The Hidden Costs of Treating Severely Ill Patients: Charges and Resource Consumption in an Intensive Care Unit

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A detailed survey of the resources used by two common groups of intensive care unit (ICU) admissions in one medical center hospital found substantial cross-subsidization, with healthier patients admitted for monitoring using significantly less labor resources than sicker patients. Both groups had equal bed charges. This suggests that the resource costs of admitting stable patients to an ICU for monitoring are smaller than their average bed charge. On the other hand, the actual resource costs of treating sicker patients are almost twice their billed ICU charges.

ICU care is approximately 3.8 times more expensive than routine hospital care, a higher ratio than previously estimated. These results should be considered when estimating the national cost of treating severely ill patients and when proposing changes in hospital reimbursement policies, especially with regard to ICU patients.

Introduction

A large part of the rising cost of medical care in the United States is attributed to more intensive use of health care resources. In large part these are increased expenditures for the care of both moderately and severely ill patients using more laboratory tests, x-rays, and other advanced technology ordered by a growing number of technically trained physicians. (Scitovsky and McCall, 1976; Schroeder *et al.*, 1979; Fineberg, 1979; Russell, 1979).

The increased use of intensive care has received relatively little attention. Currently there are 66,000 coronary care unit (CCU) and intensive care unit (ICU) beds, or 6 percent of this nation's total acute care hospital beds. Nationwide ICU beds are growing by 3 to 4 percent per year (American Hospital Association, 1981).

An ICU bed is usually estimated to be three times as expensive as a regular ward bed (Russell, 1979). In one state, Massachusetts, the prices charged for ICU services are growing substantially faster than those charged in other parts of the hospital (Shepard and Ghanotakis, 1979). As a result CCU's and ICU's currently account for 15 to 20 percent of total hospital expenditures, with ICU's accounting for two-thirds of the total.

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This large demand for intensive care stems from three factors. First, there are monitored patients brought to the ICU because they are thought to be at risk of developing a complication for which prompt treatment would be needed. Second, the ICU is used as a prolonged postoperative recovery area for patients undergoing major complicated surgical procedures, such as open-heart surgery. Third, a growing number of patients with chronic diseases are admitted to ICU's for treatment of acute problems.

Louise Russell, who examined the rapid diffusion of ICU's during the 1953-75 period, mentioned some of these driving forces, but did not address resource utilization among these patient groups. Another economic review estimated the capital and operating costs of intensive care by surveying a number of clinical articles which had tabulated charges on particular ICU's (Little, 1979). None of the U.S. studies surveyed by these two reviews attempted to determine the actual resource cost of treating ICU patients while in intensive care. Instead, they typically reported aggregate charges for the entire hospital stay for a particular group of intensive care patients.

This study provides detailed descriptions of the types and estimated costs of resources used by two common groups of intensive care patients in one medical center ICU. It includes a detailed count of the labor effort and a painstaking counting of ancillary services, with particular attention paid to discrepancies between when a particular service was provided and the date it was entered into the billing system.

This analysis is important because it provides a clearer picture of the distribution of resources used in intensive care, how the distribution differs among patient groups, and the possible impact of cost reduction strategies.

Methods

In principle one can compute total costs of ICU treatment by simply counting up the frequency of all resources used, multiplying by corresponding prices, and summing. At first glance, hospital bills appear to provide sufficient detail to do this. There are four difficulties, however, in applying this approach to intensive care patients.

First, ICUs receive a very broad mix of patients who receive a multitude of services. At the hospital studied there were over 10,000 individually billed items. Manually counting 10,000 items was not feasible. Second, while hospital bills may be accurate counts of total ancillary utilization, the dating of individual items on patient bills does not always correspond to the date of service delivery. This makes separation of the items into ICU and non-ICU periods difficult. Third, not all items are individually billed. Some ICU services are included in the daily bed charge. Fourth, the prices charged for individual items are at substantial divergence from resource costs of producing the services. A substantial divergence between charge and marginal costs for one university hospital has been demonstrated (Harris, 1979). The difference between costs and revenue for ancillary departments in a typical hospital has also been described (Stoughton, 1982).

These difficulties, especially the large number of billed items, forced this survey to examine two narrowly defined groups of ICU patients. Within each group, patients received essentially the same set of products. This reduced the number of potential items from 10,000 to approximately 300. Knowledge of the clinical needs and treatment of these two groups also made it possible to divide the ancillary items into ICU and non-ICU portions.

To avoid using the average bed charge as a measure of cost, a direct measure of the intensive care labor effort was used. The Therapeutic Intervention Scoring System (TISS) is a relative value scale that reduces most of the tasks commonly performed within an intensive care unit to 75 items and assigns relative weights ranging from 1 to 4 to each task (Cullen *et al.*, 1974). For example, taking vital signs (heart rate, temperature, blood pressure, and respiratory rate) each hour is 1 TISS point. Maintaining a patient on a ventilator is 4 points. TISS is defined as the sum of the points. One experienced ICU nurse is capable of producing 40 to 50 TISS points during one 8-hour shift. TISS has been used in a number of other university hospitals for various purposes, including utilization review, nurse staffing, and demonstration of need in health facilities planning proceedings (Silverman *et al.*, 1975; Byrick *et al.*, 1980; DOH, 1979). This appears to be the first report of an association of TISS points with other explicit measures of resource consumption in intensive care.

The divergence between costs and charges for other items of hospital care was the most difficult challenge. Charges were adjusted for some of the divergences between charges and costs, but not all. The adjustments are most easily understood by first reviewing routine hospital accounting procedures.

For reimbursement purposes there are three classes of hospital patients: (1) nonpaying, (2) cost paying, and (3) charge paying. All hospitals have a problem raising revenue to pay for the resources consumed by patients who subsequently do not pay. But ethically, and due to Hill-Burton legislation, hospitals cannot turn away acutely ill patients solely for financial reasons. Therefore, hospitals try to set their charges high enough so that the paying customers will cover most bad debts. The problem is that a substantial number of patients (Medicare, Medicaid, and in most regions Blue Cross) are covered by cost-reimbursing intermediaries that do not pay their share of bad debts. Thus, the relatively small portion of self-paying and private insurance patients are charged larger prices. It is these artificially high prices that are called "charges" and appear on hospital bills. In any hospital the charge/cost ratio is directly related to the percentage of nonpaying patients and the percentage covered by the cost-reimbursing intermediaries. Since the latter is a large portion of the total, the ratio between charges and costs can vary substantially between hospitals.

Department cost/charge ratios from the hospital's Medicare Cost Report were used to estimate the resource costs for individually billed items. For departments not covered by the Medicare Cost Report cost/charge ratios were obtained from departmental fiscal managers. Although more accurate than charges, these estimates do not correct for further inter-departmental cross-subsidies from overhead allocation or other types of revenue maximizing behavior (Finkler, 1982). They also do not correct for nonlinear or discontinuous cost functions in the production of individual therapies, or intra-departmental cross-subsidies.

A new severity of illness scale, the Acute Physiology Score (APS), was used to compare the two groups of patients. The APS uses objective physiologic measurements (vital signs and various routine lab tests) and a relative value scale based on clinical judgment to assign a score ranging from 0 to 50 to acutely ill patients. Previous research has revealed a strong and stable relationship between APS and various measures of therapy and outcome (Draper *et al.*, 1981; Knaus *et al.*, 1982; Scheffler *et al.*, 1982).

The Patients

The George Washington (GW) University Medical Center is a 500-bed medical school-affiliated teaching hospital within the District of Columbia. GW's ICU is a 16-bed medical-surgical unit admitting patients with a wide range of diagnoses with the sole exceptions of acute myocardial infarctions and burns. Other than an 8-bed CCU, it is the only intensive care unit in the hospital. The patient mix is reasonably representative of that found in tertiary care hospital ICUs (Knaus *et al.*, 1982).

For this study two groups of ICU admissions were selected. Both groups were typical of one of the previously mentioned reasons behind recent ICU growth: new operations and their requirements for prolonged postoperative observation. The groups were different, however, in their average severity of illness and need for treatment.

One group consisted of all patients who had elective brain surgery for cancer. All brain surgery patients in this hospital are admitted to the ICU for two to four days of post-surgical monitoring. The study excluded patients who had emergency surgery, intra-operative complications, or those who had brain surgery for trauma or cerebrovascular disease. Previous research showed that these patients are at relatively low risk of ever needing active treatment in intensive care (Knaus *et al.,* 1981). The Hospital Discharge Survey indicates that there were approximately 30,000 to 40,000 such patients treated in U.S. hospitals in 1979.

The second study group was patients recovering from coronary artery bypass graft surgery (CABG). Once again, patients who had emergency surgery or intra-operative complications were excluded. Post-open-heart surgery patients normally stay in the ICU for 2 to 3 days, receiving many intensive services during their initial day but then rapidly reducing this need. CABG surgery is performed approximately 150,000 times per year in the U.S. at an estimated cost of approximately 2 billion dollars. CABG has been the subject of considerable attention by economists and clinicians as an example of aggressive new treatment for a chronic disease (Finkler, 1979; Luft *et al.,* 1979; Chaitman *et al.,* 1980).

Together brain surgery and CABG patients are roughly representative of elective admissions to GW's ICU. The relative frequency of these two groups is approximately the same as the division of total ICU admissions into monitor (44 percent) and active treatment (56 percent) patients. The total amount of nursing effort they received is equal to the average for all patients (150 TISS points).

On the other hand, these two patient groups are unrepresentative of all ICU admissions in that they were scheduled to receive ICU treatment after elective surgery. Only 40 percent of all admissions to GW's ICU come following elective surgery. Brain surgery and CABG patients also have a much higher hospital discharge survival rate (99 percent) than other ICU patients (75 percent).

Results

Table 1 reports summary statistics on the two ICU patient groups. They are compared to each other as well as to all other hospital inpatients during the same fiscal year. Both brain surgery and CABG patients had considerably longer hospital stays and higher hospital bills than the average of all hospital patients. The longer length of stay of the brain surgery patients consists of both a longer preoperative diagnostic period and a longer post-ICU recovery period. CABG patients have a shorter preoperative stay.

The major difference between brain surgery and CABG patients is the threefold increase in ICU ancillary charges to CABG patients. This difference reflects the intensity of effort during the ICU stay with the difference in mean ancillary charges proportional to the difference in TISS points. Ancillary charges for pre- and post-ICU days are roughly equivalent, as are the length of ICU stay and corresponding ICU bed charges.

TABLE 1

Summary Data on Two Types of Intensive Care Patients[1]

	Brain Surgery (N=44)	CABG (N=52)	All Hospital Patients (N=15,000)
Physical Data			
Average Length of Stay	25.0 (3.3)	13.9 (0.5)	8.6
Average ICU Stay	2.7	2.5	—
Post-ICU Stay	16.5	7.7	—
Average Total TISS Points in ICU	81.6 (6.8)	212.0 (10.1)	—
Charges Data (in dollars, 1979 prices)			
Total Hospital Stay			
Bed Charges	6,854	4,333	1,900
Ancillary Charges	4,537	6,538	1,000
Operating Room	2,865	3,253	700
Total	14,256 (1552)	14,124 (423)	3,600
ICU Charges			
Bed Charges	1,882	1,698	
Ancillary Charges	858	2,479	
Total	2,740	4,178	
Non-ICU Charges			
Bed Charges	4,972	2,635	
Ancillary Charges	3,678	4,058	
Operating Room	2,865	3,253	
Total	11,515	9,946	

[1]These two patient types are comparable to DRG category 1 (brain surgery) and DRG 107 (CABG). The lengths of stay are slightly longer and more heterogeneous than experienced in New Jersey because outliers were not trimmed and some of the CABG patients received preoperative cardiac catheterization during this hospital stay. (Standard errors in parentheses.)

Differences in use of total ancillary services are also illustrated by frequency counts of individual services. The typical CABG patient totaled 61 lab tests during 60 hours in ICU, including 8 arterial blood gas tests and 4 blood chemistries. The brain surgery patients averaged only 27 laboratory tests, including 2 arterial blood gas tests and 2 blood chemistry measurements.

Table 2 reports a similar distribution of ancillary charges among the different hospital departments. Thirty percent of ancillary charges is for laboratory tests; 20 percent for drugs; and 10 percent each for central supply, inhalation therapy, and x-rays. In all of these categories, the CABG patients received about 3 times as much as brain surgery patients. Approximately 75 percent of all ancillary charges were accounted for by low-cost items (charge under $20.00 per item).

Table 3 reports estimates of resource costs in intensive care using departmental charge/cost ratios for ancillaries. The 25-percent difference between the total charges and total costs for ancillary services reflects the magnitude of bad debts and small portion of charge-paying patients. The

TABLE 2

Distribution of Ancillary Charges during ICU Stay for Two Types of Intensive Care Patients

	Brain Surgery (n=44)		CABG (N=52)	
Department	Mean Charge[1]	% of Total	Mean Charge	% of Total
Blood Processing	80.86$	9.4%	131.04$	5.3%
Central Supply	100.12	11.7	298.99	12.1
Pharmacy	162.95	19.0	545.51	22.0
Inhalation Therapy	112.19	13.1	273.48	11.0
Hypothermia	0.97	—	18.38	0.7
ICU Physician	40.91	4.8	65.38	2.6
Laboratory	271.86	31.7	758.48	30.6
Radiology	72.07	8.4	223.96	9.0
Nuclear Medicine	7.00	0.8	4.04	.2
Electrocardiogram	3.64	0.4	126.15	5.1
Physical Medicine	5.84	0.6	34.10	1.4
Total	$858.41		$2,479.52	

[1]1979 prices

TABLE 3

Resource Costs of Ancillary Services and ICU Unit Services during ICU Stay for Two Types of Intensive Care Patients[1]

	Brain Surgery (n=44)		CABG (N=52)	
Costs				
Ancillary Services				
Department	Mean Cost	% of Total	Mean Cost	% of Total
Blood Processing	65.86$	10.0%	105.04$	5.7%
Central Supply	81.12	12.3	240.99	13.0
Pharmacy	140.95	21.3	450.51	24.4
Inhalation Therapy	96.19	14.6	210.48	11.4
Hypothermia	0.80	—	15.38	0.8
ICU Physician	40.91	6.2	65.38	3.5
Laboratory	176.71	26.7	493.01	26.7
Radiology	43.96	6.7	136.61	7.4
Nuclear Medicine	5.00	0.8	3.04	.2
Electrocardiogram	2.64	0.4	101.15	5.5
Physical Medicine	4.84	0.7	27.10	1.5
Total	$658.98		$1,848.69	
ICU Unit Costs				
Average TISS Points	81.6		212.	
Cost per TISS Point	$16.00		$16.00	
Resource Cost per Case	$1,305.49		$3,391.16	
Medicare Reimbursement				
ICU Unit				
Medicare Expense per Day[2]	$640.80		$640.80	
Average Days	2.7		2.5	
Medicare Expense per Case	$1,730.32		$1,602.78	
Ancillary Costs	$658.98		$1,848.69	

[1]All prices are 1979 vintage

[2]Computed by applying the Medicare cost/charge ratio to the ICU bed charge of $690 per day.

decline in the proportion of ancillaries accounted for by the radiology department and the laboratory reflects the relatively higher markup charged by these departments.

ICU unit costs are estimated with TISS points, using the reasonable assumption that TISS points in the ICU are linearly related to ICU unit costs ($16 per TISS point).[1] ICU unit resource costs of $3,391 for CABG patients are substantially greater than Medicare reimbursement ($1,602). Brain surgery patients, on the other hand, actually receive less resources ($1,305) than Medicare reimburses ($1,730).

It is also interesting to examine the relationship between resource consumption in the ICU and use of ancillary services. Table 4 reports regressions between ancillary charges during ICU stay and total TISS points for both patient groups. The T-ratios and R-squared on these equations are exceptionally high for sample sizes of this size on individual observations. This indicates that for these two patient groups the ancillary charges are a strong proxy for intensive care effort.

TABLE 4

The Relationship between Therapeutic Effort and Ancillary Charges in the ICU[1]

	Brain Surgery	CABG
Intercept	–361.1	254.7
	(1.97)	(0.99)
Therapeutic Effort (TISS Points)	14.94**	10.48**
	(7.35)	(9.35)
R-Squared	.57	.62
N	43	52

[1]Dependent variable: total charges for ancillary services during ICU stay.
**p <.01.

We expected the differences in intensity of ICU services to be directly related to the severity of illness of the two groups. The CABG patient averaged 17.3 APS points, while the brain surgery patients averaged only 7.3 points (p<.01). This indicates that on admission to the ICU, CABG patients are significantly more severely ill than brain surgery patients.

Finally, for the two patient groups combined, the total charge per day of ICU care averaged $1370, approximately twice their average charge for non-ICU days. This $1370 per day charge, which includes the $690 bed charge plus $680 for ancillaries, is approximately 3.8 times as large as the average hospital charge for all non-ICU days of care in this hospital.

[1]Computed by dividing total TISS points produced by the ICU unit over a calendar year into budgeted expenses.

Discussion

ICUs provide a wide range of services, from monitoring patients to the aggressive therapy of severely ill admissions. In this study we examined the resource use of two patient groups, both frequent users of ICU services, and found important differences in ICU resource utilization despite equal ICU bed charges.

Table 1 demonstrates that ICU care is indeed expensive, twice as expensive as the non-ICU portions of these patients' hospital stays and 3.8 times as expensive as all days of hospital care. The two greatest contributors to these costs are labor and laboratory charges, together accounting for a majority of total ICU charges. More importantly, Table 3 points out the contribution of labor and ancillary services to the resource cost of ICU care and the variation found among different patient types. These data also support Derzon's view that hospitals have been able to circumvent Medicare payment limitations on routine costs (223 rules) through ancillary and intensive care use (Derzon, 1982). In the hospital studied, transferring a stable Medicare patient from the ward to the ICU increases revenue by $500 per day with a considerably smaller increase in costs. With this "profit" incentive, it is not surprising that the number of beds in ICUs nationwide continues to increase by 3 to 4 percent a year even though total hospital beds have been stagnant since the mid-1970s.

Low-risk patients brought to the ICU for prophylactic monitoring (brain surgery admissions) used less ancillary and labor services when compared to active treatment patients (CABG). The divergence between the daily bed charge and the resource costs of the labor services received by these two groups allows for an interesting comparison.

It is quite clear that the Medicare-reimbursed "cost" of a day of ICU care is substantially larger than the labor resources consumed by ICU brain surgery patients. The opposite is true for CABG patients. This implies that fiscal intermediaries whose patient populations are over-weighted with monitor patients subsidize the care of severely ill patients. This also implies that if monitor patients are commonly admitted to ICUs, hospitals collect substantial amounts for option demand.

On the other side of the subsidy, the resource cost of treating the sickest patients is substantially understated by hospital bills. Approximately $1800 of the resource cost of ICU treatment for Medicare CABG patients is paid by other patients or insurers. This suggests that the actual national costs of CABG surgery are greater than currently estimated.

Policy Implications

Before policy implications are drawn from these results, it is desirable to test their reliability in a broader spectrum of ICU patients, as well as in other hospitals. Nevertheless, it is intriguing to speculate.

These results suggest that the portion of hospital resources accounted for by ICU patients may be larger than commonly stated. The often quoted 15 percent is based on the assumption that a day of ICU care is 3 times as expensive as other hospital days of care. This study showed a ratio of 3.8. This would mean that ICUs now account for 18 to 19 percent of total hospital expenditures.

These findings also suggest, however, that policies aimed at reducing ICU use by reducing the number of low-risk admissions could result in substantial resource savings. Savings would come from fewer total ICU bed days and reduction in ancillary utilization. The magnitude of these savings would be especially important in community hospitals, which have the majority of intensive care beds and the greatest percentage of monitored admissions (Draper *et al.*, 1981).

It should be recognized that a more restrictive ICU admission and utilization policy would also reduce a hospital's ability to charge for option demand. With fewer monitored patients, a hospital could not use ICU bed charges to subsidize sicker ICU admissions. In a price-regulated environment, this would lead to even higher average bed charges for ICU care, as hospitals would have to recover costs over a much smaller patient base. Whether this would lead to an overall reduction in the total cost of ICU services is unknown. It would, however, make billed charges closer to actual services, thereby enabling only those hospitals that treat severely ill patients to recover the higher costs. This would improve the accuracy of national estimates of the cost of this care and provide for improved equality in reimbursement policy.

Finally, the substantial divergence between bed charges and resource costs of nursing care for these two DRGs suggest that existing hospital data such as HICDA face sheets, patient billing records, and Medicare cost reports will be inadequate for determining appropriate prices for DRG categories.

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