Feed intolerance and postpyloric feeding in the critically ill child

María José Solana, Jesús López-Herce, Jorge López

Pediatric Intensive Care Service, Hospital General Universitario Gregorio Marañón, Madrid, Spain

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Correspondence to: Jesús López-Herce, PhD. Pediatric Intensive Care Service, Gregorio Marañón Hospital, Dr. Castelo 47, 28009, Madrid, Spain. Email: pielvi@hotmail.com.

Abstract: Feeding intolerance (FI) is a common problem in critically ill children that results in feed interruptions impacting heavily on outcome. The lack of consistent and validated definition for FI makes difficult to know the real prevalence of this problem in these patients and precludes obtaining conclusive results on predictors and outcomes. Gastric dysmotility (GD) is the principal mechanism underlying FI. The aetiology of GD is largely unknown but many factors (vasoactive drugs, sedatives, opioids, muscle relaxation drugs, hypoperfusion) may be involved in its appearance. Future research must focus on clarifying the potential mechanisms of FI during critical illness as well as finding a proper and validate definition of FI. Several actions are used in clinical practice to reduce FI in critically ill children as prokinetic agents, change from polymeric to semi-elemental formulation and change of feed delivery method from intermittent bolus to continuous feeding. However, the evidence does not support the routine use of these methods to manage FI. Transpyloric enteral nutrition (TEN) is another option to manage FI in sick children as it has proven to be safe and well tolerated with few complications in these patients. TEN promote early nutrition and reduce the volume of gastric residues and the number of enteral nutrition interruptions increasing energy intake. Children with shock, acute kidney injury (AKI) and in the recovery of cardiac surgery may benefit from this technique. However, feeding tube insertion is difficult and it is not exempt of problems. Staff must be trained to detect and decrease complications associated with its utilization.

Keywords: Postpyloric enteral nutrition; critically ill patients; gastric dysmotility (GD)

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Background

Feeding intolerance (FI) is a common problem in critically ill patients that results in feed interruptions potentially impacting on outcome (1).

The lack of consistent and validated definition for FI makes difficult to know the real prevalence of this problem in sick patients (2) and precludes obtaining conclusive results on predictors and outcomes (3). Moreover, the false perception of FI, may withhold enteral nutrition unnecessarily leading to an under delivery of protein and energy and malnutrition (4).

There are several definitions for FI but most of them includes an increase in gastric residues associated or not, to other gastrointestinal (GI) problems (vomiting, diarrhea, abdominal pain or abdominal distension). However, many other reasons different from FI such as drugs, infections, gastroesophageal reflux, ascites or edema can cause these symptoms in critically ill patients (4).

Factors involved in FI in critically ill children

Critically ill children usually experience gastric dysmotility (GD) that is an abnormally slow and/or uncoordinated activity of the stomach or antroduodenal musculature (5). In addition, these patients suffer from gastrojejunal dissociation with atony or hypomotility of the stomach but adequate peristalsis in the small intestine (6). As a result, an increase in gastric residues and abdominal distension develops, potentially leading to a higher risk of aspiration and nosocomial pneumonia (7) and lower caloric and protein intake (8). Impaired GI motility is the principal mechanism underlying FI (7). The aetiology of GD is largely unknown but many factors may be involved in its appearance (3). Critically ill children often require sedative and muscle relaxation drugs that have a relaxant effect on the intestinal smooth muscle and abdominal skeletal muscle inducing abdominal distension (9). Epinephrine and high doses of dopamine are common drugs used in severely ill patients that can impair tolerance to nutrition because they reduce intestinal perfusion (10).

Patients with gastric, peritoneal or cerebral disease are at higher risk of developing this complication (7). On the other hand, sick patients often have circulatory shock that alters gut tissue due to hypoperfusion and gut inflammation, leading to malabsorption and bowel dysmotility (11). They also have alterations in hormonal responses and vagal tone, and increased levels of GI peptides (especially CCK and PYY) that impairs gastric emptying (4).

Severity of GD depends on the phase of the illness (acute, stable, recovery) (4), the severity of illness of the patient and the treatment required to achieve the stabilization of the patient (12). The ability to tolerate different amount of nutrients and the organ support required by the child, changes along the different stages of the critical illness and can be useful to develop a FI model (13).

Finally, factors related to the formula as the osmolality, the composition, or the form of administration of the diet can also increase gastric residues (7).

Future research must focus on clarifying the potential mechanisms of FI during critical illness as well as finding a proper and validate definition of FI (3,13).

Based on Eveleens *et al.* systematic review (3) and on Marino *et al.* editorial (13), a practical tool for FI diagnosis and severity can be developed to allow the clinician to identify and treat this problem efficiently (*Table 1*).

Several actions are used in clinical practice to reduce FI in critically ill children. Prokinetic agents, change from polymeric to semi-elemental formulation and change of feed delivery method from intermittent bolus to continuous feeding (4) are common methods used in PICU to manage FI and to improve nutrient delivery. However, currently no studies have compared polymeric versus (semi)-elemental formulas, nor analyzed the use of prokinetic agents or the influence of feeding route in FI (3). Therefore, currently the evidence does not support the routine use of these methods to manage FI.

The use of transpyloric enteral nutrition (TEN) is another option to manage FI in critically ill children. Although existing evidence cannot make recommendations regarding the optimal site to deliver EN in sick children, guidelines suggest the gastric route be the preferred site for EN in the first instance (14). However, TEN may be an alternative feeding route in critically ill children unable to tolerate gastric feeding, those at high risk for aspiration or requiring frequent fasting for surgery or procedures (14,15).

Benefits of postpyloric feeding in critically ill children

Malnutrition is associated with increased mortality in critically ill patients (16) while successful nutrition is associated with reduced complications and improves outcome (17). Enteral nutrition is the preferred method of nutrient delivery in Pediatric Intensive Care Unit (PICU) because it maintains intestinal trophism, improves immune function and reduces bacterial translocation and multiorgan failure (17,18). As FI may hamper enteral nutrition in severely ill PICU patients, duodenojejunal enteral nutrition can be an alternative to gastric or parenteral nutrition (PN) in critically ill children because it is safe, well tolerated and has few complications (9,10,19,20). TEN can reduce the volume of gastric residues and the number of enteral nutrition interruptions (21-23) and may increase energy intake because it promotes early nutrition and enables to reach the maximum volume of nutrition prescribed rapidly (24-27). Early enteral nutrition has many benefits in critically ill children (25,28-30) and adults (31,32) because it improves nutritional status and immune system activity and associated with reduced incidence of septic complications and muscle fatigue (17,18,30,33,34). Moreover, the incidence of abdominal distension is lower in critically ill children on early TEN than children on late TEN (25).

A previous study in PICU comparing children on PN and on TEN found that patients in the first group developed higher number of metabolic complications (hyperglycemia, hypertriglyceridemia and cholestasis) than children in the TEN group (35). The study also highlighted that the cost of TEN was lower than that of PN with an estimated annual saving of $5.422.

Table 1 Feeding intolerance diagnosis and severity

Diagnosis of feeding intolerance (Items 1 and 2 must be fulfilled. Item 1 will be considered for clinical reasons not for procedures)
1. Inability to achieve the EN goal
Enteral intake two-thirds of prescribed daily target
EN withholding for ≥24 h
EN reduction or not increased for ≥24 h
2. Presence of at least one GI symptom
Vomiting of gastric content
Diarrhoea: ≥4 times loose stool or less if they are liquid. Excluding infectious aetiology
Abdominal distension and/or pain
Melena/hematochezia
Factors that may influence the severity of feeding intolerance
3. Preexisting nutritional impairment
Malnutrition
Intestinal failure/malabsorption
Parenteral nutrition
Impaired gastric motility
Short bowel syndrome, intestinal resection presence of stomas
4. Presence of critical conditions
Shock
Acute kidney injury
Cardiac or abdominal surgery
5. Phase of the critical illness
Acute
Stable
Recovery
6. Organ support
Mechanical ventilation
Vasoactive drugs
Sedatives/opioids/muscle relaxants
7. Electrolytic disturbances
Hyperglycemia
Hypokalemia
Hypomagnesemia

EN, enteral nutrition; GI, gastro-intestinal.

Postpyloric feeding tube placement in children

Transpyloric tube insertion is a complex technique and must be performed by trained personal (36). Postpyloric tubes are usually inserted into sick patients at the bedside by blind insertion (9,10,19,27). However, TEN is often delayed by the difficulties in placement of the feeding tube, resulting in multiple attempts (35). Different techniques for advancing tubes across the pylorus exist including the use of stylets and weighted tube tips, magnet, lateral decubitus position, air insufflations and prokinetic agents (9,17,36-41).

Feeding tubes should be emplaced ideally into the third or the fourth part of the duodenum (42), however, advancing the tubes across the pylorus without direct visualization may be difficult and sometimes fluoroscopy (43) or endoscopy (9,44) are required to be successful.

Another method for this purpose based on electromagnetic guidance can be useful in critically ill patients (6,37). The technique uses a stylet with an electromagnetic tip inside the tube, which transmits its signal to a receiver unit, placed at the epigastric region of the patient and a graphic display of the tube location is displayed (6). Electromagnetic guidance system seems to be a successful, efficient and cost-effective method of bedside postpyloric tube placement in critically ill children (37).

Sonographic technique is also feasible in sick patients with severe impairment of the peristaltic activity of the stomach (45).

After insertion, clinicians must confirm proper tube emplacement to avoid complications. Assistance by auscultation can significantly improve the success rate of nasal feeding tube placement (46). Radiology is widely used for this purpose but other methods without radiation exposure, as measurement of the volume of gas aspirated from the tube, and determination of the change in aspirate pH and color during tube advancement are also useful (9,10,19,20,42). More recently, other test based in bilirubin, pepsin and trypsin concentration have proved to predict tube position (42).

Indications of TEN in critically ill children

TEN in critically ill children is currently indicated for FI or when increased risk of pulmonary aspiration exist (14,15). It can also be used in children on mechanical ventilation, suffering from respiratory failure without mechanical ventilation and with neurologic complications or abdominal surgery (27).

A prospective study in postsurgical and nonsurgical children admitted to PICU, showed that most of these patients tolerated TEN with few abdominal complications (19). Although feeding tolerance was similar in different groups of age, GI complications were significantly more prevalent in postsurgical than in nonsurgical patients.

Children with congenital cardiac disease are frequently malnourished due to an increase in metabolic requirements, a decrease in nutrition intake, or malabsorption secondary to changes in the intestinal mucosa because of low cardiac output (47). Malnutrition in these patients has deleterious hemodynamic effects (48) so it is advised that nutritional status to be improved before and after surgical treatment (49). TEN is a safe practice after pediatric cardiac surgery and allows an early initiation and a rapid advance of enteral nutrition in these patients with increased chance of an adequate energy intake within 24–48 hours of the procedure (9). Moreover, the low incidence of diarrhea in these children (9,36) confirms that an adequate absorption of the nutrients with standard diets is achieved.

TEN may also be useful in shocked children (10). Shock leads to a poor organ perfusion due to an imbalance between oxygen delivery and oxygen consumption (50). Splanchnic perfusion is particularly affected during shock and can even get worse during feeding leading to GI complications (51-53). On the other hand, shocked children need high doses of vasoactive drugs that reduce intestinal perfusion and impair tolerance. TEN is feasible in critically ill children with shock although the incidence of complications is higher than in other sick children (10). A previous study showed that abdominal distension, gastric residues and diarrhea were significantly more frequent in pediatric patients with shock than in children admitted to PICU for other pathologies. Most of the patients tolerated enteral nutrition without complications but two of them developed a necrotizing enterocolitis and one child died because of a complication related to nutrition (10). TEN must be used with caution in shocked patients with closely monitoring of GI complications.

Most of the sickest patients admitted to PICU develop acute kidney injury (AKI) as part of other syndromes (i.e., heart failure, liver failure, and sepsis) or due to a primary renal disease. Incidence of GI complications is higher in patients with AKI than in patients with normal renal function (20,54). Uremia may impair feeding tolerance due to its implication in delaying gastric emptying (55) and produce GI mucosal abnormalities ranging from edema to ulceration (56). TEN can be useful in critically ill children with AKI even if they are on inotropic support, sedative or muscle relaxant drugs, as these children achieve lower caloric intake than children whit no AKI (20).

Complications associated with transpyloric feeding tubes

TEN is safe and well tolerated in critically ill children (19,35,36,57) and has many advantages (23), however, mechanical and abdominal complications have been described (19,36,58). Mechanical complications are associated with the type of transpyloric tube, the technique of tube insertion, the anatomic localization and the duration of postpyloric feeding. Small and flexible tubes should be used to decrease the incidence of mucosal nasal injuries, pressure ulcers, otitis and sinus infection (36).

Transpyloric feeding tube must be inserted by trained personal as it is a complex technique and pleural o bronchial break can develop during the emplacement (27,36). Although insertion is easier in children than in adult patients (7), duodenal perforation due to transpyloric tube placement in infants has been reported (58). Unsuccessful attempts of tube insertion may improve with the administration of prokinetic agents (19) or under endoscopic vision (9). Adequate location of the tube must be confirmed radiographically especially if any complication is suspected (19,58).

Development of pyloric stenosis (59) or enterocutaneous fistulas (60) is rare and is associated with prolonged TEN.

Critically ill children on TEN can also develop GI complications (9,10,19,20). Abdominal distension, excessive gastric residue and diarrhea are the most prevalent digestive tract complications but rarely involves enteral nutrition discontinuation (19,36,61). Even though they are minor complications, a higher incidence of shock and increased dopamine or epinephrine requirement in these patients has been reported (61). These results support the hypothesis that FI may be a sign of poor vital prognosis (19,62).

Shock, epinephrine infusion at a rate higher than 0.3 µg/kg/min and hypophosphatemia are the most important factors associated with GI complications in critically ill children (61). Acute renal failure, hypokalemia and dopamine and vecuronium infusions are also risk factors for this problem (61).

Despite high doses of inotropic infusion may reduce intestinal perfusion and affect tolerance to enteral nutrition, most of the critically ill children present an adequate tolerance to TEN (10,61). Sick children on inotropic support can receive duodeno-jejunal enteral nutrition with careful monitoring (9,10).

Conclusions

GD is a common problem in critically ill children resulting in FI, high risk of aspiration and pneumonia and lower caloric and protein intake. Future research must focus on clarifying the potential mechanisms of FI during critical illness as well as finding a proper and validate definition of FI.

TEN is feasible in this population, as it seems to be safe and well tolerated with few complications. In addition, postpyloric feeding tubes may promote early nutrition and reduce the volume of gastric residues and the number of enteral nutrition interruptions increasing energy intake. However, feeding tube insertion is difficult and it is not exempt of problems. Staff must be trained to detect and decrease complications associated with its utilization.

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Footnote

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