


Adult Admissions to a Canadian PICU during the COVID-19 Pandemic

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Abstract

In response to the burden of coronavirus disease 2019 (COVID-19) and overwhelmed intensive care unit (ICU) resources, some pediatric intensive care units (PICUs) have had to adapt. The purpose of this study was to assess the criticality, scope of diagnosis, and outcomes of an adult cohort admitted to a Canadian PICU. A retrospective chart review was completed on all patients between 17 and 50 years of age admitted to the PICU between June 2020 and December 2021. Admission data included body mass index (BMI), admission sequential organ failure assessment score (SOFA), COVID-19 status, diagnosis, and comorbidities. The duration of ventilatory support, PICU and hospital admission, and mortality and discharge disposition were assessed. Discrete variables were reported as percentages and continuous data as means with standard deviations or medians with interquartile range. Sixty-five adult patients were admitted to the PICU for a total of 437 days, with a mean SOFA score of 6.6 and the overall mortality rate of 4.6%. Six patients were diagnosed with COVID-19 pneumonia, were admitted with a mean SOFA score of 11.8 and a BMI of 38.3 kg/m², and all were discharged to the ward. During the COVID-19 pandemic, pediatric intensivists in a Canadian PICU managed adult patients up to 50 years of age with high criticality and broad-ranging diagnoses with a low mortality rate. PICUs may be a safe critical care decompression option for adult ICUs during future endemics or pandemics.

Keywords

- ▶ adult
- ▶ Canada
- ▶ COVID-19 pandemic
- ▶ critically ill
- ▶ pediatric intensive care unit
- ▶ staffing

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has created intensive care unit (ICU) bed shortages across well-developed health care systems. In response, pediatric intensive care units (PICUs) have had to adapt. Initially, PICUs were viewed as critical care surge beds to be managed by adult intensivists. However, in many jurisdictions, pre-existing shortages of ICU staffing were exposed or expandable staffing pools were limited.¹ Concomitantly, PICU admissions decreased due to lockdown, masking, and social-distancing measures, with only small proportions of children with COVID-19 requiring ventilatory support. As such, some PICUs began to admit and manage adults, as there was a

recognized clinical intersection familiar to both adult and pediatric intensivists.²

Outcomes for this transition of care are important to consider, as significant differences (i.e., respiratory and cardiac conditions, nature and effects of trauma, metabolic pathophysiologies, and cancer types) and anticipated complications differ between the two specialties.³ For COVID-19 respiratory infections only, one Spanish PICU admitted 17 adult patients, ventilated all but one, and experienced no mortalities.⁴ Their most frequent cited comorbidities were asthma, obesity, and hypertension. Thirty adults were admitted to a PICU in Boston, 86% were intubated and only two died (7.1%).⁵ Their cohort was much older (median age of 54

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years), with a median body mass index (BMI) of over 28 kg/m², and common comorbidities including diabetes, hyperlipidemia, and hypertension. In the only propensity-matched study, nine adult patients were admitted to a PICU in New York with a mean age of 49 years and a sequential organ failure assessment (SOFA) score of 4.⁶ Their outcomes were similar to those admitted to an adjacent ICU. England repurposed seven PICUs and provided care for 145 adult patients that were also COVID-19 negative: they reported a 14% mortality rate.⁷ Their cohort had a median age in the late 50s, 14% required continuous renal replacement therapy (CRRT), and 4% were cannulated for extracorporeal membrane oxygenation (ECMO). In these instances, physicians articulated the necessity for PICUs to be a part of future pandemics targeting adult populations, with the proviso of appropriate clinical support, communication, and medico-legal protection.⁴⁻⁷

In the province of Saskatchewan, the PICU at the Jim Pattison Children's Hospital began to admit patients >17 years of age early in the pandemic. The purpose of this study was to assess the clinical criticality and outcomes of these patients so that future care decisions would be informed.

Materials and Methods

This retrospective chart review study was approved by the research ethics board at the University of Saskatchewan (Bio# 3099). Adult patients were identified through the PICU's admission registry. The inclusion criteria include: (1) all patients >17 years of age; (2) admitted to PICU at the Jim Pattison Children's Hospital; and (3) admitted between June 2020 and the end of the Delta variant wave (December 2021). There were no specific exclusion criteria.

Saskatchewan Context

Saskatchewan's PICU is a medical-surgical 12-bed academic unit that provides CRRT, apheresis, veno-venous ECMO, and medical oversight for the provincial interfacility transport team. Early in the pandemic, staffing plans were developed to expand to 18 critical care beds if required. Adult and pediatric ethical triage frameworks were also created^{8,9} to ensure, in part, that a potential adult surge would not infringe upon pediatric access to critical care support. Adult admission criteria to the PICU remained flexible, and in response to the changing provincial ICU demands, eventually involving maternal patients and adults <50 years of age. Initially, patients with single-system disease processes were only eligible, but as comfort developed, admission criterion loosened.

Variables

An electronic chart review was conducted by two pediatric intensivists (T.H. and G.H.). Data were stored in a password-protected Excel file in an institutional cloud. Patient identifiers included age, weight, and sex. Baseline data included BMI, admission SOFA score, COVID-19 status (positive or negative), diagnosis, and most frequent comorbidities. The SOFA score was created to "describe quantitatively and as

objectively as possible the degree of organ dysfunction/failure over time in groups of patients or even individual patients."¹⁰ Patient transfer data included referring health center and distance of transport. Their course in the PICU included requirements for days of conventional mechanical ventilation, noninvasive ventilation, high-flow nasal cannula, and/or CRRT, need for cardiopulmonary resuscitation, and tracheostomy. Outcomes were assessed as the duration of PICU and hospital admission, mortality, and complications.

Statistical Methods

All analyses were done using SPSS Statistics for Windows, version 24. Discrete variables were reported as percentages and continuous data as means with standard deviations or medians with interquartile range.

Results

Between June 19th, 2020 and December 6th, 2021 ($n = 535$ days), 65 adult patients ranging from 17 to 46 years of age were admitted to the PICU (→ **Table 1**). Six were diagnosed with COVID-19 pneumonia and were analyzed separately. Twenty percent ($n = 13$) of patients had significant comorbidities including congenital cardiac physiologies, debilitating seizure disorders, autoimmune diseases, and chronic respiratory, cardiac, renal, endocrine, and hematologic

Table 1 Admitted adult characteristics ($n = 65$)

Age (years) ^a	21.9 (7.5)
Sex (female), n (%)	30 (45.2)
BMI (kg/m ²) ^a	26.0 (7.9)
Diagnosis, n (%)	
a) Mental health	13 (20.0)
b) Polytrauma	8 (12.3)
c) Respiratory (COVID-19)	6 (9.2)
d) Respiratory (non-COVID-19)	7 (10.8)
e) Neurologic	6 (9.2)
f) Post-operating room	7 (10.8)
g) Sepsis	3 (4.6)
h) Others	15 (23.1)
COVID-19 status, n (%)	10 (15.4)
Respiratory COVID-19, $n = 6$	
a) Age (years) ^a	34.3 (10.3)
b) Sex (female), n	3
c) BMI (kg/m ²) ^a	38.3 (13.0)
Referring center, n (%)	
a) Local	59 (90.8)
b) Transported	6 (9.2)
Transport distance (km) ^a	232 (107)

Abbreviations: BMI, body mass index; COVID, coronavirus disease.

^aMean (standard deviation);

Table 2 Course in PICU and outcomes

	Total cohort (n = 65)	COVID-19 pneumonia (n = 6)
Admission SOFA score ^a	6.6 (4.10)	11.8 (4.7)
Maximal ventilatory support, n (%)		6 (100)
a) CMV	42 (64.6)	
b) NIV	5 (7.7)	
c) HFNC	1 (1.5)	
PICU length of stay (days) ^a	6.7 (6.9)	16.5 (8.8)
Disposition, n (%)		6 (100)
a) Home	11 (16.9)	
b) Ward	49 (75.4)	
c) ICU	2 (3.1)	
d) Died	3 (4.6)	

Abbreviations: CMV, conventional mechanical ventilation; HFNC, high-flow nasal cannula; ICU, intensive care units; NIV, noninvasive ventilation; PICU, pediatric intensive care units; SOFA, sequential organ failure assessment.

^aMean (standard deviation).

diseases. Two patients were transferred from the maternal ward.

Their course in PICU is summarized in ►Table 2. No patients required cardiopulmonary resuscitation. A total of 535 days were managed in the PICU, with an overall mortality rate of 4.6%. Specific to the COVID-19 pneumonia group, their mean SOFA score was 11.8 with no mortalities. An elective tracheostomy was performed in one patient, while another required CRRT.

Discussion

During the COVID-19 pandemic, adults who were admitted to a Canadian PICU and managed by pediatric intensivists had high criticality over a wide breadth of diagnoses and low mortality rate. Furthermore, patients with COVID-19 pneumonia were all discharged to the adult ward despite high SOFA scores and BMIs.

SOFA admission scores were used for assessing criticality in adults, as it was the standardized triage tool for Saskatchewan's pandemic ethical framework.⁸ The mean admission SOFA score of 6.6 was consistent with in-hospital mortality rates between 20 and 25% reported from a large European prospective study with septic and nonseptic patients.¹¹ While it is erroneous to equate cohorts from this restricted triage with large multicenter serial admissions, it nevertheless reflects the degree of criticality that was managed. Furthermore, patients were not uniform with their diagnoses, as the breadth expanded with increased comfort and ability of PICU care providers. Nearly 65% required conventional mechanical ventilation but only 20% had respiratory illnesses, and CRRT was utilized on one patient. Injuries from mental health were the most common presentation, but this

accounted for only 20% of admission diagnoses. The others were consistent with common presentations seen in the PICU including polytrauma, respiratory illnesses, and sepsis.

The 4.6% mortality rate is an important metric for future considerations. All three patients perished within 72 hours of admission, following overwhelming neurologic brain injuries. These admissions were all preceded by a devastating mechanism of injury that could account for the clinical exam and neuroimages. As a reference, average mortality rates in the adult ICU range from 8 to 19% in the United States.^{12–14} This is not to insinuate that superior care occurred in the PICU, as lower mortality rates can be largely explained by the much younger cohort (mean 21.9; range 17–46 years) with fewer comorbidities. However, they are similar to the outcomes previously cited^{4–7} and add to the emerging literature that PICUs may be able to provide excellent adult care.

Most surprising were the COVID-19 outcomes. Published mortality rates for adult patients who were critically ill with COVID-19 have ranged between 29.1 and 89.9%.^{15,16} We report a younger cohort of six adults with high BMIs (mean 38.3 kg/m²) and very high SOFA admission scores (mean 11.8). Despite their long PICU admissions and need for elective tracheostomy (*n* = 1) and CRRT (*n* = 1), no mortalities were noted. Of note, adult respiratory consultants were particularly involved with these patients, and electrical impedance tomography and esophageal balloon measurements were utilized to optimize peek end-expiratory pressures.

The purpose of involving Saskatchewan's PICU in the pandemic was to safely assist in load leveling adult critical care resources: 437 adult ICU patient days were spared while not compromising PICU access to pediatric patients. We learned that three critical initial steps needed to occur concurrently, and these mirrored those reported from a Parisian narrative.¹⁷ First, very close communications with adult intensivists and provincial stakeholders were necessary to identify strict triage parameters. This also entailed the creation of an adult and pediatric ethical resource allocation framework^{8,9} ensuring the fair sharing of resources.¹⁷ Second, medico-legal protection and accreditation to include an expanded scope of care was essential. This would require approval from hospital directors, chief medical officers, licensing authorities, and/or legal authorities depending on the jurisdiction. Third, additional nurse education and adult code simulations were supported by adult nursing and physician colleagues. In Paris, pediatric intensivists visited adult ICUs to learn about anticipating difficulties and management issues.¹⁷ Together, these actions created an environment whereby the PICU felt supported—both clinically and operationally. More importantly, it created open lines of communication and trust, where inevitable setbacks or imperfections could be freely and safely discussed.

The limitations of this study were a relatively small case series in a single center. However, the sample size was comparable to those previously published, and the experiences are likely generalizable to high-resourced PICUs that are capable of managing a wide scope of criticality. Finally, the cohort was not matched to patients managed in an adult

ICU, and consequently, comparisons of outcomes could not be elucidated.

Conclusions

During the COVID-19 pandemic, pediatric intensivists in a Canadian PICU managed adult patients up to 50 years of age with high criticality and a broad range of diagnoses. Their mortality rate was 4.6%. This is consistent with an emerging literature that reveals PICUs may be a safe critical care decompression option for adult ICUs during future endemics or pandemics.

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Conflict of Interest

None declared.

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