

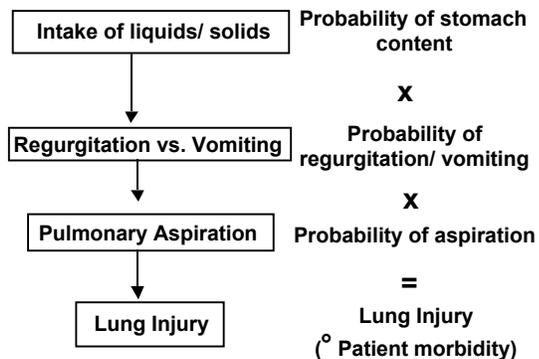
Myths in Pediatric Anesthesia

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With the recent explosion of healthcare costs, feasibility, effectiveness, indications for use, *and* improved outcome with decreased cost have become the focus of our health care system. In turn, physicians are being asked to adjust their practice from that based on beliefs and anecdotal experiences to that based on evidence (i.e. *evidence-based medicine*). In this next lecture, we will approach some common clinical dilemmas in pediatric anesthesia using these principals.

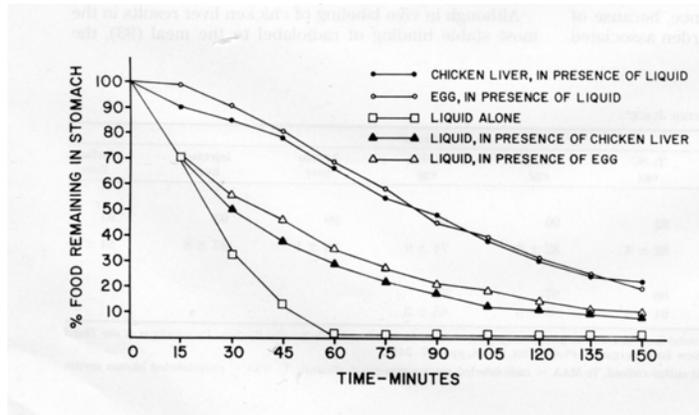
Preoperative Fasting Guidelines

The issue of preoperative fasting is quite controversial and was the subject of practice guidelines published in 1999 by the American Society of Anesthesiology (1). The guidelines indicate that the minimal fasting period for clear liquids is 2 hours, breast milk is 4 hours, non-human milk is 6 hours, infant formula is 6 hours, light meal is 6 hours and solids is 8 hours. When one examines this issue the first question may arise is why do we need preoperative fasting guidelines? The answer seems straightforward. Appropriate fasting guidelines will decrease the gastric fluid volume, which in return will decrease the incidence of pulmonary aspiration. How much acid aspirate is needed to cause damage to the lungs? For years we have been believed that the “magic number” is 0.4 ml/kg. This number was based on a study published by Roberts and Shirley in 1974 (2). Of particular interest is that the published study did *not* support 0.4 ml/kg and this number was only mentioned in the introduction under “our preliminary work in the rhesus monkey suggests that 0.4 ml/kg is the maximum acid aspirate that does not produce significant changes in the lungs”. In a more recent investigation that was conducted by Raidoo et al. and involved a primate model it was found that the maximal acid aspirate that will not cause damage to the lungs is 0.8 ml/kg (3). A review of NPO pediatric perioperative studies reveals that the residual gastric fluid volume (GFV) in children following two hours of clear liquids prior to surgery ranges from 0.24±0.31 ml/kg to 0.66±0.79 ml/kg (4-5). Based on these data as well as Raidoo's data it seems that 15-50% of patients would be at risk and thus the incidence of pulmonary aspiration would be quite high. All recent studies have indicated, however, that the incidence of pulmonary aspiration under general anesthesia is quite low in infants and children. A recent study by Warner et al. has reported that following 63,180 anesthetics there have been only 8 cases of pulmonary aspiration that required respiratory support or mechanical ventilation for more than 48 hours (6). Further more, Warner et al reports that all children that needed respiratory support or mechanical ventilation had significant



systemic illness such as bowel obstruction and bowel ischemia. Thus, since $GFV > 0.8 \text{ ml/kg}$ are common and pulmonary aspiration is not, it is likely that other factors and co-morbidities are involved in this process. Schreiner et al has addressed this issue in a recent editorial and advocated that gastric fluid volume is not really a risk factor for pulmonary aspiration but rather a surrogate outcome (7). That is, GFV is easy to measured but has no clinical significance as an isolated indicator.

Let us then review the data that exists in the literature and explains the findings to date. As can be seen from the figure below, in order for lung injury to occur there has to be intake of liquids or solids. Next there has to be an act of active vomiting or passive regurgitation followed by aspiration and lung injury. In order to calculate the incidence of lung injury we need to multiply the probability of stomach content to exist times the probability of vomiting or regurgitation times the probability of aspiration times the probability that lung injury will indeed occur and lead to patient morbidity. Lets examine this path. First, what is the likelihood of a patient having clear liquids or solids in their stomach? The answer obviously depends on the time the patient ate last. Please refer to a graph that illustrates the GFV as a function of time. As can be seen, water are being absorbed very quickly with minimal water remaining in the stomach at 60 minutes. This illustration, which is based on radionucleotide studies, is supported by the perioperative clinical studies that indicate minimal GFV at 2 hours following water intake. The data of the perioperative studies is less clear when formula, breast milk or rice cereal is discussed. This



issue will be addressed during the lecture. Also, Sethi et al. has recently reported the results of an ultrasonographic study that demonstrated that the traditional NPO times might be unnecessary long; this study will also be addressed during the lecture (8). Unlike Clear liquids, the illustration demonstrates that gastric emptying of solids is more involved and is dependent on a number of factors. Overall, one can conclude based on available data that it takes at least 8 hours to evacuate a full heavy dinner (1692 Kcal) and about 4-6 hours for

light breakfast. Next, we need to address the likelihood of active vomiting or passive regurgitation to occur. There is paucity of data in the literature with regard to this issue. Plourde and Hardy have addressed the issue of passive regurgitation in a cat model (9) The investigators found that gastric volume required to produce regurgitation in cats under general anesthesia is 20.8 ± 7.8 ml/kg and the range is 8-41 ml/kg. These volumes are obviously quite higher than the 0.8 ml/kg of gastric aspirate that is needed to cause lung damage. Next, a patient needs to actually aspirate the stomach content that was vomited or regurgitated. There are no data in the literature with regard to the likelihood of this event to occur. Finally, even if the patient aspirated that does not mean that significant morbidity will develop. Please refer to the study by Warner et al that we reviewed earlier (6). Based, on all the data above it seems that some of the ASA recommendations can be questioned. Specifically, clear liquids (1 hour?), breast milk (3 hours?), non-human milk (3 hours?) and infant formula (4 hours ?). There are no data to indicate that the NPO period for light meal or full meal should be challenged. More data are required before final determination can be made.

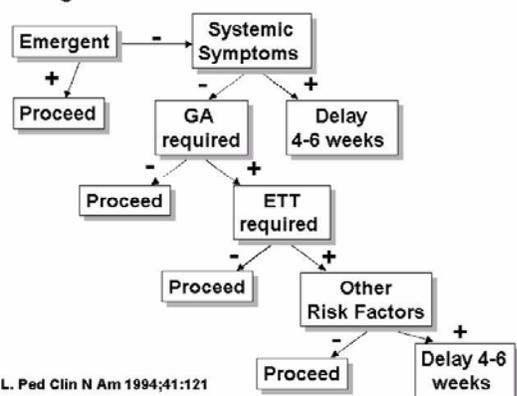
Upper Respiratory Infections:

Currently, the most common reason for cancellation of surgery in children, which is not preventable, is upper respiratory illness (URI). Before discussing whether we should cancel or proceed with a case, we must be aware of the data available in the literature regarding this issue. Cohen et al., in a prospective, case-controlled study involving over 20,000 anesthetics, found that the incidence of respiratory complications increased two to seven-fold, and increased eleven-fold if endotracheal intubation was performed in children with URI (10). The investigators also found that the incidence of respiratory complications was correlated with patient age; children 1 to 5 years had an intermediate risk, while those older than 5 had significantly less risk. In fact, if one reviews all the available literature, one

concludes that there are good data to suggest that the incidence of minor complications, such as mild oxygen desaturation as well as more potentially serious complications such as bronchospasm, laryngospasm, and respiratory failure, may increase in children who either have URI's or who have recently recovered from one (11-15). One should note, however, that a significant number of studies had methodological limitations, including small sample size, no good definition of a URI and retrospective data. A recent study by Tait et al. aimed to overcome many of these problems (16). Tait et al studied over 1000 children who were scheduled to undergo general anesthesia and elective surgery (16). The investigators found that children with active or recent URI had significantly more episodes of breath holding, desaturation episodes (<90%), and a greater incidence of overall adverse respiratory episodes. The investigators reported that risk factors for development of respiratory complications include endotracheal intubation, history of prematurity, surgical procedure involving the airway, reactive airway disease and nasal congestion. As in previous studies, none of the complications was associated with any long-term adverse sequel.

Given the complications that may develop, why not to cancel all cases involving URI? The average child gets 6-7 URI's per year and each URI lasts about 7 to 10 days. Further, there is evidence to suggest that airway reactivity is increased for at least 7 weeks after a URI. That is, of the 52 weeks per year only about 9 weeks may be left in which the average does not have a URI episode or after a URI

URI Algorithm



Martin L. *Ped Clin N Am* 1994;41:121

episode. This does not leave a lot of room for cancellation and rescheduling. Moreover, a child is quite likely to be developing another URI by the time that waiting period is over! If we do not cancel all cases involving URI, should we cancel all cases of a 'serious URI'? But how do we define a serious URI? One should realize that there are no good laboratory tests that can be used to decide whether to postpone surgery or not. Baker has suggested that if a child has 2 of the following criteria the case should be delayed: sore throat; sneezing; rhinorrhea and congestion; nonproductive cough; temp > 101⁰F; laryngitis & malaise (17). Martin et al. has suggested the above algorithm to help in the decision process (18). Clearly, some groups of

patients are clearly at increased risk. These include children with asthma, especially those whose symptoms are exacerbated by upper respiratory infections, children with bronchopulmonary dysplasia, Children with a history of prematurity, children under one year of age, children with sickle cell disease, and children who are to undergo surgery involving the airway. Patients in these categories should be carefully assessed and strong consideration should be given to postponing elective surgery. We may need to be less conservative, however, with children who are about to undergo procedures such as PE tube placement or T&A. These procedures are therapeutics and may have a direct impact on the patient's respiratory well being.

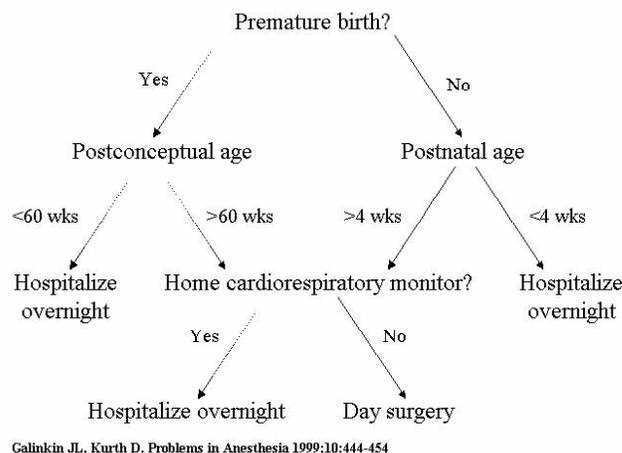
The Former Premature Infant: Postoperative Apnea

General anesthetics and sedative hypnotics all can depress ventilatory drive and cause central apnea in infants less than 56 weeks postconceptual age (19-21). With improved medical technology, the gestational age at which premature infants are saved has lowered significantly, and while in the past only tertiary care centers were providing services for these patients, today these children may present to community hospitals. The former premature infant has an increased risk for complications, including anemia, bronchopulmonary dysplasia and postoperative apnea. The issue of postoperative apnea after general anesthesia is of particular importance as a significant number of patients are today being treated as

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outpatients. The incidence of this phenomenon in the PACU is unclear, but is thought to range between 0 and 32% (32-34). The reason for this variation is related a lack of a uniform definition of “apnea”. While some studies define apnea as a lack of turbulent airflow under the nostrils, other studies define it as no breathing movements a period of over 30 seconds (19-21). This raises the very interesting issue of “surrogate outcomes”. A surrogate outcome defined as an outcome that is easily measured but is *not* relevant to clinical practice and the overall well being of the

patient. In this case, is the air flow under the patient’s nostrils relevant to our clinical practice? Perhaps not. What may be relevant is a period of apnea that results in a significant morbidity (‘real outcome’). The challenge is, of course, to conduct clinical trials that will measure real outcomes without scarifying patient safety.

At what postconceptual age is the child no longer at risk to develop postoperative apnea? The answer varies based on the investigation examined and it ranges from 48 to 60 weeks postconceptual age as well as on the likelihood that one is willing to accept of apnea. That is, based on the work by Cote one can conclude that the probability of apnea in the PACU is not less than 5% until postconceptual age is 48 weeks with gestational age 35 weeks *or* postconceptual age is 50 weeks with gestational age 32 weeks . Similarly, one can conclude that this risk for apnea is not less than 1% until postconceptual age is 56 weeks with gestational age 32 weeks *or* postconceptual age was 54 weeks and gestational age 35 weeks. One should note, however, that these recommendations are all based on a total of about 250 children and that the endpoints used in all these investigations are not the same (i.e. what is apnea?).

There is general agreement that children who are at risk to develop postoperative apnea *must* be admitted to the hospital for a period of 12-24 hours after anesthesia for cardiorespiratory monitoring (figure).. It should be noted, however, that the 56-60 weeks postconceptual age mark for hospital admission is somewhat conservative and that currently some anesthesiologists would replace that mark with 48 or 52 weeks postconceptually (depending on gestational age). This decision also has to be based on the type of anesthetic used for the surgical procedure. It is well established that regional techniques (i.e. spinal) lead to a significantly lower incidence of postoperative apnea in this patient population. In fact, there is currently a strong controversy among pediatric anesthesiologists with regard to the

appropriate “cut off” age at which a child needs to be admitted postoperatively to a hospital. This author expects guidelines in this area to evolve significantly over the next few years.

The question of when to perform semi-elective surgery, such as inguinal herniorrhaphy, in premature infants is controversial. Although inguinal herniorrhaphy may be considered an elective procedure, there is an increased risk of incarceration in these patients, making this not a purely elective procedure. One therefore must frequently proceed in these cases and accept the risk of postoperative apnea. Purely elective surgery, however, is best postponed until the child reaches at least 52-60 weeks postconceptual age.

Parental Presence During Induction of Anesthesia

Potential benefits from parental presence during induction of anesthesia include reducing the need for preoperative sedatives such as midazolam and avoiding the anxiety that occurs upon separation to the OR. Other benefits may include increasing child’s compliance and increased parental satisfaction. Objections to parental presence during induction of anesthesia include concern about disruption of the operating room routine, crowded operating rooms, and possible adverse reactions of parents. Other objections include prolonged anesthetic induction, and additional stress on the anesthesiologist especially should a complication develop.

Although early studies suggested reduced anxiety if parents were present during induction (22), *all* recent randomized controlled trials indicate that routine parental presence is *not* beneficial (23-25). When interpreting the results of these studies, however, it should be noted that the design of a randomized controlled study, does *not* reflect the practice of *all* anesthesiologists. That is, we hypothesize that while a RCT is applicable to centers that offer parental presence for *all* parents, it may not be applicable to centers that consider each request for parental presence based on personality characteristics of each child and parent. Such centers may have different results with parental presence during induction of anesthesia than were demonstrated in RCT’s. Research interests should shift towards an emphasis on *what parents actually do* during induction of anesthesia, rather than simply on their presence. Some parental behaviors, such as criticism and commands, reassurance with empathic statements, apologizing, and bargaining are associated with greater distress. In contrast, parental behaviors such as distraction methods (humor, toys, party blowers etc.) and commands to engage in active coping are associated with decreased child’s anxiety in the psychological and pain literature (26). Recently, we have developed such an instructional program at our institution and we are currently looking into the effectiveness of the program. In conclusion, allowing a parent into an operating room without significant preparation may be counterproductive and some process control has to be implemented.

Finally, parental presence during induction of anesthesia is also associated with important legal implications. Lewyn described a case in which a mother was invited to accompany her son into an emergency treatment room (27). According to the court, the mother fainted and suffered an injury to the head. In its verdict the Illinois Supreme court stated that a hospital which *allows* a non-patient to accompany a patient during treatment does not have a duty to protect the non-patient from fainting. However, if medical personnel *invite* the non-patient to participate in the treatment than the hospital has a legal responsibility toward the non-patient. Interestingly, some hospitals in the United States now require the parents to sign a written informed consent acknowledging the risk of being present during induction of anesthesia.

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