

# Inter-operator Reproducibility of Ultrasound Assessment of Gastric Residual Volume in Critically Ill Patients

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## Introduction

Optimal nutrition is essential for managing critically ill patients in intensive care units (ICUs), with enteral nutrition (EN) being the preferred method due to its benefits in preserving gut integrity, reducing infection risk, and improving outcomes. However, achieving feeding goals is often challenged by gastrointestinal intolerance, with gastric residual volume (GRV) as a key indicator of feeding tolerance. GRV is traditionally assessed using nasogastric aspiration, a method with limitations, including discomfort, variability, risk of tube displacement, and nutrient loss. Frequent GRV monitoring can also disrupt feeding, leading to caloric deficits and delayed recovery. Ultrasound (US) has emerged as a non-invasive, bedside tool for GRV assessment, providing real-time, reproducible measurements without disrupting feeding or causing discomfort. Its reliability in clinical practice requires validation to ensure inter-operator reproducibility and accuracy compared to the standard method. This approach offers a more efficient, comfortable alternative to improve nutritional management in ICU patients.

## Aim of the work

- Assess inter-operator reproducibility in gastric ultrasound assessment.
- Compare sonographic assessment of GRV with nasogastric aspirate GRV.

## Patients and Methods

sixty critically ill adult patients admitted to ICU were included in this single-center prospective observational study conducted at Alexandria Main University Hospitals to evaluate the reproducibility and accuracy of gastric residual volume (GRV) measurements using ultrasound (US) versus nasogastric aspiration. Demographic and clinical data, including age, gender, BMI, diagnoses, APACHE-II scores, and hemodynamic parameters, were collected. A 16 French enteral feeding tube was placed, and correct positioning was confirmed. Patients were fed in a semi-recumbent position, with tube position and feeding schedules standardized. GRV was measured every eight hours using both US and nasogastric aspiration. US assessments were performed by the researcher under radiology consultant supervision, and two trained intensivists independently performed blinded US measurements. Three measurements were taken for each operator, and the mean value was used. Agreement between US and nasogastric aspiration and inter-operator reproducibility were analyzed.

## Results

Table (1): Patients' Baseline Characteristics

Category	Variable	Frequenc y	%	Median	IQR
Demographics	Sex (Male)	34	57		
	Sex (Female)	26	43		
	Age (years)			52	39 - 62
	Body Mass Index (kg/m <sup>2</sup> )			27	22-31
Diagnosis	CVS	20	33.4		
	Traumatic brain injury	18	30		
	CNS infection	4	11.7		
	Pneumonia	8	13.3		
	Urinary Tract Infection	6	10		
	Diabetic Foot Infection	1	1.7		
	CRBSI	1	1.7		
Hemodynamics	COPD Exacerbation	2	3.3		
	Mean Arterial Pressure (mmHg)			75	60 - 95
	Norepinephrine Dose (µg/kg/min)			0	0 - 0.11
Severity Score	APACHE-II score			12	9 - 17
Gastric Residual Volume (GRV)	Nasogastric aspirate (ml)			155	88 - 250
	Ultrasound (ml)			188	108-281

CVS: cerebrovascular stroke, CNS: central nervous system, CRBSI: catheter related blood stream infection, COPD: chronic obstructive pulmonary disease, APACHE II: Acute Physiology and chronic health evaluation.

This cohort study included 57% males and 43% females, with a median age of 52 years and a BMI of 27 kg/m<sup>2</sup>. Common diagnoses were cerebrovascular strokes (33.7%), traumatic brain injury (30%), and pneumonia (13.3%). Most patients had a mean arterial pressure of 75 mmHg and low norepinephrine requirements. The median APACHE-II score was 12. GRV measurements showed ultrasound (188 ml) slightly higher than nasogastric aspirate (155 ml).

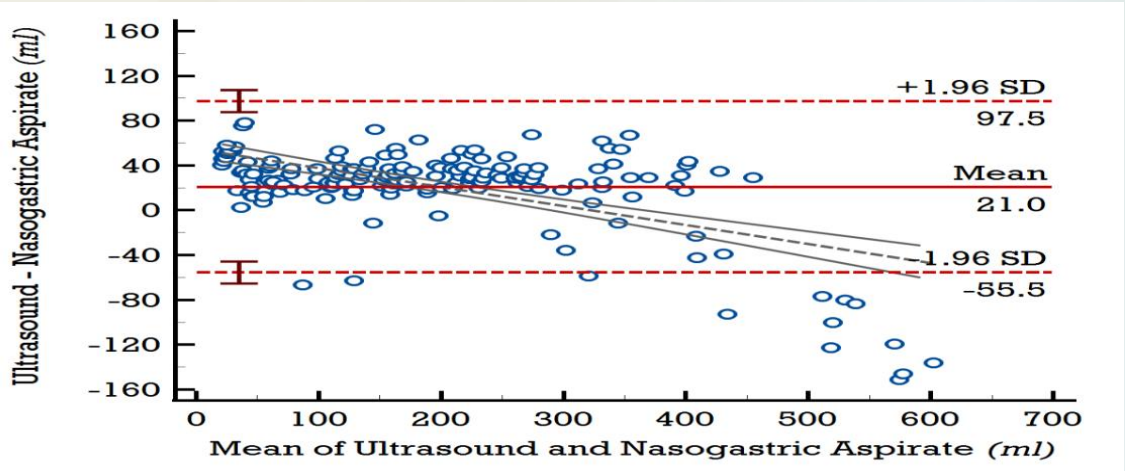


Figure (1): Bland–Altman plot showing the mean bias between ultrasound via the researcher and nasogastric aspirate GRV values (solid red line), with the 95% limits of agreement (red-dotted lines) and its confidence intervals (red error bars), as well as proportional bias regression line (grey-dotted line) and its confidence intervals (solid grey line).(2) Distribution of cervical spine injuries according to type maxillofacial trauma (n=186)

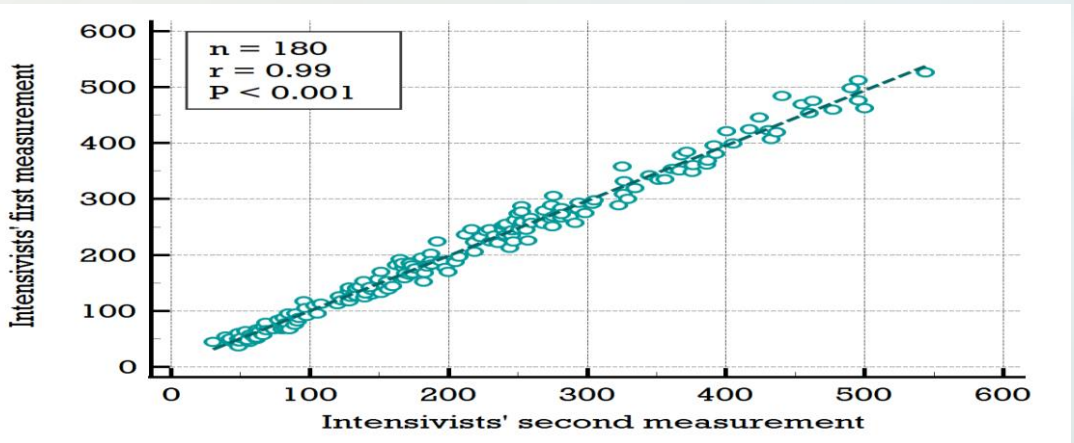


Figure (2): Scatter plot for the correlation between ultrasound measurements of GRV done by the two intensivists.

## Conclusion

Ultrasound is a reliable, reproducible, and non-invasive alternative to nasogastric aspiration for measuring gastric residual volume (GRV) in critically ill patients. The strong correlation with traditional methods, minimal bias, and narrow limits of agreement support its accuracy. However, clinicians should consider potential measurement variability and integrate ultrasound findings with comprehensive clinical evaluations to ensure optimal patient care.