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Original Article

Is Gastric Residual Volume Measurement Really Necessary to Achieve Targeted Calories?

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ABSTRACT

Objective: Malnutrition, energy protein, and inadequate or excessive intake of other nutrients have measurable effects on tissues, body function, and clinical outcomes of patients. We aimed to determine the time to reach target calories, nutritional failures, and complications during feeding in measured and unmeasured gastric residual volume patients under ventilation in the intensive care unit.

Methods: The study was completed with 62 patients under mechanical ventilatory support in the intensive care unit. According to the consultation order, patients were divided into 2 groups. Gastric residual volume was measured in the control group (gastric residual volume, n = 31) and not in the other (non-gastric residual volume, n = 31). Nutrition nurses continuously monitored all enteral-fed patients, and the results were recorded.

Results: The feeding pause of the gastric residual volume group was longer than that of the non-gastric residual volume group ($P < .001$). The time to reach target calories was higher in the gastric residual volume group than in the non-gastric residual volume group ($P = .010$). The rate of vomiting as a complication was 9.7% (3 patients) in the gastric residual volume group and 6.5% in the non-gastric residual volume group, although the difference was not significant ($P = .641$). The observation rate of abdominal distension was 6.5% (2 patients) in the gastric residual volume group and the non-gastric residual volume group ($P = .999$). The positive end-expiratory pressure (PEEP) values were higher in patients who vomited, but the difference was not significant ($P = .203$). In patients with abdominal distension, PEEP values were higher than in patients without distension, but the difference was not significant ($P = .282$).

Conclusion: In conclusion, gastric residual volume measurement in patients with mechanical ventilatory support prolonged nutritional breaks and extended the time required to reach target calories compared with patients without gastric residual volume measurement.

Keywords: Enteral nutrition, gastric residual volume, intensive care unit, malnutrition, target calorie

INTRODUCTION

Over the past 30 years, with a better understanding of the molecular and biological effects of nutrition, more emphasis has been placed on nutrition, which has positively impacted the treatment of critical care patients.[1] Nutritional homeostasis refers to all metabolic regulatory mechanisms that aim to maintain the physiological functions, energy, and other nutrient stores in a constant state.[2] Nutritional support is an important component of the treatment strategy for intensive care patients.

In intensive care units (ICU), most patients do not achieve targeted caloric and protein intake, although various nutritional supplements are available today. This leads to malnutrition. Malnutrition, energy protein, and inadequate or excessive intake of other nutrients have measurable effects on tissues, body structure, body function, and clinical outcomes of patients receiving treatment. It is a broad term that encompasses protein-energy malnutrition and nutrient deficiencies such as micronutrients. It increases hospital-acquired infections, hospitalizations, and intensive care prolongs and leads to complications.[3] A compilation assessing malnutrition rates in patients presenting to the ICU found that malnutrition rates ranged from 37.8% to 78.1% in heterogeneous ICU patients.[4] Uncontrolled factors are related to the nutrition of ICU patients. Although several measures have been proposed to support the nutritional status of these patients, unfortunately, there are currently no standard guidelines. Nutritional Risk Screening (NRS 2002) is one of the most established screening tools for inpatient medical care.[5] Nutritional Risk Screening assesses the patient's nutritional status (weight loss, body mass index, based on general condition or dietary intake) and severity of illness (stress metabolism associated with severity of illness) and is associated with a higher risk of adverse outcomes. Each area is evaluated from 0 to 3, with patients receiving an additional point if they are 70 or older.[6] Heyland et al[7] to determine the causes of malnutrition, found that 52% of patients could not tolerate enteral nutrition. One of

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the common causes of this tolerance failure was gastric residual volume (GRV).[7] The GRV is the amount of undigested nutrients remaining in the stomach after enteral feeding. It is composed primarily of undigested food formula and gastric fluid. In enteral nutrition patients, GRV measuring is frequently used to determine nutritional tolerance. Gastric aspiration contents can be measured with a 50 mL injector or by draining into a bag using gravity.[8] Adam and Baston[9] found that only 76% of the targeted calories could be administered to ICU patients. In another study by McClave et al[10] 44 patients could be fed enteral nutrition and received only 78.1% of the planned calories. It was found that only 14% of the patients reached their daily target calories in the first 72 hours. Gastric residual volume was the leading cause of this deficit in the same study.[10]

Increased GRV carries the risk of gastroesophageal reflux and aspiration.[11] It delays gastric emptying and increases the risk that the patient's tolerance to food will decrease, leading to interruption of food intake.[12] This risk could lead to long-term access to target calories and malnutrition. Our study aimed to observe the time to reach target calories, nutritional failures, and complications during feeding in measured and unmeasured GRV patients receiving enteral nutrition under ventilation in the ICU.

METHODS

The study was performed at the Erzincan Binali Yıldırım University Mengücek Gazi Training and Research Hospital Anesthesiology and Reanimation intensive care unit. Approval was obtained from the Erzincan Binali Yıldırım University ethics committee (Date: April 26, 2021, Number: 06/22). The full study protocol was registered in the Clinical Trials Database (NCT05238051). Nutritional procedures were explained to the legal heirs of all patients hospitalized in the ICU, and their informed consent was obtained. Patients who received tracheal intubation with mechanical ventilatory support between May 2021 and January 2022 were included in the study. Patients with a history of gastrointestinal bleeding, parenteral nutrition support, hospital stay of fewer than 2 days, and those under 18 years of age were excluded from the study. Our nutrition team screened patients treated in the ICU with the malnutrition screening tool and assigned patients with a score of 2 or higher to the nutrition department. Patients in whom enteral nutrition was not contraindicated were divided into 2 groups according to the consultation order. All patients were placed with a 110 cm polyurethane 14F nasogastric tube and their location was confirmed. The patients' target calories were calculated using the Schofield equation because the hospital did not have an indirect calorimetry device. Feeding pumps were used in the study, and patients were fed continuously. All patients received a head elevation of 30° during feeding. Ready-to-eat foods found in the hospital pharmacy and approved by the ICU physician were used. The calculated target calorie amount was administered via a nasogastric tube using a continuous infusion method. Nutrition nurses continuously monitored all enteral-fed patients, and the results were recorded.

A total of 72 patients were enrolled in the study. Gastric residual volume was measured in one group and not in the other. In the GRV group, feeding was initiated at an infusion rate of 20 mL/h. The GRV was measured every 4 hours. When it was less than 200 mL, the infusion rate was increased by 20 mL/h. The infusion rate, which was increased every 4 hours according to the GRV, was continued constantly when the target calorie was reached. It was kept constant when the GRV was above 200 mL and then the feeding rate was reduced to half when the GRV volume was above 400 mL. In 4 patients, enteral nutrition was discontinued due to melena and excluded from the study. In 6 patients with persistently high GRV values, enteral nutrition was discontinued and parenteral nutrition was initiated. The study was completed with 62 patients; GRV (n = 31) and non-GRV (n = 31).

In patients without measuring GRV, the feeding rate was increased by 20 mL/h every 4 hours. The infusion rate was kept constant when the target calories were reached. All patients were observed for vomiting, diarrhea, recovery, and constipation for 10 days. When complication was present, the infusion rate was reduced by 20 mL/h. In patients who experienced vomiting and flatulence, the intensivist initiated treatment of complications. Enteral nutrition was discontinued if the complication persisted despite the reduced dose, and parenteral nutrition was started. The dietitian recorded all the patients' daily data.

Malnutrition Screening Tool

We used NRS 2002 screening tool to determine malnutrition. Weight loss and food consumption are measured, and scores are tallied. Patients with a score of 0 or 1 are deemed not at risk, whereas those with a score of 2 or more are considered at risk.

Scofield Equation

Target caloric intake was measured using the Scofield equation, which is a simple, practical, widely used, and more accurate method of predicting resting energy expenditure. Energy intake corrected for stress factors or metabolic values was held constant for all patients throughout the study.[13]

Statistical Method

All statistical analyses were performed using IBM Statistical Package for Social Sciences software package program version 22 (IBM SPSS Corp. Released 2013, Armonk, NY, USA). Categorical variables were summarized as number and percentage, and continuous variables were summarized as average and standard deviation or median. We used chi-square test for analyzing categorical variables, the Kolmogorov-Smirnov test to analyze the compatibility of variables with the normal distribution, Student's *t* test for group comparisons of data with normal distribution, and Mann–Whitney *U* test in cases where there was no assumption of

Main Points

- Malnutrition is more common than anticipated, but there are problems with its detection.
- Nutritional procedures in intensive care may be a cause of malnutrition that is difficult to detect.
- This study opened a new window to the discussion of gastric residual volume measurement in the routine nutritional procedures.

Table 1. Patients Characteristics

Gastric Residual Volume		Age	Corr. Weight	Target Calories	Break Time (Hours)	Reach Time (Hours)
Group non-GRV	Mean	72.81	64.48	1449.74	4.35	46.10
	Standard deviation	13.370	11.524	208.852	1.199	10.137
	Median	74.00	65.00	1430.00	4.00	44.00
	Minimum	26	41	1100	3	32
	Maximum	89	85	1800	6	72
Group GRV	Mean	67.71	66.81	1542.10	7.74	52.45
	Standard deviation	16.485	8.822	176.426	2.449	13.125
	Median	71.00	65.00	1500.00	7.00	48.00
	Minimum	26	47	1297	3	24
	Maximum	89	83	2000	16	96

The mean age of the GRV group was 67.71 years and that of the non-GRV group was 72.81 years. The adjusted weight was 66.81 for the GRV group and 64.48 for the non-GRV group.
GRV, gastric residual volume.

normality. In all statistical tests, $P < .05$ was deemed statistically significant.

RESULTS

The gender distribution of male and female patients included in the study was equal. The mean age of the GRV group was 67.71 years and that of the non-GRV group was 72.81 years. The adjusted weight was 66.81 for the GRV group and 64.48 for the non-GRV group. Age and adjusted weight did not differ in a statistically significant way (Table 1). The feeding pause of the GRV group was longer than that of the non-GRV group ($P < .001$) (Figure 1). The time to reach target calories was higher in the GRV group than in the non-GRV group ($P = .010$) (Figure 2).

The rate of vomiting as a complication was 9.7% (3) in the GRV group and 6.5% (2) in the non-GRV group and there was no significant difference. The observation rate of abdominal distension as a complication was 6.5% (2 patients) in the GRV group and the non-GRV group.

Although there was no significant difference, positive end-expiratory pressure (PEEP) values were higher in vomited

Figure 1. The feeding pause of the GRV group was longer than that of the non-GRV group ($P < .001$). GRV, gastric residual volume.

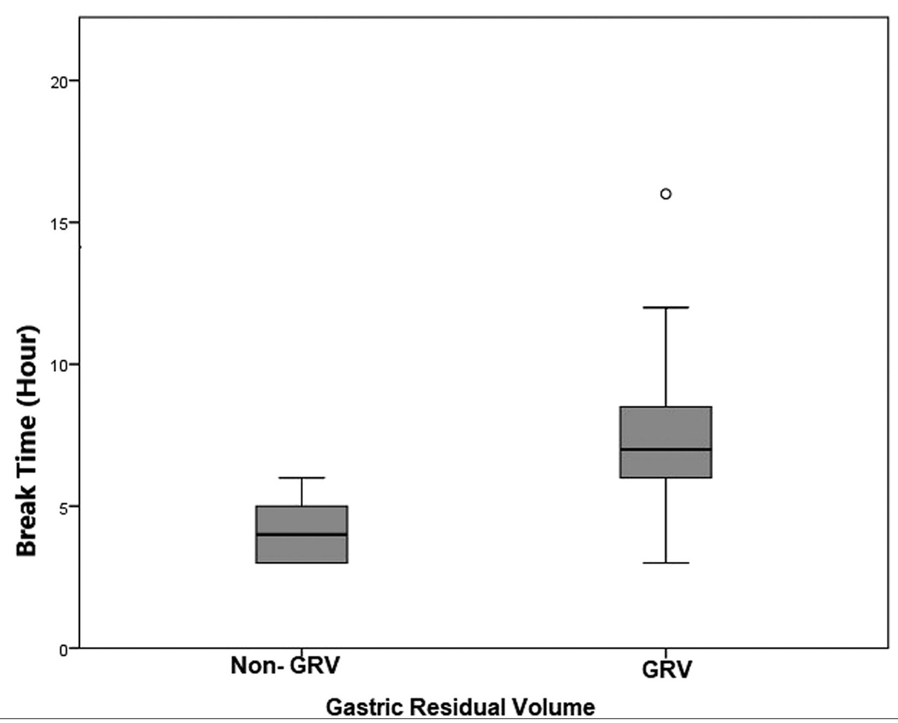
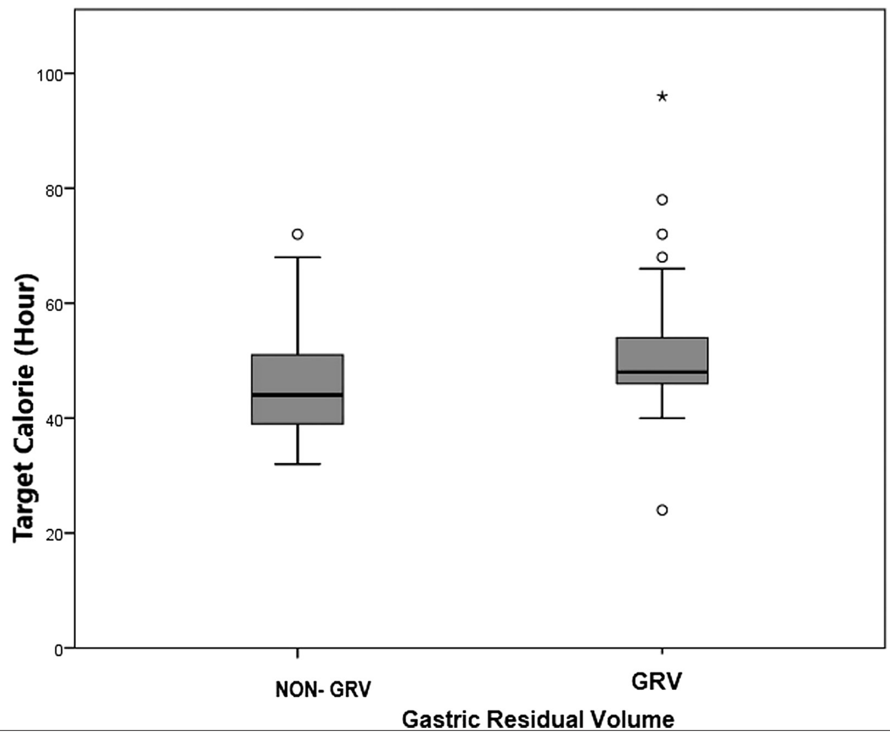


Figure 2. The time to reach target calories was higher in the GRV group than in the non-GRV group ($P=.010$). GRV, gastric residual volume.



patients. In patients with abdominal distension, PEEP values were higher than in patients without distension, but the difference was not statistically significant (Table 2).

DISCUSSION

Critically ill patients are exposed to many adverse conditions and diseases that lead to intensive care. In these patients, malnutrition can quickly occur, negatively affecting the recovery of the underlying diseases.[2] Measurement of GRV is a common method for assessing nutritional tolerance in ICU patients. However, various factors, including patient posture, feeding tube placement, feeding tube inner diameter, syringe size, and measuring method, might impact the amount of GRV.[14] One study found that GRV was approximately 2-fold higher on average compared to patients with large feeding tubes and narrow feeding tubes.[15] Our study used a 14F, 110-cm-long, PVC-coated polyurethane feeding tube. The patient's head position was kept elevated by 30° during feeding. No problems occurred with the probe.

Table 2. Comparison of PEEP on Enteral Nutrition Complications

Vomiting		PEEP	Distension		PEEP
None	Mean	5.93	None	Mean	6.00
	Standard deviation	1.613		Standard deviation	1.707
	Median	5.00		Median	5.00
	Minimum	4		Minimum	4
	Maximum	12		Maximum	12
Yes	Mean	7.20	Yes	Mean	6.50
	Standard deviation	2.168		Standard deviation	1.291
	Median	8.00		Median	6.50
	Minimum	5		Minimum	5
	Maximum	10		Maximum	8

PEEP values were higher in vomited patients. In patients with abdominal distension, PEEP values were higher than in patients without distension, but the difference was not statistically significant.
GRV, gastric residual volume.

There are no universally accepted GRV values in the dietary guidelines. The acceptable GRV value stated by The American Parenteral and Enteral Nutrition Society[16] was 500 mL and was 250 to 500 mL by the Canadian Clinical Practice Guidelines.[17] Clinical practices and procedures related to high GRV levels also vary. In a study of 2298 critical care nurses, 36.5% of nurses accepted a high amount of GRV that required interruption of enteral feeding as 250 mL and 25% as 500 mL.[18] Another study reported that reflux and aspiration could occur even with deficient GRV levels of 150 mL.[19] In our study, the volume of GRV in the measured group below 200 mL was accepted as usual and continued by increasing the dose, a fixed dose between 200 and 400 mL was maintained, and the dose above 400 mL was of halved. Food intolerance is described as vomiting, abdominal distension, diarrhea, and elevated GRV levels.[20] Although it is hypothesized that high GRV levels lead to increased food intolerance, many studies have provided conflicting results. There is no consistent association between a GRV level and gastric intolerance; it can develop even in patients with a low GRV level. Patients with a high GRV are considerably more likely to vomit, according to Mentec et al.[21]

Abdominal distension is a common but late sign of nonocclusive intestinal necrosis associated with early enteral feeding.[22] In contrast, Montejo et al[20] found in their work that there was widespread intolerance of food in the 500-mL GRV group compared with 200 mL. There was no difference in complications, including vomiting and flatulence, between patients with and without GRV measurement in our study. Akinci et al[23] found that GRV did not increase up to PEEP =13, but gastric pH decreased at values above 13. There was no significant difference in PEEP values in our study in patients who had vomiting and abdominal distension. There is no standard for measuring the residual gastric volume. Several studies have reported that these measurements are unnecessary.[24] Wiese et al did not measure GRV and performed dose titration. As a result, they found no difference in the target calorie lead time and complication rates of the patients.[25] Some patients had taken prokinetic agents during the diet phase in their studies. Some patients began taking prokinetic when vomiting was observed. We did not administer prophylactic prokinetic agents to any patient during the study. In our study, patients with GRV measurement reached target calories longer than those without measurement and took longer breaks.

In their meta-analysis, Wang et al[26] came to similar conclusions as our work. They discovered that not monitoring GRV did not affect the incidence of feeding intolerance, ventilator-associated pneumonia, or death. There was also no change in the duration of mechanical ventilation or length of stay in the ICU. Failure to monitor GRV was associated with a significant increase in vomiting.[26] In our study, vomiting was not different between groups. Bouwet et al found that GRV measurement with ultrasound was more reliable than measurement with gavage in their studies comparing monitoring with gastric ultrasound. Their results suggest that gastric ultrasound is a feasible and promising tool for monitoring gastric volume in clinical practice.[27] In their studies of patients fed via a nasogastric tube in an intensive care unit, Kaçmaz et al[28] found that measuring GRV volume is unnecessary to determine gastrointestinal motility function and reduce complication rates. When compared with GRV measurement in a methanol study that included 5 studies with 998 patients, it was found that the absence of GRV monitoring decreased the rate of food intolerance in critical patients and did not increase ventilator-related pneumonia or mortality rates. These results supported our work.[28]

Our study has several limitations. It was conducted at a single center, and blinding was not permitted due to the critical care environment. There is the possibility that other changes in medical or nursing care were made in the study that could lead to a different assessment of enteral nutrition (EN) competence and affect patient outcomes.

CONCLUSION

As a result of this study, we found that GRV measurement in patients with mechanical ventilatory support prolonged nutritional breaks and extended the time required to reach target calories compared with patients without GRV measurement. In addition, we found that complications such as gastroesophageal reflux (GER), abdominal distension, and vomiting did not increase when GRV was not measured. We believe that GRV measurement, which may lead to malnutrition, should be reviewed.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Erzincan Binali Yıldırım University (Date: April 26, 2021, Decision no: 06/22).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Peer-review: Externally peer-reviewed.

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