



and mechanically ventilated. In addition, many pediatric CICU patients are chronically cyanotic and/or experience hypoxia, which can further increase risk for cerebral dysfunction, and may present clinically as delirium. Therefore, we sought to determine the incidence of delirium, describe the course of delirium, associated risk factors, and short-term outcomes in a prospective cohort of pediatric CICU patients.

## 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.<sup>36</sup> 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.<sup>37</sup>

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 in-

cluded 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  $\leq 3$ ), bypass time (15-minute increments), cross-clamp 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.<sup>8,9,30,31,40-49</sup> 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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