

## Care of the Extremely Low Birth Weight Infant

Mindy Morris, DNP, NNP-BC, CNS  
Extremely Low Birth Weight Program  
Coordinator

## Outline

- ELBW Data/Outcomes
- Delivery Room Considerations
- Nutrition
- Respiratory
- Neuroprotective Care

## Objectives

- Describe two evidence-based practices that your NICU provides ELBW infants; and two that you could provide
- Describe one nutritional interventional that can prevent growth restriction in ELBW infants
- List three neuroprotective practices that you or your NICU can implement in the care you provide to ELBW infants

## Demographics

- In the US each year 450,000-500,000 Preterm Births
  - <28 weeks 0.73%
  - Complications from prematurity is the number one cause of death in children < 5 years of age
- Major risk factors for preterm births:
  - multiple births
  - history of preterm delivery, stress, infection
  - smoking & illicit drug use
  - extremes in maternal age

March of Dimes, [www.marchofdimes.com](http://www.marchofdimes.com); CDC, [www.cdc.gov](http://www.cdc.gov); WHO, [www.who.int](http://www.who.int)

## Disclosures

- No conflicts of interest or disclosures

## ELBW Data

GA	Survival	GA	Survival	w/o morbidity
22	5%	22	6%	0%
23	26%	23	26%	8%
24	56%	24	55%	9%
25	76%	25	72%	20%
		26	84%	34%
		27	88%	44%

NICHD Neonatal Network 1998-2003 (N = 4446, 19 centers) Tyson et al. *NEJM* April, 2008

Stoll et al 2010, *Pediatrics*, NICHD Report 2003-2007

### ELBW Risk of Impairment

Gargus, et al., <i>Pediatrics</i> , 2009	n = 5250 at 18-22 months
Unimpaired	16%
Mild Impairment	22%
Moderate/Severe Impairment	22%
Died	40%

### Prenatal Consultation

- Standardize approach
- Current outcomes of ELBW nationally and at your center
- Family expectations and support for their decision



### Care of the ELBW

- *Regionalized care* reduces mortality  
Phibbs, et al *NEJM*, 2007
- Specialized care of this unique population using *EBP* improves outcomes  
Geary, et al *Pediatrics*, 2008
- Implementation of practice guidelines with staff education in a *dedicated group* can impact major morbidities (ROP)  
Chow, et al *Pediatrics*, 2003



### Creation of an ELBW Program

- A specially trained team dedicated to the care of ELBW infants
- A uniform way of management based on latest evidence
- A developmentally appropriate location



## Delivery Room Management

- Transition to extra uterine environment
- Goal - resuscitation without injury
- Checklist
- Teamwork
- Respiratory
  - CPAP
  - Ventilation
- Basic Care



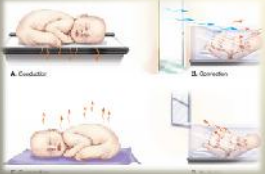
CPQCC, [www.cpqcc.org](http://www.cpqcc.org); Finer & Rich, 2004 *Current Opinion in Pediatrics*

## Importance of Early Nutrition

- Prevent postnatal growth restriction – begins at birth
- Extrauterine growth restriction (EUGR) in NICU premature infants is estimated at 90% Martin CR, et al. *Pediatrics*, 2009; Carlson & Ziegler, 1998; Ehrenkrantz 2000; Ehrenkrantz et al., 1999; Embleton et al., 2001; Radmacher et al., 2003; Clark et al., 2003
- 30-40% are still growth restricted at 18-22 months Bloom et al., 2003; Clark et al., 2003
- AAP: growth should approximate of the normal fetus Kleinman 2009, AAP



## Thermoregulation



## Nutrition Goals – Prevent Postnatal Growth Restriction

- Inadequate nutrition appears to be the predominant cause of growth failure Ziegler et al, 2007
- Inadequate nutrition has significant consequences on Neuro-developmental outcomes Morley, 1999; Ziegler et al, 2007; Neubauer et al, 2008; Bolduc & Shevell, 2005; Cooke & Foulider-Hughes, 2003; Cooke, 2006; Gale et al, 2006; Ehrenkrantz, et al, 2006

## Thermoregulation

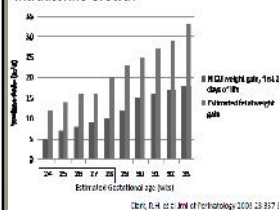
### NRP recommendations

- Increase delivery room temperature 77-80 F
- Preheat radiant warmer
- Polyethylene bag without first drying the skin
- Keep side walls up & heated humidified isolette
- Portable warming pads, hats
- Warm fluids
- Shorten time for admit

AAP/AHA Neonatal Resuscitation 5<sup>th</sup> ed 2006; Vohra, 1999; Bjorkland, 2000; Epicure Study Group, 2000; Vohra, 2004; Lyon, 2004; Knobel, 2005

## EUGR

### Extrauterine Growth vs. Intrauterine Growth



### Poor Neurodevelopmental Outcomes

Outcomes at 18 to 22 Months Corrected Age According to Weight Gain Quartile

Outcome	Quartile 1 N=124	Quartile 2 N=127	Quartile 3 N=125	Quartile 4 N=121	P value
Weight gain (kg/m <sup>2</sup> )	13.2	15.6	17.8	21.2	
CPN	21	13	13	6	<.01
MDI <70, %	39	37	34	21	<.01
PSD <75, %	39	32	18	14	<.01
MDI, %	55	40	41	21	<.01
Behavioral issues	63	50	50	43	<.01

Ehrenkrantz, R.A. et al *Pediatrics* 2009 127:1259-1265

### Poor Neurodevelopmental Outcomes

Outcomes at 18 to 22 Months Corrected Age According to Head Circumference Quartile

Outcome	Quartile 1 N=124	Quartile 2 N=127	Quartile 3 N=125	Quartile 4 N=121	P value
Size of HC growth cm/week	0.67	0.67	0.66	1.17	
CPN	35	13	13	5	<.01
MDI <70, %	36	41	28	22	<.01
PSD <75, %	46	29	13	17	<.01
MDI, %	62	51	38	28	<.01
HO-Abnormality, %	38	18	20	16	<.01

Ehrenkrantz, R.A. et al *Pediatrics* 2005 117:1229-1241

### Avoiding Metabolic Shock

- ELBW infant is immediately catabolic
- No fetal accrual of fat/protein stores
- High caloric and protein needs
- Resting metabolic rate requires 50-60kcal/kg/day

### Enteral Nutrition



- Breast Milk
- Use of Standardized Feeding Guidelines
  - Reduced risk of NEC
  - Less Variability
  - Achieves full feeding volumes earlier

CPQCC/CAN; Kamitsuka 2000 Peter, et al, 2002; Ziegler, 2002; Kuzman-O'Reilly, 2003; Berseth; Patole 2005 Yu, et al, 2005; Street 2006

### Parenteral Nutrition



- Glucose
  - Should be infusing by 1 hour of life
- Protein
  - Needed for growth and prevention of poor neurodevelopmental outcomes Ehrenkranz 2007; Valentine et al 2009
- Intralipid
  - Prevention of EFA deficiency
  - Myelination

CPQCC/CAN

### Colostrum/Enteral Feeds

- First feeds
- Oropharyngeal Swabs
- Parental Involvement



### Trophic Feeds – What's the Evidence

- Improves feeding tolerance
- Stimulates gut motility and maturity
- Shortens time to full feeds
- Decreases LOS
- Does not increase risk of NEC



CPQCC/CAN; McClure, 2000; Peter, et al, 2002; Ziegler, 2002; Kuzman O'Reilly, 2003; Berseth; Yu, et al, 2005; Tyson & Kennedy Cochrane Review 2005


### Bronchopulmonary Dysplasia

- Complex disorder
- Oxygen requirement at 36 weeks CGA
- Inflammatory cascade
- Costly disease



## NCPAP vs. MV

Support trial: NEJM 2010			
	Early CPAP	Intubation & Surfactant	P value
N	663	663	
GA	28.2 ± 1.1	28.2 ± 1.1	
Death	14.2%	17.5%	0.09
BPD	48.7%	54.1%	0.07
MV (med)	10 days	13 days	0.03
Survival without MV at 7 d	55.3%	48.8%	0.01
Air leaks	6.8%	7.4%	0.56
Steroids for BPD	7.2%	13.2%	<0.01



\*Recent, large trials reflecting current practice (antenatal steroids & routine stabilization on CPAP) demonstrate less risk of CLD or death with early stabilization on CPAP with selective surfactant administration to infants requiring intubation!

Rojas-Rojas et al. Cochrane Database 2012

## NCPAP Tips

- Standardize Practice
  - Choose one modality
  - Choose a strategy
- Position prone when possible
- Appropriate size & position of nasal prongs/mask
- CPAP 5-7 cm H2O, humidified
- Optimize delivery
- Suction prn
- Comfort measures

## CPAP

CPAP


- Increases Functional Residual Capacity
- Improves static lung compliance
- Reduces airway resistance
- Improves V/Q matching
- Decreases BPD

## Apneas, Bradys & Desats

- The ELBW has poor control of breathing
- Character of A/B/Ds episodes
- Therapeutic strategies for apnea have changed little
  - The standard therapy remains NCPAP and methylxanthines (caffeine)


## Complications of NCPAP

- Pneumothorax
- Nasal obstruction - mechanical
- Abdominal distention: Orogastric tube to gravity
- Nasal septal injury - Skin barriers
  - Air cushion
  - Alternating interfaces?



Squires, et al Neonatal Network, 2009

## Methylxanthine (Caffeine) Therapy



- Reduces frequency of apnea of prematurity and the need for mechanical ventilation
- Decreases failed extubation attempts
- Reduces the rate of BPD & death in VLBW

Henderson-Smart, 2003; Schmidt et al. NEJM 2006

### Methylxanthine (Caffeine) Therapy

**TREATMENT**

NEW ENGLAND JOURNAL OF MEDICINE

Long-Term Effects of Caffeine Therapy for Premature Infants

**Caffeine (CAP study):**

Incidence of Cerebral Palsy

Treatment	Incidence (%)
Placebo	2.8%
Caffeine	0.7%

**TREATMENT**

Caffeine (CAP study):

Died or survived with a neurodevelopmental disability

Treatment	Percentage (%)
Placebo	43.2%
Caffeine	40.2%

**Caffeine (CAP study):**

Incidence of Cognitive Delay

Treatment	Incidence (%)
Placebo	34.2%
Caffeine	23.4%

### Site of Bleeding – Germinal Matrix

- Subependymal germinal matrix
  - Site of neuronal & glial precursors in the developing brain
- Characteristics
  - Highly vascularized
  - Thin walled capillary beds
  - Poorly regulated blood flow (autoregulation)

Fig. 6. Schematic diagram of cerebral hemisphere with rostral ventral sulci. The germinal matrix is the rostral-most part of the ventral sulci. Note the normal axis in the subependymal germinal matrix.

Volpe, 1989

### Neuroprotection for the ELBW

- IVH
- Neurodevelopment
- Neuroprotection

### Pathogenesis of IVH

**Vascular Factors**

- Remodeling capillary bed
- No collagen/muscle support
- Vulnerability to hypoxic-ischemic insult

**Extravascular factors**

- Gelatinous, friable structure with no mesenchymal support
- Genetics

**Intravascular factors**

- Fluctuating cerebral blood flow (CBF)
- Increased CBF: HTN, rapid volume expansion (rapid flush thru UAC), hypercarbia, anatomy (U-shaped venous system)
- Decreased CBF: hypotension followed by rapid volume expansion, rapid withdrawal from UAC

### Neurologic - IVH

- Incidence
  - ~20% of neonates < 1500 g
  - 20-25% of ELBW
- Timing
  - 25% first 12 hours
  - 50% first 24 hours
  - 90% first 72 hours
- Pathogenesis
  - Fragile germinal matrix
  - Auto Regulation

Volpe, et al., *Neurology of the Newborn*, 2008  
 McCrea et al., *Clinics in Perinatology*, 2008

### NICU Factors Associated with IVH

- High CPAP
- Rapid fluid administration
- Rapid change in BP
- Hypotension
- Hypo/Hypercarbia
- Pneumothorax
- Asphyxia
- Hypernatremia
- Hypothermia

- Thrombocytopenia
- PDA
- Seizure
- Routine Cares
  - Suctioning
  - Excessive handling
  - Noxious, painful stimulation/stress

Malusky & Donze, *Neonatal Network*, 2011

### Potentially Better Practices to Reduce Brain Injury

- Antenatal steroids & delivery room management
- Early Management by Neonatologist/NNP
- Neutral Head Position
- Minimize Pain & Stress
- Thermoregulation
- Limit Harmful Medications
- Respiratory Management
- Indomethacin Prophylaxis

McLendon et al. *Pediatrics* 2003;  
Carteaux, et al. *Pediatrics* 2003

### Fetal Brain Development

23 weeks gestation  
30-32 weeks gestation  
40 weeks gestation

### Neuroprotection Bundle

- Head midline/neutral – +/- HOB elevated
- Thermoregulation
- Minimizing pain/stress
- Limit Harmful Medications

Venous Anatomy

Malusky & Donze, *Neonatal Network*, 2011  
McLendon et al. *Pediatrics* 2003

### Focus on Sleep

**Sleep Patterns:**

- Develop in utero before 30 weeks
- Fetus sleeps 20 – 22 hrs/day
- REM sleep is essential for development of vision system

**Deprivation leads to:**

- Disordered sensory system
- Decreased learning & memory capabilities
- Smaller adult brain
- Irritability

**Caregivers should:**

- Promote & Protect Sleep Cycles
- Never wake a baby in REM sleep

### Focus on Neuroprotective Care

- ELGAN Study
  - 6% of those with “normal” CUS diagnosed with CP
  - 38% with CP had “normal” CUS
- EPIPAGE Study
  - 4% of those with “normal” CUS diagnosed with CP
  - 1/3 with CP had “normal” CUS

Kuban et al *Pediatr Radiol*, 2007  
Kuban et al *J Child Neurology*, 2009  
Ancel et al *Pediatrics*, 2006  
Marret et al *PLoS One* 2013

### Focus on Hearing

**Development:**

- Fetal hearing begins at 24 weeks, processing at 30 weeks
- In utero, low intensity sounds only

**Early & high exposure leads to:**

- Decreased auditory processing, language delays, & growth
- Light too soon impacts hearing/auditory processing

**Caregivers should:**

- Speak at low levels & keep ambient noise to  $\leq 50$  dB
- Cover incubators as an additional buffer
- Protect vision
- Important for some low level voices & language exposure while in the NICU

Pineda et al, 2014; Caskey et al, 2012; Caskey et al, 2010; Jardri et al, 2012; Moon et al, 2013

## Focus on Vision



### Development:

- The last sensory system to develop & mature

### Early exposure leads to:

- Interference with auditory discrimination pathways *Graven et al, 2004*
- Problems with peripheral vision, motor coordination, wandering eyes, disconjugate gaze, & visual processing disorders

### Caregivers should:

- Protect sleep cycles, especially REM
- Protect eyes from direct & bright lights throughout hospitalization
- Focus on faces, but no visually engaging toys until 38+ weeks
- Consider cycled lighting protocol *Graven, et al, 2011; Guyer et al, 2012; Morag & Ohlsson, 2013; White et al, 2013*

## Standardizing ELBW Care

- Team
- Focus on the little things
- Tools: Guidelines/checklists
- Partner with the family in providing care



## Focus on the Family

- Building bonds
- Maternal & paternal instinct
- Constant in the baby's life
- Long-term outcomes
- Quality & safety

## Skin to Skin

- Improved oxygenation
- Stabilization of vital signs
- Increased weight gain
- Regulation of sleep cycle
- Better self regulation & organization
- Improved brain maturation, connectivity, & complexity
- Promotes parent-infant attachment
- Increases mother milk production
- Increased duration of breastfeeding

Scher, et al. 2009, *J Clinical Neurophysiology*;  
Kaffashi, et al. 2013 *J Clinical Neurophysiology*