A Comparison of Costs Between Medical and Surgical Patients in an Academic Pediatric Intensive Care Unit

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ABSTRACT

Objective: To estimate the impact of patient type on costs incurred during a pediatric intensive care unit (PICU) hospitalization.

Patients and Methods: Retrospective cohort study at an academic PICU located in the United States that examined 850 patients admitted to the PICU from January 1 to December 31, 2009. Forty-eight patients were excluded due to lack of financial data. Primary service was defined by the attending physician of record. Outcome measures were total and daily pediatric intensive care costs (2009 US dollars).

Results: Of 802 patients in the sample, there were 361 medical and 441 surgical patients. Comparing medical to surgical patients, severity of illness as defined by Pediatric Risk of Mortality (PRISM) III scores was 4.53 vs 2.08 ($P < 0.001$), length of stay was 7.37 vs 5.00 days ($P < 0.001$), total pediatric intensive care hospital costs were $34,786 vs $30,598 ($P < 0.001$), and mean daily pediatric intensive care hospital costs were $3985 vs $6616 ($P < 0.001$).

Conclusions: Medical patients had higher severity of illness and length of stay resulting in higher total pediatric intensive care costs when compared to surgical patients. Interestingly, when accounting the length of stay, surgical patients had higher daily pediatric intensive care costs despite lower severity of illness.

INTRODUCTION

Per capita national health expenditure in the United States has grown at an annual rate of 4.5% from 1965 to 2010, with total health care expenditure reaching $2.7 trillion in 2011 or 17.9% of gross domestic product.[1,2] In 2005, over 13% of hospital costs within the United States were attributed to critical care medicine.[3] Given the high proportion of the rapidly growing US health care expenditure attributed to critical illness, understanding the impact of patient type on resource utilization and costs within the pediatric intensive care setting may have policy implications in the current climate of cost control.

Preliminary studies have shown that health care costs and resource utilization vary based on the types of patients.[4] However, a thorough exploration of existing literature regarding hospital costs segmented by patient type revealed a gap in the research. Specifically, there have been no studies examining the difference between medical vs surgical patients within the pediatric intensive care setting. Our study aimed to address this gap.

METHODS

Population

The study site was a 21-bed university-based closed pediatric intensive care unit (PICU) within a 61-bed children's hospital attached to a 500-bed adult hospital in the Midwest. Data was collected on all patients admitted to the PICU (including direct admissions, transfers, and postoperative admissions) between January 1, 2009 and December 31, 2009. Patients admitted before January 1, 2009 but hospitalized past January 1, 2009 were excluded. Patients admitted before December 31, 2009 but hospitalized past December 31, 2009 were included. A critical care team consisting of a pediatric critical care attending physician, pediatric critical care fellows, pediatric residents, nurses, respiratory therapists, and pharmacy staff cared for all patients. A subset of patients also received care from consultants across various pediatric medical and surgical specialties. Patients can be admitted under a surgical attending physician if the reason for admission was surgical in nature. Approval was obtained from the University of Wisconsin Institutional Review Board prior to data collection.

Exclusions

The study panel was cross-referenced with the financial database from hospital decision support. Forty-eight patients with incomplete financial data were excluded. The data set was unclear as

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to why financial data were unavailable. One possibility was that those excluded represent patients who were physically in the PICU but not cared for by the pediatric intensive care team. No other exclusion criteria were applied.

Clinical and Demographic Data

A pediatric critical care division administrator collected patient data daily for all patients in the PICU. Data specific to our study included the age of the patient on admission to the PICU, gender, length of stay within the PICU (based on date of admission to the intensive care unit and date of transfer or discharge from the intensive care unit), discharge disposition (survival with discharge from hospital, transfer from the PICU, or death), admission service to the PICU (medical vs surgical based on primary attending physician of record), and Pediatric Risk of Mortality (PRISM) III score captured 24 hours after admission to the PICU.

PRISM III scoring is a validated mortality risk score based on physiologic status.[5,6] PRISM III scores were captured within the first 24 hours of admission and used physiologic and laboratory factors in predicting mortality. This scoring system has been used nationally and internationally for both quality and cost research.[7-9]

Financial Data

Patient-level data were obtained from the hospital decision support system that identified costs during the PICU hospitalization. PICU hospitalization was defined as having a pediatric critical care provider as part of the care team. Thus, patients under intermediate care status with pediatric critical care physician involvement were included in the study. In comparison, costs incurred during the hospitalization not specific to the PICU were excluded. For instance, supplies used during the intensive care stay were included, whereas similar supplies used during the hospitalization on the pediatric ward were excluded.

Costs were compiled as a combination of direct and indirect costs. Direct costs were those related to direct patient care, such as medications and central line kits. Indirect costs were those used to support patient care not specific to direct patient care, such as building maintenance and administrative costs.

Statistical Analysis

Medical vs surgical patient types were identified based on primary attending physician of record. Descriptive statistics of mean and 95% confidence intervals were determined for age, gender, mortality, length of stay, PRISM III scores, and hospital costs. All costs were in 2009 US dollars. Mean values were used for determination of statistical significance. Due to the nonparametric characteristic of the dependent variables, Mann-Whitney tests were used to identify *P*-value for interval variables. Similarly, chi-square tests were used to identify *P*-values for categorical variables. Statistical significance was set at $P < 0.05$. Statistical analyses were conducted using STATA/IC 12.1 (StataCorp LP, College Station, Texas).

Table 1. Included Patients vs Excluded Patients

	Included	Excluded	*P*-value
No. of Patients	**802**	**48**	
PRISM III Score (95% CI)	3.18 (2.82-3.54)	0.94 (0.45-1.42)	<0.001
Age, years (95% CI)	8.02 (7.58-8.46)	8.22 (6.46-9.98)	0.70
Gender, % female (95% CI)	47.4% (43.9%-50.8%)	47.9% (33.3%-62.6%)	0.94
Length of stay, days (95% CI)	6.06 (5.31-6.81)	1.50 (1.23-1.77)	<0.001
Mortality, % (95% CI)	1.9% (0.9%-2.8%)	0.0% (0.0%-0.0%)	<0.001
Primary service medical, % (95% CI)	45.01% (41.56%-48.46%)	60.42% (46.07%-74.77%)	0.04

Abbreviation: PRISM, pediatric risk of mortality; CI, confidence interval

RESULTS

Our study population included a total of 850 patients with 802 (94.4%) patients included in the study and 48 (5.6%) patients excluded due to having incomplete financial data (Table 1). Excluded population was similar in age (8.22 to 8.02 years, $P = 0.70$) and gender (47.9%, vs 47.4% females, $P = 0.94$) when compared to the included population. However, length of stay (1.50 vs 6.06 days, $P < 0.001$), mortality (0.0% vs 1.9% $P < 0.001$), and severity score (PRISM III Score of 0.94 vs 3.18, $P < 0.001$) were all lower in the excluded population. Patients with incomplete critical care financial data may represent those who were physically in the PICU, but not cared for by the pediatric intensive care team, and therefore they did not incur critical care costs.

Three hundred sixty-one (45%) patients were identified as primarily medical and 441 (55%) patients were identified as primarily surgical (Table 2). Mean age for medical vs surgical patients was 7.21 vs 8.69 years of age ($P < 0.001$). Mean distribution for gender for medical vs surgical patients was 49% vs 46% female ($P = 0.21$). In examining severity of illness using PRISM III scores, we found medical patients with higher mean severities on admission vs surgical patients (4.53 vs 2.08, $P < 0.001$) with mortality rates higher in medical patients but statistically comparable (2.5% vs 1.4%, $P = 0.27$). Mean length of stay was higher in medical vs surgical patients (7.37 vs 5.00, $P < 0.001$). Total hospital costs for the pediatric intensive care portion were higher in medical patients ($34,786 vs $30,598, $P < 0.001$). In comparison, daily hospital costs for the pediatric

Table 2. Demographics and Resource Utilization Comparing Medical vs Surgical Inpatients

	All Patients	Medical Patients	Surgical Patients	*P*-value
No. of Patients	**802**	**361**	**441**	
Age, years (Mean, 95% CI)	8.02 (7.58-8.46)	7.21 (6.55-7.86)	8.69 (8.10-9.27)	< 0.001
Gender, % female (Mean, 95% CI)	47.4% (43.9%-50.8%)	49.0% (43.8%-54.2%)	46.0% (41.4%-50.7%)	0.21
Length of stay, days (Mean, 95% CI)	6.06 (5.31-6.81)	7.37 (5.93-8.81)	5.00 (4.33-5.66)	0.05
PRISM III Score (Mean, 95% CI)	3.18 (2.82-3.54)	4.53 (3.92-5.14)	2.08 (1.68-2.49)	< 0.001
Mortality, % (Mean, 95% CI)	1.9% (0.9%-2.8%)	2.5% (0.9%-4.1%)	1.4% (0.3%-2.4%)	0.27
Total PICU costs, 2009 (Mean, 95% CI)	$32,483 ($28,006-$36,961)	$34,786 ($26,701-$42,872)	$30,598 ($25,803-$35,366)	< 0.001
Daily PICU costs, 2009 (Mean, 95% CI)	$5432 ($5122-$5741)	$3985 ($3663-$4307)	$6616 ($6146-$7087)	< 0.001

Abbreviation: PRISM, Pediatric risk of mortality; PICU, pediatric intensive care unit; CI, confidence interval

intensive care portion were lower in medical patients ($3985 vs $6616, $P < 0.001$) (Table 2).

DISCUSSION

We assessed the differences in costs during the pediatric intensive care portion of hospitalization for medical and surgical patients. We discovered that medical patients had longer average lengths of stay by greater than 2 days. These longer lengths of stay were associated with an expected higher PRISM III score.[10] Interestingly, we found that medical patients had 12% higher total costs ($34,786 to $30,598, $P < 0.001$) but 66% lower mean daily costs during their PICU hospitalization ($3985 vs $6616, $P < 0.001$).

These findings suggest 2 possible conclusions. First, higher total costs of care for medical patients as compared to surgical patients can be attributed to the impact of length of stay as opposed to severity of illness. Second, when holding length of stay constant, the lower severity surgical patients may have consumed more costs per day (based on averages of daily costs) as compared to the higher severity medical patients. However, this data set was only able to describe costs and unable to characterize the specific resource use. In other words, costs are related to the values assigned to the equipment and individuals and not necessarily the amount of resource utilized. A surgical tool may be used in patients with low severity of illness, but be assigned a high cost due to the price of the equipment as compared to a low cost central line kit used on a more severe medical patient. This level of distinction was unclear through our database.

Our extensive literature review revealed no prior studies characterizing the difference in costs between medical vs surgical patients in pediatric intensive care units. Moreover, there were no studies examining this topic within an academic pediatric intensive care unit setting. Thus, our study took the first step to fill this gap in the literature.

We contend that understanding the difference in costs of care based on patients' service types can help policymakers and health care providers allocate the limited health care dollars more efficiently given a certain patient mix. This added efficiency might help address the rising health care spending within the United States.

Moreover, the length of stay findings of this study, when combined with understanding of a hospital's patient mix, may help a hospital to define the resource need to care for that population. Although specific resource use was not characterized by this data set, varying lengths of stay can indicate differences in use of resources such as nursing and rooming. Thus, this study may have supply chain and operational efficiency impacts. If more surgical patients are seen at a hospital, then adjustments can be made to inventory in order to respond to high turnover, short-term consumption of resources.

Future studies may expand on these findings by specifically characterizing health care resource use. Possibility comparisons can be made in examining full-time employee (FTE) time required for patient care, whether it be physicians, nurses, or therapists. Moreover, distinct resource comparisons, such as medications and equipment, also can be made. Given existing health care financial and resource constraints, insights to our consumption can have significant policy impacts.

There are several limitations of the study, including being a single institution study, lack of assessment of other clinical variables, and the use of an administrative data set. Moreover, this study uses the raw PRISM III score for severity of illness. Although this score has been validated for the pediatric intensive care population, the authors know of no study validating the scale specific to surgical vs medical patients. Thus, the scale may not be applicable when comparing the 2 types of patient populations.

CONCLUSION

Understanding the varying levels of costs by service can have policy implications by clarifying health care spending patterns. We found that for those admitted to the PICU, medical patients differed from surgical patients in the severity of illness, length of

stay, and cost of care. This study was an initial step in exploring the effect of patient mix on the potential to improve efficiency in health care finances. Future steps may include identifying specific use of resources to assess the relationship between service type and resource utilization.

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