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How Bougie is BUGI? Bedside Upper Gastrointestinal (BUGI) in the Neonatal Intensive Care Unit

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Abstract

Objective: Transport outside the neonatal intensive care unit (NICU) for radiology studies is challenging for certain patients. The development of a bedside upper gastrointestinal (BUGI) protocol allowed for evaluation of malrotation within the NICU.

Study Design: We report the use of BUGI in 21 cases of bilious emesis performed at UH Rainbow Babies & Children's Hospital NICU to correctly identify the duodenojejunal junction (DJJ).

Results: No malrotation was identified in 19 cases, with one indeterminate and one positive. Images required were ≤4 in 78% and ≤6 images in 95% of studies. Median time to final image was 16.5 minutes. Median gestation was 28.4w with postmenstrual age of 30.1w. Median birthweight was 1115g and, at study, 1070g.

Conclusion: Successful introduction of BUGI avoided risks of transport to radiology, obviated need for in-person radiologists, and spurred development of an algorithm (provided) to guide evaluation of bilious emesis incorporating both ultrasound and BUGI.

Introduction

Bilious emesis is a common presentation in the neonatal intensive care unit (NICU). While often attributed to feeding intolerance or delayed gastric emptying, bilious emesis caused by malrotation with midgut volvulus is a surgical emergency. Delays in diagnosis can lead to bowel ischemia or necrosis, and significant morbidity and mortality. The upper gastrointestinal (UGI) series is the current gold standard for diagnosing malrotation and plays a critical role in evaluation of midgut volvulus. However, for critically ill infants in the NICU, especially if premature, a trip to fluoroscopy carries significant risks including hypothermia, dislodgement of endotracheal tubes and lines with subsequent limited access to acute interventions[1]. To mitigate these risks, a bedside upper gastrointestinal (BUGI) study technique has been developed and refined.

The BUGI technique was first described by Nayak et al [1] at Montefiore Medical Center in a retrospective review of 27 premature infants weighing less than 1,500g. Of these, 78% of the studies were diagnostic, which was defined by successful identification of the duodenojejunal junction (DJJ).

To bring this procedure to our own NICU, a multidisciplinary team of neonatologists, pediatric surgeons, and pediatric radiologists collaborated in the development of an updated BUGI protocol. We report our practical experience and provide a detailed protocol, as well as a bilious emesis management algorithm that incorporates both ultrasound and BUGI to establish a safe and effective alternative to conventional fluoroscopic evaluation.

Materials/Subjects and Methods

This retrospective, observational study was reviewed and approved by the Institutional Review Board at UH Rainbow Babies and Children's Hospital with a waiver of informed consent. Medical records of neonates admitted to the NICU between June 2023 and January 2025 were reviewed. Neonates were included if they underwent BUGI for evaluation of bilious emesis or bilious residuals due to clinical instability precluding transport to the fluoroscopy suite for a conventional UGI. Twenty-one neonates met our inclusion criteria, and their BUGI protocol studies were reviewed.

The BUGI protocol was developed by our pediatric radiology faculty in conjunction with the neonatology and pediatric surgery teams to facilitate timely evaluation of volvulus and malrotation in critically ill neonates. Radiology technicians were subsequently trained to perform the study independently without a radiologist at bedside. An average of 3.7 mL of contrast was administered via nasogastric tube. Although water-soluble contrast or barium may be used, the use of water-soluble contrast if advantageous if additional studies may be necessary. AP radiographs were obtained at 1 and 2 minutes after contrast administration. If the DJJ could not be clearly identified after 2 minutes, additional images were obtained as determined by the pediatric radiologist remotely monitoring the study. All images were reviewed by pediatric radiologists with expertise in neonatal abdominal imaging.

Normal positioning of the DJJ was defined as being to the left of the left spinal pedicle at the level of the pylorus/duodenal bulb[2, 3]. Malrotation was suspected if the DJJ was visualized to the right of the spine, positioned inferior to the expected level of the pylorus/ duodenal bulb (low-lying position), or if the course of the duodenum was abnormal. When the DJJ could not be clearly visualized, the study was deemed indeterminate.

Demographic and clinical data were collected from electronic medical records, including gestational age, birth weight, and indication for BUGI. While evaluating outcomes following implementation of the BUGI protocol, we also examined whether an abdominal ultrasound had been performed during the development of our bilious emesis management algorithm.

Study outcomes were categorized as malrotation identified, malrotation ruled out, or indeterminate. Long-term outcomes were collected, and neonates were classified as being discharged home or continuing to require NICU care.

Results

Twenty-one neonates who were admitted to the UH Rainbow Babies and Children's Hospital NICU from May 2023 to January 2026 were identified as having undergone BUGI studies; 19 of these infants had bilious emesis, and 2 had bilious residuals from enteric tubes. The median gestational age (GA) of our population was 28.4 weeks, with an average postmenstrual age at the time of study of 30.1 weeks (Table 1). The average birth weight was 1116 grams, and average weight at the time of the study was 1070 grams.

Table 1
Bedside UGI infant characteristics (n = 21)

Gestational Age (weeks)	**28.4 (27.2, 30.5)**
Birth Weight (grams)	1115 (992.5, 1212.5)
Postmenstrual Age at Time of Study (weeks)	30.1 (28.3, 32.4)
Weight at Time of Study (grams)	1070 (941, 1215)
Age at Time of Study (days)	6 (5, 11)
Indication for Study	19 (90.5%)
Bilious emesis	2 (9.5%)
Bilious residual	
Number of Images Required for BUGI	16 (76%)
≤ 4	20 (95%)
≤ 6	
Time from first to last image (minutes)	16.5 (7, 27.5)
Outcome of Study	19 (90.5%)
Diagnostic: negative for malrotation	1 (4.75%)
Diagnostic: positive for malrotation	1 (4.75%)
Indeterminate	
Data are presented as median (IQR) or n (%)	

A set of representative serial radiographs demonstrating contrast movement at 1 minute, 2 minutes, and 5 minutes after administration are shown in Fig. 1. Of the 21 neonates who underwent BUGI studies, 19 (90.5%) demonstrated normal position of the DJJ, ruling out malrotation (Fig. 2). One study (4.75%) was diagnostic for malrotation, and one study (4.75%) was indeterminate. A subsequent ultrasound was obtained in the indeterminate case, which did not demonstrate evidence of malrotation or midgut volvulus. An ultrasound was deemed to rule out malrotation when a normal retroperitoneal D3 was seen. If the whirlpool sign or cut-off sign was not shown on ultrasound, midgut volvulus was excluded due to normal positioning of SMA/SMV[4]. No reported adverse events arose during BUGI studies, and all infants in our population tolerated the study without complication.

The infant identified with malrotation (Fig. 2d) was an 8-day-old neonate born at 37w2d gestational age with a history of repaired gastroschisis on day 1 of life and known intestinal malrotation. BUGI study was performed due to new-onset bilious emesis, and included small bowel follow through images. A 5-minute image demonstrated a low-lying DJJ to the right of the spine and contrast within a proximal loop of small bowel on the right side of the abdomen confirming known malrotation. A 45-minute delayed

image was also obtained which demonstrated progression of contrast through multiple dilated jejunal loops on only the right side of the abdomen, consistent with malrotation. While the BUGI is not a gastric emptying study, several infants had significant delay in emptying time, with the DJJ identified as long as 199 minutes after contrast administration. In our population, 12 (57%) of patients underwent abdominal ultrasound prior to a BUGI, with 8 being diagnostic to rule out volvulus and 4 being inconclusive.

Discussion

Since conventional fluoroscopic UGI exams are not always feasible in critically ill or low birth weight infants in the NICU, we developed a BUGI protocol at our institution based on the few papers we had noted in the literature. Through the production of a protocol, our radiology and NICU teams performed 21 of these studies with active real-time radiographic monitoring by our radiologists. For each examination, we recorded the primary outcome (malrotation versus no malrotation), as well as technical details including the number of images acquired and examination duration. Unlike the conventional UGI, the BUGI can be performed in the controlled environment of the patient's isolette by the NICU team and monitored remotely by a radiologist. For resource-constrained or multisite hospital systems, the BUGI can deliver a timely diagnosis, reduce after-hours workflow and disruptions, and be performed safely, preventing unnecessary transfers and the associated risks.

Our study demonstrates that the BUGI is a safe and reliable alternative for the evaluation of malrotation in the NICU when a fluoroscopic UGI cannot be performed. The standardized BUGI protocol created at our institution is provided (Fig. 3). In our cohort of 21 infants, the DJJ was successfully identified in 20 cases, with 19 demonstrating normal intestinal rotation and one confirming malrotation in the setting of gastroschisis. The indeterminate study was due to minimal progression of contrast, precluding confident DJJ localization.

An important component of our protocol is the active guidance of a remote radiologist monitoring the images in real-time to determine the correct timing of subsequent radiographs. Although all patients had an image obtained immediately and 1 minute after the instillation of contrast, there was notable variability in the timing of subsequent films due to the delay in emptying time. In one patient, the DJJ could not be accurately identified until 199 minutes after contrast instillation. While the BUGI is not intended to function as a formal assessment of gastrointestinal motility, delayed gastric emptying and prolonged intestinal transit are commonly seen in premature critically ill infants. Therefore, additional abdominal radiographs should be obtained at intervals tailored to the individual patient[2]. These authors suggest that positional adjustments, such as placing the infant in right lateral decubitus positioning prior to obtaining a radiograph can optimize the visualization of the DJJ.

Although only one nondiagnostic study was encountered in our cohort, limitations of the BUGI technique have been reported in the literature. A delay in obtaining radiographs can result in opacification of jejunal loops, resulting in obscuration of the DJJ position and a non-diagnostic study[1]. Additionally, our BUGI protocol, consistent with others described in the literature, does not include a lateral view of the DJJ,

which is standard in the conventional fluoroscopic UGI to confirm the retroperitoneal position of the 2nd, 3rd and 4th portion of the duodenum[3]. The lack of a lateral view can result in a false-negative exam, however, in NICU patients, lateral positioning can be difficult and may pose additional clinical risks[2]. We have not had to use this in our current cohort but could consider a cross-table lateral image if the study is inconclusive. True anteroposterior positioning of the patient for each radiograph is critical to determine the accurate position of the DJJ and reduce uncertainty secondary to rightward or leftward deviation of the DJJ[1]. Finally, correct placement of the enteric tube within the gastric body should be confirmed before instillation of contrast, as positioning of the enteric tube in the distal antrum or pylorus can limit evaluation of stomach configuration, altering the timing of contrast through the duodenum, and distorting the position of the DJJ. Recent abdominal radiographs should be reviewed prior to the instillation of contrast material and if there is any uncertainty regarding enteric tube position, a scout radiograph should be obtained prior to the start of the BUGI.

While we were developing our BUGI protocol, evidence was evolving for the use of abdominal ultrasound for evaluating infants with bilious emesis in the NICU.A recent multicenter retrospective study reported high diagnostic accuracy of ultrasound for the evaluation of malrotation and midgut volvulus, with a sensitivity of 93% and specificity of 96%[4]. For midgut volvulus specifically, ultrasound demonstrated even higher diagnostic accuracy, with a sensitivity and specificity of 97% and 98%, respectively[4]. These findings suggest that ultrasound may be a valuable first-line screening modality, particularly for the detection of midgut volvulus, the more urgent and clinically significant diagnosis. The development and use of the BUGI protocol at our institution, as well as the new ultrasound data, spurred our multidisciplinary team, with physician representation from pediatric surgery, pediatric radiology, and neonatology to create an algorithm to guide clinical decision-making NICU patients with bilious emesis. A central component of our new algorithm (Fig. 4) was the utilization of ultrasound to rule out midgut volvulus prior to any contrast evaluation of the GI tract. Ultrasound has demonstrated high sensitivity and specificity in excluding volvulus[4, 5, 6]. As our multidisciplinary protocol for bilious emesis evolved, we began assessing midgut volvulus by US first. Per our algorithm, if an US is positive for midgut volvulus, there is no need for further imaging because the patient will go immediately to surgery. However, in a clinically unstable, low birth weight neonate with an ultrasound that is negative or indeterminate for volvulus, a BUGI is indicated for the evaluation of malrotation. Our algorithm also incorporates BUGI as a reasonable alternative to conventional fluoroscopic UGI outside of routine work hours to conserve resources, with conventional UGI reserved for indeterminate cases or performed following discussion with the clinical team. In our cohort, no patient required subsequent conventional fluoroscopic UGI when BUGI findings were interpreted in the context of the overall clinical picture.

Conclusion

BUGI is a safe and reliable alternative to conventional fluoroscopic evaluation of malrotation/ volvulus in the preterm infant. In our cohort of 21 NICU infants, the DJJ was successfully identified in 95% of studies, consistent with the growing body of literature supporting the diagnostic utility of BUGI studies.

Furthermore, we provide a new algorithm that adds appropriate use of abdominal ultrasound to complement the use of BUGI. Future studies with larger cohorts are needed to further validate and standardize the use of ultrasound with BUGI for the evaluation of bilious emesis in critically ill neonates.

Declarations

Conflict of Interest Disclosure: The authors have no conflict of interest relevant to this article to disclose

Funding source: none

Data Availability: The de-identified data set generated from the study is available from the corresponding author on reasonable request and following approval by the Institutional Review Board of Rainbow Babies and Children's Hospital

The study was presented in part as a poster presentation at the Pediatric Academic Societies Meeting in Boston, Massachusetts on April 26th, 2026

Approval and Consent to Participate: This study was approved by the University Hospitals' Institutional Review Board with waive of informed consent. All methods were performed in accordance with the relevant guidelines and regulations

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work

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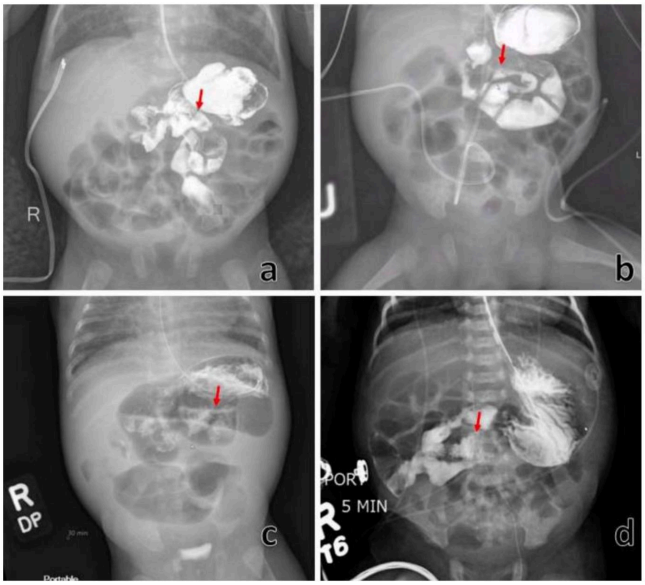
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Figures

Figures 1: Representative Images of from BUGI in 4 different patients



(a): Image of a 45-day old neonate, 26w0d gestational age. Image 7 minutes after administration of barium demonstrates normal positioning of the DJJ (arrow) with proximal loops of jejunum in normal position in the left side of the abdomen.

(b): Image of a 5-day old neonate, 27w4d gestational age. Image 9 minutes after administration of barium demonstrates mildly distend loops of bowel resulting in slight depression of the DJJ (arrow). However DJJ is in normal position at the lower margin of the duodenum to the left of the spine.

(c): Image of an 11-week-old neonate, 29w2d gestational age. Initial BUGI images obtained at 1 minute and 10 minutes in this neonate with multiple dilated loops of small bowel were nondiagnostic however a 30-minute delayed image accurately determined the normal positioning of the DJJ (arrow) despite the multiple dilated loops of bowel).

(d): An 8-day old neonate, 37w2d gestational age, with history of repaired gastroschisis on day 1 of life and known intestinal malrotation. This study was done for new onset bilious emesis and also included small bowel follow through images. A 5-minute image demonstrates a low-lying DJJ (arrow) which is to the right of the of the spine and contrast within a proximal loop of small bowel within the right side of the abdomen confirming the known malrotation.

Figure 1

See image above for figure legend.

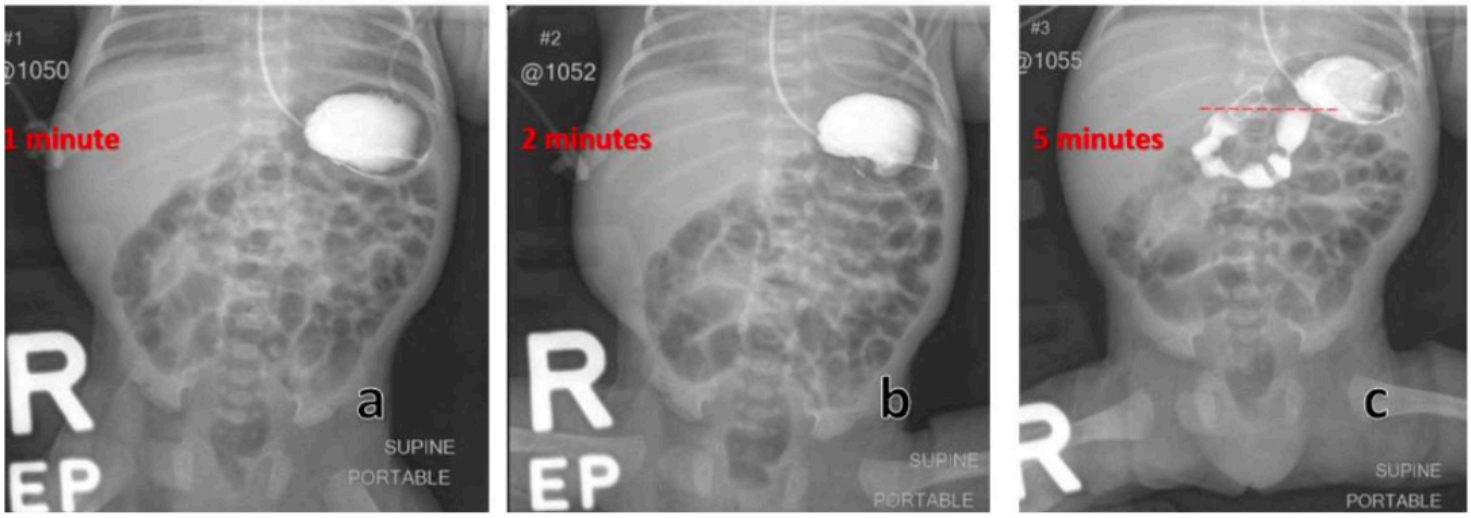


Figure 2

Sequential Images of a 6-day old neonate

Images from a bedside UGI examination in a 6-day old neonate, 26w0d gestational age. Images including a radiograph obtained 1 minute after contrast administration via enteric tube (a), at 2 minutes (b) and at 5 minutes. Initial 1- and 2-minute images demonstrate contrast within the stomach After right lateral decubitus positioning between images the normal position of the DJJ is seen on the 5 minutes (c) image to the left of the spine at the level of the pylorus (red line).

Bedside Portable UGI for Malrotation/Midgut Volvulus Protocol

Purpose: To safely and efficiently evaluate critically ill or low birth weight neonates with bilious emesis for malrotation.

Protocol:

1) **NICU Attending** orders a Bedside UGI
2) **Pediatric Radiology Attending or Radiology Resident** confirms the request is appropriate. **Radiology Resident notifies Radiology Attending Bedside UGI has been ordered via EPIC Haiku if after routine work hours.** Ultrasound for Midgut Volvulus should be completed and reviewed. Prior KUB should also be reviewed to confirm appropriate enteric tube placement.
3) **Radiology Technologist** coordinates timing of exam with the **NICU Nurse**.
4) **Radiology Technologist** confirms contrast type (Omnipaque 180 or Barium) and volume with the pediatric radiology attending or radiology resident and NICU Nurse. Use Epic Haiku to include the Radiologist, NICU Nurse and Radiology Technologist to plan for and monitor the exam.
5) **Radiology Technologist** will take a total of at least 10 mL of either Omnipaque 180 or 10 ml barium to the NICU. Confirm appropriate syringe depending on the type of enteric tube. If patient has a Replogle, take the appropriate blunt plastic adapter from pediatric fluoroscopy suite.
6) **NICU Nurse** will position infant supine with no rotation of chest or abdomen.
7) **Radiology Technologist** will take an AP scout abdominal radiograph prior to administration of contrast to confirm placement of the enteric tube in the stomach body/antrum.
8) **NICU Team** will withdraw any air from the stomach, then inject 3-5 ml contrast through patient's Replogle/NG/OG tube.
    a. If patient has a Replogle, make sure the bedside nurse has taken it off suction. Do not place back to suction until after the procedure.
9) **Radiology Technologist** takes an abdominal radiograph. Share the radiograph with the **monitoring radiologist** on Epic Haiku. Radiologist will determine need for additional radiographs or additional contrast (2-3 cc). Additional contrast can be administered up to a total volume of 10 cc. Additional images may include:
    - If any contrast has started to enter duodenum: Keep the patient flat and take another exposure in one minute. Please time the interval using you phone or watch.
    - If contrast remains only in the stomach: Ask the NICU team to help position patient on their right side for 30-45, timing the interval using your phone or watch. Return the infant to the supine position and then take another AP image of the abdomen.

    All images should be checked by the monitoring Attending Radiologist.

10) A typical bedside UGI includes AP images obtained at 1,3, and 5 minutes after administration of contrast. The exam is complete when the duodenal jejunal junction is clearly identified.

Figure 3

Rainbow BUGI Protocol

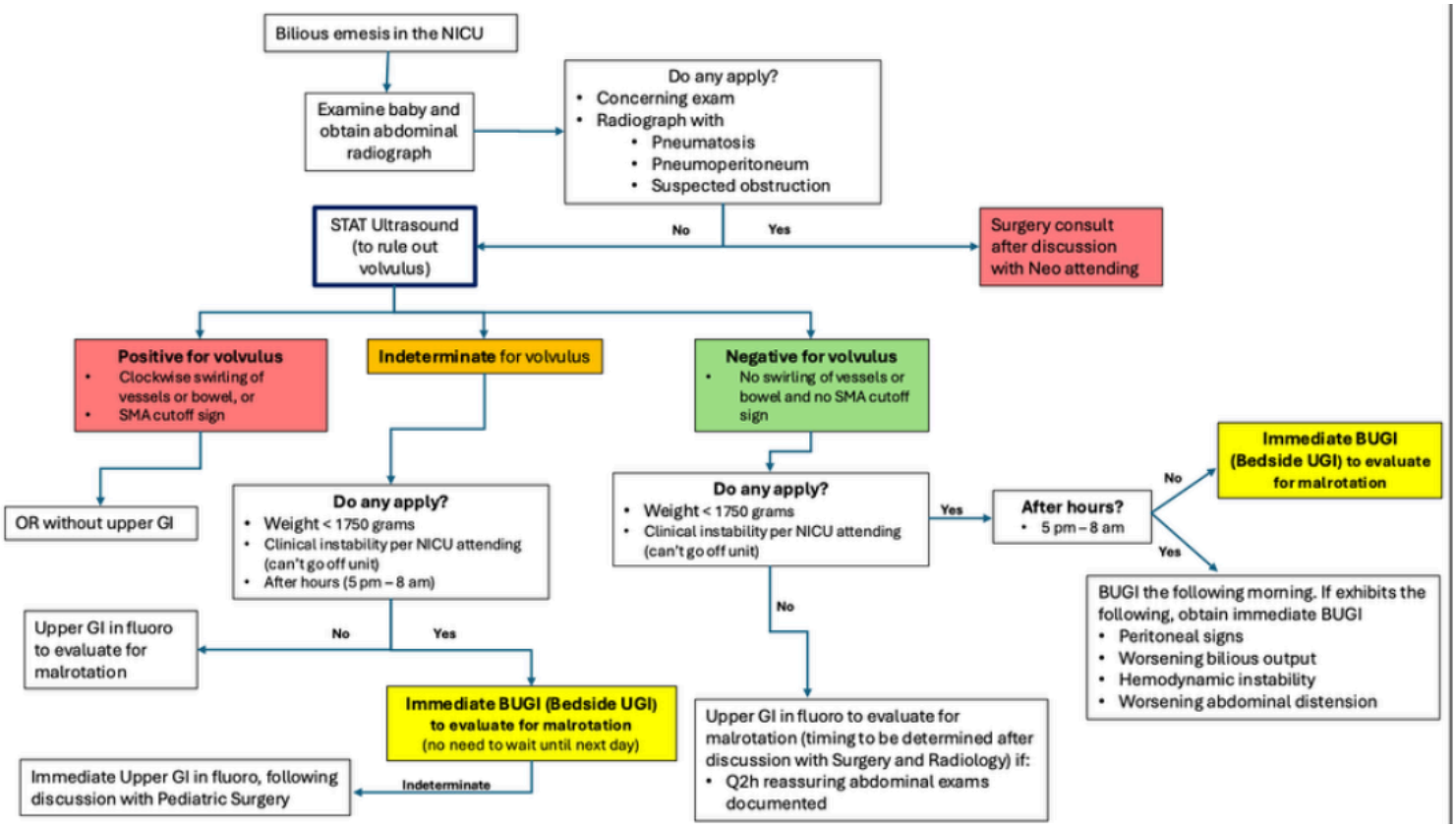


Figure 4

Rainbow Bilious Emesis Algorithm