Routine Point of Care Ultrasound (POCUS) Assessment of Gastric Antral Contents in Traumatic Emergency Surgical Patients for Prevention of Aspiration Pneumonitis: A Randomized Clinical Trial

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Abstract

Background: Polytrauma patients are at a higher risk of delayed gastric emptying. To assess gastric volume, a reliable diagnostic tool is needed to prevent the occurrence of aspiration pneumonia, which remains a serious complication associated with anesthesia. Gastric antral ultrasound can provide reliable information about the size of the gastric antrum in traumatized patients undergoing emergency surgery.

Methods: A prospective observational study of 45 polytrauma patients undergoing emergency surgery under general anesthesia. Prior to induction of anesthesia in the emergency department, gastric ultrasound was performed to allow qualitative and quantitative assessment of gastric antrum in a supine position and right lateral decubitus (RLD) position. Followed by routine placement of nasogastric tube to aspirate and calculate the volume of the stomach contents.

Results: Forty-five polytrauma patients who underwent gastric ultrasound examination showed that the risk assessment of aspiration and anesthesia technique changed in 14 patients (31.1%) after the ultrasound examination.

A very good relationship existed between the expected stomach volume at the RLD position and the suction volume in the nasogastric tube. In all cases, no aspirations were documented.

Conclusion: Ultrasound examination of the stomach in polytrauma patients allows assessing the size and type of stomach contents. The data obtained can influence the choice of anesthesia technique while inducing anesthesia and reduce the risk of aspiration pneumonia.

Trial registration: This trial was registered at ClinicalTrials.gov. Registry number: NCT04083677.

Background:

Pulmonary aspiration of gastric contents is rare in elective surgical groups but is more common in trauma patients requiring emergency surgery because trauma affects gastric motility and emptying. [1]

The presence of residual gastric contents at the time of induction of anesthesia is an important risk factor for aspiration pneumonia. The routine use of bedside ultrasound provides valuable information about the volume and type of gastric contents. Preoperative gastric contents determination helps the anesthesiologist assess the risk of pulmonary aspiration. [2, 3]

Ultrasonographic measurement of the antral cross sectional area (CSA) may determine the risk of occurrence of aspiration pneumonia during the perioperative period which can be determined by the size of the stomach (i.e., the presence of solid particles and/or gastric volume < 1.5 ml / kg). [4]

The aim of our study is to allow routine use of point of care ultrasound (POCUS) of gastric contents in order to assess aspiration risk and guide the anesthetic management in trauma patients.

Methods:

A prospective observational study was conducted in Ain Shams University Hospital Emergency Department. Institutional Research Ethics Committee approval was obtained in August 2019, number FMASU R 42 / 2019, this study was registered in clinical trial .gov (clinical trial ID NCT04083677) and carried out according to the Consolidated Standards of Reporting Trials (CONSORT) 2010 statement. This study was conducted in the period from September 2019 to January 2020. Written informed consent was obtained from all participants or from the legal gurdians in case of presence of patients with a disturbed conscious level before enrollment. The study included forty-five polytrauma patients (18–65 years old of both sexes) admitted for emergency surgery.

At the time of admission, the ABC protocol, the Glasgow Coma Scale (GCS) Assessment, full laboratory and radiological examinations and complete clinical assessment (including information about fasting hours) were done.

Exclusion criteria had included pregnancy, history of upper gastrointestinal disorders, including gastro esophageal reflux disease, hiatal hernia, gastrointestinal cancer or upper gastrointestinal surgery, patients with marked impaired level of consciousness (Glasgow coma scale less than 10), patients with fracture base of the skull and patients with severe bleeding.

We used Siemens low frequency curved probe (2–5 MHz) and ACUSON x 300 ultrasound system from Siemens by an experienced radiologist as part of a focused assessment with sonography in trauma (FAST) studies. All patients were examined in the supine position, followed by the right lateral decubitus position (RLDP). Gastric antrum was determined at the level of sagittal scans in the epigastrium beneath the xiphoid and superior to the umbilicus. The liver (anteriorly), aorta, inferior vena cava and pancreas (posteriorly) were used as anatomical landmarks (Fig. 1).

The "empty" antrum appears collapsed and "flat", as the anterior and posterior walls are too close to each other or round to ovoid shape and resemble the target of a “bull’s eye” (Fig. 2).

The antrum appears to expand in a circle when it is filled with transparent liquid. Several gas bubbles appear as punctuate hyper-echoic regions within the hypoechoic fluid and mimicking the formation of a "starry night" (Fig. 3).

The antrum with mixed echo contents appears to expand when filled with solid contents, giving the film a "frosted glass" appearance (Fig. 4).

If the stomach contains clear liquids, the volume measurement can help distinguish between small volume that correspond to baseline secretions and a larger volume than baseline.

The antral cross-sectional area (CSA) was calculated after measuring the two antral dimensions [Anteroposterior diameter (APD) and Craniocaudal diameter (CCD)] according to the following equation: π [APD X CCD] / 4. The volume of the transparent fluid was calculated using the CSA measured in an RLD, and a previously published mathematical model: Volume (ml) = 27.0+ (14.6 x Right - Lat (CSA) - (1.28 x Age). This equation accurately predicts the size of the stomach up to 500 ml. [4]

Additionally, the antrum is classified according to a three-point rating system (Perlas score 0–2) based on the absence or presence of clear liquid in the supine and RLD position. Grade 0 indicates that there are no contents in the antrum in the supine and RLD positions. The first grade indicates a clear old liquid that can only be seen in the RLD. The second grade indicates a clear liquid, which is documented in both the supine and RLD positions. [3]

With explanations of stomach ultrasound results and Perlas classification, we can plot this flowchart of risk stratification and decision making (Fig. 5).

Nasogastric tube was inserted preoperatively to confirm gastric ultrasound volume calculation.

Low risk class indicates that the risk of aspiration is low and it can be safe to perform surgery with slow induction of anesthesia with a laryngeal mask or by endotracheal tube.

A high-risk class indicates that the risk of aspiration is high, and these measures may be of help: 1, delay of the surgery depending on its urgency (which may not be acceptable), 2, acid aspiration prevention medications such as metoclopromide and drugs that neutralize stomach acid such as non-particle antacids, H2 inhibitor and proton pump inhibitor, 3, nasogastric tube for gastric drainage, 4, local anesthesia and neuraxial anesthesia and 5, general anesthesia with rapid sequence induction up to awake fibro-optic intubation.

Primary endpoint:

It included the incidence of change of aspiration risk after gastric ultrasonographic assessment in comparison to clinical assessment.

Secondary endpoints:

They included the incidence of perioperative aspiration and the correlation between predicted volume in RLD position and volume in nasogastric tube.

Sample size calculation:

Based on a study done by Sabry et al, [10] to show a difference in the incidence of change of aspiration risk after gastric ultrasonographic assessment in comparison to clinical assessment with a confidence interval at 95% and the acceptable margin of error at 5%. The p-value was considered significant if < 0.05 and needed minimally a sample size of 45 patients.

Statistical analysis:

Analysis of data was done by IBM computer using SPSS (a statistical program for social science, version 16). The quantitative variables were described as mean and standard deviation, while the qualitative variables expressed as number and percentage. Statistical analysis was performed using statistical tests which included the Chi-square test, a student test, and table analysis. *P*-value < 0.05 was considered significant.

Results:

45 polytrauma patients (25 males, 20 females) were planned for emergency surgery. Demographic data are summarized in table (1).

Table (1): Patient demographic data.

Patient demographics	**N.=45**
Gender M/F	25(55.5%)/20(44.4%)
Age (y) (mean and standard deviation SD)	40.22 ± 7.11
Height (cm) (mean and standard deviation SD)	161.02 ± 1.13
Weight (kg) (mean and standard deviation SD)	80.65 ± 5.66
Body Mass Index (kg/m2) (mean and standard deviation SD)	31.88 ± 2.47
All data were presented as mean ± SD except gender which was presented as percentage	

Patients presented for various surgical procedures (neurosurgery: 11 operations, vascular surgery: 9 operations, orthopedics: 11 operations, general surgery: 7 operations, and maxillofacial surgery: 7 operations).

Detailed information about the types of intake and fasting intervals were provided in the table (2) [solid food intake N = 33, thick fluid N = 6, clear fluid N = 6], [Non-Fasting N = 25, Fasting N = 20].

An empty stomach was documented in 10 patients (22.2%). The remaining 35 patients (77.7%) showed a full stomach on gastric sonography, twenty-nine of them had solid content and six had clear fluid of excess than 1.5 ml/kg. We found changed aspiration risk stratification and anesthesia decision making in 14 patients (31.1%) following the gastric ultrasound assessment compared to the use of preoperative clinical examination and fasting hours assessment (Fig. 6).

Table (2): Clinical and gastric ultrasound assessment results and anesthetic decision-making plan changes.

Patient number	Fasting hours/type of food intake	Anesthetic plan after clinical assessment	Gastric ultrasound			Anesthetic management after gastric ultrasound
			Type of content	Perlas grade	Conclusion	
1	4 h/bread and cheese	ETT: RSI	solid	-	Full	ETT:RSI
2	2 h/coffee	ETT: RSI	Empty	0	Empty	ETT: SI
3	6 h/banana	ETT:SI	Empty	0	Empty	ETT: SI
4	7 h/bread and cheese	ETT: SI	solid	-	Full	ETT: RSI
5	4 h/water	ETT: SI	Empty	0	Empty	ETT: SI
6	3 h/water	ETT: SI	Empty	0	Empty	ETT: SI
7	6 h/tea and biscuit	LMA	Empty	0	Empty	LMA
8	5 h/ vegetable soap	ETT:RSI	Empty	0	Empty	LMA
9	4 h/cheese sandwich with tea	ETT: RSI	solid	-	Full	ETT: RSI
10	2 h/water	ETT: SI	Empty	0	Empty	ETT: SI
11	2 h/coffee with milk	ETT: RSI	CF	II	Full	ETT: RSI
12	4 h/clear juice	ETT:SI	CF	1	Empty	ETT: SI
13	3 h/vegetable soap	ETT: RSI	Solid	-	Full	ETT: RSI
14	4 h/tea and water	ETT: SI	CF	1	Empty	ETT: SI
15	4 h/potato chips	ETT: RSI	solid	-	Full	ETT:RSI
16	3 h/bread and cheese with tea	ETT:RSI	Solid	-	Full	ETT:RSI
17	2 h/coffee and water	ETT:RSI	CF	II	Full	ETT:RSI
18	5 h/banana	ETT:RSI	Solid	-	Full	RSI
19	8 h/two meat sandwiches	ETT:SI	Solid	-	Full	ETT:RSI
20	8 h/mesh potato with rice	ETT:SI	Solid	-	Full	ETT:RSI

Patient number	Fasting hours/type of food intake	Anesthetic plan after clinical assessment	Gastric ultrasound			Anesthetic management after gastric ultrasound
			Type of content	Perlas grade	Conclusion	
21	3 h/two cheese sandwiches and tea	Delay for 3hour	Solid	-	Full	Delay for 3hour
22	3 h/ bread and cheese	Delay for 3hours	Solid	-	Full	Delay for 3hour
23	6 h/ vegetable soap	ETT:SI	Solid	-	Full	ETT:RSI
24	4 h/cheese sandwich with tea	ETT:RSI	Solid	-	Full	ETT:RSI
25	2 h/water	ETT:SI	CF	II	Full	ETT:RSI
26	3 h/coffee with milk	Delay for 1hour	CF	II	Full	Delay for 1hour
27	3 h/clear juice	spinal	CF	II	Full	spinal
28	6 h/ vegetable soap	ETT:SI	Solid	-	Full	ETT:RSI
29	4 h/tea and water	ETT:SI	CF	II	Full	Delay for 2 hours
30	4 h/potato chips	ETT:RSI	Solid	-	Full	ETT:RSI
31	5 h/ fried chicken	ETT:RSI	Solid	-	Full	ETT:RSI
32	4 h/ cheese sandwich	Delay for 2 hours	Solid	-	Full	Delay for 2 hours
33	9 h/ fatty meal	ETT:SI	Solid	-	Full	ETT:RSI
34	8 h/ meat and rice	ETT:SI	Solid	-	Full	ETT:RSI
35	8 h/ chicken	ETT:SI	Solid	-	Full	ETT:RSI
36	5 h/ rice and meat	ETT:RSI	Solid	-	Full	ETT:RSI
37	5 h/ fruits	ETT:RSI	Solid	-	Full	ETT:RSI
38	3 h/ meat	spinal	Solid	-	Full	spinal
39	3 h/ meat sandwich	ETT:RSI	Solid	-	Full	ETT:RSI

Patient number	Fasting hours/type of food intake	Anesthetic plan after clinical assessment	Gastric ultrasound			Anesthetic management after gastric ultrasound
			Type of content	Perlas grade	Conclusion	
40	4 h/ pizza	Spinal	Solid	-	Full	spinal
41	9 h/ meat	ETT:SI	Empty	0	Empty	ETT:SI
42	8 h/ meat and potato	ETT:SI	Solid	-	Full	ETT:RSI
43	9 h/ rice with chicken	ETT:SI	Solid	-	Full	ETT:RSI
44	6 h/ fatty meal	Delay for 2hours	Solid	-	Full	Delay for 2hours
45	4 h/ 2 cheese sandwiches	Delay for 2hours	Solid	-	Full	Delay for 2hours
CF: clear fluid, ETT: RSI: Endotracheal intubation-rapid sequence induction, ETT: SI: Endotracheal intubation-smooth induction, LMA: Laryngeal mask airway.						

Two patients (cases 2 and 8) were found to have a lower aspiration risk than anticipated by history alone and more liberal anesthetic techniques were used as shown in the table (2) and figure (7).

Twelve patients (cases 4,19,20,23,25,28,29,33,34,35,42 and 43) were found to have a higher aspiration risk than anticipated by history alone and more conservative anesthetic techniques were used as shown in table (2) and figure (7).

Table (3): Change of aspiration risk after clinical assessment and after gastric ultrasonographic assessment.

	After clinical assessment (N = 45)	After gastric ultrasonographic assessment (N = 45)	P-value
High risk of aspiration	25 (55.5%)	35 (77.7%)	0.0445*
Low risk of aspiration	20 (44.4%)	10 (22.2%)	0.0444*
All data were presented as percentage *P-value < 0.05 = significant, N = Number.			

As shown in table (3), the number of patients with a high risk of aspiration was increased after the gastric ultrasonographic examination (35 patients) than before it (25 patients) and the difference was statistically significant, also the number of patients with low risk of aspiration was decreased after the gastric ultrasonographic examination (10 patients) than before it (20 patients) and the difference was statistically significant. This reflects the importance of routine point of care ultrasound (POCUS) assessment of gastric antral contents in traumatic emergency surgical patients for prevention of aspiration pneumonitis.

Despite there is a highly significant statistical difference between the predicted volume in RLD position and volume in nasogastric tube, there was a good clinical correlation documented between them as shown in table (4).

Table (4): Correlation between predicted volume in RLD position and volume in nasogastric tube:

Predicted volume in RLD position (ml) (mean and standard deviation SD)	**200 ± 2.5**
Volume in the nasogastic tube (ml) (mean and standard deviation SD)	190 ± 5.5
P-value	< 0.001* HS
All data were presented as mean ± SD *HS = highly significant.	

No aspiration episodes were reported in all patients

Discussion:

Aspiration pneumonia remains a serious perioperative complication [5].

The presence of residual gastric contents at the time of induction of anesthesia is one of the major risk factors for pulmonary aspiration [6].

The motility of the digestive system can be affected by stress, pain, and anxiety, as well as the use of opioids, which makes prediction of the gastric contents difficult .Patients with a "full stomach" are at risk of aspiration during sedation or general anesthesia, as the tone of the lower esophageal sphincter and airway reflexes are reduced. The problem of pulmonary aspiration is greater during emergency surgery. [7].

The severity of aspiration is directly proportional to the volume, type and the acidity of the contents of the stomach. Because of basal gastric acid secretion, stomach volume less than 1.5 ml/kg is common in fasting patients and is considered safe [4].

History taking about fasting hours may be unreliable in elderly people with poor awareness, in children, and in cases of delayed stomach emptying, as in emergency surgery in patients with multiple traumas [2].

In anesthesia, the use of gastric ultrasound provides more accurate information about gastric contents than the general assumption based on fasting hours [1].

Gastric ultrasound is a promising technology because it is readily available, non-invasive and relatively easy to use [8].

The Retrospective study by Van de Putte et al. (2018) indicated that gastric ultrasound may be a useful diagnostic tool in addition to the standard assessment of gastric contents if fasting guidelines were not followed in elective surgical patients. Also, this study revealed significant changes in aspiration risk stratification and anesthetic management following a standard history-based clinical assessment compared to an assessment based on gastric sonography in elective surgical patients who had not followed fasting guidelines [9].

We concluded as Van de Putte et al. (2018) that gastric ultrasound allows planning anesthetic management to prevent the risk of aspiration [9], but we allowed routine ultrasound for trauma surgical patients when the risk of aspiration is higher.

Bouvet et al. (2017) reported the prevalence of the full stomach in 56% of emergency surgery patients and suggested that preoperative ultrasound assessment of gastric contents may be particularly helpful in this case [4].

Sabry et al. (2019) demonstrated that gastric ultrasound is used as a reliable method to assess the residual gastric volume in fasting diabetics compared to the healthy control for elective surgery and reported that the residual gastric volume in diabetic patients fasting for 8 hours was higher than in patients without diabetes scheduled for elective surgery [10].

Cubillos et al. (2012) concluded that bedside ultrasound can determine the type of gastric contents (nil, clear fluid, thick fluid or solid content). This qualitative information can be useful on its own to assess aspiration risks, especially in cases where the fasting state is unknown or uncertain [2].

In our study, we used gastric antral ultrasonography before induction of anesthesia in polytrauma patients undergoing emergency surgery to allow qualitative and quantitative assessment of gastric antrum in supine and right lateral decubitus position for the prevention of aspiration pneumonitis.

Also, nasogastric tube was inserted preoperatively to aspirate the gastric contents to be compared with gastric ultrasound volume calculation with a very good correlation between them.

Our data suggest that routine gastric ultrasound in polytrauma patients allows to personalize aspiration risk assessment to guide anesthetic management.

Conclusion:

This study concluded that routine preoperative gastric ultrasound is a useful, safe and noninvasive tool for assessment of gastric contents in emergency surgical patients in order to plan the anesthetic management to prevent aspiration.

Abbreviations:

POCUS: Routine Point of Care Ultrasound.

RLD: right lateral decubitus.

CSA: cross sectional area.

CONSORT: Consolidated Standards of Reporting Trials.

GCS: Glasgow Coma Scale.

FAST: Focused assessment with sonography in trauma.

A: antrum.

L: liver.

P: pancreas.

SMA: superior mesenteric artery.

Ao: aorta**.**

D: Duodenum**.**

Py: Pylorus.

IVC: Inferior vena cava.

APD: Anteroposterior diameter.

CCD: Craniocaudal diameter.

SPSS: statistical program for social science.

CF: clear fluid.

ETT: RSI: Endotracheal intubation-rapid sequence induction

ETT: SI: Endotracheal intubation-smooth induction.

LMA: Laryngeal mask airway.

Declarations:

Ethics approval and consent to participate:

This study was approved by ethics committee of Ain Shams University number FMASU R 42 / 2019 and the protocol was registered at ClinicalTrials.gov: NCT04083677, initial registration was on September 6, 2019. All procedures performed in this study involving human participants were in accordance with the Ethical Standards of the Institutional Ethics Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All patients or relatives signed written informed consent before surgery.

Consent for publication:

Not applicable.

Availability of data and materials:

The data sets used during the current study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

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Authors’ contributions:

MS: Conception and design, editing of manuscript, data collection, analysis and revision of the manuscript. AAK: Editing of manuscript, data collection, analysis and revision of the manuscript. AAG: Ultrasonography examination, data collection, analysis and revision of the manuscript. RM: Data collection, analysis, editing of manuscript and revision of the manuscript. All authors have read and approved the final manuscript.

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References:

1. **Perlas A, Davis l, Masood KNM, Vincent WS, Chan VW**: Gastric Sonography in the fasted surgical patient: A Prospective Descriptive Study: Anesthesia and Analgesia (2011) July: 113:39-7.
2. **Cubillos J, Cyrus T, Vincent WS, Chan VW, Perlas A**: Bedside ultrasound assessment of gastric content: an observational study: Can J Anesth (2012) 59:416-423.
3. **Perlas A, Arzola C, Van de Putte P**: point-of-care gastric ultrasound and aspiration risk assessment: a narrative review Anesthesiology (2015) 90:313-330.
4. **Bouvet L, Chassard J, Benhamou B**: clinical assessment of the ultrasound measurement of antral area for estimating preoperative gastric content and volume. Eur J Anaesthesiol (2017):114:1086-92.
5. **Mendelson CL.** The aspiration of stomach contents into the lungs during obstetric anesthesia. Am J Obstet Gynecol (1946); 52: 191-205?
6. **Levy DM.** Pre-operative fasting-60 years on from Mendelson BJA Educ, continuing education in anesthesia. Critical Care & Pain (2006); 6: 2015-8.
7. **Bisinotto F M, Pansani PL, Silveira LA, Naves AD, Peixoto AC, Lima HM, et al.** Qualitative and quantitative ultrasound assessment of gastric content. Revista da Associação Médica Brasileira. (2017)Feb; 63(2):134-4.
8. **Arzola C, Perlas A, Siddiqui NT, Carvalho JC.** Bedside gastric ultrasonography in term pregnant women before elective cesarean delivery: a prospective cohort study. Anesthesia and Analgesia. (2015); 121(3):752-8.
9. **Van de Putte P, Van Hoonacker J, Perlas A.** Gastric ultrasound to guide anesthetic management in elective surgical patients non-compliant with fasting instructions. A retrospective cohort study. Minerva Anestesiol. (2018); 84(7):787-95.
10. **Sabry R, Hasanin A, Refaat S, Abdel Raouf S, Abdallah AS Helmy N.** Evaluation of gastric residual volume in fasting diabetic patients using gastric ultrasound. Acta Anaesthesiologica Scandinavica. (2019); 63(5):615-9.

Figures

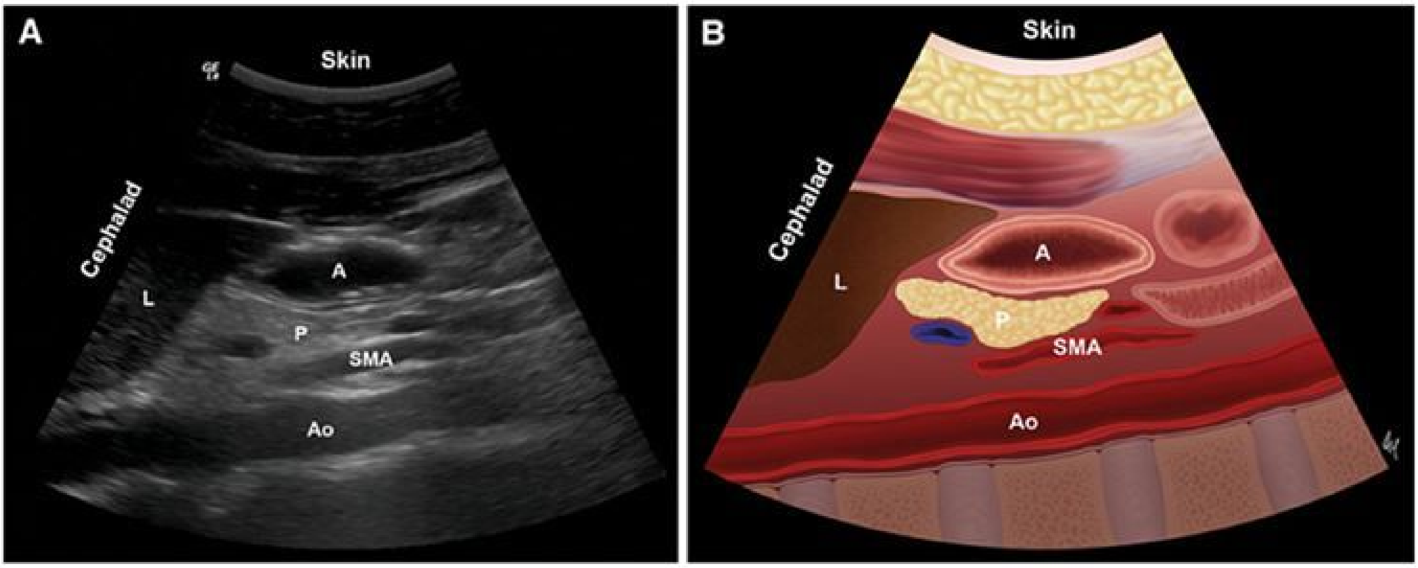

Figure 1

A Sagittal sonography of the gastric antrum. A = antrum; L = liver; P = pancreas; SMA = superior mesenteric artery; Ao = aorta. B Sagittal picture of the gastric antrum.

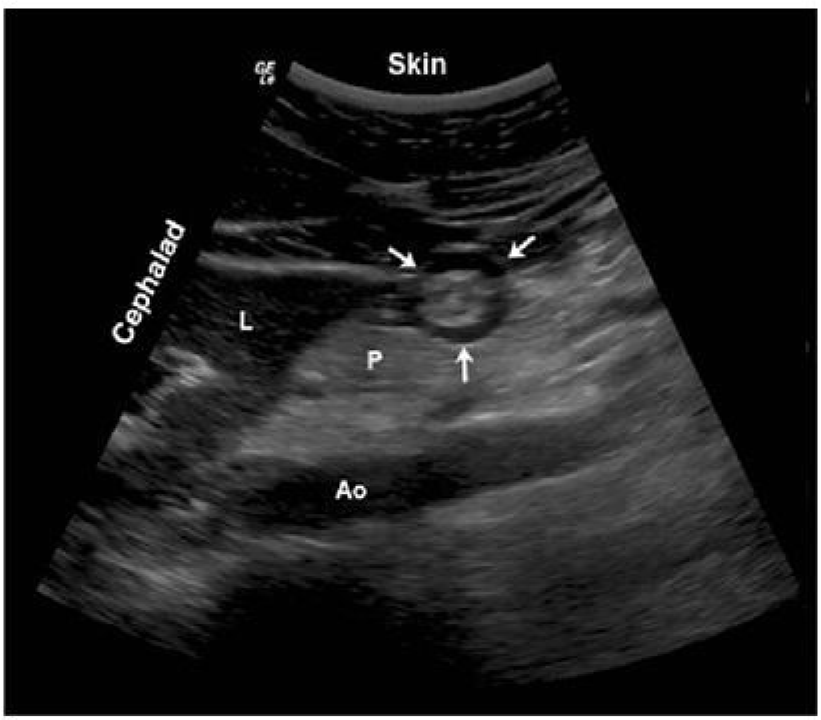

Figure 2

Bull’s eye sign. L= Liver. P=Pancrease. Ao= Aorta.

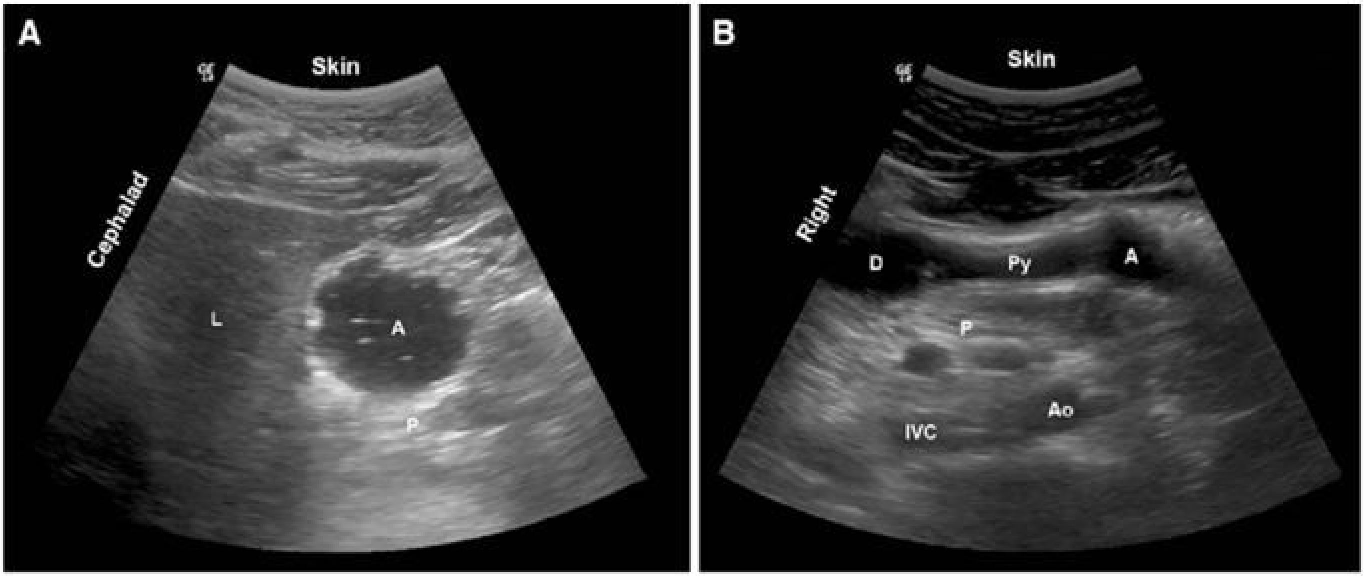

Figure 3

Starry night sign. A Sagittal sonography of the gastric antrum immediately following ingestion of 200 mL of clear fluid ("starry night" appearance) A = antrum; L = liver; P = pancreas. B Axial A=Antrum, D=Duodenum, Py = Pylorus, IVC = Inferior vena cava, Ao = Aorta.

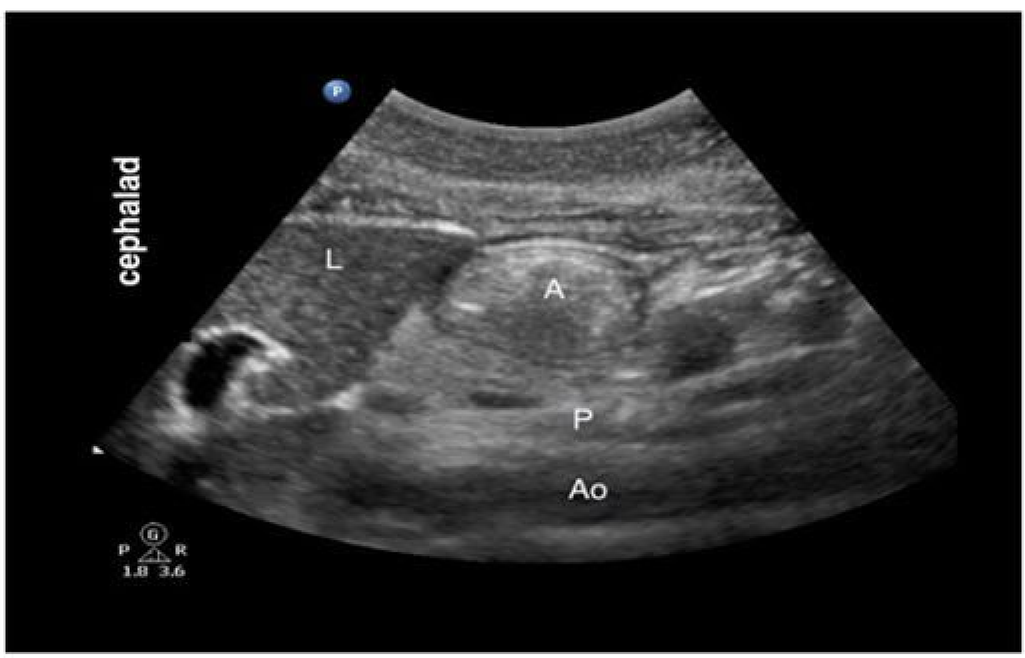

Figure 4

frosted glass sign. A = antrum; L = liver; P = pancreas; Ao = Aorta.

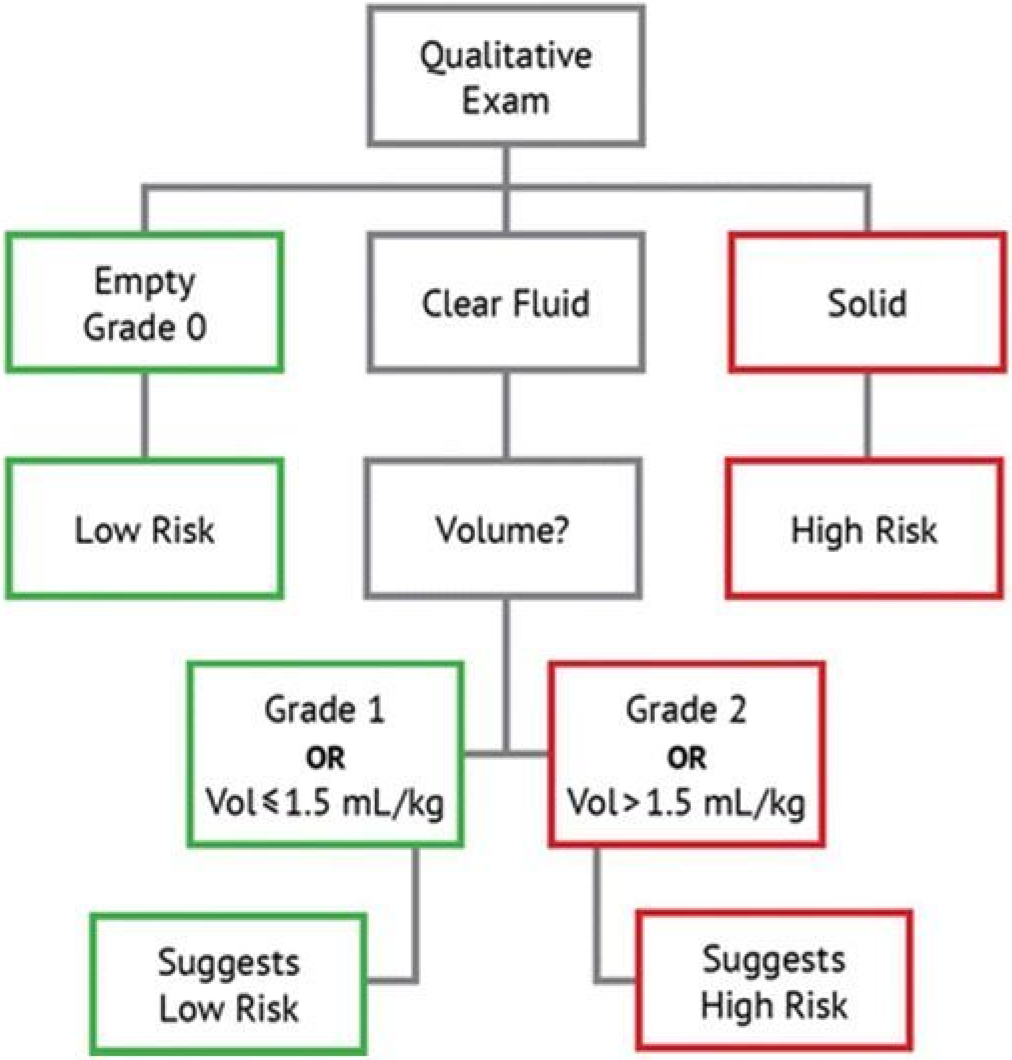

Figure 5

Flow chart for analysis of findings and medical decision-making based on gastric point-of-care ultrasound findings.

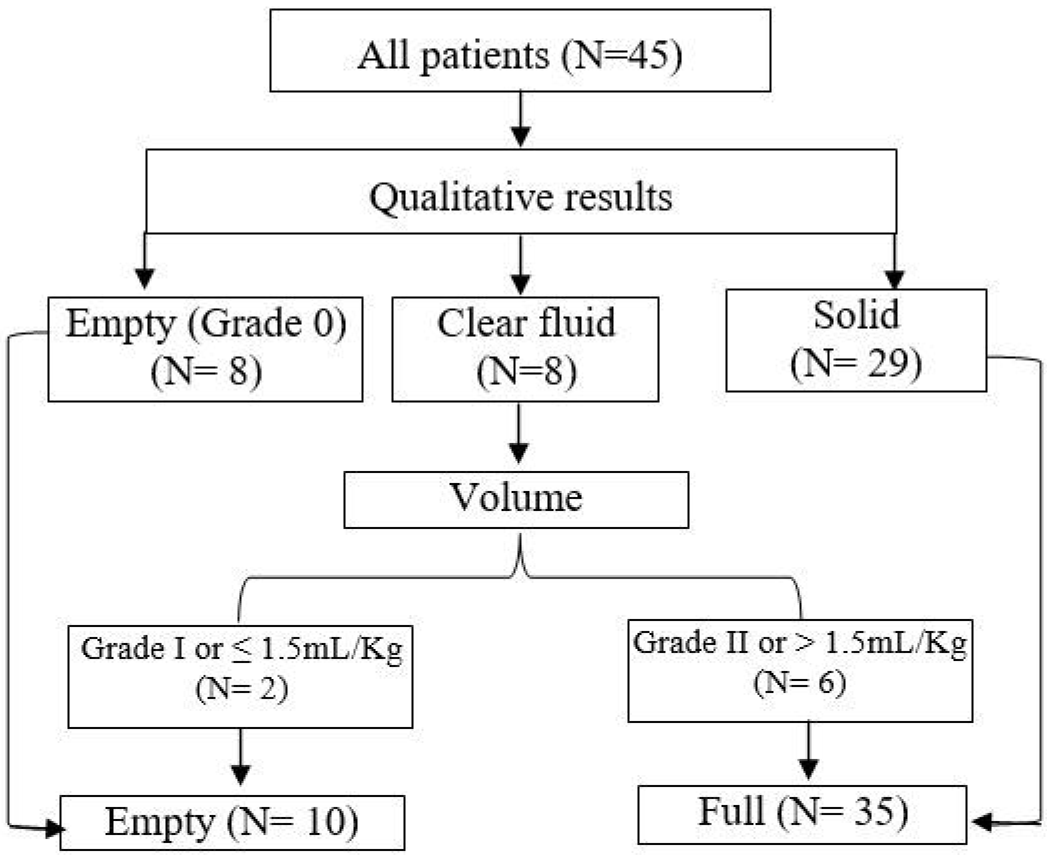

Figure 6

Results of gastric ultrasound examination of gastric contents.

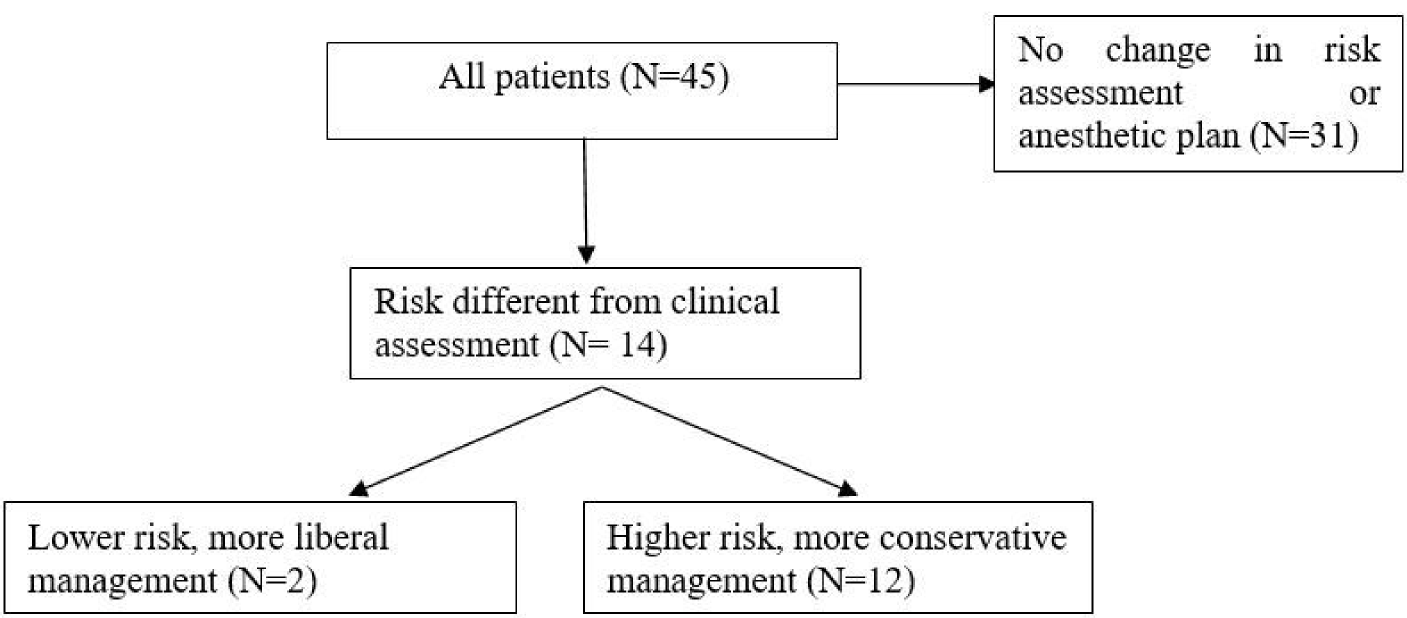

Figure 7

patient management.

Supplementary Files

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- CONSORT2010Checklist.doc