The Late Preterm Birth Infant

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Moderately Preterm Infants: “Underprivileged Newborns” [32-36 weeks]

Amiel-Tison et al, 2002
Age Terminology During the Perinatal Period
## Antepartum Gestational Age Assessment

<table>
<thead>
<tr>
<th></th>
<th>Accuracy</th>
<th>Comment</th>
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</thead>
<tbody>
<tr>
<td><strong>Clinical</strong></td>
<td></td>
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</tr>
<tr>
<td>Last menstrual period</td>
<td>± 2 wks</td>
<td>Depends on cycle length and recall</td>
</tr>
<tr>
<td>Uterine size-1st trimester</td>
<td>± 2 wks</td>
<td>Depends on operator skill</td>
</tr>
<tr>
<td>Fetal heart tones-auscultation</td>
<td>± 2 wks</td>
<td>~ 20 wks (fetoscopy) 12 wks (doppler scope)</td>
</tr>
<tr>
<td>Fundal height measurement</td>
<td>± 3 wks</td>
<td>Varies with maternal body habitus</td>
</tr>
<tr>
<td><strong>Sonography</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestational sac diameter</td>
<td>± 5 days</td>
<td>Variable shape affects measurement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Performed 4.5–5.5 wks</td>
</tr>
<tr>
<td>Embryonic crown–rump length</td>
<td>± 3 days</td>
<td>Performed 5–12 wks</td>
</tr>
<tr>
<td>Biparietal diameter</td>
<td>± 10 days</td>
<td>Performed 15–22 wks</td>
</tr>
<tr>
<td>Femur length, cerebellar transverse diameter</td>
<td>± 14 days</td>
<td>Performed &gt; 22 wks</td>
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</table>
Postnatal Gestational Age Determination

<table>
<thead>
<tr>
<th>Variability: ± 2 weeks if ≥ 28 weeks’ gestation</th>
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<tr>
<td>± 3 weeks if &lt; 28 weeks’ gestation</td>
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</tbody>
</table>
Definition of Late Preterm Infant

- Defined as preterm birth between the end of the last day of the 34th week of gestation (34 0/7 or beginning of the 239th day since the first day of the mother’s last normal menstrual period) through and including the 36 6/7th completed week of gestation (end of the 259th day since the first day of the mother’s last normal menstrual period).

Impact to Infant Health from Rising Late Preterm Birth

- Higher Neonatal and Infant mortality:
  - U.S. neonatal deaths/1000 live births (2002)
    - 34-36 weeks = 4.1
    - 37-41 weeks = 0.9
  - U.S. infant deaths/1000 live births (2002)
    - 34-36 weeks = 7.7
    - 37-41 weeks = 2.5
University of Colorado Classification of Newborns by Birth Weight and Gestational Age
Background

• U.S. PTB has increased more than 30%
  • ~3/4 of all singleton preterm infants (34-36 weeks)
  • 7.5% of all U.S. births (2003)

• Factors associated with PTB increasing
  • Multiples
  • C-sections
  • Inductions

• Recent studies: 34-36 weeks increased risk for certain morbidities
  • Often go to the “normal nursery”
Percentage of all births classified as preterm in the USA, 1981–2004
Preterm Birth Rates by State
United States, 2003

U.S. Total = 12.3%

Percent of Live Births
- Over 13.0  (16)
- 11.6 to 13.0 (18)
- Under 11.6  (17)

Note: Value in ( ) = number of states (includes District of Columbia). Value ranges are based on equal counts.
Economic Consequences of Preterm Birth

- Hospital charges for premature infants\(^1\) totaled $18.1 billion in 2003.

- Premature infants accounted for half of the hospital charges for all infants ($36.7 billion).

- The average charge for the most severe stays\(^2\) was $77,000 compared to $1,700 for an uncomplicated newborn stay.

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\(^1\)Includes any diagnosis of prematurity/low birthweight
\(^2\)Defined as having a principal diagnosis of prematurity

Epidemiology of Preterm Birth

- Obstetric precursors leading to preterm birth
  - Delivery for maternal or fetal indications
    - Labor is either induced or the infant is delivered by prelabor caesarean section
  - Spontaneous preterm labor with intact membranes
  - Preterm premature rupture of the membranes irrespective of whether delivery is vaginal or by caesarean section

- Racial/ethnic differences
  - Spontaneous preterm birth is most commonly caused by preterm labor in white women, but by PPROM in black women.

- Gestational age
  - 5% of preterm births occur at less than 28 weeks' (extreme prematurity)
  - 15% at 28–31 weeks' (severe prematurity)
  - 20% at 32–33 weeks' (moderate prematurity)
US Near Term Singleton Births

75% of all PTs!

Source: NCHS, final natality data
Prepared by March of Dimes Perinatal Data Center, April 2006.
US Near Term live births are on the rise: % Change 1992-2002

United States Live Births  MOD: Davidoff 2005
Race/ Ethnicity Comparison:
Singleton Live Births and Preterm Births, U.S., 2002

Live Births
- Other: 14%
- Black: 22%
- White: 57%
- Hispanic: 22%

Preterm Births
- Other: 22%
- Black: 22%
- White: 50%
- Hispanic: 22%
Singleton Preterm Birth Rates by Race/Ethnicity, 1992 and 2002

Source: National Center for Health Statistics
Prepared by the March of Dimes Perinatal Data Center, November 2005.
Cesarean deliveries are on the rise in the US & elsewhere!

Rate per 100

Year

1989 1991 1993 1995 1997 1999 2001 2003 2004†

Total cesarean

Primary cesarean

VBAC†

29.1%
CS and Labor Induction Rates
United States, 1992 and 2002

Source: NCHS, final natality data
Prepared by March of Dimes Perinatal Data Center, April 2006.
Caesarean-delivery Rates According to Gestational Age

Caesarean Section for Preterm Neonates According to Weight Percentile Group

Change in rates relative to 1989 of Singleton Preterm Births
NICU Admissions Among Term & Near Term Infants

Estimated Gestational Age (wks)

Clark R et al. 2005
Morbidities of the Near-term Infant

At one tertiary medical center -

34 week babies represented:

- 1.6% of deliveries
- 7% of NICU admissions
- 19% of NICU bed-days

Morbidities Associated with Late Preterm Birth

- Increased immediate problems:
  - Respiratory distress
  - Jaundice
  - Feeding difficulties
  - Hypoglycemia
  - Temperature instability
  - Sepsis

- Increased NICU use (and re-admissions)

- Increased cost

- Long term outcome - ?? - NO DATA!
# Morbidities in Late Preterm Infants According to Gestational Age

<table>
<thead>
<tr>
<th>Gestational age (weeks)</th>
<th>34 - 34.6 (A) n=123</th>
<th>35 - 35.6 (B) n=122</th>
<th>36 - 36.6 (C) n=221</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory distress</td>
<td>32 (26%)</td>
<td>20 (16.4%)</td>
<td>11 (5%)</td>
<td>0.04*</td>
</tr>
<tr>
<td>Hyperbilirubinemia</td>
<td>83 (67.5%)</td>
<td>57 (46.7%)</td>
<td>64 (29%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Feeding difficulties</td>
<td>55 (44.7%)</td>
<td>19 (15.6%)</td>
<td>10 (4.5%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>25 (20.3%)</td>
<td>14 (11.5%)</td>
<td>29 (13.1%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Average hospital stay (in hours)</td>
<td>262</td>
<td>147</td>
<td>98</td>
<td>A v/s B*, A v/s C*</td>
</tr>
</tbody>
</table>

* Statistically significant

Jain, PAS 2008
Respiratory Issues

- TTN – lack of clearance of fetal lung fluid
  - Absence of labor, absence of catecholamine surge associated with labor.

- RDS – surfactant deficiency
  - Mature surfactant system but delayed release from lamellar bodies

- Persistent pulmonary hypertension

- Pneumonia

- Many respiratory diseases in the late-preterm infant are poorly defined
Do ECS deliveries contribute to HRF in Near-Term Births?

![Near term C/S chart]

- Emergency
- Elective CS

Years: 1985 to 2003
Neonatal Morbidity in ECS

- Nearly 50% of all near term infants are delivered by CS
- Up to 30% infants develop respiratory distress
- Problems with FLF clearance
- Higher rates in fetuses never exposed to labor
Neonatal Transition in the Near Term Infant

- Ability to clear FLF peaks at term gestation
- Surfactant maturity is not an all or none phenomenon
- Changes in pulmonary vasculature
- Developmentally regulated proteins (ENaC)
Fetal Lung Fluid Dynamics

Bland RD, 79.
Fetal Lung Fluid Clearance

Epithelial Sodium Channels Diversity: Mixing and Matching Subunits

Unassembled ENaC Subunits in Membrane

Hypoxia, Steroid Depletion, or impermeable matrix

Normoxia, Steroid Repletion, and permeable matrix

\[ \text{FETAL} \quad \alpha - ENaC \text{ Only} \]

\[ \text{HSC Channel:} \quad \alpha, \beta, \gamma - ENaC \]

Term Gestation & Labor

Jain et al. 06
ENaC Subunit Expression and GA in Airway Epithelium 1 to 5 hours After Birth

Correlation between ENaC subunit expression and gestational age in airway epithelium in newborn infants 1 to 5 hours after birth. A, α-ENaC; B, β-ENaC; C, γENaC. CK18 indicates cytokeratin 18;

Helve, O. et al. Pediatrics 2007;120:1311-1316
Respiratory Distress Syndrome

- **Insufficient surfactant**
  - Collapsed alveoli
  - Inadequate oxygen exchange

- **Sufficient surfactant**
  - Expanded alveoli
  - Adequate oxygen exchange
Frequency of RDS, Sepsis and Apnea in Late Preterm Infants

Surfactant Therapy for RDS

- Markedly reduced the mortality rate of premature infants
- Standard care for management of premature infants

Presurfactant  Postsurfactant
Respiratory Interventions by Gestational Age/Location Prior to NICU

Bailey, PAS 2008
Near term Infant Management

- High oxygen oxhhoods are not benign
- Absorption atelectasis & Oxygen toxicity
- Pulmonary hypertension develops quickly and is self propagated
High Oxygen Atelectasis

- Alveolar collapse due to oxygen absorption and denitrogenation ("Nitrogen washout")
- 2X greater atelectasis in 100% VS 30% group (Rothen, ‘95)
- High FiO2 for 10 minutes before extubation increases post-operative atelectasis (Benoit, ‘02)
- Prevented by PEEP/CPAP (Sirafini, ‘99)
High Oxygen Atelectasis
Lung Function in Healthy Late Preterm Infants

Venigalla, PAS 2008
Pulmonary Hypertension is Common in Near Term Infants
HRF and PPHN in Near term Infants
A Case for Early iNO?
HRF in Near Term Infants: ECMO
# Near-Term ECMO Demographics

<table>
<thead>
<tr>
<th>1989-2005</th>
<th>Near Term (N=2258)</th>
<th>Term (N=13,332)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Weight (kg)</td>
<td><strong>2.80 ± 0.51</strong></td>
<td><strong>3.42 ± 0.56</strong></td>
</tr>
<tr>
<td>Gestation (wks)</td>
<td><strong>35.3 ± 0.9</strong></td>
<td><strong>39.7 ± 1.5</strong></td>
</tr>
<tr>
<td>Male</td>
<td>66%</td>
<td>57%</td>
</tr>
<tr>
<td>Median Apgar 1</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Median Apgar 5</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

*Dudell & Jain 2006*
Near-Term ECMOs: Primary Diagnosis
Near-Term ECMO Course

<table>
<thead>
<tr>
<th></th>
<th>Near Term (N=2258)</th>
<th>Term (N=13,332)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age on ECMO (d)</td>
<td>2.7 ± 3.6</td>
<td>2.3 ± 2.9</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Hours on ECMO</td>
<td>146 ± 104</td>
<td>136 ± 86</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Discontinuation or Death on ECMO</td>
<td>28.2%</td>
<td>15.5%</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
# Complication Rates in Near Term ECMO

<table>
<thead>
<tr>
<th>Neurologic</th>
<th>Near Term</th>
<th>Term</th>
<th>RR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurologic</td>
<td>12.4%</td>
<td>8.2%</td>
<td>1.51</td>
<td>1.40-1.63</td>
</tr>
<tr>
<td>IVH</td>
<td>4.4%</td>
<td>1.9%</td>
<td>2.33</td>
<td>2.02-2.69</td>
</tr>
<tr>
<td>Other</td>
<td>8.0%</td>
<td>6.3%</td>
<td>1.27</td>
<td>1.15-1.39</td>
</tr>
<tr>
<td>Hemofilt/Dialysis</td>
<td>7.3%</td>
<td>5.6%</td>
<td>1.31</td>
<td>1.18-1.45</td>
</tr>
</tbody>
</table>
Survival Trends in the Near Term ECMO Patients

Near term survival 74% vs 87% at Term
Hypothermia

- More body surface area / small body mass
- Thinner skin
- Less subcutaneous fat (insulation)
- Less brown fat
- Less flexed posture
- 10% at 35-36 weeks vs. 0% at term
- Assumption is that the late-preterm infant can be cared for in the same way as term
- Risk after birth and the first 24-48 hr of life
Hypoglycemia

- Less glycogen stores
- Delayed glycogenolysis & gluconeogenesis
- May have been delivered for fetal stress, maternal diabetes (to prevent fetal death)
- Greater glucose needs
- Respiratory distress
- Limited feeding
- Most now use a threshold of 50 mg/dL
- Incidence 18% at 35-36 weeks, 4% at term
Gastrointestinal Issues

- Adapt quickly to enteral feedings
- Less mature peristalsis.
- Immature suck, suck swallow reflexes (maturity occurs at 36-38 weeks)
- Feeding behavior: fewer sucks, fewer sucks per burst, lower maximum pressure during sucking
- Delay in successful feeding, breast feeding
- Poor weight gain
- Dehydration
- Poor postnatal growth may affect long-term development
- Necrotizing enterocolitis rate is higher
Newborn Jaundice

- Nearly 60% of infants born in the United States will develop some level of jaundice (or hyperbilirubinemia) within the first two weeks of life.

- If untreated, the build-up of bilirubin in the blood can cause serious and irreversible damage or death (kernicterus).
Near-term Infants: Hyperbilirubinemia

4/11 (36%) of infants in an HMO with serum bilirubin of 30+ were born at 35-36 weeks

Newman, Pediatrics 2003
TcB Levels in the First 96 Hours in the Late Preterm Infant

Guidelines for phototherapy in hospitalized infants

The graph shows the total serum bilirubin levels (in mg/dL and μmol/L) over different ages for infants at various risk levels:

- Infants at lower risk (≥ 38 wk and well)
- Infants at medium risk (≥ 38 wk + risk factors or 35-37 6/7 wk. and well)
- Infants at higher risk (35-37 6/7 wk. + risk factors)
Kernicterus

Kernicterus manifests through syndromes including: vision and hearing impairments, cerebral palsy, dental dysplasia and in some instances mental retardation.

Treatment with Phototherapy or exchange transfusions can prevent severe hyperbilirubinemia and kernicterus.
### “Healthy” Term and Near-term Babies With Kernicterus Readmitted by Age 7 Days

<table>
<thead>
<tr>
<th>Readmission Age (days)</th>
<th>All Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (days)</td>
<td>2.5 to 3</td>
</tr>
<tr>
<td># Total Babies</td>
<td>N = 8</td>
</tr>
<tr>
<td>Median TSB value (mg/dl)</td>
<td>38.5</td>
</tr>
<tr>
<td>Range TSB values (mg/dl)</td>
<td>21.5 – 42.0</td>
</tr>
<tr>
<td>% 35 / 36 GA (weeks)</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

#### Contributory causes of hyperbilirubinemia†

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<thead>
<tr>
<th></th>
<th>2</th>
<th>7</th>
<th>6</th>
<th>2</th>
<th>4</th>
<th>19 (31.5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idiopathic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>G6PD deficiency</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>19 (31.5%)</td>
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<tr>
<th></th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>1</th>
<th></th>
<th>10 (14.7%)</th>
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<tr>
<td>Increased hemolysis* (excl. sepsis and G6PD)</td>
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<tr>
<th></th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>2</th>
<th>1</th>
<th>6 (9.9%)</th>
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<tbody>
<tr>
<td>Extensive Bruising and/or Cephalhematoma</td>
<td></td>
<td></td>
<td></td>
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<td>4 (6.6%)</td>
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<tr>
<th></th>
<th>1</th>
<th>-</th>
<th>1</th>
<th>-</th>
<th></th>
<th>2 (3.2%)</th>
</tr>
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<tbody>
<tr>
<td>Systemic Infection (excl. G6PD deficiency)</td>
<td></td>
<td></td>
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<thead>
<tr>
<th></th>
<th>1</th>
<th>-</th>
<th>1</th>
<th>-</th>
<th></th>
<th>1 (1.6%)</th>
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<tr>
<td>Crigler Najjar syndromes</td>
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<tr>
<td>Galactosemia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Contributory causes of hyperbilirubinemia† include idiopathic, G6PD deficiency, increased hemolysis (excl. sepsis and G6PD), extensive bruising and/or cephalhematoma, systemic infection (excl. G6PD deficiency), Crigler-Najjar syndrome, and galactosemia.
The Late Preterm Human Brain and Risk for Periventricular Leukomalacia

- In USA, ~55,000 infants born with BW<1500g and ~90% survive; ~10% develop CP and ~50% develop cognitive and behavioral deficits
- The common perception is that ‘late preterm’ infants, defined as 34 0/7 to 36 6/7 weeks, are spared substantial birth injury and are neurologically ‘normal’ or ‘almost normal’ in the neonatal period and beyond.
• The brain volume increases at a rate of $\sim 15 \text{ mL} (1.4\%)$ per week between 29 and 41 weeks of gestation.
• At 28 weeks of gestation, the brain is $\sim 13\%$ of term brain volume; by about 34 weeks of gestation, the volume is $\sim 65\%$ of term brain
• More than one-third of brain size increase takes place during the final 6 to 8 weeks of gestation
Development of the Human Cerebral Cortex

The immaturity of the laminar position and dendritic arborization of neurons, as demonstrated by Golgi drawings, in the cerebral cortex in the late preterm infant at 35 gestational weeks is striking in comparison to neurons at midgestation (20 weeks) and at term (40 weeks).

**Brain Structure**

- A five-fold increase in white matter volume occurs between 35 and 41 weeks of gestation.
- Structural maturation during late preterm gestations include, increasing in neuronal connectivity, dendritic arborization and connectivity; increasing in synaptic junctions; and maturation neurochemical and enzymatic processes augmenting growth and maturation of the brain.
Relative Risks and Attributable Fractions for CP by Birth Weight/Gestational Age

<table>
<thead>
<tr>
<th>Birth weight (grams) and Gestational age (weeks)</th>
<th>Terms commonly used to refer to this group</th>
<th>Relative risk for CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. &lt;1501; any gestational age</td>
<td>very low birth weight</td>
<td>24.4</td>
</tr>
<tr>
<td>2. 1501-2500; ≤36 weeks</td>
<td>low birth weight and appropriate-for-gestational age; i.e., pre-term</td>
<td>6.2</td>
</tr>
<tr>
<td>3. 1501-2500; 37 weeks</td>
<td>low birth weight and small-for-gestational age; full term</td>
<td>1.8</td>
</tr>
<tr>
<td>4. 2500; ≤36 weeks</td>
<td>large-for-gestational age: pre-term</td>
<td>1.4</td>
</tr>
<tr>
<td>5. 2500; ≥37 weeks</td>
<td>normal and high birth weight; full term</td>
<td>1.0</td>
</tr>
</tbody>
</table>


Mechanisms of Brain Injury in Late the Preterm Infant

- Does prematurity alter normal ‘fetal development’?
  - Injury model – cell loss, fibrosis (fetal insults, IVH, nutritional deficiencies)
  - Altered developmental program (prematurity alters timing and regulation of developmental processes)

- Do care strategies modulate development?

- Does accelerated maturation alter the subsequent developmental potential?
Common Events in the Care of the Preterm Infant that Might Adversely Affect the Adult

- Endocrine adaptations to preterm birth

![Graph showing plasma cortisol levels with different lines for normal term birth and preterm birth at 36 weeks gestation]

- Fetal and/or postnatal growth failure
- Hyperalimentation solutions
Length of Hospital Stay: Full term vs. Near term

Near Term Births:
Excess Hospital Costs by Week of Gestation
Compared to Costs at 38 Weeks

<table>
<thead>
<tr>
<th>Delivery group</th>
<th>Gestational age (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34</td>
</tr>
<tr>
<td>All deliveries</td>
<td></td>
</tr>
<tr>
<td>Number of cases</td>
<td>5788</td>
</tr>
<tr>
<td>Difference in mean cost ($1000)</td>
<td>6.01</td>
</tr>
<tr>
<td>Total excess cost ($1000)</td>
<td>34,784</td>
</tr>
<tr>
<td>Deliveries without induction or cesarean</td>
<td></td>
</tr>
<tr>
<td>Number of cases</td>
<td>3892</td>
</tr>
<tr>
<td>Difference in mean cost ($1000)</td>
<td>4.26</td>
</tr>
<tr>
<td>Total excess cost ($1000)</td>
<td>16,570</td>
</tr>
</tbody>
</table>
Rehospitalization in NICU Survivors
Reading, Spelling, and Arithmetic Difficulties in Late Preterm Infants

Adjusted for gender, breastfeeding, and parental educational level

Kirkegaard, Pediatrics 2006;118:1600-6
Rate of Therapy Use in Late and Very Preterm Infants

First-year Medical Costs Among Late-preterm and Term Infants

Near term Infant Management

☐ Community hospitals are important!
  ■ 3024 community hospitals in US deliver babies
  ■ 241 academic medical centers with deliveries*

☐ Less rigorous dating and timing of delivery

☐ Often cared for by pediatricians in term nurseries; more prone to clinical problems related to delayed transition

☐ Transitional care requires higher level of monitoring and support
# Variations in Neonatal Characteristics and Perinatal Management in California and Massachusetts Hospitals for Infants 33-35 Weeks Gestation

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>G</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Birth Weight</td>
<td>2119.4 (324.6)</td>
<td>2196.9 (366.8)</td>
<td>2160.9 (392.6)</td>
<td>2215.4 (421.8)</td>
<td>2063.7 (444.2)</td>
<td>2015.0 (374.3)</td>
<td>2148.9 (352.2)</td>
<td>2058.8 (398.2)</td>
<td>2190.5 (394.6)</td>
<td>1959.3 (378.5)</td>
</tr>
<tr>
<td>Mean SNAP-IIPE-II Scores</td>
<td>4.0 (5.7)</td>
<td>4.1 (5.6)</td>
<td>4.0 (6.8)</td>
<td>5.6 (7.2)</td>
<td>3.4 (5.0)</td>
<td>4.4 (6.0)</td>
<td>2.0 (3.3)</td>
<td>3.0 (4.4)</td>
<td>4.9 (6.1)</td>
<td>5.6 (6.9)</td>
</tr>
<tr>
<td>% with SNAP-II-II ≥20</td>
<td>1.7</td>
<td>0</td>
<td>5.1</td>
<td>4.2</td>
<td>0</td>
<td>5.4</td>
<td>0</td>
<td>0</td>
<td>3.8</td>
<td>4.4</td>
</tr>
<tr>
<td>% Small for Gestational Age (&lt;5th percentile)</td>
<td>6.7</td>
<td>1.6</td>
<td>7.9</td>
<td>2.7</td>
<td>10.0</td>
<td>10.7</td>
<td>6.5</td>
<td>11.1</td>
<td>5.7</td>
<td>13.3</td>
</tr>
<tr>
<td>% Antenatal Steroids</td>
<td>53.3</td>
<td>53.1</td>
<td>50.8</td>
<td>67.1</td>
<td>55</td>
<td>50.9</td>
<td>65.2</td>
<td>63.9</td>
<td>52.8</td>
<td>52.3</td>
</tr>
<tr>
<td>% C-Section Delivery</td>
<td>38.3</td>
<td>70.3</td>
<td>57.1</td>
<td>50.7</td>
<td>50.0</td>
<td>58.9</td>
<td>37.0</td>
<td>50.0</td>
<td>56.6</td>
<td>55.6</td>
</tr>
</tbody>
</table>

McCormick, Sem Perinatol, 2006;30:44-7
Variations in Neonatal Management in California and Massachusetts Hospitals for Infants 33-35 Weeks Gestation

<table>
<thead>
<tr>
<th>Neonatal Management Variables</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>G</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Any Respiratory Support</td>
<td>30.0</td>
<td>35.9</td>
<td>46.0</td>
<td>43.8</td>
<td>52.5</td>
<td>33.9</td>
<td>15.2</td>
<td>33.3</td>
<td>52.8</td>
<td>28.9</td>
</tr>
<tr>
<td>% Mechanical Ventilation</td>
<td>28.3</td>
<td>29.7</td>
<td>33.3</td>
<td>24.7</td>
<td>30.0</td>
<td>30.4</td>
<td>8.7</td>
<td>30.6</td>
<td>43.4</td>
<td>15.6</td>
</tr>
<tr>
<td>% Hyperalimentation</td>
<td>10.0</td>
<td>4.7</td>
<td>25.4</td>
<td>13.7</td>
<td>17.5</td>
<td>66.1</td>
<td>6.5</td>
<td>5.6</td>
<td>7.5</td>
<td>15.6</td>
</tr>
<tr>
<td>Mean Weigh Gain (g)/Day (± St. Dev.)</td>
<td>8.8</td>
<td>2.1</td>
<td>13.2</td>
<td>0.8</td>
<td>3.2</td>
<td>12.1</td>
<td>4.0</td>
<td>3.6</td>
<td>-8.1</td>
<td>-4.2</td>
</tr>
<tr>
<td>Mean PMAD (± St. Dev.)</td>
<td>36.4</td>
<td>36.2</td>
<td>36.6</td>
<td>35.8</td>
<td>35.9</td>
<td>36.7</td>
<td>36.0</td>
<td>35.9</td>
<td>35.5</td>
<td>35.6</td>
</tr>
</tbody>
</table>

McCormick, Sem Perinatol, 2006;30:44-7
Variations in Care of the Late Preterm Infant

- Late preterm infants generally represent a low acuity population in NICUs.
- However, substantial differences across different institutions occur in the use of interventions like mechanical ventilation and hyperalimentation.
- These differences have implications not only for outcomes like growth but also length of stay, as well as costs of care.
- Evidence-based practice guidelines for the care of late preterm infants are needed to reduce unnecessary interventions and to improve outcomes.
Near term Infant Summary

- Near term infants: significant contributors to M & M
- Appear mature but more prone to clinical problems related to delayed transition
- Need for further studies in this vulnerable population
Visual Function in Preterm (35 wks) and Term Infants at 40 Hours of Age

A. Spontaneous motility

B. Tracking Horizontal

C. Fixation

D. Tracking Vertical

E. Tracking Arc

F. Tracking coloured stimulus

G. Attention at distance

H. Stripes discrimination

## Incidence of Adverse Neonatal Outcomes According to Completed Week of Gestation at Delivery

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Any adverse outcome or death</strong></td>
<td>128/834 (15.3)</td>
<td>430/3909 (11.0)</td>
<td>524/6512 (8.0)</td>
<td>101/1385 (7.3)</td>
<td>57/505 (11.3)</td>
<td>22/113 (19.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Adverse respiratory outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory distress syndrome</td>
<td>31/833 (3.7)</td>
<td>75/3904 (1.9)</td>
<td>58/6510 (0.9)</td>
<td>13/1381 (0.9)</td>
<td>4/504 (0.8)</td>
<td>2/113 (1.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Transient tachypnea of the newborn</td>
<td>40/833 (4.8)</td>
<td>153/3904 (3.9)</td>
<td>178/6508 (2.7)</td>
<td>34/1381 (2.5)</td>
<td>24/504 (4.8)</td>
<td>7/113 (6.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Respiratory distress syndrome or transient tachypnea of the newborn</td>
<td>68/833 (8.2)</td>
<td>213/3904 (5.5)</td>
<td>221/6510 (3.4)</td>
<td>42/1381 (3.0)</td>
<td>26/504 (5.2)</td>
<td>9/113 (8.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Admission to the NICU</td>
<td>107/833 (12.8)</td>
<td>316/3905 (8.1)</td>
<td>382/6510 (5.9)</td>
<td>66/1381 (4.8)</td>
<td>40/504 (7.9)</td>
<td>16/113 (14.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Newborn sepsis‡</td>
<td>58/833 (7.0)</td>
<td>156/3904 (4.0)</td>
<td>163/6508 (2.5)</td>
<td>37/1381 (2.7)</td>
<td>19/504 (3.8)</td>
<td>12/113 (10.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Proved case</td>
<td>3/833 (0.4)</td>
<td>3/3904 (0.1)</td>
<td>7/6508 (0.1)</td>
<td>2/1381 (0.1)</td>
<td>2/504 (0.4)</td>
<td>0/113</td>
<td>0.260</td>
</tr>
<tr>
<td>Treated hypoglycemia</td>
<td>20/833 (2.4)</td>
<td>35/3904 (0.9)</td>
<td>44/6508 (0.7)</td>
<td>11/1381 (0.8)</td>
<td>8/504 (1.6)</td>
<td>2/113 (1.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CPR or ventilation in 1st 24 hr</td>
<td>16/833 (1.9)</td>
<td>35/3904 (0.9)</td>
<td>27/6509 (0.4)</td>
<td>5/1381 (0.4)</td>
<td>2/504 (0.4)</td>
<td>0/113</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ventilation in 1st 24 hr</td>
<td>16/833 (1.9)</td>
<td>34/3904 (0.9)</td>
<td>27/6509 (0.4)</td>
<td>5/1381 (0.4)</td>
<td>2/504 (0.4)</td>
<td>0/113</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hospitalization ≥5 days</td>
<td>76/831 (9.1)</td>
<td>221/3904 (5.7)</td>
<td>237/6503 (3.6)</td>
<td>56/1381 (4.1)</td>
<td>38/504 (7.5)</td>
<td>13/113 (11.5)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### Odds Ratios for Adverse Neonatal Outcomes According to Completed Week of Gestation at Delivery


<table>
<thead>
<tr>
<th>Outcome</th>
<th>Wk 37</th>
<th>Wk 38</th>
<th>Wk 39</th>
<th>Wk 40</th>
<th>Wk 41</th>
<th>Wk ≥42</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Any adverse outcome or death</strong></td>
<td>2.1 (1.7–2.5)</td>
<td>1.5 (1.3–1.7)</td>
<td>Reference</td>
<td>0.9 (0.7–1.1)</td>
<td>1.4 (1.0–1.8)</td>
<td>2.5 (1.5–4.0)</td>
</tr>
<tr>
<td><strong>Adverse respiratory outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory distress syndrome</td>
<td>4.2 (2.7–6.6)</td>
<td>2.1 (1.5–2.9)</td>
<td>Reference</td>
<td>1.1 (0.6–2.0)</td>
<td>1.0 (0.4–2.8)</td>
<td>2.3 (0.6–9.7)</td>
</tr>
<tr>
<td>Transient tachypnea of the newborn</td>
<td>1.8 (1.2–2.5)</td>
<td>1.5 (1.2–1.9)</td>
<td>Reference</td>
<td>0.9 (0.6–1.3)</td>
<td>1.7 (1.1–2.7)</td>
<td>2.2 (1.0–4.8)</td>
</tr>
<tr>
<td>Respiratory distress syndrome or transient tachypnea of the newborn</td>
<td>2.5 (1.9–3.3)</td>
<td>1.7 (1.4–2.1)</td>
<td>Reference</td>
<td>0.9 (0.6–1.2)</td>
<td>1.5 (1.0–2.4)</td>
<td>2.4 (1.2–4.9)</td>
</tr>
<tr>
<td>Admission to the NICU</td>
<td>2.3 (1.9–3.0)</td>
<td>1.5 (1.3–1.7)</td>
<td>Reference</td>
<td>0.8 (0.6–1.0)</td>
<td>1.3 (0.9–1.9)</td>
<td>2.5 (1.5–4.4)</td>
</tr>
<tr>
<td>Newborn sepsis‡</td>
<td>2.9 (2.1–4.0)</td>
<td>1.7 (1.4–2.2)</td>
<td>Reference</td>
<td>1.0 (0.7–1.5)</td>
<td>1.4 (0.8–2.2)</td>
<td>4.1 (2.2–7.6)</td>
</tr>
<tr>
<td>Treated hypoglycemia</td>
<td>3.3 (1.9–5.7)</td>
<td>1.3 (0.8–2.0)</td>
<td>Reference</td>
<td>1.2 (0.6–2.4)</td>
<td>2.6 (1.2–5.7)</td>
<td>2.8 (0.7–11.7)</td>
</tr>
<tr>
<td>Hospitalization ≥5 days</td>
<td>2.7 (2.0–3.5)</td>
<td>1.8 (1.5–2.2)</td>
<td>Reference</td>
<td>1.0 (0.8–1.4)</td>
<td>1.9 (1.3–2.7)</td>
<td>2.9 (1.6–5.3)</td>
</tr>
</tbody>
</table>
Children with Adverse Early School-age Outcome by Gestational Age