**Introduction**

Emergence Delirium (ED) is a self-limited, postanesthesia complication occurring in anywhere between 10-80% of children. It is important to recognize that emergence agitation to emergence delirium represents a continuum of increasing severity. (1) While there are no long term sequelae as a result of ED, the short term consequences can be trying for parents and caregivers alike.

The ICU literature is replete with the use of heart rate variability to predict multiple organ dysfunction, sepsis, and long term survival. While its use in the perioperative setting is far more acute and limited in context, we found that absolute heart rate change was correlated with emergence delirium.

**Methods**

Subjects. 122 ASA I & II children, age 5-10, scheduled for ambulatory surgery [all types] were recruited for this study. Written parental permission was obtained per IRB protocol. Choice of premedication and intraoperative anesthetic were at the discretion of the individual attending anesthesiologist.

Procedures. Patients were visually monitored by a study coordinator from arrival in PACU until discharge. Most patients were still sleeping on PACU arrival when HR was recorded. Just prior to discharge, the PACU nurse filled out the 4-point Watcha Behavior Scale (2,3) to measure ED upon emergence. Antiemetic and analgesic therapy were provided per post-surgical protocol. Several physiological variables were measured including heart rate, BP, and respiratory rate.

Data Analysis. Heart rate change from preoperative admission (baseline) to PACU entry was calculated. Similarly, HR change from baseline to pre-discharge was calculated. The patients were divided into 2 groups based on presence of ED (WBS ≥ 3). Heart rate change was then compared between the two groups at each timepoint by nonparametric Mann-Whitney U test. This nonparametric test was used due to the unequal sample sizes, as well unequal variance (and hence distribution) between the two groups.

**Results**

- A total of 111 patients had complete data sets for analysis.
- Of these patients, 18 (16.3%) had emergence delirium.
- HR change did not differ between groups at pre-op admission or entry to OR.
- However, the HR change from pre-op baseline to PACU entry was higher (P<.001) in the patients who subsequently had ED (Figure 1). Note this measure was taken while patients were still asleep on arrival at PACU. ED developed 10-15 mins later when patient awakened.
- In these patients, HR change from pre-op baseline remained elevated (P<.001) at immediate pre-discharge (Figure 1).
- Table 1 shows mean measured HR at the 4 timepoints for ED and non-ED groups.

![Figure 1: Heart Rate Change relative to preoperative admission, in patients with and without Emergence Delirium in PACU.](image)

**Table 1. Measured HR at 3 Timepoints between ED and non-ED patients. Values are mean ± std. dev. *P < .05 **P < .01**

<table>
<thead>
<tr>
<th></th>
<th>HR at Pre-op Baseline</th>
<th>HR at OR Entry</th>
<th>HR at PACU Entry</th>
<th>HR at Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NO ED</strong> (N=93)</td>
<td>88.6 ± 13.9</td>
<td>110.2 ± 25.0</td>
<td>100.2 ± 15.1</td>
<td>94.8 ± 14.7</td>
</tr>
<tr>
<td><strong>EMERGENCE DELIRIUM</strong> (N=18)</td>
<td>85.6 ± 12.6</td>
<td>115.8 ± 21.4</td>
<td>116.6 ±19.6**</td>
<td>106.3 ± 17.9*</td>
</tr>
</tbody>
</table>

**Discussion**

We have demonstrated that heart rate change between the preoperative and PACU entry/pre-discharge is an effective method to predict ED before it occurs. The non-parametric nature of our study made it difficult to predict an exact "sweet spot" of change, but a heart rate increase of 20 bpm relative to pre-op baseline should arouse strong suspicion in the clinician of impending ED.

In summation, we have demonstrated that heart change as a biomarker is a strong predictor of ED in a cohort of patients who are in the upper range of age for the phenomenon. Further studies are needed in younger children and with matching size cohorts to predict the heart rate change in a more exact manner and guide pre-emptive therapy.

**References**


**Conclusion**

The study suggests that heart rate change can be a useful biomarker in predicting emergence delirium in children undergoing ambulatory surgery.