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. (Slovsky 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 between costs and resources of producing the services. A substantial divergence between charge 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-reimburseing 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-reimbursement 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 patient. 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 opera-
tions 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 Patients¹ | 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                            | 81.6 (6.8)             | 212.0 (10.1) | —                                |
| in ICU                                               |                        |              |                                  |
| **Charges Data**                                     |                        |              |                                  |
| (in dollars, 1979 prices)                            |                        |              |                                  |
| **Total Hospital Stay**                              |                        |              |                                  |
| Bed Charges                                          | 8,854                  | 4,333        | 1,900                            |
| Ancillary Charges                                    | 4,537                  | 6,539        | 1,000                            |
| Operating Room                                      | 2,655                  | 3,253        | 700                              |
| Total                                                | 14,256 (1552)          | 14,124 (423) | 3,600                            |
| **ICU Charges**                                      |                        |              |                                  |
| Bed Charges                                          | 1,882                  | 1,666        |                                  |
| Ancillary Charges                                    | 859                    | 2,479        |                                  |
| Total                                                | 2,740                  | 4,178        |                                  |
| **Non-ICU Charges**                                  |                        |              |                                  |
| Bed Charges                                          | 4,972                  | 2,635        |                                  |
| Ancillary Charges                                    | 3,678                  | 4,059        |                                  |
| Operating Room                                      | 2,865                  | 3,253        |                                  |
| Total                                                | 11,515                 | 9,946        |                                  |

¹These 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 for 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
| Department       | Mean Charge | % of Total | Mean Charge | % of Total |
|------------------|-------------|------------|-------------|------------|
| Blood Processing | 80.86$      | 9.4%       | 131.04$     | 5.3%       |
| Central Supply   | 100.12      | 11.7%      | 288.99      | 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    | 40.81       | 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        | 0.2%       |
| 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   |            |

1979 prices

### TABLE 3

| 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      | 0.2%       |
| 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
- **Cost per TISS Point**: $16.00
- **Resource Cost per Case**: $1,305.49

### Medicare Reimbursement

- **Medicare Expense per Day**: $640.80
  - **Average Days**: 2.7
  - **Medicare Expense per Case**: $1,730.32

### Ancillary Costs

- **Ancillary Costs**: $658.98
  - **Total**: $1,848.69

### Notes

1 All prices are 1979 vintage
2 Computed by applying the Medicare cost/charge ratio to the ICU bed charge of $690 per day.
while the brain surgery patients averaged only 7.3 points.

ICU unit costs are estimated with TISS points, using the
reasonable assumption that TISS points in the ICU are lin-
earily related to ICU unit costs ($16 per TISS point).1 ICU
unit resource costs of $3,391 for CABG patients are sub-
stantially 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 ser-
dices. Table 4 reports regressions between ancillary
charges during ICU stay and total TISS points for both pa-
tient groups. The T-ratios and R-squared on these equa-
tions 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

|                | Brain Surgery | CABG |
|----------------|---------------|------|
| Intercept      | -361.1        | 254.7|
|                | (1.97)        | (3.99)|
| Therapeutic Effort | 14.94** | 10.48** |
| (TISS Points)   | (7.35)        | (9.35)|
| R-Squared       | .57           | .62  |
| N              | 43            | 52   |

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, approxi-
mately 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.

**Discussion**

ICUs provide a wide range of services, from monitoring
to the aggressive therapy of severely ill admis-
sions. 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 de-
spite equal ICU bed charges.

Table 1 demonstrates that ICU care is indeed expensive,
twice as expensive as the non-ICU portions of these pa-
tients' 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 ac-
counting for a majority of total ICU charges. More impor-
tantly, 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 sta-
bile Medicare patient from the ward to the ICU increases
revenue by $500 per day with a considerably smaller in-
crease in costs. With this "profit" incentive, it is not surpris-
ing that the number of beds in ICUs nationwide continues
to increase by 3 to 4 percent a year even though total hos-
pital 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 pa-
tients (CABG). The divergence between the daily bed
charge and the resource costs of the labor services re-
ceived by these two groups allows for an interesting com-
parison.

It is quite clear that the Medicare-reimbursed "cost" of a
day of ICU care is substantially larger than the labor re-
sources consumed by ICU brain surgery patients. The op-
posite 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 pa-
tients. This also implies that if monitor patients are com-
monly 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
day or insurers. This suggests that the actual national
costs of CABG surgery are greater than currently esti-

**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 re-
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 expen-
sive 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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