Neonatal Respiratory Support

Past
Present
Future

*With a little resuscitation thrown in*
Disclaimer

- Dave Hampton works for ONY, Inc. of Amherst, New York
- He lives in Wichita, KS
A Little History

The Bible

Ancient times

1700-1850

1850-1950

1950-1999

1999-Present

The future??
The Bible

Old Testament, II Kings 4:24-34:
“The child died on his mother’s lap.... and he (the prophet Elisha) went up... and lay upon the child, and put his mouth upon his mouth. . . and the flesh waxed warm”
Hippocrates

- ~ 400 BC
- Described intubation of the trachea to support ventilation
Talmud (200BC-500AD)

- Infants who do not cry at birth.... “should be shaken to-and-fro and rubbed against the placenta”
- Story of a lamb revived by inserting a reed into the trachea
- Recommendation of “blowing into the nostrils” of infants
Galen (129-199 AD)

- Inflated the lungs of dead animals with a bellows and postulated that air movements caused the chest to rise.
**Paracelsus (1493-1541)**

- Described resuscitation of drowned individuals using a bellows and oral tube
Andreas Vesalius (1543)

Described tracheostomy, intubation and ventilation to maintain life . . . in a pregnant sow
Boyle and Hooke (1600s)

(1600s)
• Described the fundamental laws of gas pressure and volume
• When placed in vacuum chambers larks, sparrows and mice promptly died
• Recognized there was something essential for life in the air that we breathe
Joseph Priestly (1774)

- In Birmingham, U.K., Priestley produced “dephlogisticated air” (oxygen)
- Priestly noted that this substance kept mice alive and resulted in a brighter candle flame, but he did not relate the gas to respiration
William Smellie (1752)

- Scottish obstetrician considered to be the “Father of modern obstetrics”
- Described a straight silver endotrachael tube for resuscitating newborn infants
Dr. Benjamin Pugh (1754)

“To recommend to public practice some instruments and other observations, and improvements in the art after 14 years practice…”

• Recommended and described the technique of mouth to mouth resuscitation
• Described the air-pipe for intra-tracheal ventilation
John Hunter (1776)

• Bellows type ventilator with a pressure limiting valve
Francoise Chaussier (1746-1828)

- Professor of Obstetrics in the French Academy of Science:
  - Gave oxygen to a neonate in 1780
  - Described mouth-to-mouth resuscitation of infants
  - Described an intra-laryngeal tube for use in infants
  - Described a means of providing ventilatory support for infants
Why were the French such leaders in the field of Neonatal Resuscitation?

- It’s not for the reasons that you think
James Blundell (1790-1878)

- Accoucheur (obstetrician) at Guy’s Hospital (London)
- Described mouth to trachea inflation using a silver tracheal tube “which every accoucheur should carry”
- For resuscitation, he recommended:
  - Quick and skillful intubation
  - Palpation of the umbilical cord to assess heart rate
  - Gradual cessation of ventilatory assistance when the infant begins spontaneous breathing
B.S. Schultze (1871)

- Described a resuscitation maneuver which purportedly:
  - Stimulated respiratory effort
  - Removed meconium
  - Reversed ductal shunting
Gairal (1879)

The aerophore pulmonaire for intermittent positive pressure ventilation of newborn infants
Fell-O’Dwyer (1887)

- apparatus described in which long-term positive pressure ventilation was performed in a large series of children
Franklin Delano Roosevelt

- 32nd President of the U.S. and only person elected four times had to be resuscitated at birth due to his mother receiving chloroform during labor.
Alexander Graham Bell's negative pressure ventilator (1889)
So What Happened?

- We were doing so well and then we took some giant steps backward.
Positive Pressure Ventilation

- Advances in the ventilation of adults led to the deaths from complications of PPV.

- Which would be..................
Reference

- Portions or entire slides of the previous 18 have been gleaned from
- “Historical Evolution of Neonatal Resusitation” a program from the good folks at NRP
So we are having complications from PPV, what should we do??

Believe it or not........
RC would love this
Rub them with this
Or this......

Or these......

Or these......

Or these......

Or these......
Or this.
Stimulate them with this
More stuff........
In addition to pinching, slapping and tickling........
Immersion Therapy
Even more stuff......
not pleasantly placed
You’re placing this; Where?????
Insufflation of tobacco smoke into the rectum
My favorite.........
In 1914, Von Reuss described the use of CPAP to resuscitate newborn infants:

- One of the techniques was Von Tiegel’s apparatus.
- Note the O2 tank, tubing attached to a mask/rubber ball, and a water bottle into which the tubing is placed to provide CPAP.

*Von Reuss AR. Diseases of the Newborn. London: John Bale and Sons; 1921*
1920s-1950s

Resuscitation Improvements
Yandell Henderson
Julius Hess
Virginia Apgar
When Dave started in NICU

- A really long........... time ago
Led to..............
Early ventilators
BABYbird VENTILATOR
SPECIFICATIONS

direct orders to your distributor or
bird corporation
MARK 7
palm springs, california 92262

photography and design: audio visual dept., bird corp.

inspiratory time range 0.4 or less - 2.5 sec.
expiratory time range 0.4 or less - 10 sec.
frequency range 4.2 - 100/min.
pressure control range 13 - 81 cmH₂O (10 - 60mmHg)
peak inspiratory flow 30 LPM
maximum safety pressure 88 cmH₂O (65mmHg)
subatmospheric pressure range 0 to -10 cmH₂O (0 to -8mmHg)
end expiratory positive pressure range 0 - 20 cmH₂O (0 - 15mmHg)
inspiratory mixture 21-100% oxygen ≤ 3%
power source 50 p.s.i. oxygen and air
power consumption 42.5 L/min. max.
inspiratory time limit 0 - infinity
weight 40 lbs.
width 27 inches
height 60 inches

TWO MANUALS ARE FURNISHED WITH EACH BABYbird
VENTILATOR ADDITIONAL COPIES AVAILABLE AT $4.50 EA.
INSTRUCTION MANUAL
BOURNS® INFANT VENTILATOR
MODEL LS 104-150
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PART NO. 50000-10104  BOURNS IS A REGISTERED TRADEMARK OF BOURNS, INC.  PRICE $1.00
Positives and Negatives

- Improvements in ventilation AND surfactant led to increased survival rates for smaller and earlier in gestation infants.

- It also led to a relatively new disease process in these premature who were now surviving. CLD became a new disease process for the NICU.
Neonatal Respiratory Support

- Oxygen and pressure are “evil”, BUT
- REMEMBER:
  - Krebs Cycle
  - How do we rid the body of excess Carbon Dioxide?

NEONATAL RESPIRATORY SUPPORT IS BASED UPON PREVENTION OF CLD
Chronic Lung Disease

- A discussion we could have until tomorrow
- There are multiple definitions of CLD
- Preventing premature birth is still the primary mechanism for the avoidance of CLD.
- Note the new ACOG resuscitation guidelines
<table>
<thead>
<tr>
<th>Intervention</th>
<th>20 0/7 to 21 6/7 weeks</th>
<th>22 0/7 to 22 6/7 weeks</th>
<th>23 0/7 to 23 6/7 weeks</th>
<th>24 0/7 to 24 6/7 weeks</th>
<th>25 0/7 to 25 6/7 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonatal assessment for resuscitation*</td>
<td>Not recommended 1A</td>
<td>Consider 2B</td>
<td>Consider 2B</td>
<td>Recommended 1B</td>
<td>Recommended 1B</td>
</tr>
<tr>
<td>Antenatal corticosteroids</td>
<td>Not recommended 1A</td>
<td>Not recommended 1A</td>
<td>Consider 2B</td>
<td>Recommended 1B</td>
<td>Recommended 1B</td>
</tr>
<tr>
<td>Tocolysis for preterm labor to allow for antenatal corticosteroid administration</td>
<td>Not recommended 1A</td>
<td>Not recommended 1A</td>
<td>Consider 2B</td>
<td>Recommended 1B</td>
<td>Recommended 1B</td>
</tr>
<tr>
<td>Magnesium sulfate for neuroprotection</td>
<td>Not recommended 1A</td>
<td>Not recommended 1A</td>
<td>Consider 2B</td>
<td>Recommended 1B</td>
<td>Recommended 1B</td>
</tr>
<tr>
<td>Antibiotics to prolong latency during expectant management of preterm PROM if delivery is not considered imminent</td>
<td>Consider 2C</td>
<td>Consider 2C</td>
<td>Consider 2B</td>
<td>Recommended 1B</td>
<td>Recommended 1B</td>
</tr>
<tr>
<td>Intrapartum antibiotics for group B streptococci prophylaxis*</td>
<td>Not recommended 1A</td>
<td>Not recommended 1A</td>
<td>Consider 2B</td>
<td>Recommended 1B</td>
<td>Recommended 1B</td>
</tr>
<tr>
<td>Cesarean delivery for fetal indication*</td>
<td>Not recommended 1A</td>
<td>Not recommended 1A</td>
<td>Consider 2B</td>
<td>Consider 1B</td>
<td>Recommended 1B</td>
</tr>
</tbody>
</table>

Abbreviation: PROM, premature rupture of membranes.

*Survival of infants born in the perivable period is dependent on resuscitation and support. Between 22 weeks and 25 weeks of gestation, there may be factors in addition to gestational age that will affect the potential for survival and the determination of viability. Importantly, some families, concordant with their values and preferences, may choose to forgo such resuscitation and support. Many of the other decisions on this table will be linked to decisions regarding resuscitation and support and should be considered in that context.

Group B streptococci carrier, or carrier status unknown

For example, persistently abnormal fetal heart rate patterns or biophysical testing, malpresentation
High Flow Nasal Cannula

- When compared to NCPAP as a primary support HFNC failed.
- Trial was stopped early.
- There is a place for HFNC, just not as primary support.
What about NCPAP?

- Where does NCPAP fit into ventilation strategies?
- Does it fit in?
- Can it replace ventilation?
- More about CPAP to come
NIPPV and BIPAP

- From the AAP in Feb. ‘16
- When compared to NCPAP, synchronized NIPPV decreases the frequency of post-extubation failure.
- Studies using non-synchronized NIPPV or BIPAP for post-extubation failure are inconclusive.
- Data does not support the superiority of NIPPV/BIPAP over NCPAP for the management of RDS and the prevention of CLD.
- There is no published evidence of benefit of NIPPV/BIPAP for apnea of prematurity.
NIPPV and BIPAP

- Further research is needed before recommending NIPPV or BIPAP over NCPAP for the management of infants with RDS or apnea.
- Haven’t even addressed the issue of BPD.
- Most studies used more mature infants obtain their data.
INSURE vs. NCPAP

- IN(tubate) SUR(factant) E(tubate)
- There is currently no evidence to support either method alone as superior to the other.
- INSURE does not appear to increase CLD and may reduce adverse outcomes associated with NCPAP alone*

*Isayama, JAMA June 2015
**Neurally Adjusted Ventilatory Assist**

- In short term studies it has been shown to maintain similar or better ventilation and gas exchange with lower pressures and better synchrony compared to conventional ventilation.*
- NAVA is promising alternative but long term effects need to be explored to determine the impact on weaning from mechanical ventilation and on pulmonary outcomes.*
There is a group of patients who are going to require intubation and MV, no matter how much we try to avoid it.

So what mode should we use?
Meta-analysis of Mechanical Ventilation Modes for RDS in Infants*

- Limitations of Meta-analysis
  - Started with 7,299 studies and ended up with 20
  - Primary outcome was Mortality
  - Secondary outcomes: IVH and PDA
  - Only eight looked at BPD, which is NOT enough data to draw conclusions from.

- *Wang
Conclusions

- Compared with SIMV + PSV, the TCPL,
- HFOV, SIMV +VG and V-C ventilation modes are associated with lower mortality*.

*Wang
Summary

The rate of CLD remains in the range of 30% to 40%.
It has NOT changed in 20 years!!!