
Is there evidence to support the measurement of abdominal girth as an indicator of feeding intolerance or necrotizing enterocolitis (NEC) in neonates? Is there evidence to support its use in certain subpopulations (e.g. preterm babies)? What is the exact procedure?

This report aims to summarize the best available evidence around the indications for using abdominal girth to predict feeding intolerance or necrotizing enterocolitis (NEC) in the neonatal population. This information can serve to guide procedures to measure and interpret the values of abdominal girth at the neonatal intensive care unit (NICU) of the MUHC.

Please NOTE that, for the purposes of this Rapid Review, and according to the evidence, *abdominal girth* and *abdominal circumference* are considered equivalent terms; therefore, for the ease of reading this text, we will use the term **abdominal girth (AG)** throughout this Rapid Review.

Key Messages:

- Abdominal distention remains a common indicator and predictor of feeding intolerance and necrotizing enterocolitis (NEC) in hospitalized neonates¹⁻⁸.
- There are no clear guidelines regarding the frequency of measurement of abdominal distention producing the best prevention outcomes for feeding intolerance and/or NEC^{2,6,9}, although 4 times a day and before a feed is reported^{4,7}.
- Many healthcare teams measure the gastric residual volume and consider the colour of the gastric aspirates^{4,8-10}. The interpretation of these values is not standardized¹⁰, which means that the decision to delay the next enteral feed to prevent NEC is subjective. This carries serious risks for the newborn. The short-term effects of delaying enteral nutrition include extra uterine growth restriction and increased use of parenteral nutrition leading to liver disease and sepsis¹¹. The long-term effects are primarily a poorer neurodevelopmental outcome at 24 months^{9,12,13}. Recent recommendations suggest that infants less than 1000 g should reach full enteral feeds by 2 weeks of life and those between 1000 g and 1500 g should reach full feeds by the end of the first week of life¹⁴. Gastric residual volume and colour measurement is traumatic for the infant; best practices are currently exploring ways to obtain clinical data in as minimally invasive ways as possible^{10,15}.
- Measurement of abdominal girth remains one of the least invasive measures used to determine the presence of feeding intolerance and/or NEC^{2,4-6,8-12}.
- The measurement of abdominal girth remains a proxy indicator for feeding intolerance and/or NEC^{1-4,6-9,11}.
- There is no evidence that supports the practice of measuring gastric residual content in neonates to predict feeding intolerance or NEC¹⁰.
- Currently, researchers are conducting studies to develop an algorithm that includes the phenomenon of abdominal distension, in combination with other indicators, to establish guidelines for best practice.
- As a reference, the following link to the Current Practice Guidelines for Diagnosis and Treatment of NEC is provided: Kim, JH. (2020). **Neonatal necrotizing enterocolitis: Clinical features and diagnosis**. In Abrams, S. And Kim, M. (Ed.), *UpToDate*. Retrieved from:

<https://biblioproxy.muhc.mcgill.ca/cvbn/https://www.uptodate.com/contents/neonatal-necrotizing-enterocolitis-clinical-features-and-diagnosis>. [Instructions to access electronic resources off-site can be found at: <https://www.muhclibraries.ca/e-resources/proxy-muhc/>.]

- A systematic review provides an overview of standards of care for nursing assessment of feeding intolerance for very-low-birth-weight (VLBW) pre-term infants⁷.

Who is this summary for?

This summary is provided to Elissa Remmer and Stephanie Mardakis, 2nd Prize Winners of the LIT Contest & NPDEs for the MUHC NICU.

Information about this summary:

This report covers a broad collection of literature and evidence sources, with a search emphasis on RCTs and observational studies.

This summary includes:

Key findings from a broad collection of recently published literature (from 2012-2020) and evidence sources.

This summary does not include:

Recommendations, additional information, or detailed description of the interventions in the studies.

Background and Methods:

The LIT  Contest (formerly called the “Dinosaur Contest”), is launched at the beginning of every calendar year, asking the nursing workforce of the MUHC to inquire about and to identify either unquestioned and/or outdated clinical practices. Nurses submit formulated questions regarding these practices to the chair of the LIT Contest, Nursing Practice Consultant for Research within the Nursing Directorate of the MUHC, and the questions go through an evaluation process. Winning questions are the ones that have successfully identified a practice gap which needs to be addressed with evidence.

Contents:

1. Background and Methods
2. Summary of findings
3. References

This year’s 2nd place winners, both NPDEs in the NICU, pointed to the practice of measuring abdominal girth of neonates to detect the presence of feeding intolerance and/or NEC. They were questioning frequency and relevance of the procedure, and generally if the procedure is done appropriately. Specifically, they asked for:

1. Evidence to support the effectiveness of non-invasive abdominal girth measurement to identify feeding intolerance and prevent development of NEC;
2. A clear procedure to follow for this measurement (including frequency of measurement, timeframes when it is more relevant to measure, and the neonate populations for which this practice applies, if appropriate).

These NPDEs were especially concerned with the fact that abdominal girth measurement for each patient in the NICU could occur up to 8 times a day, and they were questioning if this high frequency was absolutely necessary to prevent NEC, especially since it requires handling the fragile neonate more often than ideal. These concerns were recorded before the search for evidence was launched.

The following PICO framework was determined for this question:

P (Population concerned) = Neonates in Intensive Care (mostly prematurely born)

I (Intervention) = abdominal girth measurement

C (Comparison) = no abdominal girth measurement, or measurement of other clinical parameters

O (Outcome) = Feeding intolerance and NEC prevention

This rapid review presents summaries of the best available evidence for the effectiveness of measurement of abdominal girth in neonates for feeding intolerance and NEC detection and prevention. Where relevant, other detection methods are discussed. Detailed search strategies were developed by an experienced librarian (A. Bergeron). Sources include: Medline via Ovid SP, Embase, CINAHL and The Cochrane Library. The concepts were searched using both Subject Headings and text words (specific search terms are available upon request). *UpToDate* was searched to find guidelines for this practice. The search date was August 6, 2020. Initial screening and deduplication were done by the librarian, with a result of 10 articles for the Knowledge Broker to further screen. All articles were considered relevant and retained for analysis. The Research Assistant looked further into the reference lists of certain articles^(4,8,9), and identified 7 more relevant articles for inclusion in the Rapid Review. She also searched on Google Scholar with the keywords “**nursing assessment feeding intolerance nicu**” to find specific practical information for nurses to apply in assessing the state of newborns in regards to frequency of assessment⁽⁷⁾. The analysis of studies and the report were prepared by the Research Assistant, completed by the Knowledge Broker and reviewed by the librarian. The final document was reviewed by the Nursing Practice Consultant before being shared with the NICU.

The studies that were reviewed range from 2012-present, and are mainly randomized controlled trials (RCTs) (n = 2) and observational studies (n = 6) of moderate quality; as well as 1 systematic review. As well, evidence-based guidelines are provided from *UpToDate*. A list of all the articles found and reviewed is available upon request (marie-linda.boghdady@muhc.mcgill.ca).

Levels of Evidence (adapted from OHRI KTA Evidence Summary document)

Each piece of evidence presented in this summary is assigned a level.

This assignment is based on the evidence being presented and not on the claim made by the authors.

- ✦ **Platinum:** Systematic reviews and meta-analysis
- ✦ **Gold:** Randomized controlled trials (RCTs)
- ★ **Silver:** Observational studies (non-randomized trials, case-control, time-series, cohort studies, case series, literature reviews, qualitative studies.)
- ✦ **Bronze:** Expert committee guidelines, reports or opinions, commentary or editorials.
- **Level of evidence** cannot be determined.

2. Summary of Findings:

a. Evidence supporting the effectiveness of abdominal girth measurement in detecting and preventing feeding intolerance and NEC, in comparison to other detection methods

✦ A RCT conducted by Kaur et al.⁴ compared the measurement of abdominal girth and gastric residual volume (GRV) in determining feeding intolerance in very low birth-weight (VLBW) infants. Important background information highlighted in this article is that early initiation of minimal enteral feeds has already been shown to improve feed tolerance, reduce days to full enteral feeds and shorten the duration of parenteral nutrition¹⁸. In this study, infants were randomized into 2 groups: feeding intolerance being monitored by AG measurement or feeding intolerance being monitored by GRV measurement. There were 40 participants in each group (80 subjects in total). In the group where the AG was measured, there were less feeding interruption days, infants used parenteral nutrition for a shorter amount of time, and there was a lower incidence of culture-positive sepsis.

✦ Another RCT comparing abdominal girth measurement and GRV measurement for determining the presence of feeding intolerance in neonates (between the gestational ages of 27-37 weeks) was conducted by Thomas et al.⁹. They confirmed the findings of the study previously mentioned, showing that abdominal girth measurement alone allowed the infant to reach a full enteral feed more quickly than GRV measurement. Furthermore, neonates that had their abdominal girth measured instead of GRV had shorter hospital stays.

★ Finally, a retrospective study conducted in China by Lin et al.¹, which aimed to evaluate the frequency of clinical signs and symptoms of NEC in diagnosed neonates, considered abdominal girth as a proxy measure of abdominal distention, the most frequent symptom in both fulminant and non-fulminant cases of NEC. [Note that

fulminant NEC is defined as progressing within 48 from time of diagnosis to either serious morbidity or death, whereas non-fulminant NEC is not so rapid, and is less severe.] To assess the proper diagnosis and severity of NEC, Lin et al. recommend to look for other symptoms in conjunction with abdominal girth which are associated with NEC, such as bowel sounds, sepsis preceding NEC, leuko/neutropenia, C-reactive protein, procalcitonin, metabolic/respiratory pH, radiologic imagery indicating pneumoperitonium or seroperitoneum upon ultrasound.

b. Evidence regarding effective abdominal girth measurement and correlations with other clinical indicators and measurements

★ A 2020 single centre study by Setruk et al.² aimed to construct references and percentile ranges of the ratio comparing abdominal girth: head circumference (AG/HC) in prematurely born neonates (24-34 weeks' gestation). The visual appearance of abdominal distention is subjective and open to clinician interpretation based on clinical experience in neonatology and duration of patient's hospitalization. Therefore, this small study aimed to standardize abdominal girth measurements to quantify and measure abdominal distention. The hospital where the study took place used abdominal girth (AG) and head circumference (HC) weekly to evaluate feeding tolerance and growth in premature infants. The study built AG/HC ratios for two purposes: to build reference values from these ratios to quantify abdominal distention, and to report the data in cases of abdominal distention, confirmed NEC and suspected NEC. The goal was that, if abdominal distention is noted early in the neonatal assessment using standards, more proactive steps could be taken to prevent the NEC complication. However, the values and ratios established in this study need to be confirmed by further research.

★ A prospective, multicentre, observational study was conducted to determine if a physical examination can predict surgical candidacy for NEC in neonates.¹⁵ One of the criteria in the physical examination was abdominal girth (AG) measurement, combined with other abdominal indicators. The AG was taken before and after the onset of NEC. Any change in abdominal girth was noted. This was part of a more global, head-to-toe assessment to identify NEC surgical candidates.

In this study, abdominal girth larger than 2 cm was considered an abnormal finding, thus given the score of "1" in the scoring sheet (0 = normal finding, 1 = abnormal finding, except for capillary refill where a score was given between 0-2). The physical examination was performed at onset, and then at 8<12 hours, 12<36hours and 36<48 after diagnosis of NEC (see Fig.1 from that study on the next page).

CATEGORY	SCORING KEY (NORMAL FINDINGS)	EXAM AT TIME OF DX	EXAM 8-12 HOURS	EXAM 12-36 HOURS	EXAM 36-48 HOURS
EXAM DATE &					
Abdominal girth	>2 cm = 1				
Abdominal Erythema	yes = 1				
Abdominal Discoloration	yes = 1				
Tender	yes = 1				
Bowel Sounds for 1 Minute	None = 1				
Cap Refill	2-3 sec = 1 >3 sec = 2				
Induration	Yes = 1				
Total Score	(0 – 8)				

Fig. 1 Physical Exam for Necrotizing Enterocolitis (PE-NEC) Scoring Sheet. © 2016 Rubia Khalak, Albany Medical Center; Jeffrey Meyers, University of Rochester Medical Center; Bobby Mathew, Children’s Hospital of Buffalo

15(p1645)

This study concluded that the physical examination was sensitive and specific in predicting neonates that would need to undergo surgery for NEC/die. A score of 3 or more had a sensitivity of 0.88 and a specificity of 0.81, for neonates that needed surgery. They also emphasized the need to consider the contribution of each indicator, when assessing need for surgery. No single assessment finding (i.e. not AG measurement alone) could automatically predict the need for surgery in neonates diagnosed with NEC.

★ This prospective cohort study by Fox et al.³ evaluated the efficiency of the Neo-NEEDS tool to predict and detect NEC severity.

Necrotizing Enterocolitis Early Warning System (Neo NEEDS)				
	0	1	2	Score
Behavior	Alert/Active	Drowsy, Decreased activity, but responds appropriately to stimulation	Lethargic, Decreased activity with minimal response to stimulation	
Cardiovascular	No ABD episodes, Brisk capillary refill, <2 secs, HR and MAPs stable	capillary refill, 2-5 secs OR Decreased MAP>10% baseline	capillary refill, >5 seconds OR HR>160>1 hr OR MAP unstable requiring pressors	
Respiratory	No change in current settings or RR rate	Increased ABDs above baseline OR RR >60 for 1 hr OR Using accessory muscles OR Increase in FiO2 level>10% from baseline	ABD clusters or ABD with stimulation/bagging OR RR>20 above normal rate with retractions OR Increase in level of respiratory support (i.e. increasing pressures or method of ventilation)	
Abdominal	Soft, non-distended, non-tender, normoactive bowel sounds	Slightly distended abdomen (>1cm from baseline) OR Hypoactive Bowel Sounds	Distended (>3cm of baseline) OR Guarding/Tender OR NO bowel sounds for 2 mins OR Skin discoloured/ OR heme + stools	
Feeds	Tolerating bolus, no residuals, no emesis	Emesis/Residuals >10% volume, partially digested	Emesis/Residuals >20% feed volume OR Discoloured (bilious) residuals or emesis	
<p><u>Scoring Directions (0 to 2)-</u> Score by starting with the most severe parameters first Add 1 for each additional risk factor: a) BW < 1000g or GA <28 wks, b) Formula feeds <u>Contact Provider for SCORE ≥5 and consider ABD XR</u></p>			<p><u>Neonate Vital Sign References</u> Heart Rate (at rest): 100-160 Respiratory Rate (at rest): 40-60</p>	

Fig. 2 NeoNEEDS Tool.

³(p929)

This tool assessed multiple systems of the neonate to determine NEC severity: cardiovascular, respiratory, GI, feeding tolerance and behaviour. Abdominal distention was identified as a late indicator of NEC in this study. A

change in >3 cm of abdominal girth prompted a score of “2” in the Neo-NEEDS tool, the highest score that can be given in the abdomen assessment category. Other assessment findings that would warrant a score of 2 under the abdomen assessment are: guarding/tenderness or no bowel sounds for 2 minutes OR discolouration of skin OR discolouration of heme and stools. This study found that cardiac variability is an early indicator of developing NEC (heart rate of >160, slow capillary refill or unstable mean arterial pressure requiring pressor administration), while AG measurement is a later indicator.

★ This Latvian study by Meldere et al.⁵ aimed at drawing a correlation between AG and birth weight (BW) in healthy neonates. The goal was to provide a basis for further research to eventually build a reference table to potentially detect **early** abdominal distention and risk of NEC in premature infants. According to this study, the following equation was created, representing the relationship between AG and BW of healthy neonates:

$$y = 0.0053x + 14.83$$

y = abdominal girth in cm

x = weight of infant in grams

0.0053 = regression coefficient;

14.83 = regression constant

As well, the study found that there is no statistically significant difference in AG/BW between male (n = 105) and female (n = 115) infants; therefore, suggesting that this relationship between AG and BW could be applied to all neonates.

★ A German study⁶ explored the relationship between AG and BW in premature infants to detect any neonates suffering from feeding intolerance or NEC. Daily measurements of abdominal girth and body weight were taken for 28 days in 30 premature infants. This study concluded that an increase in the total enteral feeding amount resulted in a decrease of AG/BW. They also noted that larger volumes of enteral feeding and the administration of non-invasive ventilator support (CPAP) had no significant impact on the AG.

c. Evidence regarding effective nursing assessments of abdominal girth

✿ A systematic review⁷, although based on earlier studies, is perhaps one of the most useful in terms of setting standard for nursing practice for VLBW (< 1500 grams) preterm infants. Carter provided a review of nursing assessments in neonatal patients at risk of or experiencing feeding intolerance and/or NEC. Given that abdominal distention is only one of many signs and symptoms of a feeding intolerance and/or NEC, a nurse can use many techniques to assess the patient. A nursing practice guideline for monitoring and assessment was created to assist nurses in identifying feeding intolerance.

Gastro-intestinal (GI) assessments should be completed before every feed: *The only mention of frequency of AG measurement was related to when the patient is receiving continuous enteral feeding, in which case it was recommended to assess GI every 4 hours. Every change in the patient should be documented, even the subtlest ones, as they can be indicators of feeding intolerance or NEC⁷.*

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