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Management of gastrointestinal failure in the adult critical care setting

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Purpose of review
Gastrointestinal failure is a polymorphic syndrome with multiple causes. Managing the different situations from a practical, metabolic, and nutritional point of view is challenging, which the present review will try to address.

Recent findings
Acute gastrointestinal injury (AGI) has been defined and has evolved into a concept of gastrointestinal dysfunction score (GIDS) built on the model of Sequential Organ Failure Assessment (SOFA) score, and ranging from 0 (no risk) to 4 (life threatening). But there is yet no specific, reliable and reproducible, biomarker linked to it. Evaluating the risk with the Nutrition Risk Screening (NRS) score is the first step whenever addressing nutrition therapy. Depending on the severity of the gastrointestinal failure and its clinical manifestations, nutritional management needs to be individualized but always including prevention of undernutrition and dehydration, and administration of target essential micronutrients. The use of fibers in enteral feeding solutions has gained acceptance and is even recommended based on microbiome findings. Parenteral nutrition whether alone or combined to enteral feeding is indicated whenever the intestine is unable to process the needs.

Summary
The heterogeneity of gastrointestinal insufficiency precludes a uniform nutritional management of all critically ill patients but justifies its early detection and the implementation of individualized care.

Keywords
gastrointestinal dysfunction, Nutrition Risk Screening, nutrition therapy, score

INTRODUCTION

Most clinicians agree on the need to feed patients and recognize the increase in morbidity and mortality linked to malnutrition [1▪▪] but the nonimmediacy of the repercussions of acute underfeeding makes the task more complex and often devolved on nursing teams, in the same way as early mobilization or pressure injury prevention. Indeed the ICU patients are characterized by acute organ failure(s) and its/their management. Although the cardiac, pulmonary, or renal failure are all systematically searched for and regularly assessed, gastrointestinal failure is still not uniformly addressed and recognized. This important organ system has until now been excluded from the assessment of multiple organ failure scores, such as in the SOFA score, where only the liver is representing the entire gastrointestinal tract [2▪▪]. This manifests by a lack of diagnostic standardization and reliable clinical markers [2▪▪], compared with the bedside echocardiography for the heart, the blood gas analysis for the lung, or diuresis/creatinine for the kidney. Moreover, the gastrointestinal barrier is the largest surface of the body in contact with the environment [3], playing an essential role in physical and microbiological human defenses. To realize its different functions, the gastrointestinal tract requires 30–40% of body's energy expenditure in baseline [4], making it particularly vulnerable in case of hemodynamic shock.

In the ICU, the prevalence of gastrointestinal failure symptoms is very high. The critically ill

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KEY POINTS

- Gastrointestinal dysfunction (GIDS) is very frequent in critically ill patients, and requires careful analysis of the dominant problem to be efficiently addressed.
- High gastric residual volumes, constipation and diarrhea are the most frequent functional alterations.
- The heterogeneity of gastrointestinal insufficiency precludes a uniform nutritional management of all critically ill patients but justifies its early detection of nutritional risk and the implementation of individualized care.
- Micronutrient deficiencies are often present: most frequent deficiencies include zinc and vitamins B12 and D.
- Nutritional assessment of the intestine's absorption capacity is particularly important to decide feeding strategy: enteral nutrition is often inefficient or not feasible, making the patients dependent on combined enteral and parenteral nutrition strategies.

patients are getting older and have often many comorbidities (cancer, diabetes, other chronic diseases), favoring preadmission malnutrition often associated with sarcopenia. Their principal diagnosis includes one or more organ failures. Most critically ill patients are mechanically ventilated, sedated and under vasoactive drugs. They receive opioid medications and sometimes a significant volume of crystalloid fluids for resuscitation. Each of these factors promotes gastrointestinal failure. Moreover, the critically ill patients are subject to multiple imaging or invasive procedures, resulting in recurrent fasting periods.

Although a definition of gastrointestinal failure has emerged called acute gastrointestinal injury (AGI) with a grading from I (low risk) to IV for the worst stages [5], it is a polymorphic syndrome, resulting from impaired gastrointestinal motility (gastroparesis or lower gastrointestinal paralysis), enterocyte function disorders (impaired absorption mechanism and/or impaired mucosal barrier function), altered bile acid homeostasis or impaired mesenteric perfusion. All the pathophysiological mechanisms can be both cause and consequence of the critical illness. Depending on their severity, these mechanisms can lead to life-threatening conditions, such as Ogilvie's syndrome, gastrointestinal perforation, massive gastrointestinal bleeding, sepsis because of bacterial translocation, abdominal compartment syndrome and nonocclusive bowel ischemia [6▪▪]. Despite having contributed to improve communication, the AGI score has recently been replaced by the concept of gastrointestinal dysfunction score (GIDS) [2▪▪].

A further difficulty is the lack of reliable biomarkers. Several have been proposed, such as plasma citrulline concentration to estimate enteric mass [7], fatty acid-binding protein, tracer glucose absorption, or paracetamol absorption to provide a semiquantitative evaluation of absorption [8,9], and a few others [2▪▪]. Gastric residual volume (GRV), the most frequent indicator of dysfunction, is neither linked to any biomarker nor to any imaging (although gastrointestinal ultrasound is promising). There is, thus, a requirement for a regular and targeted clinical assessment of a sum of gastrointestinal symptoms and signs. An increasing number of detected gastrointestinal symptoms is associated with increased mortality [10]. This review will attempt to provide a global view of the management.

HOW TO ASSESS

To assess the patient's nutritional status within the first 48 h of admission is the first step of management [1▪▪]. The Nutrition Risk Screening (NRS) score is a simple tool that has been validated in critical care settings: scores at least 5 points are associated with an increased mortality [11].

The enteral feeding tolerance and the capacityof the gut to cover the nutritional needs remains the gold standard for monitoring of gastrointestinal function in critically ill patients. The GIDS includes absence of oral food intake as a marker of dysfunction. Food intolerance is diagnosed on at least twice daily clinical examination, based upon repeated or profuse vomiting, regurgitation, abdominal distension, absent/abnormal bowel sounds, abdominal pain, absence/presence of stool, flow of any stoma, severe diarrhea, enhanced intra-abdominal pressure (IAP) and/or GI bleeding. Surprisingly, these easily available variables are not always reported on the patient's charts, and thus remain unrecognized. The assessment is based mainly on two numeric variables: the GRV and the IAP.

Gastric residual volume

Measurement is realized by suctioning of a gastric tube with a syringe or by connecting a drainage bag positioned at the stomach level and observing for a period between 15 and 120 min. Ultrasound imaging is attractive for gastric overfilling evaluation, for free-fluid screening, to exclude digestive loops distension and correct positioning control of the nasogastric tube [12]. This widely used variable became controversial after a large randomized trial [13] failed to demonstrate a difference in incidence of

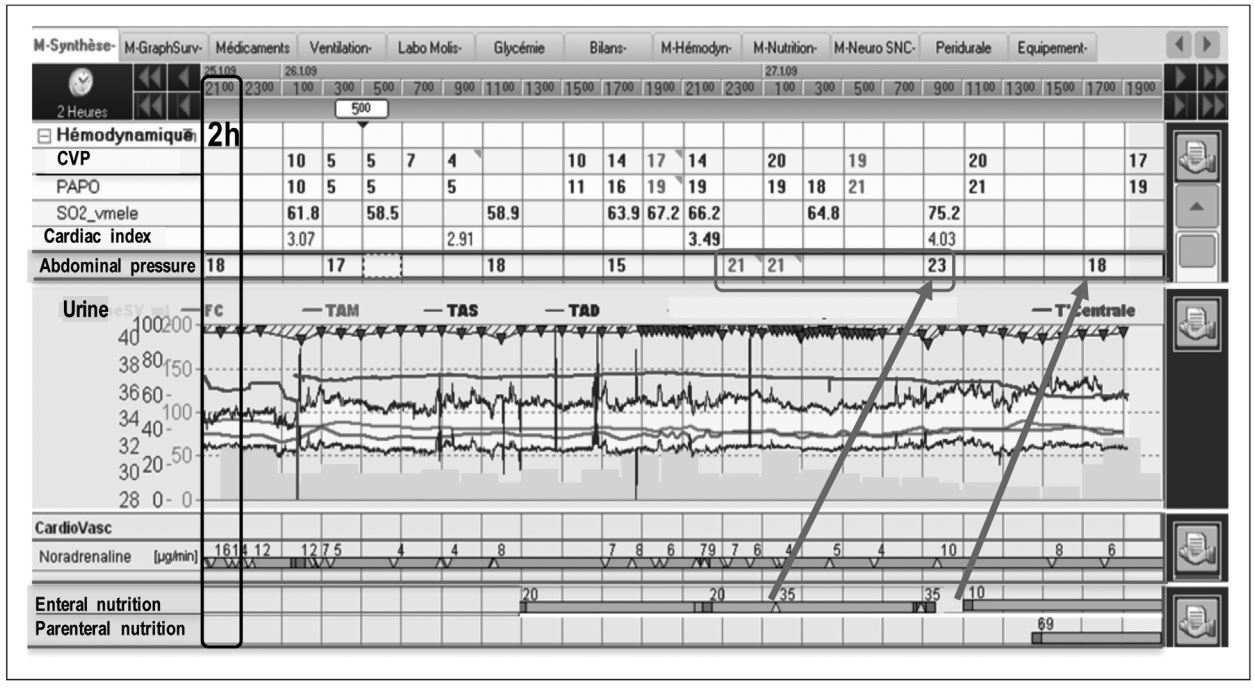

FIGURE 1. Case of intra-abdominal hypertension after major vascular surgery: intra-abdominal pressure increased with the patients in receiving 35 ml/h of enteral nutrition (EN). When intra-abdominal pressure (IAP) reached 23 mmHg, EN was stopped for 2 hrs, and reintroduced at 10 ml/h with parallel introduction of parenteral nutrition. IAP stabilized at 17 mmHg under simultaneous negativing of fluid balance.

ventilation-associated pneumonia in patients with protected airway: moreover GRV measurement was associated with reduction of nutrition delivery [14]. However, high gastric residuals indicate a higher vomiting risk during initiation of enteral nutrition and/or in patients presenting abdominal symptoms during enteral nutrition. The management of high gastric residuals, includes metoclopramide, a widely used prokinetic drug, despite its relatively low efficiency, often in association with erythromycin during 48 h for a longer sustained effect [15]. These drugs accelerate gastric emptying. Postpyloric feeding can also be proposed in confirmed gastroparesis. Positioning the patient is very important, as a bed angle less than 30° is associated with increased gastric aspirates [16].

Intra-abdominal pressure

IAP is measured by instilling 50 ml water with a syringe into the bladder via an urinary catheter. It is often a neglected variable, despite its high prevalence [17▪▪], and its grading being correlated with mortality rates. The World Society of the Abdominal Compartment (WSACS), published recommendations for medical management in three steps to reduce IAP [18]. The therapeutic objectives are to evacuate intraluminal contents, and intra-abdominal space occupying lesions, to improve abdominal wall compliance, and to optimize fluid administration and systemic/regional perfusion. The monitoring of IAP, during introduction and increasing the rate of enteral nutrition, will assist the clinician to detect abnormal increases of IAP in patients with severe abdominal disorders, hypoperfusion and fluid overload. Although a modest increase of IAP should not lead to the automatic discontinuation of enteral nutrition, values reaching 20 mmHg should be considered a warning against enteral nutrition start or progression, raising the question of reducing of stopping enteral nutrition as shown in Fig. 1: the enteral nutrition flowing at 35 ml/h was first stopped, and restarted at 10 ml/h (trickle feeding) 2 hrs later when IAP decreased, whereas parenteral nutrition was initiated to cover the needs. The laxatives are sometimes used in prophylaxis to reduce the time to defecation but their effect is limited.

HOW TO MANAGE PRACTICAL PROBLEMS

Abnormal gastrointestinal motility

Constipation

Constipation is more frequent than diarrhea [19], the incidence varying from 5 to 83% [20], but is

less frequently diagnosed. It is defined as absence of passing stools for more than 4 days. It is more common among enterally fed patients compared with oral feeding, and may have serious consequences on other organs, particularly the lung [16]. Constipation enhances the risk of abdominal compartment syndrome. Specific risk factors are dehydration, drugs that reduce gastrointestinal motility (myorelaxant, opioid, antihypertensive drugs, iron/calcium supplements) and bed rest. Current treatments are based on laxatives and enema. Neostigmine is used in the most persistent cases of paralytic ileus [21]: the latter may be delivered intravenously or subcutaneously.

Preventing constipation may prevent organ dysfunction as shown by a randomized trial including patients on mechanical ventilation: a significant grated reduction of the SOFA score in those receiving laxatives from start was observed [22]. The dietary fiber play an important role in prevention [23▪▪], whereas absence of fibers is associated with a reduction of number and diversity of microorganisms. In addition, insoluble dietary fibers improve intestinal transit by increasing bulk reducing the need for laxatives. Recent reviews and meta-analysis indicate that fibers should be part of any enteral feeding solution for gut and global health purpose, including in inflammatory bowel disorders [24▪,25].

Diarrhea

Diarrhea is both a burden for the nurses [26], and a risk for the patients as it threatens skin integrity, and potentially causes malabsorption. The reported diarrhea prevalence is between 2 and 68%. Prevention is based on the use of fiber containing enteral feeding solutions [25]. The main cause of diarrhea is the antibiotic prescription, present in over 70% of ICU patients [27]. The mortality due to antibiotic-associated diarrhea, including Clostridium positive patients, varies between 10% and 56%.

The pathophysiological mechanisms of the different forms of diarrhea, inflammatory (ulcerative colitis, Crohn's disease and coeliac disease), the infectious, and secretory, include multiple alterations of ion and solute transporters, as well as activation of cyclic nucleotide and Ca^{2+}-signaling pathways [28].

Current management of diarrhea has not changed much over 30years, and includes replacement of fluid and electrolyte losses using oral or intravenous rehydration, and cautious use of drugs reducing intestinal motility (μ-opioid agonists) or fluid secretion [29].

For diarrhea caused by enteric infections, various antibiotics are also used depending on the pathogenic organism [30]. The use of antimotility drugs has been limited by concerns of ileus, ischemic colitis and overgrowth bacterial risk. Several meta-analyses and clinical studies have suggested that probiotics prevent or reduce the duration of diarrhea [31,32].

Fibers are also important in the treatment of diarrhea, particularly the soluble ones (guar gum and others). The dietary fiber intake (15–30 g/day) is recommended in patients and in healthy individuals as it supplies short-chain fatty acid to the gut mucosa, promoting electrolytes and water reabsorption in the colon, limiting the growth of pathogenic bacteria, and normalizing transit times, and supplemented in partially hydrolyzed guar gum.

Short bowel syndrome

In patients with short bowel syndrome (SBS) with jejuno-ileostomy, nutritional therapy is essential to prevent complications associated with a high-output stoma (HOS), considered clinically significant if the volume exceeds 2000 ml/day [33,34]. The complications of HOS include dehydration, electrolyte imbalances (sodium and magnesium), and undernutrition. Even if the large healthy bowel can absorb, after an adaptive phase, up to 1000 kcal per day in SBS patients (normally roughly 150 kcal per day), the absorption of most nutrients occurs in the first 100 cm of the jejunum. B12 vitamin and bile salts are absorbed in the last 100 cm of the ileum, magnesium in the terminal ileum and proximal colon, and water and sodium absorption occur throughout the bowel [35].

Further a multidisciplinary approach including a psychological support is essential to assure the best possible outcome and quality of life [36,37]. HOS in short bowel syndrome can be anatomical (postsurgical resection, resulting in less than 200 cm of proximal short bowel) or functional (such as intra-abdominal sepsis). The treatment is based on oral fluid restriction (isotonic drinks 500–1000 ml/ day) and intravenous hydration [loss compensation by NaCl 0.9% (1:1 above 1500 ml/24 h) and KCl supplementation], antimotility drugs (loperamide, codeine phosphate) and antisecretory drug (proton pump inhibitors, octreotide). In all cases including if surgical restoration of continuity is considered, the various deficiencies need to be corrected (magnesium, vitamins B12/A/D/E/K, and zinc) and the nutritional needs covered by artificial nutrition (combined enteral nutrition and parenteral nutrition). If fat malabsorption, steatorrhea, or pruritic bilious output is present, we add cholestyramine. The calcium bilirubinate gallstones can be prevented by maintaining an enteral feeding, limiting periods of oral fasting and by limiting the use of narcotic and anticholinergic medications.

Abnormal lymphatic drainage

Chylous losses (thoracic or ascitic) are another rare condition resulting nutritional, immune and metabolic deficiencies. The chylothorax and chylous ascites are defined similarly by a triglyceride concentration above 120 mg/dl (1.35 mmol/l) in pleural fluid and ascites. A cholesterol concentration less than 200 mg/dl (5.2 mmol/l) in pleural fluid is also indicative. Chylothorax and chylous ascites are caused bythe traumatic (postesophagectomy or major abdominal surgery) or obstructive (tuberculosis, malignancy, cirrhosis) disruption of the lymphatic system that leads to extravasation of thoracic or intestinal lymph into the abdominal space and the accumulation of a milky fluid rich in triglycerides [38,39]. Medical management of chylous ascites is nutritional and aims at decreasing chyle flow will enable the spontaneous closure of the fistula. Recommended dietary therapy is high-protein and low-fat nutrition with medium-chain triglycerides (MCTs) to decrease the production of chyle. Total parenteral nutrition with MCT may be required. Other treatments (therapeutic paracentesis, somatostatin, octreotide) are beyond the scope of this text [40].

WHEN TO REST AND WHEN TO FEED

Most contraindications to enteral feeding have become relative, except in presence of a full stop on the gastrointestinal tract but using enteral nutrition requires close monitoring. Indeed except for full stop conditions there may be variable degrees of gastrointestinal dysfunction (GID) in critically ill patients as shown by a recent large observational study [2▪▪].

Total stop

In conditions of gut obstruction or perforation and bowel ischemia, nil per intestine is the rule and needs no comment other than the initiation of parenteral nutrition until resolution of the problem.

Bowel necrosis

Bowel necrosis may rarely occur in the context of jejunal feeding [41]: it may occur in patients without risk factors for enteric ischemia. The patients on enteral nutrition develop nonspecific symptoms, severe shock and eventually multiorgan failure: these patients are candidates for prompt enteral resection and bowel rest for a few days.

Acute mesenteric ischemia

Acute mesenteric ischemia (AMI) is a potentially lethal issue generally requiring ICU admission: whereas enteral nutrition must be completely interrupted during the episode and until recanalization of the affected vessels. A randomized trial including 183 AMI patients testing the reintroduction of enteral nutrition versus parenteral nutrition within the first week postrevascularization showed that there were several advantages to the enteral nutrition strategy [42] with significantly less prolonged parenteral nutrition requirement, less infections, less respiratory complications, and earlier bowel continuity restoration in case of resection were observed.

Relative stop

Inflammatory bowel disease

Bowel rest is an old concept from the 80 s. It is theoretically attractive as one might expect that inflamed intestine would heal more quickly if relieved of mechanical trauma, intestinal secretions and the antigenic challenge of food. A randomized trial conducted in 47 patients with severe acute colitis, showed that bowel rest compared with oral food did only result in a reduction of stool weight [43] but had no impact on surgical requirements or on other outcome variables. In the most severe forms of Crohn's disease, bowel rest is still applied in cases of exacerbated painful symptoms.

Severe diarrhea

Severe diarrhea (such as due to *C. difficile*), is another form of inflammatory bowel disease, which is a condition that may call for bowel rest, and for combined parenteral nutrition and enteral nutrition.

Chylous leaks

Chylous leaks require the temporary suppression of enteral fat supply, and eventually shifting over to parenteral nutrition [44]: the MCT are used as energy source combined with amino acids and glucose. A progressive reintroduction of enteral feeding is done using a semi-elemental diet including MCT. Oral diet is reintroduced when this strategy has strongly reduced the chyle production.

No restriction

At the area of enhanced recovery after surgery (ERAS), bowel rest has limited place in the management of surgical patients: on the contrary, there is an encouragement to use the gut for feeding as early as possible [45,46▪]: using oral nutrition supplements for a few days may complete this strategy [47]. The same early start is recommended for any intubated medical or surgical patient [1▪▪].

NUTRITIONAL OPTIONS

Enteral and/or parenteral?

Recent large sized randomized trials have shown that there is equipoise between enteral nutrition and parenteral nutrition when using similar energy targets and rapid feeding progression, even in septic shock conditions [48,49]. The ESPEN-ICU guidelines insist that the enteral route should be tried first to get the nonnutritional benefits of feeding the gut: in the end the route matters little, and any tool should be used to prevent acquired malnutrition. The non-nutritional benefits [1▪▪] include supporting mucosal health (by improving blood flow, releasing trophic agents, such as cholecystokinine and bile salts), improving systemic immunity by stimulating the gastrointestinal and mucosal-associated lymphoid tissue (GALT and MALT) [50], feeds the micro-biota and is less costly than parenteral nutrition. But as gastrointestinal dysfunction is frequent and results in poor progression of feeding, and eventually malnutrition, the delivery should be monitored. Gastrointestinal dysfunction patients are typical candidates for supplemental parenteral nutrition to avoid increasing the energy and protein deficit [51▪]. The strategy is summarized in Fig. 2.

Micronutrients (vitamins and trace elements)

Absorption is compromised in gastrointestinal dysfunction, rendering the bioavailability of enterally delivered micronutrients uncertain: this uncertainty occurs especially during the early phase of acute disease, and affects all micronutrients. For this reason and as many acute admissions are associated with prior low nutrition intake, a strategy delivering a combination of moderate dose micronutrients by the intravenous route in addition to thiamin is rational (Fig. 3).

In chronic intestinal disorders, the status of several micronutrients is compromised. Deficiency of vitamins B7, B12, D, and trace elements Cu and Fe should be actively searched for using blood levels for assessment [52–54]. In the inflammatory bowel diseases, vitamins B12, A, D, E, K, and trace elements. Se and Zn deficiencies have often been shown [55]. In case of surgical bypass of the duodenum (bariatric procedures and others), malabsorption of vitamin B12 may require its therapeutic administration for the whole life [56▪]. In patients with long-standing intestinal disorders, the above micronutrient deficiencies should be systematically searched and compensated.

CONCLUSION

Each type of gastrointestinal dysfunction or failure requires specific management but all require watching for the potential development of malnutrition, by monitoring actual nutritional intake. At the area of equipoise between enteral nutrition and parenteral nutrition, both routes having advantages and complications, the assessment of the nutritional status

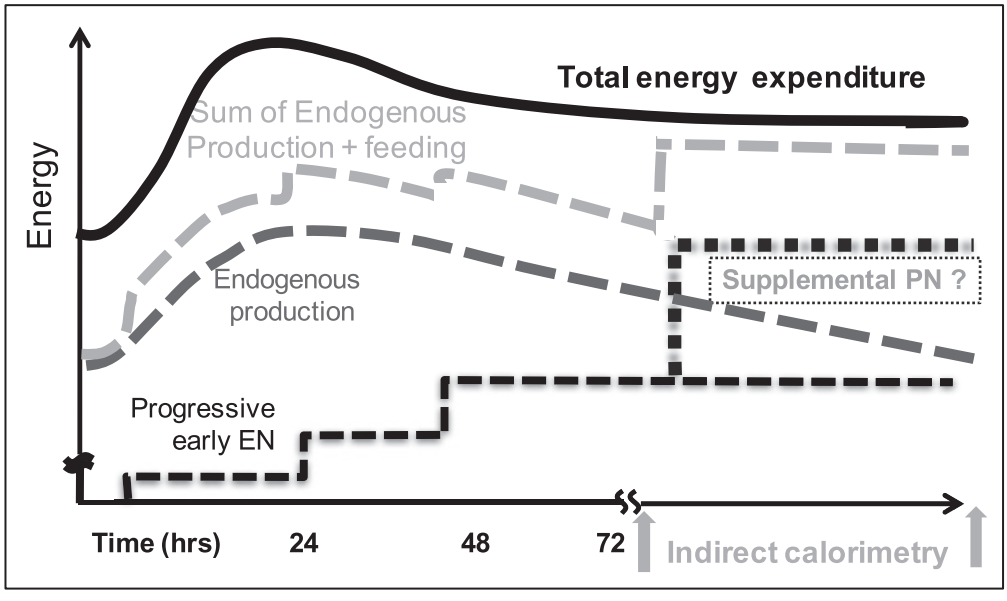

FIGURE 2. Feeding strategy aiming at an early progressive introduction of enteral nutrition while monitoring feed delivery progression and considering the indication to parenteral nutrition or supplemental parenteral nutrition in presence of gastrointestinal dysfunction score. This strategy prevents both underfeeding and overfeeding. Adapted with permission from Oshima T *et al. Clin Nutr* 2017; 36: 651–662.

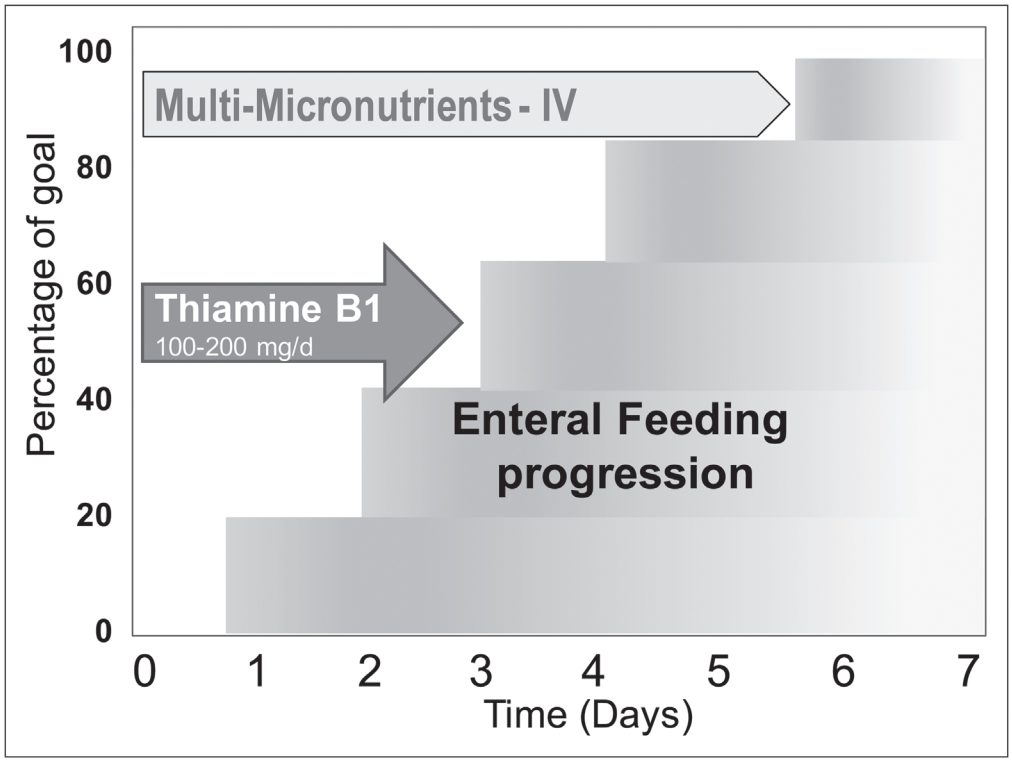

FIGURE 3. Proposed intravenous micronutrient complementation strategy combining 100–200 mg thiamine/day for 3–4 days and parenteral nutrition doses of vitamins and trace elements until enteral nutrition goals is reached, that is, for 5–6 days. Adapted from Preiser *et al.* [57▪].

and of the gastrointestinal function upon admission are the essential first steps to determine the strategy.

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Conflicts of interest

There are no conflicts of interest.

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