Nutrition Interventions Associated with Favorable Growth In Infants with Congenital Diaphragmatic Hernia

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Abstract

Nutrition complications are common in survivors of the rare, life-threatening anomaly congenital diaphragmatic hernia (CDH). Infants diagnosed with CDH may require feeding tubes and gastro-esophageal reflux treatment yet still demonstrate poor growth. This literature review was conducted to determine nutrition interventions resulting in favorable growth which may improve outcomes in these infants. Results indicate that early nutrition support including supplemental parenteral nutrition with calorie and protein provisions of $\geq$125 kcal/kg and $\geq$2.3 g/kg protein may have a positive impact on growth, potentially impacting neurological development.

Introduction / Methods

- Multiple studies documenting growth difficulties in DH
- Few studies with guidelines to help improve outcomes
- Literature review* with only 5 studies that answered PICO question
  - Most studies weak design – retrospective cohort
- Opportunities for future research

*Conducted in 2019

Conclusions

- Plan for nutrition > RDA for age
  - Most infants will be hypermetabolic
  - $\geq$125 kcal/kg
  - $\geq$2.3 g/kg
- Aggressive early PN
- Cautious transition to EN
- Longer PN may improve growth outcomes

References

[1]Bairdain S, Khan FA, Fisher J, et al. Nutritional outcomes in survivors of congenital diaphragmatic hernia (CDH)-factors associated with growth at one year. *J Pediatr Surg.* 2015;50(1):74-77.
[2]Gien J, Murthy K, Pallotto EK, et al. Short-term weight gain velocity in infants with congenital diaphragmatic hernia (CDH). *Early Hum Dev.* 2017;106-107:7-12.
[3]Haliburton B, Chiang M, Marcon M, Moraes TJ, Chiu PP, Mouzaki M. Nutritional Intake, Energy Expenditure, and Growth of Infants Following Congenital Diaphragmatic Hernia Repair. *Journal of pediatric gastroenterology and nutrition.* 2016;62(3):474-478.
[4]Howell HB, Farkouh-Karoleski C, Weindler M, Sahni R. Resting energy expenditure in infants with congenital diaphragmatic hernia without respiratory support at time of neonatal hospital discharge. *J Pediatr Surg.* 2018;53(11):2100-2104.
[5]Terui K, Yoshida H, Usui N, et al. Impact of nutrition in the treatment of congenital diaphragmatic hernia. *Pediatrics International.* 2019;61(5):482-488.

Results

Author, Year, Study Design, Rating	Study Purpose	Study Population and setting	Outcomes	Conclusions	Strengths Limitations
Bardian S, Khan FA, Fisher J, et al. 2015[1] Retrospective Cohort Study Massachusetts, US QCC Grade: Positive	• Assess nutritional status of infants with CDH at hospital discharge and during follow-up for the first year • Determine risk factors for low WAZ *z* scores	• 107 infants born 2000-2010 surviving 1st year • 67.3% (n = 72) male, 23.3% (n = 25) premature • Defect size 54.2% (n = 58) smaller, 45.8% larger (n = 49)	RF related to lower WAZ at 12 months: • Patch repair (p = 0.009) • Protein intake < 2.3 g/kg/day (p = 0.014) • Birthweight $\leq$ 2.5 kg (p < 0.001) • O2 (p = 0.04) • PPI (p = 0.002)	• Minimum protein goal 2.3 g/kg/day	• Large cohort • Similar to ASPEN recommendations for critical illness • Retrospective, single-institution study • Incomplete nutrient intake data
Gien J, Murthy K, Pallotto EK, et al. 2017[2] Retrospective Cohort Study United States Funding: Children's Hospitals Neonatal Consortium (CHNC) QCC Grade: Positive	• Association between post-natal WGV and survival • Secondary: • Respiratory support • PN duration • EN route	• 480 infants born 2010-2014 • 28 Level IV NICUs [a] • Median GA 38 weeks	• Q1: 24.8% (n = 156) WGV: 1.9 g/kg/day • Q2-3: 50.2% (n = 316) WGV: 4.6 g/kg/day • Q4: 25.1% (n = 158) WGV: 6.8 g/kg/day (p <0.0001) • Q1 = fewest PN days (p <0.0001)	• WGV inadequate all Q, better with longer PN course • Slower EN transition may ↑ WGV • EN via tube rather than oral = better WGV	• Large cohort • Sample included high risk infants (PT and SGA) • Retrospective • Incomplete nutrient intake data
Haliburton B, Chiang M, Marcon M, Moraes TJ, Chiu P, Mouzaki M. 2016[3] Retrospective Cohort Study Toronto, Canada Funding: None QCC Grade: Positive	• IC used to evaluate caloric requirement for appropriate growth • Used measured resting energy expenditure (mREE)	• 43 infants born 2011-2014 • 43 infants (male: 60.5%, n = 26) • Primarily left sided defects (90.7%, n = 39) • Premature (25.6%, n = 11)	• Calorie intake 125 $\pm$ 20 kcal/kg/day = 25-35 g/day weight gain • IC in 17 patients (39.5%), 59% (n = 10) hypermetabolic	• mREE = hypermetabolic • Poor growth outcomes = higher than expected energy needs	• IC = gold standard • Retrospective, single institution • IC data obtained on medically stable infants
Howell HB, Farkouh-Karoleski C, Weindler M, Sahni R. 2018[4] Prospective Cohort Study New York, United States Funding: None QCC Grade: Positive	• Compare REE to PE	• 18 infants born >37 weeks GA • 9 male, 9 female • 72%, n = 13 with left sided DH	• REE increased with age (r2 = 0.3, p < 0.02) • Mean ratio measured-to-predicted REE 1.10 +/- 0.17. • 50% (n = 9) hyper- metabolic (ratio > 1.10)	• No significant difference compared with historical healthy (95% CI = 13.5-5.9, p = 0.30) • Findings do not support DH hypermetabolism	• Prospective • Included calorie intake • Very small sample • Relatively healthy population
Terui K, Usui N, Tazuke Y, et al. 2019 Retrospective Cohort Study Japan Funding: Ministry of Health, Labour and Welfare of Japan grant QCC Grade: Positive	• Weight gain with differing EN / PN doses	• 105 infants born 2006-2010 • 5 institutions • Gender: male = 53.3% (n = 56), female = 46.7%, (n = 49) • Majority left side defect (91.4%, n = 96)	• No significant weight difference in high (n = 35, 32.4%) vs low (n = 71, 67.5%) PN • Weight higher in high EN (n = 39, 37.1%) vs low	• Early EN is crucial for weight gain • Aggressive PN crucial when EN not tolerated	• Multi-site study • Larger sample • High PN group may have been sicker • IV fat not assessed • Surgery timing not assessed

Abbreviations: CDH, congenital diaphragmatic hernia; EN, enteral nutrition; GA, gestational age; IC, indirect calorimetry; NICU, neonatal intensive care unit; O2, oxygen supplementation; PN, parenteral nutrition; Q1-Q4, quartile 1-4; RF, risk factor; WAZ, weight for age z score; WGV, weight gain velocity

[a]Atlanta, Georgia (2), Birmingham, Alabama, Memphis, Tennessee, Boston, Massachusetts, Chicago, Illinois, Columbus, Ohio, Dallas, Texas, Aurora, Colorado, Detroit, Michigan, Fort Worth, Texas, Houston, Texas, Kansas City, Missouri, Little Rock, Arkansas, Los Angeles, California, Oakland, California, Philadelphia, Pennsylvania, Pittsburgh, Pennsylvania, St Louis, Missouri, St. Petersburg, Florida, San Diego, California, Washington, District of Columbia, Wilmington, Delaware, Salt Lake City, Utah, Milwaukee, Wisconsin, Omaha, Nebraska, Orlando, Florida. Institution locations are listed in the order given in the article. Although the authors state that 28 institutions participated, only 27 were included in their list.