Pat Scheans, DNP, NNP-BC
Clinical Support for Neonatal Care
pscheans@lhs.org

RANDALL CHILDREN'S HOSPITAL
LEGACY EMANUEL

The Case of the Disappearing Newborn

(NICU Transfer Case Studies)

OBJECTIVES:

1. Discuss what the heck happens to a baby when you transfer them to an NICU
2. Describe current therapies for critically ill neonates

"Life is infinitely stranger than anything which the mind of man could invent."

~ Sherlock Holmes

- IDM>PPHN>iNO
- VLBW> surf, cpap, NEC
- NRP> HIE> cooling
- FLK> genetics

The Case of the Super Sick IDM

- 36 2/7 weeks, IDM, male, induction for LGA
- C-section under epidural for FTP, FIL

- Apgar scores 2, 6, 6, 6
  - off for color and tone
- Birth: low tone but breathing
- 10 min: grunting
  - 50% oxygen to keep SaO_2 = 90%
- 20 min: ↑work of breathing -> mask CPAP
  - 80% oxygen to keep SaO_2 = 88%
- 25 min: PO probe changed, moved to left foot
  - SaO_2 = 76%

That CAN'T be right…

http://media.clinicaladvisor.com/

http://image.slidesharecdn.com

http://www.aafp.org/

- Multiple IV attempts due to chubbiness
- Blood sugar 120%
- Ped provider arrives at 30 minutes of life
  - > SaO_2 issue attributed to poor perfusion
  - > CXR — Blood culture; CBC with diff & plts
  - > Labs ordered — Ampicillin 100 mg/kg q 12 h; Gentamicin 4 mg/kg q 24 h over 30 min
  - > Antibiotics ordered
- Call for transport at 1 hour of life

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90 minutes: transport team arrives

- -ETT ->ventilator -> only slight improvement
  - > Pulse ox right hand =86%
  - > Pre and post-ductal differential noted
- UAC and UVC placed
  - > Blood sugar 25% -> $D_{10}W$ started
  - > Ampicillin given; gentamicin started
- Transillumination -> no pneumothorax

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"There is nothing more deceptive than an obvious fact."

~Sherlock Holmes

What could this be?

- Differential diagnosis:
  - > TTN
  - > Asphyxia
  - > Meconium aspiration syndrome (MAS)
  - > Respiratory distress syndrome (RDS)
  - > Pneumonia
  - > Pneumothorax
  - > Obstruction
  - > Congenital heart disease (CHD)

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NICU Course

- Cardiac echo: R to L shunting at ductal and foramen ovale
- iNO for 4 days
- Weaned to CPAP by 5 days
- Breastmilk feeds started day 2 NG; slowly advanced to breastfeeding
- Antibiotics stopped after 48 hours
- Discharged 14 days of life
  - > Breastfeeding with support

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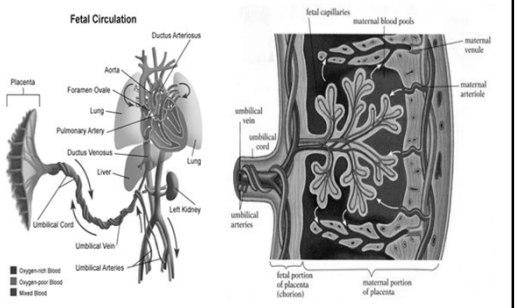
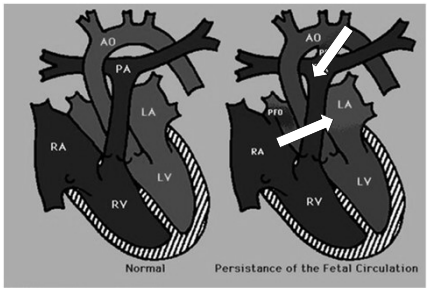
Fetal-placental circulation



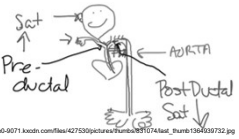
Lungs go back to fetal state high lung blood pressure



Blood flows down hill -> right (lungs) to left (heart) shunting

Cardiovascular symptoms

- Pallor
- Mottling
- Capillary fill time >2-3 seconds
- Cyanosis
- Pulses
- SaO_2 pre- and post-ductal "split"



https://showme0-9071.kxcdn.com/files/427530/pictures/thumbs/891074/last_thumb1364939732.jpg

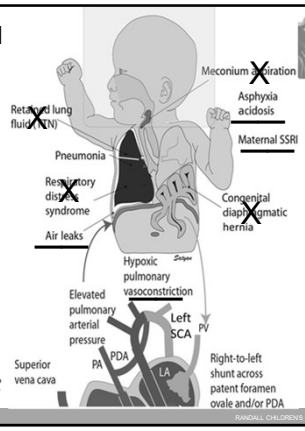
Inhaled Nitric Oxide (iNO)

Potent vasodilator

https://i.ytimg.com/vi/Gqa5mnNXjEo/hqdefault.jpg

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTaUhfW-NYEBRIHISXzNKoQFWzggsMWE5VRwwacOYI7OYp4Z3Aimg

Causes of PPHN



http://neoreviews.aappublications.org/content/neoreviews/16/12/e680/F2.large.jpg?width=800&height=600&carousel=1

Takeaways

- Rapid deterioration needs rapid assessment:
  - > History, history, history
  - > R/O pneumothorax
  - > Pre and post oximetry simultaneously
  - > Consider heart vs lungs
  - > Transillumination: otoscope, penlight, IV light

"*When you have eliminated the impossible, whatever remains, however improbable, must be the truth*."

~ Sherlock Holmes

The Case of the Itty Bitty Baby

- G3 P2 presents at the desk at 24 5/7 weeks
- Into the triage room ASAP
- "I feel pressure, I need to go to the bathroom"
- Pull back the sheet -> crowning tiny head
- Emergency button/all hands on deck
- Taken to OR, baby born 2 minutes later
- Apgar scores 6, 7, 8
  - > weak cry, low tone, poor color
- Mask too big -> blow by oxygen given
- Ped calls for transport while en route
  - Arrives at 25 minutes

https://www.todaysparent.com/wp-content/uploads/2017/04/extremely-premature-babies.jpg

- Team arrives at the same time as ped provider
- Intubation -> surfactant
- UVC placed -> $D_{10}W$
- Packed up and shown to mom

https://commons.wikimedia.org/wiki/File:Nina_wcze%C5%9Bniak.jpg

- "Uneventful" transfer

https://www.hpcimedia.com/images/website/ProductProfiles/DIR_12/F_20745.jpeg

This does <u>NOT</u> mean there is an NICU…

https://commons.wikimedia.org/wiki/File:Hospital_sign.svg

Feeling a bit like Dorothy…?

Preterm = incomplete organogenesis

In a word…IMMATURE:

- Skin: loses heat easier
- Tissues: damaged more easily by oxygen
- Chest muscles: limited effort, strength
- Lungs: deficient in surfactant: expansion/ventilation more difficult
- Immune system: infection risk
- Brain autoregulation/fragile blood vessels: intraventricular hemorrhage
- Family: may not be prepared for this

Add to that…

- Cause not always clear, but could be related to a complication of pregnancy
  - > Infection: Triple I, chorioamnionitis
  - > Blood pressure: preeclampsia
  - > Anatomy: "incompetent" cervix, placentation, uterus
- Highly stressed family
- And now, highly stressed staff…

ABCs +

Airway

Body temperature & Blood sugar

Circulation

Delayed cord clamping & Developmental care

Evaluation for sepsis

Family care

Get transport team there ASAP (before if possible)

Chronologically…

Get transport team there ASAP

Delayed cord clamping & Developmental care

Airway

Circulation

Body temperature & Blood sugar

Evaluation for sepsis

Family care

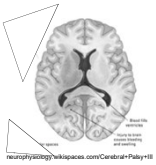
"Elementary!"

~ Sherlock Holmes

Delayed (timed) cord clamping

- At least 30-45 seconds, as possible
- Intraventricular hemorrhage (IVH) decreased by 50%!
  - > 18.3% vs 35.2% (Chiruvolu et al., 2015)
- Establish airway before cord cut, if possible
  - > Non-breathing group was more likely to be intubated (p = 0.01), have chronic lung disease (p = 0.02), and severe intraventricular hemorrhage (p = 0.02) (Nevill & Meyer, 2015)

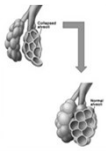
https://commons.wikimedia.org/wiki/File:Newborn_umbilical_suction.jpg



neurophysiology.wikispaces.com/Cerebral+Palsy+III

Airway goals

1. Prevent iatrogenic complications: "gentle ventilation"
2. Establish and maintain FRC
3. Maintain adequate oxygenation
   - > Oxygen: start with 30%
   - > CPAP: T-piece resuscitator CPAP 4-6 cm H_2O
   - > PPV via facemask- watch chest for gentle rise
   - > ETT (yikes), will an LMA fit?



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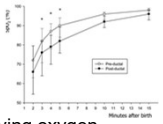
https://i.ytimg.com/vi/zLbd.3GO_o/hqdefault.jpg

Goal: avoidance of hyperoxia

- Fetal pO_2 ~ 35 mmHg = SaO_2 ~ 65%
- Rise in oxygen saturation occurs slowly ~ 10 minutes to reach 90%
- Oxidative stress can have negative impact
  - > oxygen radicals damage cellular membranes
  - > IVH, NEC, childhood leukemia
- SpO_2 target 90-95%...NEVER 100% if receiving oxygen
  - > pulse oximeter on right hand
  - > titrate oxygen based on condition and SpO2
    - as long as HR is stabilizing >100 & saturation is gradually rising, no need to increase FiO2



Targeted Pre-ductal SpO_2 After Birth	
1 min	60%-65%
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

www.researchgate.net/242016003_fig1_Figure-3-Line-graph-displaying-mean-oxygen-saturation-for-each-minute-after-birth-from

Gentle ventilation tips

- Support spontaneous respiratory efforts with CPAP 4-6 cm H_2O
- Positive pressure ventilation if necessary
  - > T-piece or bag/mask—remember PEEP is imprfatn for FRC
- Start with low pressures: 16-18/5 cm H_2O
- FiO_2 to maintain SpO_2 ~ 90- 95%
- Intubate for resuscitation, apnea, severe respiratory distress, high FiO_2 need
  - > 2.5 endotracheal tube
  - > 6 + weight in kg = 7 cm-ish

Circulation

- Total blood volume 85 mL/kg (less than 3 ounces!)
  - > doesn't take much volume loss to get into trouble
  - > immediate cord clamping: 30-50% of blood left in placenta
- Cardiac output
  - > tachycardia main mechanism/limited ability to increase contractility
  - > fetal shunts
  - > PPV increases intrathoracic pressure
- Rapid BP changes can rupture germinal matrix vessels
  - > immature cerebral autoregulation
  - > do not lift legs
  - > very slow infusion, consider pump vs pushing fluids

Circulation goals

- Mean BP is ~ gestational age
- CRT/CFT 2-3 seconds
- Access for dextrose and meds

Goal: temperature WNL 36.1-37.5ºC (ax)

- Hypothermia is common
  - > 28% of VLBW neonates had admission temperature of < 36º
- Increases risk of morbidity and mortality
- World Health Organization (WHO) lists hypothermia as a "top killer" during the neonatal period
  - > it is widely underreported and underestimated

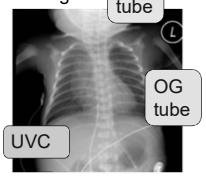
Temperature tips

- Room temperature 80°
- Plastic bag or wrap
- Radiant warmer on servo-control
- Warming mattress
- Transport in warm blankets

**Must also avoid hyperthermia
- Cooking bags are nylon

Sepsis evaluation

- Lab work- smallest sample possible
  - > Blood culture (umbilical cord?)
  - > Blood count- CBC/diff/platelets
  - > Blood gas
  - > Blood sugar
- Antibiotics maybe- broad spectrum coverage
  - > Ampicillin 50 mg/kg IV
  - > Gentamicin 4 mg/kg IV
- Imaging
  - > Avoid bodygram
  - > Chest for lines, tubes



Hypoglycemia risk

- Glycogen stores develop during last trimester
- Increased glucose use
  - > hypothermia
  - > respiratory distress
  - > Infection
  - > asphyxia

Hypoglycemia prevention

- Maintain blood glucose > 40-45 mg/dL
- Check blood glucose frequently starting at 30 minutes
- Get vascular access and begin D10 W infusion of @ 4-6 mg/kg/min = 80-100 mL/kg/d = 2-4 mL/hr
- Beware- even higher risk
  - > intrauterine growth restriction (IUGR)
  - > asphyxia
  - > infant of diabetic mother (IDM)

Goal: maximize neurodevelopmental outcome

- Birth is stressful (for everyone)
- Preterm particularly susceptible to stressors
- Frequent painful procedures
- Exposure to noxious sensory inputs
  - > auditory
  - > visual
  - > tactile
  - > chemosensory

Developmental care = brain care

- Tactile: receive baby in bag or warm blanket
  - > use "nesting"
- Dry and handle gently:
  - > do not lift legs, try to keep head midline
- Minimize pain:
  - > umbilical lines vs peripheral IV
  - > sucrose for painful procedures: 24% drop on tongue
- Chemosensory: alcohol, etc away from nose
- Sound:
  - > minimize conversation, keep voices low
  - > silence or keep alarms at low volume
- Light:
  - > lowest light necessary, shield eyes with hat or washcloth over eyes

Family care

- Loss of the perfect birth experience/baby
  - > Support system
  - > Professional
- Loss of control:
  - > Involve in care and decision-making
- Fear of the unknown
- Fear regarding outcome
- Health literacy
  - > Keep up-to-date in plain language

https://clinicalgate.com/wp-content/uploads/2015/03/c00004_f004-001-9781455726387.jpg

You got this!

1. Plastic wrap
2. Warmth under and over
3. Flat, midline positioning
4. Gentle airway support
5. Targeted oxygen saturation
6. Blood sugar support
7. Family support

NICU course

- Second dose of surfactant given in 12 hours -> nasal CPAP
- Tiny baby protocol
  - > Head kept midline
  - > Minimal handling- no daily weights
  - > Relative humidity 70%
  - > Phototherapy days 1-5
  - > Kangaroo care as much as possible
- Trophic feeds started day 2
  - > Oral care with colostrum- SEND SOME
- Nasal CPAP for 20 days
  - > Mild residual lung disease
  - > RSV prophylaxis given
- Head ultrasound on day 5
  - > Left grade 2 IVH
  - > Right grade 1 IVH
- LOS: 110 days

https://www.thenewsfact.com/wp-content/uploads/2017/09/article-2203121-1501E2210000050C-898_634x461.jpg

http://health.sunnybrook.ca/wp-content/uploads/2018/05/kangaroo-2.png

Takeaways

- NRP for < 30 weeks (close enough/easier to remember)
  - > 30% FiO2 : wean to target ranges
  - > Mask size: what do YOU have?
  - > Plastic wrap, heat under and over: what do YOU have?
  - > Minimal handling: advocate

References

Chiruvolu A, Tolia VN, Qin H, et al. (2015). Effect of delayed cord clamping on very preterm infants. *Am J Obstet Gynecol*, *213*:676.e1-7. DOI: http://dx.doi.org/10.1016/j.ajog.2015.07.016

Naumburg, E., Bellocco, R., Cnattingius, S., Jonzon, A., & Ekbom, A. (2002). Supplementary oxygen and risk of childhood lymphatic leukaemia. *Acta Paediatrica*, 91(12), 1328-1333.DOI: 10.1111/j.1651-2227.2002.tb02829.x

Nevill, E., & Meyer, M. P. (2015). Effect of delayed cord clamping (DCC) on breathing and transition at birth in very preterm infants. Early human development, 91(7), 407-411.DOI: http://dx.doi.org/10.1016/j.earlhumdev.2015.04.013

Reilly, M. C., Vohra, S., Rac, V. E., Dunn, M., Ferrelli, K., Kiss, A., ... & Prevention, V. O. N. H. L. (2015). Randomized trial of occlusive wrap for heat loss prevention in preterm infants. *The Journal of pediatrics*, *166*(2), 262-268. Retrieved from http://www.jpeds.com/article/S0022-3476(14)00933-0/abstract

Saugstad, O. D., & Aune, D. (2013). Optimal oxygenation of extremely low birth weight infants: a meta-analysis and systematic review of the oxygen saturation target studies. *Neonatology*, *105*(1), 55-63. DOI:10.1159/000356561

Sutherland, M. R., Bertagnolli, M., Lukaszewski, M. A., Huyard, F., Yzydorczyk, C., Luu, T. M., & Nuyt, A. M. (2014). Preterm birth and hypertension risk the oxidative stress paradigm. *Hypertension*, 63(1), 12-18. Retrieved from http://hyper.ahajournals.org/content/63/1/12.short

Thank you!