Original Article

Effect of Eliminating Routine Gastric Residual Volume Monitoring on Ventilator-associated Events in Patients Receiving Enteral Feeding

Enas Abd El-sadek Abd El-salam Shoeab[1] Sahar Younes Othman Ramadan [2] Ahmed Moustafa El Menshawy [3] Shimmaa Mohamed Mohamed Elsayed [4]

1. Demonstrator at Critical Care and Emergency Nursing Department, Faculty of Nursing, Damanhour University. Egypt
2. Professor of Critical Care and Emergency Nursing, Faculty of Nursing, Damanhour University. Egypt
3. Assistant Professor of Critical Care Medicine, Faculty of Medicine, Alexandria University. Egypt
4. Lecturer of Critical Care and Emergency Nursing, Faculty of Nursing, Damanhour University. Egypt

*Corresponding author: Enas Abd El-sadek Abd El-salam Shoeab, Demonstrator at Critical Care and Emergency Nursing Department, Faculty of Nursing, Damanhour University. Egypt, Enas_shoeab@nur.dmu.edu.eg

Abstract:

Background: Eliminating routine gastric residual volume (GRV) monitoring had several debates surrounding the necessity of monitoring gastric residual volume in nursing care of enteral nutrition and its effect on the occurrence of ventilator-associated events (VAEs). This study aims to investigate the effect of eliminating routine GRV monitoring on ventilator-associated events (VAEs) in patients receiving enteral feeding. Research design: A single-blinded randomized control. Subjects: About 160 patients were randomly assigned to one of two groups in a 1:1 ratio in the general ICUs of Itay Elbaroad and Kafer Eldawar Hospitals. Tools: One tool was a ventilator-associated Events Observation Record. Results: The control group had a higher incidence of VAEs than the intervention group with no significance between studied groups regarding the occurrence of ventilator-associated condition (VAC) (p=0.144,), infection-related ventilator-associated complication (IVAC) (P=0.335), and Possible ventilator-associated pneumonia (PVAP) (p=0.719). Conclusion: The intervention group receiving eliminating routine GRV monitoring had lower occurrences of VAE, VAC, IVAC, and PVAP compared to the control group. As a result, routine GRV monitoring, which is an important component of the ventilator-associated pneumonia (VAP) prevention bundle, is not suggested for critically ill patients. Recommendations: Eliminating routine GRV monitoring may be had advantage for patients decreasing the possibility for VAEs and decreasing nursing workload for nurses. Give critical care nurses (CCNs) training and educational opportunities on the most recent recommendations regarding the advantages of eliminating GRV monitoring.

Keywords: Critically Ill Patient, Enteral Nutrition, Gastric Residual Volume, Ventilator-Associated Events.

Introduction:

Critically ill patients often experience a sharp decline in their physiological function, which is closely related to their nutritional status. Upon admission, rapid nutritional depletion occurs due to stress-induced and pro-inflammatory cytokines and hormones, resulting in a loss of up to 25% of body protein content within just 10 days. [(1–3)] Malnutrition is common in mechanical ventilation (MV) patients, with estimates ranging from 38% to 78%. [(4)] Underfeeding can negatively affect respiratory epithelium and muscle strength, prolong MV, and negatively affect

PISSN: 2974-3281
EISSN: 2974-329x

physiological processes. It can also increase the risk of respiratory tract infection, pulmonary edema, and reduced ventilatory drive. [5–7]

Enteral nutrition (EN) is the standard metabolic support for critically ill patients under MV. However, feeding intolerance is one of several complications of EN that can cause feeding problems in critically ill patients. [8] Monitoring the gastric residual volume (GRV) is crucial in managing EN in intensive care units (ICUs) as it helps assess gastrointestinal function and feeding tolerance. Vomiting and aspiration can increase the risk of ventilator-associated pneumonia (VAP). [9] Therefore, monitoring GRV is recommended to reduce these complications. High GRV increases the risk of aspirating gastric contents and can result in VAP. [10] In a recent study conducted by the American Society of Anesthesiologists (2021) [11], it was reported that 5% of mechanically ventilated patients experienced aspiration of gastric contents, and 57% of those cases resulted in death directly related to pulmonary aspiration. [12]

The National Healthcare Safety Network (NHSN) introduced a new surveillance definition for ventilator-associated events (VAE) in 2013, identifying patients with complications during MV. This definition outlines the various events in a step-by-step manner, beginning with ventilator-associated condition (VAC), followed by infection-related ventilator-associated complication (IVAC), and possible ventilator-associated pneumonia (PVAP). VAEs affect 9%-40% of patients and can prolong MV, increase ICU stay, and increase healthcare costs. Furthermore, Adherence to VAP preventative bundles did not lower VAE incidence. [13,14]

Nevertheless, there have been conflicting findings on the necessity of GRV monitoring in critically ill patients on MV. Recent trends in GRV monitoring, especially in critically ill patients, suggest a move away from routine monitoring. [15] Studies [16,17] indicate that the elimination of GRV monitoring does not lead to an increase in VAP occurrence and can reduce complications associated with methods of GRV monitoring. Therefore, it is suggested that eliminating GRV monitoring may decrease the likelihood of VAE occurrence.

Significance of the study:

The newest critical care guidelines recommend a comprehensive approach to evaluating patients' ability to tolerate EN, which goes beyond relying solely on GRV monitoring. CCNs are advised to take into account clinical signs and symptoms, such as abdominal distension and vomiting when making decisions about the amount of nutrition to provide. By streamlining nursing processes, this approach improves patients' nutritional status and overall care efficiency, reducing interruptions in EN. Research shows that staff education and training can successfully facilitate practice modifications that prioritize patient outcomes, as evidenced by high compliance rates with this new strategy. [18]

The use of GRV monitoring as a proxy for feeding intolerance in critical care units is a contentious issue. American Society for Parenteral and Enteral Nutrition (ASPEN) [19] recommended against withholding EN for GRVs below 500 mL unless there are no other signs of intolerance, while the European Society of Intensive Care Medicine (ESICM) [19] suggests delaying EN for GRVs over 500 mL every six hours. The 2019 (ESPEN) [1] recommendations for clinical nutrition in the ICU and GRV monitoring may help detect feeding intolerance early and as EN progresses. However, there is growing evidence questioning the reliability and precision of GRV monitoring. Despite this evidence, CCNs continue to rely on GRV monitoring as an indicator of gastric emptying and feeding intolerance. CCNs are particularly concerned about the risk of vomiting with possible pulmonary aspiration, which can be detrimental to patients. [20]

Objective of the study:

This present study aimed to Investigate the effect of eliminating routine GRV monitoring on VAEs in patients receiving enteral feeding.

Research Hypothesis

Eliminating routine GRV monitoring will be associated with a lower incidence of VAE compared with routine GRV monitoring in patients receiving early enteral feeding.

PISSN: 2974-3281
EISSN: 2974-329x

II. Materials and Methods

Research Design:

A single-blinded randomized controlled trial (RCT) was conducted with two parallel groups at a 1:1 ratio.

Setting:

This research was carried out in the general ICUs of Itay Elbaroad and Kafer Eldawar Hospitals, which are affiliated with the Ministry of Health and Population. Itay Elbaroad's ICUs are split into two general ICUs (A and B). Unit A has 15 beds, whereas Unit B has 12 beds. Kafer Eldawar Hospital's ICUs are divided into two general ICUs (Unit A and Unit B). Unit A has 12 beds, whereas Unit B has 5 beds.

Sampling:

- A sample size of 160 participants was used, which included a 5% increase from the minimum required size. The sample size was determined using G*Power software version 3.1.9.6.

- Eligible participants for this study included patients aged ≥18 years, newly admitted patients who were attached to a mechanical ventilator for ≥ 48 hours, and those starting enteral nutrition via a nasogastric tube within 36 hours after intubation. The exclusion criteria were as follows: abdominal surgery within the last month; history of esophageal, duodenal, pancreatic, or gastric surgery; bleeding from the esophagus, stomach, or bowel; enteral nutrition via a jejunostomy or gastrostomy; and pregnancy.

Study Tools:

One tool was included in this study

Tool I: Ventilator-Associated Events Observation Record:

The researcher developed this tool after reviewing related literature. (17,22–24) This tool was used to assess VAE occurrence throughout seven observation days for both the intervention and control groups. It included three parts:

Part I: Patient's bio-demographic and clinical profile :

This part included patients' bio-demographic data such as age, gender, admission date, sequential organ failure assessment score (SOFA), Simplified Acute Physiology Score (SAPS) II, patient's diagnosis, and history. Also, it includes vital signs (temperature, respiratory rate, heart rate, and main arterial pressure MAP), ventilation data (date of initiation of MV, mode, positive end-expiratory pressure [PEEP], tidal volume [VT], a fraction of inspired oxygen [FIO2], pressure support [PS]), and oxygenation parameters as oxygen saturation [SaO2] and [SpO2] by a pulse oximeter, arterial blood gases (PH, PaO2, and PaCo2).

Part II: " Feeding Intolerance Manifestation Assessment"

This part was used to assess feeding intolerance manifestation for both intervention and control groups throughout seven observation days. It will include the following data: gastric residual volume (ml), abdominal distension, episodes of vomiting, and diarrhea (frequency).

Part III: "Ventilator-Associated Events Observation Flow Sheet"

The researcher developed this tool after reviewing the relevant literature. (25,26) It was designed as a flow sheet that was used to monitor and record the occurrence of VAE criteria (Ventilator-Associated conditions [VAC], infection-related ventilator-associated complications [IVAC], and Possible Ventilator-Associated Pneumonia [PVAP]) throughout the seven observation days after 2 days of initiation of MV. It includes the following specific events of VAEs:

- Ventilator-associated condition (VAC): daily PEEP increase ≥ 3 cm H2O for ≥ 2 days, daily Fio2 increase ≥ 2 days (after 2+ days of stable or decreasing daily minimum values).

PISSN: 2974-3281
EISSN: 2974-329x

- Infection-related ventilator-associated complication (IVAC): Temperature > 38°C or < 36° or white blood cell count ≥ 12,000 or ≤ 4,000 cells/mm3 and a new antimicrobial agent is started, and is continued for ≥ 4 days.
- Possible ventilator-associated pneumonia (PVAP): Criterion 1: Positive culture of an endotracheal aspirate specimen. Or Criterion 2: Purulent respiratory secretions plus organisms identified from an endotracheal aspirate specimen.

Methods:

1. An ethical approval from the ethical committee, Faculty of Nursing, Damanhour University was obtained.
2. Administrative permission to conduct the study was obtained from the administrative authorities of the previously mentioned settings after an explanation of the aim of the study.
3. One tool was used in the current study "Ventilator-Associated Events Observation Record".
4. Content validity was done by a jury of five experts in the field of the study including professors of critical care nursing.
5. A pilot study was carried out on sixteen patients to evaluate the clarity and applicability of the research tool and necessary modifications were made. The reliability of the tool was tested using Cronbach's Alpha test. The tool was reliable and the test values were (0.755).

Data collection procedure:

Data collection was started on November 20, 2022, and ended on May 20, 2023. All newly admitted mechanically ventilated patients to the previously mentioned units who met inclusion criteria and agreed to participate in the study were enrolled in this study. On the third day of admission, ICU patients were randomly allocated to one of two groups. The intervention group, which did not undergo GRV monitoring and instead assessed for signs of feeding intolerance such as vomiting, diarrhea, and abdominal distention, or the control group, which underwent conventional GRV monitoring.

For the control group, depending on the amount of GRV, the decision for continuity of feeding is taken. If the GRV amount is≥500 throughout 24 hours, stopping feeding and using drainage is recommended. Also, if GRV ≤ 250 ml, with the presence of vomiting and severe diarrhea, half amount of the amount aspirated was returned to the patient, and nasogastric tube (NGT) feeding was continued. Recorded by tool one part II.

VAE diagnosis:

VAE criteria (Ventilator-Associated conditions [VAC], infection-related ventilator-associated complications [IVAC], and Possible Ventilator-Associated Pneumonia [PVAP]) were recorded and monitored in a flow sheet by using tool one part III throughout the seven observation days after 2 days of initiation of MV. The VAEs were assessed daily based on the calculator for ventilator-associated events a CDC pre-validated calculator (2021). (27) On the CDC website version 9.0, a calculator is a web-based tool https://www.cdc.gov/nhsn/vae-calculator/index.html. The output of the calculator is no VAEs or the presence of VAEs which has three ordinal categories: VAC, IVAC, and PVAP. The data that were required fed the online calculator are ventilator FiO2, PEEP, patients' temperature, WBC counts, new antibiotic starting, and the respiratory culture result.

Statistical analysis:

The study used statistical methods to analyze data, including mean, frequency, and percentages. Comparisons were made between study groups using student t-tests, paired t-tests, Chi-square tests, exact tests, and McNemar tests. Pearson moment correlation equations were used for linear relations of

PISSN: 2974-3281
EISSN: 2974-329x

normally distributed variables and Spearman rank correlation equations for non-normal variables. Multivariate logistic regression analysis was used to identify significant predictors of VAEs. Statistical significance was determined by two-sided p-values less than 0.05. All statistical analyses were conducted using IBM SPSS release 22 for Microsoft Windows.

Ethical considerations:

The research was authorized by the faculty of nursing's ethical committee. Written informed consent was acquired from the relatives of the patients. It stressed to subjects their right to refuse enrollment in the study and contained information about the study's objectives, potential benefits, dangers, and discomforts associated with participation. Throughout the study, the study participants' identities, the confidentiality of the information gathered, and privacy were all upheld. The researcher ensured the maintenance of anonymity and confidentiality of the subject data using a code number. Patients' privacy of the collected data was maintained during the implementation of the study.

Results:

The trial involved 160 patients who met the inclusion criteria. The two groups were homogeneous regarding biodemographic and clinical characteristics.

Table 1 Vital signs and ABG parameters for the control and intervention groups throughout seven days. The study compared the mean temperature, respiratory rate, heart rate, and MAP between the control and intervention groups. The control group had a higher mean temperature of 37.54±0.42 and a higher mean respiratory rate of 19.28±2.59. There were no significant differences between the two groups in these parameters. However, the control group showed a significantly higher mean PaO2 (157.96±30.33) and abnormal PaCo2 (31.84±6.63) compared to the mean PaO2 in the intervention group was (137.80±27.10) and PaCo2 (36.44±8.89). The mean change in oxygen parameter Sao2 (95.20±3.98)) and SpO2 (96.28±2.28) was significantly higher in the intervention group (p= 0.010). These findings suggest that the intervention may be more effective in reducing symptoms of VAE.

Table 1: Vital signs and ABG parameters for the control and intervention groups throughout seven days

Variables	Control (n=80)	Intervention(n=80)	t	P
Vital signs Mean ±SD				
Temperature C°	37.54±0.42	37.46±0.49	1.135	0.258
Respiratory rate C/min	19.28±2.59	18.93±2.35	0.891	0.374
Heart rate b/min	91.0±8.0	90.1±10.1	0.609	0.543
Mean arterial pressure (MPB) mmHg	87.6±13.8	89.5±13.3	0.856	0.393
ABG parameters (Mean ±SD)				
PH	7.45±0.09	7.43±0.07	1.989	0.048
PaO2 (mmHg)	157.96±30.33	137.80±27.10	4.434*	**<0.001***
PaCO2 (mmHg)	31.84±6.63	36.44±8.89	3.709*	**<0.001***
SaO2 %	95.20±3.98	97.48±2.55	4.314*	**<0.001***
SpO2 %	95.32±2.39	96.28±2.28	2.598*	**0.010***

Student t-test *** Statistically significant p-value at ≤0.05**

Table 2 illustrates a comparison between the control and intervention groups regarding the occurrence of ventilator-associated events. The study compared VAE in the control and intervention groups. Results showed that 30% of the intervention group and 20% of the control group did not develop VAE symptoms. However, 70% of the intervention group and 80.0% of the control group had VAC, and 53.5% of VAC patients in the intervention group had IVAC. PVAP occurred in 61.0% of IVAC patients in the control group and 66.7%

PISSN: 2974-3281
EISSN: 2974-329x

in the intervention group. No statistical significance was found between the groups regarding no event, VAC, IVAC, and PVAP. (p= 0.144, 0.144, 0.335, 0.719 respectively).

Table 2: Comparison between the control and intervention groups regarding the occurrence of ventilator-associated events

VAE No. (%)	Control(n=80)	Intervention(n=80)	Test	P value
No event	16 (20.0%)	24 (30.0%)	2.133	0.144
Ventilator-associated condition (VAC)	64 (80.0%)	56 (70.0%)	2.133	0.144
Infection-related ventilator-associated complications (IVAC)	36 (56.3%)	30 (53.5%)	0.928	0.335
Possible ventilator-associated pneumonia (PVAP)	22 (61.0%)	20 (66.7%)	0.129	0.719

t: Student t-test

A bar chart is used to explore the frequency distributions between the mean GRV and the frequency of VAE in the control group. Figure 1 illustrates the mean of GRV and the frequency of VAC throughout the seven days for the control group. The mean gastric volume randomly increased in the VAC patients compared to the non-VAC patients from the first day to the fourth observation day. It was noticed that there was a dramatic increase in the gastric residual volume on day five in VAC patients compared to non-VAC patients. The mean gastric volume ±SD of VAC patients on the first day was 51.8± 32.11, while in non-VAC patients it was 47.2 ± 26.2. On day five, the mean ±SD of GRV in VAC patients was 130.3± 253.4, and for non-VAC patients was 47.5± 57.6. On day seven, the mean GRV in VAC patients was 77.2± 163.2, and in non-VAC patients was 50.8± 74.4.

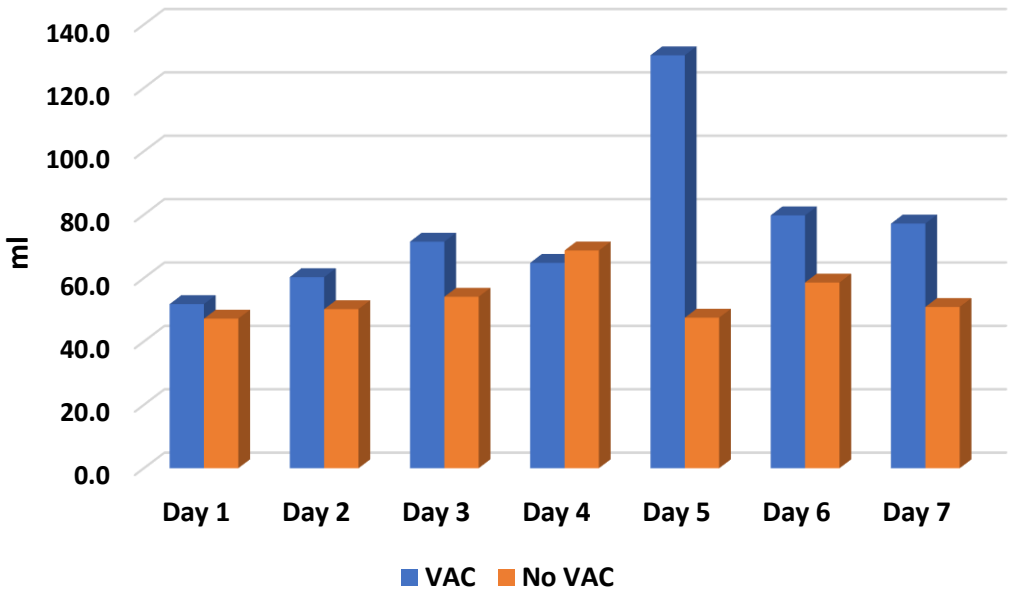

Figure (1): Mean GRV over the study period between cases with and without VAC

PISSN: 2974-3281
EISSN: 2974-329x

Accordingly, Figure 2 demonstrates frequency distributions between the mean GRV and the frequency of IVAC throughout the seven days for the control group. The highest mean of GRV for IVAC patients observed on day four was 69.2 ml. The highest mean of GRV for non-IVAC patients observed on day five was 76.9 ml. Both IVAC and non-IVAC patients had the lowest GRV mean± SD on day one (26.4, 51.2, respectively); on the seventh day, it was noticed that the mean GRV was 60.5 ml in non-IVAC patients and 50.6 ml in IVAC patients.

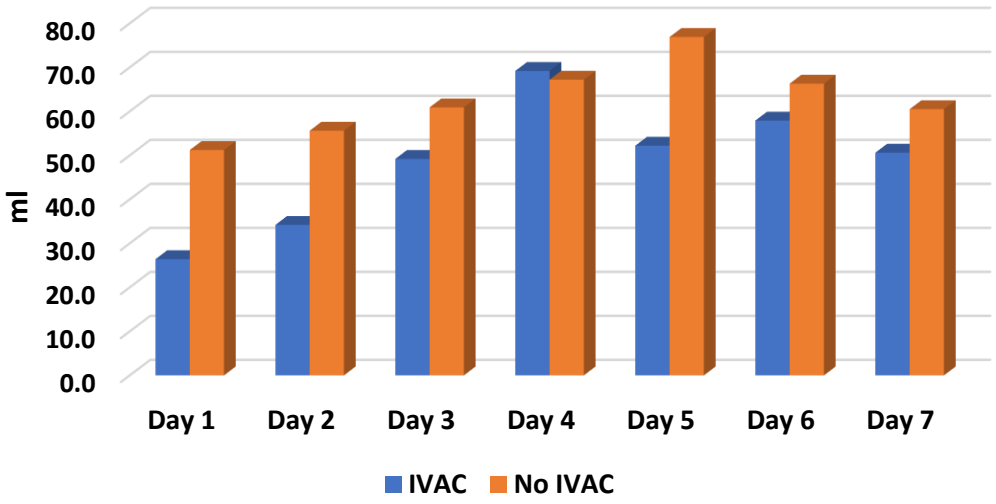

Figure (2): Mean GRV over the study period between cases with and without IVAC

Figure 3 shows frequency distributions between the mean GRV and the occurrence of PVAP throughout the seven days for the control group. It was found that the highest mean GRV value of PVAP patients' occurrence on day four was 76.6± 131.7 ml, while it was lower to 64.0± 53.7 ml on non-PVAP patients. On the other hand, the highest mean of GRV values of No-PVAP was 87.2± 180.4 ml and was lesser in PVAP patients (40.6± 24.9 ml) on day five. In addition, the highest mean GRV value of non-PVAP patients on day six was 73.3 ml, while it was lower in PVAP patients at 44.9 ml on day six. Also, on day seven, it was found that the mean of GRV was 67.9 ml in non-PVAP patients, while it was lower to 37.4 ml in PVAP patients.

PISSN: 2974-3281
EISSN: 2974-329x

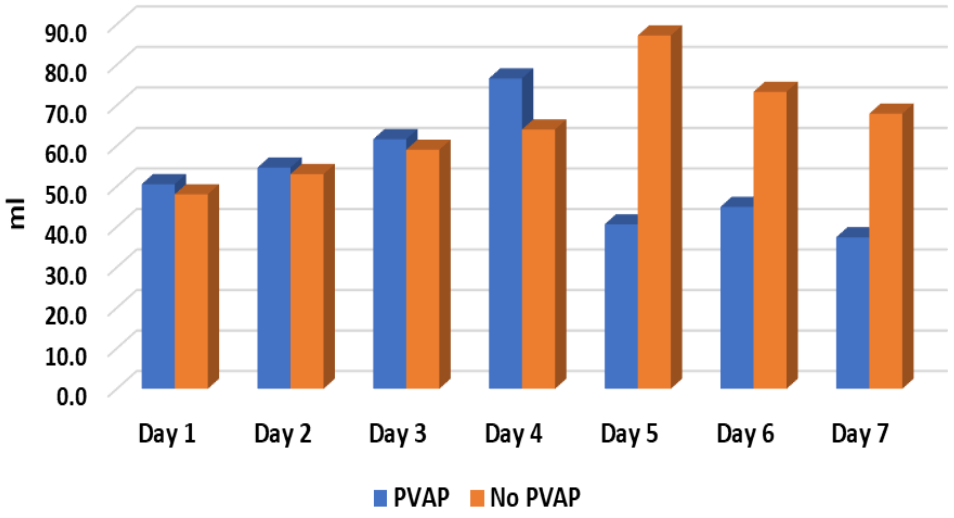

Figure (3): Mean GRV over the study period between cases with and without PVAC

Discussion:

Our study is the first in nursing to use an RCT design to determine the effect of eliminating routine gastric residual volume (GRV) monitoring on ventilator-associated events (VAEs) in patients who received EN. Our results show that eliminating GRV monitoring is not inferior to GRV monitoring in terms of the occurrence of VAEs. The Centers for Disease Control and Prevention (CDC) introduced a new definition of ventilator-associated events (VAEs) in 2013, replacing the earlier definition of ventilator-associated pneumonia (VAP). The new definition comprised three tiers: ventilator-associated condition (VAC), infection-related ventilator-associated complication (IVAC), and possible ventilator-associated pneumonia (PVAP). The purpose of this change was to simplify surveillance, enhance objectivity, and broaden prevention efforts. (28–30)

Our study exhibited that the control group had a higher occurrence of VACs than in the intervention group with no statistically significant difference between the two groups. This might be the result of recurrent EN interruption in the control group due to the use of GRV monitoring leading to weakening and atrophies of the body's muscles, particularly the diaphragm. Consequently, this condition could reduce a patient's ability to be weaned off MV, prolong the duration of MV, and increase the risk of VAEs.

Another rationale for the increased frequency of VACs in the control group than in the intervention group is due to the dramatic consequences of long-term exposure of the patients in the control group to high oxygen levels that can interrupt surfactant and epithelial injury triggering the upregulation of cytokines, which activate inflammatory cells. (31) Also, recent studies done by Piraino et al. (2022) (32) and Singer et al. (2021) (33) who evaluate conventional versus conservative oxygen approaches reported that both approaches have not revealed additional advantages for patients having PaO2 levels greater than 150 mmHg. Excessively high oxygen levels may not be necessary and could potentially lead to adverse effects such as pneumonia.

The current study finding is similar to the study conducted by Wiese et al. (2020) (34) who studied the outcome of the elimination of GRV on 277 mechanically ventilated patients. This study highlighted that the post-intervention group without GRV monitoring compared to the preintervention group with GRV monitoring. The occurrence of VAC was evaluated as a secondary outcome and limited to a maximum of 10 days. Wiese's study found that there was no significant difference in the occurrence of VAC between both groups. However, it is worth mentioning that the occurrence of VAC decreased in the GVR monitoring group compared to the elimination of the GRV monitoring group.

In our study, the control group showed a higher occurrence of IVAC and PVAP compared to the intervention group. There was no statistically significant difference between the two groups. This may be due to the use

PISSN: 2974-3281
EISSN: 2974-329x

of GRV monitoring in the control group increasing aspirating of gastric contents, which can increase the risk of introducing pathogens into the gastrointestinal tract. The act of aspiration can lead to contamination of the feeding tube or the surrounding area, potentially increasing the risk of infections.

Furthermore, the current study did not identify any correlation between elevated GRV occurrence and IVAC, and PVAP. Despite the increase in mean GRV on the fifth day of the study, the occurrence of IVAC and PVAP was the lowest. Moreover, the majority of patients in the intervention group who developed IVAC and PVAP experienced mild feeding intolerance manifestations. These results align with the study conducted by Millot et al. (2024). (35) This study involved 50 patients who received MV for less than 5 days and aimed to evaluate the relationship between VAE and high GRV which may lead to aspiration. The main findings of this study were that no significant relationship was observed between VAE and high GRV.

Our study advocates several possible reasons that could be put forth to explain the lack of a substantial association between VAE and high GRV which is the main cause of the increased risk for aspiration. For instance, VAE can be caused by additional factors other than VAP, such as congestive heart failure, pulmonary embolism, and atelectasis. Another reason could be the small sample size of VAE patients which was similar to the limitation of Millot's study and may have been insufficiently powered to detect a significant connection between VAE and high GRV.

Furthermore, the current study is comparable to the initial medical study conducted in Egypt by Nashed et al. (2024). (36) It is a prospective cohort study designed to determine whether the risk of VAP is elevated when GRV is not closely monitored, as compared to routine monitoring at Ain Shams University Hospitals and Rashid General Hospital for 6 months. The study specifically targeted critically ill patients who were admitted to the ICU and received MV. The study had two divisions, each comprising 215 patients, resulting in a total of 430 patients being enrolled. The study's results revealed that VAP was more prevalent in the control group, which underwent GRV monitoring, as compared to the intervention group.

The current study's findings were consistent with Faramarzi et al. (2020). (16) This study involved 100 patients of both genders admitted to the ICU. GRV was monitored every three hours, and feeding intolerance was defined as GRV > 250 ml. The study revealed that there was a higher occurrence of VAP among patients with GRV less than 250 ml, compared to patients with GRV greater than 250 ml. However, no significant difference was observed between the two groups. Additionally, it was noted that vomiting was more frequent among patients with GRV greater than 250ml compared to those with less than 250ml.

Additionally, the current study aligns with the findings of Backorder et al. (2021) (37), which involved 70 patients randomly divided into groups one and two. Group one was fed with routine GRV monitoring, while Group two was fed without GRV monitoring. The occurrence of VAP was assessed using the modified clinical pulmonary infection score before the intervention and on the fifth day after the intervention. The results showed that eliminating routine GRV monitoring did not negatively impact the occurrence of VAP in mechanically ventilated patients, supporting the practice of eliminating this monitoring approach. However, there was a higher occurrence of VAP in Group one with GRV monitoring compared to Group two without GRV monitoring.

The study has several strengths, first its inclusion of both medical and trauma patients because it was conducted in a general ICU, second its RCT design. The researchers also advocated for the use of RCTs as the most appropriate design to resolve this issue. However, it also has some potential limitations. For example, most of the patients in our RCT had a medical diagnosis at admission to the ICU, which could limit the generalization of our results.

Conclusions and Recommendations:

Conclusions:

Overall, our RCT found that eliminating routine monitoring of GRV did not increase the occurrence of VAE, VAC, IVAC, and PVAP. However, there were no statistical differences between both groups regarding VAE occurrence. Therefore, eliminating the practice of monitoring GRV in the critical care setting and instead focusing on interventions that have been proven to reduce VAE may be more beneficial.

PISSN: 2974-3281
EISSN: 2974-329x

Recommendations:

GRV monitoring should be eliminated as a crucial signal for EN, according to the suggestions made by the current study. Further research is necessary to evaluate the potential of intra-abdominal pressure (IAP) as a predictor of VAE in critically ill patients. Additional study is also required to explore the benefits of postpyloric feeding for patients who are at high risk of developing VAE due to aspiration of gastric content. Provide training programs to upgrade nurses' knowledge and practices as regards VAE, VAC, IVAC, and PVAP assessment, early detection of ventilation complications, and VAE prevention measures. Also, nurses' knowledge and practices concerning the calculation of nutrient requirements, prevention of feeding method-related complications, and monitoring the response to nutritional support.

References:

1. Singer P, Blaser AR, Berger MM, Alhazzani W, Calder PC, Casaer MP, et al. ESPEN guideline on clinical nutrition in the intensive care unit. Clin Nutr [Internet]. 2019;38(1):48–79. Available from: https://doi.org/10.1016/j.clnu.2018.08.037
2. Allen K, Hoffman L. Enteral Nutrition in the Mechanically Ventilated Patient. Nutr Clin Pract. 2019 Aug;34(4):540-557. doi: 10.1002/ncp.10242. Epub 2019 Feb 11. PMID: 30741491.
3. Reintam Blaser A, Deane AM, Preiser JC, Arabi YM, Jakob SM. Enteral Feeding Intolerance: Updates in Definitions and Pathophysiology. Nutr Clin Pract. 2021 Feb;36(1):40-49. doi: 10.1002/ncp.10599. Epub 2020 Nov 26. PMID: 33242218.
4. Díaz G, Maria MI, Gonzalez MC, Reyes M. The global leadership initiative on malnutrition criteria for the diagnosis of malnutrition in patients admitted to the intensive care unit: A systematic review and meta-analysis. Clin Nutr [Internet]. 2023;42(2):182–189. Available from: https://doi.org/10.1016/j.clnu.2022.12.007
5. Mohammadi P, Varpaei HA, Khafaee Pour Khamseh A, Mohammadi M, Rahimi M, Orandi A. Evaluation of the Relationship between Nutritional Status of COVID-19 Patients Admitted to the ICU and Patients' Prognosis: A Cohort Study. J Nutr Metab. 2022 Jul 18; 2022:5016649. doi: 10.1155/2022/5016649. PMID: 35865866; PMCID: PMC9295016.
6. Floro GC, Schwenger KJP, Ghorbani Y, Zidar DJ, Allard JP. In critically ill adult patients with COVID-19, lower energy and higher protein intake are associated with fewer mechanical ventilation and antibiotic days but not with ICU length of stay. Nutr Clin Pract. 2023 Dec;38(6):1368-1378. doi: 10.1002/ncp.11019. Epub 2023 Jun 11. PMID: 37302065.
7. Kangalgil M, Küçük AO, Ulusoy H, Özçelik AÖ. Nutrition determinants of acute skeletal muscle loss in critically ill patients: A prospective observational cohort study. Nutr Clin Pract. 2024 Jun;39(3):579-588. doi: 10.1002/ncp.11086. Epub 2023 Oct 25. PMID: 37877164.
8. .Brotfain E, Erblat A, Luft P, Elir A, Gruenbaum BF, Livshiz-Riven I, et al. Nurse-performed ultrasound assessment of gastric residual volume and enteral nasogastric tube placement in the general intensive care unit. Intensive Crit Care Nurs [Internet]. 2022;69(May 2021):103183. Available from: https://doi.org/10.1016/j.iccn.2021.103183.
9. Yasuda H, Kondo N, Yamamoto R, Asami S, Abe T, Tsujimoto H, Tsujimoto Y, Kataoka Y. Monitoring of gastric residual volume during enteral nutrition. Cochrane Database Syst Rev. 2021 Sep 27;9(9):CD013335. doi: 10.1002/14651858.CD013335. pub2. PMID: 34596901; PMCID: PMC8498989.
10. Orieux A, Enaud R, Imbert S, Boyer P, Begot E, Camino A, Boyer A, Berger P, Gruson D, Delhaes L, Prevel R. The gut microbiota composition is linked to subsequent occurrence of ventilator-associated pneumonia in critically ill patients. Microbiol Spectr. 2023 Sep 15;11(5):e0064123. doi: 10.1128/spectrum.00641-23. Epub ahead of print. PMID: 37713505; PMCID: PMC10581192.
11. Warner MA, Meyerhoff KL, Warner ME, Posner KL, Stephens L, Domino KB. Pulmonary Aspiration of Gastric Contents: A Closed Claims Analysis. Anesthesiology. 2021 Aug 1;135(2):284-291. doi: 10.1097/ALN.0000000000003831. PMID: 34019629.
12. Kothapalli S, Anandaswamy TC, Patil S, Anne N, Muthalgiri CM, Niranjan A. Ultrasound evaluation of gastric residual volume in fasting end-stage renal failure patients. J Clin Anesth [Internet]. 2024;94(November 2023):111414. Available from: https://doi.org/10.1016/j.jclinane.2024.111414 .

PISSN: 2974-3281
EISSN: 2974-329x

13. Ramírez-Estrada S, Peña-López Y, Serrano-Megías M, Rello J. Ventilator-associated events in adults: A secondary analysis assessing the impact of monitoring ventilator settings on outcomes. Anaesth Crit Care Pain Med. 2024 Jun;43(3):101363. doi: 10.1016/j.accpm.2024.10136. Epub 2024 Mar 1. PMID: 38432476.
14. Weinberger J, Rhee C, Klompas M. Incidence, Characteristics, and Outcomes of Ventilator-associated Events during the COVID-19 Pandemic. Ann Am Thorac Soc. 2022 Jan;19(1):82-89. doi: 10.1513/AnnalsATS.202103-364OC. PMID: 34170781; PMCID: PMC8787787.
15. Feng L, Chen J, Xu Q. Is monitoring of gastric residual volume for critically ill patients with enteral nutrition necessary? A meta-analysis and systematic review. Int J Nurs Pract. 2023 Dec;29(6): e13124. doi: 10.1111/ijn.13124. Epub 2022 Dec 20. PMID: 36540042.
16. Faramarzi E, Mahmoodpoor A, Hamishehkar H, et al. Effect of gastric residual volume monitoring on incidence of ventilator-associated pneumonia in mechanically ventilated patients admitted to intensive care unit. Pak J Med Sci. 2020;36(2):48-53. doi: https://doi.org/10.12669/pjms.36.2.1321
17. Wang Z, Ding W, Fang Q, Zhang L, Liu X, Tang Z. Effects of not monitoring gastric residual volume in intensive care patients: A meta-analysis. Int J Nurs Stud [Internet]. 2019; 91:86–93. Available from: https://doi.org/10.1016/j.ijnurstu.2018.11.005
18. Smith M, Smith M, Robinson KN. Using Nurse-Driven Protocols to Eliminate Routine Gastric Residual Volume Measurements: A Retrospective Study. Crit Care Nurse. 2022 Aug 1;42(4):e1-e10. doi: 10.4037/ccn2022584. PMID: 35908766.
19. Boullata JI, Carrera AL, Harvey L, Escuro AA, Hudson L, Mays A, et al. ASPEN Safe Practices for Enteral Nutrition Therapy. J Parenter Enter Nutr. 2017;41(1):15–103 .
20. Bruni A, Garofalo E, Grande L, Auletta G, Cubello D, Greco M, et al. Nursing issues in enteral nutrition during prone position in critically ill patients: A systematic review of the literature. Intensive Crit Care Nurs [Internet]. 2020; 60:102899. Available from: https://doi.org/10.1016/j.iccn.2020.102899
21. Kim J, Shin W. How to do random allocation (randomization). Clin Orthop Surg. 2014;6(1):103-109. doi:10.4055/cios.2014.6.1.103.
22. Lew CCH, Lee ZY, Day AG, Heyland DK. Correlation between gastric residual volumes and markers of gastric emptying: A post hoc analysis of a randomized clinical trial. JPEN J Parenter Enteral Nutr. 2022 May;46(4):850-857. doi: 10.1002/jpen.2234. Epub 2021 Aug 23. PMID: 34292628.
23. Eaton P, Faulds M. Gastrointestinal dysfunction in the intensive care unit. Surg (United Kingdom) [Internet]. 2021;39(10):684–9. Available from: https://doi.org/10.1016/j.mpsur.2021.08.009.
24. Klompas M. Ventilator-Associated Events: What They Are and What They Are Not. Respir Care. 2019 Aug;64(8):953-961. doi: 10.4187/respcare.07059. PMID: 31346070.
25. Network National Healthcare safety. Ventilator-Associated Event (VAE). 2021;(January):1–45, available at Ventilator-associated Event (VAE) (cdc.gov)
26. Raoof S, Baumann MH; Critical Care Societies Collaborative, consisting of the leadership of the American Association of Critical-Care Nurses, the American College of Chest Physicians, the American Thoracic Society, and the Society of Critical Care Medicine. Ventilator-associated events: the new definition. Am J Crit Care. 2014 Jan;23(1):7-9. doi: 10.4037/ajcc2014469. PMID: 24382609.
27. CDC. NHSN Ventilator-Associated Event (VAE) Calculator Version 9.0. Centers for Disease Control and Prevention. 2022. [Internet]. Available from: https://www.cdc.gov/nhsn/vae-calculator/index.html
28. Klompas M, Branson R, Cawcutt K, Crist M, Eichenwald EC, Greene LR, Lee G, Maragakis LL, Powell K, Priebe GP, Speck K, Yokoe DS, Berenholtz SM. Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilated hospital-acquired pneumonia in acute-care hospitals: 2022 Update. Infect Control Hosp Epidemiol. 2022 Jun;43(6):687-713. doi: 10.1017/ice.2022.88. Epub 2022 May 20. PMID: 35589091; PMCID: PMC10903147.
29. Eryilmaz-Eren E, Senbayrak S, Karlidag GE, Mert D, Urkmez FY, Peña-López Y, et al. Ventilator-associated event (VAE) epidemiology and prognosis: Preliminary results of VAE-Türkiye. J Crit Care. 2024; 81:154671.
30. Ventilator-Associated Event (VAE). 2023;(January):1–44. Ventilator-associated Event (VAE) (cdc.gov).
31. Cooper JS, Phuyal P SN. Oxygen Toxicity. [Updated 2023 Aug 1]. Treasure Island. In: StatPearls Publishing; StatPearls [Internet]. Available from: https://www.ncbi.nlm.nih.gov/books.
32. Piraino T, Madden M, Roberts KJ, Lamberti J, Ginier E, Strickland SL. AARC Clinical Practice Guideline: Management of Adult Patients With Oxygen in the Acute Care Setting. Respir Care. 2022;67(1):115–128 .

PISSN: 2974-3281
EISSN: 2974-329x

33. Singer M, Young PJ, Laffey JG, Asfar P, Taccone FS, Skrifvars MB, et al. Dangers of hyperoxia. Crit Care. 2021;25(1):1–15 .
34. Wiese AN, Rogers MJ, Way M, Ballard E. The impact of removing gastric residual volume monitoring and enteral nutrition rate titration in adults receiving mechanical ventilation. Aust Crit Care [Internet]. 2020;33(2):155–161. Available from: https://doi.org/10.1016/j.aucc.2018.12.001.
35. Millot G, Behal H, Jaillette E, et al. Relationship between microaspiration and ventilator-associated events: A post-hoc analysis of a randomized controlled trial. Intensive Crit Care Nurs. 2025; 86:103778. doi: 10.1016/j.iccn.2024.103778.
36. Nashed, S. W., Serwi, E., El Din, H. B., Derh, E., Sadek, M., & Abdelmonem Aboarab SA. Effect of Residual Gastric Volume on Risk of Ventilator-Associated Pneumonia in Adults Receiving Mechanical Ventilation and Early Enteral Feeding. QJM An Int J Med [Internet]. 2024;117(Supplement_1). Available from: https://doi.org/10.1093/qjmed/hcae070.008.
37. Barkhordari M, Jahani S, Soltani F, Molavynejad S, Maraghi E. Effect of Tubular Feeding with the Measurement of Gastric Residual Volume on Ventilator Associated Pneumonia. Tanaffos. 2021;20(4):319-326 . PMID: 36267927; PMCID: PMC9577209.

PISSN: 2974-3281
EISSN: 2974-329x