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Anesthetic and pharmacologic considerations in perioperative care of obese children

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ABSTRACT

Purpose: Anesthetic management of obese pediatric patients is challenging. With increasing prevalence of childhood obesity, more severely obese children with comorbidities present for surgery every day. The purpose of this review is to provide an up-to-date comprehensive narrative review on the impact of pathophysiological changes imposed by pediatric obesity on the perioperative management of obese children, especially drug dosing. This knowledge is necessary to provide safe delivery of anesthesia for severely obese children.
Source: MEDLINE and PubMed peer-reviewed manuscripts in obesity and pediatric anesthesia. When there was no information in pediatric literature, we included adult studies in our review.
Principal findings: Defining obesity in a growing child is based on body mass index percentiles specific to age and sex. The precursors of adult obesity-related comorbidities are often seen in obese children. Respiratory and cardiovascular comorbidities increase perioperative risk in the severely obese child [>99th percentile]. Obstructive sleep apnea is highly prevalent and requires consideration of opioid sparing techniques and careful postoperative disposition. A detailed discussion on the effect of obesity on pharmacokinetics of different commonly used anesthetics and analgesics is presented, with current recommendations on dosing.
Conclusion: Optimal and safe anesthetic management of an obese child requires thoughtful pre-procedure assessment and meticulous perioperative management tailored to associated comorbidities, with heightened awareness of potential perioperative complications. There remains a need for improved guidelines for risk stratification, drug dosing and postoperative disposition in this patient population.

Contents

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1. Introduction

Pediatric obesity has reached epidemic proportions worldwide, with an estimated 42 million obese children under age five [1,2]. This is alarming due to the direct relationship between co-morbidities and childhood obesity [3]. Pediatric anesthesia providers increasingly encounter obese patients requiring anesthesia/sedation in the operating room or off-site locations for invasive and non-invasive procedures. While previous reviews have focused on specific areas such as perioperative management for bariatric surgery [4], clinical pharmacology [5] or pediatric obstructive sleep apnea (OSA) [6] we sought to provide a comprehensive narrative review focused on preoperative and anesthetic considerations dictated by pathophysiological changes associated with obesity. Pediatric anesthesiologists are acutely aware of developmental changes with age in children that have implications. Obesity adds another challenge as it is associated with pathophysiological changes affecting various organ systems, of which the most relevant to anesthesiologists include the airway, cardiopulmonary system, endocrine and hepatic systems. Changes in body composition also affects drug disposition and requires awareness of appropriate weight scalars for dosing in obese children.

2. Definitions

Body weight is sometimes used as a simple measure of obesity in adults, but weight as a single measure of obesity is difficult in childhood and adolescence, because during growth, not only does the height increase but the body composition also changes at a rapid yet variable rate. Body mass index (BMI) which relates weight to height, correlates with direct measures of body fat, obtained by anthropometric radiologic, and other methods [7]. However, even BMI in children varies by sex, age and maturity. Male and female BMIs tends to be similar in childhood, but are higher in females during adolescence. After birth, babies accumulate fat mass as an energy reserve for growth, and BMI increases, reaching a peak at about seven months. Thereafter, until age six, growth in length exceeds growth in mass, resulting in decreasing BMI. Thereafter, mass and length increase with growth and BMI increases until growth concludes. At birth, the median BMI is 13 kg m^{-2}, increasing to 17 kg m^{-2} at one year, decreasing to 15.5 kg m^{-2} at age six, and increasing again to 21 kg m^{-2} at age 20. This variation makes *BMI difficult to interpret in pediatric patients* [8]. Therefore, in children, age and sex-specific BMIs must be interpreted by percentiles, relative to other children of the same age and sex.

World Health Organization (WHO) growth charts monitor growth for infants and children 0–2 years [9]. They define childhood obesity as the 95th BMI centile based on US data from 1971 to 4. In 2000, the International Obesity Task Force standard proposed a new standard based on pooled international data for BMI linked to the widely used adult obesity cut off point of 30 kg/m^2. Cole and colleagues opine that this definition is less arbitrary and would allow global comparisons [10]. In the United States (US), the Centers for Disease Control and Prevention (CDC) BMI-for-Age gender-specific charts compare size and growth of children over age two. These charts contain curved lines percentiles that express BMI relative to children who participated in national surveys from 1963 to 65 to 1988–94 [11]. BMI-for-age weight status categories and corresponding percentiles are based on expert committee recommendations [12]. Cut-off points of the 85th, 95th and 99th percentiles are used respectively to define overweight, obese and severely or extremely obese. A threshold of BMI ≥ 120% of the 95th percentile has also been used to define severe obesity [13]. While rigid cut-offs have not been presented for assessing risk, severe obesity (SO) has been described a significant risk factor for perioperative adverse events, but most studies are in children undergoing adenotonsillectomies. In 100 SO children undergoing tonsillectomy, there was higher frequency of perioperative airway complications (15.0% vs 2.0%), and risk for perioperative complications was higher after adjusting for the presence of severe systemic disorders or syndromes (OR 8.8; 95% CI 2.8–27.5, $P < 0.001$) and also after adjusting for preoperative respiratory disorders (OR 7.7; 95% CI 2.5–24.3, $P < 0.001$) [14]. SO was also associated with an increased rate of unplanned hospital admission (OR 3.80, 95% CI 1.83–7.87, $P < 0.001$). In the authors' opinion, in SO, the indication for surgery and the presence of other co-morbidities need to be factored in for risk assessment and postoperative admission planning.

3. Epidemiology

The prevalence of childhood obesity increased from 4.2% in 1990 to 6.7% in 2010, and is predicted to increase to 9.1% by 2020, with an estimated 60 million overweight and obese children [15]. Since obese children frequently become obese adults [16], it is estimated that obesity will account for >16% of health care expenditures by 2030 [17]. In the US, the prevalence of obesity increased from 13.05% to 15.21%, while SO increased from 1.75% to 2.22%, from 1998 through 2003. Recently (2003 to 2010), there has been an encouraging decreased prevalence of obesity (14.94%) and SO (2.07%) [18].

3.1. Etiology

The reasons of childhood obesity are complex and multifactorial. More than 90% of obesity is idiopathic. Less than 10% is associated with hormonal or genetic causes [19], use of medications (glucocorticoids, antidepressants), sociocultural causes and changes in nutritional and physical activity patterns. Variants of genes that play an important role in nociception, opioid transport and efficacy [20,21] have been associated with obesity.

4. Common surgeries in obese children

Although the data on incidence of obesity in children presenting for surgery is not available, the prevalence of overweight and obesity was