Evidence Based Newborn Resuscitation

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Resuscitation History

But one day the woman’s son became sick and died... ”Give him to me,” Elijah replied... and he stretched himself upon the child three times ... and the spirit of the child returned, and he became alive again.

1 Kings 17:17-24
Resuscitation History

When Elisha arrived, the child was indeed dead, lying there upon the prophet’s bed...then he lay upon the child’s body, placing his mouth upon the child's mouth, and his eyes upon the child’s eyes, and his hands upon the child’s hands. And the child’s body began to grow warm again!

2 Kings 4:32-35
“If the child does not breathe immediately upon Delivery, which sometimes it will not, especially when it has taken Air in the womb; wipe its Mouth, and press your Mouth to the Child’s, at the same time pinching the Nose with your Thumb and Finger, to prevent the Air escaping; inflate the lungs; rubbing it before the Fire; by which Method I have saved many.”

Benjamin Pugh, 1754
Prevalence of Neonatal Resuscitation

- <750
- 751-1000
- 1001-1500
- 1501-2000
- 2001-2500
- >2500
Need for CPR in the Delivery Room

• 30,839 consecutive deliveries
  – 39 with CPR ± epinephrine (0.12%)
  – 1/3 with severe fetal acidemia
  – If no fetal acidemia, correction of ventilation improved heart rate
Neonatal Resuscitation Program (NRP)

NRP Flow Diagram

Birth
  - Clear of meconium?
  - Breathing or crying?
  - Good muscle tone?
  - Color pink?
  - Term gestation?
  No
  - Provide warmth
  - Position; clear air (as necessary)
  - Dry, stimulate, re
  - Give O₂ (as necessary)
  Evaluate respirations, heart rate, and color
  Apnea or HR < 100
  - Provide positive-pressure ventilation*
  HR < 60
    - Provide positive-pressure ventilation*
    - Administer chest compressions
    HR > 60
    - Administer epinephrine*

*Endotracheal intubation may be considered at several steps.
Neonatal Resuscitation Program™ - Reference Chart

The most important and effective action in neonatal resuscitation is ventilation of the baby’s lungs.

A Airway
- Put baby’s head in “sniffing” position
- Suction mouth, then nose
- Suction trachea if meconium-stained and NOT vigorous

B Breathing
- PPV for apnea, gasping, or pulse <100 bpm
- Ventilate at rate of 40 to 60 breaths/minute
- Check for rising heart rate, audible breath sounds
- Look for slight chest movement with each breath
- Use CO2 detector after intubation
- Attach a pulse oximeter

C Circulation
- Start compressions if HR <60 after 30 seconds of effective PPV
- Give (3 compressions) 1 breath every 2 seconds
- Compress one-third of the anterior-posterior diameter of the chest

D Drugs
- Give epinephrine if HR <60 after 30 seconds of compressions and ventilation
- Caution: epinephrine dosage is different for ET and IV routes

Corrective Steps

Endotracheal Intubation

Medications Used During or Following Resuscitation of the Newborn

[Table of medications and dosages]

*Note: Endotracheal dose may not result in effective plasma concentration of drug, so vascular access should be established as soon as possible.

Drugs given endotracheally require higher dosing than when given IV.

American Academy of Pediatrics

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Support in part by Fisher & Paykel Healthcare
NRP--Has it done any good?
Pathophysiology of Adult Cardiac Arrest
Mechanisms of Cardiac Arrest in Neonates

Blood pressure trends upward during the asphyxial process.
Neurophysiology of Resuscitation

Apnea

Hypoxemia → Bradycardia → Vasoconstriction → Hypercarbia
Ventilation in Neonatal Resuscitation

- 1950’s, investigators showed hypopharyngeal structures occluded airway, making chest compressions ineffective for ventilation--this was not the case with mouth to mouth
- 1958, the self-inflating bag introduced
Physiological Impediments to Artificial Ventilation in the Newborn

- Neural Reflexes
- Establishment of FRC
- Lung Liquid Clearance
- Airway Closure
- Alveolar Opening Pressure

Bag-Mask Ventilation
Effects of Artificial Ventilation on Resuscitation

Artificial Ventilation

- Hering-Breuer (overinflation) → Apnea
- Trigeminal Reflex (pressure from face mask) → Bradycardia
- Stretch Receptors → Cardioacceleration
- Reflex of Head → Breathing

- Oxygenation
Airway Closure

ECoG

CBF

Airflow

Airway Pressure

Opens Larynx

Closes Larynx

Diaphragm
Alveolar Opening Pressure

Inspiratory pressure that must be overcome to begin delivering a tidal volume

- Spontaneously Breathing
  - Not present... that is, some flow for any change in pressure

- Asphyxiated, BVM ventilated
  - 13-32 cm H₂O in asphyxiated neonates receiving PPV
Establishment of FRC

- Spontaneously breathing
  - 1st few breaths are exhaled against closed glottis, generating 71 cm H$_2$O pressure

- Asphyxiated, BVM Ventilated
  - Difficult to mimic this with BVM ventilation
Lung Liquid Clearance

- Spontaneously
  - Spontaneously breathing
    - Negative pressure breathing rapidly clears lung liquid

- Asphyxiated, BVM Ventilated
  - Median pressure to move chest during first 10 breaths is 40 cm H$_2$O
  - Pop-off valves set at 30-35 cm H$_2$O
Ventilation During Cardiac Arrest

Angelos 1992
Ventilation During Cardiac Arrest

pCO2 before and during CPR

Grundler 1986
Oxygen in Newborn Resuscitation

• 1891, Bonnaire first gave oxygen to a “blue baby” and concluded:

“Whenever there is insufficient pulmonary haematosi, either from obstruction of the respiratory passages or from weak action of the mechanical apparatus of respiration, or from want of excitation of the respiratory nerve-centre, oxygen administration is indicated. Apparent death in the newborn is, therefore, the first indication…”
Advantages of 100% Oxygen

• Overcome diffusion barriers
  – lung liquid
  – lung disease

Normal

Diffusion Barrier
Advantages of 100% Oxygen

- Pulmonary Vasodilation
Physiology of 100% Oxygen

Alveolar Gas Equation with $\text{FiO}_2 = 0.21$ and $\text{pCO}_2 = 40$

$$P_{A\text{O}_2} = (713 \times 0.21) - 40 = 110 \text{ torr}$$

Assume 0.45 aA gradient, $\text{PO}_2 = 50 \text{ torr}$

Alveolar Gas Equation with $\text{FiO}_2 = 1.0$ and $\text{pCO}_2 = 40$

$$P_{A\text{O}_2} = (713 \times 1.0) - 40 = 673 \text{ torr}$$

Assume 0.45 aA gradient, $\text{PO}_2 = 300 \text{ torr}$
Physiology of 100% Oxygen

Oxygen Content = (1.34 x Hb x O₂ saturation) + 0.003 x pO₂

For \( pO_2 \) of 25 torr and Hb 17:

\[
\text{Oxygen Content} = (1.34 \times 17 \times 0.63) + 0.003 \times 25
\]

\[= 14.3 + 0.1 = 14.4\]

For \( pO_2 \) of 50 torr and Hb 17:

\[
\text{Oxygen Content} = 21.7 + 0.15 = 20.9\]

For \( pO_2 \) of 300 torr and Hb 17:

\[
\text{Oxygen Content} = 22.8 + 0.9 = 23.7\]
Room Air vs 100% in Resuscitation of Lambs

Hutchison, 1987
Blood Pressure During Resuscitation in Intact Animals

Rootwelt et al, 1992

MAP (mmHg)

Hypoxemia
Reoxygenation

Room Air
100% Oxygen
Heart Rate During Resuscitation in Intact Animals

Rootwelt et al, 1992
ELECTRONIC ARTICLE:  
Resuscitation of Asphyxiated Newborn Infants With Room Air or Oxygen: An International Controlled Trial: The Resair 2 Study

Ola Didrik Saugstad*, Terje Rootwelt*, and Odd Aalen

From the * Department of Pediatric Research, National Hospital, Oslo, Norway, and the Section of Medical Statistics, University of Oslo, Oslo, Norway.
Resair 2 Study

TRIAL PROFILE

703 enrolled

excluded:
94 not fulfilling inclusion criteria

609 included

288 Room air

321 100% oxygen
Resair 2 Study

Heart rate

Beats per minute

Time (minutes after birth)

- Room air
- Oxygen
Resair 2 Study

Apgar scores

* p<0.05
Resair 2 Study

Proportion Not Breathing

100%

RA
TABLE 3

Number of Registered Infants With Adverse Outcome

<table>
<thead>
<tr>
<th>Event</th>
<th>RA</th>
<th>O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death within 7 da</td>
<td>35/288 (12.2%)</td>
<td>48/321 (15.0%)</td>
</tr>
<tr>
<td>Death within 28 da</td>
<td>40/288 (13.9%)</td>
<td>61/321 (19.0%)</td>
</tr>
<tr>
<td>Death within 7 d or HIE grade II or IIIa</td>
<td>61/288 (21.2%)</td>
<td>76/321 (23.7%)</td>
</tr>
<tr>
<td>HIE grade II or IIIa</td>
<td>47/288 (16.3%)</td>
<td>55/321 (17.1%)</td>
</tr>
</tbody>
</table>
### Room Air vs 100%

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>84</td>
<td>431</td>
<td>609</td>
<td>40</td>
<td>151</td>
</tr>
<tr>
<td>Inclusion criteria</td>
<td>Birthweight &gt;999 g with apnoea, HR &lt; 80 bpm, or both</td>
<td>Birthweight &gt;1000 g with HR &lt;100 bpm, apnoeic, or both, and unresponsive to stimulation.</td>
<td>Birthweight 999 g with apnoea or gasping, HR &lt;80 bpm, or both</td>
<td>Term infants with apnoea, hypotonia, unresponsive to stimuli and HR &lt; 80 bpm, or both</td>
<td>Birth weight &gt;999 g Term infants with apnoea, hypotonia, unresponsive to stimuli, HR &lt; 80 bpm, and pH &lt;7.05</td>
</tr>
<tr>
<td>Air group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birthweight (g)</td>
<td>2410 (540)</td>
<td>2529 (629)</td>
<td>2600 (1320-4078)*</td>
<td>3380 (318)</td>
<td>3160 (240)</td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td>38±4 (1.9)</td>
<td>37.9 (2.9)</td>
<td>38 (32-42)*</td>
<td>38.6 (1.7)</td>
<td>38.9 (1.6)</td>
</tr>
<tr>
<td>Umbilical arterial pH</td>
<td>7±11 (0.14)</td>
<td>7.11 (0.04)</td>
<td>7.11 (0.04)</td>
<td>7.09 (0.07)</td>
<td>7.09 (0.07)</td>
</tr>
<tr>
<td>Oxygen group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birthweight (g)</td>
<td>2410 (540)</td>
<td>2529 (629)</td>
<td>2560 (1303-3900)*</td>
<td>3190 (245)</td>
<td>3220 (168)</td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td>38±1 (2.6)</td>
<td>38.1 (2.6)</td>
<td>38 (32-42)*</td>
<td>40.2 (0.8)</td>
<td>40.5 (1.1)</td>
</tr>
<tr>
<td>Umbilical arterial pH</td>
<td>7±12 (0.18)</td>
<td>7.09 (0.04)</td>
<td>7.09 (0.04)</td>
<td>7.02 (0.3)</td>
<td>7.02 (0.3)</td>
</tr>
<tr>
<td>Methodology</td>
<td>Quasi-randomised unmasked</td>
<td>Quasi-randomised unmasked</td>
<td>Quasi-randomised unmasked</td>
<td>Randomised, masked to caregivers and assessors of outcome</td>
<td>Randomised, masked to caregivers and assessors of outcome</td>
</tr>
<tr>
<td>Long-term follow-up</td>
<td>No</td>
<td>No</td>
<td>Yes (paediatrician at 18–24 months to assess cerebral palsy and developmental milestones)</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Data are mean (SD) unless otherwise indicated. HR=heart rate; bpm=beats per minute. *Median (95% CI).
# Results of Trials

<table>
<thead>
<tr>
<th>Event</th>
<th>Studies</th>
<th>Air</th>
<th>100% oxygen</th>
<th>RR (95% CI)</th>
<th>Risk difference (95% CI)</th>
<th>Number needed to treat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death at latest follow-up*</td>
<td>4\textsuperscript{13,14,16,17}</td>
<td>70/616</td>
<td>107/659</td>
<td>0.71 (0.54 to 0.94)</td>
<td>−0.05 (−0.08 to −0.01)</td>
<td>20</td>
</tr>
<tr>
<td>Death in first week</td>
<td>4\textsuperscript{13,14,16,17}</td>
<td>65/616</td>
<td>94/659</td>
<td>0.75 (0.56 to 1.00)</td>
<td>−0.04 (−0.07 to −0.00)</td>
<td></td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>1\textsuperscript{19}</td>
<td>9/91</td>
<td>9/122</td>
<td>1.34 (0.55 to 3.24)</td>
<td>0.03 (−0.05 to 0.10)</td>
<td></td>
</tr>
<tr>
<td>Not walking†</td>
<td>1\textsuperscript{19}</td>
<td>10/91</td>
<td>13/122</td>
<td>1.03 (0.47 to 2.25)</td>
<td>0.00 (−0.08 to 0.09)</td>
<td></td>
</tr>
<tr>
<td>No words†</td>
<td>1\textsuperscript{19}</td>
<td>6/91</td>
<td>3/122</td>
<td>2.68 (0.69 to 10.44)</td>
<td>0.04 (−0.02 to 0.10)</td>
<td></td>
</tr>
<tr>
<td>Abnormal development</td>
<td>1\textsuperscript{19}</td>
<td>14/91</td>
<td>12/122</td>
<td>1.56 (0.76 to 3.22)</td>
<td>0.06 (−0.04 to 0.15)</td>
<td></td>
</tr>
<tr>
<td>Time to first breath &gt;3 minutes</td>
<td>1\textsuperscript{13}</td>
<td>28/284</td>
<td>60/321</td>
<td>0.53 (0.35 to 0.80)</td>
<td>−0.09 (−0.14 to −0.03)</td>
<td>11</td>
</tr>
<tr>
<td>5-minute Apgar score &lt;7</td>
<td>1\textsuperscript{13}</td>
<td>71/288</td>
<td>102/321</td>
<td>0.78 (0.60 to 1.00)</td>
<td>−0.07 (−0.14 to −0.00)</td>
<td></td>
</tr>
<tr>
<td>HIE Sarnat grade# 2 or 3</td>
<td>3\textsuperscript{13,14,17}</td>
<td>87/540</td>
<td>112/584</td>
<td>0.84 (0.65 to 1.08)</td>
<td>−0.03 (−0.07 to 0.01)</td>
<td></td>
</tr>
<tr>
<td>Failure of resuscitation</td>
<td>4\textsuperscript{13,15,16,17}</td>
<td>162/593</td>
<td>182/638</td>
<td>0.96 (0.81 to 1.14)</td>
<td>−0.01 (−0.06 to 0.04)</td>
<td></td>
</tr>
</tbody>
</table>

Data are number. HIE=hypoxic ischaemic encephalopathy. NNT=number needed to treat (calculated for significant results). *Deaths reported in first week\textsuperscript{14,16,17} or in first 28 days of life.\textsuperscript{12}
†In those followed-up at 18–24 months.
Meta-analysis

Table of Meta-analysis Results:

<table>
<thead>
<tr>
<th>Study</th>
<th>RR (95% CI)</th>
<th>Test for heterogeneity p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death in the neonatal period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramji, 1993</td>
<td>0.75 (0.18–3.15)</td>
<td></td>
</tr>
<tr>
<td>Saugstad, 1998</td>
<td>0.73 (0.51–1.05)</td>
<td></td>
</tr>
<tr>
<td>Ramji, 2003</td>
<td>0.68 (0.43–1.08)</td>
<td></td>
</tr>
<tr>
<td>Vento, 2003</td>
<td>0.49 (0.05–5.33)</td>
<td></td>
</tr>
<tr>
<td>Pooled estimate (95% CI)</td>
<td>0.71 (0.54–0.94)</td>
<td></td>
</tr>
<tr>
<td>Hypoxic ischaemic encephalopathy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramji, 1993</td>
<td>2.00 (0.39–10.34)</td>
<td></td>
</tr>
<tr>
<td>Saugstad, 1998</td>
<td>0.95 (0.67–1.36)</td>
<td></td>
</tr>
<tr>
<td>Ramji, 2003</td>
<td>0.69 (0.47–1.00)</td>
<td></td>
</tr>
<tr>
<td>Vento, 2003</td>
<td>0.84 (0.65–1.08)</td>
<td></td>
</tr>
<tr>
<td>Pooled estimate (95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure of resuscitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saugstad, 1998</td>
<td>0.92 (0.71, 1.21)</td>
<td></td>
</tr>
<tr>
<td>Vento, 2001</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Ramji, 2003</td>
<td>0.97 (0.77, 1.22)</td>
<td>Not estimable</td>
</tr>
<tr>
<td>Vento, 2003</td>
<td>1.38 (0.46, 4.16)</td>
<td></td>
</tr>
<tr>
<td>Pooled estimate (95% CI)</td>
<td>0.96 (0.81, 1.14)</td>
<td></td>
</tr>
<tr>
<td>Test for heterogeneity p</td>
<td>0.78</td>
<td></td>
</tr>
</tbody>
</table>
O2 Use in Premies

Assessed for eligibility (n=571)

NOT RANDOMIZED (n=465)
Did not meet inclusion criteria (n=103)
Refused to participate (n=0)
Unable to attend delivery (n=337)
Twin delivery—1 twin randomized (n=24)
Instrument failure (n=1)

Randomly assigned (n=106)

Low-Oxygen Group
Allocated to intervention (n=34)
Received allocated intervention (n=34)

Moderate-Oxygen Group
Allocated to intervention (n=34)
Received allocated intervention (n=34)

High-Oxygen Group
Allocated to intervention (n=38)
Received allocated intervention (n=38)

Analysis

Low-Oxygen Group
Analyzed (n=34)
Treatment failure (n=8)
Excluded from analysis (n=0)

Moderate-Oxygen Group
Analyzed (n=34)
Treatment failure (n=3)
Excluded from analysis (n=0)

High-Oxygen Group
Analyzed (n=38)
Treatment failure (n=1)
Excluded from analysis (n=0)

PEDiATRICS 128:Issue 2, 2011
O2 Use in Premies
Origin of Present Dosage of Epinephrine

- Redding and Pearson originally used 1 mg in dogs weighing approximately 10 kg
  - Equates to 0.1 mg/kg
- Adult recommendations are 0.5-1.0 mg, possibly based on the dose used by Redding
  - In a 70 kg patient, this would equate to 0.007-0.014 mg/kg.
- Current dosage recommendation in neonates is 0.01-0.03 mg/kg, probably extrapolated from adult dosing guidelines.
Problem

If the dose of epinephrine used by Redding et al has merit, then the current recommendations may lead to serious underdosing in adults and, by extrapolation, in children.
“Optimum” Dose of Epinephrine

Diastolic BP (mmHg)

"Optimum" Dose of Epinephrine

Coronary Perfusion Pressure
(change from baseline mmHg)

Paradis et al; JAMA 1991
“Optimal” Dose of Epinephrine

Return of Spontaneous Circulation (percentage)

“Optimal” Dose of Epinephrine

Blood Pressure and Cardiac Output During Resuscitation with Epi

Burchfield et al Resuscitation 1993
Complications of Epinephrine in Neonatal Resuscitation

- Myocardial necrosis
- Mechanical injury to the mitral valve.
- Subendocardial hemorrhage
- Pulmonary edema
- Ischemic necrosis of the liver
- Cortical hemorrhage in the kidney
- Ischemic enterocolitis

Karch SB: *Am J Forensic Med Path* 1990
Present Recommendations for Epinephrine Use

• Heart rate <60 beats per min despite 30 sec of CPR.

• Heart rate =0.
  – IV: 0.1-0.3 mL/kg of 1:10,0000 (0.01-0.03 mg/kg)

• Endotracheally, 1 mL/kg (max of 3 mL)

• Repeat every 3-5 min
Sodium Bicarbonate in Resuscitation

$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow H_2O + CO_2$
In-Utero Passage of Meconium

- Associated with fetal hypoxia
  - Intestinal ischemia followed by hyperperistalsis (Van Liere, 1942)
  - Meconium and reduced umbilical venous oxygen (Walker, 1954)
  - Autopsy studies of fetal asphyxia showing no meconium in intestine (White, 1955)
In-Utero Passage of Meconium
Normal Physiology

Usher, 1988

39-40 Weeks
41+ Weeks
42+ Weeks

% with Meconium
Meconium Aspiration Epidemiology

- 4,000,000 Births per Year
- 520,000 Meconium Stained
- 26,000 Develop MAS
- 7800 Mechanical Ventilation
- 1000 Die
Suction on Perineum?

38,324 pregnant women assessed for eligibility

3249 (9%) had MSAF

735 excluded

2514 infants randomised

1263 assigned suction
1176 suctioned
87 not suctioned

18 did not meet entry criteria

1263 analysed.

1251 assigned no suction
1225 not suctioned
26 suctioned

1251 analysed

15 did not meet entry criteria
## Results

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=1263)</th>
<th>No suction (n=1251)</th>
<th>Relative risk (95% CI)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAS</td>
<td>52 (4%)</td>
<td>47 (4%)</td>
<td>0.9 (0.6–1.3)</td>
<td>.</td>
</tr>
<tr>
<td>Need for mechanical</td>
<td>24 (2%)</td>
<td>18 (1%)</td>
<td>0.8 (0.4–1.4)</td>
<td>.</td>
</tr>
<tr>
<td>ventilation for MAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>9 (1%)</td>
<td>4</td>
<td>0.4 (0.1–1.5)</td>
<td>.</td>
</tr>
<tr>
<td>Need for endotracheal</td>
<td>106 (8%)</td>
<td>113 (9%)</td>
<td>1.1 (0.8–1.4)</td>
<td>.</td>
</tr>
<tr>
<td>intubation, suction and</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPV in the delivery room</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Other respiratory</td>
<td>61 (5%)</td>
<td>79 (6%)</td>
<td>1.3 (0.9–1.8)</td>
<td>.</td>
</tr>
<tr>
<td>disorders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>3</td>
<td>3</td>
<td>1.0 (0.2–5.0)</td>
<td>.</td>
</tr>
</tbody>
</table>

### Range of 1-min Apgar scores

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=1263)</th>
<th>No suction (n=1251)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>22 (2%)</td>
<td>15 (1%)</td>
<td>0.29</td>
</tr>
<tr>
<td>4–6</td>
<td>65 (5%)</td>
<td>73 (6%)</td>
<td></td>
</tr>
<tr>
<td>7–10</td>
<td>1174 (93%)</td>
<td>1163 (93%)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### Range of 5-min Apgar scores

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=1263)</th>
<th>No suction (n=1251)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>0</td>
<td>0</td>
<td>0.29</td>
</tr>
<tr>
<td>4–6</td>
<td>13 (1%)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>7–10</td>
<td>1230 (97%)</td>
<td>1231 (98%)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### Duration of oxygen treatment (days) in infants with MAS (mean, SD)

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=52)</th>
<th>No suction (n=47)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.7, 8.8</td>
<td>5.1, 7.1 (n=52)</td>
<td>5.1, 7.1 (n=47)</td>
<td>0.91</td>
</tr>
</tbody>
</table>

### Duration of mechanical ventilation (days) in infants with MAS (mean, SD)

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=21)</th>
<th>No suction (n=14)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1, 4.9</td>
<td>4.2, 4.6 (n=21)</td>
<td>4.2, 4.6 (n=14)</td>
<td>0.49</td>
</tr>
</tbody>
</table>

### Duration of hospital care (days) in infants with MAS (mean, SD)

<table>
<thead>
<tr>
<th></th>
<th>Suction (n=50)</th>
<th>No suction (n=43)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2, 10.7</td>
<td>9.0, 8.6 (n=50)</td>
<td>9.0, 8.6 (n=43)</td>
<td>0.14</td>
</tr>
</tbody>
</table>
Risks for MAS

- Cesarean vs. Vaginal Delivery
- < 5 prenatal visits
- Moderately thick vs. thin MSAF
- Thick MSAF vs. thin MSAF
- Thick vs. moderately thick MSAF
- No oropharyngeal suctioning
- Meconium present in trachea
- Abnormal FHR monitoring
- 1-minute Apgar < 7
- 5-minute Apgar < 7
- Oligohydramnios
- Male gender

Odds Ratios and 95% Confidence Intervals
Risks for all respiratory distress, not MAS

- Cesarean vs. Vaginal Delivery
- < 5 prenatal visits
- Moderately thick vs. thin MSAF
- Thick MSAF vs. thin MSAF
- Thick vs. moderately thick MSAF
- No oropharyngeal suctioning
- Meconium present in trachea
- Abnormal FHR monitoring
- 1-minute Apgar < 7
- 5-minute Apgar < 7
- Oligohydramnios
- Male gender (N.S.)

Odds Ratios and 95% Confidence Intervals
ET Suction of Meconium


<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Intubate (n = 1051)</th>
<th>Expectant (n = 1043)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Racial background</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>483 (46.0%)</td>
<td>483 (46.3%)</td>
<td>NS</td>
</tr>
<tr>
<td>Black</td>
<td>234 (22.3%)</td>
<td>251 (24.1%)</td>
<td>NS</td>
</tr>
<tr>
<td>Hispanic</td>
<td>253 (24.1%)</td>
<td>233 (22.3%)</td>
<td>NS</td>
</tr>
<tr>
<td>Asian</td>
<td>73 (6.9%)</td>
<td>68 (6.5%)</td>
<td>NS</td>
</tr>
<tr>
<td>Other</td>
<td>8 (0.8%)</td>
<td>8 (0.8%)</td>
<td>NS</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>530 (50.4%)</td>
<td>523 (50.1%)</td>
<td>NS</td>
</tr>
<tr>
<td>Female</td>
<td>521 (49.6%)</td>
<td>520 (49.9%)</td>
<td>NS</td>
</tr>
<tr>
<td>Range of 1-min Apgar scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-3</td>
<td>36 (3.5%)</td>
<td>14 (1.3%)</td>
<td>( P = .0018 )</td>
</tr>
<tr>
<td>4-6</td>
<td>139 (13.2%)</td>
<td>51 (4.9%)</td>
<td>( P = .0001 )</td>
</tr>
<tr>
<td>7-10</td>
<td>876 (83.3%)</td>
<td>978 (93.8%)</td>
<td>( P &lt; .0001 )</td>
</tr>
<tr>
<td>Range of 5-min Apgar scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-3</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>NS</td>
</tr>
<tr>
<td>4-6</td>
<td>14 (1.3%)</td>
<td>8 (0.8%)</td>
<td>NS</td>
</tr>
<tr>
<td>7-10</td>
<td>1037 (98.7%)</td>
<td>1035 (99.2%)</td>
<td>NS</td>
</tr>
<tr>
<td>Occurrence of MAS (n = 62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>34/1051 (3.2%)</td>
<td>28/1043 (2.7%)</td>
<td>NS</td>
</tr>
<tr>
<td>Thin MSAF</td>
<td>5/447 (1.1%)</td>
<td>2/453 (0.4%)</td>
<td>NS</td>
</tr>
<tr>
<td>Moderately-thick MSAF</td>
<td>7/301 (2.3%)</td>
<td>6/307 (2.0%)</td>
<td>NS</td>
</tr>
<tr>
<td>Thick MSAF</td>
<td>22/303 (7.3%)</td>
<td>20/283 (7.1%)</td>
<td>NS</td>
</tr>
<tr>
<td>Occurrence of other respiratory disorders (n = 87)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>40/1051 (3.8%)</td>
<td>47/1043 (4.5%)</td>
<td>NS</td>
</tr>
<tr>
<td>Thin MSAF</td>
<td>6/447 (1.3%)</td>
<td>8/453 (1.8%)</td>
<td>NS</td>
</tr>
</tbody>
</table>
Discontinuation of Resuscitation

• After 10 minutes of continuous and adequate resuscitative efforts, discontinuation of resuscitation may be justified if there are no signs of life (no heart beat and no respiratory effort).
Summary

• Newborn resuscitation has little direct evidence based practices
• NRP has been helpful in establishing guidelines “Everyone singing from the same sheet of music…”
• Because it is published in NRP does not mean that we should stop questioning and trying to improve