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Physician decision-making – Evaluation of data used in a computerized ICU

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Abstract

New instrumentation, techniques and computers have made such large amounts of information rapidly available to ICU clinicians that there is now a danger of information overload. To help with this problem at LDS Hospital, a computerized system was implemented in the Shock-Trauma ICU. This ICU is almost totally computerized with each patient's physiologic, laboratory, drug, demographic, fluid input/output and nutritional data integrated into the patient's computer record.

In the ICU, physician decision-making takes place in two situations: during rounds and on-site. For this study, data usage in decision-making was evaluated in both of these environments. The items of data used in decision-making were tabulated into six categories: 1) bedside monitor, 2) laboratory, 3) drugs, input/output and IV, 4) blood gas laboratory, 5) observations and 6) other. Comparisons were made between the portion of the computerized database occupied by a category and its use in decision-making.

Combined laboratory data (clinical, microbiology and blood gas) made up 38 to 41% of total patient data reviewed and occupied 16.3% of the database. Observations made up 21–22% of the data reviewed and occupied 6.8% of the database. Drugs, input/output and IV data usage ranged from 13% to 23%, but occupied 36% of the database. Bedside monitor data usage was 12.5% to 22% and occupied 32.5% of the database. The 'other' category, used 2.5% to 5% of the time, made up 8.4% of the database.

These results indicate that patient data collection and storage must be evaluated and optimized. This evaluation, along with implementation of the computerized ICU Rounds Report developed for optimal data presentation, will help physicians to evaluate patient status and should facilitate effective decisions.

Introduction

Intensive Care Units (ICU's) have become an integral part of many hospitals throughout the world. Their concentration on treatment of critically ill patients requires pertinent physiologic data to be readily available for medical personnel so that quick and accurate decisions can be made in life-threatening situations. In recent years, development of instrumentation and techniques aided by computer technology, has made an unprecedented amount of physiologic data available to clinicians in the ICU. Physiologic monitoring of all kinds originated and developed due to the feeling that more patient data would result in better patient care (4–5). It was thought additional data would improve the timeliness and appropriateness of medical decisions, reduce the number of of oversights, and facilitate training of those specializing in intensive care (1). However, so much data is becoming available that it will soon be difficult to assimilate and use it effectively (6). Important factors may become obscured or forgotten in the midst of numerous less important ones (1). Devices which permit monitoring of new physiologic signals have generated an exploration of additional indices and models for patient care that are constantly being evaluated and may or may not become permanent fixtures on the medical scene. All these factors cause confusion and uncertainty in both the medical community and the instrumentation industry (6).

Because of their speed and information processing capabilities, computers have been increasingly employed in the ICU environment to aid in management of patient data. At LDS Hospital, computers are employed in six ICUs to the extent that the units are almost completely computerized (3). Quantitative physiologic data, laboratory results, drug and IV information, and demographics are all integrated into the patient's computer record. Only some observational data, such as that obtained from physical examination, and free text nurse and physician comments on patient status, are excluded from our computer records(3).

At the LDS Hospital, computing capabilities have not been limited to data storage and retrieval, but have also been applied to the problems of data management to facilitate effective use of the patient database. Goals in this area include development of an organized, compressed, prioritized presentation of important information and the refinement of the computerized database to make it as efficient as possible. Steps taken to realize these goals include the development of the ICU Rounds Report, and a study of the use of patient data by physicians in decision-making in the ICU.

Methods

Background

This study was conducted in the Shock-Trauma Intensive Care Unit at LDS Hospital. The unit admits about 550 patients per year and the average length of stay is 4.5 days. Annual mortality rate during 1982 was 14%. The patient population consists of trauma victims (30%), patients with postoperative complications (50%), and patients with medical problems such as diabetes, renal failure or cardiac arrest (20%). The majority of the patients (65%) come to the unit from within the hospital. Of the patients included in this study, 88% were hemodynamically monitored with arterial and/or pulmonary artery catheters. The unit is staffed by four house officers, two medical students, a critical care fellow, and 3 full time staff physicians who specialize in critical care. The nurse to patient ratio is usually 1 to 2.

At the time this project commenced, patient data was accumulating in the computer system at an approximate rate of 8 Kbytes per patient per day, and was accessed through a series of computer reports. For each twelve hour shift, the computer compiled cardiac output reports, blood gas reports, several laboratory reports, and shift reports containing drug, IV, input/output, temperature and cardovascular data (3). Seven day reports were also available showing the patient's course in temperature, blood pressure, drugs, fluid input/output, weight and nutrition (3).

ICU Rounds Report

The ICU Rounds Report was developed to provide an organ system oriented report of important patient data, including hemodynamic, respiratory, clinical laboratory, blood gas laboratory, medication and nutritional information. The unit's specialists in critical care medicine chose the items included in the report as being the most useful in assessing patient status.

The top of the report (Fig. 1) contains the patient's demographic data including name, patient number, room number, date, attending physician, sex, age, height, weight, body surface area, estimated basal energy expenditure (BEE) and a multi-organ failure score (MOF) which gives an indication of the seriousness of the patient's condition. The rest of the report is then organized by organ system. There is space on the report to record observational data which is not available from the computer record (dotted lines). If an item (such

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                     L D S   H O S P I T A L   I C U   R O U N D S   R E P O R T
                                       DATA WITHIN LAST 24 HOURS

NAME:                                        NO.               ROOM: 4S30                             DATE: OCT 31 07:00
DR. BOX, TERRY D.                  SEX: M    AGE:  74  HEIGHT: 176   WEIGHT:  72.50   BSA:  1.88   BEE:  1436   MOF:    7
===========================================================================================================================
CARDIOVASCULAR: 0                                                             EXAM: ____________________________________
    -- NO CARDIAC OUTPUT DATA AVAILABLE                                             ____________________________________
                      SP    DP    MP   HR  ! LACT          CPK          CPK-MB        LDH-1        LDH-2
  LAST VALUES        142    72    96  130  !
  MAXIMUM            161   128   134  136  ! 2.1 (04:30)      (     )      (     )      (     )      (     )
  MINIMUM             91    47    69   70  !
  HEART RATE =           QRS =        PR =       QRS AXIS =
  -- NO ECG DECISIONS AVAILABLE --
===========================================================================================================================
RESPIRATORY: 3
OCT 31 83     pH     PCO2    HCO3    BE    HB   CO/MT   PO2   SO2   O2CT   %O2  AVO2  VO2   C.O.  A-a  Qs/Qt  PK/ PL/PP  MR/SR
31 05:20 A   7.51    48.2    38.4  14.6  11.8   2/ 1     56    89   14.7     5
        SAMPLE #  15, TEMP 38.0, BREATHING STATUS : NASAL CANNULA
        MODERATE METABOLIC ALKALOSIS
        HYPOVENTILATION MARKEDLY IMPROVED
        MODERATE HYPOXEMIA
       RATE   VT    VE     VC     MIF     COMP    VD/VT    VCO2    EXAM:                            X-RAY:

    ON  ______ _____ _____ ______ _______ ________ ________ ________ !                                 !
    OFF ______ _____ _____                                          !                                 !
===========================================================================================================================
NEURO AND PSYCH: 0
    GLASGOW 15 (00:15) VERBAL ________   EYELIDS ________   MOTOR __________   PUPILS _______    SENSORY _______

    DTR ___________  BABIN. ________   ICP ____________   PSYCH __________
===========================================================================================================================
COAGULATION: 0
    PT:             (     ) PTT:          (     ) PLATELETS:  268 (05:20)   FIBRINOGEN:     (     ) EXAM: __________________
    FSP-CON:        (     ) FSP-PT:       (     ) 3P:            (     )                               __________________
===========================================================================================================================
RENAL, FLUIDS, LYTES: 2
   IN   6083 CRYST   3168  COLLOID          BLOOD     NG/PO    1865 ! NA    143 (05:20) K     4.5 (05:20)  CL  101   (05:20)
   OUT  4729 URINE   1610  NGOUT            DRAINS 1000 OTHER  2119 ! CO2    34 (05:20) BUN  49   (05:20)  CRE   4.6 (05:20)
   NET  1354 WT     72.50  WT-CHG    0.00   S.G.   1.018            ! AGAP  15.4        UOSM               UNA       CRCL
===========================================================================================================================
METABOLIC --- NUTRITION: 0
   KCAL      2427   GLU  226    (05:20)   ALB    2.1 (04:30)  !  CA    7.7 (04:30)    FE         (     )  TIBC        (     )
   KCAL/N2    596   UUN         (     )   N-BAL               !  PO4   4.3 (04:30)    MG         (     )  CHOL    148 (04:30)
===========================================================================================================================
GI, LIVER, AND PANCREAS: 1                                                                                  EXAM:
   HCT     36.4 (05:20)  TOTAL BILI    4.8 (04:30)  SGOT    84 (04:30)  ALKPO4  281 (04:30)  GGT      131 (04:30) ___________
   GUAIAC 1+    (00:00)  DIRECT BILI   3.4 (04:30)  SGPT    81 (04:30)  LDH     327 (04:30)  AMYLASE     (     ) ___________
===========================================================================================================================
INFECTION: 1
   WBC  9.0 (05:20) TEMP  38.2 (02:00) DIFF  17B, 48P, 23L, 11M,  1E (05:20) GRAM STAIN: SPUTUM ___________ OTHER _________
CULTURES:
   BLOOD _______  SPUTUM ________  URINE _________  CSF ________  CATH ________  WOUND _________  OTHER ______________
===========================================================================================================================
SKIN AND EXTREMITIES:
   PULSES ________  RASH ________  DECUBITI ____________
===========================================================================================================================
TUBES:
   VEN ________   ART ________   SG ________   NG ________   FOLEY ________   ET ________   TRACH  ________ DRAIN______

   CHEST ______________ RECTAL ______  JEJUNAL ________  DIALYSIS ________   OTHER ___________________________________
===========================================================================================================================
MEDICATIONS:

MEPERIDINE (DEMEROL), INJ               MGM   IM       50.0   METAPROTERENOL (ALUPENT), SOLUTION   MGM   INHAL     50.0
AMPICILLIN, INJ                         MGM   IV       6000   RIOPAN, LIQUID                       ML    ORAL       300
NYSTATIN, SUSPENSION                    ML    ORAL     15.0   AMPHOJEL, LIQUID                     ML    ORAL        60
CLINDAMYCIN (CLEOCIN), INJ              MGM   IV       1200   PROMETHAZINE (PHENERGAN), INJ        MGM   IM        25.0
CEFOXITIN (MEFOXIN), INJ                MGM   IV       2000   INSULIN REGULAR, INJ                 UNITS IV         200
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Fig. 1. ICU Rounds Report. This is an organ system oriented computer report designed to present important items of patient data concisely. Space has been left to allow the addition of pertinent information not contained in the computer record.

as a laboratory result) is normally stored on the computer, but that particular test or procedure has not been done for a patient during the last 24 hours, the corresponding space is left blank. Recent additions to the report include microbiology and x-ray results.

Patient data usage study

The most easily observed decision-making situation in the Shock-Trauma ICU occurs during morning physician teaching rounds. At this time, pertinent data on each patient being cared for in the unit are reviewed, and plans are formulated for the patient's care during that day. The initial part of the study evaluated the use of patient data in physician decision-making in the rounds setting. During December 1982 and January 1983, patient data used in rounds was recorded for 30 patients. Fourteen patients in the study were reviewed more than once, with each review taking place on a separate day. For this time period, patient data usage for 63 patient evaluations was recorded.

Review of patient data was by organ system in a format similar to the ICU Rounds Report. Because of this, the Rounds Report became a convenient form for recording the items of patient data used in formulating plans for patient care. The items used were checked off on the report as they were reviewed. Items not present on the rounds report, were written in the margin.

To evaluate data gathered, all the patient data

Table 1. Patient data categories.

1. Bedside monitor	Heart rate, blood pressures, cardiac output, cardiac rhythm, respiratory rate, temperature.
2. Laboratory	Electrolytes, white count, differential, cultures coagulation, lactate, enzymes, drug levels, hematocrit-hemoglobin, metabolic/nitrogen balance.
3. Blood gas	pH, PCO_2, HCO_3, BE Hb, COHb, PO_2, $SatO_2$, O_2 content, FIO_2, AVO_2 diff., venous O_2, A-a gradient Qs/Qt.
4. Drugs – input/output IV	Medications, intravenous feeding, fluid balance urine output, energy balance.
5. Observations	Cardiac exam, respiratory parameters (weaning), neuro-psych, weight, weight change, GI exam, Gram stains, skins & Extremities.
6. Other	History, ECG, X-ray, EEG, CT scan, etc.

available for decision-making was divided into six categories (Table 1). For each patient evaluation, the data used were tabulated in the appropriate category. The number of items used in each category was summed over the entire patient population. Each category total was converted into a percentage of the total amount of data used in all of the patient evaluations. Patients were then divided into 3 subgroups based on their hemodynamic monitoring status. These subgroups were 1) no invasive monitoring, 2) arterial catheter monitoring, and 3) arterial and pulmonary artery catheter monitoring. One patient with only pulmonary artery catheter monitoring was not included in the analysis. Each subgroup was analyzed to determine what percent of total patient evaluation data each data category represented. The percentage of data used per category was compared with the corresponding average percentage of data used for the total population. The computerized patient database was also analyzed to determine what percent of patient data storage each category represented. The average percentage of data used per category was compared with the corresponding percentage of data stored in the computer. This ratio was used to evaluate the efficiency of data storage and to point out areas in which the computerized patient database could be improved.

The second phase of the study evaluated the use of patient data outside of rounds (in 'on-site' or bedside decision-making), and repeated the evaluation of data usage in rounds done in phase one. The evaluation of on-site data usage was included to provide a more complete picture of patient data usage in physician decision-making. It was decided that the most workable plan for looking at patient data usage on-site was to devise a checklist to be marked by physicians after a decision was made to indicate which items of patient data had been used in making the decision. Our goals in the development of this checklist were to include all items of patient data frequently used in physician decision-making, to make it as concise as possible and to organize it so that data items used by the physician could be easily found and tabulated. Additional research was then undertaken to provide the necessary information to meet these goals.

The first step was to identify the patient problems about which a nurse most frequently consulted a physician. This was accomplished through the use of another checklist which we entitled the Nurse–Physician Interactions sheet (Table 2). This sheet was based on a list, compiled by the ICU nursing staff, of reasons that a nurse might consult a physician concerning patient status. The list was put into the organ system format used in the ICU Rounds Report. A section on the right of the sheet provided space for the nurse to mark the reasons for which they had consulted a physician during a shift. The nurse's name, the date, and the shift were entered at the top to insure that a sheet would be filled out by each nurse on duty so that the information gathered would be as complete as possible.

Nurses in the Shock-Trauma ICU filled out these sheets for a ten day period. During this time, nineteen patients were treated in the ICU for a diverse set of problems considered by the ICU staff to be typical.

Over 1960 nurse–physician (RN-MD) interactions were recorded during the ten day period. The number of interactions triggered by each of the 72

Table 2. Nuse–Physician Interactions checklist

NURSE: DATE: SHIFT:

Please check the appropriate reason each time you consult with a physician in regard to a patient. Possible reasons are listed by organ system in a format similar to the Rounds Report. If the reason is not listed, please record it under 'Other'.

SYSTEM	REASON – CHANGES IN:	FREQUENCY
Cardiovascular	BP	
	HR	
	CO/CI	
	Rhythm	
	Chest pain	
	Lactic acid	
	Swan PW	
	PA	
	RA	
Respiratory	ABG's	
	Lung auscultation	
	Lung compliance	
	Respiratory pattern	
	Supplemental O_2	
	Vent 1 FiO_2	
	2 mode	
	3 rate	
Neuro	Level of consciousness	
	Pupils	
	Motor activity	
	EEG	
Coagulation	PT	
	PTT	
	Platelets	
Renal, fluid & lytes	Urine output	
	Specific gravity	
	SMA 6	
	IV rate	
	IV fluid	
Nutrition, GI, liver & pancreas	TPN	
	NG output	
	NVD problems	
	Amylase	
Infection	CBC	
	Temp	
	Cultures	
	Wound – drainage, odor, color, etc.	
Skin & extremities	Pulses	
	Rash	
	Decubiti	
Tubes	IV site problems	
	Line placement probs	
	Feeding tube position	
	Foley problems	
Other	Patient's family	

Table 3. ICU Patient Data Use checklist

Instructions:
1. Please put patient's name on this checklist.
2. Check the reason you were asked to see the patient.
3. Check each data item that you took into consideration in making your decision concerning this problem. Where multiorgan system evaluation is applicable, please check items in each system.
4. For *each* data item you considered that is not listed, place a check mark by 'Other'.

Patient Name: ______________________________

Reason for seeing patient
BP___ Urine Output___ Mental status___ Blood Gases___ PW Pressure___ HR___ Other______________

Patient data items used: ______________________________

Cardiovascular
HR___ BP___ CO___ CI___ SVR, PVR___ PW, CVP___ PA___ CPK___ ECG___ Cardiac Exam___ Lactate___
Rhythm___ Drugs___ Mechanical Problem___ Other______________

Respiratory
Spontaneous Rate___ V_T___ V_T___ pH___ PCO_2___ PO_2___ Compliance___ $\%O_2$___ X-ray___ Lung Exam______
Chest Exam___ Drugs___ Other______________
Ventilator:
Rate___ Mode___ V_T___ Peak Pressure___ Plateau Pressure___ PEEP___ Mechanical Problem___ Other______

Coagulation
PT___ PTT___ Platelets___ Drugs___ Other______________

Neuro & Psych
Glasgow___ Verbal___ Eyelids___ Eye Movements___ Corneals___ Motor___ Pupils___ Sensory___ DTR___ Babinski___
ICP___ PSYCH___ Pain___ Drugs___ Other______________

Renal, Fluid & Lytes
In___ Out___ Urine Out___ NG Out— Wt-Chg___ S.G.___ Na___ K___ Cl^-___ HCO_3___ BUN___ Cre___ AGAP___
UNa___ UOsm___ IV Fluids___ Drugs___ Mechanical Probs___ Other______________

GI, liver & pancreas
Hct___ Guaiac___ Bili___ SGOT___ SGPT___ $AlkPO_4$___ LDH___ GGT___ Amylase___ Exam___ Drugs___
Other______________

Infection
WBC___ Temp___ Diff___ Sputum Gram Stain___ Chills, Sweats___ Drugs___ Other______________
Cultures:
Blood___ Urine___ Sputum___ Other______________

Skin & extremities
Pulses___ Edema___ Skin Color___ Skin Temp___ Drugs___ Other______________

Tubes
Ng___ Drains___ Other______________

Metabolic & nutrition
TPN Rate___ Serum Glucose___ Serum Ketones___ Urine Glucose___ Urine Ketones___ Drugs___ Other______

items of patient data listed on the sheets was totaled, and the 8 most frequent items, constituting 45% of the total RN-MD interactions, were found. The problems included changes in blood pressure, urine output, blood gases, level of consciousness, IV rate, pulmonary wedge pressure, IV fluid and heart rate. It was felt that a reasonably comprehensive list of patient data used in on-site decision-making would be obtained by taking the data used in the decision logic for dealing with the 8 most frequent problems and combining them with items of patient data found on the rounds report. The end result of this process was the ICU Patient Data Checklist (Table 3). Patient history was not included on the checklist because it was felt that any decision on patient care would require such knowledge, and therefore, its use in any given situation could be assumed.

Both the on-site and the second rounds data usage evaluations were conducted in October 1983. For the study of on-site patient data usage, the ICU's physician and nursing staffs were oriented on the use of the Patient Data Use Checklist by the ICU director and head nurse, and asked to cooperate in marking them for one month. It had been decided earlier that the most feasible plan was to ask the house staff to fill out a form directly after they made each decision concerning a patient. It was feared that if forms were not filled out at this time, or if a number of decisions made over a specified period of time (8, 12 or 24 hours) were lumped together, the physicians would be unable to recall their thought processes accurately. Data gathered both inside rounds and on-site was evaluated in the same way as data from the December 1982–January 1983 phase of the study described above.

Results

The results of each phase of our study of data usage in decision-making are shown in Table 4 and summarized in Figure 2. During December 1982 and January 1983, use of patient data in physician decision-making during rounds was recorded for 63 evaluations of 30 ICU patients. The percentage of data used in each of the six categories of patient data is as shown in A. Patient data use in rounds during October 1983 was recorded for 58 evaluations of 30 ICU patients. Percentage of data use per category for this this time period is listed in B. Results from both study periods were combined to give the average percentage of data use per category. These averages are found in C. In the on-site phase of the study, 35 ICU Patient Data Use checklists, filled out during one month, reflected items of patient data used in 35 decisions relating to patient care. The results of this phase of the study are shown in D. The difference in data usage between rounds and on-site decision-making was calculated and is listed in E. F shows the composition of the computerized patient database. Figure 2 shows use of patient data in each of the six data categories for both settings looked at in the study.

The distribution of data usage in rounds over the total patient population for the bedside monitor and combined laboratory (laboratory and blood gas laboratory) categories is shown in the graphs in

Table 4. Patient data use study results

		Lab	Drugs input/ output & IV	Observations	Bedside monitor	Blood gas lab	Other
A.	% of data reviewed in rounds – 63 patient evaluations (Dec 82–Jan 83)	33	22	21	13	9	2
B.	% of Data reviewed in rounds – 58 patient evaluations (Oct 83)	29	24	21	12	10	3
C.	Average % of A and B 121 patient evaluations	31.5	23	21	12.5	9.5	2.5
D.	% of data used on-site (35 decisions) (Oct 83)	18	13	22	22	20	5
E.	% Change in data usage between C and D	−13.5	−10	+1	+9.5	+10.5	+2.5
F.	% of data in computer record	8.5	36	6.8	32.5	7.8	8.4

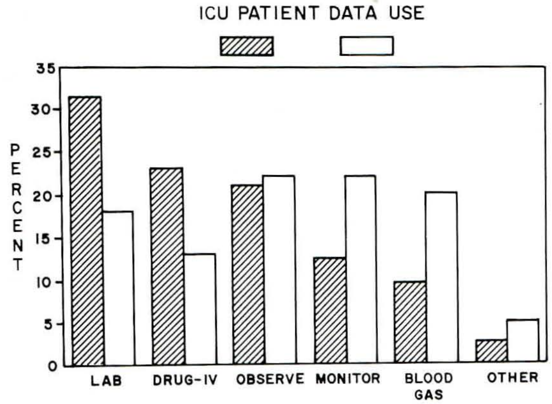

Fig. 2. ICU patient data use. This graph shows the average percentage of patient data used in physician decision-making from each of the six patient data categories in both the rounds and on-site decision-making settings.

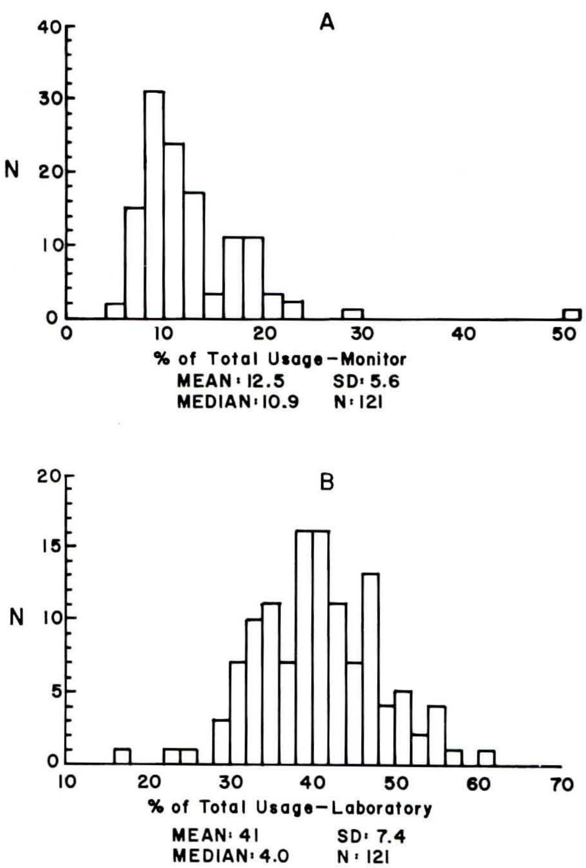

Fig. 3. A and B. These graphs show the distribution over the total patient population of the percent of patient data used in physician decision-making from the bedside monitor and combined laboratory (laboratory and blood gas laboratory) data categories in the rounds setting.

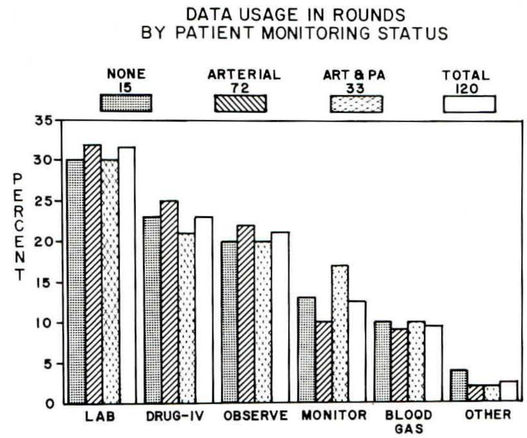

Fig. 4. Data usage in rounds by patient monitoring status. This graph compares use of patient data from the six patient data categories for 3 subgroups of patients with the average use calculated for the total patient population. The subgroups of patients were 1) no invasive hemodynamic monitoring (NONE), 2) arterial catheter monitoring (ARTERIAL), and 3) arterial and pulmonary artery catheter monitoring (ART & PA). TOTAL was used to designate results for the total patient population.

Fig. 3A and B along with the mean, median and standard deviation for each.

Figure 4 compares patient data use in rounds for the 3 hemodynamic patient monitoring subgroups with the average figures for the total patient population. Also shown is the number of patients which belong to each subgroup. This type of figure was not presented for the on-site data because of its different structure and the small sample size.

Discussion

From the study of data usage in physician decision-making, the adequacy of our computerized database and data collection system was analyzed. Data usage was compared to data storage in the computer to pinpoint areas that could be improved for each category (Table 4C, D and F).

The most widely used patient data in the rounds decision-making setting was laboratory data. Clinical, blood gas and microbiology laboratory results made up approximately 40% of all patient data reviewed during both the periods in which rounds data usage was recorded (Table 4). Our preliminary work on-site indicated that laboratory data usage was about 38% (18% + 20%) of total usage, with a large drop in the use of clinical and microbiology laboratory data (to 18%) and an almost equally large increase in the use of blood gas laboratory data (to 20%). The total laboratory data occupied only 16.3% of the computerized database. Because of the high usage to storage ratio for laboratory data, it was felt that optimization of the speed and ease of data retrieval was the indicated improvement to be made.

The second most widely used categories of data during rounds were observations and drugs, input/output and IV (Table 4). The amount of data usage in both the rounds and on-site settings for the observations category was about the same. Comparison of data usage with data storage for this category shows a favorable ratio. However, much of the observational data used by physicians in decision-making is not currently entered into the computer record. We are therefore proposing to add more entries from the observations category to the computer data base. There was a large drop in the use of data from the drugs, input/output and IV category in on-site decision-making (Table 4E). This suggested that data stored exceeds data used by 13% to 23%. One mitigating factor was that in rounds, the actual amount of patient data used for this category was somewhat higher than 22% because in rounds, all medications were looked at as a group and were counted as only one data item. On-site, this effect was lessened because drugs were listed as an item of data under each organ system on the Patient Data Use Checklist, so that if, for example, a physician looked at both cardiac drugs and antibiotics in making a decision, these would be marked and counted as two separate data items. It would probably have given a more correct picture if each drug had been considered as a separate item, in which case the percentage of use would have been more in line with the storage space occupied. For the drug, input/output and IV category, we want to optimize the amount of data stored while still meeting medical decision-making, longterm and legal requirements relating to the patient record.

Data obtained from bedside monitors during rounds made up only about 13% of total data used in decision-making while occupying 32.5% of the computer record. On-site, this usage increased to 22%, which still left a gap of over 10 percentage points between the amount of data stored and the amount of data actually used. This finding indicates an area in which data storage should be reevaluated and optimized so that medical and legal requirements for the patient database can be efficiently met.

The final category, including history, x-ray and ECG, represented between 2.5% to 5% of the data used and took up 8.4% of the computerized database. It is important to remember that each of the items in this category contained a great deal of information about the patient which was not being broken down into individual components, but rather was viewed as a conglomerate. Items in this category are required parts of the patient record, so that medical and legal requirements are satisfied.

Of the two decision-making settings studied, it was only in the rounds setting that sufficient information was gathered to draw quantifiable conclusions. Physician decision-making in rounds in our ICU utilizes the computerized patient database to a greater extent than does on-site decision-making. This is due to the ready availability of some patient data types at the bedside (on-site) without the need to access the patient's computer record (an example is 'real time' data from the bedside monitor). The use of patient data in rounds followed the same general pattern regardless of the hemodynamic monitoring status of the patient (Fig. 4). The greatest difference in data utilization occurred in the bedside monitor category with a high of 17% (Art & PA) and a low of 10% (Arterial) of total patient data reviewed. The percentage of patient data use from each data category varied from patient to patient as shown in the graphs in Fig. 3 for the bedside monitor and laboratory categories. It is important to realize that a data category can make up a very large percentage of total patient data reviewed even though only a small number of items in the category were looked at by physicians if the total number of patient data items reviewed is also small. Such is the case for the patient in which 50% of total data used was from the bedside monitor category. These factors taken together led to our choice of average percentage of patient data use per data category taken over the total patient population (Table 4C) as the most useful figure for evaluating our computerized patient database.

It was estimated that physicians made over 5000 decisions on patient treatment on-site during the month's time that they were asked to mark Patient Data Use Checklists. The estimate was based on the number of nurse-physician interactions recorded over the course of ten days and assumed that a decision resulted from each interaction. Of these 5000 decisions, use of patient data in the decision-making process was recorded only 35 times. Among reasons for there being such a small amount of on-site data was the fact that paperwork is not a top priority for physicians, especially in an ICU setting where a patient's condition may deteriorate rapidly and necessitate immediate therapeutic action. However, the members of the ICU house staff stated that they were using the Patient Data Use Checklist to record data usage in the majority of their decisions. It appears from this observation that many decisions on patient care are made so automatically that a physican may not even recognize that a decision is being made. To rectify this, it is necessary either to continue the data collection process for a much longer period of time, or to devise some other method of looking at data usage in on-site decision-making.

In this study, it was recognized that the frequency with which a data item is used by a physician in decision-making does not correspond on a one-to-one-basis with the importance of the data item in influencing the physician's decision. Definitive attempts to rank data items in the order of importance in patient treatment were beyond the scope of this preliminary study, and were only indicated generally in the results by the frequency with which an item was looked at. Also, it was not possible to equate frequency of use with proven value of use or with any proven effect of knowledge of an item of patient data on the patient's outcome. Unfortunately, data collection and utilization procedures are often implemented in medical care before their real value or effect is known, and they may then become standard practice regardless of this knowledge. We regard this study as preliminary work in which we have only been able to take certain 'snapshots' of the total data utilization in decision-making process by which patients are treated in a specific ICU. Much work remains to be done to bring the total picture into view.

It has been pointed out that conventional paper medical records are bulky, disorganized, unstructured and redundant, and that retrieval of patient information is slow (2). It has also been shown that fixed format patient records organized as flow sheets, such as the ICU Rounds Report, can be accessed in one-fourth the time of a conventional record (2). The design of the ICU Rounds Report has overcome many of the problems associated with conventional paper medical records, and has been accepted and utilized by clinicians.

It is hoped the implementation of the ICU Rounds Report, along with improvements in the patient database, will facilitate physician decision-making by making the most important items of patient data rapidly and readily available. Beyond this, it should be pointed out that the results obtained from this study show several areas in which our emphasis in patient data collection and storage needs to be changed to make best use of available resources. Notable among these is data collected from the patient's bedside monitor which is collected and stored in much greater volume than it is subsequently used. This does not discount the importance of the bedside monitor in reflecting the current hemodynamic status of a patient at bedside, but rather forces us to evaluate how much of this information is really useful after the fact. Since monitoring equipment may well represent the most costly component in equipping an ICU, it is important to evaluate which physiologic parameters must be monitored for effective patient care. Our study also shows that it is desirable to have monitors which are capable of transmitting their physiologic data to a computerized database. These data, when selectively stored and combined with other types of data in an optimized database, allow the physician to get an overall picture of patient status to facilitate effective medical decision-making.

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