# Delirium is a Common and Early Finding in Patients in the Pediatric Cardiac Intensive Care Unit

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**Objective** To determine incidence, associated risk factors, and characteristics of delirium in a pediatric cardiac intensive care unit (CICU). Delirium is a frequent and serious complication in adults after cardiac surgery, but there is limited understanding of its impact in children with critical cardiac disease.

**Study design** Single-center prospective observational study of CICU patients ≤21 years old. All were screened for delirium using the Cornell Assessment for Pediatric Delirium each 12-hour shift.

**Results** Ninety-nine patients were included. Incidence of delirium was 57%. Median time to development of delirium was 1 day (95% CI 0, 1 days). Children with delirium were younger (geometric mean age 4 vs 46 months; P < .001), had longer periods of mechanical ventilation (mean 35.9 vs 8.8 hours; P = .002) and had longer cardio-pulmonary bypass times (geometric mean 126 vs 81 minutes; P = .001). Delirious patients had longer length of CICU stay than those without delirium (median 3 (IQR 2, 12.5) vs 1 (IQR1, 2) days; P < .0001). A multivariable generalized linear mixed model showed a significant association between delirium and younger age (OR 0.35 for each additional month, 95% CI 0.19, 0.64), need for mechanical ventilation (OR 4.1, 95% CI 1.7, 9.89), and receipt of benzodiazepines (OR 3.78, 95% CI 1.46, 9.79).

**Conclusions** Delirium is common in patients in the pediatric CICU and is associated with longer length of stay. There may be opportunities for prevention of delirium by targeting modifiable risk factors, such as use of benzodiazepines. (*J Pediatr 2017*;

ntensive care unit (ICU) delirium is a clinical syndrome with acute disturbance in consciousness and cognition that can fluctuates over the course of the day. The etiology of delirium can be multifactorial including severe illness, its treatment, and the critical care environment. Delirium occurs frequently in adults, and is known to be linked to poor outcomes including increased mortality, longer hospital length of stay, and long-term cognitive impairments in survivors. Therefore, delirium has increasingly received attention as a significant entity in pediatric critical care. However, investigations of the impact of delirium in critically ill children has been limited, until recently, by lack of a practical diagnostic tool. An international survey revealed that many pediatric intensive care units (PICUs) do not routinely screen for delirium. Thus, little is known about the incidence, risk factors, presentation, time course, and outcomes of delirium in the PICU and pediatric cardiac intensive care unit (CICU).

Implementation of practical monitoring tools for diagnosis of delirium in the adult ICU has directly led to an understanding of the risk factors, morbidity associated with delirium, and strategies to prevent and treat this ICU complication. 1,7,14-29 To meet this need in children, researchers developed and validated practical bedside tools for the diagnosis of pediatric delirium. 30-32 As a result, there is now prospective literature that reports the prevalence of pediatric delirium in a general PICU population to range from 17% to 38%. There is evidence that pediatric delirium is associated with developmental delay; mechanical ventilation; young age; severity of illness; prior coma; a diagnosis of infection or inflammation; exposure to benzodiazepines, narcotics and anticholinergics; use of physical restraints; and exposure to vasopressors and antiepileptics. 11,33-35

Presently, there is limited data on delirium in pediatric CICU patients. 11,30,31 We hypothesized that delirium is a common occurrence in the pediatric CICU, as these patients are exposed to many of the previously described risk factors for pediatric delirium. Pediatric CICU patients are often young, severely ill, deeply sedated,

CAPD Cornell Assessment of Pediatric Delirium

CICU Cardiac intensive care unit
CPB Cardiopulmonary bypass
ICU Intensive care unit
LOS Length of stay

PICU Pediatric Intensive care unit
RASS Richmond Agitation Sedation Scale

 ${\tt STS\text{-}EACTS\ score}\quad {\tt The\ Society\ of\ Thoracic\ Surgeons\ and\ the\ European\ Association\ for}$ 

Cardiothoracic Surgery Congenital Heart Surgery Mortality Score

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#### **Methods**

We conducted a prospective observational cohort study in the pediatric CICU of a tertiary care center. Delirium screening was instituted in the unit as part of a quality improvement initiative 6 months prior to the study. Approval of the study with a waiver of consent was granted by our Institutional Review Board. All patients from birth to 21 years old admitted over a 10-week period between June 2015 to August 2015 were included in the analysis. Patients were excluded if admitted to the pediatric CICU for less than 12 hours. In addition, patients admitted to the pediatric CICU >24 hours prior to first screening were excluded, to identify only new delirium diagnoses. Lastly, those under neuromuscular blockade and/or therapeutic hypothermia were excluded, as depth of sedation made it impossible to assess for delirium.

#### **Delirium Screening**

The Cornell Assessment of Pediatric Delirium (CAPD) was scored by the bedside nurse once per 12-hour shift. This is an 8-item tool, scored on a Likert scale, that uses the child's observable behavior to assess consciousness and cognition. A developmental anchor points chart was used as an aid to identify age appropriate behavior for each of the CAPD questions in the context of the ICU environment. A CAPD score of  $\geq$ 9 was defined as a positive screen for delirium. This is consistent with clinical practice guidelines that recommend routine use of the CAPD to detect delirium in critically ill children. The score of the CAPD to detect delirium in critically ill children.

The Richmond Agitation Sedation Scale (RASS) was used to assess sedation status and to determine delirium subtype. The RASS ranges from -5 (deeply sedated) to +4 (very agitated). Hypoactive delirium was defined as delirium with a negative RASS score. Hyperactive delirium was defined as delirium with a positive RASS score. Mixed delirium can present with a fluctuation between negative and positive RASS scores and/or a RASS of 0; an alert and calm patient. Withdrawal was defined as a Withdrawal Assessment Tool-1 score greater than 3.<sup>38</sup>

Children who were delirious on more than 1 assessment were categorized as follows: "continuous" if they remained delirious after onset; "intermittent" if they had multiple discrete episodes of delirium, and "recovery" if they were delirious but then recovered.

A delirium screening compliance goal of 80% was set a priori. The tool and supplemental developmental anchor points were previously incorporated into the electronic medical record for ease of use.

Data was collected from the electronic medical record for every day the patient was admitted to the pediatric CICU up to a maximum of 14 days. Patient characteristics collected included age, sex, race/ethnicity, date of admission, date and type of surgical procedure, and diagnoses. In patients who underwent surgical procedures, we collected The Society of Thoracic Surgeons and the European Association for Cardiothoracic Surgery Congenital Heart Surgery Mortality Score (STS-EACTS), which is used to estimate risk of in-hospital mortality by surgical procedure.<sup>39</sup> In addition, cardiopulmonary bypass (CPB) time, deep hypothermic circulatory arrest time, and cross-clamp time were collected. Clinical characteristics collected were type of respiratory support (both on admission and daily), use of vasopressor/inotrope, opiates, benzodiazepines, anticholinergics, steroids, Withdrawal Assessment Tool-1 scores, and CAPD score. In addition, the same clinical characteristics were collected for the 24 hours prior to the pediatric CICU admission if the patients were admitted from another hospital unit.

#### **Statistical Analyses**

The cohort and their outcomes were characterized using descriptive statistics. Clinical characteristics of the children who developed delirium were compared with those who did not develop delirium using 2-sample t tests,  $\chi^2$  tests, and Wilcoxon rank-sum tests for continuous, categorical, and continuous outcomes that were not normally distributed, respectively. Median time to delirium was calculated using the Kaplan-Meier method, with the log-log approach for CIs. Mixed logistic regression models, with a random intercept to account for correlation of outcomes within a subject, were used to assess the independent association between development of delirium and each relevant demographic and clinical factor: STS-EACTS score (>3 vs ≤3), bypass time (15-minute increments), crossclamp time (minutes), age (months), mechanical ventilation on admission, any mechanical ventilation, benzodiazepine use, opioid use, drug exposure prior to admission, location prior to admission (home vs inpatient), and anticholinergics. These variables were chosen based on known clinical relevance and knowledge from previous studies. 8,9,30,31,40-49 Variables that were statistically significant in the individual models were included in a final multivariable mixed logistic regression model. Surgical subgroup analysis was planned a priori as this group would represent the largest proportion of patients admitted to the pediatric CICU and to determine whether there were unique risks for delirium among this group compared with medical patients. Missing data were excluded. Normality was visually assessed using histograms; outcomes were log transformed when necessary. All hypothesis tests were 2-sided with significance set at 0.05. R v 3.1.1 software (R Foundation for Statistical Computing, Vienna, Austria).

## **Results**

A total of 145 patients were admitted to the pediatric CICU during the study period. Forty-six were excluded due to the following: 3 had no recorded delirium assessments, 5 were over 21 years old, and 38 were not evaluated for delirium within 24 hours of admission to the pediatric CICU. A total of 99 patients were analyzed, 88 surgical and 11 medical admissions.

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