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Ultrasound versus Radiography for Evaluating Surgical Necrotizing Enterocolitis

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INTRODUCTION

- Necrotizing enterocolitis, can be difficult to diagnose and is the leading cause of death in neonates with very low birth weight with a mortality up to 35%⁴
- It develops following the feeding of preterm babies, progressing to intestinal necrosis, sepsis and death⁴
- Current gold standard of NEC diagnostic workup is abdominal X-ray (AR)⁶
- Abdominal X-ray, despite its specificity up to 92-100%, sensitivity is rated as low as 13% leading to missed NEC cases Pathognomonic findings such as pneumatosis, perforation and
- portal venous gas are difficult to identify on x-ray⁹
- Abdominal ultrasound (AUS), portable and non-invasive, has been shown to be superior to AR in diagnosis, management, and prediction of outcomes for NEC¹
- Sensitivity of AUS in intestinal necrosis and perforation is greater than that of AR³
- However, AUS lacks integration in clinical practice⁵

SIGNIFICANCE

- Abdominal radiograph (AR), the imaging standard for NEC, may miss up to 50% of early signs of NEC and has been described to have a sensitivity as low as 15.4% for detecting pneumoperitoneum⁹
- Abdominal ultrasound (US) is portable, non-invasive, and allows real-time bowel integrity, movement, and perfusion assessment.
- Integration of AUS has been limited due to unfamiliarity of clinicians, a poor diagnostic consensus among clinicians, and a lack of a standardized algorithm³
- We aim to evaluate the concordance between US and AR in detecting NEC features and the diagnostic performance of both modalities in detecting pneumoperitoneum.

REFERENCES

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Ultrasound versus Radiography for Evaluating Surgical Necrotizing Enterocolitis ^{1,2}Sayed Aftab, ²Santiago Martinez-Correa, ²Minh-huy Huynh, ²Wondwossen T. Lerebo, ²Jorge Delgado, ²Rebecca Denis, ²Misun

METHODS

- IRB-approved retrospective, cross-sectional, single-center study
- Identification of infants with a diagnosis of NEC confirmed by pathology reports that had a bowel US and AR studies obtained before surgery from January 2012 to August 2022 Clinical and demographic data extracted from CHOP
- electronic chart system
- Two pediatric radiologists, blinded to reports, evaluated the images to determine the presence of pneumatosis (PI), portal vein gas (PVG), bowel distension (BD), and pneumoperitoneum on both modalities
- A third pediatric radiologist resolved discrepant responses • The diagnostic performance of both modalities to detect perforation based on the presence of pneumoperitoneum, and the concordance between them were calculated using
- the kappa statistic (κ)
- Studies with insufficient diagnostic quality were excluded

RESULTS				
US findings	Kappa coefficient	Interobserver effect		
Portal vein gas	0.89	96%		
Pneumatosis	0.37	70%		
Ascites	0.21	84%		
Type of ascites	0.61	84%		
Free gas	0.66	87%		
Peristalsis*	0.26	57%		
Perfusion*	0.42	58%		
Distension	0.48	74%		

Figure 1. The agreement of specific pathognomonic findings between the three pediatric radiologists in terms of the kappa coefficient. 1.0: perfect agreement. 0.81 \leq Kappa (κ) \leq 0.99: almost perfect agreement. 0.61 \leq Kappa (κ) \leq 0.80: substantial agreement. 0.41 \leq Kappa (κ) \leq 0.60: moderate agreement. 0.21 \leq Kappa (κ) \leq 0.40: fair agreement. 0.01 \leq Kappa (κ) \leq 0.20: slight agreement. 0: No agreement. Kappa (κ) < 0: agreement worse than chance.

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Statistic

- Sensitivity
- Specificity
- Positive Likelihood R
- Negative Likelihood
- Disease prevalence
- Positive Predictive V
- Negative Predictive V
- Accuracy (*)

Statistic	Value	95% CI
Sensitivity	15.00%	3.21% to 37.89%
Specificity	100.00%	69.15% to 100.00%
Positive Likelihood Ratio		
Negative Likelihood Ratio	0.85	0.71 to 1.02
Disease prevalence (*)	66.67%	47.19% to 82.71%
Positive Predictive Value (*)	100.00%	29.24% to 100.00%
Negative Predictive Value (*)	37.04%	32.86% to 41.42%
Accuracy (*)	43.33%	25.46% to 62.57%

Figure 2B. Statistical properties of abdominal x-ray. Of note, the sensitivity of 15%, compared to the 35% sensitivity of abdominal ultrasound in Figure 2A.

Discussion and Insights

- Cohort included 9 girls and 22 boys, median age 23 days

- sensitivity and 100% specificity
- Each feature was present more frequently on US than AR
- and intestinal perforation
- outperformed AR in identifying NEC features
- the need for revising current NEC algorithm
- NEC diagnostic algorithm

	Value	95% CI		
	35.00%	15.39% to 59.22%		
	90.00%	55.50% to 99.75%		
latio	3.50	0.50 to 24.67		
Ratio	0.72	0.49 to 1.06		
(*)	<mark>66.67%</mark>	47.19% to 82.71%		
alue (*)	87.50%	49.82% to 98.01%		
Value (*)	40.91%	32.08% to 50.36%		
	53.33%	34.33% to 71.66%		

(*) These values are dependent on disease prevalence.

Figure 2A. Statistical properties of abdominal ultrasound. Of note, the sensitivity of 35%.

(*) These values are dependent on disease prevalence.

23 (76%) were born prematurely, 20 had confirmed intestinal perforation US demonstrated 35% sensitivity and 90% specificity, while AR demonstrated 15%

Agreement between US and AR was 10/30 (33%) for PI (κ=0.01), 22/28 (79%) for PVG $(\kappa = 0.2)$, 19/31 (61%) for BD ($\kappa = 0.21$), and 24/31 (77%) for pneumoperitoneum ($\kappa = 0.34$).

This study demonstrated AUS is a valuable complimentary tool for detecting NEC features

Despite a low to moderate agreement between both modalities, US consistently

These findings highlight the significance of integrating US into NEC diagnostic process and

Future efforts should include larger cohorts and a collaborative approach to improve the