# NEC-Zero Evidence Based Resources to Prevent Complications in Fragile Infants

Sheila M. Gephart, PhD, RN; Maribeth Slebodnik, MLIS, BSN; Christina Wyles, MLIS, MS, RN





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Maribeth Slebodnik, MLIS, BSN

### Christina Wyles, MLIS, MS, RN



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Sheila M. Gephart, PhD, RN

### **ACKNOWLEDGEMENTS AND DISCLOSURES**

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- Dr. Gephart created GutCheck<sup>NEC</sup> and NEC-Zero. Both are open access and publically available.
- Dr. Gephart serves on the Scientific Advisory Council for the NEC Society and the Scientific Advisory Board of the Morgan Leary Vaughan Fund.

The **University of Arizona Continuing Professional Education** is an approved provider of continuing nursing education by the Western Multi-State Division, an accredited approver by the American Nurses Credentialing Center's Commission on Accreditation.

The planners and presenters have no relevant financial relationships to disclose.

# OUTCOMES

After viewing this webinar, participants will be able to:

- To describe **measures** that can be employed by healthcare providers and parents **to prevent and for timely detection of NEC**
- Locate and share reliable clinical information about NEC and NEC prevention, including that developed by the NEC Zero project and the National Library of Medicine
- Locate and share reliable parent and consumer information about NEC and NEC prevention

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5 years 10 years Custom range <b>Species</b>	<ol> <li><u>Closure of Hemodynamically Significant Patent Ductus Arteriosus in Preterm</u> <u>Infants: A Systematic Review and Meta-analysis.</u> Mitra S, Florez ID, Tamayo ME, Mbuagbaw L, Vanniyasingam T, Veroniki AA, Zea</li> </ol>	<u>Review (597)</u> Available Full Text (2366) Manage Filters
Humans Other Animals <u>Clear all</u>	AM, Zhang Y, Sadeghirad B, Thabane L. JAMA. 2018 Mar 27;319(12):1221-1238. doi: 10.1001/jama.2018.1896. Review. PMID: 29584842 <u>Similar articles</u>	Sort by:
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	Arch Dis Child Fetal Neonatal Ed. 2018 Mar;103(2):F182-F189. doi: 10.1136/archdischild-2017- 313880. Epub 2018 Jan 9. Review. PMID: 29317459 Free Article Similar articles	
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Scope: Na	arrow •			
Results: 5 of	434	Results: 5 of 511	Results: 5 of 423	
Does fortification of pasteurized donor human milk increase the incidence of necrotizing enterocolitis among preterm neonates? - A randomized controlled trial. Adhisivam B, Kohat D, Tanigasalam V, Bhat V, Plakkal N, Palanivel C. J Matern Fetal Neonatal Med. 2018 Apr 4; :1-151. Epub 2018 Apr 4. Association of Placebo, Indomethacin, Ibuprofen, and Acetaminophen With Closure of Hemodynamically Significant Patent Ductus Arteriosus in Preterm Infants: A Systematic Review and Meta-analysis. Mitra S, Florez ID, Tamayo ME, Mbuagbaw L, Vanniyasingam T, Veroniki AA, Zea AM, Zhang Y, Sadeghirad B, Thabane L.		Probiotics for the prevention of surgical necrotising enterocolitis: systematic review and meta-analysis. Rees CM, Hall NJ, Fleming P, Eaton S.	<ul> <li>Smith-Lemli-Opitz syndrome: clinical and biochemical correlates.</li> <li>Donoghue SE, Pitt JJ, Boneh A, White SM.</li> <li>J Pediatr Endocrinol Metab. 2018 Mar 28; 31(4):451-459.</li> <li>Early microbial colonization affects DNA methylation of genes related to intestinal immunity and metabolism in preterm pigs.</li> <li>Pan X, Gong D, Nguyen DN, Zhang X, Hu Q, Lu H, Fredholm M, Sangild PT, Gao F.</li> <li>DNA Res. 2018 Jan 19; . Epub 2018 Jan 19.</li> <li>Prevalence of curli genes among Cronobacter species and their roles in biofilm formation and cell-cell aggregation.</li> <li>Hu L.</li> <li>Int J Food Microbiol. 2018 Jan 16; 265:65-73. Epub 2017 Oct 21.</li> </ul>	
		BMJ Paediatr Open. 2017; 1(1):e000066. Epub 2017 Nov 1. Acute kidney injury in preterm infants with		
		Recrotizing enterocolitis. Bakhoum CY, Basalely A, Koppel RI, Sethna CB. J Matern Fetal Neonatal Med. 2018 Apr 9; :1-6. Epub 2018 Apr 9.		
		Association of Placebo, Indomethacin, Ibuprofen, and Acetaminophen With Closure of Hemodynamically Significant Patent Ductus Arteriosus in Preterm Infants: A Systematic Review and Meta-analysis.		

JAMA. 2018 Mar 27; 319(12):1221-1238.

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Necrotizing enterocolitis associated with <i>Clostridium butyricum</i> in a Japanese man. Sato Y, Kujirai D, Emoto K, Yagami T, Yamada T, Izumi M, Ano M, Kase K, Kobayashi K. Acute Med Surg. 2018 Apr; 5(2):194-198. Epub 2018 Jan 23.		1. Acute kidney injury in preterm infants with necrotizing enterocolitis. Bakhoum CY, Basalely A, Koppel RI, Sethna CB. J Matern Fetal Neonatal Med. 2018 Apr 9; :1-6. Epub 2018 Apr 9.	methylation of genes related to intestinal immun and metabolism in preterm pigs. Pan X, Gong D, Nguyen DN, Zhang X, Hu Q, Lu H, Fredholm M, Sangild PT, Gao F. DNA Res. 2018 Jan 19; . Epub 2018 Jan 19.		
	between pneumoneritoneum and	Association of Placebo, Indomethacin, Ibunrofen	Prevalence of curli genes among Cronobacter species and their roles in biofilm formation and		

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[Correlation between pneumoperitoneum and surgical findings and morbidity and mortality in newborns with necrotising enterocolitis].

Villamil V, Fernández-Ibieta M, Gilabert Ubeda MA, Aranda García MJ, Ruiz Pruneda R, Sánchez Morote JM, Ruiz Jiménez JI.

An Pediatr (Barc). 2018 Apr 10; . Epub 2018 Apr 10.

Protective effect of Lactobacillus reuteri DSM 17938 against experimental necrotizing enterocolitis is mediated by Toll-like receptor 2. Hoang TK, He B, Wang T, Tran DQ, Rhoads JM, Liu Y. Am J Physiol Gastrointest Liver Physiol. 2018 Apr 12; . Epub 2018 Apr 12.

#### Neonatal independent predictors of severe NEC.

Duci M, Fascetti-Leon F, Erculiani M, Priante E, Cavicchiolo ME, Verlato G, Gamba P.

Pediatr Surg Int. 2018 Apr 11; . Epub 2018 Apr 11.

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This column displays citations filtered to a specific clinical study category and scope. These search filters were developed by <u>Haynes RB et al.</u> See more <u>filter information</u>.

Association of Placebo, Indomethacin, Ibuprofen, and Acetaminophen With Closure of Hemodynamically Significant Patent Ductus Arteriosus in Preterm Infants: A Systematic Review and Meta-analysis.

Mitra S, Florez ID, Tamayo ME, Mbuagbaw L, Vanniyasingam T, Veroniki AA, Zea AM, Zhang Y, Sadeghirad B, Thabane L. JAMA. 2018 Mar 27; 319(12):1221-1238.

Donor human milk and risk of surgical necrotizing enterocolitis: A meta-analysis.

Silano M, Milani GP, Fattore G, Agostoni C. Clin Nutr. 2018 Mar 10; . Epub 2018 Mar 10.

#### Higher versus lower amino acid intake in parenteral nutrition for newborn infants.

Osborn DA, Schindler T, Jones LJ, Sinn JK, Bolisetty S. Cochrane Database Syst Rev. 2018 Mar 5; 3:CD005949. Epub 2018 Mar 5.

#### See all (511)

This column displays citations for systematic reviews, meta-analyses, reviews of clinical trials, evidencebased medicine, consensus development conferences, and guidelines. See <u>filter information</u> or additional related sources. species and their roles in biofilm formation and cell-cell aggregation.

#### Hu L.

Int J Food Microbiol. 2018 Jan 16; 265:65-73. Epub 2017 Oct 31.

# Commensal Propionibacterium strain UF1 mitigates intestinal inflammation via Th17 cell regulation.

Colliou N, Ge Y, Sahay B, Gong M, Zadeh M, Owen JL, Neu J, Farmerie WG, Alonzo F 3rd, Liu K, et al. J Clin Invest. 2017 Nov 1; 127(11):3970-3986. Epub 2017 Sep 25.

Maternal Pregravid Obesity Remodels the DNA Methylation Landscape of Cord Blood Monocytes Disrupting Their Inflammatory Program.

Sureshchandra S, Wilson RM, Rais M, Marshall NE, Purnell JQ, Thornburg KL, Messaoudi I.

J Immunol. 2017 Oct 15; 199(8):2729-2744. Epub 2017 Sep 8.

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Gephart, S.M., Hanson, C., Wetzel, C.M., Fleiner, M., Umberger, E., Martin, L. Rao, S., Agrawal, A., Marin, T., Kirmani, K., Quinn, M., Quinn, J., Dudding, K., Clay, T., Sauberan, J., Eskenazi, Y., Porter, C., Msowoya, A., Wyles, C., Ruiz, M., Vo; S., Reber, K., & Duchon, J. (2017). **NEC-Zero recommendations from scoping review of evidence to prevent and foster timely recognition of necrotizing enterocolitis**. *Maternal Health, Neonatology & Perinatology*. Dec 2017, Vol. 3, No. 1. **Available FREE at https://mhnpjournal.biomedcentral.com/articles/10.1186/s40748-017-0062-0** 

# WHAT IS NEC?





0%-6%-12%







# **NEC WARNING SIGNS**

31



- Lethargy or irritability
- Temperature unstable
- Decreasing oxygen levels, apnea or bradycardia
- "Not acting right"
- Not tolerating feeding (vomiting, milk not digesting in stomach from last feeding, increased abdominal girth)
- Bloody stool
- Vomiting
- Red or dusky abdomen
- Abdomen is taut, tender to touch

#### **DIAGNOSING AND TREATING NEC**





# THE CHALLENGE

- Necrotizing enterocolitis (NEC) is among the chief causes of emergency surgery and premature death in infants born very low birth weight
- Gaps between what we know and consistently do
  - Feeding exclusive human milk, using feeding protocols, stopping antibiotics, watching for deterioration, engaging with parents
- NICU NEC rates vary and some NICUs are reducing to "zero"

## **DO NEC RATES VARY?**

Percentile	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90th
NEC (%)	0.0	2.6	5.3	9.1	13.2

- Vermont-Oxford Network reports that in 2008 in 750 NICUs, NEC rates for infants weighing 501-1500 gm varied (N=53, 440). Mean 5.3% (range 0-13.2 %+)
- In 2017, Horbar et al. showed that it took 8 years for 75% of NICUs to achieve 2005 rates for the top 25% of NICU performers for NEC.

Horbar JD et al. J Perinatol;37 (2010), 29-47. Horbar JD et al. JAMA Pediatrics; 2017;171(3):e164396.





**Canadian Neonatal Network:** Risk adjusted incidence of NEC by hospital for neonates <33 weeks' GA. (Adjusted for GA, Apgar score at 5 minutes, SNAP-II, girl, cesarean delivery, and SGA.) Hospital sites are on the x-axis, and the odds ratio (95% CI) is on the y-axis.


### IF NEC IS PREVENTABLE- OR AT LEAST REDUCIBLE- HOW DO WE DO IT?



37

From: Making research relevant: if it is an evidence-based practice, where's the practice-based evidence? Fam Pract. 2008;25(suppl 1):i20-i24. doi:10.1093/fampra/cmn055

The "Pipeline" Concept of Disseminating Research to Get Evidence-Based Practice\*



Gephart, S.M., Hanson, C., Wetzel, C.M., Fleiner, M., Umberger, E., Martin, L. Rao, S., Agrawal, A., Marin, T., Kirmani, K., Quinn, M., Quinn, J., Dudding, K., Clay, T., Sauberan, J., Eskenazi, Y., Porter, C., Msowoya, A., Wyles, C., Ruiz, M., Vo; S., Reber, K., & Duchon, J. (2017). **NEC-Zero recommendations from scoping review of evidence to prevent and foster timely recognition of necrotizing enterocolitis**. *Maternal Health, Neonatology & Perinatology*. Dec 2017, Vol. 3, No. 1. **Available FREE at https://mhnpjournal.biomedcentral.com/articles/10.1186/s40748-017-0062-0** 



# NICU PRACTICES???





### **DOSE-RESPONSE OF NEC TO HUMAN MILK**







### Impact of Optimized Breastfeeding on the Costs of Necrotizing Enterocolitis in Extremely Low Birthweight Infants

Tarah T. Colaizy, MD, MPH<sup>1</sup>, Melissa C. Bartick, MD, MSc<sup>2</sup>, Briana J. Jegier, PhD<sup>3</sup>, Brittany D. Green, MSc<sup>4</sup>, Arnold G. Reinhold, MBA<sup>5</sup>, Andrew J. Schaefer, PhD<sup>6</sup>, Debra L. Bogen, MD<sup>7</sup>, Eleanor Bimla Schwarz, MD, MS<sup>8</sup>, and Alison M. Stuebe, MD, MSc<sup>9,10</sup>, on behalf of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Neonatal Research Network\*

**Objective** To estimate risk of necrotizing enterocolitis (NEC) for extremely low birth weight (ELBW) infants as a function of preterm formula (PF) and maternal milk intake and calculate the impact of suboptimal feeding on the incidence and costs of NEC.

Study design We used aORs derived from the Glutamine Trial to perform Monte Carlo simulation of a cohort of ELBW infants under current suboptimal feeding practices, compared with a theoretical cohort in which 90% of infants received at least 98% human milk

**Results** NEC incidence among infants receiving  $\geq$ 98% human milk was 1.3%; 11.1% among infants fed only PF; and 8.2% among infants fed a mixed diet (*P* = .002). In adjusted models, compared with infants fed predominantly human milk, we found an increased risk of NEC associated with exclusive PF (aOR = 12.1, 95% Cl 1.5, 94.2), or a mixed diet (aOR 8.7, 95% Cl 1.2-65.2). In Monte Carlo simulation, current feeding of ELBW infants was associated with 928 excess NEC cases and 121 excess deaths annually, compared with a model in which 90% of infants received  $\geq$ 98% human milk. These models estimated an annual cost of suboptimal feeding of ELBW infants of \$27.1 million (Cl \$24 million, \$30.4 million) in direct medical costs, \$563 655 (Cl \$476 191, \$599069) in indirect nonmedical costs, and \$1.5 billion (Cl \$1.3 billion, \$1.6 billion) in cost attributable to premature death.

**Conclusions** Among ELBW infants, not being ted predominantly numan milk is associated with an increased risk of NEC. Efforts to support milk production by mothers of ELBW infants may prevent infant deaths and reduce costs. (*J Pediatr 2016*;  $\blacksquare$  :  $\blacksquare$  -  $\blacksquare$ ).



### HIGHER RISK FOR NEC WITH FORMULA COMPARED TO DONOR HUMAN MILK

	Formula	milk	Donor breas	t milk		Risk Ratio	Risk Ratio
tudy or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% Cl	M-H, Fixed, 95% Cl
0.1 Term formula							
ross 1983 <b>ibtotal (95% CI)</b>	3	26 <b>26</b>	1	41 41	7.4% 7.4%	4.73 [0.52, 43.09] 4.73 [0.52, 43.09]	
otal events	3		1				
eterogeneity: Not ap	plicable						
est for overall effect:	Z = 1.38 (F	P = 0.17	")				
.20.2 Preterm formu	ıla						
ristofalo 2013	5	24	1	29	8.6%	6.04 [0.76, 48.25]	
ucas 1984a	4	76	1	83	9.1%	4.37 [0.50, 38.23]	
ucas 1984b	5	173	2	170	19.2%	2.46 [0.48, 12.49]	
chanler 2005	10	88	5	78	50.5%	1.77 [0.63, 4.96]	- <b>+</b>
yson 1983	1	44	0	37	5.2%	2.53 [0.11, 60.39]	
ubtotal (95% CI)		405		397	92.6%	2.61 [1.27, 5.35]	-
otal events	25		9				
leterogeneity: Chi² =	1.39, df=	4 (P = 0)	.85); I² = 0%				
est for overall effect:	Z = 2.62 (F	P = 0.00	19)				
otal (95% CI)		431		438	100.0%	2.77 [1.40, 5.46]	-
otal events	28		10				-
lotorogonoity: Chiž –	1 68 df=	5 (P = 0)	189); I <b>2</b> = 0%				+ + + + + + + + + + + + + + + + + + + +

Citation: Quigley M, McGuire W. Formula versus donor breast milk for feeding preterm or low birth weight infants. *Cochrane Database of Systematic Reviews* 2014, Issue 4. Art. No.: CD002971. DOI: 10.1002/14651858.CD002971.pub3.

### EVIDENCE FOR HUMAN MILK: DONOR HUMAN MILK FORTIFIER

	DHM for	tifier	Bovine for	rtifier		Odds Ratio		Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% Cl	Year	M-H, Random, 95% Cl
Sullivan et al.	8	138	11	69	33.8%	0.32 [0.12, 0.85]	2010	<b>-</b>
Herrman & Carroll	7	199	15	443	34.8%	1.04 [0.42, 2.59]	2014	<b>+</b>
Cristofalo et al.	1	29	5	24	14.8%	0.14 [0.01, 1.26]	2014	
Assad, Elliott and Abraham	1	86	17	176	16.7%	0.11 [0.01, 0.84]	2015	
Total (95% CI)		452		712	100.0%	0.36 [0.13, 1.00]	]	
Total events	17		48				· · · ·	
Heterogeneity: Tau <sup>2</sup> = 0.58; C/ Test for overall effect: Z = 1.9(	hi² = 6.82, 6 (P = 0.05	, df = 3 ( <sup>j</sup> 5)	P = 0.08); I <sup>2</sup>	'= 56%				0.01 0.1 1 10 100 Eavours DHM fartifier Eavours having fartifier

Gephart, S.M., Hanson, C., Wetzel, C.M., Fleiner, M., Umberger, E., Martin, L. Rao, S., Agrawal, A., Marin, T., Kirmani, K., Quinn, M., Quinn, J., Dudding, K., Clay, T., Sauberan, J., Eskenazi, Y., Porter, C., Msowoya, A., Wyles, C., Ruiz, M., Vo; S., Reber, K., & Duchon, J. (2017). NEC-Zero recommendations from scoping review of evidence to prevent and foster timely recognition of necrotizing enterocolitis. *Maternal Health, Neonatology & Perinatology.* Dec 18 2017, 3:23. doi: 10.1186/s40748-017-0062-0. eCollection 2017

### PROCESSES TO SUPPORT HUMAN MILK IN CALIFORNIA DURING QUALITY COLLABORATIVE



PEDIATRICS

#### Lee H C et al. Pediatrics 2012;130:e1679-e1687

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### PERCENT OF ELIGIBLE INFANTS WITH NEC BY **COLLABORATIVE PARTICIPATION.**



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### **EVIDENCE FOR FEEDING PROTOCOLS TO PREVENT NEC**

Patole & deKlerk (2005) showed that among all LBW infants, using a feeding protocol reduced odds of NEC by 87%. When only VLBWs used, risk was reduced by approx. 40% but effect was not stable (CI 0.31, 1.06). In 2017, Gephart et al. showed reduced risk of 67% for VLBWs (P=0.001).





Gephart et al. Maternal Health, Neonatology & Perinatolog Dec 18 2017, 3:23. doi: 10.1186/s40748-017-0062-0.

### EVIDENCE FOR AVOIDING PROLONGED ANTIBIOTIC USE WHEN BLOOD CULTURES ARE NEGATIVE



# EVIDENCE FOR AVOIDING H2 BLOCKERS

### Association of Inhibitors of Gastric Acid Secretion and Higher Incidence of Necrotizing Enterocolitis in Preterm Very Low-Birth-Weight Infants

Kiran More, MD<sup>1,2</sup> Gayatri Athalye-Jape, MD<sup>1,2</sup> Shripada Rao, FRACP<sup>1,3,4</sup> Sanjay Patole, FRACP<sup>2,3,4</sup>

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<sup>4</sup>Department of Neona tal Pae dia trics, University of Western Australia,

for Women, Perth, Western Australia

Perth. Western Australia Am | Perinatol 2013;30:849-856.

and Education. Perth. Western Australia

Neonatal Paediatrics, Princess Margaret Hospital, Roberts Road, <sup>2</sup>Department of Neonatal Paediatrics, King Edward Memorial Hospital Subjaco, City of Perth, Western Australia-6008 (e-mail: drkiranmore@vahoo.com: kiran.more@health.wa.gov.au). <sup>3</sup>Department of Neonatal Paediatrics, Centre for Neonatal Research

Address for correspondence Dr Kiran More, MD, Department of

H2 Blockers were associated with 1.78 higher odds of NEC compared to no exposure.



Fig. 2 Forrest plot of association of necrotizing enterocolitis with inhibitors of gastric acid secretion. Abbreviations: CI, confidence interval; SE, standard error.

### Reduced Necrotizing Enterocolitis after an Initiative to Promote Breastfeeding and Early Human Milk Administration

Michelle Feinberg, MD\*†; Lynn Miller, NNP-BC\*; Barbara Engers, RNC\*; Kathy Bigelow, RN, BSN\*; Ann Lewis, RD\*; Shannon Brinker, OTR/L\*; Fran Kurland, RN, IBCLC\*; Elizabeth Potthoff, NT\*; Melynda Wallin, NT\*; Alfonso Pantoja, MD\*†; John R. Britton, MD, PhD\*†

Photo courtesy of NEC Society, taken at NEC Symposium in Davis, CA April 20

## **SUCCESS STORIES...**

Quality Improvement Initiative to Reduce the Necrotizing Enterocolitis Rate in Premature Infants

Maria M. Talavera, DO,<sup>a</sup> Gary Bixler, MD,<sup>b</sup> Corin Cozzi, MD,<sup>c</sup> James Dail,<sup>d</sup> Randy R. Miller, MD,<sup>c</sup> Richard McClead Jr, MD, MHA,<sup>a,d</sup> Kristina Reber, MD<sup>a</sup>



Detailed Analysis of NEC Risks Across a Decade in a Low Incidence NICU: Can We Drive the Incidence of NEC Toward Zero?

Joshua Benjamin MD<sup>1</sup>, Euming Chong MD<sup>2</sup>, Jane Reynolds MD<sup>2</sup>, and Phillip V. Gordon MD, PhD<sup>2</sup> <sup>1</sup>University of Colorado School of Medicine, Denver, CO <sup>2</sup>Department of Pediatrics, Tulane School of Medicine, New Orleans, LA

# **EARLY RECOGNITION TOOLS**

A Novel Neonatal Feeding Intolerance and Necrotizing Enterocolitis Risk–Scoring Tool Is Easy to Use and Valued by Nursing Staff

Jane Naberhuis, PhD; Christine Wetzel, MSN, RN, IBCLC; Kelly A. Tappenden, PhD, RD, FASPEN

#### **ORIGINAL ARTICLE**

Abnormal heart rate characteristics before clinical diagnosis of necrotizing enterocolitis

ML Stone<sup>1</sup>, PM Tatum<sup>2</sup>, J-H Weitkamp<sup>3</sup>, AB Mukherjee<sup>3</sup>, J Attridge<sup>4</sup>, ED McGahren<sup>1,5</sup>, BM Rodgers<sup>1,5</sup>, DE Lake<sup>6</sup>, JR Moorman<sup>6</sup> and KD Fairchild<sup>5</sup>

**ORIGINAL ARTICLE** Discrimination of GutCheck<sup>NEC</sup>: a clinical risk index for necrotizing enterocolitis

SM Gephart<sup>1</sup>, AR Spitzer<sup>2</sup>, JA Effken<sup>1</sup>, E Dodd<sup>2</sup>, M Halpern<sup>3</sup> and JM McGrath<sup>4,5</sup>

### Early Detection Tool of Intestinal Dysfunction: Impact on Necrotizing Enterocolitis Severity

Jenny R. Fox, MD, MPH<sup>1</sup> Leroy R. Thacker, PhD<sup>2</sup> Karen D. Hendricks-Muñoz, MD, MPH<sup>1</sup>

# **GUTCHECK**<sup>NEC</sup> **STORY**

- Identified 66 unique NEC risk factors through narrative review of literature (which mattered most?)<sup>1</sup>
- Study 1: applied 3 Delphi rounds reduced to 33 most important risk factors(long GNEC version)<sup>2</sup>
- Study 2: applied modeling to big data to weight and identify risk factors most important<sup>3</sup>
  - 284 NICUs, 170k babies <2500 g, 60 k babies < 1500 g
  - NICU NEC rate highest weight in the score
    - 1. Gephart et al. (2012). Necrotizing enterocolitis risk: State of the science. *Advances in Neonatal Care, 12*(2), 77-87
    - 2. Gephart et al. (2013). Expert consensus building using e-Delphi for necrotizing enterocolitis risk assessment. *JOGNN*, *42*(3), 332-347.
    - 3. Gephart et al. (2014). Discrimination of GutCheckNEC: a clinical risk index for necrotizing enterocolitis. *Journal of Perinatology*, *34*(6), 468-475.

## **GUTCHECKNEC STORY**

- **Study 3:** 3 Arizona NICUs (N=132 babies) identified timing for scoring, that early (72 hrs. of age) score predicted worst NEC and that clinical signs were present up to 36 hrs. before diagnosis (Gephart, Fleiner & Kijewski, 2017). Identified risk thresholds and showed that the score was related to severity of illness (SNAPPE-II) and clinical deterioration (PEWS) but that neither improved the score.
- **Expert group (NEC-Zero):** found that 3 NEC risk scores were available, GNEC was best validated, recommended that communication about NEC concern be standardized (SBAR tool developed) (Gephart et al. 2017)
- **Study 4:** Focus groups with 27 clinicians showed that NEC risk awareness is limited, putting the story together in the EHR is HARD and that timely recognition is deeply affected by team trust, communication effectiveness and early action.
- **Study 5:** Intl. survey of parents of infants with NEC- parents WANT to know NEC risk factors and they WANT to know NEC warning signs (Gadepelli et al. Adv Neo Care, 2017)

Gephart, S. M., Fleiner M, & Kijewski, A. (2017). The conNECtion between clinical signs and necrotizing enterocolitis in infants 501-1500 grams. Advances in Neonatal Care. 2017 Feb;17(1):53-64. doi: 10.1097/ANC.00000000000345. Gephart, S.M., Hanson, C., Wetzel, C.M., Fleiner, M., Umberger, E., Martin, L. Rao, S., Agrawal, A., Marin, T., Kirmani, K., Quinn, M., Quinn, J., Dudding, K., Clay, T., Sauberan,

Gephart, S.M., Hanson, C., Wetzel, C.M., Fleiner, M., Umberger, E., Martin, L. Rao, S., Agrawal, A., Marin, T., Kirmani, K., Quinn, M., Quinn, J., Dudding, K., Clay, T., Sauberan, J., Eskenazi, Y., Porter, C., Msowoya, A., Wyles, C., Ruiz, M., Vo; S., Reber, K., & Duchon, J. (2017). NEC-Zero recommendations from scoping review of evidence to prevent and foster timely recognition of necrotizing enterocolitis. *Maternal Health, Neonatology & Perinatology*. Dec 18 2017, 3:23. doi: 10.1186/s40748-017-0062-0. eCollecton 2017. Gadepalli, S.K., Canvasser, Eskenazi, Y., Quinn, M., J., Kim, J. & Gephart, S.M. (2017). Roles and experiences of parents in necrotizing enterocolitis: an international survey of parental perspectives of communication in the NICU. *Advances in Neonatal Care*, 17(6): 489-498. doi: 10.1186/s40748-017-0062-0. eCollection 2017.



DiCenso A, Bayley L, Haynes RB (2009). Accessing pre-appraised evidence: finetuning the 5S model into a 6S model. Evidence-Based Nursing, 12(4),99-101.

# **NEC-Zero Toolkit**

- GutCheckNEC risk score
- SBAR communication tool for NEC concern
- NEC Prevention Checklist
- NEC-Zero prevention adherence score (0-10)
- Parent support and education materials
- Coming soon: Video!!
- Electronic tools: clinical decision support logic, NEC-Zero dashboard



## NEC-ZERO ELECTRONIC HEALTH RECORD (EHR) CLINICAL DECISION SUPPORT INTERVENTION



AHRQK08 HS22908-01A1 & RWJF Nurse Faculty Scholars Program (72114)

### WHAT ABOUT TRANSFUSION AND NEC?

Plausible? Yes. But what is the mechanism? Check out my animal model... Akhil Maheshwari

No dinner? That is a bridge too far... But of course do whatever it takes to avoid ANEMIA... Bob Christensen

Photo courtesy of NEC Society, taken at NEC Symposium in Davis, CA April 2017

### IF WE EDUCATE, WILL THEY COMPLY?



GutCheck <sup>NEC</sup> (< 1	500 g	rams	)		Points
Gestational age (weeks) (9 max.)		<28	28-31 6/7	≥ 32	
Calculate GA in weeks at birth based preferably on due date determined by 1 <sup>st</sup> trimester ultrasound. If that is unavailable, gestational age assessment at delivery (Ballard or Dubowitz)	use the	9 points	8 points	0 points	
Race (2 max)		Black	Hispanic	Other races	
If the infant is either Black or Hispanic race assign 2 points. assign only 2 points. If not Black or Hispanic, assign 0 points	If both, s.	2 points	2 points	0 points	
Outborn (3 max)			Yes	No	
If the infant is transferred into this center from another hospit birth, assign 3 points.	al at any t	ime after	3 points	0 points	
NICU NEC rate (23 max.)	2- 4.99%	5- 7.99%	8-11.99%	> 12 %	
This is the annual calculated NEC rate for infants weighing less than 1500 grams at delivery. If < 2%, assign 0 points.	9 points	16 points	19 points	23 points	
Exclusive human milk feeding (0 max)			Yes	No	
Defined as human milk fed at both day 7 and day 14 of life. N milk fed is not defined. If <i>any</i> milk is fed at <i>both</i> day 7 and da <u>points</u> from the total score. Points cannot be subtracted until	/olume of ay 14, <u>sub</u> day of life	human tract 3 14.	-3 points	0 points	
Probiotics (0 max)			Yes	No	
If any probiotic preparation has been given at any dose or any volume, <u>subtract 5 points</u> from the total score.			-5 points	0 points	
How many culture-proven infections has the infant had s	ince	One	Two	None	
day 3 of life? (6 points max)		4 points	6 points	0 points	
Packed Red Blood Cell transfusion history (8 max)			Yes	No	1
If any PRBC transfusion has been given, regardless of feedir volume given. Once the infant receives a transfusion, from th scored "yes." Highest risk for NEC is associated within 48 ho transfusion.	ng status o nat time o urs of the	or n it is :	8 points	0 points	
Hypotension treated with Inotropic Medication (4 max)			Yes	No	
If hypotension is severe and medications such as dopamine, milfinone are given to treat it, regardless of dose, frequency of treatment. Once this is "yes" it stays "yes".	dobutami or duration	ne or 1 of	4 points	0 points	
Metabolic Acidosis (3 max)			Yes	No	
After the 1 <sup>st</sup> 12 hours of life, if the infant experiences metabol defined as low pH associated with low serum bicarbonate (HI normal or near normal pCO2 (pH< 7.30) or lactate > 6.1 mm clinician (physician, NNP, PA-C) documents "metabolic acido "yes."	ic acidosi CO <sub>3</sub> < 17) bl/L. If ord osis" code	s, but ering as	3 points	0 points	
TOTAL: Score > 32 At Risk; > 36 high risk (especially at 72	2 hours of	age); 58	points maximu	ım	
© Gephart 2015 Do Not Reproduce or Automate without P	ermission	gepharts	@arizona.edu		

#### Structured communication form for clinical concern when NEC is suspected

7	Situation: Purpose of call
S	Hello, this is, I am calling about in room
	because I have some concerns about his/her assessment.
n	Background: All pertinent risk factors and recent history
В	Gestational Age Corrected GA Day of Life Rick Same (Gut(ChanNRC)
	Feeding type (EBM, fortified?) and tolerance
	Transfusion within the last 48 hours?
	Relevant history
	Assessment: Give your conclusion about the present situation based on assessment
Α	Is the parent concerned? Y N
<b>1</b>	Tachycardia at rest? Y N Hypotension? Y/N
	Temp <sub>max</sub> &/or Temp <sub>min</sub> x 24 hours outside normal limits? Y N
	Significant increase in isolette temperature? Y N
	Increased respiratory support or FiO2? Y N
	Increase in apnea/bradycardia spelis / I N Blood annotation starl an annotation / N
	Change in color fullness or feel of abdomen? Y N
	Change in color, fulliess, of feel of abdoments in the Change in abdominal girth > 1 cm? Y N
	Bowel sounds present? Y N
	Feeding tolerance: Residual color, amount, dark bilious? Y N
	Emesis in last 24 hours? Y N
	Stooling? Y N Change in general skin color or perfusion? Y N
	Behavior: Initability (early) or lethargy (late)? Y N
	Recommendation: Clarify expectations - may differ with severity of situation or institutional policy-
	ASK for something specific
	- Hold feeding?
	<ul> <li>Abdominal x-ray?</li> </ul>
	<ul> <li>Come in to see baby?</li> </ul>
	<ul> <li>Order sepsis workup?</li> </ul>
Content based on	evidence about NEC risk and clinical presentation (Christensen et al., 2010; Gephart, Wetzel, & Krisman, 2014;
Gregory, Deforge,	Nataie, Phillips, & Van Marter, 2011)

Christensen, R. D., Wiedmeier, S. E., Baer, V. L., Henry, E., Gerday, E., Lambert, D. K., ... Besner, G. E. (2010). Antecedents of Bell stage III necrotizing enterocolitis. *J Parimatol*, 30(1), 54-57. doi:10.1038/jp.2009.93

Gephart, S. M., Werzel, C., & Krisman, B. (2014). Prevention and early recognition of necrotizing enterocolitis: a tale of 2 tools-eNEC and GutCheckNEC. Adv Neonatal Care, 14(3), 201-210; quiz 211-202. doi:10.1097/anc.0000000000000063

Gregory, K. E., Deforge, C. E., Natale, K. M., Phillips, M., & Van Marter, L. J. (2011). Necrotizing enterocolitis in the premature infant: neonatal nursing assessment, disease pathogenesis, and clinical presentation. Adv Neonatal Care, 11(5), 155-164, quiz 165-156. doi:10.1097/ANC.0b013e31821baaf4

Low risk= <20 points, Moderate risk= 20-32 points, High risk= 33-36 points, Very high risk > 36 points. Scores typically range from 8-58 points. Request form via http://neczero.nursing.arizona.edu/gutchecknec



### Avoiding NEC Checklist- VLBW

#### Hospital Name [customize]

#### Before Delivery of Baby

#### Facility verifies:

- Contract for donor breast milk has been established
- Standardized breast milk promotion strategies
- Have nurses been educated on GutCheckNEC
   Has policy on antibiotic use and implementation
- Has policy on antibiotic use and implementation
   Has feeding protocol been adopted
- Bedside focused assessment and communication tools
- System to audit protocol adherence
- □ Facility guideline on H2 blocker use

#### Nurse and Neonatologist verify:

- Feeding initiation and protocol use
- Benefits of human milk as critical therapy for preemies shared verbally along with proper milk preperation
- Benefits of human milk printed information given
- Determine champions to promote feeding protocol use Lactation consultant verifies:
- Pumping kit with colostrum for oral care supplies given
   Advised mother [Insert Name \_\_\_\_\_] to pump
- within first hour after delivery and by 6 hours postdelivery
- Parents as partners information given

#### At delivery

#### OB Nurse, Obstetrician and NICU nurse verify:

- Delayed cord clamping plans
- Plans to draw admission labs off the cord
- OB nurse to help mother pump by 1 hour post-delivery
- Initiate feeding protocol
- Infant GutCheckNEC score and neonatal sepsis score
- Obtain cultures to determine infecton

#### 24 hour briefing

#### Mother-baby nurse

- Mother meets with lactation specialist
- Time first pumping completed (Goal= < 6 hours postdelivery) \_\_\_\_\_
- Colostrum for oral care kit given or scheduled
- Ensure mother has way to pump milk at home
- Nurse shares at handoff and rounds:
- First oral care with colostrum given
- Initial GutCheckNEC score \_\_\_\_\_
  - High risk
  - Moderate risk
     Low risk
- Neonatologist verifies:

#### Risks and benefits of probiotics shared

Donor milk consent signed

#### Before Advancing Feeding (3 days of age)

#### ROUNDS (with family)

#### Nurse asks:

"Is everyone ready to perform the feeding check-in for [first name, last name]? Please state your name and role."

#### **TEAM BRIEFING**

#### Physician shares:

- Feeding plan
- Antibiotics and steroid plan
- Probiotic use plan
- Warning signs to watch for (use term necrotizing enterocolitis)
- Standardized risk assessment

#### Parent shares:

- Parent's plans to be in NICU
- □ When wants to do kangaroo care
- Pumping log- volume
- Other concerns

#### NICU Nurse shares:

- □ GutCheckNEC score
- Warning signs pamphlet given to parent
- How baby is tolerating feeding
- Relevant focused assessment findings
- Other concerns

#### Pharmacist shares:

- Date antibiotics should be stopped if culture negative (Goal: < 5 days Tx)</li>
- Dietitian shares:
- Plan for feeding advance and goal
   Fluid management goals

#### Neonatologist asks:

"Does anybody have any concerns? If you see something that concerns you during the care of [First Name, Last Name], please speak up."

#### Before Advancing to 80 ml/kg/day

#### Nurse reports to team (\* or dietitian)

- Proportion of human milk feeds given (% of total)\*
- □ Total ml dose of human milk given\*
- □ Received any formula?
- □ GutCheckNEC score
- Feeding tolerance
- Weight and growth\*

#### Physician states:

- Plans to fortify to 22 kcal
- □ Share risks of cow's milk fortifier with parent if used
- Transfusion plan- read HgB \_\_\_\_\_, If HgB < \_\_\_\_\_ plan to transfuse. Says "If we transfuse, we will time the transfusion to not happen at the same time as feeding."
- Will remove central line when reaches 120 ml/kg/day and increase fortifier to 24 kcal at that time [adjust for protocol]

#### Parent shares

- Pumping log and volume [Goal= 500 ml/day]
- □ # of kangaroo care times completed
- Other concerns

#### When Transfusion is needed

#### Entire Team discusses:

- Timing to avoid feeding at time of transfusion
- Higher NEC awareness within 48 hrs of transfusion
- Plans to not advance or fortify on the day of transfusion

#### After Discharge [May be deleted]

#### Entire Team: discussed:

- Measures for adherence scores
- Contacting mother for updates on how infant is progressing

Adapted from the safe surgery checklist retrieved 03/02/17 from http://www.safesurgery2015.org/checklist-templates.html. Modiflying this checklist to fit your NICU's practice is encouraged. These components are based on the NEC-Zero Working Group Scoping Review and a Workgroup at the NEC Symposium sponsored by the NEC Society 04/08/2017. © 2017 Gephart and Vartanian. All Rights Reserved.

# **INTEGRATING GUTCHECKNEC INTO WORKFLOW**

itive Red Dystems								19 May :	2016 Accour
art Q Workb	bench Dashboard				_				Full Screen
NICU, Bed EGA 26+2 DOL 5, BW	itain, Jose (male)   312, MR# 123-45-6789 2wks, CGA 27+0wks V 950g, TW 920g, Calc	Weight 950g		No Known Alle	ergies				Close
Vitals	a Q			< 🛍 _ / _ /	- >				
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1100		67	70	10		20		-	
Hea	rt Rate	67	70	68		/8	164	-	
Tem	np (F)(r)	96.7	96.2	96.0		97.9	97.6		
Gut	Check Nec	32						31	8
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	Detail	Quality Review	GutCheck	NEC (< 1	500 ç	grams		Podcasts	Points 38
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*Gephart et al. Journal of Perinatology, 2014, 34*(6), 468-475. doi:10.1038/jp.2014.37

## CLINICAL DECISION SUPPORT FOR ADHERENCE AND CASE ANALYSIS

- NEC-Zero integrates risk awareness, comprehensive NEC evaluation and adherence monitoring
- NEC-Zero being designed to plug in across EHRs
- App can be used at individual, group or organizational level
- Designed to "hook into" with a clinical decision support hook your existing EHRGOAL is open source, free tool for broad use
- GOAL is open source, free tool for broad use
- Logic will be hosted on University of Arizona repository
- For examples of other SMART apps, see <u>https://smarthealthit.org/</u>



# www.neczero.nursing.arizona.edu



### **PREVENT AND MINIMIZE**

### PARENTS

Want more information?

LEARN MORE »

### HEALTH PROFESSIONALS

Be prepared for NEC

**LEARN MORE »** 



### Download Pamphlets

What is Necrotizing Enterocolitis (NEC)? / ¿Qué es la enterocolitis necrotizante (ENC)? Prevent Complications! / ¡Prevenga complicaciones!



### www.neczero.nursing.arizona.edu/parents/what-is-nec

### **PARENT EDUCATION MATERIALS**



# Expecting a Preemie?

How the gift of your milk protects your new baby.





Prevent Complications!

It's a team effort!





### What is Necrotizing Enterocolitis?





### Give Colostrum as Soon as Possible

Give colostrum as soon as possible Colostrum is the first milk mothers produce. It contains vital immune stimulating components that prematu infants lack. Swabbing a few drops of colostrum inside your baby's mouth before your baby is taking feedings is important.

### **Donor Milk**

Mothers should start pumping their breasts within 6 hours after the baby is born. If mom's milk is not available, feeding donor breast milk is the next best option for very small or very early babies.

# Prevent Complications!

It's a Team Effort!

# **ASK QUESTIONS**

### MINIMIZE

### For Parents

#### **For Parents**

What is NEC?

#### How does NEC happen?

What are the symptoms of NEC?

Treatment of NEC

#### Recovery

#### Resources and Support Groups



For more information about NEC:

- Medline Plus Health Topic Necrotizing Enterocolitis
- KidsHealth from Nemours About Necrotizing Enterocolitis

# **RESOURCES FOR PARENTS**

### For Parents

**For Parents** 

What is NEC?

How does NEC happen?

What are the symptoms of NEC?

Treatment of NEC

Recovery

**Resources and Support Groups** 

- Peekaboo ICU App
- NEC Society\*
- The Morgan Learly Vaughen Fund
- Team Grayson
- Preemie Parent Alliance
- Hand to Hold
- Graham's Foundation
- NEC Society Inspire Group

### **RESOURCES AND SUPPORT GROUPS**

Short-gut Specific:

- Short Gut Syndrome's Family Support Group
- Hunter Evan Short Gut Foundation
- Short Bowel Syndrome Foundation
- Short Bowel Support



For families impacted by necrotizing enterocolitis

# NEC Society Research Collaborative

## **RESOURCES FOR HEALTH PROFESSIONALS**

### For Health Professionals

**Healthcare Professionals** 

**Early Recognition** 

Caring for Babies with NEC in the Hospital

Breastfeeding

Breastfeeding and the Workplace

GutCheckNEC

Resources

**Upcoming Webinars** 



### HEALTH PROFESSIONALS

Be prepared for NEC

**LEARN MORE »** 

### www.neczero.nursing.arizona.edu/healthcare -professionals
## **MORE RESOURCES**

### Prevention

#### Prevention

#### Breastfeeding

Importance

Benefits of Breast Milk



Find out more about the benefits of breast milk

Learn More

- American Academy of Pediatrics
- Healthychildren.org
- La Leche League
- Medline Plus
- Womenshealth.gov
- LactMed
- Workplace & Breastfeeding Law



PARENTS HEALTH PROFESSIONALS GU	СНЕСК NEC
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### SUMMING UP... TO PREVENT AND SUPPORT TIMELY NEC RECOGINITION

### Do...

- Stop antibiotics before 5 days if there is no infection
- Use a feeding protocol
- Give mother's milk and donor milk if don't have mother's milk
- Try to avoid anemia (e.g. with delayed umbilical cord clamping)
- Use a risk score for NEC

# Don't...

- Use antacids
- Ignore early warning signs
- Ignore parents as partners
- Avoid talking about NEC as a potential complication because of being afraid to scare parents

### THANK YOU!

- Alan Carr, Associate Director of the NNLM Pacific Southwest Region, The UCLA Library and the staff at the Darling Biomedical Library who are assisting us in this project
- The University of Arizona, CON, Office of Learning and Healthcare Technology Innovations Staff – Peg, David, Stephen, and Princess – Thank you so much!
- The University of Arizona, CON, Continuing Professional Education Staff Janelle, Paula and Dr. Koithan
- Parent advocates who graciously shared their stories and pictures.





Evaluation: Let us know what you think and get Continuing Nursing Education hours. Please complete the evaluation by May 10 at 5 pm MST. https://uarizona.co1.qualtrics.com/ jfe/form/SV\_6KZjMIP4Td6xJqJ



# Link to postwebinar survey:

https://uarizona.col.qualtrics.com/jfe/form/SV\_6KZj MIP4Td6xJqJ

Please ask your questions via the chat box. Thanks for joining today!

Sheila Gephart, PhD, RN gepharts@email.arizona.edu

NEC-Zero website: https://neczero.nursing.arizona.edu/



To obtain your Continuing Nursing Education certificate you can complete the evaluation at <u>https://uarizona.co1.qualtrics.com/jfe/form/SV\_</u> <u>6KZjMIP4Td6xJqJ</u>

Print the certificate at the end OR go to **cne.nursing.arizona.edu** and find your event under the "Quick Links CPE Evaluations" tab.



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