do not always make full use of the capabilities of the computer-based charting system. For example, they often chart the same information both manually and at the computer. Third, even if the time required to chart by computer is actually less than that required to chart manually, the differences may be too small to be measured by the work sampling technique. It is also possible that the most important benefits of computerization have already been realized with the implementation of such approaches as computer-based reporting of laboratory results and automatic collection of vital signs. Fourth, if a small amount of time is actually saved, it is easily spent on other activities, and the savings do not necessarily result in an increase in time devoted to direct patient care.

We believe that time-savings benefits from computer-based charting systems can be realized if the data entered by nurses are used to facilitate communication between nurses and physicians, if more complete and accurate re-

AVERAGE NUMBER OF NURSES WORKING IN THE THORACIC ICU DURING THE TWO PHASES OF THE WORK-SAMPLING STUDY*

Table 5

	Day	Night	Total	Difference
Phase 1	7.96	7.84	7.90	−0.12
Phase 2	7.55	6.93	7.24	−0.62
Difference	−0.41	−0.91	−0.66	

*None of the differences were statistically significant.

RATIOS OF THE CHANGE IN PATIENT ACUITY AND TIME SPENT IN DIRECT PATIENT CARE DURING THE NIGHT VERSUS DAY IN PHASES 1 AND 2 AND DURING PHASE 2 VERSUS PHASE 1

Table 6

	Patient Care	Acuity
Phase 1, night vs. day	0.86	0.90
Phase 2, night vs. day	0.91	0.93
Phase 2 vs. Phase 1	0.88	0.86

THE NURSES' HIGHEST PRIORITY WAS TO MEET THE PATIENTS' NEEDS FOR DIRECT CARE. WHEN THERE WAS LESS NEED FOR DIRECT PATIENT CARE, NURSES USED THE EXTRA TIME TO CHART, UPDATE PLANS FOR CARE AND TEACHING, AND PERFORM OTHER TASKS.

ports on patient status are generated, and if nursing management practices are designed to make the best use of the capabilities of the computing system. Such benefits will not occur as an automatic effect of a computer-based charting system but as a result of finding ways to improve patient care. Appropriate changes must be identified and instituted, so that the potential benefits of the computing system to nurses, patients, and the hospital can be fully realized [12].

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