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Evaluating the gastric residual volume (grv) monitoring influence on ventilator-associated pneumonia's (vap) frequency in icu patients undergoing mechanical ventilation

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Abstract:
Objective: In recent years, there has been considerable debate over the value of assessing the gastric residual volume (GRV), or the quantity of food still in the stomach, for patients with ventilator-associated pneumonia (VAP). A study on critically sick patients receiving mechanical ventilation was done to find out whether GRV has any effect on the incidence of VAP.
Methods: The critical care unit at Mayo Hospital received 150 adult patients from December 2022 to December 2023. This descriptive research was conducted on these patients. Gastric intolerance was determined by GRV readings greater than 250 ml, which were taken every three hours. The mortality rate, GRV, VAP, stay on mechanical ventilation, stay in the intensive care unit, SOFA and APACHE II scores, and frequency of vomiting were also noted.
Results: According to the quantity of gastric residual volume (GRV) that the patients produced—one group generating more than 250ml and the other producing less than or equal to 250ml—patients were split into two groups for the research. Longer hospitalizations in the intensive care unit (ICU), more frequent use of mechanical ventilation, and higher ratings for disease severity (as determined by APACHE II and SOFA scores) were also characteristics of the group with a greater GRV. In addition, compared to the lower GRV group, more patients in the higher GRV group reported experiencing illness and vomiting. Patients with higher APACHE II and SOFA scores were more likely to have a GRV larger than 250 ml. Additionally, it was shown that the rise in GRV was greater in individuals who did not survive compared to those who did.

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Conclusions: Elevated GRV wasn't related to a higher incidence of VAP, duration of stay in the ICU, or death. As a result, it is not advised for critically sick patients to routinely assess GRV, a crucial component of the VAP preventive bundle.
Keywords: intensive care unit, gastric, ventilator-associated pneumonia

Introduction:

Early intravenous feeding is typical for metabolic support in patients with chronic illnesses who are receiving mechanical breathing. For patients whose nutritional demands cannot be addressed by oral feeding, enteral feeding (EN) is the suggested mode of support.[1] On the other hand, gastric dysmotility, which causes sluggish stomach emptying, affects more than 50% of ICU patients.[2] Delayed stomach emptying may cause several issues, which might affect ICU outcomes and result in insufficient calorie intake or sparing use of enteral nutrition. Aspiration, regurgitation, and nausea may all raise the risk of VAP. [3-5] To reduce the likelihood of these issues, it is advised to monitor gastric residual volume (GRV). As a result, it would seem that enteral feeding volume or formula osmolality should be reduced in situations with excessive GRV. Controversial subjects concerning the monitoring of stomach remaining volume in chronically sick patients receiving mechanical ventilation have been discussed in several publications.[6,7] Studies from the past that suggested a link between VAP and GRV were not properly constructed to demonstrate GRV as a reliable marker of elevated risk of VAP.[8] A recent study found that regulating GRV in patients who are mechanically ventilated is not essential and does not provide these patients any additional benefits. [9] Because confounding variables were not taken into account in the research stated above, it is important to interpret the findings with caution.

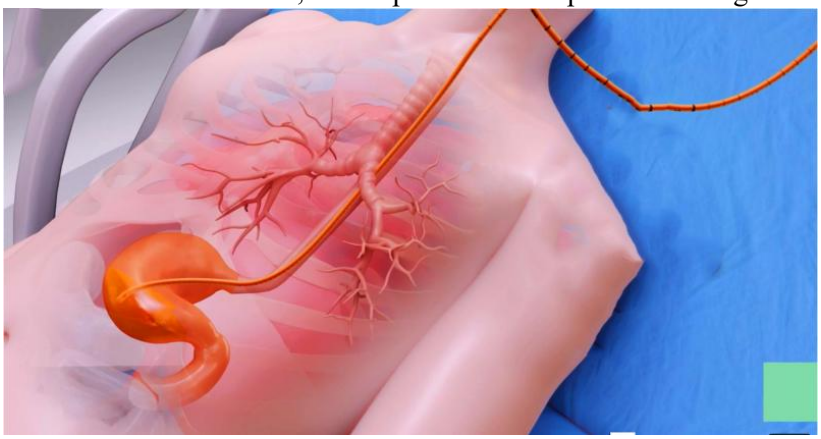

Figure 1: Gastric residual volume monitoring

Previous research has raised questions about the usefulness of GRV as a predictor of ICU patients' propensity for complications. As a result, the current research assessed how GRV and VAP in chronically sick patients relate to one another.

Methods:

Study Design: From December 2022 to December 2023, 150 adult patients who were hospitalized in Mayo Hospital's critical care unit underwent this prospective cross-sectional research. After giving their informed consent, 150 patients who were receiving enteral nutrition (EN) while being mechanically ventilated were included in this prospective study. Age of more than 18 years and a mechanical ventilation duration of over forty-eight hours were inclusion criteria. Intestinal blockage, enteral feeding via a jejunostomy tube, severe pancreatitis, esophageal gastrointestinal hemorrhage history, and pregnancy were the exclusion criteria. Using a nasogastric tube, EN was administered. The patients' daily energy needs were estimated at 25 kcal/kg. Every patient was given the same enteral formula, which contains carbohydrates, protein, fat, minerals, and micronutrients in a 1 kcal/1 ml serving. Seven times throughout the course of a day, EN was given intermittently to all trial participants. When enteral feeding was started, the goal rate was reached in 48–72 hours. Thereafter, the rate was raised by 20 milliliters/hr every 3 hours. Every eight hours, chlorhexidine mouthwash was administered to all patients, and pantoprazole was provided as a stress ulcer preventative while they were all laying in a semi-recumbent position.

GRV was assessed using a 50-ml syringe aspiration every three hours until the conclusion of enteral feeding. Vomiting or GRV levels of more than 250 cc were used to determine intolerance. The patient received the aspirated residual and feeding was resumed if the GRV was under 250cc. When a patient's GRV was more than 250 ml, we employed the prokinetic drugs metoclopramide and erythromycin. When patients didn't respond to metoclopramide, we switched to erythromycin and continued treating them with it. The following phase included combining two medications, and then we reduced the quantity of external nourishment to combat the high level of GRV. In all patients, subglottic secretion drainage was done using the Taper Guard Evac endotracheal tubes' suction port. Continuous monitoring and maintenance of the tracheal cuff pressure between 20 and 30 cm H2O was carried out. VAP (Ventilator-associated pneumonia) can be diagnosed through a chest X-ray that shows a new or expanding area of infection in the lungs along with at least two of the following conditions: body temperature higher or lower than 38.3°C, elevated white blood cell count (more than 12000 cells per microliter) or decreased white blood cell count (less than 4000 cells per microliter), and secretion of pus from the trachea and bronchial tubes. The diagnosis can be confirmed if a tracheal aspirate or bronchoalveolar lavage (BAL) culture test shows bacterial growth of more than 104 colony-forming units per milliliter.

Gender, age, main ICU stay diagnosis, energy needs, GRV, VAP, diarrhea, prokinetic therapy, vomiting, duration of the intensive care unit and hospitalizations, SOFA score, APACHE II score, mechanical

ventilation length, fatality rate, rate of infection, comorbidity, albumin, and lactate serum levels, and CRP were among the demographic information gathered.

Statistical Analysis: Statistical analysis: SPSS version 29 was used to analyze the data. Means, standard deviations (SD), percentages, and Frequency, descriptive data were reported. The independent t-test, Mann-Whitney U test, and chi-square test were used to compare both categorical and numerical features. Crude and adjusted odds ratios (OR) and their accompanying 95% confidence intervals (CI) were calculated via the use of logistic regression analysis. Statistical significance was defined as 0.05 or less at the significance level.

Results:

The goal of the research was to ascertain the association between GRV and critical illness severity, mortality, and incidence of infections and vomiting. There were 150 participants in the study, with a mean age of 57.72±19.01 years and a 63.3% male gender distribution. (Table 1) At the time of admission, 54% and 49.3% of all patients, respectively, had respiratory and cardiac conditions.

Table 1: Demographic information of the participants included in the study

	Variable	**Mean**	**SD**	**n**	**%**
	Age	57.72	19.01		
	Energy intake	1784.9	184.23		
	SOFA	11.45	2.24		
	APACHE II	25.14	5.86		
	Lactate	2.43	0.55		
	Cr	1.46	0.52		
	BUN	27.51	8.4		
	Alb	3.24	0.4		
Gender					
	Female			55	36.7
	Male			95	63.3
Clinical History					
	Cancer			41	27.3
	Diabetes			53	35.3
	Renal Disease			37	24.7

	Liver disease			6	0.4
	Cardiovascular Disease			74	49.3
	Respiratory disease			81	54
Admission Cause					
	Cardiorespiratory disease			37	24.7
	Emboli syndrome			13	8.7
	Infection/septic shock/sepsis			13	8.7
	Malignancy			21	14
	Cerberovascular accident			17	11.3
	Polytrauma			24	16
	Other			25	16.7

In contrast to patients with GRV250 ml, those with GRV>250 ml had substantially greater SOFA, APACHE II, ICU stay length, and mechanical ventilation duration. Additionally, among patients with GRV>250 ml, the severity of the illness as determined by the SOFA and APACHE II categories was higher. In comparison to the GRV≤250 ml group, the incidence of infection and vomiting was significantly greater in the GRV>250 ml group. Additionally, the mortality rate was observed to be increased by GRV>250 ml and was significantly greater in the GRV>250 ml group relative to the GRV≤250 ml group. (Table 2)

Table 2: Inpatient outcomes based on gastric residual volume and disease severity variables

		GVR>250ml		**GVR≤250 ml**		**p-value**
		n=53		**n=97**		
		Mean	**SD**	**Mean**	**SD**	
	Mechanical ventilation duration	8.71	4.33	6.78	3.17	0.002
	ICU LoS	12.96	5.86	10.83	4.15	0.01
	SOFA	12.23	2.36	11.03	2.07	0.002
	APACHE II	28.15	5.85	23.52	5.08	<0.001
		n	%	n	%	
Mortality Rate	Death	14	14.43	19	35.8	0.004
	Survivor	83	85.56	34	64.2	

SOFA Score Classification	>15	2	2.1	4	7.5	
	11-15	57	58.8	42	79.2	
	6-10	38	39.2	6	11.3	<0.001
APACHE-II Classification	>30	9	9.3	18	34	<0.001
	21-30	62	63.9	28	52.8	
	15-20	26	26.8	6	11.3	
	Vomiting	43	44.8	38	71.7	0.002
	Diarrhea	32	33.7	23	44.2	0.21
	Infection	33	34	33	62.3	0.001
	VAP	21	21.6	15	28.3	0.42
	Prokinetic drugs use	55	57.3	37	69.8	0.16

The relationship between illness severity and GRV weakened after accounting for factors such as CRP, Alb, Cr, BUN, gender, and age. After normalizing these elements and prokinetic medication usage, it was also discovered that the frequency of vomiting and infection decreased. The probability of GRV > 250 ml rose with SOFA scores > 15 and APACHE II scores > 30, which led to the greatest odds ratio. (Table 3)

Table 3: Disease Severity and stomach residual volume correlation

		OR (Adjusted)	**Confidence Interval Range**	**p-value**	**OR (Unadjusted)**	**Confidence Interval Range**	**p-value**
APACHE-II Classification	>30	8.78	1.49-51.58	0.004	8.66	2.62-28.63	<0.001
	21-30	3.51	0.73-16.96	0.01	1.95	0.72-5.28	0.18
	15-20						
SOFA Score Classification	>15	10.09	1.01-99.97	0.04	12.66	1.88-84.96	0.009
	11-15	5.36	1.40-20.50	0.01	4.66	1.8-12.05	0.001
	6-10						
	Mortality	1.96	0.73-5.28	0.18	3.27	1.47-7.26	0.004
	VAP	0.78	0.27-2.18	0.63	1.41	0.65-3.04	0.38
	Diarrhea	1.1	0.44-2.73	0.82	1.56	0.78-3.12	0.2
	Vomiting	1.63	0.63-4.23	0.3	3.12	1.51-6.41	0.002

	Infection	2.04	0.77-5.39	0.15	3.2	1.95-6.42	0.001

Both groups started with comparable gastric residual volumes (GRV), according to a comparison of how those volumes changed throughout the course of the research between survivors and non-survivors. But during the course of the trial, the mean GRV climbed dramatically in both groups, with the non-survivor group seeing a greater rise than the survivor group.

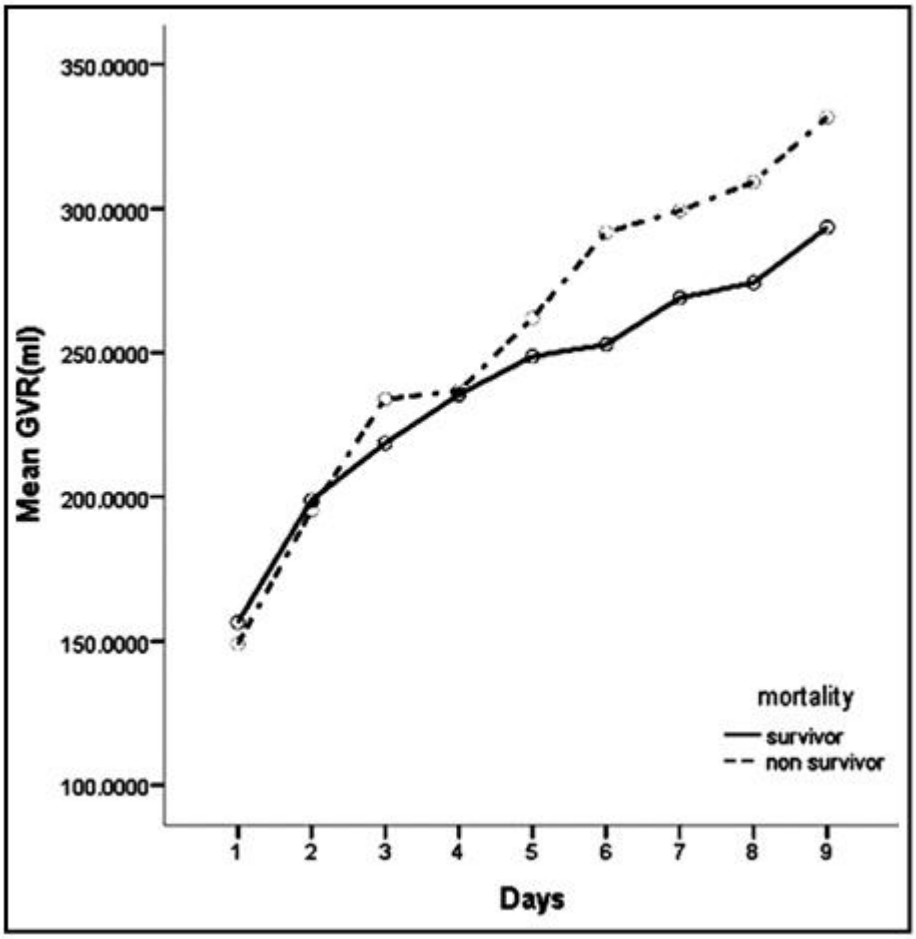

Figure 2: Comparing the study's survivors and non-survivors changes in stomach residual volume

Discussions:

GRV of over 250 ml had no significant impact on VAP or death in critically sick patients, according to the findings, which were adjusted for confounding variables. The severity scores a patient receives are the

most crucial component for GRV; the higher the score, the higher the GRV. Over the years, there have been many arguments made against the effectiveness of routine GRV assessments in lowering the likelihood of VAP occurrence. Previous studies that suggested a lower quantity of GRV for intolerance in surgical patients also showed a larger prevalence of VAP with GRV, which is the exact opposite of our results, since the bulk of our patients were surgical patients. Raising the GRV threshold before terminating gastric feeding only marginally improves EN enrichment. According to a recent meta-analysis of six RCTs and six observational studies, it is not recommended to use a lower stomach residual volume threshold. Routine GRV monitoring in patients receiving mechanical ventilation is not advised and reduces the amount of labor required of nurses [10]. However, it was unable to be shown that delivering more calories enhanced survival.[11] Only one of the six observational studies modified the conclusion based on confounding risk variables, which makes it difficult to evaluate the findings.[12] The authors of the aforementioned research demonstrated that GRVs more than 250 ml or, if repeated, greater than 200 ml, substantially increased the frequency of aspiration. There were only two high-quality RCTs in the whole group. These results demonstrated that GRV increase did not result in negative side effects. The nursing staff was not rendered indifferent to the patient groupings, and as a consequence, the intervention group's patients received only around 200 kcal more during the first week after randomization.[13,14] A study discovered that GRV levels between 200 and 500 ml should be taken into account as potential risk factors for VAP; however, in circumstances where GRV > 500 ml, feeding should be stopped, especially during aspiration and regurgitation.[15] The findings of a study revealed that EN should only be discontinued in cases of overt regurgitation and aspiration; regular monitoring of GRV was not advised since it did not cause insufficient feeding. [16] An earlier study found that using GRV as an accepted norm preventative measures strategy in medical ICUs can be discontinued due to inaccuracies in the measurement of GRV; however, patients undergoing surgery could help from a lower GRV threshold.[17] To attain a more physiological approach to managing stomach content while taking dysglycemia into account, different research suggested reintroducing gastric aspirate at a rate of up to 250 ml at each check-in of critically sick patients.[18]

The findings of the current study on GRV, which are in line with earlier research, may be explained by several variables. First, there is no accepted definition for gastric residual volume, and the aspiration technique used to measure it depends on the size and placement of the tube as well as the nurses' level of expertise. Second, the ideal GRV cutoff that induces regurgitation or vomiting has not been established [19]. In this case, the literature was utilized to determine the intolerance threshold value of 250 ml. [19, 20] Third, leakage of oropharyngeal secretions around the ETT cuff is the main pathway for VAP in the pathophysiology. However, there are several results for the gastro-pulmonary route that are controversial, such as studies on sucralfate and continuous versus intermittent enteral feeding.[21] According to the current findings, greater SOFA and APACHE II scores are linked to increased GRV. This association was still observed after correction, particularly for APACHE II scores over 30 and SOFA values above 15.

Furthermore, enteral nutrition was not monitored, which resulted in an overestimation of the calories supplied and an increase in morbidity and mortality. Enteral nutrition is lost by vomiting or being refused. Because there are several components involved in the pathophysiology of VAP, of which GRV is just one, the findings indicated that increased GRV is not significantly linked with mortality. In contrast, adherence to the VAP bundle requirements by healthcare personnel is crucial in terms of VAP frequency. Almost 85% of the VAP bundle requirements are met in our ICU, which has a strong compliance rate. It would be possible to concentrate more on therapies that have been shown to lower the risk of VAP if GRV monitoring—a time-consuming process—was removed from the VAP bundle.

Because of the small sample size and the fact that the current research was conducted in only two ICUs with surgical patients, it is not possible to generalize the findings to all critically sick patients. For stomach intolerance and excessive GRV, a cutoff of 250 ml was also utilized. For high gastric residual volume, more research with bigger sample numbers and other cutoff values is required. The inability to completely conceal the group designations from the ICU personnel was another drawback of this research. Unblinded designs, on the other hand, have been proven in prior studies to have little to no impact on vomiting rates.

Conclusions:

An essential component of the practice is the regular evaluation of GI tolerance to tube feedings. The findings of the current research demonstrated that higher GRV did not lead to a higher incidence of VAP, duration of stay in the ICU, or death. Therefore, regular GRV monitoring as a crucial component of the VAP prevention bundle is not advised in critically sick patients, and its removal from the bundle enables a greater emphasis to be placed on therapies that have been shown to lower the risk of VAP. To reach the caloric objectives and prevent underfeeding in these patients, this may improve enteral nutrition optimization.

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