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Research Article

Admission source and mortality in a pediatric intensive care unit

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Abstract

Background and Aims: Studies carried out in different countries have shown that source of patient admission in Intensive Care Units (ICUs) is associated to death. Patients admitted from wards show a greater ICU mortality. The aim of the present study was to investigate the association between admission source and outcome in a Pediatric Intensive Care Unit (PICU). **Materials and Methods:** We studied all PICU admissions that took place between January 2002 and December 2005 in a tertiary hospital in Brazil. The major outcome studied was death while in the PICU. The independent variable analyzed was admission source, defined either as pediatric emergency room (PER), wards, operating room (OR) of the same hospital or other sources. **Results:** A total of 1823 admissions were studied. The overall expected mortality based on the Pediatric Index of Mortality 2 was 6.5% and the observed mortality was 10.3%. In adjusted analysis, the mortality was doubled in patients admitted from wards when compared with the PER patients. **Conclusions:** Observed mortality rates were higher in patients admitted from wards within the same hospital, even after adjustment.

Keywords: Child, intensive care units, mortality, patient admission, pediatric

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Introduction

Studies carried out in different countries show that source of patient admission is associated with death in Intensive Care Units (ICU). Patients transferred from wards within the same hospital show a greater ICU mortality when compared with those coming from other sources.[1-4] A dose–response effect has also been identified in adults, with longer stays in other wards being directly associated with higher mortality.[5] It is unknown if this is true for pediatric patients, because diagnostic casemix and morbidity are different in Pediatric Intensive Care Units (PICUs).

Other studies have shown that the conditions of both adult and pediatric patients transferred from other hospitals are generally worse than those of patients coming from within the same hospital.[6,7] Among the transferred patients, those transferred from other ICUs show a higher mortality than the remainder.[8] A study on pediatric trauma patients also found that those patients admitted directly from the scene had a lower injury severity, higher Glasgow Coma Scale and lower adjusted mortality rate compared with those admitted from interhospital transfer.[9]

We were unable to locate studies carried out in Brazil investigating the association between source of admission and mortality in the PICU. The primary aim of the present study was to evaluate the effect of admission source on mortality in a tertiary PICU in the city of Porto Alegre, Southern Brazil. We also evaluated the performance of the Pediatric Index of Mortality (PIM2) as a predictor of death risk.

Materials and Methods

Study type and population studied

We carried out a cross-sectional, retrospective study including all recorded admissions of patients up to 18

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years of age admitted to the PICU of the *Hospital de Clinicas de Porto Alegre* (HCPA) between January 2002 and December 2005. This hospital is a reference center for genetics, gastroenterology, hematology, oncology and pneumology, the latter being the most frequent source of admissions. However, this hospital does not perform pediatric heart surgery nor does it provide care to polytraumatized children.

Information on each patient during stay in the PICU is routinely entered into a digital database, from which they were later extracted. Patients admitted more than once were considered as independent admissions.

Variables investigated

The outcome studied was death while in the PICU. Independent variables investigated included sex, age in months at time of admission, expected probability of mortality (calculated using the PIM2,[10] which ranges from 0 to 100%, grouped for analysis into five categories [<1%, 1–4.9%, 5–14.9%, 15–29.9% and ≥30%]), length of stay in the PICU in days and source of admission. The latter was categorized as HCPA pediatric emergency room (PER), wards or operating room (OR); other facilities (other hospitals, health centers or walk-in facilities); and home. Presence of comorbidities at the time of admission was recorded. We defined as a comorbidity any preexisting diagnosis or clinical condition irrespective of its relationship to the event leading to PICU admission. PIM2 has been previously validated and calibrated at our institution.[11]

It is important to mention that the decision to shift patients from wards to the PICU in our hospital is of the attending physician or of the resident caring for the patient during the day shift. At night, the decision is of the pediatrician on duty at the wards. At the emergency room, this decision is of the pediatrician on duty.

Data analysis

Data analysis was carried out using SPSS 13.0 software. We initially examined sample distribution and mortality rates according to independent variables. We calculated the overall expected mortality based on PIM2 as well as the observed mortality. The association between exposures and death was determined using the chi-squared test for categorical variables and the linear trend test for ordinal variables. Differences between means were analyzed by ANOVA. The strength of the association between exposure and outcome was analyzed using logistic regression. Owing to the small number of patients originating from their own homes (n = 12), this group was excluded from analyses of odds ratios. For similar reasons, age was recoded, merging the categories ≤1 month (n = 109) and 2–11 months. For the adjusted analysis of effect of admission source on mortality, we included in the model all variables with the exception of presence of comorbidity, given that a large number of diagnoses were already included in the PIM2.

Power of the study

The sample size investigated led to 95% power to detect relative risks equal to or greater than 2.0 with a 5% significance level, given the observed ratio of exposed (wards) to unexposed of 3:7 and the cumulative incidence of death among the unexposed of 7.4%.

Ethics committee approval

The study protocol was approved by the Research Ethics Committee of the *Hospital de Clínicas de Porto Alegre*, and all researchers signed a term of commitment to maintaining the confidentiality of patient information.

Results

We analyzed 1823 admissions, of which 188 ended in death. The overall expected mortality according to PIM2 was 6.5% and the observed mortality was 10.3%.

Table 1 describes the sample according to independent variables. The majority of the patients (55.2%) was male. Mortality was similar for both sexes – 9.1% among boys and 11.8% among girls (P = 0.06).

Regarding subject age, 683 patients (37.5%) were aged 2–11 months. The majority of the subjects (78.3%) was under 5 years of age. Mortality increased significantly with increasing age. The mortality rate was 0.9%, 8.9%, 12.3%, 10.4% and 17%, respectively, for children aged ≤1, 2–11, 12–59, 60–143 and ≥144 months (P < 0.001).

PIM2 was under 5% for most (72%) of the patients [Table 1]. As would be expected, the mortality increased linearly with PIM2. Cumulative mortality in the period was 2.1% among children with PIM2 <1% and 53.1% among those with PIM2 ≥30% at admission (P < 0.001).

Over one-third of the patients (34.7%) were transferred from other facilities. Most other admissions originated from the hospital itself – 29.8% from wards, 21.5% from PER and 13.5% from OR. Only 0.7% of the patients were admitted directly from home. Mortality was highest among wards (17.4%) and lowest among OR (2.4%) patients.

Presence of comorbidity was found among 55.2%

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of the cases. Mortality was two-times higher among children with comorbidities (13.9%) when compared with those without comorbidities (6.4%) ($P < 0.001$). The most common comorbidities were neurologic (11.5%), oncologic/hematologic (11.4%), genetic (7.3%), gastroenterological/hepatic (6.3%), respiratory (6%) and multiple (5.8%). Mortality rates were different according to the organ or system involved: immunologic (29.7%), oncologic/hematologic (17.4%), gastroenterological/hepatic (16.7%), neurologic (13.4%), multiple (12.7%), nephrologic (12.5%), genetic (12%), cardiocirculatory (9.1%) and respiratory (7.3%).

Prevalence of comorbidity varied between different admission sources ($P < 0.001$). Over 80% of the children originating from the OR showed some form of comorbidity. Prevalence of comorbidity among children originating from other services, PER or wards was 25.6%, 42.1% and 76.5%, respectively. The prevalence of specific comorbidities varied when patients admitted from wards were compared with those admitted from all other sources. Wards patients had more oncologic/hematologic (22.6% vs. 6.7%), neurologic (15.9 vs. 6.6%), multiple (8.9% vs. 4.5%), gastroenterological/hepatic (9.2% vs. 5%) and genetic (9.6% vs. 6.3%) comorbidities.

The nonsurgical indications for ICU admission were respiratory dysfunction (43.9%), hemodynamic instability (19.5%), central nervous system disorders (17.3%), other causes (8.2%), mixed respiratory and hemodynamic dysfunction (5.3%), postcardiac arrest (2.9%), hepatic dysfunction (1.9%) and renal dysfunction (1.1%). The indication for ICU admission for wards patients differed from clinical patients from other sources. The following indications were more common in wards patients: hemodynamic instability (25.2% vs. 16.9%), postcardiac arrest (4.5% vs. 2.2%) and hepatic dysfunction (2.4% vs. 1.7%).

Regarding length of stay in PICU, the majority of the patients (52.9%) were admitted for up to 3 days. Mortality among patients staying for less than 1 day was 17.2%, versus 8.3% and 9.5% among those staying for 1–3 and 3.1–7 days, respectively. Mortality among those who stayed for over 7 days was 11.9%. Thirty-four (1.9%) patients died within 24 h of admission. Median (IQ25-75) length of stay regardless of outcome was 3 (1–7) days. Close to half the children (42%) stayed in the PICU for 1–3 days.

Length of stay in the PICU was significantly associated with source of admission ($P = 0.005$). Median (IQ25-75) length of stay was 4 (2–8) days among children transferred from other facilities, compared with 2 (1–5) for OR, 3 (1–7) for wards and 3 (1–7) for PER.

Figure 1 shows that the severity of cases from different sources was similar, with the exception of patients from OR, among which there was a greater proportion of less-severe cases (58% with PIM2 <1%). Adjusted analysis revealed a direct association between mortality and PIM2. Figure 2 shows that the difference in mortality between patients originating from the wards when compared with other patients was mostly due to less-severe cases (PIM2 between 1% and 29.9%).

Table 1: Sample characteristics and mortality among the studied population

Variables	N (%)*	% mortality rate	P
Sex	1815		0.06
Male	1001 (55.2)	9.1	
Female	814 (44.8)	11.8	
Age (months)	1821		<0.001
≤1	109 (6.0)	0.9	
2-11	683 (37.5)	8.9	
12-59	634 (34.8)	12.3	
60-143	289 (15.9)	10.4	
≥144	106 (5.8)	17.0	
PIM2 (%)	1721		<0.001
<1	614 (35.7)	2.1	
1-4.9	625 (36.3)	6.6	
5-14.9	287 (16.7)	17.8	
15-29.9	97 (5.6)	25.8	
≥30	98 (5.4)	53.1	
Source	1818		<0.001
PER	390 (21.5)	7.2	
OR	245 (13.5)	2.4	
Other facilities	630 (34.7)	9.4	
Wards	541 (29.8)	17.4	
Home	12 (0.7)	8.3	

PIM2: Pediatric Index of Mortality 2; PER: Pediatric emergency room; OR: Operating room; other facilities: walk-in facilities, health centers or emergency rooms, wards or PICUs of other hospitals. *Different denominators occur because of data loss

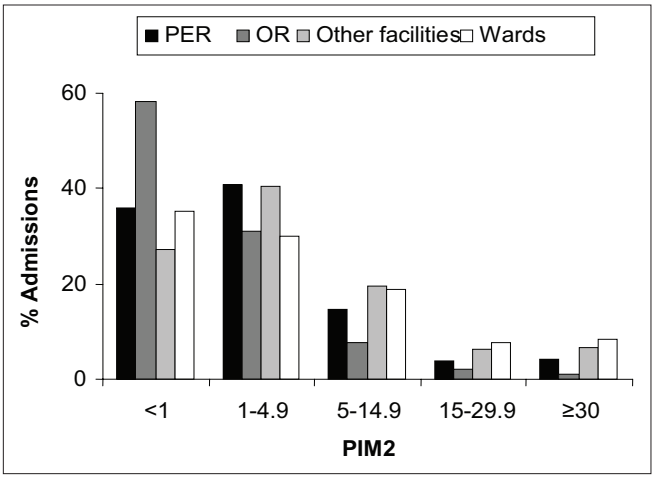

Figure 1: Distribution of cases according to risk of death at admission (PIM2) and source of patients. PIM2: Pediatric Index of Mortality 2; PER: pediatric emergency room; OR: operating room; other facilities: walk-in facilities, health centers or emergency rooms, wards or PICUs of other hospitals

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Table 2 presents the crude and adjusted (for sex, age, PIM2 and length of stay in PICU) odds ratios for the effect of admission source on PICU mortality. In crude analysis, patients originating from wards were roughly three-times more likely to die (2.72; 95% CI 1.74–4.24) than those coming from PER, defined as the reference category. In the adjusted analysis, all variables with the exception of sex were shown to be associated with risk of death. The odds ratio for patients transferred from wards remained significant, at over two-times the odds of patients originating from PER (2.12; 95% CI 1.29–3.49; $P < 0.001$).

Discussion

The present study has shown admission source to be an important factor associated with fatal outcome in the PICU of a tertiary hospital. The odds ratio for death was two-times higher in patients originating from the hospital's wards when compared with PER patients, even after adjustment for sex, age, length of stay and risk of death at the time of admission. This finding is consistent with those of other studies conducted in other countries, which included both children and adults.[1-4]

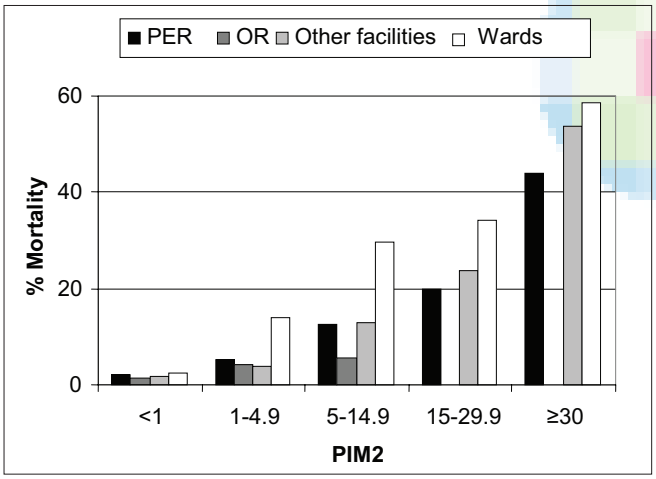

Figure 2: Mortality rate according to risk of death at admission (PIM2) and source of patients. PIM2: Pediatric Index of Mortality 2; PER: Pediatric emergency room; OR: Operating room; other facilities: walk-in facilities, health centers or emergency rooms, wards or PICUs of other hospitals

Table 2: Crude and adjusted odds ratios for death according to source of admission

	Crude OR	95% CI	Adjusted OR	95% CI	P
Source					
PER	1.00		1.00		<0.001
OR	0.32	0.13-0.80	0.49	0.19-1.25	
Other facilities	1.34	0.84-2.14	0.99	0.59-1.66	
Wards	2.72	1.74-4.24	2.12	1.29-3.49	

OR: Odds ratio; CI: Confidence interval; PIM2: Pediatric Index of Mortality 2; PER: Pediatric emergency room; OR: Operating room; other facilities: walk-in facilities, health centers or emergency rooms, wards or PICUs of other hospitals.

The reasons behind the association between admission source and fatal outcome are still unclear. In the present study, we found that mortality was approximately two-times higher among patients with comorbidities, regardless of source of admission. Prevalence of comorbidities was similar among patients originating from wards when compared with those transferred from OR; however, mortality was significantly higher among the former. The underlying hypothesis is that, unlike OR patients, certain patients transferred from wards would also have severe comorbidities refractory to treatment and/or acute diseases with poor response to routine treatment.[2] Furthermore, these patients are also more likely to have had prior prolonged stays, favoring colonization and infection by resistant microorganisms, which, in patients weakened by comorbidities and prolonged hospital admission, could result in unfavorable progression. A previous study with adult subjects,[5] which may provide support for such a hypothesis, detected a direct correlation between length of stay in the wards prior to ICU admission and mortality. However, it is clear that adult and pediatric subjects have different diagnostic casemix and morbidity.

In addition, indication for PICU admission depends on the clinical judgment of the hospital team. It is possible that the team responsible for the patients in the wards may eventually delay shifting them to the PICU while they are clinically deteriorating. This potential delay in transferring a patient to intensive care in more severe scenarios may be related to worse prognosis. In our study, we have identified that hemodynamic instability and postcardiac arrest care were more common indications for admission in wards patients when compared with all other nonsurgical patients. This may possibly reflect a delay on indication for admission on ICU or yet that those specific patients did not respond well to the usual therapeutics that would have been taken at any location.

On the other hand, we cannot exclude the hypothesis that patients admitted to the wards with complex diseases and poor prognosis may have been admitted to the PICU, where they subsequently died. Compared with all other patients, those admitted from wards had more oncologic/hematologic, neurologic, multiple, gastroenterological/hepatic and genetic comorbidities. It is evident, however, that in certain cases, the clinical evolution and prognosis of acute intercurrences among patients with complex chronic diseases cannot be defined prior to the adoption of advanced life support measures. Another factor that may be associated with PICU admission of patients with poor prognosis is the difficulty medical teams may have in adopting only

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palliative, rather than curative, therapy.[12] On the other hand, studies have shown that, in the United States, children with chronic diseases increasingly are dying at home.[13] This finding indicates a trend toward the adoption of palliative therapy in that country in cases of poor prognosis.

As described by Odetola *et al*.,[1] the present study also found that cases originating from the OR were less severe and showed more favorable outcomes. Risk of death among OR patients, calculated using PIM2, was below 1% in over half of the present sample. This finding indicates that PICU referral among these patients may be exaggerated, which may be relevant to both hospital expenditure and PICU bed occupancy. Patients transferred from OR were less severe in spite of the higher proportion of patients with comorbidities among this group (81.6%).

The overall expected mortality according to PIM2 was approximately 37% lower than the observed mortality. Regardless of any differences in case management between the PICU investigated in the present study and those in which the PIM2 score was developed, it is possible that the performance of this score may be different in our settings. A study of adults admitted to ICUs[2] compared observed and expected mortality – calculated using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score – among patients of different origins. The observed mortality in this study was equal to the expected mortality among patients coming from the emergency room. However, mortality among patients originating from clinical wards, intermediate care units and other hospitals was significantly higher than expected, indicating, according to the authors, that APACHE II was incapable of accurately measuring the severity of all patients admitted to the ICU.

Another study, carried out in a PICU in India,[14] compared the performance of three scores, one of which was PIM2. In this study, the observed mortality was also higher than expected based on the severity scores. The authors suggest that patients admitted to that PICU may have differed from those used for developing the scores. The authors also suggest the existence of differences in care quality. Moreover, cases admitted to that PICU may have been more severe, and available resources more limited. Such findings underscore the importance of evaluating the validity and reliability of diagnostic tools before they can be employed in settings that differ from those where the scores were created.[15]

The present study has a number of limitations. First, it was based on secondary data, extracted from a database. Second, this database did not contain information on length of stay in the wards prior to PICU admission. Furthermore, the database does not discriminate, among patients transferred from other facilities, between cases originating from different sources (health centers, walk-in facilities or clinical wards or PICUs of other hospitals), which prevents an adequate analysis of the effect each of these sources may have had on length of stay and mortality among PICU patients.

Conclusion

We conclude based on the present study that, as reported in other countries, in this Brazilian PICU, there is an association between fatal outcome and admission source, with patients originating from the same hospital's clinical wards being at greater risk. We suggest that profile of patients according to source should be considered when comparing the performances of different PICUs.

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