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To Correlate the Impact of Disease Severity on Gastric Residual Volume among the Critically Ill Patients

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Abstract: ***Feeding often receives lower priority compared with other intensive care units (ICU) treatments such as hemodynamic and ventilation control.[1] A descriptive co-relational study design was adopted and a quantitative research design was applied by recruiting 88 subjects for the study using nonprobabilitypurposive sampling technique. It was concluded from the study that on days 1 and 3, there was a moderate positive statistical significance whereas on day 2, there was a weak positive statistical significance between gastric residual volume and disease severity. Measuring gastric residual volume among critically ill patients in ICU is a common practice because the patients are likely to experience delayed gastric emptying, intolerance of enteral feeding, infections, and mortality. More than 50% of patients in ICU have gastric dysmotility, leading to slow gastric emptying and can induce several problems like inadequate caloric intake.[3]***

Keywords: APACHE-II score, Gastric residual volume, critically ill patients

1. Introduction

There are different parameters to prognosticate a patient's condition and gastric aspiration is one of the key indicators of a patient's progress to health.

Feeding is frequently given less priority than other ICU treatments such as haemodynamic and ventilation control.[1]

Patients in the ICU who are critically ill and mechanically ventilated are more likely to have delayed gastric emptying.Medications, hyperglycaemia, electrolyte disturbances, hypoxia, sepsis, increased intracranial pressure, and administration of calorically dense or hyperosmolar formulas can all impair gastrointestinal motility.Measuring the gastric residual volume (GRV) is the most commonly used method for determining a patient's tolerance to enteral nutrition and preventing pulmonary aspiration.[2]

Delayed gastric emptying can trigger a variety of problems that may influence ICU outcomes and lead to inadequate caloric intake or infrequent use of enteral nutrition.[3]

In an Indian study of 89 non-diabetic, patients of various stages(3,4,5) of chronic kidney disease (CKD), it was identified that 25% had delayed gastric emptying which was more common among patients who were in stage 5 of their illness (31%) than in stages 3 and 4 (17.5%).

This study thus justifies that the greater the disease severity, the more the delay in gastric emptying.[4]

An international study conducted in Korea among 259 subjects revealed that through a univariate analysis, gastric emptying at T ½ (GE T½) was significantly associated with the incidence of cardiovascular events (p=0.014).[5]

Critical illness is a dynamic process that requires persistent monitoring and clinical accuracy to eliminate the causes which might contribute to its prognosis of it.

2. Literature Survey

In the year 2001, a prospective study on 'Upper digestive intolerance during enteral nutrition in critically ill patients: frequency, risk factors and complications' was undertaken in an ICU of a general hospital. The study included 153 patients to identify the frequency and predisposing factors for increased GRV and upper digestive intolerance, along with the complications that can emerge during enteral nutrition in critically ill patients. It was noted that 49 patients were presented with increased GRV after a median enteral nutrition duration of 2 days and 70 patients presented with upper digestive intolerance.

The presence of a high gastric aspirate volume was an early indicator of upper digestive intolerance, which was associated with a higher incidence of nosocomial pneumonia, a longer ICU stay, and a higher ICU mortality.[10]

A cross-sectional analytical study on 'Delayed gastric emptying among Indian patients with non-diabetic chronic kidney disease' was carried out in a tertiary hospital in south India between 2017 and 2018. Convenience sampling technique was adopted to recruit 89 non-diabetic chronic kidney disease (CKD) patients (stages 3, 4, and 5) for the study. It was revealed through the study approximately 25% of the patients had delayed GE and 9% had rapid GE. The prevalence of delayed GE was higher among stage 5 (31%) than that of stages 3 and 4 patients (17.5%). [4]

The stomach performs functions such as breaking down large chunks of food into smaller pieces and mixing food with gastric acid and digestive enzymes. During meal ingestion, the stomach expands to approximately 1,000 mL

before the pressure in the lumen of the stomach begins to rise.[11]

In 2009, 28 intensive care units in Spain participated in a study to compare the effects of increasing the limit of gastric residual volume on the adequacy of enteral nutrition. The study was conducted on 329 intubated and mechanically ventilated patients with enteral nutrition. Patients were randomized to be included in a control (GRV = 200 ml) or in study group (GRV = 500 ml).Gastrointestinal complications were higher in the control group (63.6 vs. 47.8%, p = 0.004), but the only difference was in the frequency of high GRV (42.4 vs. 26.8%, p = 0.003). The diet volume ratio was higher for the study group only during the 1st week (84.48 vs. 88.20%) (p = 0.0002). It was concluded that increasing the GRV limit does not affect the diet volume ratio of mechanically ventilated patients receiving enteral nutrition. A value of 500 ml could be equally recommended as a normal limit for GRV.[12]

APACHE II scoring system was developed by Knaus, et al.(1985).[13]

APACHE II drives an Acute Physiological Score (APS), reflecting the patient's physiological status combined with scores for chronic disease state (CHI "Chronic Health Index") and Age score to develop APACHE II. The APACHE II score was primarily designed to predict the mortality of patients in ICUs but attempts have been made to apply this scoring system to patients with severe trauma, abdominal complications, COPD, and acute pancreatitis.[14]

From January to December 2009, a prospective study was conducted in the department of chest medicine at Jinnah Hospital, Karachi.All patients of any age and gender admitted to the chest ICU for any reason were consecutively enrolled in the study. The sample size of the study was 143. The results revealed that 63 out of 143 patients were alive, whereas 80 patients died. The mean APACHE II score in the first 24 hours was 20.09 ± 7.49. For patients who were later discharged, the mean APACHE II was 18.93 ± 7.19 whereas for patients who later died, the mean APACHE-II score was 22.33 ± 7.80.[15]

3. Methods and Approach

A quantitative research approach was adopted and a descriptive correlational design was applied. Formal permission was sought from Institutional Ethics Committee (IEC) and administrative authorities to conduct the study. Subjects were recruited based on inclusion and exclusion criteria. Nonprobability purposive sampling technique was applied.

The need and purpose of the study were explained to the relatives of selected subjects and informed consent was obtained from them.Instruments used in this study were categorised into - Section A: A structured proforma to elicit demographic variables and Section B and C: Assessments scales to elicit mean GRV and Acute physiology and chronic health evaluation-II (APACHE-II).

After 24 hours of admission to the ICU, APACHE –II scores of the selected subjects were obtained using pre-installed software for calculation and data for APACHE-II scores were obtained from medical records. GRV was monitored 24 hours after the administration of nasogastric feed. The values were recorded by the staff nurse who performed the aspiration just before the administration of next consecutive NG feed. The investigator then calculated the mean of all the recorded GRVs. APACHE –II scores and mean GRV of the selected patients were captured for 3 consecutive days. Data were organised in MS excel for tabulation and statistical processing.

4. Results

The present study revealed that, 37.5% of the population fell into the age category of 41-60, 29.5% belonged to the age group category of 61-80, 25% belonged to 21-40 category, 5.7% belonged to 81-100 age group category whereas, 2.3% were <21 years of age.

69% of the subjects were male and 21.6% were female. 93.2% had a BMI range of 18.5-24.9, 4.5 % had a range of 25-29.9 whereas 1.1% had a range of > 30. It was noted that 25% of the subjects had normal blood sugar levels of 100-120 and 11.4% had sugar levels of <100 and 141-160 respectively.

31.8% of the subjects had a GCS score of 2, 29.5% had a score of 9-12 range, and 6.8% had a score range of 3-5. 71.6% of the subjects received Inj.Fentanyl as sedatives and 1.1% received Inj.Propofol and a combination of Inj.Fentanyl and Inj.Dexmedetomidine hydrochloride respectively. 89.9% did not receive any paralytics and 59.1% did not receive any vasopressors.

76.1% of the subjects were treated with mechanical ventilation and 23.9% were not. 50% of the population had hypertension as comorbidity, 39.8% had diabetes mellitus, and 1.1% had asthma and Rheumatic heart disease respectively. 37.5% of the subjects fell into the category of neurology as their primary ICU diagnosis, 27.3% as nephrology,23.9% as cardiovascular, 20.5% as respiratory and sepsis whereas 3.4% fell into the category of- Auto immunology, Burns and Multi-organ dysfunction respectively.

Association of Gastric Residual Volume with selected Socio-Demographic Variable

It was noted that there was statistically no association of gastric residual volume with the selected socio-demographic variables.

Correlation between Mean GRV and APACHE -II Score

Table 1A: Correlation between mean GRV and APACHE-II score on day 1(n=88)

S. No.	Mean	Standard Deviation	Correlation	p Value
1. Gastric residual volume	290	42.1	0.453	<0.001
APACHE-II	21.63	8.274		

Table 1A depicts that the mean GRV on day 1 is 290, whereas the mean APACHE-II score is 21.63. There is a positive moderate correlation between GRV on day 1 and APACHE-II at $p < 0.001$.

Table 1B: Correlation between mean GRV and APACHE-II score on day 2 (n=88)

S. No.	Mean	Standard Deviation	Correlation	p Value
1. Gastric residual volume	125	26.94	0.216	0.044
APACHE-II	19.70	6.509		

Table 1B depicts that the mean GRV on day 2 is 125, whereas the mean APACHE-II score is 19.70. There is a positive weak correlation between GRV on day 2 and APACHE-II at $p = 0.044$.

Table 1 (C): Correlation between mean GRV and APACHE-II score on day 3, (n=88)

S. No.	Mean	Standard Deviation	Correlation	p Value
1. Gastric residual volume	150	25.45	0.448	<0.001
APACHE-II	18.86	6.660		

Table 1C shows that the mean GRV on day 1 is 150, whereas the mean APACHE-II score is 18.86. There is a moderate positive correlation between GRV on day 3 and APACHE-II at $p < 0.001$.

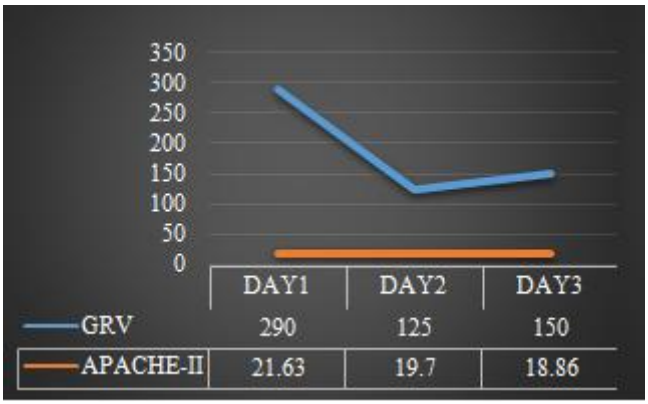

Figure 1: Line graph on correlation of mean GRV and APACHE-II on days- 1, 2, 3

Hence, it can be concluded that on day 1 and day 3, there was a moderately positive statistical significance of mean GRV with APACHE –II score at $p < 0.001$ whereas on day 2 there was a weakly positive statistical significance at $p = 0.044$.

5. Discussion

The current study enrolled 88 subjects of whom, 37.5% belonged to the age group of 41-60 years and 78.4% were males.

The findings of this study are supported by a prospective cross-sectional study conducted in Pakistan on 'The effect of gastric residual volume monitoring on the incidence of ventilator-associated pneumonia in mechanically ventilated patients admitted to intensive care unit' in 2020. It was carried out among 150 adult patients admitted to the critical care unit. The mean age was 57.72± 19.01 and 63.3% were males.[3]

The present study revealed that 93.2% of the subjects had a BMI range of 18.5-24.9 and almost 25% of the subjects had a blood glucose level of 100-120mg/dL. The findings of this study are in concordance with a similar study conducted as a prospective observational study in Taiwan on 'Impact of disease severity on gastric residual volume in critical patients in 2010 where the mean BMI of the subjects was 23.1±0.5 kg/m^2 and the mean blood glucose levels of the patients were 184.7± 8.6 mg/dL.[6]

From the study conducted by the investigator, it was noted that 31.8% of the subjects had a GCS score of 2, and 76.1% were mechanically ventilated.

In 1991, the Department of Surgery in Kentucky conducted a prospective study on 'Altered gastric emptying in the head-injured patient: relationship to feeding intolerance.' among 12 patients with moderate to severe head injury (GCS between 4 and 10). The study was intended to evaluate the relationship between altered gastric emptying and feed intolerance in head-injured patients. It was concluded that patients who initially had a normal gastric emptying process, tolerated feeds better as compared with those who had delayed emptying rates at $p< 0.001$.[16]

In a prospective study conducted on 'GRV and aspiration in critically ill patients receiving gastric feedings' in 2008 among 206 critically ill patients, it was found that almost 72.3% of the patients had a mean GCS score of less than 9.[17]

The present study revealed that 71.6% of the subjects received Inj.Fentanyl as a sedative. 89.9% did not receive paralytics and 59.1% of the subjects did not receive vasopressors. The study findings are in concordance with a study conducted on 'The effect of opioids on gastro-intestinal function' in 2021, China which revealed that 63-86% of the patients were treated with opioids.[21] The findings of this study are also in line with a prospective observational study conducted on ' Upper digestive intolerance during enteral nutrition in critically ill patients: frequency, risk factors, and complications' in 2001 among 153 patients, 32% presented with an increased gastric aspirate. 95% CI received sedation (Inj Fentanyl) during enteral nutrition.[10]

In the current study the comorbidities of the subjects was Hypertension which was 50%.

In this study, 37.5% of the subjects were diagnosed with neurological disorders as their primary diagnosis. The results for this findings were supported by a prospective study on GRV and Aspiration in critically ill patients receiving gastric feedings in 2008 among 206 critically-ill patients who received gastric tube feedings for 3 consecutive days. Almost 46% of the population had a primary diagnosis of neurological disorders.[17]

The present study results concluded that on day 1 the mean GRV was recorded to 290ml and the mean APACHE-II was 21.63 ± 8.274 with p=<0.001 whereas on days 2 and 3 it was

125 and 150ml and APACHE-II was 19.70 ± 6.509 on day 2 and 18.86 ± 6.660 on day 3 respectively.

To explore the reasons for the same, a supportive study was referred. In a descriptive study on Effect of gastric residual volume monitoring on incidence of ventilator-associated pneumonia in mechanically ventilated patients, done in Pakistan showed that severity of disease based on SOFA (Sequential Organ Failure Assessment)and APACHE-II classification greater in patients with GRV >250ml than those with GRV ≤ 250ml (P<0.001).[22]

In the present study, since there was a drop in mean GRV on day 2 (125ml) in comparison with day 1 (290ml) and 3 (150ml) with APACHE-II being 21.63 ± 8.274 on day-1, 19.70 ± 6.509 on day-2 and 18.86 ± 6.660 on day-3. There was a positive moderate correlation between GRV and APACHE-II at p<0.001 on day-1, 3 and a positive weak correlation on day 2 at p=0.044. The change can be attributed to the diverse conditions of the critically ill patients whose prognosis can vary from day to day. Since 37.5% of the study variables were diagnosed with neurological disorders, the primary diagnosis can be a confounding variable in the study.

In this study, subjects belonging to age category of 81-100, at 75th percentile had a mean GRV of 81.25.

At p=0.763, there is no significance of age in comparison with GRV on day-3.

At 75th percentile, there were 25.00 females.At p=0.126, there is no significance of gender in comparison with GRV on day-3.

At 75th percentile, 23.74 belonged to the BMI category of 18.5-24.9.At p=0.610, there is no significance of BMI on day 3 of GRV.

In a retrospective review which was conducted on 'The relationship between blood glucose control and intolerance to enteral feeding during critical illness' among 132 mechanically ventilated patients in 2007, Australia revealed that an overall of 60% of the patients had delayed gastric emptying and a mean GE coefficient of 2.9± 0.1.

Delayed gastric emptying was noted in subjects with a mean age of 57.8±2.2.On a univariate analysis, gastric emptying significantly correlated with older age. p=<0.01. Thus, it was concluded that there was no relationship between delayed gastric emptying and patient gender or BMI.[19]

In this study, it was noted that at 75th percentile, the median for GRBS range was 28.75 among subjects with blood sugar levels <100mg/dl.Atp=0.977, there was NO significance of GRBS on day 3 of GRV.

A retrospective review conducted among 132 mechanically ventilated patients in 2007, Australia. Overall 60% of the patients had delayed gastric emptying and a mean GE coefficient of 2.9± 0.1. Slow GE was more common in patients with higher blood glucose on admission. (9.7±0.9 with p=<0.01).The findings of this study are in line with the aforementioned study as the patients on admission, did not have elevated blood glucose levels.[19]

It was noted in this study that at 75th percentile, subjects belonging to GCS category of score-2 and score- 3-5 had a median value of 25.00.At p=0.228, there was no significance of GCS on day 3 of GRV.

The study findings were contradictory to that of a cross-sectional study conducted on 'The prevalence and possible causes of enteral tube feeding intolerance in critically ill patients' in 2019 at 3 general ICUs in Iran among 245 critically ill patients. The study findings revealed that the highest prevalence rate of enteral feed intolerance was 91.8%, which occurred on the 2nd day. Feeding intolerance was also associated with duration of mechanical ventilation at p<0.001.[20]

It is suggested that further studies can be carried out for the same.

It was noted from this study that at 75th percentile, subjects receiving INJ. FENTANYL + INJ. PROPOFOL had a median value of 34.95.At p=0.194, there was no significance of sedatives on day 3 of GRV.

The study findings were parallel with a descriptive study which was conducted in 2008 among 36 mechanically ventilated, critically ill patients. The study was done to evaluate the effects of sedation (inj.morphine and midazolam) vs inj. propofol on gastric emptying. The results of the study shows that total gastric retention was greater in patients receiving midazolam and morphine (n=20) compared to inj. propofol (n=16). p<0.01.[18]

The investigator of this study noted that at 75th percentile, subjects receiving INJ. VECURONIUM had a median value of 25.00.At p=0.694, there was no significance of PARALYTICS on day 3 of GRV.

It was also noted that at 75th percentile, subjects received both INJ.NORADRENALINE and INJ.VASOPRESSIN had a median value of 40.00.At p=0.021, there was no significance of VASOPRESSORS on day 3 of GRV.

In concordance with this study, a prospective observational study that was conducted on 153 patients with nasogastric tube feeding in 2001, was referred.49 patients (32%) presented with increased gastric aspirate volume after a median EN duration of 2 days and 70 patients (46%) presented with UGI intolerance. It was concluded that high GAV was frequent in patients with sedation (p=0.004) or catecholamines (p=0.007).[10]

The study investigator noted that in the 75th percentile, subjects who didn't have any comorbidities had a median value of 23.75 and at p=0.257, there was no significant association between comorbidities and GRV on day 3.To support the findings, the following study was referred - A retrospective analysis of gastric emptying on 'The Impact of admission diagnosis on gastric emptying in critically ill patients was conducted in 2007 in Australia, using a ^{13}C-octatonic acid breath test in 12 type-II DM patients. 132

mechanically ventilated, critically ill patients were involved.GE was faster in critically ill patients with DM (t50 122±11 min, gastric emptying coefficient: 3.8±0.3) than in patients without DM (t50 168±16 min, gastric emptying coefficient: 2.8±0.1.It was concluded that long-standing DM may not be a risk factor for slow GE in critically ill patients.[9]

Conclusion

The main aim of the study was to correlate the impact of disease severity on gastric residual volume among the critically ill, nonsurgical patients admitted in the ICUs of a tertiary hospital in Bengaluru. 88 subjects were recruited for the study. The major findings of the study are as follows:

- On day 1 and day 3, there was a moderately positive statistical significance of mean GRV with APACHE – II score at $p < 0.001$ whereas on day 2 there was a weakly positive statistical significance at $p = 0.044$.
- It was noted that there was statistically no association of gastric residual volume with the selected socio-demographic variables.

Future Scope

The researcher recommends the replication of the study on a larger group of subjects. The subjects can be isolated according to their primary ICU diagnosis and can be studied individually. Monitoring GRV provides a database on the existing practice in the ICU.

Limitations

The recording of GRV on all 3 consecutive days was limited to chart review and not through direct observations and measurements and the type of feed was not included as a part of this study.

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