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Authors

Geneslaw, Andrew S
Jia, Haomiao
Lucas, Adam R
et al.

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Pediatric intermediate care and pediatric intensive care units: PICU metrics and an analysis of patients that use both

Dr. Andrew S. Geneslaw, MD[a], **Haomiao Jia, PhD**[b], **Adam R. Lucas, PhD**[c], **Michael S. D. Agus, MD**[d], and **Dr. Jeffrey D. Edwards, MD, MA, MAS**[a]

[a]Division of Pediatric Critical Care Medicine, Department of Pediatrics, Columbia University College of Physicians and Surgeons, Morgan Stanley Children's Hospital, 3959 Broadway, New York, NY 10032, United States of America

[b]School of Nursing, Columbia University, 617 West 168th Street, New York, NY 10032, United States of America

[c]Department of Statistics, University of California, 367 Evans Hall, Berkeley, CA 94720, United States of America

[d]Division of Medicine Critical Care, Boston Children's Hospital and Harvard Medical School, 300 Longwood Avenue, Boston, MA 02115, United States of America

Abstract

Purpose—To examine how intermediate care units (IMCUs) are used in relation to pediatric intensive care units (PICUs), characterize PICU patients that utilize IMCUs, and estimate the impact of IMCUs on PICU metrics.

Materials & Methods—Retrospective study of PICU patients discharged from 108 hospitals from 2009–2011. Patients admitted from or discharged to IMCUs were characterized. We explored the relationships between having an IMCU and several PICU metrics: physical length-of-stay (LOS), medical LOS, discharge wait time, admission severity of illness, unplanned PICU admissions from wards, and early PICU readmissions.

Results—Thirty-three percent of sites had an IMCU. After adjusting for known confounders, there was no association between having an IMCU and PICU LOS, mean severity of illness of PICU patients admitted from general wards, or proportion of PICU readmissions or unplanned ward admissions. At sites with an IMCU, patients waited 3.1 hours longer for transfer from the PICU once medically cleared ($p<0.001$).

Corresponding author: Andrew Geneslaw, Division of Pediatric Critical Care Medicine, Morgan Stanley Children's Hospital, 3959 Broadway, New York, NY 10032. ang2021@nyp.org; phone: 212-305-8458; fax: 212-342-2293.

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This study was performed at Columbia University.

Conclusions—There was no association between having an IMCU and most measures of PICU efficiency. At hospitals with an IMCU, patients spent more time in the PICU once they were cleared for discharge. Other ways that IMCUs might affect PICU efficiency or particular patient populations should be investigated.

Keywords

intensive care units; pediatric; child; length of stay; hospitals; pediatric; patient acuity; patient discharge

Introduction

Intermediate care units (IMCUs) are used to provide more intensive monitoring and care to non-critically ill patients who are too sick or complex to be cared for on general wards. This includes "step-down" care for patients recovering from critical illness, "step-up" care for patients acutely worsening but not yet critically ill, and post-operative care[1,2]. IMCUs have been used at some pediatric hospitals for decades[3], and guidelines for admission to and discharge from pediatric IMCUs have been proposed[4]. Advocates of intermediate care argue that IMCUs can safely improve critical care efficiency and patient flow[5–10]. However, few studies have described the ways pediatric IMCUs are used and whether they affect critical care efficiency.

Using a multi-institutional clinical PICU database that specified whether or not each participating site had a separate IMCU, we sought to characterize the PICU patients admitted from and discharged to IMCUs, and to examine the impact of IMCUs on several PICU metrics. We hypothesized that having a separate IMCU would be associated with better metrics of PICU efficiency.

Patients and Methods

Data Source and IMCUs

We performed a retrospective, cross-sectional study of patients discharged between 2009 and 2011 from 108 North American PICUs that participated in the Virtual Pediatric Systems, LLC (VPS, Los Angeles, CA). VPS only contains data from PICU encounters. Participating sites self-disclosed whether they had a separate IMCU. VPS imposed no particular definition of an IMCU, and sites were not asked to specify what intermediate care meant for them. VPS grouped IMCUs and telemetry units together as an option for location of patient admission and discharge. In order to differentiate between IMCUs and telemetry units, we assumed that non-cardiac patients were admitted from or discharged to IMCUs and that cardiac patients were admitted from or discharged to telemetry units. Cardiac patients were defined as those whose primary or secondary diagnoses were congenital or acquired diseases of the heart (Supplemental Table 1).

We compared the number of licensed pediatric beds, number of licensed PICU beds, and presence of a pediatric critical care medicine (PCCM) fellowship program at sites with and without IMCUs using Pearson’s chi-square test.

IMCU Utilization and Patient Characterization

In order to examine how IMCUs are utilized in relation to PICUs and how this varied across sites, we reported the median proportion and range of proportions of non-cardiac PICU patients admitted from and discharged to IMCUs.

We examined the characteristics of PICU patients admitted from or discharged to IMCUs. When patients had multiple PICU admissions, each was reported as a separate encounter. Patient characteristics included age, gender, number of complex chronic conditions (CCC), and baseline and discharge Pediatric Overall Performance Characteristic (POPC) and Pediatric Cerebral Performance Characteristic (PCPC)[11]. CCCs were defined using Feudtner's definition[12] and identified among VPS diagnosis codes developed in Edwards et al[13]. CCCs were presented as an ordinal variable (none, 1, 2, or ≥3 CCC). Admission characteristics included Paediatric Index of Mortality 2 (PIM2) risk of mortality[14]; whether the admission was perioperative, due to trauma, or unplanned; whether the admission or discharge occurred during a night or weekend; the season of admission; and physical and medical length of stay (LOS) in the PICU.

To examine the reasons for PICU patients to require transfer from or to an IMCU, we described the admitting PICU diagnoses of patients admitted from and discharged to IMCUs. Diagnoses were categorized as respiratory, infectious, neurologic, cardiac, hemodynamic instability, endocrine, hematologic, gastrointestinal, renal, and oncologic.

Data are presented as proportions and 95% confidence intervals (CI), medians and interquartile ranges (IQR), or means and standard deviations (SD). For the above characteristics, we compared PICU patients admitted from or discharged to IMCUs with patients admitted from or discharged to general wards using Pearson's chi-square test, Mann-Whitney U-test, or unpaired two-tailed t-test. As a sensitivity analysis of our assumption that cardiac patients were admitted from or discharged to telemetry units (as opposed to IMCUs), we also described these PICU cardiac patients in each of the above analyses.

Impact of IMCUs

To explore the possible contributions of IMCUs to PICU efficiency, we analyzed PICU LOS, the acuity of patients admitted to the PICU from general wards, early readmissions to the PICU, and unplanned PICU admissions from general wards.

Three PICU LOS metrics were studied — physical LOS (time from PICU admission to PICU discharge), medical LOS (time from PICU admission until documentation of medical readiness for PICU discharge), and wait time between these two measures. Medical discharge was determined by the date/time of a medical discharge order written by a physician or alternatively by the date/time of medical discharge readiness reflected in a progress note. If such dates/times of medical discharge were not available, these data were left blank. Unadjusted comparisons were made between sites with and without an IMCU of each median LOS using Mann-Whitney U tests. The adjusted effects of having an IMCU on the physical and medical LOS were evaluated with Cox proportional hazard models and were reported as hazard ratios (HR). The effect of having an IMCU on wait time was estimated using a multiple linear model. Not all sites reported medical LOS, so models of medical LOS and wait time were fitted using only the subgroup of observations that reported these data. Patients who died in the PICU were excluded from LOS analyses. We hypothesized that having a separate IMCU would be associated with shorter PICU LOS and PICU discharge wait times.

Patients with CCCs are frequently cared for in PICUs. IMCUs may be more capable than general wards of caring for them, and thus allow for more efficient PICU throughput. In order to estimate the impact of IMCUs on this patient subgroup, LOS analyses were repeated using only PICU patients with CCCs.

Similarly, patients dependent on chronic ventilation via tracheostomy are not managed on the general wards in many institutions. Thus, LOS analyses were repeated using only this patient sub-group, for the subgroup of sites with data that allowed identification of patients using chronic ventilation via tracheostomy[15]. For this analysis, sites with IMCUs that accepted/transferred PICU patients on chronic ventilation were compared to sites with an IMCU that did not accept such patients combined with sites without an IMCU.

Next, we used linear mixed modeling to examine the unit-level effect of having an IMCU on an institution’s mean acuity of patients admitted to the PICU from general wards. PIM2 scores were used as a surrogate for acuity. We hypothesized that mean PIM2 scores would be higher in PICUs at hospitals with an IMCU compared to PICUs in hospitals without one, reasoning that IMCUs would divert the lowest acuity patients from the PICU. We repeated this analysis for only the subset of PICU patients admitted from IMCUs with the lowest quartile PIM2 scores, as potentially the most appropriate group for IMCU care.

Given that having an IMCU may alter early PICU readmission rates by providing an additional safe location to care for patients, we used linear regression to examine the association between having a separate IMCU and the rate of PICU readmissions within 48 hours.

Finally, we used linear regression to examine the association of having an IMCU with the proportion of unplanned transfers to the PICU from the general wards at each hospital. We hypothesized that, of patients admitted to the PICU from the wards, fewer admissions would have been unplanned at hospitals with an IMCU compared to hospitals without one. We reasoned that an IMCU would admit some of the lower-acuity ward patients who were acutely worsening, thus allowing the PICU to admit proportionally more planned patients.

For each model, we controlled for the patient and institutional characteristics described above, plus each unit's average daily census by quarter. Because hospitals vary in their practice patterns, admissions from the same unit were clustered as a random effect. Due to non-linearity, age and PIM2 were transformed into cubic splines. We adjusted for PICU admission origin and discharge destination, and whether the patient was admitted from or discharged to a different hospital. Race, POPC, and PCPC were not included in the models as not all sites reported this information. Patient discharge location, timing, and season were not included in the model of mean acuity of patients admitted from the wards because these variables were unknown at the time of PICU admission. In the models of unplanned admissions from the wards and PICU readmissions within 48 hours, we controlled for institutional characteristics as well as the mean PIM2 score at each institution. Covariates for the final models were included if their P-value was <0.2 and they were not collinear with other variables. In all applicable models, age and PIM2 score were retained as important clinical covariates.

When information was available for only a subgroup of the patients, we noted this in the text or tables. Statistical significance was determined for all comparisons using a P-value of 0.05. Stata 14 (StataCorp LP, College Station, TX) was used for all statistical analyses. Columbia University Medical Center's Independent Review Board approved this study.

Results

From 2009 to 2011, 108 PICUs submitted data on 222,837 admissions and 181,622 unique patients. Thirty-six sites (33%) had an IMCU. PICU mortality was 2.5%.

Institutional characteristics

Sites with an IMCU had more pediatric beds, more PICU beds, and were more likely to have an accredited PCCM fellowship program, but these differences were not statistically significant (Supplemental Table 2). Sites with an IMCU varied in their utilization patterns, but overall more PICU patients were discharged to an IMCU than were admitted from one (10.4% (IQR 1.9–25.5%) versus 3.3% (IQR 0.5–6.1%)). (Table 1).

Patient characteristics and diagnoses

The characteristics of PICU patients based upon admission location are presented in Table 2. Compared to PICU patients admitted from general wards, patients admitted from an IMCU were younger, had more CCCs, and had higher risk of PICU mortality. More patients admitted from IMCUs had worse baseline POPC and PCPC scores. The unadjusted physical PICU LOS was longer for patients admitted from an IMCU than for those admitted from a general ward (3.3 versus 2.5 days, p<0.001).

Patients' admitting PICU diagnoses grouped by organ dysfunction are presented in Table3. The most common diagnoses were respiratory, infectious, and neurologic diseases. Patients admitted from an IMCU compared to a general ward were nearly twice as likely to be admitted for hemodynamic instability.

Table 4 presents the characteristics of PICU patients stratified by whether they were discharged to an IMCU or a general ward. Patients discharged to an IMCU were younger, had more CCCs, and had higher PICU risk of mortality. The unadjusted physical LOS was longer for patients discharged to an IMCU compared to a general ward (2.1 versus 1.6 days, p<0.001).

Patients' admitting PICU diagnoses grouped by discharge location are presented in Table 5. Patients discharged to an IMCU rather than a general ward more commonly had a respiratory, infectious, or hemodynamic admitting diagnosis.

Impact of IMCUs

The unadjusted median PICU physical LOS was 1.8 days in sites with an IMCU versus 1.7 days in sites without an IMCU (p<0.001). Medical LOS was reported for 208,468 discharges (94%), and the median was 1.52 versus 1.49 days in sites with versus without an IMCU (p=0.013). The median wait time between physical and medical LOS was 2.8 hours at sites with an IMCU compared to 2.2 hours at sites without one (p<0.001). After controlling for age, PICU mortality risk, number of licensed pediatric and PICU beds, PCCM fellowship program, admission from or discharge to another hospital, number of CCCs, whether the hospitalization was unplanned, perioperative, or due to trauma, patient origin and discharge locations, season of admission, average daily PICU census by quarter, and admission or discharge during a night or weekend, the presence of an IMCU was not associated with either physical or medical LOS (HR_{IMCU} for physical LOS=1.00 [CI 0.93–1.07] and HR_{IMCU} for medical LOS=1.04 [CI 0.96– 1.12]). Having an IMCU was associated with a 3.1 hour (CI 1.2–4.9 hours, p<0.001) longer wait time until transfer from the PICU, adjusting for the same covariates.

When examining only patients with CCCs, the presence of an IMCU was not associated with either physical or medical LOS after controlling for the same covariates (HR_{IMCU} for physical LOS=1.04 [CI 0.97–1.12], HR_{IMCU} for medical LOS=1.07 [CI 0.99–1.16]). Having an IMCU was associated with a 3.9 hour (CI 1.5–6.3, p<0.001) longer wait time until transfer from the PICU.

Of the 69 sites that reported the requisite data, 23 had an IMCU that cared for patients dependent on chronic ventilation via tracheostomy. After controlling for the same covariates as above, the presence of an IMCU that accepted patients requiring chronic ventilation was not associated with physical or medical LOS (HR_{IMCU} for physical LOS=1.03 [CI 0.94–1.12], HR_{IMCU} for medical LOS=1.08 [CI=0.99–1.19]). Having an IMCU was associated with a 3.5 hour (CI 1.2–5.7, p=0.003) longer wait time until transfer from the PICU for patients using chronic ventilation.

After controlling for the same covariates, having an IMCU was not associated with mean PIM2 score in PICU patients admitted from the wards (p=0.23), nor was it associated in the subset of patients with the lowest quartile PIM2 scores (p=0.18). Having an IMCU was not associated with the rate of PICU readmissions within 48 hours (p=0.54). Finally, having an IMCU was not associated with the proportion of unplanned admissions from the wards (p=0.82).

Discussion

In some pediatric hospitals, IMCUs have been used for decades to provide more intensive care and monitoring than is usually provided on general wards. IMCUs have been hypothesized to improve hospital efficiency without compromising quality of patient care, such as by providing step-up or step-down locations, thus allowing for more advantageous use of PICU resources. We examined how PICU patients utilized IMCUs and how IMCUs may impact several PICU metrics across a large sample of hospitals. We found that $\frac{1}{3}$ of sites had an IMCU, and that more PICU patients were discharged to IMCUs than admitted from them. PICU patients admitted from or discharged to IMCUs tended to be younger and sicker than those admitted from or discharged to general wards. Among these hospitals, having a separate IMCU had no impact on PICU LOS, mean severity of illness of PICU patients admitted from the general wards, rate of early PICU readmissions, or the proportion of unplanned PICU admissions from the general wards. This lack of impact remained even when examining specific sub-populations whom we speculated might have benefited more from intermediate care. We did find a slightly longer wait time until PICU discharge in hospitals with an IMCU.

Very few prior studies have addressed how pediatric IMCUs are used or their impact on PICUs. A recent survey suggested that pediatric hospitals vary widely in their use of IMCUs, but that having an IMCU provides an alternative location to the PICU to care for patients needing intense monitoring and nursing care[16]. PICU patients discharged to IMCUs have tended to be "long-stay" patients[17] and had greater odds of early unplanned PICU readmission[18]. Adult studies of the impact of IMCUs on ICU metrics have provided mixed results regarding ICU and hospital LOS[19,20], illness severity in the ICU[5,7,8], and non-emergency ICU admissions[20].

To our knowledge, our study is the first to examine the relationship between IMCUs and PICUs across a large sample of pediatric hospitals. After adjusting for several patient and institutional factors, most of our studied PICU efficiency metrics were unaffected by the presence of an IMCU. One interpretation of this finding is that hospital administrators should be wary of creating a separate IMCU with the goal of decreasing PICU LOS, ensuring that the PICU is used for more severely ill patients, or decreasing the number of unplanned PICU admissions/readmissions. However, having an IMCU might be advantageous for other PICU, hospital, or patient-centered metrics that we could not investigate, such as costs, throughput for other hospital locations, or patient/family comfort/ satisfaction. In addition, IMCUs may experience the same "demand-elastic phenomenon" that has been suggested for ICUs—creating more critical care beds also "creates" patients to fill those beds[21]. A perpetually full IMCU might not positively impact PICU metrics, though it may allow the institution a greater ability to care for increased numbers of sick, complex patients.

Our study has several limitations. First, we could not examine each institution's definition of IMCU[1,4], and variability across sites likely exists. Some types of IMCUs might be more advantageous than others in general, or for particular institutions or populations. Second, PICU metrics are certainly multifactorial. Institutional facilities and practices undoubtedly vary, and we were limited by the patient and institutional confounders we could control for in our analyses. Hospitals with IMCUs are likely different from hospitals without them, and we only were able to adjust for a few of these differences within our multivariable models. Confounding from the idiosyncrasies of individual hospitals was somewhat mitigated by clustering data at the unit level to incorporate within-unit correlations. Third, this study focused entirely upon the potential benefits of an IMCU to PICU efficiency, and did not evaluate the potential myriad benefits to the pediatric ward or hospital in general. Fourth, treating all patients with a primary cardiac diagnosis admitted from or discharged to an "IMCU/telemetry unit" as having moved from/to a telemetry unit may have introduced misclassification error, because some cardiac patients might have been admitted from or discharged to IMCUs. Finally, while large, our sample of institutions may not be representative of North American pediatric hospitals in general—a recent survey reported a lower proportion (17%) of hospitals with an IMCU[16].

Conclusions

Contrary to our hypotheses, having a separate IMCU was not associated with earlier PICU discharge, higher mean illness severity of PICU patients admitted from general wards, the rate of early PICU readmissions, or the proportion of unplanned admissions from general wards. Further research is necessary to discern if and how IMCUs might positively impact efficiency for PICUs, pediatric wards, and hospitals as a whole. Future studies should investigate other hospital and patient-centered metrics, as well as particular subtypes of IMCUs and patient groups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CCC	Complex Chronic Condition
CI	Confidence Interval
HR	Hazard Ratio
ICU	Intensive Care Unit
IMCU	Intermediate Care Unit
IQR	Interquartile Range
LOS	Length of Stay
PCPC	Pediatric Cerebral Performance Category
PCCM	Pediatric Critical Care Medicine
PICU	Pediatric Intensive Care Unit
PIM2	Paediatric Index of Mortality 2
POPC	Pediatric Overall Performance Category
SD	Standard Deviation

VPS Virtual Pediatric Systems, LLC

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Highlights

- Study of PICU patients at hospitals with versus without intermediate care units
- PICU efficiency metrics similar at both types of hospitals
- Wait time to PICU discharge longer at hospitals with intermediate care units

Table 1

Proportion of PICU patients admitted from and discharged to intermediate care units and telemetry units

Unit and patient population	Median %	IQR	Range
Admission location			
Non-cardiac patient admitted from IMCU	3.3	0.5 – 6.1	0 – 10.0
Non-cardiac patient with CCC admitted from IMCU	2.1	0.4 – 4.2	0 – 5.7
Cardiac patient admitted from telemetry unit	0.5	0.1 – 1.6	0 – 7.5
Discharge location			
Non-cardiac patient discharged to IMCU	10.4	1.9 – 25.5	0 – 54.8
Non-cardiac patient with CCC discharged to IMCU	6.9	1.2 – 15.0	0 – 24.7
Cardiac patient discharged to telemetry unit	2.4	0.4 – 16.8	0 – 82.6

CCC, complex chronic condition; IMCU, intermediate care unit; IQR, interquartile range; PICU, pediatric intensive care unit

For each site, the percentage of encounters in which the specified patient type was admitted from or discharged to the specified unit type was calculated. The denominator is the total number of encounters at a given site. The median value, IQR, and range of these percentages are shown. Only the 36 sites with an IMCU are included.

Table 2

Demographic and clinical characteristics of PICU patients by admission location

Characteristic, %, (95% CI)	Non-cardiac, admitted from IMCU n=3,561	Admitted from wards n=29,439	Cardiac, admitted from telemetry unit n=1,000
Age, months, median (IQR) **	36.3 (7.3 – 132.6)	48.2 (9.1 – 144.8)	8.4 (2.7 – 75.0)
Male Gender	55.1 (53.4 – 56.7)	55.8 (55.2 – 56.4)	57.8 (54.7 – 60.9)
Race [a]			
Caucasian	46.7 (44.8 – 48.6)	47.9 (47.3 – 48.6)	53.0 (49.5 – 56.4)
African American **	24.6 (23.0 – 26.3)	20.4 (19.9 – 21.0)	22.0 (19.2 – 24.9)
Hispanic	20.2 (18.6 – 21.7)	20.1 (19.6 – 20.6)	15.8 (13.3 – 18.4)
Asian/Indian/Pacific Islander **	1.5 (1.0 – 1.9)	2.9 (2.7 – 3.1)	1.2 (0.5 – 2.0)
Other/Mixed *	4.8 (4.0 – 5.7)	6.2 (5.9 – 6.5)	3.7 (2.4 – 5.0)
Unspecified	2.2 (1.6 – 2.8)	2.5 (2.3 – 2.7)	4.2 (2.8 – 5.6)
CCC			
no CCC **	33.5 (32.0 – 35.1)	40.1 (39.5 – 40.6)	14.4 (12.2 – 16.6)
1 CCC	22.5 (21.1 – 23.9)	21.5 (21.1 – 22.0)	21.4 (18.9 – 23.9)
2 CCC	15.4 (14.3 – 16.6)	15.7 (15.3 – 16.2)	18.1 (15.7 – 20.5)
3 or more CCC **	28.5 (27.0 – 30.0)	22.7 (22.2 – 23.1)	46.1 (43.0 – 49.2)
Baseline POPC [b]			
Normal **	21.1 (17.8 – 24.4)	39.6 (38.6 – 40.7)	12.6 (6.7 – 18.4)
Mild disability **	32.2 (28.4 – 36.1)	23.4 (22.4 – 24.3)	44.1 (35.3 – 52.8)
Moderate disability **	18.9 (15.7 – 22.1)	25.7 (24.8 – 26.6)	35.4 (27.0 – 43.9)
Severe disability **	26.8 (23.2 – 30.4)	11.2 (10.5 – 11.9)	7.9 (3.1 – 12.6)
Coma or vegetative state **	1.0 (0.2 – 1.9)	0.1 (0.1 – 0.2)	0.0 (0.0 – 0.0)
Discharge POPC [b]			
Normal **	17.2 (14.1 – 20.2)	32.5 (31.5 – 33.5)	7.9 (3.1 – 12.6)
Mild disability	30.2 (26.5 – 33.9)	27.0 (26.1 – 28.0)	45.7 (36.9 – 54.5)
Moderate disability **	18.5 (15.4 – 21.7)	25.2 (24.3 – 26.2)	33.9 (25.5 – 42.2)
Severe disability **	25.7 (22.2 – 29.3)	10.8 (10.1 – 11.5)	5.5 (1.5 – 9.5)
Coma or vegetative state *	0.7 (0.0 – 1.4)	0.2 (0.1 – 0.3)	0.8 (−0.8 – 2.3)
Brain death **	7.7 (5.5 – 9.9)	4.2 (3.8 – 4.6)	6.3 (2.0 – 10.6)
Baseline PCPC [b]			
Normal **	53.3 (49.3 – 57.4)	66.4 (65.4 – 67.4)	66.9 (58.6 – 75.2)
Mild disability *	17.5 (14.4 – 20.6)	13.3 (12.6 – 14.1)	19.7 (12.7 – 26.7)
Moderate disability	10.6 (8.1 – 13.1)	11.5 (10.8 – 12.2)	9.4 (4.3 – 14.6)
Severe disability **	17.5 (14.4 – 20.6)	8.7 (8.1 – 9.3)	3.9 (0.5 – 7.4)

Characteristic, %, (95% CI)	Non-cardiac, admitted from IMCU n=3,561	Admitted from wards n=29,439	Cardiac, admitted from telemetry unit n=1,000
Coma or vegetative state **	1.0 (0.2 – 1.9)	0.1 (0.1 – 0.2)	0.0 (0.0 – 0.0)
Discharge PCPC [b]			
Normal **	49.4 (45.3 – 53.5)	62.6 (61.5 – 63.6)	62.2 (53.7 – 70.8)
Mild disability	14.8 (11.9 – 17.6)	13.5 (12.8 – 14.2)	18.1 (11.3 – 24.9)
Moderate disability	10.1 (7.7 – 12.6)	11.1 (10.5 – 11.8)	10.2 (4.9 – 15.6)
Severe disability **	17.3 (14.2 – 20.4)	8.4 (7.8 – 9.0)	2.4 (0 – 5.0)
Coma or vegetative state *	0.7 (0.0 – 1.4)	0.2 (0.1 – 0.3)	0.8 (−0.8 – 2.3)
Brain death **	7.7 (5.5 – 9.9)	4.2 (3.8 – 4.6)	6.3 (2.0 – 10.6)
PIM2, risk of mortality, % (SD) **	3.4 (7.0)	2.5 (6.4)	4.7 (9.5)
Perioperative **	11.2 (10.2 – 12.2)	8.4 (8.1 – 8.7)	9.6 (7.8 – 11.4)
Trauma *	2.7 (2.2 – 3.2)	1.9 (1.8 – 2.1)	0.5 (0.1 – 0.9)
Unplanned admission	96.3 (95.7 – 97.0)	96.8 (96.6 – 97.0)	94.7 (93.3 – 96.1)
Admitted at night	57.0 (55.3 – 58.6)	57.8 (57.2 – 58.3)	51.2 (48.1 – 54.3)
Admitted on weekend	30.7 (29.2 – 32.2)	30.1 (29.5 – 30.6)	32.1 (29.2 – 35.0)
Admission season			
Summer	21.9 (20.5 – 23.3)	21.4 (21.0 – 21.9)	26.8 (24.1 – 29.5)
Fall	25.6 (24.1 – 27.0)	25.8 (25.3 – 26.3)	25.9 (23.2 – 28.6)
Winter	26.7 (25.2 – 28.1)	27.8 (27.3 – 28.3)	24.0 (21.3 – 26.7)
Spring	25.9 (24.4 – 27.3)	24.9 (24.4 – 25.4)	23.3 (20.7 – 25.9)
Physical LOS, days, median (IQR) **, [c]	3.3 (1.6 – 7.4)	2.5 (1.2 – 5.3)	4.1 (1.9 – 9.1)
Medical LOS, days, median (IQR) **, [c, d]	3.0 (1.4 – 6.9)	2.3 (1.1 – 5.1)	3.9 (1.7 – 9.0)

CCC, complex chronic condition; CI, confidence interval; IQR, interquartile range; LOS, length of stay; PIM2, Pediatric Index of Mortality 2 Scale % Risk of Mortality; POPC, Pediatric Overall performance Category; PCPC, Pediatric Cerebral Performance Category.

* p<0.05 when comparing admissions from IMCUs (column 1) to admissions from wards (column 2) using Mann-Whitney U test, two-tailed unpaired t-test, or Pearson's chi-square test.

** p<0.001, as above.

[a] Based on 162,264 admissions (73%) that reported race.

[b] Based on 62,545 admissions (28%) that reported POPC and PCPC.

[c] Based on 217,190 admissions (97%) that survived.

[d] Based on 208,468 admissions (94%) that reported medical LOS.

Table 3

Admitting diagnoses of PICU patients by admission location

Admitting Diagnosis, % (95% CI)	Non- cardiac, admitted from IMCU n=3,561	Admitted from wards n=29,439	Cardiac, admitted from telemetry unit n=1,000
Respiratory **	32.8 (31.3–34.4)	27.2 (26.7 – 27.7)	14.6 (12.4 – 16.8)
Infection **	26.3 (24.9–27.8)	29.1 (28.5 – 29.6)	6.0 (4.5 – 7.5)
Neurologic	12.1 (11.1–13.2)	11.5 (11.1 – 11.8)	3.3 (2.2 – 4.4)
Cardiac	9.4 (8.5–10.4)	9.0 (8.7 – 9.4)	72.8 (70.0 – 75.6)
Hemodynamic Instability **	7.1 (6.3–7.9)	3.9 (3.7 – 4.1)	4.6 (3.3 – 5.9)
Endocrine	0.9 (0.6–1.2)	0.9 (0.8 – 1.0)	0.0 (0.0 – 0.0)
Hematologic **	1.7 (1.3–2.1)	2.9 (2.8 – 3.1)	0.1 (0 – 0.3)
Gastrointestinal	4.6 (3.9–5.3)	4.5 (4.3 – 4.8)	1.5 (0.7 – 2.3)
Renal	1.7 (1.3–2.1)	1.8 (1.6 – 1.9)	0.2 (0 – 0.5)
Oncologic **	2.7 (2.2–3.3)	4.5 (4.2 – 4.7)	0.1 (0 – 0.3)

CI, confidence interval; IMCU, intermediate care unit

** p<0.001 when comparing admissions from IMCU (column 1) to admissions from wards (column 2) using Pearson's chi-square test.

Table 4

Demographic and clinical characteristics of PICU patients by discharge location

Characteristic, %, (95% CI)	Non-cardiac, discharged to IMCU n=15,386	Discharged to wards n=137,506	Cardiac, discharged to telemetry unit n=10,158
Age, months, median (IQR) **	51.0 (10.0 – 145.2)	63.3 (14.1 – 154.6)	9.5 (2.6 – 67.9)
Male Gender	56.3 (55.5 – 57.1)	55.5 (55.3 – 55.8)	55.8 (54.8 – 56.7)
Race [a]			
Caucasian **	48.7 (47.8 – 49.7)	51.3 (51.0 – 51.6)	60.2 (59.1 – 61.3)
African American **	21.7 (20.9 – 22.4)	19.7 (19.5 – 20.0)	16.1 (15.3 – 17.0)
Hispanic **	20.1 (19.4 – 20.9)	17.9 (17.7 – 18.1)	11.9 (11.2 – 12.7)
Asian/Indian/Pacific Islander **	1.8 (1.6 – 2.1)	2.7 (2.6 – 2.8)	2.0 (1.7 – 2.3)
Other/Mixed	5.3 (4.9 – 5.7)	5.7 (5.6 – 5.9)	4.7 (4.3 – 5.2)
Unspecified *	2.3 (2.0 – 2.6)	2.7 (2.6 – 2.8)	5.0 (4.5 – 5.5)
CCC			
no CCC **	43.6 (42.8 – 44.4)	47.1 (46.9 – 47.4)	20.5 (19.7 – 21.3)
1 CCC **	22.3 (21.7 – 23.0)	24.1 (23.9 – 24.4)	30.2 (29.3 – 31.1)
2 CCCs	14.2 (13.6 – 14.7)	14.1 (13.9 – 14.3)	20.0 (19.2 – 20.8)
3 or more CCCs **	19.9 (19.3 – 20.5)	14.6 (14.4 – 14.8)	29.3 (28.4 – 30.2)
Baseline POPC [b]			
Normal **	37.2 (35.5 – 38.8)	48.0 (47.5 – 48.4)	13.1 (11.0 – 15.2)
Mild disability **	28.7 (27.2 – 30.2)	25.6 (25.1 – 26.0)	52.4 (49.3 – 55.5)
Moderate disability *	18.1 (16.8 – 19.4)	19.8 (19.4 – 20.2)	31.7 (28.8 – 34.6)
Severe disability **	15.7 (14.5 – 16.9)	6.6 (6.4 – 6.9)	2.7 (1.7 – 3.8)
Coma or vegetative state **	0.4 (0.2 – 0.6)	0.1 (0.0 – 0.1)	0.1 (−0.1 – 0.3)
Discharge POPC [b]			
Normal **	27.4 (25.9 – 28.8)	38.8 (38.3 – 39.3)	10.8 (8.9 – 12.8)
Mild disability *	35.1 (33.5 – 36.7)	32.8 (32.4 – 33.3)	56.2 (53.1 – 59.3)
Moderate disability	20.1 (18.7 – 21.4)	21.3 (20.9 – 21.7)	29.8 (26.9 – 32.6)
Severe disability **	16.8 (15.5 – 18.0)	7.0 (6.7 – 7.2)	3.1 (2.0 – 4.2)
Coma or vegetative state **	0.7 (0.4 – 1.0)	0.1 (0.1 – 0.2)	0.1 (−0.1 – 0.3)
Baseline PCPC [b]			
Normal **	65.2 (63.7 – 66.8)	75.3 (74.9 – 75.7)	76.8 (74.2 – 79.5)
Mild disability *	12.6 (11.5 – 13.7)	11.2 (10.9 – 11.5)	14.3 (12.1 – 16.5)
Moderate disability *	9.9 (8.9 – 10.8)	8.3 (8.0 – 8.5)	7.6 (5.9 – 9.2)
Severe disability **	12.0 (10.9 – 13.1)	5.2 (4.9 – 5.4)	1.2 (0.5 – 1.9)
Coma or vegetative state **	0.4 (0.2 – 0.6)	0.1 (0.0 – 0.1)	0.1 (−0.1 – 0.3)

Characteristic, %, (95% CI)	Non-cardiac, discharged to IMCU n=15,386	Discharged to wards n=137,506	Cardiac, discharged to telemetry unit n=10,158
Discharge PCPC [b]			
Normal **	63.7 (62.1 – 65.3)	72.7 (72.2 – 73.1)	75.9 (73.2 – 78.6)
Mild disability	12.6 (11.5 – 13.7)	12.9 (12.6 – 13.3)	14.9 (12.7 – 17.1)
Moderate disability *	10.4 (9.4 – 11.4)	8.8 (8.6 – 9.1)	7.8 (6.1 – 9.5)
Severe disability **	12.7 (11.6 – 13.8)	5.4 (5.2 – 5.7)	1.3 (0.6 – 2.0)
Coma or vegetative state **	0.7 (0.4 – 1.0)	0.1 (0.1 – 0.2)	0.1 (−0.1 – 0.3)
PIM2, risk of mortality, % (SD) **	3.0 (7.2)	1.9 (4.6)	4.6 (8.2)
Perioperative **	30.4 (29.6 – 31.1)	34.6 (34.4 – 34.9)	64.3 (63.4 – 65.3)
Trauma **	10.2 (9.7 – 10.7)	8.8 (8.7 – 9.0)	0.5 (0.4 – 0.7)
Unplanned admission **	81.2 (80.6 – 81.8)	73.7 (73.5 – 73.9)	33.7 (32.8 – 34.7)
Discharged at night **	41.1 (40.3 – 41.9)	32.4 (32.2 – 32.7)	22.7 (21.9 – 23.6)
Discharged on weekend *	24.7 (24.0 – 25.4)	25.5 (25.3 – 25.8)	24.4 (23.5 – 25.2)
Admission season			
Summer **	22.9 (22.2 – 23.6)	24.5 (24.3 – 24.7)	28.5 (27.6 – 29.4)
Fall **	25.0 (24.3 – 25.7)	26.5 (26.3 – 26.8)	27.8 (26.9 – 28.6)
Winter **	26.6 (25.9 – 27.3)	24.9 (24.6 – 25.1)	21.8 (21.0 – 22.6)
Spring **	25.5 (24.8 – 26.2)	24.1 (23.9 – 24.3)	21.9 (21.1 – 22.7)
Physical LOS, days, median (IQR) **, [c]	2.1 (1.0 – 5.3)	1.6 (0.9 – 3.3)	3.0 (1.5 – 6.9)
Medical LOS, days, median (IQR) **, [c, d]	1.8 (0.8 – 5.0)	1.4 (0.7 – 3.0)	2.8 (1.2 – 6.6)

CCC, complex chronic condition; CI, confidence interval; IQR, interquartile range; LOS, length of stay; PIM2, Pediatric Index of Mortality 2 Scale % Risk of Mortality; POPC, Pediatric Overall performance Category; PCPC, Pediatric Cerebral Performance Category.

* p<0.05 when comparing admissions from IMCU (column 1) to admissions from wards (column 2) using Mann-Whitney U test, two-tailed unpaired t-test, or Pearson's chi-square test.

** p<0.001, as above.

[a] Based on 162,264 admissions (73%) that reported race.

[b] Based on 62,545 admissions (28%) that reported POPC and PCPC.

[c] Based on 217,190 admissions (97%) that survived.

[d] Based on 208,468 admissions (94%) that reported medical LOS.

Table 5

Admitting diagnoses of PICU patients by discharge location

Admitting Diagnosis, % (95% CI)	Non- cardiac, discharged to IMCU n=15,386	Discharged to wards n=137,506	Cardiac, discharged to telemetry unit n=10,158
Respiratory **	23.2 (22.5 – 23.9)	19.4 (19.2 – 19.6)	3.8 (3.4 – 4.1)
Infection **	20.1 (19.5 – 20.8)	16.3 (16.1 – 16.5)	1.9 (1.6 – 2.1)
Neurologic *	15.9 (15.3 – 16.5)	16.6 (16.4 – 16.8)	0.8 (0.6 – 1.0)
Cardiac **	6.8 (6.4 – 7.2)	10.0 (9.8 – 10.2)	91.1 (90.6 – 91.7)
Hemodynamic Instability **	5.0 (4.7 – 5.3)	2.7 (2.6 – 2.8)	1.7 (1.5 – 2.0)
Endocrine **	2.5 (2.2 – 2.7)	5.5 (5.4 – 5.6)	0.0 (−0.0 – 0.0)
Hematologic	1.3 (1.1 – 1.5)	1.4 (1.3 – 1.5)	0.0 (0.0 – 0.1)
Gastrointestinal **	5.1 (4.8 – 5.5)	4.5 (4.4 – 4.6)	0.8 (0.7 – 1.0)
Renal	1.8 (1.6 – 2.0)	1.6 (1.5 – 1.6)	0.1 (0.0 – 0.2)
Oncologic *	5.1 (4.7 – 5.4)	5.5 (5.4 – 5.6)	0.1 (0.1 – 0.2)

CI, confidence interval; IMCU, intermediate care unit.

* $p<0.05$ when comparing discharges to an IMCU (column 1) to discharges to wards (column 2) using Pearson's chi-square test.

** $p<0.001$, as above.