Quality Assurance and Utilization Assessment: The Major By-Products of an ICU Clinical Information System

M. Michael Shabot, M.D., F.A.C.S., H. Scott Bjerke, M.D., Mark LoBue, B.A. and Beverley J. Leyerle, R.N., M.P.H., CCRN

Department of Surgery, Cedars-Sinai Medical Center, Los Angeles, California

Abstract

In 1985 we developed a method of automatically extracting indices of severity of illness and intensity of interventions from CIS charts daily. These indices, when combined with outcome measures such as length of stay and mortality, provide a powerful new tool for quality management in the ICU. In this paper we describe our ICU's severity adjusted survival rates as compared to internationally publish norms. In addition we provide a detailed analysis of glucose levels in our ICU, which suggests that glucose control in surgical ICU patients is more closely related to measured severity of illness than administration of intravenous alimentation per se. CIS extracted indices provide a new basis for continuous quality measurement and improvement in the ICU.

Introduction

The power of computerized Clinical Information Systems (CIS) has yet to be tapped by most hospital Quality Assurance (QA) and Utilization Review (UR) departments. The CIS provides an economical and reliable means by which key clinical data can be extracted from the electronic chart and utilized for quality and utilization analyses. In comparison with current manual methods of extracting data by chart audits, the electronic method is not only faster, it also allows for every chart to be audited against standards for efficiency and quality of care. The science of industrial quality management is well known and appreciated in most other industries - many agree that the time is at hand for using these techniques in health care institutions.[1] The Joint Commission for Accredation of Health Care Organizations (JCAHO), the Health Care Financing Authority (HCFA) and other regulatory agencies now require detailed information and trends about outcomes that can not be easily obtained by traditional, tedious methods of manual chart review. However, this volume of data can objectively be extracted from the electronic record provided by a comprehensive CIS. A reduction in the number of hours spent by QA and UR nurses culling data from charts could be channeled into more meaningful activities of data interpretation and reporting. In this paper we describe the use of CIS-derived data for secondary QA and UR activities. ICU's that have a CIS are ready to enjoy the benefits such a system can provide for daily monitoring of patient care and resource activities.

The CIS as a Tool for Quality Assurance and Utilization Assessment

The Surgical Intensive Care Units (SICUs) at Cedars-Sinai Medical Center in Los Angeles, California have utilized a CIS for routine patient care charting for the past seven years. The current system is the Hewlett Packard CareVue 9000 System (Hewlett-Packard Company, Waltham, MA). In 1986, we wrote PDMS software which filtered through all flowsheet data daily in order to extract patient-specific indices of severity of illness and resource utilization.[2] These indices have been combined with information extracted from other hospital databases, including hospital outcome and nosocomial infection data.[3] At the present time, this database contains the records of over 10,000 consecutive SICU patients requiring 27,000 days of care. Analyses of many indicators of quality of care and utilization have been performed on this data.

Severity Scoring

ICU quality control requires a continuous quality improvement program with ongoing assessment of outcomes. In order to objectively measure outcomes and appropriateness for ICU care, it is necessary to determine the severity of illness of patients on admission to the ICU and

0195-4210/91/$5.00

during their stay. Several measurement tools have been introduced for this purpose. Although the APACHE II scoring system is popular, in 1985 we selected for our SICU the Simplified Acute Physiology Score (SAPS) as described by Le Gall. [4] SAPS scores 14 common ICU measurements including age, heart rate, blood pressure, urine output, Glasgow coma score and results of several basic laboratory tests. All 14 SAPS parameters were already being charted by our nurses as part of the routine electronic flowsheet. Therefore, we could perform SAPS calculations automatically with no extra data entry and no dedicated personnel. At the same time, we began to calculate a quantitative version of the Therapeutic Intervention Scoring System (QTISS).[2] The QTISS provides a measure of intensity of services delivered to a patient. When summed, the severity and intensity scores produced the Computerized Intensity-Intervention Score (CIIS). In 1988, we reported that the CIIS on the first ICU day was a reliable predictor of ICU and in-hospital deaths.[5]

In 1989, The French Multicenter Group of ICU Research reported the pooled SAPS-adjusted mortality rates for 3,687 patients from 38 French ICUs.[6] For the first time, the scores of surgical patients were separated from medical patients so that distinct subgroups could be examined. This provided an opportunity to compare our ongoing outcome analyses with the French experience. Figure 1 compares the severity-adjusted outcomes of approximately 5,500 Cedars-Sinai SICU patients with the French outcomes. There are likely to be differences in case selection, management and ICU admission and discharge policies which account for some of the differences between our outcomes and the French experience. However, the data provide an ongoing standard that the SICU can use in future years to monitor the severity of patients admitted to the unit and the efficacy of the care delivered. Patient's are concerned about the overall outcome of the process of care, *e.g., death and survival*, and these scoring methods provide a way of monitoring that process as a whole. If a decline in severity-adjusted survival is observed for a certain period of time, detailed review for contributing factors may be undertaken. The contribution of automated, CIS derived scoring is that these analyses of ***total quality assurance*** can proceed in the background and, in a continuous manner, provide both periodic reports and more urgent warnings if unfavorable trends are detected.

These standardized scores have also provided a way for us to monitor global trends in severity of illness and utilization of resources for our patients. Over the past several years, we have noted a progressive rise in severity of illness, a trend which has been appreciated by many but documented only occasionally (Table 1).

These data indicate that severity of illness is rising year by year and that trauma care days are increasing, but that length of stay has begun to decrease. To some degree the recent improvement in efficiency is a result of feedback from our prior CIS generated experience with outcome and utilization information.

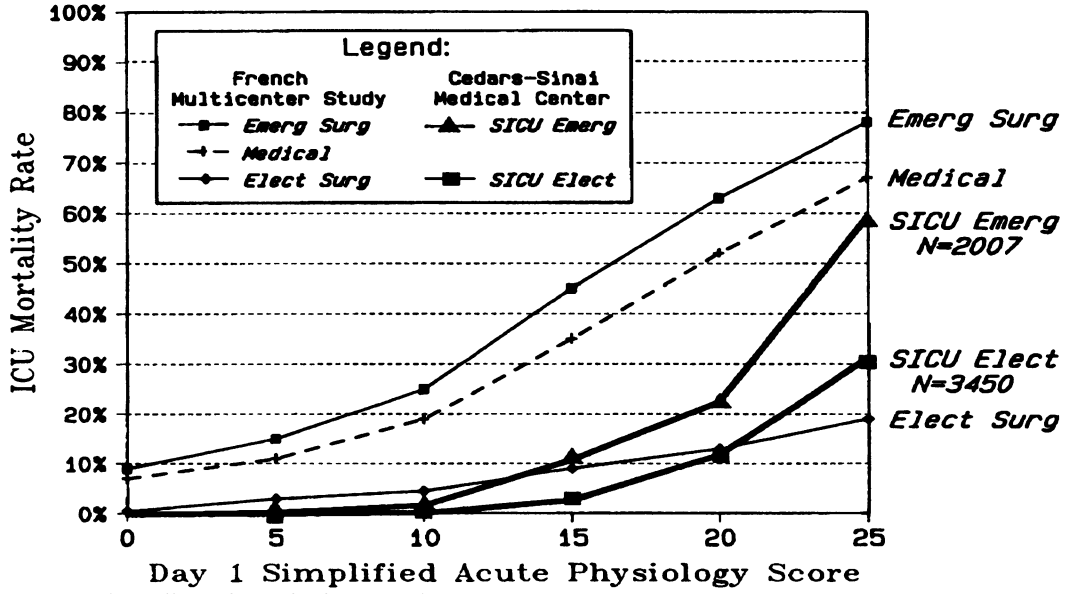

Figure 1: Severity-adjusted survival curves for Cedars-Sinai SICU and French Multicenter Study patients

Table 1: Severity and Utilization Trends 1986-1990

Fiscal Year	*86-87*	*87-88*	*88-89*	*89-90*
Admissions	2521	2393	2062	2227
Days of Care	5710	6066	6216	6144
Trauma Days	1313	1409	1752	1920
Mean ICU Stay (days)	2.27	2.53	3.02	2.77
Mean SAPS	10.0	10.8	11.0	11.3
Mean QTISS	27.7	28.8	29.8	30.9
Mean CIIS	37.7	39.6	40.8	42.2

Glucose Control Study

In 1990 the SICU was asked by the Nutritional Support Committee to determine whether problems with glucose control were occurring in patients receiving IV alimentation in the perioperative period. It was well known that perioperative disturbances in endogenous catacholamine and glucocorticoid metabolism impair the body's ability to handle a glucose load. The committee wondered whether it might be better to forgo nutritional support in the perioperative period than to risk "wide fluctuations in serum glucose". The question was a good one, but one which would formerly have been impossible to answer without manually reviewing hundreds or perhaps thousands of charts. However, we were able to provide a definitive answer with simple queries of our CIS and laboratory information system (Flexilab, Sunquest Information Systems, Tucson, AZ). These queries collated laboratory blood glucose results with CIS information on each patient's IV alimentation status and severity of illness.

We examined glucose values of all patients cared for in the SICU over a six month period from October 1, 1989 to March 31, 1990. We found a total of 4,985 glucose determinations taken on 1,189 consecutive patients. Only 48 (0.96%) of the glucose values were found to be in the critically abnormal range, over 400 mg/dL or below 40 mg/dL (Figure 2). Nearly all critical values represented hyperglycemia, as shown in Table 2. While the incidence of hyperglycemia was greater in patients receiving perioperative IV nutrition, no detrimental effects occurred which would support discontinuing nutrition prior to surgery. Of the 23 patients who had one or more critical glucose values, only 9 patients were on IV alimentation. These 9 patients had a mean SAPS of 15.2, while the 14 hyperglycemic patients not receiving IV alimentation had a mean SAPS of 10.8 ($p<0.001$). We then stratified all measured glucose values by the SAPS severity of illness on the day of sampling. This revealed that higher glucose levels correlated directly with increasing severity of illness (Figure 3). This suggests that the relative glucose intolerance noted in TPN patients may be due to their underlying severity of illness rather than TPN per se. These results confirm the benefits of the CIS, which in a short time answered a specific clinical question, and enhanced our understanding of patients at risk for serious glucose problems.

Outcome Control Chart

Control charts are commonly used in industrial quality control, but seldom seen in hospitals. The charts, which depict outcome measurements over time, are valuable indicators of trends, favorable or otherwise. Significant adverse deviations form the long term average demand closer investigating. The following graph is a control chart for SICU mortality over the same period as the severity-adjusted outcomes above. The upward peak in mortality noted in the summer of 1988 was probably related to an outbreak of nosocomial infections, in part identified by this and corresponding infectious disease data.

Table 2. Incidence of critically abnormal glucose values

	# Patients	*# Glucoses*	*>400 mg/dL*	*<40 mg/dL*
IV Nutrition	89	996	17 (1.7%)	0 (0.0%)
No IV Nutrition	1,040	3,989	28 (0.7%)	3 (0.1%)
p value			*0.003*	*ns*

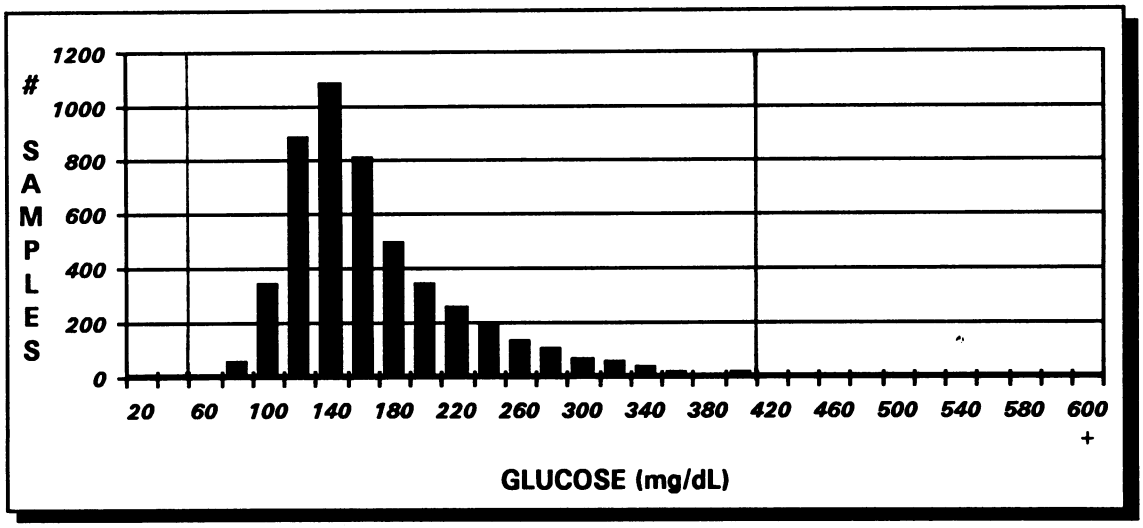

Figure 2: Histogram of blood glucose values for 1,189 consecutive SICU patients

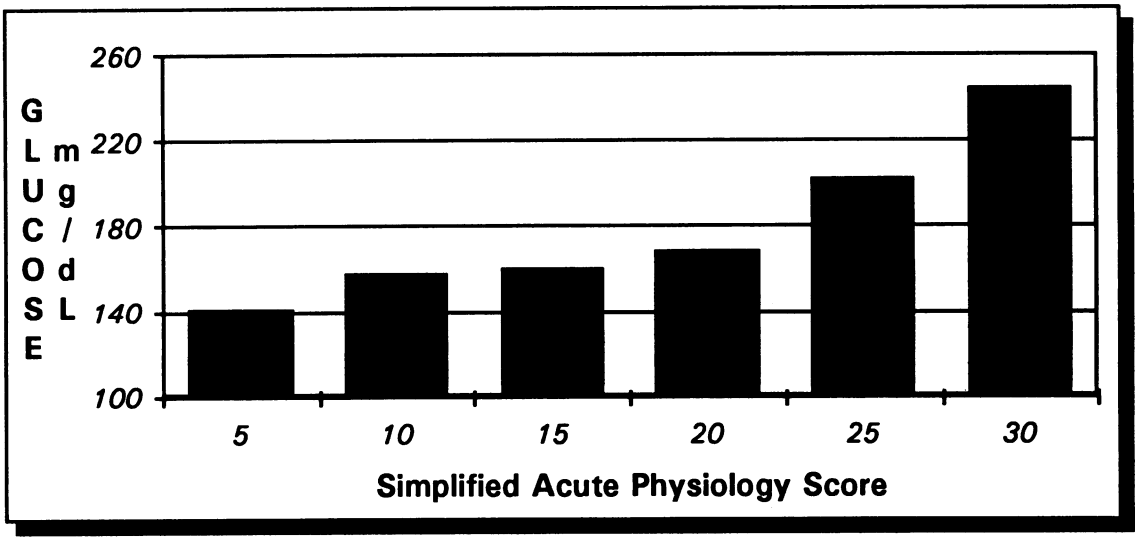

Figure 3: Relationship between glucose level and severity of illness

Realized and Potential Benefits of an ICU CIS

An ongoing program of ICU quality improvement must begin with objective measurements of the processes and outcomes of care. This is in contrast with traditional methods of medical quality assurance, in which individuals, rather the processes, are analyzed.[7] Mortality control charts, analyses of severity adjusted mortality and correlation of adverse clinical events with severity of illness are starting points for effective quality assurance. Many other aspects of ICU care can and must be evaluated, ***but first they must be measured.*** It is for this reason that a comprehensive ICU CIS is so valuable: as it automatically gathers crucially needed census, intensity and intervention data in a hectic environment that is otherwise poorly suited for administrative data collection.

Although many feel that the primary benefit of an ICU CIS is the maintenance of a well-organized, legible patient care flowsheet, we believe that this represents only the most superficial level of CIS functionality. We have programmed our CIS to automatically provide a second level of function in the daily measurement of severity of illness and intensity of interventions. We find these assessments to be invaluable in the daily management of a busy ICU, including triage of patients into and out of the unit and allocation of

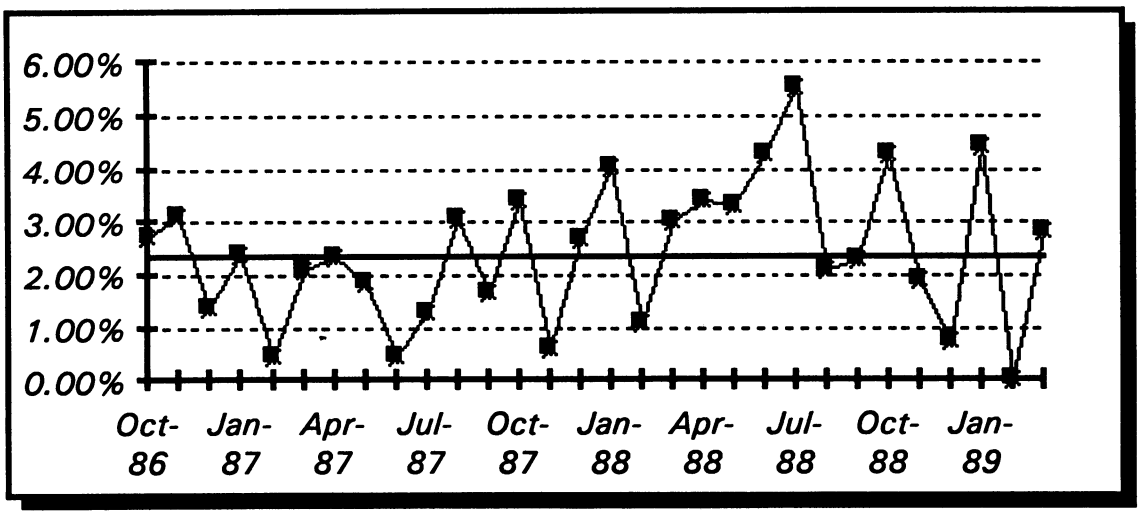

Figure 4: SICU mortality rate control chart, 1986-1989.

nursing/physician resources. Finally we have utilized CIS-derived analyses to provide a third le vel of ICU data management, the evaluation of long term outcomes (Figure 5).

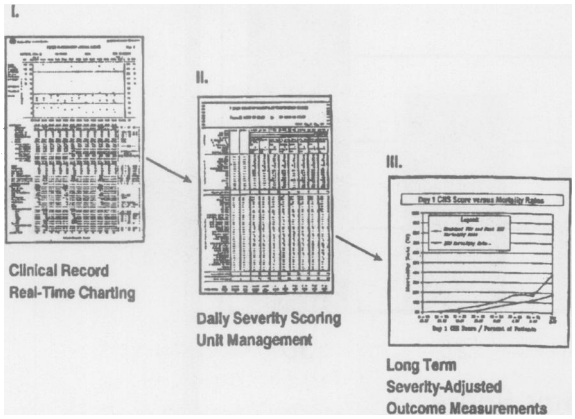

Figure 5: The three levels of operation

The ongoing mass of severity and intensity data, when combined with mortality, nosocomial infection and other available hospital data, is a powerful tool in the assessment of quality of care. We have utilized this data to effect changes in practice which provide more efficient and effective care.

There are potential benefits which have not yet been realized by our CIS and most others. Although our CIS is networked to data producing systems such as the clinical laboratory, the blood gas lab and many bedside measuring devices, it does not have automatic access to the outcome data in other hospital computers. Thus, we periodically cull outcome data from other systems to manually perform outcome analyses on personal computers and hospital mainframe systems. We look forward to the time when all our systems are fully networked so that automatic analyses of severity-adjusted outcome can be carried on in the background. All the severity data available in a given month could be automatically compared to all available outcome criteria, so that both routine reports and non-routine alerts could be issued. Such a system would provide earlier warning for adverse events and trends than are provided by current QA methods. Full use of the capabilities of a comprehensive CIS will provide more medically-effective and cost-effective ICU care.

References

1. Laffel G, Blumenthal B: The case for using industrial quality management science in health care organizations. *JAMA* 1989;262:2869.

2. Shabot MM: Automatic extraction of intensity intervention scores from a computerized Surgical ICU flowsheet. *Am J Surg* 1987;154:72.

3. Leyerle BJ, LoBue M, Shabot MM: Integrated databases for data management beyond the bedside. *Int J Clin Mon Comput* 1990;7:83.

4. LeGall et al: The simplified acute physiology score. *Crit Care Med* 1984;12:975.

5. Shabot MM, Leyerle BJ, LoBue M, et al: First day intensity-intervention score predicts ICU and in-hospital deaths. *Crit Care Med* 1988,16:412.

6. The French Multicenter Group of ICU Research: Factors related to outcome in intensive care: French multicenter study. *Crit Care Med* 1989, 17:490.

7. Albright JM, et al: Outcome reporting to target areas for quality improvement. *SCAMC 14*, 1990, 276.