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An analysis of medicine costs of adult patients on a critical care unit ☆

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ABSTRACT

Purpose: To evaluate the costs of medicines used to treat critically ill patients in an intensive care environment and to correlate this with severity of illness and mortality.
Materials and Methods: The study was conducted at a London Teaching Hospital Critical Care Unit. Data were collected for patients who were either discharged or died during September 2011 and stayed longer than 48 hours. The drug cost was related to 150 drugs that were then related to patient's acuity and outcome.
Results: The median daily drug cost of the 85 patients was £26. The highest cost patients in the 85th percentile had significantly higher daily drug costs (median, £403) and higher scores for patient acuity. Patients with hematologic malignancy had a median daily drug cost (£561) more than 20 times higher than those without. A regression analysis based on patient's diversity explained 93% of the variance in the daily drug cost.
Conclusions: Although the median daily drug cost for an adult critically ill patient was low, this cost significantly escalated with patient acuity and hematologic malignancy. A reference method has been designed for an in-depth evaluation of daily drug cost that could be used to compare expenditure in other units.

1. Introduction

The current financial climate, together with the escalation in health care expenditure as a result of advancements in therapeutic modalities, patients' expectations, and an increasingly aging population, imposes a responsibility on health care professionals to use resources efficiently. Therefore, it is essential to optimize the use of resources in expensive specialities such as critical care because they make a significant contribution to the overall hospital costs [1].

The high costs are related to the use of sophisticated equipment, specialized pharmacotherapy, high staff-to-patient ratio, and the need for a highly trained workforce [2]. Published literature suggests that critical care costs are significantly higher than that of a general ward [1], with one study reporting that the daily cost of treating a patient in an intensive care unit (ICU) was up to 5 times higher than for treating patients in a ward setting [3].

Drug expenditure for each patient is a reflection of their chronic condition, severity of illness, and acute treatment. The cost impact of drugs used in critical care on the overall hospital drug expenditure is significant [4]. A study conducted in the United States (2003) reported that ICU drugs accounted for 38% of the overall hospital drug costs. The study also reported that the annual rate of increase of ICU drugs cost was double that of non-ICU drugs (12% vs 6%) [5].

Although this is an important finding, indicating a common trend, it may not reflect typical UK cost because, in the US study, the ICU bed count accounted for one fifth of all hospital beds, higher than typically found in the UK setting. This finding is supported by a more recent study where it was reported that the United States has 7 times as many ICU beds per capita as the United Kingdom [6]. It should also be remembered that although newer, novel drugs are often used in the ICU setting, many of the branded drugs are now available as generics, with a lower associated cost than when first introduced. This is clearly important when determining the impact of earlier studies, such as that undertaken in 2003 by Weber and colleagues [5]. Therefore, a study is required to provide a more contemporary view of drug expenditure in this setting.

Although there is literature focused on an aspect of critical care using a cost-effectiveness analysis model [7] (eg, drotrecogin alfa vs placebo [8] and mechanical ventilation vs nonmechanical ventilation [9]), there is less in the literature focusing on drug expenditure in general. Furthermore, those few published have been reported to have methodological bias [10] because often the use of hospital charges or bills does not reflect the actual expenses [5], or the use of average bed day price assumed constant expenditure over the entire stay [11], or using cost based on diagnosis rather than severity of

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illness was misleading [10]. Any future studies should aim to minimize these types of bias in the design process.

Intensive care units typically produce monthly drug expenditure reports, which are limited by their lack of specificity because they relate to all admissions from a variety of acuity and chronic conditions and a range of length of stay. There has been no previous attempt to relate the cost to patients' diversity and case mix. Consequently, our study profiles patients in terms of severity of illness, speciality, source of admission, mortality, length of stay, drugs used, and the drug cost per patient-day.

The objective of this study was to evaluate the components that influence daily drug cost (DDC) per patient. A method was designed to calculate the DDC for each individual patient, focusing on the drugs that significantly contribute to expenditure. This method could serve as a way to compare drug expenditure between units, both in the United Kingdom and internationally, as well as in the non-ICU setting to compare within and between other specialities.

2. Methods

2.1. Hospital setting and study population

A retrospective evaluation and analysis of drug cost per patient-day within a 35-bed general adult critical care unit at a London teaching hospital housing medical admissions, transfers from other hospitals, and general surgical patients (but not postoperative cardiac or neurologic patients) was performed.

The monthly trend in cost per bed day throughout 2011 was reviewed to identify any variance. September appeared to be a typical month and was selected for more in-depth analysis. The sample included patients who were either discharged or died in September 2011.

Patients with a length of stay of 48 hours or less were excluded because it was agreed that patients staying in the unit for short periods were typically admitted for postanesthetic care. It was considered that patients with short-stay recovery would have diluted the data, making it less representative of the critically ill. An earlier study showed that postanesthetic care patients represented 34% of the low-cost group [12]. Those discharged from and readmitted to the unit during the study month were included in the final analysis [5].

2.2. Cost composition and selection of drugs

Because this study focused on drug costs alone, only the data relating to the hospital acquisition cost, plus value added tax, at 20%, were included in the analysis. Consequently, the cost of any reconstitution fluids, equipment, or labor used in the process of reconstituting and administering the medicines were not captured because these were not easily quantifiable and considered beyond the remit of this study.

Because collecting drug use on an individual patient basis is time-consuming, limiting the numbers included in the analysis, a streamlined method was devised to maximize the number of patients evaluated. The Pharmacy Information Management System, Proprietary System (London), reported that 475 drugs (medicines, immunoglobulin, hemofiltration fluid, parenteral nutrition, and intravenous fluids) were used within the ICU during the study month. Of these 475 drugs, 150 accounted for 97% of the total expenditure, as determined by an examination of the cumulative expenditure data. These 150 drugs were categorized into therapeutic classes and used as the basis to determine drug use and cost in our study population.

2.3. Data collection

The daily drug use per patient was manually extracted from the computerized ICU information system (qs GE Medical, GE Healthcare, Anapolis, MD) by viewing retrospective administration records. Each patient-day was reviewed against the list of the 150 drugs. A spreadsheet was used to enter the unit cost of each drug within its therapeutic class for the corresponding day of stay.

The unit cost for each drug was calculated by dividing pack price by size to determine cost per tablet, capsule, infusion bag or injection or where vials and ampoules were used, and the number required to administer the dose. The cost of any oral liquids administered was based on the dose volume rather than the whole bottle. Inhaler cost was taken as that for the whole pack because the device could not be reused by another patient. The list did not include any topical creams or eye drops because these were in the low cost (3%) and thus excluded from the data collection.

2.4. Measurement of acute illness morbidity and outcome

Data routinely recorded by the unit to reflect both morbidity and mortality were collected to represent the patients' health acuity at admission, during their stay, and on discharge. These reflect the mandatory requirement under the Critical Care Minimum Dataset used by the National Health Service for remuneration. Thus, the Critical Care Minimum Dataset is a useful indicator of workload in ICUs within the United Kingdom [13].

On admission, the Acute Physiology and Chronic Health Evaluation II (APACHE II) score was used to reflect acuity because it has been shown to be a good predictor of outcome and to significantly correlate with overall resource use for the entire ICU stay [14,15].

During the patients' stay, factors known to influence expenditure were recorded, including organ system supports and levels of care. Assessment of changes in organ function plays a role in describing the magnitude of a patient's acute illness. Therefore, the type and number of organ supported reflect resource use and, in turn, the extent of the patient's morbidity. Organ support was described in 2 ways. The first was based on the use of mechanical ventilation during the stay (respiratory support). The second was a cardiovascular-renal index. This index was readily available because it could be determined from the database of drug usage itself and was based on an aggregate established from both cardiovascular and renal organ support.

Level of care (LoC) classifies patients based on their needs using definitions provided by the UK Department of Health. Level 2 corresponds to patients requiring more detailed observation and intervention or have a single-organ support ("high dependency" care), and level 3 describes those requiring mechanical ventilation and also where there is a multiorgan support ("intensive" care). The unit has combined level 2 and 3 beds, and patients often fluctuate between the 2 LoCs during their stay, so it is not possible to provide a definitive number within each level for the study month. Consequently, to overcome this problem, patients were allocated to an overall LoC based on a simple frequency calculation (aggregate) and on their length of stay. In addition, any patients who deteriorated during their stay, that is, move up from level 2 to 3, were identified for further analysis, as it was hypothesized that such patients could add to the overall costs, whereas the outcome of ICU stay was based on patients' mortality.

2.5. Data analysis and presentation

Descriptive statistics were used to summarize patients' characteristics and costs. Data were expressed as median and interquartile range (IQR), whereas categorical data were presented as number and percentage.

Average drug cost per day was calculated for each patient as the total cost of stay divided by the length of stay. This was referred to as the *DDC* for each patient. The trend in the DDC was presented using the percentage cost per day ([total day cost/total cost of stay] $\times$ 100).

Because DDC was not normally distributed, nonparametric statistical tests were used. Comparison between groups was carried out by Mann-Whitney (2 groups) and Kruskal-Wallis tests (>2 groups). Spearman correlation (r values) coefficient was used to