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Gastric Residuals in Neonates:
Evidence-Based Practice Approach

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The immature body systems of premature infants continue to be challenging and ever changing. Caregivers work to find effective ways to provide adequate nutrition and to find a feeding regimen each neonate tolerates. Many health care providers are faced with the question of intolerance and its meaning. One of the most concerning problems in feeding a neonate is the presence of gastric residuals or pre-feeding aspirates. There are many other symptoms associated with intolerance; however, this paper will focus on those associated with gastric residuals.

Definition and Description of the Issue

Preterm infants are born with limitations in their digestive ability due to anatomical and functional limits. Neurological development is important for gastrointestinal motility. “Peristalsis in the esophagus is immature and bidirectional in the preterm infant with appropriate forward movement of food to the stomach developing only near term” (Anderson et al, 2006, p. 392). The more preterm the infant is at birth, the more immature and disorganized their intestinal motor activity is. Once enteral feedings are started in neonates, it promotes the ongoing maturation and development of the gastrointestinal system. After the initiation of feedings in term infants, there is a significant increase in the intensity of motor activity, which is not seen in preterm infants. Therefore, initiation of feedings alone does not help the gastrointestinal intestinal system; rather, maturation comes with older gestational age.

Gastric residuals or pre-feeding aspirates are the presence of food in the stomach from a previous feeding that is found at the start of the next feeding. Gastric residuals also contain acid and enzymes (Hodges & Vincent, 1993) used in the digestive process. The basal secretions in the stomach are gastric and salivary in origin, and vary depending

on the weight of the neonate. In infants ranging from 800-2300 grams, gastric secretions could be up to 2.8 mL +/- 0.63 mLs (Malhotra et al.). The process of checking gastric residuals was started to ensure correct placement of the feeding tube prior to the beginning of a feeding. When a gastric residual is assessed in a significant amount, some caregivers see this as an indication of intolerance to the feeding. The process in proceeding after a significant residual was found tends to be dealt with very differently between facilities. There is no standard procedure amongst health care institutions, making the decision on how to deal with residuals very different. In a study done by Hodges & Vincent, 1993, they state that many of the problems related to gavage feedings remain unsolved due to the varying practices that exist from institute to institute. Thus, defining guidelines was suggested as a possible solution.

Defining feeding tolerance is a challenge to those that provide care to neonates. It is also a concept that varies between institutions. Research indicates feeding tolerance is dependent on: gastric residual volume, gastric residual color, stooling patterns, presence of hematochezia, emesis, abdominal distention and abdominal tenderness (Schanler, 2011). Providers often will not proceed with feedings when an infant shows signs of intolerance due to the concern of necrotizing enterocolitis (NEC) developing. This concern is based on numerous research findings, which indicate NEC may be associated with signs of feeding intolerance.

“Necrotizing enterocolitis (NEC) is an ischemic and inflammatory necrosis of the bowel primarily affecting premature neonates after the initiation of enteral feeding” (Gomella, Cunningham, & Eyal, 2009, p.590). NEC is the most common gastrointestinal emergency in the NICU population and usually results in very devastating consequences.

It has an overall mortality rate of 10-30% (Gomella, Cunningham & Eyal, 2009). Some have equated the presence of pre-feeding aspirates or gastric residuals as an early sign of the gastrointestinal manifestations of NEC and therefore are apt to act upon them.

The consequences of withholding feedings based on the presence of gastric residuals can affect the neonate in many ways, in particular, those related to growth and developmental outcomes. The practice of withholding feedings based on high amounts of gastric residuals has been shown to cause marked delays in reaching goal nutritional needs, poor weight gain and delayed growth (Weckwerth, 2004). This can cause lasting effects on the neurological development of the neonate. Therefore, more consideration must be placed on researching and providing evidence on feeding through gastric residuals. It is important to consider the immaturity of the neonate intestinal tract which can cause decreased gastric emptying, slower intestinal motility, decreased gastrointestinal hormones, enzymes and juices, which all affect overall digestion and feeding tolerance.

Review of the Evidence-Based Literature

The literature was searched for information on feeding tolerance and the presence of gastric residuals in feeding regimens in neonates. An electronic search of CINAHL, PUBMED, and GOOGLE SCHOLAR was performed using keywords feeding tolerance, feeding intolerance, gastric residuals and neonates.

Cohen, et al. (2004) studied the effects of body positioning in gastric emptying and residuals. The hypothesis was that right lateral decubitus led to less residual than left lateral decubitus positioning. A comparison of prone positioning to supine positioning

and how it affected the gastric residuals in neonates was also conducted. A prospective randomized clinical trial with triple crossover of healthy growing appropriate for gestational age preterm infants was conducted. Gastric residuals were measured at 1 hour and 3 hours after the initiation of the feeding. The results of their study showed at 1 hour, right lateral decubitus led to less significant residuals than left lateral decubitus ($p=0.029$). The prone position led to less residual than the left lateral decubitus position ($p=0.38$). It was noted that supine positioning had less residual than left lateral decubitus. At 3 hours of age, there was no significant difference noted among the four positions. The researchers concluded that at 1-hour post feeding, positioning had a significant difference on a neonates feeding tolerance; it was speculated that positioning preterm infants in the right lateral decubitus position might alleviate the presence of residuals. The amounts of gastric residuals 1 hour after feeding were noted to be least to greatest in the following order: right lateral decubitus, prone, supine, left lateral decubitus.

The effect of enteral feeding temperature on feeding tolerance was studied by Gonzales, et al. (1995). They reviewed literature prior to the start of their research on documented consequences of cool feeds in animal studies. Reduced gastric and intestinal blood flow, mucosal injury, body cooling and shivering, and decreased growth rates were associated with feeding animals cool substrate. Based on these findings, Gonzales et al. evaluated the effect of milk temperature and feeding tolerance as measured by gastric residuals in very low birth weight infants. The study posed three hypotheses:

1. Preterm infants fed milk at cooler temperatures (10 degrees C) would have gastric residual volumes that were significantly greater than preterm infants that were fed milk at body temperature (37 degrees C).

2. Preterm infants fed milk at room temperature would have gastric residuals that were significantly higher than those fed milk that was body temperature.
3. Preterm infants fed milk at cooler temperatures would have significantly greater residuals than those fed milk at room temperature.

Tolerance was defined as gastric residuals less than half of the total feeding with no emesis, no abdominal distention, and normal stooling patterns. All infants in the study were positioned prone with the head of the bed elevated 30 degrees. The results showed the temperature of the milk provided to the preterm infants significantly influenced tolerance by using ANCOVA, $F(2, 26) = 41.06, p < .01$. Results of the study support the two hypotheses: Preterm infants fed milk at cooler temperatures will have significantly greater gastric residual volumes than infants fed milk at body temperature; and preterm infants fed milk at room temperature will have significantly greater volumes of gastric residuals than infants fed milk at body temperature. Keeping this in mind, many institutions provide feedings from ready to use bottles of formula that are stored and fed at room temperature. Warming breast milk prior to feeding was not addressed and may be an area to be further researched. Results of this study support the practice of warming feedings to body temperature rather than feeding the formula at room temperature. Warming the feeding to body temperature may promote greater feeding tolerance in the preterm infant.

Feeding tolerance in preterm infants was also studied by Dollberg, et al., 2000, by examining the affects of bolus feeding versus continuous feedings. A prospective, randomized clinical trial was conducted in order to investigate whether bolus or continuous feedings showed better feeding tolerance in preterm infants. They

hypothesized prior to conducting the study that continuous feedings would be better tolerated than intermittent gastric bolus feedings. Feeding tolerance was assessed by measuring gastric residuals every two hours in infants that weighed between 501-750 grams and every three hours in all the other infants receiving the continuous feedings. Infants in the bolus group had gastric residuals checked prior to their next scheduled feeding. The result showed infants in the continuous feeding group took significantly higher amounts of time to reach full feedings than those in the bolus feeding group. It was also demonstrated that very low birth weight (VLBW) infants had better feeding tolerance with intermittent gastric bolus feedings than with continuous gastric infusion feedings. The researchers in this study also speculate that there might be a need for stomach distention by a minimum volume of feeds in order to optimize gastrointestinal peristalsis.

The effects of breast milk versus formula have been researched as a possible factor affecting gastric emptying. Ewer et al., 1994, examined how breast milk and formula differed in respect to feeding tolerance. Research was done to look at serial ultrasound measurements to examine the cross sectional area of gastric antrum (ACSA) to assess differences in gastric emptying based on the type of feeding provided. During the study, infants received bolus nasogastric feedings of either expressed breast milk or infant formula. They were then fed the alternative milk at the following feeding. Real time ultrasonic images were conducted measuring the ACSA. The stomach was aspirated prior to the feeding and ACSA was measured before the feeding, as soon as the feeding was complete and every 10 minutes until the prefeed value was reached. It was seen that expressed breast milk emptied faster from the stomach than formula milk and the

difference was highly significant ($p < 0.0001$). They concluded that the difference may lie in the fact that breast milk contains prokinetic agents that despite efforts to humanize cows' milk formulas, we have not been able to replicate these agents.

Aly, et al. (2006) conducted a randomized trial to evaluate the effectiveness of erythromycin as a prokinetic drug promoting gastrointestinal motility in preterm infants with feeding intolerance. Subjects were formula-fed premature infants, so it does not provide data for infants receiving breast milk. The results of the study revealed that full enteral feedings were achieved at an earlier age in infants that were >32 weeks (5.8 days) where $p = 0.01$, but did not demonstrate a difference in infants <32 weeks ($p = 0.50$). Erythromycin was also associated with fewer episodes of gastric residuals in infants > 32 weeks ($p = 0.03$), but not in infants < 32 weeks ($p = 0.77$). There is evidence to suggest that erythromycin enhances gastric emptying, reducing gastric stasis, and decreases the incidence of gastric residuals in infants > 32 weeks.

Research indicates that gastric residuals may result from many different etiologies. If they exist without any other clinical symptoms, gastric residuals can be a benign issue arising from: the position the neonate was placed in, the temperature and type of substrate they were fed, medications the infant may or may not be taking, and how they are being fed.

Treatment of Gastric Residuals

As mentioned earlier, gastric residuals are dealt with differently depending on facility guidelines. From the research, it is reasonable to conclude gastric residuals can result from many different etiologies. Hodges & Vincent, 1993 conducted a survey of neonatal intensive care unit (NICU) nurses asking how they dealt with gastric residuals.

Most of the nurses surveyed stated they gavage feed premature infants weekly and all but one nurse, checks gastric residuals prior to each gavage feeding. 81% of the respondents indicated they never or almost never refeed aspirates. From the data, they found the nurses surveyed in the study believe a physician order is required before being allowed to refeed the aspirate.

Current treatment of gastric residuals spans from refeeding, continuing feedings, holding feedings, subtracting the residual from the feeding total, placing the infant NPO (nothing by mouth), checking an abdominal x-ray, and even doing a full sepsis evaluation (blood cultures, CBC with differential, antibiotic treatment, etc.). There are no established standards for gastric residuals. “Gastric residuals are probably a benign consequence of delayed gut maturation and motility in VLBW infants. When aspirates occur in isolation, whatever their colour, they should not immediately induce the neonatologist to withhold feeds” (Lucchini, et al., 2011). Gastric residuals become more crucial when they are accompanied by other warning signs such as: bilious vomiting, abdominal distention, abdominal wall erythema, bloody stools, apnea, bradycardia, temperature instability and decreased bowel sounds. When these signs/symptoms are seen in combination with the gastric residuals, an abdominal x-ray should be performed to rule out the possibility of NEC.

Patient and Family Counseling

Gastric residuals in preterm infants are a fairly common occurrence when establishing feedings. Parents need to be educated on the immaturity of the gastrointestinal tract of their neonate and what types of things to expect when initiating

feedings. From the research, variables such as: positioning, type of formula/milk fed, temperature of the formula, bolus feedings vs. continuous feedings, and medications being used, can affect the presence and amount of gastric residuals. It is important for parents to be informed of the potential risks that neonates are prone to when initiating feedings. It is not necessary to give all the details about the extremes of NEC, unless the residuals are seen in combination with some of the other risk factors mentioned. Keeping the patient's family well informed on the neonate's condition helps to alleviate any surprise if changes arise. Education should be done in a clear and concise manner, making sure to answer any questions the family should have.

Future Research

There is inadequate research to support not checking gastric residuals. However, there are reasons gastric residuals exist. There are normal physiologic adaptations that the digestive tract must go through in order to facilitate the digestive process. Many things about the immature digestive tract of the neonate still remain complicated. The delay in feedings can cause significant growth and development delays; another disadvantage for the neonate.

In order to facilitate adequate nutrition for neonates, more research needs to be conducted into gastric residuals and how discarding and checking them may be more detrimental to the infant than currently thought by providers. There are some thoughts that residual checks could cause damage to mucosal tissue in the stomach wall.

Occasionally professional opinions also feel checking residuals causes more harm than good.

Currently a randomized research study is being conducted titled “Gastric Residuals and Gastrointestinal Function in Very Low Birth Weight Infants.” The investigators are Leslie Parker, Josef Neu and Roberto Murgas (L. Parker, personal communication, December 5, 2011). Dr Josef Neu in an email stated, “We are in the process of starting a randomized study of checking and not checking gastric residuals. There is really a paucity of information to guide us one way or the other, and the theoretical risk of checking the residuals and how they might mislead the clinicians is a concern” (personal communication, November 11, 2011). Hopefully the information gained through this new research will be a better guide for advance practice clinicians and physicians to follow in deciding if gastric residuals are truly a sign of feeding intolerance.

Conclusion

Gastric residuals exist in neonates due to the immaturity of their digestive tract. They may be a benign sign or may be a warning of a more serious issue. Currently, there is not sufficient research to support the practice of not checking pre-feeding residuals. There is evidence to prove why gastric residuals exist. Until further research is done focusing on the practice of not checking pre-feeding residuals, checking and treating them according to the protocols or guidelines that are instituted must be continued. Further research can provide a way to move past focusing on residuals and instead, focusing on maintaining adequate nutrition for growth and development of premature infants.

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