Neonatal Transport

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Disclosures

• None
Neonatal 1

- Ideal:
Neonatal Transport

- Also ideal:
Neonatal Transport

- Safe passage of neonates from one care location to another
- **NOT** scene runs
  - Car wrecks, injuries, etc
History of Pediatric Transport Programs

• First formal guidelines - 1986 AAP
• AAP Section on Transport Medicine - established 1995
• Most recent revisions to AAP guidelines – 2006
• Must have’s:
  • IV fluids
  • Supplemental O2
  • BVM equipment
  • Intubation equipment
  • Monitors
  • Resuscitation protocols
Team Sport
Organization and Practice

What a rush

The job in the pits is one of the most pressured in Formula 1. A pit stop is studied choreography and only the best are good enough to ensure comprehensive service for the driver in the race against the clock. Every individual role is practiced thousands of times and must be carried out perfectly.

- **0.0s** Car is stationary, time is running
- **0.2s** High-powered airgun set to central wheel nuts
- **1.0s** Hydraulic jack lifts the front end, manual jack at rear
- **1.5s** Fuelling hose onto tank nozzle; red light in refueller’s helmet visor indicates fuel flow of 12 litres per second
- **2.5s** Wheels removed
- **3.5s** New wheels mounted and central nut is tightened
- **3.8s** Car lowered off jacks
- **4.3s** Lollipop man signals to driver to engage 1st gear
- **4.3s** Green light in refueller’s visor; fuel hose is disconnected
- **1.3s** Lollipop man signals to driver to go

Number games: This is how long it takes to...

- **2s** fit a new steering wheel
- **3s** change a tyre
- **11s** replace the nose

“NATIONWIDE CHILDREN’S
When your child needs a hospital, everything matters.”
Our Team
Equipment
Equipment
Equipment
Equipment

- High frequency ventilator
- Nitric oxide
- ECMO
Neonatal Transport

• General types of neonatal transports
  • Transfers from one NICU to a higher level NICU for specific care
    • ECMO, surgery, subspecialty evaluation, etc
  • Transfers from non-NICUs to NICU for higher level of care
  • Transfers from higher level to lower level NICU for either beds pace or family reasons
• All potentially require provision of critical care while en route
Neonatal Transport

- Safe passage of neonates from one care location to another
- Provision of critical care to neonates to begin or continue the process of resolving disease while safely moving each neonate to the care location most suited to their degree of illness
Neonatal Transport

- Occurs within a context of often limited resources
- Far fewer pediatric subspecialists
- Regionalized health care
- Access to care
Fixed Wing Transports
Scale

• Birthrate ~ 63/1,000 women ages 15-44
  • Range 51 (New Hampshire) – 81 (Utah)
    • Ohio 63, California 62
• ~4,000,000 births annually, ~500,000 in CA (#1), ~140,000 in OH (#7)
  • ~11% premature = 450,000
  • ~2% are <32 weeks = 80,000
    • All of these will need prolonged hospitalization, many will have complications
  • Not all can be born in level III settings
Achieving the Mission

• The job of the transport team is to take critically ill babies to the facility able to care for them
• Requires remarkable talents
• Great diversity of skills
  • Most neonatal transport teams are also pediatric transport teams
  • Must be able to handle all disease processes any likely complications
  • Variable physician presence
Who We Are

- In general, teams are made up of 2 clinicians and a driver or pilot
  - Team leader – RN
  - Associate – RN, RT, paramedic
National Data

- Majority of programs transport < 400 neonates per year
- RN-RT combination is most common ~ 40-45%
- RN-RN is next ~ 11%
- NNPs in ~12%
- Physicians in ~ 8-9%
Who We Care For

Transports 2014

- Pediatric
- Neonatal
Diverse Talents

- Safety
- Customer service/diplomacy
- Patient assessment and analysis of data
- Communication
- Medical management
- Procedural skills
- Protocol development
- Quality improvement
- Education
- “Keep calm and carry on”
Safety

• Safety is the first priority of transport medicine
  • Patient safety and team member safety
  • 100% are trained in safety
    • “zero hero”, crew resource management
  • Flight safety
    • Track all serious safety events and chart “days between”
• We take appropriate amounts of time to turn around at referral centers – typically ~60mins
Transport can be Dangerous
Customer Service and Diplomacy

- Transport team is the face of the hospital and the first interaction with the families and referring facilities.
- Called upon to enter stressful and/or traumatic situations.
  - May need to take over from nominally more senior people.
  - Gray area of responsibility.
- Nearly every trip for a neonate reflects major, unexpected pathology.
Patient Assessment and Analysis of Data

• For neonates, maternal and neonatal history are critical
• Physical exam is evolving
• Often substantial amounts or data
  • ABG, glucose, CBC, chemistries, CRP, hepatitis status, serologies, etc
  • Variety of respiratory support modes
• Protocol-based, but critical thinking is key
  • “Pediatric patients are not small adults, and neonates are not small children”
  • Fluid management, blood pressure management, sedation, etc.
    are all different for neonates
Communication
Communication

• Transport team members must communicate effectively with many stakeholders
  • Receive and verify information from referral nurses, RT, parents, physicians, etc.
  • Provide information to referral site/parents
  • Provide information and analysis to medical control
  • Provide information to receiving staff
  • Relay and implement plan from MCP to staff in referral
Communication

• Occurs in a context of limited time
  • Goal to turnaround in less than 60 mins
  • Requires carefully scripted conversations, timeouts, etc.
Medical Management

• Guided by disease-specific protocols
  • Shock, sepsis, burn, etc for pediatrics
  • RDS, congenital heart disease, NEC, prematurity, etc for neonates
• Protocols are created collaboratively by team members and leadership
• Leadership consists of
  • Transport Medical Director
  • Associate Medical Directors – PICU, ED, CTICU, NICU
MEDICAL PROTOCOL
Nationwide Children's Hospital
Critical Care Transport Team

PROCEDURE:
RAPID SEQUENCE INTUBATION
(updated 9/2013)

DEFINITION:
Sequential preparation, sedation, and paralysis to safely intubate emergently. This includes preoxygenation, medications for certain scenarios, and cricoid pressure/avoidance of bagging in the setting of a full stomach.

POINTS TO CONSIDER:
- Last meal < 6 hrs ago – apply cricoid pressure and avoid bagging during RSI (adequately preoxygenate for 2-3 minutes)
- Known mediastinal mass – may affect ability to ventilate patient after intubation. Consider performing intubation in a controlled setting with appropriate backup (i.e.: consider consulting on-site anesthesia personnel prior to procedure if possible)
- Poor perfusion or BP's – have NS bolus ready to give as RSI meds are being given
- Attempt bagging at least once prior to paralyzing, to help ensure that you will be able to do BVM should it be a difficult intubation
- Placement of NG tube or venting the GT to help decompress and promote effective bagging
- **Atropine** 0.02 mg/kg IV may be used for any patient < 3 yo, as infants have exaggerated vagal responses

The following SCENARIOS are designed to assist the clinician in preparing for emergent intubation. Alternative medication choices may be discussed with or ordered by MCP:

- **NEONATAL RESPIRATORY DISTRESS/FAILURE:**
  - **Atropine** 0.02mg/kg IV (min dose 0.1mg does NOT apply to neonates)
  - **Fentanyl** 2 mcg/kg IV SLOW push
  - **Succinylcholine** 2mg/kg IV

CLINICAL PRESENTATION:
Medical Management

• In addition to protocols, a medical control physician (MCP) is designated for each trip
  • Specific transport training
  • Responsible for care
  • Often MCP = receiving physician
• All information is presented to MCP
• Assessment and plan are proposed
• MCP signs off or suggests alternatives
• Team embarks
Procedures

• Team members are trained to perform all commonly expected procedures
• Skills are maintained with ongoing training
  • 48 hours skills/competency (12 each quarter)
  • 12 hours OR/Anesthesia
  • 12 hours PICU
  • 12 hours L&D/NICU
Procedures

• All team leaders are expected to maintain competency in their clinical skills, including
  • IV/IO placement
  • Advanced pediatric/neonatal assessment, including trauma
  • Endotracheal intubation/advanced airway management
  • Chest tube insertion and needle decompression
  • Umbilical catheter placement
  • Ventilator management, including nitric oxide and oscillator
  • Critical care medication administration, including vasopressors
  • Disease process/pathophysiology knowledge
Skills Training
Additional Training

• ALL team members carry additional certification (CNPT, CCRN, etc.)
• Night Vision Goggle Training
• Crew Resource Management
• Survival Training
• ACLS/PALS/NRP/ATLS
• PAIP/Emergency Drills
Protocol Development

• Nearly all care is determined by protocol
  • Collaborative approach to protocol design
  • Evidence review
  • Feedback and observation
  • Protocol draft and revision
  • Sign off by leadership
Quality Improvement

• Historically have engaged in quality assurance, not quality improvement
  • Avoidance of mistakes
  • Maintenance of standards
  • Critical and necessary
• Quality improvement is more recent area of emphasis
  • CLABSI, VAP, surgical site infections, adverse drug events….

→ “How can we provide better care for our neonates?”
Quality Improvement

• Focus on doing what we already know how to do, only better
  • “Time to table”, “time to first abx dose”, CLABSI prevention bundles, golden hour
• Ongoing projects
  • Improving intubation success on first attempt
  • Reducing medical errors via formalized handoff
  • Improving dispatch time
• Typically required grass roots cultural change
• Facilitated by state-wide, regional and national collaboration
Education

- Team has multiple education roles
  - Education of team by content experts
    - Protocol development, didactic lectures, rounding and shadowing, debriefs and huddles
  - Education by team of referral staff and physicians
  - Education by team of parents
  - Followup
Why is all this Necessary?

- Transporting critically ill neonates is potentially incredibly risky.
- Usually critically ill.
- Little margin for error.
- Multiple invasive devices.
- Multiple medications, pressors.
- Enormously fragile skin.
- Often either unsedated or only moderately sedated.
- High sensitivity to noxious sounds, lights, stimuli.
- Often transported because status is worsening.
Unique Challenges

• Who’s responsible for care?
  • Before transport team gets there
  • During transition of care
  • *En route*
The Boss

- Transferring doc has control... ...in their own institution.
- Transport Team control... ...after facility departure
- Joint patient management key
“Stability”

• Stability **IS NOT** a prerequisite for transport
  • Referring facility must stabilize “within capabilities”
  • Do best to ensure “no deterioration likely”, either from or during a transfer
• MCP to inform the family of potential deterioration and give realistic expectations.
• Maintain constant contact with transport team en route for updates and ongoing recommendations
Unique Challenges

- Limited space and resources while *en route*
Unique Challenges in Flight

1. Barometric Pressure
2. Hypoxia
3. Fatigue
4. Noise
5. Vibration
6. Third spacing
7. Dehydration
8. Gravitational Forces
FiO2 is 21% everywhere...
Altitude is Everything!

...so why do I feel so bad when I drive up to Pikes Peak??
Air is still 21% $\text{O}_2$ as you ascend Mt. Everest, but the air is “thinner” with fewer air particles per cubic feet. Thus, symptomatic HYPOXIA occurs at higher elevations!
Physiological Demonstrations

Progressive deterioration of handwriting:

Interestingly the subject is able to read the writing under hypoxia; once back on $O_2$, deciphering becomes impossible.
Altitude Physiology

- To calculate the needed FiO\textsubscript{2} needed to maintain P\textsubscript{AO2}:
  \[ \text{FiO}_{2(1)} \times \text{P}_{B(1)} = \text{FiO}_{2(2)} \times \text{P}_{B(2)} \]

- Maintenance of a specific barometric pressure can be tempered to some extent in the fixed-wing (cabin pressurization), but not in helicopters.

- Descending in altitude increases barometric pressure, however it is at the expense of:
  - Less efficient fuel consumption = shorter range of flight
  - Increased flying time
  - Increased turbulence
Relationship between Pressure and Volume

• **Boyle’s Law**: there is an *inverse* relationship between volume and the pressure of a gas:
\[ P_1 V_1 = P_2 V_2 \]

• At 5000’, barometric pressures decreases by 20% and gas volumes increase by 20% - most heli’s
• At 8000’, barometric pressure decreases by 30% and gas volumes increase by 30% - most commercial aircraft

• Normal gas-filled compartments can markedly EXPAND:
  • ETT cuffs ← deflate cuffs and fill with saline
  • Pneumothoraces ← preemptive pigtail chest tubes
  • Gastric bubbles ← decompress with NGT
  • Compression stockings ← disable
Overcoming Challenges

1st Attempt Intubation Success Rate (95% CI)

- Numerous safety and quality mechanisms to reduce risks, complications, and minimize potential harms
- Checklists and protocols
- Crew resource management
- Time outs
- MCP


Success Rate

Collaborative-wide Average 1st Intubation Success
* P < 0.05

Institution
(n=14 Required for Inclusion)
Choice of Mode - MICU

- All transports less than 45 miles
  - Safe
  - Reliable
  - Fast turnaround
  - Capable except in extraordinary weather
Choice of Mode – Rotor-Wing

• Greatest advantages
  • Ease of deployment
  • Speed – heli’s are faster than ground if > 45 miles
  • Can fly in snow and rain, just not ice
  • Traffic is never an issue (but landing can be)
    • Not all facilities have a helipad
      • May be necessary to land at a local airport and drive in, significant time
Choice of Mode – Rotor-Wing

• Limitations
  • Radius of reach and need to refuel
  • Pilot duty hours regulations
  • High level of noise (patients wear earphones)
  • Decent amount of vibration
  • Potential for hypothermia
  • Unpressurized cabin – secretions can be thicker due to less ambient moisture (use humidified air)
  • Cost – outcomes studies vary:
    • Air is often overutilized in pediatrics, likely a reflection of referring providers’ discomfort with pediatric patients
Choice of Mode – Fixed-Wing

- Primary advantages
  - Speed
  - Long distances
  - Minimized adverse physiologic effects of altitude
  - Can withstand harsher weather than helicopters

- Disadvantages
  - Noise and movement
  - Closed workspace
  - Requires airport-to-airport transfers, with ground transport in between (multiple points of patient movement)
  - Need to file a flight plan
  - Cost
Newborn Resuscitation Algorithm.

Clinical Pearls
- NRP not PALS

Pediatric Cardiac Arrest

1. Shout for Help/Activate Emergency Response
2. Start CPR
   - Give oxygen
   - Attach monitor/defibrillator
3. Rhythm shockable?
   - Yes: Shock
   - No: CPR for 2 min
   - 1 min
   - 2 min
   - 3 min
   - 4 min
   - 5 min
4. Rhythm shockable?
   - Yes: Shock
   - No: CPR for 2 min
   - 1 min
   - 2 min
5. Rhythm shockable?
   - Yes: Shock
   - No: CPR for 2 min
   - 1 min
   - 2 min

Targeted Preductal Spo₂ After Birth
1 min: 80%-65%
2 min: 85%-70%
3 min: 75%-80%
4 min: 80%-85%
5 min: 85%-95%

John Kattwinkel et al. Pediatrics 2010;126:e1400-e1413
Clinical Pearls
Clinical Pearls

- Blood pressure starts "low" and gradually increases regardless of intervention
- In general give less fluid
- Most babies are born "wet" and are not hypovolemic
- Sodium balance in the first few days is critical to outcome
- Boluses and NaHCO₃ have lots of sodium
- Except when you need to give more
- Although rare, truly hypovolemic babies need a lot of fluid, right now
- Abruption, bleeding, hemolysis; pale, tachycardic, limp…
Clinical Pearls

- Keep the babies warm – not too cold, not too hot

![Graph showing the relationship between admission temperature and outcome rate.](image-url)
Clinical Pearls

• Manage glucose carefully
  • Both hypoglycemia and hyperglycemia are dangerous

• Gentle ventilation
  • In general, use high rate, low tidal volume strategies
    • HFOV
    • CMV with fast rate
  • Non-invasive if possible
Clinical Pearls

• The neonatal brain is particularly vulnerable to extremes, especially when already injured.
Summary

• Transport of neonates is a high-acuity, high-risk endeavor
• Collaboration and team focus are critical
• Focus on process and outcomes