NAVA
Neurally Adjusted Ventilatory Assist
In Neonates
Howard Stein, M.D.
Neonatologist
Toledo Children’s Hospital
Toledo, Ohio

Toledo Children’s Hospital
151 bed hospital
Level 3 NICU
60 beds
Inborn – 70%
Outborn – 30%
2011: > 800 admissions/year
Average daily census 40 – 45 patients

How NAVA works

Central nervous system
Phrenic nerve
Diaphragm excitation → Nasogastric tube → Ventilator Unit
Diaphragm contraction
Chest wall and lung expansion
Airway pressure, flow and volume

Disclaimers
Dr Stein:
- Is discussing products made by Maquet
- Has no commercial interest in NAVA or Maquet
- Has received no financial support or incentives from Maquet to use NAVA or collect this data

Neuro-ventilatory Coupling

Conventional Ventilation
Patient Controls using Flow Trigger:
- Initiation of Breath
- Rate (in some modes)
Ventilator Controls:
- Peak Pressure or Tidal Volume
- Inspiratory Time
- Peak Pressure
- Minimum Rate
- FiO2
- PEEP
Synchrony:
- Only for Initiation of Breath

NAVA Ventilation
Patient Controls using Neural Trigger:
- Initiation of Breath
- Inspiratory Time
- Rate
- Peak Pressure
- Termination of Breath
Ventilator Controls:
- FiO2
- PEEP
- NAVA Level
- Apnea Time (minimum rate)
- Peak inspiratory pressure alarm
Synchrony:
- Initiation of Breath
- Size of Breath
- Termination of Breath
Clement K, Thurman T, Holt S, Stein H, Age: 26 weeks

Stein HM, Howard D. Neurally Adjusted Ventilatory Assist (NAVA) in Liet

Vitale V, Ricci Z, Weight: ~ 550 grams

Emeriaud 

Blood gases improved on NAVA in some studies and NAVA improved patient

Congenital Diaphragmatic Hernia

Bengtsson Respiratory rate increased on NAVA in some studies

Stein HM, Burton J, 2012

2008 – FDA Approval

2009


Published Neonatal and Pediatric Studies

2010


Published Neonatal and Pediatric Studies

2012


Published Neonatal and Pediatric Studies

NAVA ventilation has been reported in patients with:

- Congenital heart disease
- Respiratory Distress Syndrome
- Chronic Lung Disease
- Congenital Diaphragmatic Hernia
- Respiratory Syncytial Virus

10/10/2012
Toledo Children’s Hospital

- NAVA - May 2008  NIV NAVA – July 2010
- Over 500 neonates on NAVA/NIV NAVA
- Over 25 pediatric patients on NAVA
- Used NAVA/NIV NAVA in patients with:
  - RDS
  - PPHN (NO)
  - Pneumothorax
  - Gastrochisis
  - HIE with cooling

Is SIMV (pressure control) in premature infants really ‘synchronized’?

SIMV (pressure control) in a 3 week old ex 26 week infant with CLD shows evidence of flow triggering (purple lines).

SIMV (pressure control) with EDI superimposed shows the lack of synchrony on the flow triggered breaths.

SIMV (Pressure Control) in an ‘Apneic’ neonate

‘Apnea’ - Failure to trigger
Is the Neural Trigger Synchronous?

Data from Toledo Children’s Hospital’s NICU
- Normative Edi data
  - Term neonates
  - Premature neonates
- Retrospective review of neonates < 1500 grams on NAVA
- Prospective controlled study in VLBW neonates between NAVA and PC

Term Neonates with no active respiratory problems and feeding normally

Normative Edi Data
- Premature neonates off mechanical ventilation
  - HFNC (3 - 6 lpm)
  - NC (0.5 - 2 lpm)
  - RA

Normative Edi Peak and Min at various gestational ages in non-ventilated premature neonates

Respiratory support and Edi Peak and Min over gestational age
NAVA in Neonates < 1501 grams

- 52 Neonates
  - 31 RDS
  - 21 CLD
- Gestational age: 26.3 ± 2.6 weeks
- Birth weight: 837 ± 271 grams
- Age at study: 15 ± 15 days (range 0-50 days)
- Weight at study: 958 ± 294 grams


NAVA in Neonates < 1501 grams Results

- $p < 0.05$ for all values compared to SIMV/PC

NAVA Versus Pressure Control

- First prolonged prospective study in VLBW neonates
- NAVA ventilation for 4 hours
- Pressure Control ventilation for 4 hours
- Cycle repeated for 24 hours

Results

- 5 neonates with CLD were studied
  - 15 changes from NAVA to PC
  - 10 changes from PC to NAVA
- Gestational age: 26.2 ± 0.8 weeks
- Birth weight: 810 ± 245 grams
- Age at study: 24 ± 10 days

NAVA Conclusions
In neonates:
- Intact neuro-ventilatory coupling with functional feedback pathways.
- Ventilate on NAVA with lower PIP, better TV and lower FiO2 than on conventional ventilation.
- Improved blood gases on NAVA despite ventilating with lower pressures.
- Improved compliance on NAVA.
- No adverse events noted while on NAVA.

Non-Invasive NAVA Ventilation
- Available since July 2010
- About 90 patients treated with NIV NAVA
- Uses:
  - Prevent intubation
  - Facilitate earlier extubation

Case Presentation 1
- 23 weeks gestation, 650 grams
- Intubated in DR and treated with surfactant
- NAVA invasively by 2 hours
- Extubated at 36 hours to NIV NAVA
- Weaned to CPAP on day 8 for 1 day and then to high flow nasal cannula 5 lpm

Case Presentation 2
- 26 weeks 655 grams
- Intubated in the DR and treated with surfactant
- Extubated on day 1 to NIV NAVA
- On NIV NAVA for 6 days and then weaned to HFNC 5 lpm

Clinical Guidelines
- Ventilator settings in NAVA:
  - Apnea time
  - Peak Inspiratory pressure alarm
  - How to set the NAVA level
### Apnea Time

- Time the neonate is apneic before getting a backup breath
- Apnea time can now be lowered to minimum of 2 seconds
  - After 2 seconds the neonate gets a pressure control breath
  - This allows the user to deliver a minimum guaranteed back-up rate of 30 breaths/min

### Apnea Time

- **Apnea alarm**
  - **Minimum rate**
    - 15 sec: 4 breaths/min
    - 10 sec: 6 breaths/min
    - 5 sec: 12 breaths/min
    - 4 sec: 15 breaths/min
    - 3 sec: 20 breaths/min
    - 2 sec: 30 breaths/min

This is different from the backup rate: RR when the neonate is apneic and getting pressure control.

### Peak Inspiratory pressure alarm

- **Case presentation:**
  - 22 year old G1 at 32 weeks gestation
  - Primary C-section for maternal PIH
  - 1.8 kg
  - Apgars 7/8
  - 8 minutes developed grunting and retractions – placed on CPAP 5
  - CXR showed mild to moderate RDS

### How to set the NAVA level

- NAVA level is the proportionality factor that converts the Edi signal into a pressure
- The higher the NAVA level the more work of breathing the ventilator does
- The lower the NAVA level the more work of breathing the patient does
- Goal – to unload the work of breathing from the patient to the ventilator without over assisting the patient
- The ventilator continues to respond to the patient’s respiratory drive but supports the patient’s respiratory effort
NAVA Ventilation in Neonates: Clinical Guidelines and Management Strategies

Howard Stein M.D. and Kimberly Firestone BS, RRT

Neonatology Today April 2012
NeonatologyToday.net

5 videos:
- Placing the Edi Catheter
- Setting the NAVA level
- Setting the Apnea Time
- Setting the Edi trigger
- Setting the Peak Pressure Limit

% CLD in neonates < 1500 grams
VON Data

NAVA WORKS IN NEONATES!
But does it make a difference?

- Large multi-center trials are needed to answer questions if:
  - NAVA prevents intubation or decreases time on ventilators?
  - NAVA decreases the incidence of chronic lung disease?
  - NAVA improves outcomes?