International Journal of Clinical Monitoring and Computing **6**: 173–179, 1989.

Computerized nurse charting

T. Allan Pryor
Medical Biophysics and Computing, University of Utah/LDS Hospital, 325 8th Avenue, Salt Lake City, UT 84143, USA

Accepted 1 May 1989

Key words: nursing, bed-side terminals, computerized charting, expert systems

Abstract

Computerized nurse charting programs have been used at LDS Hospital for over two years. These programs allow the nurse to create nurse care plans for the management of the patient, and chart on the computer actions and information which support the documentation of the management of the patient according to the care plan created for the patient. Computer terminals have been placed at the patient's bedside to facilitate the use of these programs. This paper describes the programs available at LDS Hospital and several evaluation studies which have been performed to measure the efficacy of the programs. The evaluation studies indicated an increase in the level of documentation completeness and accuracy by the nurse but at some minor expense to time available to the nurse for patient care. Evaluation of the need for bedside terminals versus centrally located terminals showed an overwhelming desire by the nurse in favor of the bedside terminal. It was also found that data was entered more timely with less waiting when bedside terminals were available. Physician acceptance of the nurse charting system was found to be favorable.

The nursing process presents in a conceptual manner the tasks to be performed by a nurse in deliverance of optimal patient care. If followed, this process ensures that the care provided to the patient by a nurse will include the necessary planning, assessment and evaluation of the patient's condition. On the HELP system at LDS Hospital in Salt Lake City, Utah we have for the past several years been developing a computerized nursing information system which permits the nurse to document compliance with the nursing process. Our system allows the nurse to create and manage nursing care plans which delineate the care to be administered to the patient and subsequently document through the computer compliance and assessment of the plan. The documentation of the care is provided by the nurse charting nursing actions and results of those actions through terminals located at the nursing station or the patient's bedside.

The computer charting programs at LDS Hospital have made use of the computerized decision support available on the HELP system. The need for decision support in the computerized charting system has resulted in a coded nursing database and menu driven data entry methodology. In developing the system we spent considerable time in creation of a computerized nursing database which would contain the necessary comments to be charted by the nurse. Our database includes assessment descriptions, physiological variables, nursing actions, historical facts, etc. Using this database we developed a series of data entry menus which allow the nurse to rapidly enter into a patient's computerized medical record by choosing, from the menu,

```
                CURRENT NURSING CARE PLAN                [redacted]                [redacted]
                          07/26/1988 15:09               [redacted]

 2. ALTERATION IN PERFUSION/CARDIAC OUTPUT  TIME INITIATED: 07/26/1988 12:50  LAST UPDATED: 07/26/1988 12:50

   RELATED TO (CAUSES):                          ACTIONS:
        1 HYPERTENSION                                1 ASSESS HEART SOUNDS Q 6 & PRN
        2 SURGERY                                     2 ASSESS CAPILLARY FILLING TIME Q4H & PRN
        3 VASCULAR DISEASE                            3 ASSESS PERIPHERAL PULSES Q SHIFT & PRN
                                                      4 ASSESS TEMP/COLOR OF EXTREMITIES Q 4 & PRN
   OUTCOMES:                                          5 DAILY WEIGHTS
        1 BP WNL WITHOUT MEDICATION                   6 TURN & POSITION Q 2 & PRN
        2 HEART RATE WNL
        3 NO S/S HEART FAILURE                   STANDARDS OF CARE :
        4 AFFECTED EXTREMITY SAME SIZE AS             1 ASSESS BREATH SOUNDS Q SHIFT & PRN
          UNAFFECTED EXTREMIT                         2 ASSESS/RECORD LEVEL OF CONSCIOUSNESS
        5 NORMAL COLOR IN AFFECTED EXTREMITY          3 EVALUATE FLUID BALANCE Q SHIFT
        6 URINE OUTPUT >20-30 CC/HR                   4 OBSERVE FOR S/S OF FLUID OVERLOAD
        7 STABLE HEMATOCRIT                           5 OBSERVE FOR DYSPNEA
                                                      6 OBSERVE FOR WEAKNESS/DIZZINESS/PALPITATIONS

LAST NURSE TO UPDATE CARE PLAN: [redacted], M[redacted]    07/26/1988 12:50    [redacted]

**************************************** TEMPORARY REPORT--DISCARD WHEN UPDATED ****************************************

(END)                                                                                    #280 - pg1
```

Fig. 1. A typical nurse care plan from the HELP system.

the proper selections that information which normally would be recorded by the nurse as part of the manual nursing record. In the HELP system the nurse charting function uses primarily two programs; the nursing care plan program and the charting program.

The nursing care plan program consists of a set of menus which allow the nurse to describe the problems being managed, the underlying causes (nursing diagnoses) of the problem, the desired outcomes in the management of the problem and the nursing actions to be followed to obtain the problem management outcomes. Using this program the nurse initially creates a problem for management and subsequently modifies the plan as care is given to the patient. This plan is available on the terminal or as a written report. If changes to the plan are necessary, the nurse, through the terminal, can modify, delete and/or add problems. Figure 1 is a print out of a care plan used at LDS Hospital. Upon discharge of the patient a complete history of the care plan can be printed and recorded in the patient's medical record.

The charting program consists of a set of screens which provide menu selections recording the care given. This program uses a general branching logic system which permits the developer of data entry systems to create complex data entry screens with both diagnostic logic for validation of the entered data and follow-up logic to control the flow of screen presentation. While the vast majority of data entered using this program is in coded form (i.e. menu selection), free text comments may also be entered in those situations where no appropriate codes have been provided in the nursing database. From the data entered by the nurses using this program, formatted end of shift reports are generated which are placed in the patient's written chart. Figure 2 is a nursing end of shift report from the HELP system. The data have been correlated with the nursing problems are printed under the appropriate nursing problem. In order to ensure accuracy of the final shift reports, programs are provided to the nurse to review and/or edit at any time on the terminal data previously entered by the nurse. Terminals for both creation of care plans and computer charting are located at the nursing station and the patient's bedside.

Effects on nursing activity through use of computer charting

Following introduction of our computerized nurse

```
                                L D S   H O S P I T A L   I C U   N U R S E   C O M M E N T S
NAME: [redacted]                          NO. [redacted]      ROOM: [redacted]          SHIFT: JUL 26 06:01 - JUL 26 18:00
DR. [redacted]                SEX: F      AGE: [redacted]     HEIGHT: 163          WEIGHT:  60.00          BSA:1.64
ADMIT DIAGNOSIS: [redacted]                                                    ADMIT DATE: [redacted] 09:59     SEQUENCE #  377
================================================================================================================================
PROBLEM #2          ALTERATION IN PERFUSION/CARDIAC OUTPUT
** PERIPHERAL SITES  **
   0600   RT. DORSALIS PEDAL 1+ ;  LEFT DORSALIS PEDAL 1+ ;  RT. POSTERIOR TIBIAL 1+ ;  LEFT POSTERIOR TIBIAL 1+ ;
   1400   RT. DORSALIS PEDAL 1+ ;  LEFT DORSALIS PEDAL 1+ ;  RT. POSTERIOR TIBIAL 1+ ;  LEFT POSTERIOR TIBIAL 1+ ;
** EXTREMITY TEMP & COLOR   **
   0600   ALL EXTREMITIES, WARM, DRY, PINK
   1200   ALL EXTREMITIES, WARM, DRY, PINK
** CAPILLARY REFILL  **
   0800   BILAT. UPPER EXTRM   < 3 SECONDS
          BILAT. LOWER EXTRM
   1200   BILAT. UPPER EXTRM   < 3 SECONDS
          BILAT. LOWER EXTRM
================================================================================================================================
PROBLEM #3          ALTERATION IN FLUID OR ELECTROLYTE BALANCE
** I.V. LINES  **
   0800   ARTERIAL LINE          SITE: LEFT, BRACHIAL
                                 ACTION: IN PLACE, ZEROED, DYNAMIC RESPONSE ADEQUATE
   0330   TRIPLE LUMEN           SITE: LEFT, SUBCLAVIAN
                                 ACTION: IN PLACE, CHECKED AND PATENT
   0900   HEPARIN LOCK           SITE: RIGHT, HAND
                                 ACTION: IN PLACE, CHECKED AND PATENT
================================================================================================================================
PROBLEM #4          ALTERATION IN NEUROLOGIC STATUS
** MENTAL STATUS  **
   0800   ORIENTED X 1, SPONTANEOUS EYE OPENING, WITHDRAWS FROM PAIN,
   1200   ORIENTED X 1, SPONTANEOUS EYE OPENING, WITHDRAWS FROM PAIN,
** SAFETY  **
   0800   SAFETY:    ALARMS ON, BED IN LOW POSITION, CALL LIGHT WITHIN REACH, SIDERAILS UP, ASPIRATION PRECAUTIONS,
================================================================================================================================
PROBLEM #7          ALTERATION IN ELIMINATION: BOWEL OR BLADDER
** G.U. OUT  **
   0800   FOLEY CATH URINE   180 ML   CHARACTER: AMBER,HAZY,BLOODY,
   1000   FOLEY CATH URINE    80 ML
   1200   FOLEY CATH URINE   195 ML
   1400   FOLEY CATH URINE   220 ML
** G.U. MANAGEMENT  **
   0800   CATHETER, FOLEY   ACTION: CHECKED AND PATENT
   1000   CATHETER, FOLEY   ACTION: CHECKED AND PATENT
   1200   CATHETER, FOLEY   ACTION: CHECKED AND PATENT
   1400   CATHETER, FOLEY   ACTION: CHECKED AND PATENT

================================================================================================================================
PROBLEM #9          IMPAIRED PHYSICAL MOBILITY/SKIN INTEGRITY
** SPECIAL EQUIPMENT  **
   0800   TYPE: MOON BOOTS
          MANAGEMENT: IN PLACE,
** ACTIVITY  **
   0800   TURNED & POSITIONED x  1   TO: L SIDE              TOLERATED: WELL
   1000   TURNED & POSITIONED x  1   TO: R SIDE              TOLERATED: WELL
   1200   TURNED & POSITIONED x  1   TO: SUPINE              TOLERATED: WELL
   1400   TURNED & POSITIONED x  1   TO: L SIDE              TOLERATED: WELL

================================================================================================================================
PROBLEM #11         ALTERATION IN NUTRITION
** TUBE/DRAIN MANAGEMENT  **
   0800   MILLER-FREDERICK TUBE   MGMNT: CHECKED AND PATENT
                                         BAG AND TUBING CHANGED
                                         VIA KANGAROO PUMP
                                         RESIDUAL:   0cc
   1200   MILLER-FREDERICK TUBE   MGMNT: CLAMPED
** IRRIGATION  **
   0800   MILLER-FREDERICK TUBE   SOLUTION: TAP WATER   20 ML
   1200   MILLER-FREDERICK TUBE   SOLUTION: TAP WATER   15 ML

================================================================================================================================
[redacted]                          NO. [redacted]      ROOM: [redacted]          SHIFT: JUL 26 06:01 - JUL 26 18:00
```

Fig. 2. A nursing end of shift report. The design of this report is correlated with the nursing care plan problems. All charted items are reported beneath their appropriate problem.

charting system, we have performed several evaluation studies to measure the effect of the system on nursing performance. Three primary studies were conducted. The first measured the effect of computer charting on the distribution of nursing time/activities. The second measured the system's effect on completeness/accuracy of charted data. The third study measured the effect of locating terminals directly at the patient's bedside. All studies were performed in a 46 bed medical nursing division (W8). All of the patient rooms of this unit are private. The south half of the unit was instrumented with bedside terminals and the north half had terminals available in the halls for every 4 beds. The first study was conducted as a work sampling study where for one week prior to introduction of computer charting and one year after introduction of the system nurses were sampled at 15 minute intervals to record the activity in which they were engaged.

Eight categories of activity were defined and at each sample the activity of the nurse was judged by the work sampler to be in one of the eight categories. The eight categories were:

1. Patient Care
2. Paperwork
3. Communication
4. Supplies
5. Computer Usage
6. Report
7. Inservice
8. Miscellaneous

Table 1. Results of the nursing work sampling study. Post implementation data was collected approximately one year after implementation of the system. %'s represent the percent of time that activity was recorded by the work sampler during the one week sampling period.

	Pre W8	Post W8
Avg Daily Census	41.05	35.57
Avg Daily Acuity	240.00	270.00
Avg Daily # RNs	28.90	31.90
Avg Hrs Care/Patient	5.85	7.59
Avg Hrs Care/Nurse	8.32	8.48
% Patient Care	32.48	27.32
% Paperwork	24.02	16.86
% Communication	15.72	13.80
% Supplies	9.63	13.29
% Computer Usage	2.24	13.50
% Report	6.61	6.82
% Inservice	0.00	0.12
% Miscellaneous	9.29	8.31

Several control variables were also measured to ensure comparability of the data. These variables included average daily census in the unit, average daily patient acuity (number of hours of nursing care provided for all patients in the unit), average daily number of registered nurses working in the unit, average hours of care/Patient provided by the nurses during a 24 hour period, and average hours of care/Nurse (the average number of hours spent by a nurse in actual patient care). Table 1 lists the results of the work sampling study in one unit at LDS Hospital.

The % refers to the percent of time spent by the nurse in that particular activity. Not surprisingly the percent of time spent in computer usage showed a dramatic increase with the introduction of computerized charting and a reduction of paperwork by 8%. Unfortunately, there was also a decrease in the time spent by the nurse n patient care of 5%. In order to understand these results it is necessary to review the results of the second study. This study measured the effects of the system on quality and completeness of the patient's chart. To measure the quality of nursing documentation we reviewed random samples of charts during the pre and post implementation phase of the project. The variables measured were:

Table 2. Results of the comparison of the documentation quality/quantity before and after implementation of the nurse charting system.

	Pre W8	Post W8
% Care Plans Written	59	60
% Care Plans Current	70	43
% Optional Actions Charted	34	32
% Standard Actions Charted	40	91
% Actions Reevaluated	27	90
% Legible	71	92
% Dated/Timed/Signed	87	85

1. % of Care Plans written
2. % of Care Plans which were current
3. % of Optional Actions Charted
4. % of Standard Actions Charted
5. % of Actions Reevaluated
6. % of Legible comments on the chart
7. % of comments Dated/Timed/Signed

A care plan was considered current if the chart did not suggest that either a new problem should be entered as part of the plan or an old problem had been resolved and had been removed from the care plan. In the care plan, required nursing actions to resolve a problem are recorded as either optional actions or standard actions. An optional action is one not required for every patient who is being managed for a problem, but has been specifically entered into the care plan for that particular patient. The standard actions are those required for all patients who are being managed for that problem. The patient's charts were reviewed to determine if documentation was present indicating that an action item of the care plan had indeed been accomplished and the results of the action charted.

Table 3. Comparison of the documentation between a unit with terminals only at the nursing stations and the unit with bedside terminals.

	Pod W8	Bedside W8
% Patient Care	27.04	27.93
% Paperwork	17.25	16.71
% Communication	13.79	13.99
% Supplies	13.62	13.19
% Computer Use	13.93	13.31
% Report	5.66	6.61
% Inservice	0.23	0.02
% Miscellaneous	8.50	8.26

Table 4. Results of the preference questionnaire given to the nurses regarding the use of bedside terminals versus nursing station terminals.

Question 1: How often do you have to wait for a terminal?

	Day shift		*Evening shift*		*Night shift*	
Pods	N	0	N	0	N	18
	R	9	R	18	R	47
	S	26	S	53	S	29
	O	65	O	29	O	6
Bedside	N	74	N	75	N	100
	R	21	R	25	R	0
	S	0	S	0	S	0
	O	5	O	0	O	0

N = Never R = Rarely S = Sometimes O = Often

Question 2: As a routine, how often do you write data down and enter it into the terminal at a later time?

	Day shift		*Evening shift*		*Night shift*	
Pods	N	9	N	12	N	12
	R	9	R	17	R	23
	S	13	S	6	S	18
	O	69	O	65	O	47
Bedside	N	44	N	47	N	50
	R	33	R	41	R	38
	S	17	S	12	S	6
	O	6	O	0	O	6

N = Never R = Rarely S = Sometimes O = Often

Question 3: Which terminal arrangement do you prefer?

	Day shift	*Evening shift*	*Night shift*
Pods	4	0	22
Bedside	94	100	78

Table 2 reports the results of the documentation study.

While there was some drop in the currency of the care plans, the significant finding was that a dramatic increase had occurred in the completeness of the chart in relation to the care plan. This fact explains partially the decrease in time spent in patient care by the nurse. The design of the computer charting programs had, in effect, caused the nurses to be more consistent and complete in their charting. With the manual charting system, each nurse was free to determine the quantity and quality of their charting. However, with the computer programs the nurses were forced to be more consistent. It is unclear whether this trade off of patient care time for more accurate documentation is a good one, but it clearly shows the power of the computer in directing the quantity and quality of documentation. We are continuing to study this trade off to ensure an optimal mix between the two conflicting goals.

Effects of bedside terminals on computer charting

To assess the utility of bedside terminals versus more centrally located terminals on computer charting, we compared the level of documentation from a unit with all bedside terminals against a unit where terminals were available outside the patient rooms. In this unit there was one terminal for every four beds. The terminal was recessed in the wall in an area (pod) which served the four rooms. In both units, terminals were also available for charting at the nursing station. Table 3 gives the differences in documentation completeness between the bedside unit and the pod unit. While some of the differences were not significant, in all cases the bedside unit showed increased quality over the pod unit.

We also asked the nurses to report on the number of times they were denied access to a terminal because of terminal utilization by another person. The questionnaire also asked the nurses to report the number of times they did not enter the data directly into the terminal, but wrote the information down to be entered at a later time. Finally we asked them to report their personal preference. This questionnaire revealed that there was an overwhelming support for the bedside terminals in each of the three categories. Not only was access more available and delayed entry reduced, but clearly the nurses prefer the presence of bedside terminals over the pod location of the terminals. Since one of the main reasons for installation of computer charting systems is elimination of the written record, it is imperative that the data be entered into the computer in a timely manner in order that the other medical professionals, including the physician, will have a current record of the patient's status any time they access the patient's record through the terminal. The fact that considerable delays are experienced when bedside terminals are not present may be the overriding reason to justify the cost incurred with the installation of the number of terminals necessary to have them available at every bedside.

Physician acceptance of computerized nurse charting

Physicians practicing on the unit where computerized nurse charting was implemented, were given questionnaires in order to elicit their impressions regarding the system. 83% responded that they were frequently or always able to review patient data on the terminals in the unit. 75% indicated that they considered the patient data to frequently or always be more accurate than the paper chart. 66% believed it frequently or always took them less time to locate data in the computer as compared to the paper chart. 87% found screen report formats frequently or always easy to use and complete. Overall, 80% of the physicians indicated that reviewing patient data on the terminals was very easy to do. This acceptance by the physicians was critical to our continued implementation of the nursing system since they are in many cases the ultimate user of the data being charted by the nurse and can easily modify use of the computer if their needs are not met.

Discussion

While we have yet to complete our goal of computerizing all of the chart being maintained by the nurse, our preliminary efforts have led to four basic conclusions. First, the charting programs can influence greatly the quality and quantity of data being recorded by the nurse. In this area, design of the programs is crucial to ensure that a proper balance is maintained between documentation of that which is important and entry of unimportant data whose time requirement may keep the nurse from performing his/her major responsibility of patient care.

Secondly, the use of bedside terminals is necessary for both nurse satisfaction and timeless of data entry. While the entered data in our study did not significantly change, its utility as medical information could be significantly impaired without the bedside terminals.

Thirdly, installation of a computerized nurse charting system effects not only nurses, but many of the other medical professionals involved in the care of the patient. Those professionals must also be involved in the design of the system to ensure that their needs, together with the nursing needs, are met.

Finally, this technology is acceptable and usable by the nurses. This conclusion results primarily from the positive attitude expressed by the nurses who participated in the study. While training is necessary, the nurses are readily able to grasp the knowledge necessary to interact with the terminal and rapidly adapt to its use. They soon find themselves dependent on the computer and are reluctant to work in those units where computer charting is not available.

We are continuing to expand our system by both installation of the system in other units and addition of newer programs. Currently we are working on the database elements and screens necessary for the nurse to chart the nursing patient history and nursing assessment. These new enhancements to the system will allow us to provide a nursing system which enhances the compliance by the nursing staff in implementation of the nursing process in the care of patients.

References

1. Bradshaw K. Computerized laboratory alerting system to warn of life-threatening events. Unpublished doctoral dissertation, University of Utah, Salt Lake City, Utah, 1988.
2. Burkes M. The relationship of satisfaction, beliefs, and motivation with computerized nursing programs. Unpublished masters thesis, University of Utah, Salt Lake City, Utah, 1987.
3. Cengiz M, Ranzenberger J, Johnson D, Killpack A, Lumpkins R, Pryor TA. Design and implementation of computerized nursing care plans. Proceedings, The Seventh Annual Symposium on Computer Applications in Medical Care. IEEE Computer Society, Washington, DC, 1983: 561–4.
4. Chapman R, Ranzenberger J, Killpack A, Pryor TA. Computerized charting at the bedside: Promoting the nursing process. Proceedings, The Eighth Annual Symposium on Computer Applications in Medical Care. IEEE Computer Society, 1984.
5. Halford G, Burkes M, Pryor TA. Measuring the impact of bedside terminals. Submitted article to Nursing Management, 1988.
6. Halford G, Pryor TA, Burkes M. Measuring the impact of bedside terminals. Proceedings, The Eleventh Annual Symposium on Computer Applications in Medical Care. IEEE Computer Society, Washington, DC, 1987: 359–62.
7. Johnson D, Ranzenberger J, Pryor TA. Nursing applications on the HELP system. Proceedings, The Eighth Annual Symposium on Computer Applications in Medical Care. IEEE Computer Society, Washington, DC, 1984: 703–8.
8. Johnson D, Wigertz G, Pryor TA. Nurse charting on the HELP system. MIE Conference, 1987.
9. Johnson D. Decisions and dilemmas in the development of a nursing information system. Computers in Nursing 1987; 5: 94–8.
10. Johnson D, Burkes M, Sittig D, Hinson D, Pryor TA. Evaluation of the effects of computerized nurse charting. Proceedings, The Eleventh Annual Symposium on Computer Applications in Medical Care. IEEE Computer Society, Washington, DC, 1987: 363–7.
11. Killpack A, Johnson D, Pryor T, Chapman R, Ranzenberger J. Automating patient acuity in critical care units from nursing documentation. Proceedings, The Eighth Annual Symposium on Computer Applications in Medical Care. IEEE Computer Society, Washington, DC, 1984: 709–11.