

## Original Contributions

### ACUTE ALCOHOL INTOXICATION IN ADOLESCENTS: FREQUENCY OF RESPIRATORY DEPRESSION

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**Abstract—Background:** Adolescents and young adults are frequent users of alcohol. Younger patients may be more sensitive to the effects of alcohol than their adult counterparts, and toxicity has been known to occur at lower doses. Respiratory depression is a serious adverse effect of alcohol intoxication; however, current monitoring practices may not adequately detect respiratory depression. **Objective:** Our objective was to determine the frequency of hypoventilation as measured by capnography among adolescents with acute alcohol intoxication. Our secondary objective was to determine if an association exists between alcohol levels and incidence of hypoventilation. **Methods:** This was a prospective observational pilot study of patients 14–20 years of age with acute alcohol intoxication. Blood or breath alcohol measurements were obtained on arrival. Hourly measurements of vital signs including capnography were recorded. **Results:** Sixty-five subjects were analyzed. Mean alcohol level was 185 mg/dL. Twenty-eight percent of subjects had episodes of hypoventilation. Episodes occurred in similar proportions on arrival and during the first 5 h of measurements. There was no difference in alcohol levels between subjects who did and did not hypoventilate

(185 mg/dL vs. 186 mg/dL; 95% confidence interval –29 to 25). Oxygen desaturations occurred in 14 subjects and were associated with hypoventilation ( $p = 0.015$ ). **Conclusions:** Hypoventilation is common among adolescents who are acutely intoxicated with alcohol. It is independent of alcohol level and occurs at a steady rate during the first several hours of intoxication. Capnography should be considered as an additional monitoring device to detect these episodes and enhance patient safety. © 2013 Elsevier Inc.

**Keywords—**hypoventilation; capnography; intoxication; alcohol; adolescents

#### INTRODUCTION

Alcohol is a common drug of abuse among adolescents and young adults. It is estimated that at least 50% of adolescents 12–20 years old have imbibed alcohol during any 30-d period (1). This population also accounts for nearly 20% of all the alcohol consumed in the United States (US) (1). In 2008, the rate of Emergency Department visits related to alcohol alone was 220.7 per 100,000 children age 12–17 years and 596.3 per 100,000 young adults aged 18–20 years (2).

Alcohol is one of the most commonly abused drugs that can induce respiratory failure (3). Respiratory failure from central nervous system depression is a rare but serious consequence of alcohol intoxication. In adults, this has been known to occur in a dose-dependent fashion,

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as ethanol affects the respiratory center in the medulla oblongata (3). However, the effects of alcohol may be greater in children as compared with adults because children are unlikely to be tolerant to its effects (4).

Signs and symptoms of respiratory depression and impending respiratory failure due to alcohol intoxication can be subtle. Hypoventilation can occur due to changes in either respiratory rate or tidal volume. Bradypneic hypoventilation is due to a decline in respiratory rate and can only be detected by continuous monitoring either via plethysmography or capnography. Hypopneic hypoventilation, which is due to a decrease in tidal volume and concomitant increase in dead space ventilation, cannot be detected with standard monitoring devices and may be difficult to detect on clinical examination as well (5). Pulse oximetry is a continuous monitor of oxygenation, however, it does not adequately assess ventilation. Among patients with apnea, the most extreme form of hypoventilation, pulse oximetry may not begin to decline for several minutes—an unacceptable delay that will be lengthier in patients who are hypoventilating (6–8).

While the management of acutely intoxicated patients centers around monitoring and supportive care, it is unclear whether standard monitoring devices such as pulse oximetry are sufficiently sensitive in detecting respiratory depression. Capnography, or end-tidal carbon dioxide (ETCO<sub>2</sub>) monitoring, is a continuous and objective way to monitor ventilation. This monitor can alert a provider within one breath to an airway or respiratory problem, thus demonstrating its superiority as a measure of ventilation (9). Many studies have shown the benefits of this device in the early detection of apnea and hypoventilation (10–12).

The primary objective of this study was to determine the frequency of hypoventilation as measured by capnography in adolescents and young adults with acute alcohol intoxication. Our secondary goal was to determine if an association existed between alcohol level and the incidence of hypoventilation. We hypothesized that hypoventilation would be detected more frequently by capnography compared with standard respiratory monitoring in adolescents and young adults who were acutely intoxicated. This would provide evidence for the value of continuous capnography monitoring in acutely intoxicated patients. We also hypothesized that subjects who developed hypoventilation would have higher alcohol levels than those who maintained normal ventilatory patterns.

## METHODS

Between September 2007 and December 2010, a convenience sample of subjects with acute alcohol intoxication was enrolled in a prospective observational pilot study. The Human Investigations Committee approved this

study with a waiver of consent. This study took place in the Pediatric Emergency Department of an urban tertiary care hospital. The Pediatric Emergency Department sees approximately 32,000 patients each year.

Subjects were eligible for enrollment if they were between the ages of 14 and 20 years of age and suspected of being acutely intoxicated with ethanol. Exclusion criteria included blood or breath alcohol levels <80 mg/dL, intubation prior to or upon arrival to the Emergency Department stay, traumatic injury prior to arrival, and any conditions that would affect ETCO<sub>2</sub> measurements, including evidence of major trauma, diabetic ketoacidosis, severe dehydration, or active lower airway disease.

Emergency Department staff collected basic demographic information including age, sex, and ethnicity. The presence or absence of vomiting was recorded. When possible, a serum alcohol panel and venous blood gas was obtained on arrival. The serum alcohol panel included measurements of ethanol, methanol, acetone, and isopropanol. Breath alcohol measurements (Alco-Meter III; Intoximeters Inc., St. Louis, MO) were taken on arrival and at regular intervals if the patient was awake and able to cooperate. These measurements were assumed to approximate serum levels when serum levels were not obtained. Additional toxicology screening tests were obtained at the discretion of the treating staff.

A Smart CapnoLine Plus (Oridion Capnography Inc., Needham, MA) nasal-oral cannula was placed in the patient's nose and overhanging the lip, then attached to a Nellcor NPB-70 portable monitor on loan from Nellcor Puritan Bennett LLC, doing business as Covidien (Boulder, CO). Cannulas were donated by Nellcor Puritan Bennett LLC. A pulse oximetry probe was also attached to the subject's finger to measure oxygen saturation and heart rate (Nellcor Puritan Bennett LLC, doing business as Covidien). Capnography is not routinely used for monitoring of intoxicated patients at this institution. For the purpose of this study, measurements of ETCO<sub>2</sub>, respiratory rate, heart rate, and oxygen saturation were recorded every hour on a written data form while the patient was in the Emergency Department. Nursing staff or patient care associates typically performed this task. Data were not routinely disclosed to treating physicians, but were available upon request. Any additional significant clinical events, such as apnea or desaturations, were recorded. Similarly, staff interventions related to airway, oxygenation, or ventilation were recorded. These included administration of supplemental oxygenation, patient stimulation, repositioning, insertion of an oral or nasal airway, application of continuous positive airway pressure ventilation, bag-valve mask ventilation, and endotracheal intubation. Staff recording ETCO<sub>2</sub> measurements did not receive any additional training for the purposes of this study, however, all members of the

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