Anesthetic Implications of the Obesity Epidemic

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It is estimated that 22 million of the world's children under the age of 5 years are either overweight or obese. In fact, the number of obese children in Africa may be 5 times that of malnourished children. In the US, 13% of children are obese but in other countries, this prevalence may be as great as 30%; this has become a pandemic. Girls appear to be at greater risk for adolescent obesity than boys, 45% vs. 30%.[1] Demographic data in children 6-19 years indicate that the prevalence of overweight is greater in Mexican boys than Caucasian and African-America whereas the prevalence in African-American girls is greater than in Caucasian and Hispanic girls.[2] Unfortunately, obese children are likely to become obese adults. In this lecture, we shall explore the environmental and genetic factors that have contributed to the exponential increase in obesity in childhood over the past three decades and the anesthetic implications.

Definitions.[3]
The adult definitions for excess body fat are neatly summarized as by the body-mass index (BMI): 25%ile constitutes overweight, 30%ile obesity and 40%ile morbid obesity. However, these criteria cannot be transferred directly to children because of the wide changes in weight and height with age. As a result, the criteria in children follow the growth curves as follows:

Overweight is a BMI >85%ile
Obesity is a BMI >95%ile
Super (morbid) obesity is a BMI >99%ile

Growth curves for these criteria will be illustrated.

Ideal body weight in children 1-18 years, may be estimated using the child's height as: Wt (kg) = Height (cm)^2 x 1.65/100. A more simplistic approach for ideal body weight from age is:

For children < 8 yr: Wt (kg) = 2 x Age (yr) + 9
For children ≥ 8 yr: Wt (kg) = 3 x Age (yr)

Others have indicated that lean (ideal) body weight is 20-40% of total body weight, applicable also to obese children.

Etiology.
The pathogenesis of the epidemic increase in obesity rates in childhood has not been clearly identified. What is known is that immigrants to North America have a propensity to gain weight and that the younger the child at the time of arrival in North America, the

greater the likelihood he/she will become obese. Genetic factors are generally regarded as less important than environmental factors (foods, exercise and sleep patterns). Socioeconomic factors indicate that the prevalence of obesity is greater in lower than higher socioeconomic groups.

Fewer than 5% of cases of obesity can be attributed to diseases. These include Prader-Willi syndrome (Laurence-Moon-Biedl syndrome), inborn errors of metabolism, Cushing's disease and immobility (DMD).[1,3]

Lifestyle factors may contribute substantively to the prevalence of obesity:

1. Lack of activity
2. Increased caloric intake (fast foods, high carbohydrates, limited dairy products,[4] poor buffet habits[5])
3. Insufficient sleep[6]

Several genetic defects have been identified that contribute to disturbed metabolism possibly contributing to obesity:[1]

1. Leptin mutations (receptor and prohormone convertase 1) affect feeding behavior as well as reproduction; should eliminate gene from the pool
2. Proopiomelanocortin mutation affects feeding behavior that is fatal
3. MCR4 (melanocortin receptor) deficiency affects feeding leads to obesity

Medical Conditions associated with obesity.[1,3,7]

1. Respiratory system. Asthma (particularly exercise-induced) has a 30% prevalence in overweight children. There is a restrictive pulmonary pattern in these children likely the result of the fat encasing the chest with decreased chest wall compliance, FRC and vital capacity. Increased work of breathing gives way to reduced lung volumes as the closing volume approaches the tidal volume and V/Q mismatch occurs.

Sleep disordered breathing is common in obese children (Pickwickian syndrome) with an incidence up to 17% (up to 33% if BMI >150%). Manifestations of SDB include difficulty arousing in the morning, fatigue and sleepiness during the day, narcolepsy, inability to concentrate and focus, poor performance at school, and enuresis.

2. Cardiovascular. Systemic hypertension correlates with an increase in BMI. HR and BP also increase secondary to an overactive nervous system. Left ventricular hypertrophy occurs with the increased vasculature to perfuse with increasing adiposity. Ultimately, this could increase LV strain causing ischemia. Intermittent hypoxia that occurs with sleep apnea will cause pulmonary hypertension that will be reversible early on but become fixed with time. If a right-sided CHD lesion existed, the pulmonary hypertension may exacerbate the heart defect resulting in right heart failure, which may be difficult to diagnose.

3. Endocrine. Insulin resistance and metabolic syndrome are present in 40% of moderately obese children and 50% of severely obese adolescents. Once these syndrome

begin to appear, Type II diabetes develops. Dyslipidemias are common as BMI increases, with carotid stenosis typical of middle age pathology.[8,9]

4. Gastrointestinal. The increased abdominal weight often leads to gastroesophageal reflux, although this is less common than in adults. Gastric emptying rates are either the same or delayed in obese children. We follow standard NPO intervals in these children.

Fatty infiltration of the liver leads to nonalcoholic fatty liver disease, which may chronically result in hepatic fibrosis.[10] Mild increases in ALT levels occur only in severe obesity cases.

Indications for surgery.
Orthopedics: Legg-Perthes disease, Blount's disease
GI: gall stones, bariatric surgery
GU: polycystic ovary syndrome
CNS: pseudotumor cerebri

Pharmacology.

Drug dosing in obese children should be based on the child's ideal body weight. Little is known about protein binding in these children, although volume of distribution of lipid-soluble drugs is likely increased.

Anesthesia.
Although the perioperative implications of obesity in adults has been amply investigated and published, the same does not hold true for children. In fact, few studies have investigated the perioperative implications of obesity in children undergoing general anesthesia. In 2007, Setzer et al retrospectively reported the anesthetic implications in 100 obese children undergoing dental surgery compared with 1100 non-obese children.[11] They determined that after inhalational inductions were performed in >99% of all children, that desaturation in obese children occurred with 10 fold greater frequency than in non-obese children. Similarly, that the hospital admission rates in obese children were 10 fold greater than in non-obese children, The overall complication rates in both groups were small and similar. Nafiu et al reported their experience with 6100 patients (age 12 years) of whom 14% were overweight and 17% were obese.[12] They reported:

1. a greater incidence in asthma, hypertension and type II diabetes in the overweight/obese children compared with the normal group.
2. the incidence of difficult airway and laryngoscopy in the overweight/obese group to be greater than in normals
3. PACU times for the overweight/obese children were greater than for normals.

Preoperative assessment.

1. BMI should be determined
2. SDB should be determined. Few children tolerate CPAP/BiPAP devices but if they use one, it should be brought to the hospital for overnight admissions.

3. Pre-induction SaO_2 should be determined
4. Hypertension should be sought. If present, a preoperative Echocardiogram is indicated.
5. Fasting blood glucose should be determined (blood sugar > 200 mg/dL is associated with increased wound infections)
6. Standard fasting interval.
7. Assess the airway; IV access may be difficult

Induction of anesthesia.

These children tend to be larger than similar age non-obese children and one assumes they will behave more mature than their age would dictate. Be sensitive, parental presence may be required at induction of anesthesia as premedication may be eschewed. These is no data suggesting that tracheal intubation is more difficult in obese children.[1] However, always be prepared with a styletted tube and a selection of blades for such an occurrence.

1. Expect an increase V/Q mismatch and desaturation. Therefore, preoxygenate
2. Inhaled induction oxygen enriched, apply PEEP with loss of consciousness
3. Position 25^o head-up to reduce V/Q mismatch
4. Gently assist ventilation to maintain adequate lung volumes; RSI as indicated
5. Tracheal intubation is preferred to LMA or ProSeal to prevent atelectasis and deliver IPPV.
6. Maintenance should include desflurane to avoid tissue accumulation of inhalational anesthetics. Opioid and muscle relaxant dosing should be based on lean body weight.
7. Apply compression devices to prevent stasis in the legs and DVTs.

Emergence.

1. Extubate awake, really awake!
2. Oxygen should be delivered by facemask ± PEEP as tolerated.

PACU.

1. Pain management should be based on ideal body weight and the presence of SDB. If there is no evidence of nocturnal hypoxia, the usual dose of opioid should be administered.
2. Monitor oxygen saturation. These children may require supplemental oxygen for a greater period/on the ward.

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