Nutritional Management for Infants & Children with Neurological Injuries & Impairments

Presenter: Janelle Karrell, APRN, RN, MSN – Medical Science Liaison, Nutricia
Live event date: March 10, 2022 - *Recording on NutriciaLearningCenter.com within ~2 weeks of live event*

Learning Objectives:

- Define and discuss three prevalent brain injuries within the neonatal and pediatric population
- Discuss challenges associated with feeding neurologically injured infants and children within the acute care setting
- Review nutrition interventions and management for neurologically injured infants

Notes:

Nutricia North America supports the use of breast milk wherever possible.

AGENDA

Agenda Item	Time
Introduction- name, current practice	10 minutes
What Constitutes a Neurological Injury and What Injuries are Most Prevalent	5-10 minutes
Challenges of Nutrition Care for the Child Experiencing a Neurological Injury	5-10 minutes
Review studies	10-15 minutes
Overview of Nutrition Management Strategies	10-15 minutes
Discussion Questions	

OBJECTIVES

01

Define and discuss three prevalent brain injuries within the neonatal and pediatric population.

02

Discuss challenges associated with feeding neurologically injured infants and children within the acute care setting.

03

Review nutrition interventions and management for neurologically injured infants.

WHAT CONSTITUTES A BRAIN INJURY?

WHAT IS A BRAIN INJURY?

Types of brain injuries:

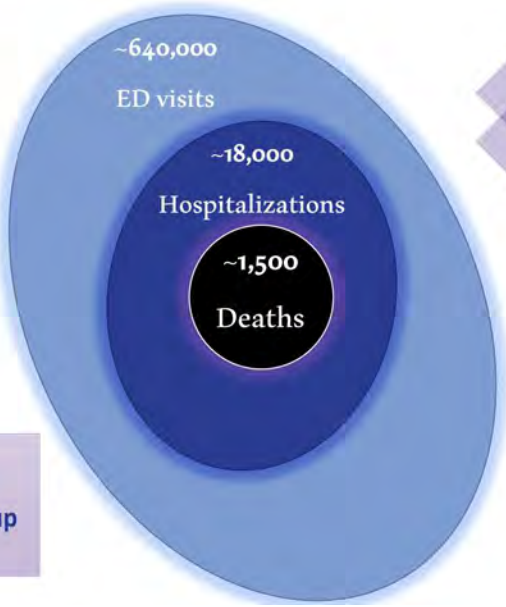
1. **Traumatic Brain Injury - occurs after birth and is not congenital, degenerative, or hereditary.**
2. **Acquired Brain Injury – caused by internal factors**

Classification of Traumatic Brain Injury, Physiopedia 2021

PREVALENCE OF TBI'S & EXAMPLES

Examples of TBI's

- Stroke
- Falls
- Assaults/ Non-Accidental
- Motor Vehicle Accidents
- Sports Injuries



In 2013:
Children aged 0 to 4 years had the highest rates of TBI-related ED visits of any age group except those over 75 years

Classification of Traumatic Brain Injury, Physiopedia 2021

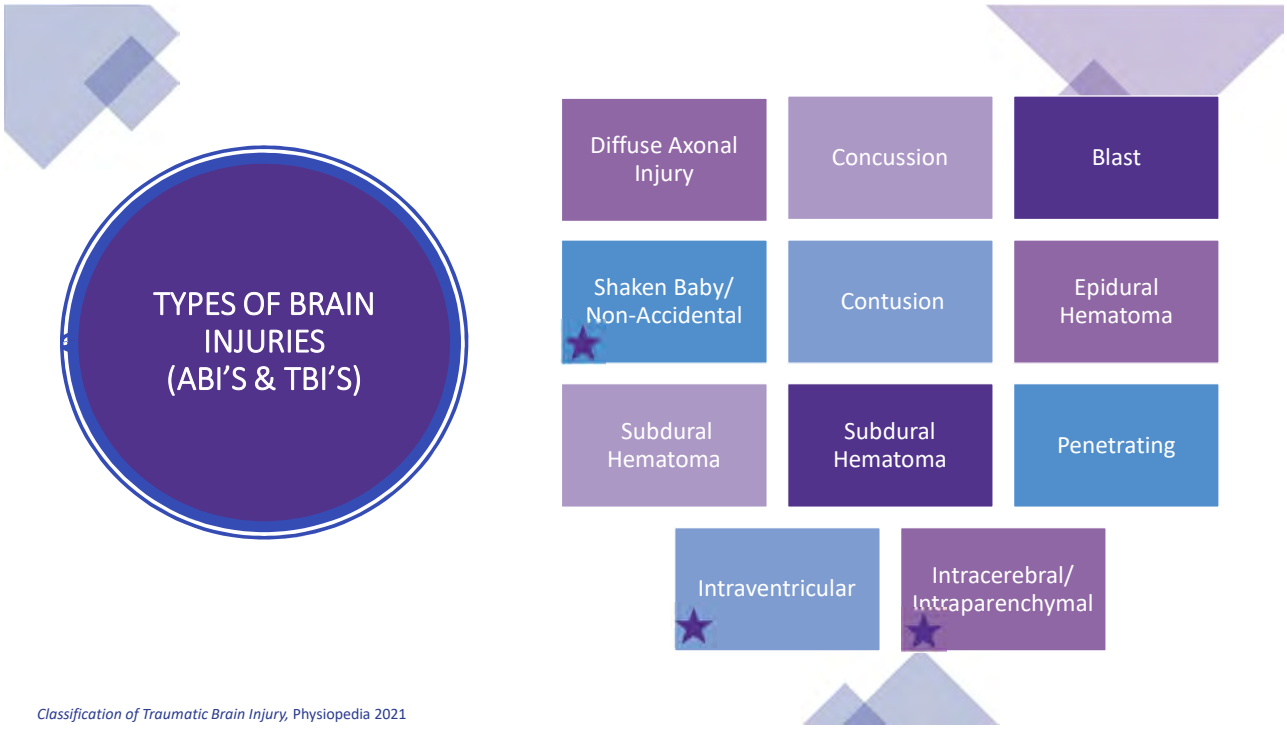
PREVALENCE OF TBI'S & EXAMPLES

Examples of ABI's

- Near drowning
- Aneurysm
- Tumors
- Infectious Disease (meningitis)
- Lack of oxygen to the brain (heart attack, HIE)

Prevalence – Difficult to assess in children due to inconsistencies with definitions and data collection.

Classification of Traumatic Brain Injury, Physiopedia 2021



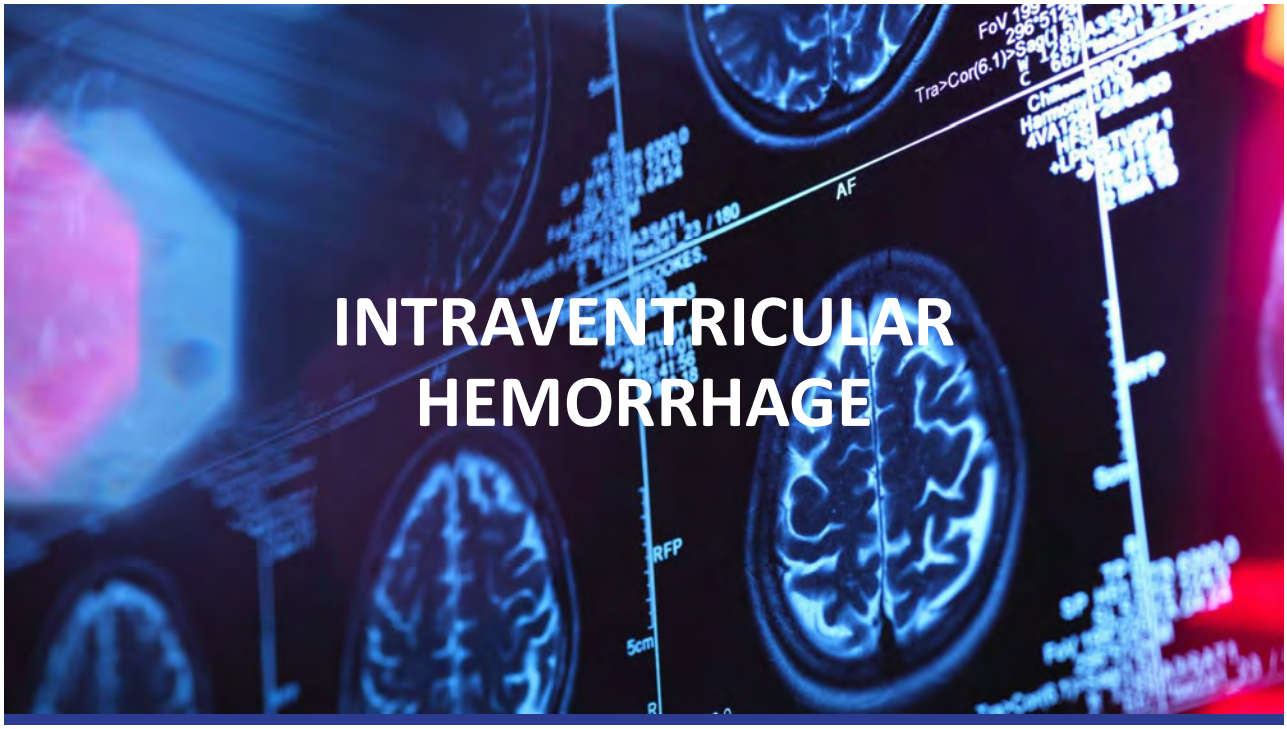
Classification of Traumatic Brain Injury, Physiopedia 2021

POLL QUESTION

RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK 'SUBMIT' WHEN DONE

Which neurological injury is responsible for the most deaths in children under the age of 1 in the USA?

- **A. Shaken baby**
- **B. Concussion**
- **C. Blast injury**
- **D. Subdural hematoma**
- **E. Intraventricular hemorrhage**



WHAT IS AN INTRAVENTRICUAR HEMORRHAGE (IVH)?

Bleeding inside or around the fluid-filled areas of the brain (also known as ventricles).

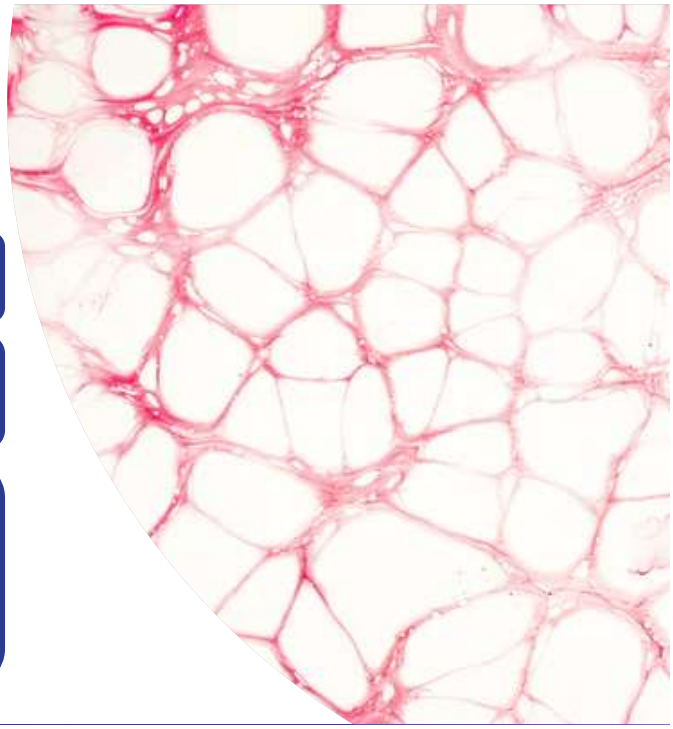
Ventricles

Spaces within the brain that contain cerebral spinal fluid (CSF).

Premature & LBW infants:

Fragile and premature blood vessels in the brain

IVH can also develop in term infants due to head injuries or trauma.



INTRAVENTRICULAR HEMORRHAGE, N.D.)

WHAT DOES IVH LOOK LIKE – CT SCAN

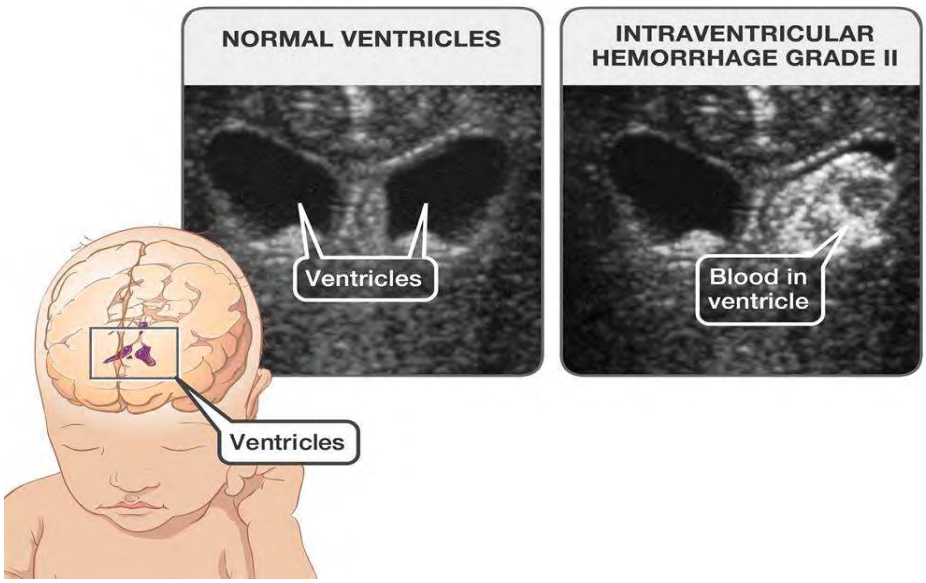
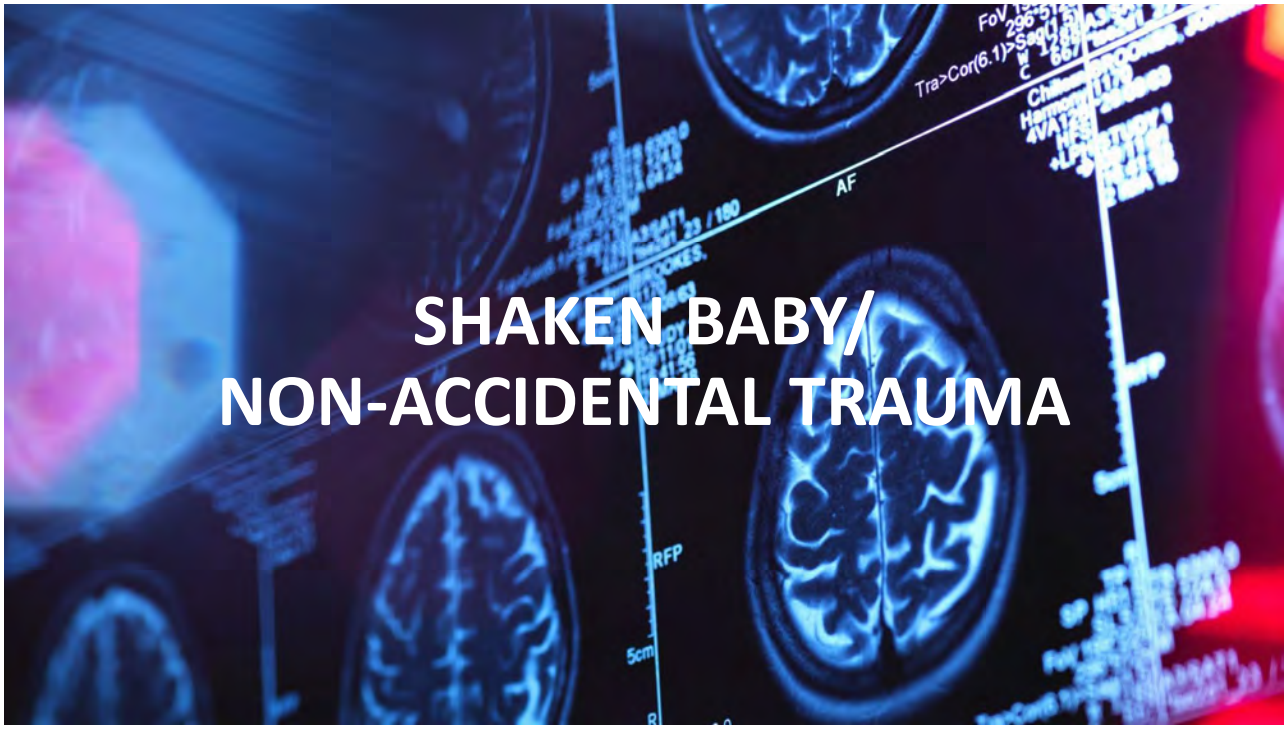


Image of Intraventricular hemorrhage (IVH) grade II head ultrasound reused with permission from The Hospital for Sick Children, www.aboutkidshealth.ca



SHAKEN BABY NON-ACCIDENTAL TRAUMA

The violent and deliberate act that causes a traumatic brain injury to an infant.

Perpetrator aggressively shakes a baby, inflicting a forceful whiplash-like motion upon the infant's brain.

Coup-Contrecoup injury results in a brain injury both at the site of impact and on the contralateral side of the brain.

SHAKEN BABY/ NON-ACCIDENTAL TRAUMA

Second most common cause of death in children under the age of one.

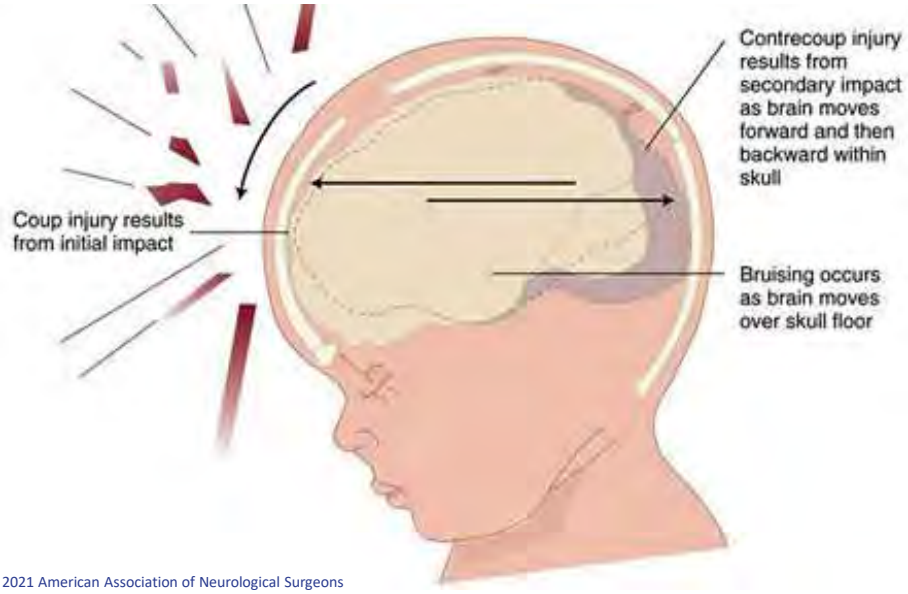
Blood vessels between the brain and skull rupture and bleed.

Brain can swell and compress, causing additional damage to the neurons.

SHAKEN BABY SYNDROME BY NICK YOUNGSON CC BY-SA 3.0 ALPHA STOCK IMAGE

Shaken Baby Syndrome, 2021 American Association of Neurological Surgeons

WHAT HAPPENS IN THE BRAIN WITH SHAKEN BABY INJURY



Shaken Baby Syndrome, 2021 American Association of Neurological Surgeons

WHAT IS HYPOXIC ISCHEMIC ENCEPHALOPATHY?

Injury that occurs in the brain due to a lack of oxygen.

Brain cells may undergo apoptosis (cell death) after just 4 minutes without oxygen.

Abnormalities in:
- Pregnancy
- Labor & delivery
- Postnatal period

These injuries can lead to a range of disabilities including death.

Neonatal hypoxic ischemic encephalopathy, 2002 - 2021. The Regents of The University of California

CAUSES OF HYPOXIC ISCHEMIC ENCEPHALOPATHY

01
Pregnancy

- Problems with blood flow to the placenta
- Preeclampsia
- Maternal Diabetes
- Fetal Infections
- Drug/Alcohol abuse
- Heart & Lung malformations

02
Labor & Delivery

- Umbilical cord problems
- Placenta abruption
- Abnormal breech position
- Very low maternal blood pressure
- Prolonged Labor

03
Postnatal Period

- Severe Prematurity
- Severe Lung and Cardiac Disease
- Infection
- TBI
- Very low Blood Pressure
- Respiratory Failure and Cardiac Arrest

Hypoxic Ischemic Encephalopathy—Newborn 2021 Lahey Health System, Inc

THE CORRELATION BETWEEN HIE AND CEREBRAL PALSY

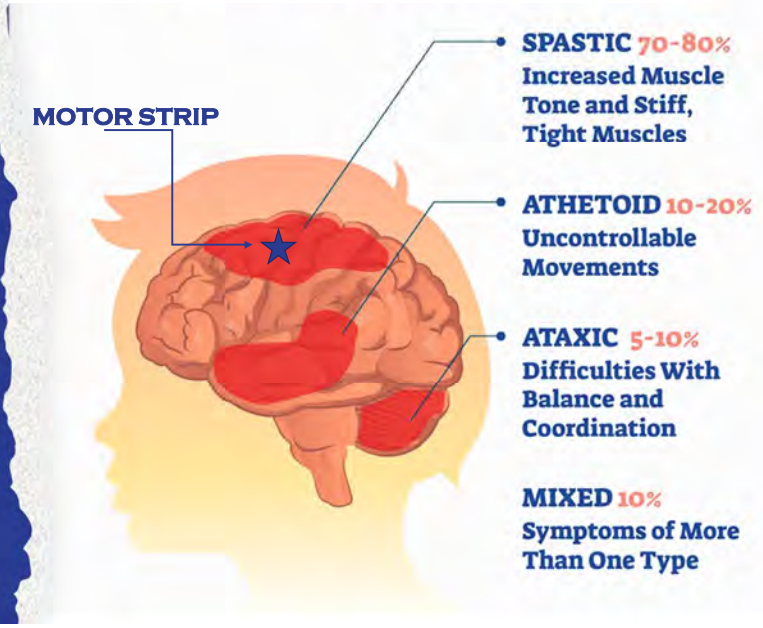
HIE can often lead to Cerebral Palsy.

1/10 cases of cerebral palsy is caused by HIE.

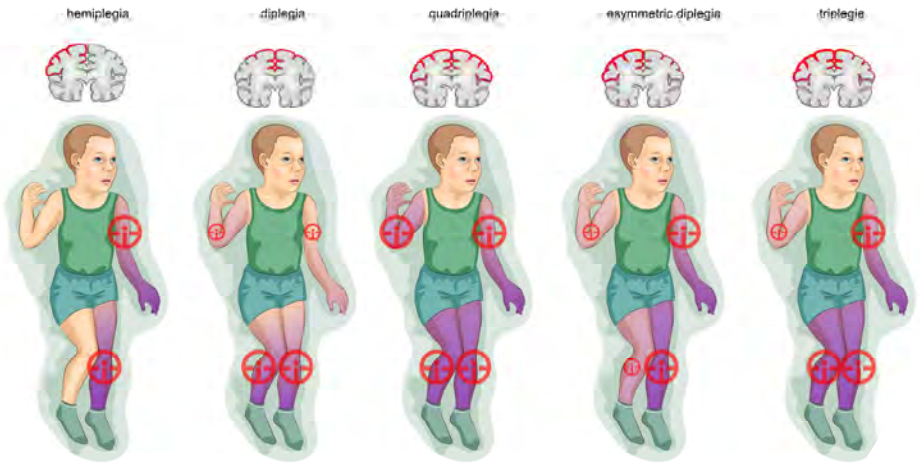
Cerebral palsy manifests itself in motor difficulties, including muscle spasms and coordination difficulties.

Hypoxic Ischemic Encephalopathy (HIE) and Cerebral Palsy, 2021 CerebralPalsyGuidance.com

Types of Cerebral Palsy



Infantile Spastic Cerebral Palsy



CHALLENGES ASSOCIATED WITH FEEDING NEUROLOGICALLY INJURED INFANTS AND CHILDREN

ACUTE CARE SETTING

POLL QUESTION

RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK 'SUBMIT' WHEN DONE

Why might neurologically injured children have higher risk for micronutrient deficiencies?
(*Choose all that apply*)

- A. Lower energy intakes
- B. Exclusive tube feeding is more common
- C. Most enteral formulas are designed to meet micronutrient needs of general population
- D. Neurodisabilities may mask symptoms of deficiency

FREQUENTLY SEEN CHALLENGES IN MANAGEMENT OF NI: NON-NUTRITIONAL FACTORS

Treatment must be Individualized

Type and Severity of Neurological Impairment

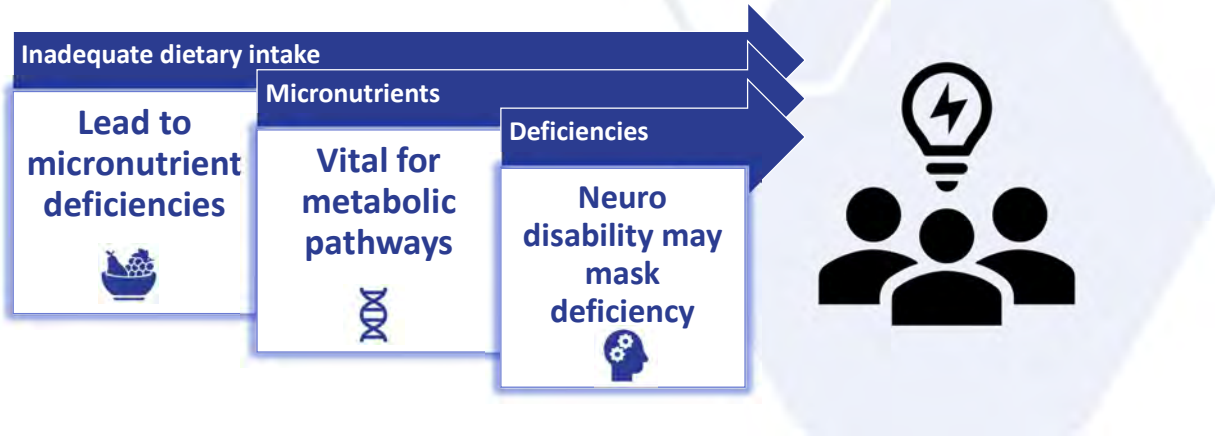
Ambulatory Status

Degree of Cognitive Impairment

Use of Antiepileptic Medications (AED's)

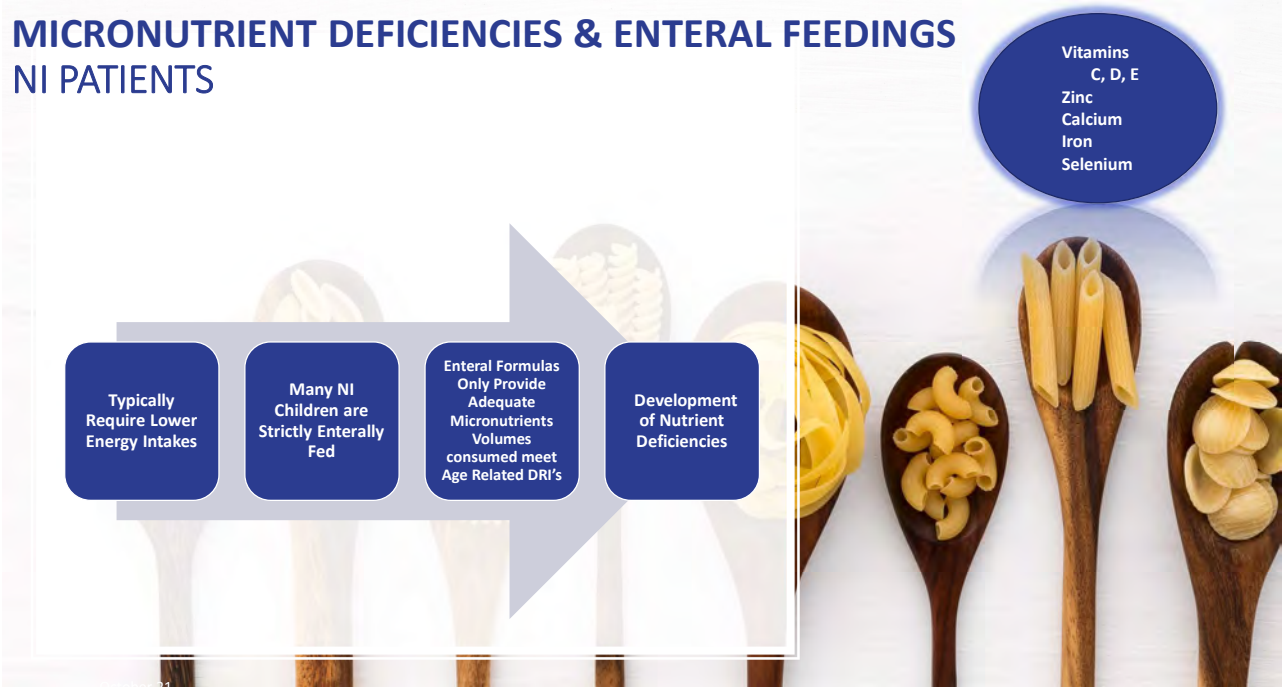
Corkins ET AL, 2016

CONSEQUENCES OF MICRONUTRIENT DEFICIENCY IN THE NI CHILD



Corkins ET AL, 2016

MICRONUTRIENT DEFICIENCIES & ENTERAL FEEDINGS NI PATIENTS



Corkins ET AL, 2016

Monitoring Micronutrients in NI Patients

- Iron deficiency anemia is frequent amongst children who suffer with NI due to low iron intake.
- Selenium deficiency is often seen in NI children who receive long-term enteral nutrition.
- Carnitine deficiency is common in children with epilepsy.

Corkins ET AL, 2016

THE MULTIFACTORIAL ETIOLOGY OF OSTEOPENIA

- Poor dietary intake of calcium and vitamin D
- Poor sunlight exposure
- Muscular weakness
- Limited mobility
- Little to no weight bearing
- Antiepileptic medications

***
FRACTURES 2-6X MORE COMMON IN PATIENTS WITH EPILEPSY
***

Kelly ET AL, 2020

MUSCLE WASTING AND NI

Muscle wasting in the ICU is of grave concern with patients potentially loosing 1-2% of lean body mass per day, **TBI's often associated with greater muscle loss.**

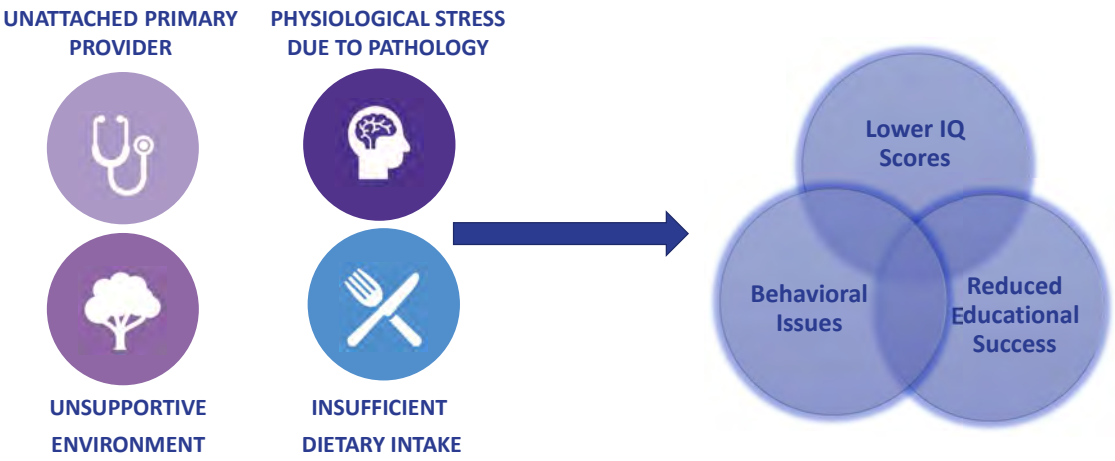
Muscle mass preservation is vital for patient rehabilitation.

Optimal nutritional support in ICU patients has yet to be defined.

HMB supplementation has appeared to improve nitrogen balance in severely injured trauma adults, however more evidence is needed regarding pediatrics. EAA+ arginine has also showed some success (adults).

WANDRAG ET AL

NUTRITION AND THE BRAIN



Dipasquale, Gottrand, Sullivan, & Romano, 2020

CHALLENGES IN NUTRITIONAL MANAGEMENT

Gastrointestinal Issues	Impaired Hydration	Weight	Height
Anthropometric Measurements	Bone Mineral Density	Impaired Wound Healing	Micronutrient Deficiencies

Dipasquale, Gottrand, Sullivan, & Romano, 2020

BURNOUT AND THE NI POPULATION

Dipasquale, Gottrand, Sullivan, & Romano, 2020

Surgery and NI patients – Why is Nutrition important?

- Promotion of Wound Healing
- Decreased Time Spent on Mechanical Ventilation
- Reduced Time Spent in ICU
- Appropriate Immune System Function

NUTRITION INTERVENTIONS AND MANAGEMENT

NEUROLOGICALLY INJURED INFANTS & CHILDREN

WHAT IS AN ENDF?

- 30 kcal/ounce term infant formula
- ↑ protein/nutrient content
- Osmolality: 360 mOsm/kg
- Ready to feed & sterile
- Nutritionally complete
- Used in Europe for 20+ years
- Supported by clinical evidence

ENDF = energy- and nutrient-dense formula

ENERGY AND NUTRIENT DENSE FORMULAS

ESPGHAN GUIDELINES

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

- Tip 1: Be aware of the Burden of the Neurological Impairment
- Tip 2: Assessment of Nutritional Status
- Tip 3: Definition of Undernutrition

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

- Tip 1: Be aware of the Burden of the Neurological Impairment
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Anthropometrics and measurements can be difficult

NI children have:
Higher fat percentages
Lower lean muscle mass

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

- Tip 1: Be aware of the Burden of the Neurological Impairment
- Tip 2: Assessment of Nutritional Status
- Tip 3: Definition of Undernutrition

No universal definition

1 or more red flags:
Physical signs of undernutrition
Weight for age z-scores
anthropometric

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

- Tip 4: Nutritional Needs
- Tip 5: GERD
- Tip 6: Know How to Diagnose and Treat Refractory Constipation

Wheelchair dependent:
60-70% of energy as compared to developing child

Overestimation of energy :
Overfeeding
Fat accumulation
Obesity

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

Tip 4: Nutritional Needs

Tip 5: GERD

Tip 6: Know How to Diagnose and Treat Refractory Constipation

Difficult to recognize in NI Risk Factors

Many risk factors for GERD in NI

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

Tip 7: Know When to Propose a Nutritional Intervention

Tip 8: Be Familiar with Enteral Nutrition: Access & Feeding Regiment

Tip 9: Know the Benefits of Enteral Nutrition

Enteral Nutrition considerations:

PO intake not able to meet 60-80% of needs
Feeding time exceeds 3h/day
Inadequate growth/weight
Decrease in height
Triceps skinfold less than 5%ile
Chewing/swallowing problems

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

Tip 7: Know When to Propose a Nutritional Intervention

Tip 8: Be Familiar with Enteral Nutrition: Access & Feeding Regiment

High-energy and nutrient dense formulas
Supplements with glucose polymers
Long-Chain triglyceride

ESPGHAN GUIDELINES: 10 TIPS

GI AND NUTRITIONAL COMPLICATIONS IN CHILDREN WITH NEUROLOGICAL DISABILITIES

Tip 9: Know the Benefits of Enteral Nutrition

Tip 10: Choose an Appropriate Formula

For infants offer human milk

When formula is needed:
High-energy density formulas
Supplements with glucose polymers
Long-Chain triglyceride

NUTRITIONAL ASSESSMENT: WHERE TO START?

- Multidisciplinary approach
- Nutritional assessment should include broad measures (not based solely on height & weight)
- Knee height or tibial length in children with NI when height cannot be obtained
- Routine fat mass measurements via skinfold thickness
- DXA scans for bone mineral density
- Laboratory assessment of micronutrients

ROMANO ET AL *JPGN* 2017

INFANT ASSESSMENT

How often should nutritional status be monitored?

- Growth assessment is recommended 1-3 months
- Children at least every 6 months
- Micronutrients checked annually

ROMANO ET AL *JPGN* 2017

ASSESSMENT CONTINUED

How often should nutritional status be monitored?

- For infants, growth assessment is recommended 1-3 months and in children at least every 6 months, and micronutrients checked annually

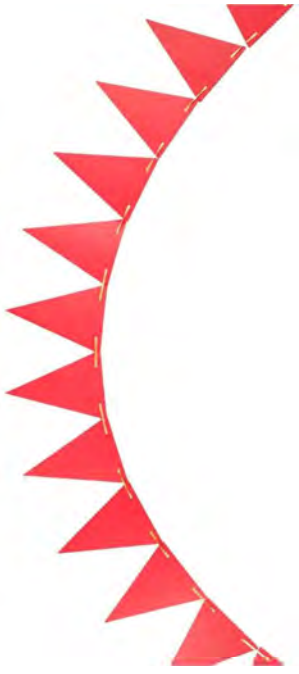
Nutritional requirements (energy, protein, fluid, micronutrients)

- Utilize the dietary reference standards for typically developing children
- Regularly monitor body weight and fat mass as indicators to adjust caloric needs
- Use the DRI's for protein in the typically developing child
- Use of supplementary protein intake in specific clinical situations
- Use the DRI for micronutrients in typically developing children

ROMANO ET AL *JPGN* 2017

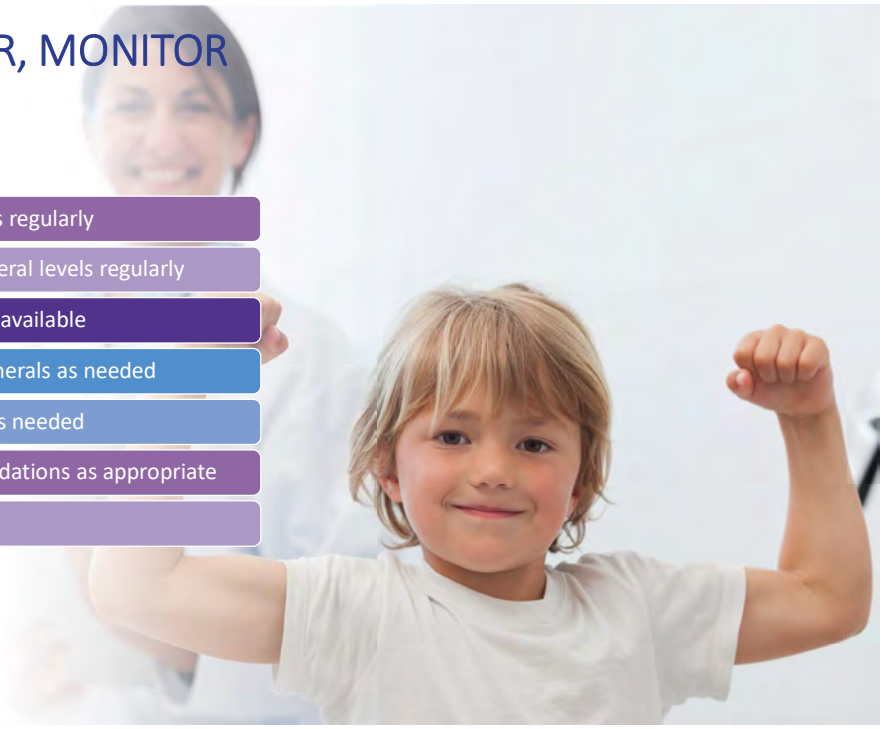
RISK FOR MALNUTRITION: RED FLAGS

- Physical signs of malnutrition such as decubitus ulcers and poor peripheral circulation
- Weight for age z-scores <-2
- Triceps skinfold thickness <10th percentile for age and sex
- Mid-upper arm fat or muscle <10th percentile
- Faltering Growth/ Failure to Thrive



ROMANO ET AL *JPGN* 2017

MONITOR, MONITOR, MONITOR



- Check anthropometrics regularly
- Monitor serum vitamin and mineral levels regularly
- Indirect calorimetry if available
- Supplement vitamins and minerals as needed
- Supplement protein as needed
- Monitor GI tolerance, make recommendations as appropriate
- Monitor I/O

ROMANO ET AL JPGN 2017

POLL QUESTION

RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK 'SUBMIT' WHEN DONE

What is your biggest challenge in feeding infants with neurological injury?

A. Meeting protein, vitamin and/or mineral needs

B. Supporting appropriate growth

C. Gastrointestinal symptoms or poor feeding tolerance

D. Bone mineral density

E.I don't currently care for or have experience caring for these infants

MAXIMIZING NUTRITIONAL INTAKE WITH ENDF: TUBE FED VOLUME RESTRICTION INFANTS

Design

- Randomized, double-blind controlled trial
- Fed continuously via NG tube
- Start 12-24 hr post-op: 1 mL/kg/h (24 mL/kg/d), advance 1 mL/kg/h Q6H as tolerated
- 5-day intervention - Study formulas:

Intervention (n = 26)	Control (n = 24)
ENDF • 1 kcal/mL • 10.4% PE	**SIF** • 0.67 kcal/mL • 8% PE

Study Population

- Term infants, 4 weeks -12 months old, post-op for CHD repair (biventricular repairs only)

Outcomes

1 – Nutrition status
- Macronutrient intake
- Daily 24-hr urinary urea nitrogen
- Biochemical

2 – Tolerance
- Emesis + stools
- GRV Q4H
- GI bleeding
- Gastric motor drugs

3 – Outcomes
- Infections
- Length of stay

CHD = congenital heart defect; ENDF = energy- and nutrient-dense formula; NG = naso-gastric; SIF = standard infant formula. 1. Cui Y et al. JPEN J Parenteral and Enteral Nutrition. 2018. 2. van Waardenberg DA et al. Clin Nutr. 2009. 3. de Betue CT et al. Arch Dis Child. 2011. 4. de Betue et al. Am J Clin Nutr. 2013.

ENDF SUPPORTED MEETING NUTRITION GOALS SOONER THAN STANDARD INFANT FORMULA WITH COMPARABLE TOLERANCE

Results

1 – Nutritional Status

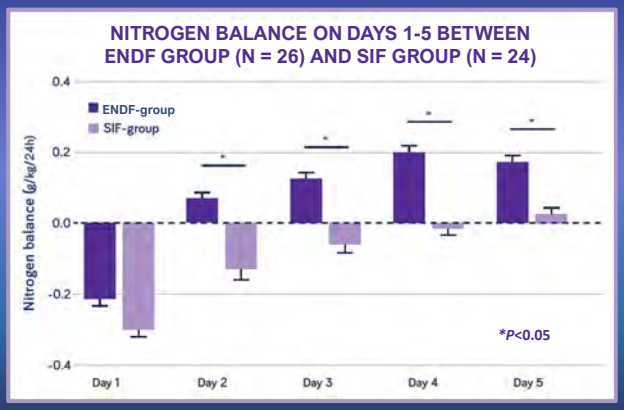
- ENDF group met adequate intake for energy and macronutrients before day 2
- SIF group achieved adequate intake for CHO only on days 2- 5

2 – Tolerance

- No significant differences other than higher "tolerable diarrhea" in ENDF group
- Stool frequency and volume did not differ between groups overall

3 – Clinical outcomes

- No significant differences



CHO = carbohydrate; ENDF = energy- and nutrient-dense formula; SIF = standard infant formula. 1. Cui Y et al. JPEN J Parenteral and Enteral Nutrition. 2018.

CLARKE ET AL. AIMED TO COMPARE ENDF TO THE CURRENT PRACTICE OF ENERGY-SUPPLEMENTED FORMULAS (ESF)

Design

- Randomized, open-label, controlled trial
- 6-week intervention
- At least 80% of kcal from study formula
- Study formulas:

Intervention (n = 26)	Control (n = 23)
ENDF • **1 kcal/mL** • **10.4% PE**	**ESF** • **1 kcal/mL** • **5.5% PE**

- Birmingham Children's Hospital, 1997-98

Study Population

Enterally fed infants <12 months old with diagnosis of FTT due to organic or non-organic causes

Diagnoses in study population:

1. **Congenital heart disease: 47% (n=23)**
2. **GI/surgical patients: 31% (n=15)**
3. **Cystic Fibrosis: 10% (n = 5)**
4. **Neurodisabilities: 6% (n = 3)**
5. **Other: 6% (n=3)**

No significant differences in anthropometry, sex, or biochemistry.

ENDF = energy- and nutrient-dense formula; ESF = energy-supplemented standard infant formula; PE = % energy from protein; FTT = failure to thrive; GI = gastrointestinal 1. Clarke, et al. J Hum Nutr Diet. 2007;20:329-39.

ENDF GROUP HAD HIGHER NUTRIENT INTAKE & BETTER PROTEIN STATUS DESPITE CONSUMING SIMILAR VOLUME AND ENERGY

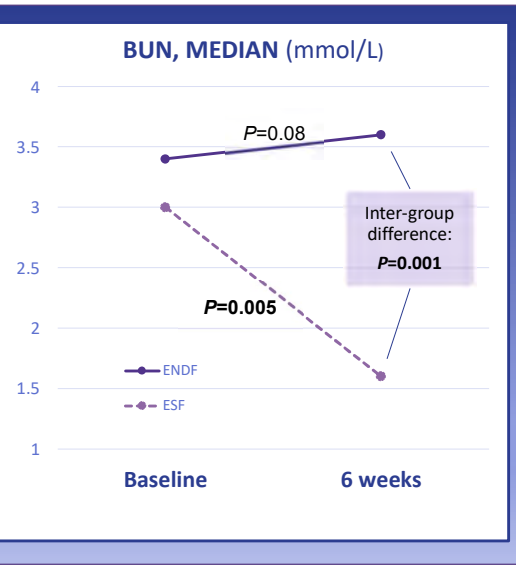
Outcomes & Results: Nutritional Status

Methods: Intake/tolerance records and hematological assessment

Results	ENDF	ESF	P-Value
Volume intake mL/kg/d, median, range	**140** (103-175)	**143** (97-199)	NS
Protein intake g/kg/d, median	**3.7**	**2.0**	**P<0.0001**
Sodium, potassium, calcium, zinc, iron, vitamins D, C, and A intake	**ENDF group 14-42% higher than ESF**		**P≤0.0001**

42% higher protein intake in ENDF group

No infants in the ENDF group had BUN outside of normal limits



BUN = blood urea nitrogen; ENDF = energy- and nutrient-dense formula ESF = energy-supplemented formula. Clarke, et al. J Hum Nutr Diet. 2007;20:329-39.

IN SUMMARY

Infants with NI have multiple nutritional challenges:

- Micronutrient deficiencies
- Volume restrictions
- Bone mineral density loss
- GI complications
- Muscle wasting
- Multiple surgeries throughout one's lifetime

Assessment:

- Regular assessments
- DRI's for the typically developing child
- Anthropometrics are not enough
- Monitor micronutrients
- Supplement as needed

Energy and Nutrient Dense Formulas:

- Used in 30 countries for 20+ years
- High calorie + High Protein
- Dense in micronutrients
- Promotes a positive nitrogen balance
- Well tolerated

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