Nutrition 29 (2013) 1075–1079

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Review

Use of gastric residual volume to guide enteral nutrition in critically ill patients: A brief systematic review of clinical studies

David D. Kuppinger M.D., Peter Rittler M.D., Wolfgang H. Hartl M.D. *, Dominik Rüttinger M.D.

Department of Surgery, University School of Medicine, Grosshadern Campus, Ludwig-Maximilian University, Munich, Germany

ARTICLE INFO

Article history:
Received 2 November 2012
Accepted 30 January 2013

Keywords:
Systematic review
Gastric residual volume
Enteral nutrition
Aspiration
Pneumonia

ABSTRACT

Objective: In critically ill patients, the optimal procedure to monitor upper gastrointestinal function is controversial. Several authors have proposed gastric residual volume (GRV) as a tool to guide enteral nutrition. The aim of this contribution is to briefly discuss corresponding studies.
Methods: We electronically searched MEDLINE, EMBASE, and CINAHL for studies relevant to the subject.
Results: Six randomized controlled trials (RCTs) and six prospective observational studies were identified. Each analyzed different thresholds of GRV to guide enteral nutrition and to avoid complications (e.g., vomiting, aspiration, nosocomial pneumonia) in artificially ventilated patients. Due to heterogeneity in outcome measures, patient populations, type and diameter of feeding tubes, and randomization procedures, combination of the results of the six RCTs into a meta-analysis was not appropriate. High-quality RCTs studying medical patients could not demonstrate an association between complication rate and the magnitude of GRV. The only observational study that adjusted results to potential confounders and that studied surgical patients found, however, that the frequency of aspiration increased significantly if a GRV $>$ 200 mL was registered more than once.
Conclusion: For mechanically ventilated patients with a medical diagnosis at admission to the intensive care unit, monitoring of GRV appears unnecessary to guide nutrition. Surgical patients might profit, however, from a low GRV threshold (200 mL).

Introduction

In critically ill patients, the frequency of motility disorders in the upper or lower gastrointestinal (GI) tract may amount to up to 80%. Among these motility disorders, a delayed passage is clearly more common (in certain cohorts up to 85% of the cases) than nutrition-related diarrhea (10%–20% of the cases). Thus, delayed gastric emptying may be found in 50% of artificially ventilated patients and in 80% of patients suffering from cerebral hypertension after a skull and brain trauma. Delayed gastric emptying also is common in severe sepsis or after burn injury or polytrauma [1]. Besides gastroparesis, severe systemic inflammatory response syndrome or sepsis also may cause paralytic motility disorders in the small and large bowel [2]. The frequency of clinically apparent, abnormal abdominal findings varies between 20% and 70% [3]. Disorders of GI motility may lead to regurgitation or vomiting of gastric contents, which then may be aspirated eventually causing severe aspiration pneumonia [4].

In critically ill patients incapable to consume oral foods, enteral nutrition is the preferred route of nutrient supply. Guidance of enteral nutrition according to upper GI function has gained a firm place in routine handling of artificial nutrition. To monitor GI function and to avoid a potentially fatal macro-aspiration, measurement of gastric residual volume (GRV) has been incorporated into specific guidelines [4–8]. Some studies have recommended that nutritional support be modified above GRV values of 500 mL [4,6], 300 mL [5], and 250 mL [7] (on the basis of measurements performed 4 h after starting nutrition).

A survey found that more than 97% of critical care nurses are measuring GRVs; the most frequently cited threshold levels for interrupting feedings are 200 mL and 250 mL. Approximately 25% of nurses reported interrupting feedings for GRVs of 150 mL or less; only 12.6% of the respondents reported allowing GRVs of up to 500 mL before interrupting feedings [9]. Recently, however, the usefulness of measuring GRV during enteral nutrition has

WHH, PR, DR, and DK performed the literature search and drafted the manuscript. WHH and DR analyzed the individual studies. All authors read and approved the final manuscript. The authors declare that there are no competing interests.

* Corresponding author. Tel.: +49 89 7095 5553; fax: +49 89 7095 5459.
E-mail address: whartl@med.uni-muenchen.de (W. H. Hartl).

0899-9007/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.nut.2013.01.025

Table 1
Prospective randomized studies that examined the use of various threshold values of GRV to guide enteral nutrition, or which examined the importance of a large GRV to predict complications (vomiting)

Author (design)	Number of patients	Patient characteristics	GRV threshold to interrupt gastric feeding	End point	Type of tube	Result
Pinilla JC et al [15] (monocentric)	96	50% surgical (invasive ventilation)	> 150 mL vs. > 250 + prokinetics	Frequency of vomiting	100% NG 14–18F	Not significant
McClave SA et al [14] (monocentric)	40	62.5% surgical (invasive ventilation)	> 200 mL vs > 400 mL	Frequency of aspiration	19 × NG 12F 19 × PEG	Not significant
Montejo JC et al [12] (multicentric)	329	Medical (invasive ventilation)	> 200 mL vs > 500 mL	Frequency of aspiration	Not specified	Not significant
Reignier J et al [13] (multicentric)	449	93% medical (invasive ventilation)	GRV > 250 mL vs. vomiting (no GRV-threshold)	Frequency of ventilation-associated pneumonia	Not specified	Not significant
			Frequency of GRV > 300–400 mL			
Desachy A et al [16] (multicentric)	100	32% surgical (invasive ventilation)	22% vs. 58%	Frequency of vomiting	100% NG 16–18 F	Not significant
EDEN Trial [17] (multicentric)	1000	62% medical (invasive ventilation)	2.2% vs. 4.9%	Ventilator-free days to study day 28	Not specified	Not significant

EDEN, Early Vs. Delayed Enteral Nutrition in ALI; GVR, gastric residual volume; NG, nasogastric tube; PEG, percutaneous tube

been seriously challenged [10]. This contribution analyzes the evidence supporting or contradicting the use of measuring GRV or of considering distinct GRV threshold values to guide enteral nutrition.

Methods

We used a multimethod approach to identify relevant studies for this contribution. The National Library of Medicine's MEDLINE database was searched for relevant studies published from 1990 to January 2013 using the following medical subject headings and keywords: (stomach OR gastric) residual volume OR upper digestive system intolerance OR gastrointestinal contents OR gastric content. Additionally, we searched EMBASE and the Cochrane Database of Systematic Reviews. Bibliographies of all selected articles and review articles that included information on gastric residual volume were reviewed.

We independently assessed allocation concealment and the likelihood of bias to determine the methodologic quality of the included trials. The allocation concealment was ranked as adequate, uncertain, or clearly inadequate, and the likelihood of bias was scored on the Jadad 5-point scale [11].

Results

Twelve prospective studies, of which 6 were randomized controlled trials (RCTs; Table 1) and 6 were observational (Table 2), examined specific end points (frequency of vomiting, aspiration, and pneumonia). Only patients requiring invasive ventilation at admission to the intensive care unit (ICU) were studied. Only two RCTs were of high quality (Jadad score ≥ 3), used random allocation, and clearly reported allocation of concealment [12,13]. In none of the studies were the treating clinicians blinded to treatment allocation; in only one RCT, the study investigators/assessors were blinded to treatment and outcome [13].

None of the RCTs found an association between the magnitude of GRV and the complication rate. Due to heterogeneity in outcome measures, patient populations, type and diameter of feeding tubes, and randomization procedures, combination of the results of the six RCTs into a meta-analysis was, however, not appropriate. Furthermore, interpretation of randomized studies was limited by a variety of problems: 1) missing information on the diameter of tubes, exclusion of high-risk patients (patients after abdominal operations) [12,13]; 2) inclusion of patients with nasogastric and percutaneous feeding tubes, small patient numbers [14]; 3) use of prokinetics in case of a large GRV [15]; and 4) randomization of patients according to the speed of nutritional enhancement (instead of the magnitude of GRV) [16,17].

The largest high-quality RCT (N = 492 patients) was a non-inferiority multicenter trial performed with a cohort of patients in which 93% had a medical diagnosis at ICU admission. Of these patients, 222 were randomized to a protocol in which GRV was checked every 6 h, with adjustment of enteral feeding rates if the GRV exceeded 250 mL (control group) and 227 patients whose GRVs were not checked and whose enteral feeding rates were adjusted only when patients experienced vomiting or regurgitation (intervention group). Despite experiencing almost twice as much vomiting, patients in the intervention group did not experience significantly more nosocomial pneumonia [13].

The other high-quality RCT was performed by Montejo et al [12]. The authors randomized 329 medical ICU patients. Target variable was the rate of GI complications (macroaspiration, vomiting). Secondary outcome parameters were the frequency of pneumonia, days on mechanical ventilation, days in the ICU, day 5 Sequential Organ Failure Assessment (SOFA) score, final SOFA score, and mortality. The authors found a comparable rate of GI complications or pulmonary infections whether 200 mL or 500 mL was used as threshold value of GRV. Overall outcome also was comparable.

Corresponding to the results of RCTs, most of the observational studies could not demonstrate an association between the magnitude of GRV and complication rate. Interpretation of observational studies, however, also is, difficult. With the exception of one study [18], no study made adjustments for confounders, and conclusions only were based on results of univariate analyses [19–23]. Furthermore, two studies did not indicate the diameter of gastric tubes [19,20], and in one study nearly half of the patients had a gastric tube that was too small (10 F) [22].

The observational study designed the best prospectively observed 206 critically ill patients (76% were operative admissions) [18]. Dependent variable was the occurrence of an aspiration. More than 3000 tracheal secretions obtained during suctioning were analyzed for pepsin. The pepsin-positive tracheal secretion served as a proxy for aspiration of gastric contents. No direct relationship was found between aspiration and GRVs; that is, patients aspirated even when high GRVs were absent. However, they aspirated significantly more often when high GRVs were present. When GRVs were entered into a regression model with other risk factors for aspiration (including low level of consciousness, low head-of-bed elevation, sedation, vomiting, and severity of illness), the following values were found to be significantly associated with aspiration: two or more