Newborn Resuscitations: Guidelines update 2010

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- I have no actual or potential conflict of interest in relation to this presentation.
The Process

• Every five years, the International Liaison Committee on Resuscitation (ILCOR) reviews evidence relating to resuscitation.

• One component part of committee is Neonatal Resuscitation Group.

• Questions are developed which prompt exhaustive literature reviews, worksheet completion and discussion. These identify evidence pro, con, neutral.
The Process

- Based on evidence, a consensus on Science is developed, upon which are based treatment recommendations
- Based on these, NRP considers changes in practice and treatment recommendations
- If evidence is lacking, treatment recommendations stay the same, even if there is no evidence for them
Without specific evidence to recommend a change, the ruling on the field stands...
Some important NON changes

• Resuscitation of the NEWLY born remains: ABC.
  • Airway, Breathing, Circulation
    • Almost all depression at birth is primarily respiratory- breathe first, think cardiac later

• In contrast, in older children and adults, the algorithm is now CAB (focused on chest compressions)

• Keep babies warm, especially premature infants
  • May be different in depressed term/late preterm
2010 Guidelines: Several changes

- Suctioning
- Temperature Control
- Assessment of oxygen need
- Administration of air or supplemental oxygen
  - Term, Late preterm
  - Premature
- Drugs

- This is a TEAM sport!
Initial Questions reduced to THREE:

Vigorous = normal, regardless of AF

Oximetry is the standard!

In its absence: adequate ventilation is more important than higher FiO2
Suctioning

- Evidence indicates suctioning can cause bradycardia during resuscitation, or pulmonary decompensation and reduced cerebral blood flow in intubated patients
- Suctioning secretions can decrease pulmonary resistance
- Clear Fluid: limit suctioning to those with obvious obstruction
Suctioning

- Meconium: Suction *non vigorous* babies
  - Depressed infants with MSF are at increased risk of MAS
  - Tracheal suctioning has not been associated with less MAS or mortality, other than single trial with historical controls
  - There is no evidence to change practice of intubating and suctioning non vigorous babies
  - Attempts should not significantly delay PPV if there is bradycardia
- Leave VIGOROUS babies with mother!
Temperature Control

- All newborns are at risk for hypothermia after birth:
  - Relatively cool environment
  - High surface area to volume
- Risk factor for morbidity and mortality
- Babies <1500 g are at markedly increased risk:
- VON (2008) 51% had admission temperature to NICU < 36.5 degrees C. BWH data was about the same.
Can hypothermia be prevented?

- Plastic Wrap
  - The baby, **undried**, is immediately placed in plastic wrap covering body and extremities
- Delivery Room Temperature 26 degrees
- Exothermic mattresses (Sodium Acetate Gel)
Occlusive Plastic Wrap

- Evaluated in many studies- systemic review done
  - 3 Randomized controlled trials
  - 5 historical controlled trials
- Gest. age < 28-33 weeks, < 1000g
- Original data was reviewed and analyzed
## Admission Temperature

<table>
<thead>
<tr>
<th>Study or sub-category</th>
<th>N Wrap mean (SD)</th>
<th>N Non-Wrap mean (SD)</th>
<th>WMD (random) 95% CI</th>
<th>WMD (random) 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 RCT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knobel 2004</td>
<td>41 36.50 (0.79)</td>
<td>47 36.00 (0.79)</td>
<td>↑↑↑ 0.50 [0.17, 0.83]</td>
<td></td>
</tr>
<tr>
<td>Vohra 1999</td>
<td>27 36.76 (0.55)</td>
<td>32 36.06 (1.15)</td>
<td>↑↑↑ 0.70 [0.25, 1.15]</td>
<td></td>
</tr>
<tr>
<td>Vohra 2004</td>
<td>27 36.50 (0.80)</td>
<td>26 35.60 (1.30)</td>
<td>↑↑↑ 0.90 [0.32, 1.48]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>95 105</td>
<td></td>
<td>↑↑↑ 0.63 [0.38, 0.87]</td>
<td></td>
</tr>
<tr>
<td>Test for heterogeneity: Chi² = 1.51 df = 2 (P = 0.47), I² = 0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 5.07 (P &lt; 0.00001)</td>
<td></td>
<td></td>
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<tr>
<td>02 HCT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bjorklund 2000</td>
<td>11 37.00 (0.38)</td>
<td>66 35.90 (0.89)</td>
<td>← ← 1.10 [0.79, 1.41]</td>
<td></td>
</tr>
<tr>
<td>Lenclen 2002</td>
<td>60 36.10 (0.60)</td>
<td>60 35.30 (0.70)</td>
<td>← ← 0.80 [0.57, 1.03]</td>
<td></td>
</tr>
<tr>
<td>Lyon 2003</td>
<td>45 37.00 (0.70)</td>
<td>185 35.70 (1.22)</td>
<td>← ← 1.30 [1.03, 1.57]</td>
<td></td>
</tr>
<tr>
<td>Meyer 2003</td>
<td>19 36.70 (0.60)</td>
<td>86 35.50 (0.70)</td>
<td>← ← 1.20 [0.89, 1.51]</td>
<td></td>
</tr>
<tr>
<td>Newton 2003</td>
<td>45 36.03 (0.93)</td>
<td>230 35.60 (0.90)</td>
<td>← ← 0.43 [0.13, 0.73]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>180 627</td>
<td></td>
<td>← ← 0.96 [0.66, 1.27]</td>
<td></td>
</tr>
<tr>
<td>Test for heterogeneity: Chi² = 23.37 df = 4 (P = 0.001), I² = 82.9%</td>
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<td></td>
<td></td>
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<tr>
<td>Test for overall effect: Z = 6.22 (P &lt; 0.00001)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test (95% CI)</td>
<td>275 732</td>
<td></td>
<td>← ← 0.87 [0.63, 1.11]</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.** Admission temperature.

No differences in respiratory outcomes, severe neurologic outcomes, or LOS.
**OR Temperature & Plastic Wrap**

<table>
<thead>
<tr>
<th>Epoch</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoch 1</td>
<td>Standard OR temperatures</td>
</tr>
<tr>
<td>Epoch 2</td>
<td>Increased OR temperature to 26 degrees</td>
</tr>
<tr>
<td>Epoch 3</td>
<td>Occlusive Plastic wrap used</td>
</tr>
</tbody>
</table>

**Table 2** Mean admission temperatures of infants in the three epochs in gestational age groups 24–27 weeks and 28–31 weeks gestation

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Mean admission temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24–27 weeks gestation (°C) (SD)</td>
<td>n = 17</td>
<td>n = 15</td>
<td>n = 10</td>
</tr>
<tr>
<td>Mean admission temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28–31 weeks gestation (°C) (SD)</td>
<td>n = 56</td>
<td>n = 20</td>
<td>n = 38</td>
</tr>
</tbody>
</table>

*Kruskal–Wallis test, P < 0.05 significant.

Kent AL, Williams J. *J Pediatr Child Health* 2008:44:325-331
No difference in survival, days of ventilation, days of oxygen, NEC, severe IVH or infection
Plastic Wrap and Exothermic Mattress

- Analysis of three case series:
  - Traditional care (drying and wrapping in towel)
  - Wrapping in standard food polyethylene bag
  - Wrapping in food bag, nursing on exothermic mattress
- Retrospective observational study, three different time periods, <30 weeks gestation

Plastic Wrap and Exothermic Mattress

Figure 1: Admission temperatures during the three time periods. Median admission temperature for the bag and mattress group was significantly higher ($P<0.001$) than either of the other two groups.
Plastic Wrap and Exothermic Mattress

- Hypothermia less frequent in “bag/mattress” group (26%) than “bag” (69%) or traditional care (84%)
- Mean increase of 1.04 degrees

**Table 2** Regression analyses of admission temperature (°C) against weight, gestation, admission age, mode of delivery and being placed on a mattress

<table>
<thead>
<tr>
<th></th>
<th>Univariate (coefficient and 95% CI)</th>
<th>Multivariate (coefficient and 95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of mattress</td>
<td>1.03 (0.69, 1.36)</td>
<td>1.04 (0.71, 1.38)</td>
</tr>
<tr>
<td>Birth weight (per 100 g)</td>
<td>0.08 (0.04, 0.15)</td>
<td>0.10 (0.04, 0.15)</td>
</tr>
<tr>
<td>Gestation (per week)</td>
<td>0.04 (−0.07, 0.16)</td>
<td></td>
</tr>
<tr>
<td>Cesarean Section</td>
<td>−0.23 (−0.56, 0.10)</td>
<td></td>
</tr>
<tr>
<td>Admission age (per minute)</td>
<td>−0.01 (−0.03, 0.01)</td>
<td></td>
</tr>
</tbody>
</table>
The evidence has mounted

- In 2005 thermal wraps were a suggested intervention
- Now, these interventions are RECOMMENDED

BUT, aren’t they a big pain to use??
- We have used them at BWH without complaints or problems
- Requires team work and clear identification of roles
Oxygen Delivery

- Too little, or too much oxygen can be harmful to the newborn
- Studies have shown the clinical assessment of cyanosis to be unreliable
- In order to best deliver oxygen:
  - We need a reliable measurement tool
  - We need to know what is normal
  - Is there information for premature babies?
2005 NRP: $O_2$ For Initiation of Resuscitation

- If resuscitation is started with less than 100% $O_2$, supplemental $O_2$ up to 100% should be administered if there is no appreciable improvement within 90 seconds following birth.

- If supplemental oxygen is unavailable, use air to deliver positive-pressure ventilation.
AHA/AAP Neonatal Resuscitation Program Guidelines 2006

*Endotracheal intubation may be considered at several steps.*
Should we ROUTINELY Expose Vigorous Late Preterm and Term Newborns in the Delivery Room to $O_2$?
Definitions

- Late Preterm and Term: > 35 weeks EGA

- Vigorous: Good respiratory effort and heart rate > 100 bpm, thus requiring no resuscitative efforts
What are Normal O₂ saturations in Vigorous Term Newborns in the DR?

- 3 min  66% (56-75%)
- 5 min  80% (55-85%)
- 7 min  83% (68-88%)

N=50 SVD, Term Vigorous

Fig. 3  SpO$_2$ rates, postductal circulation 2–20 min postnatal

What are Normal **Preductal** O2 Sats in Vigorous Term Newborns at Birth?

- 1 min 63% (53-68%)
- 2 min 70% (58-78%)
- 3 min 76% (64-87%)
- 4 min 81% (71-91%)
- 5 min 90% (79-91%)


Pre ductal readings are the ideal
Take Home Message

- Majority of evidence suggests it takes ~5-10 minutes for healthy, term newborns to reach $O_2$ saturations >90% (pink)

- Therefore, giving $O_2$ to vigorous, term infants before 5-10 minutes is **unnecessary.**

_How often do you think this happens now when pediatric team is present??_
Is $O_2$ in the Delivery Room better?

- We have increasing evidence that too much oxygen is not harmless in other clinical situations
  - Preemies:
    - Chronic Lung Disease
    - Retinopathy of Prematurity

- Newborns are relatively deficient in defense mechanisms that protect against oxygen toxicity and therefore too much oxygen may result in oxygen free radicals that are highly reactive and can cause damage to tissues
What Are Reactive Oxygen Species?

- Hyperoxemia caused by resuscitation with 100% oxygen produces oxygen free radicals and hydroperoxide which together are known as reactive oxygen species (ROS).
**Oxidant aggression**

- Supraphysiologic $O_2$
  - Resuscitation
  - Mechanical ventilation
- Infection/
  Inflammation
  - Inflammatory mediators
  - Free radicals release
- Ischemia/reperfusion
- Parenteral solution exposed to light
- Increased free circulating transition metals

**Deficient antioxidant defenses**

- Low antioxidant enzyme activity
  - Copper-zinc superoxide dismutase
  - Manganese superoxide dismutase
  - Glutathione peroxidase
- Low nonenzymatic antioxidants
  - Glutathione
  - Selenium
  - Zinc
  - Vitamin E
  - Vitamin C

↓

**Cell / Tissue injury**

↓

**Neonatal Diseases**

- Intraventricular Hemorrhage
- Periventricular Leukomalacia
- Chronic Lung Disease/Bronchopulmonary Dysplasia
- Retinopathy of Prematurity
- Necrotizing Enterocolitis
Oxygen Use

- Studies examining blood pressure, cerebral perfusion, and biochemical indicators of cell damage in asphyxiated animals resuscitated with 100% vs 21% oxygen show conflicting results.

- One study of preterm infants (33 weeks of gestation) exposed to 80% oxygen versus 21% found lower cerebral blood flow when compared with those stabilized with 21% oxygen.

- Some animal data indicate the opposite effect, that is, reduced blood pressure and cerebral perfusion with air vs 100% oxygen.
Consensus on Science for O₂

- Meta-analysis of 7 human studies of infants resuscitated with room air (RA) versus 100% O₂ [LOE 1]
  - Reduced Mortality
  - No evidence of harm
  - Other concentrations not studied
- However...
  - The 4 largest studies were not blinded
  - If no response after 90 sec, RA infants switched to 100% O₂
  - Other significant methodologic concerns regarding patient selection, randomization methods, and follow-up
- No data regarding RA vs O₂ for resuscitation of infants with
  - birth weight < 1000 g
  - congenital pulmonary or cyanotic heart disease
  - Asystole
Is Giving $O_2$ to a Vigorous Term Infant Harmful?

  - Retrospective association between supplementary oxygen exposure in the DR and childhood leukemia in Sweden
Is there a Potential for Harm?

  - Prospective association between any oxygen exposure in the DR and childhood acute lymphatic leukemia
    - 2.5X the risk of ALL (1.21-6.82)
    - > 3 minutes of \(O_2\) with BMV
      - 3.54X the risk of ALL (1.16-10.8)
Is there a Potential For Harm?

  - American Collaborative Perinatal Project 1959-1966
  - n=54,795 deliveries
  - Prospectively collected data now retrospectively reviewed for this question.
- If > 3 min $O_2$ exposure in the DR
  - 2.87X the risk for childhood cancer by age 8 (1.46-5.66)
O₂ For Initiation of Resuscitation

- Resuscitation should be focused on results (normally increasing oxygen saturations) not on oxygen concentration.
- For term and late preterm infants it makes sense to begin in RA and “wean-up” as dictated. There is no data on intermediate concentrations.
- If resuscitation is started with less than 100% O₂, supplemental O₂ up to 100% should be administered if there is no appreciable improvement within 90 seconds following birth.
- If supplemental oxygen is unavailable, it is fine to use air while delivering positive-pressure ventilation.
Do We Really Need Pulse Oximetry in the DR?

- NRP previously recommended using color to decide if oxygen is needed. Now an Oximeter is recommended

- How good are we at judging color?

  - Video Recording with Hi-fidelity color and simultaneous $\text{SaO}_2$ monitoring
  - Do clinicians agree whether infants are pink?
  - At what preductal $\text{SaO}_2$ are infants first perceived as pink?
Clinical Assessment of Infant Color at Delivery

$O_2$ Sat at Which Infant “Pink”

Can you get oximeter to work?

Table 1. Demographic data and times taken to apply patient sensor, signal processing, and time from birth to display oximetry data by gestation

<table>
<thead>
<tr>
<th></th>
<th>All infants (N = 175)</th>
<th>Preterm (&lt;37 weeks; N = 54)</th>
<th>Term infants (≥37 weeks; N = 121)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation (weeks)</td>
<td>37.5 (3.0)</td>
<td>33.5 (1.8)</td>
<td>39.3 (1.3)</td>
</tr>
<tr>
<td>Birth weight (g)</td>
<td>2953 (867)</td>
<td>1965 (557)</td>
<td>3393 (560)</td>
</tr>
<tr>
<td>5 minute Apgar</td>
<td>9 (9–9)*</td>
<td>9 (9–9)*</td>
<td>9 (9–9)*</td>
</tr>
<tr>
<td>1 minute Apgar†</td>
<td>8 (7–9)* n = 92</td>
<td>8 (7–9)* n = 37</td>
<td>8 (8–9)* n = 55</td>
</tr>
<tr>
<td>Time to apply sensor (seconds)</td>
<td>58 (21)</td>
<td>53 (16)</td>
<td>60 (23)</td>
</tr>
<tr>
<td>Time for signal processing (seconds)</td>
<td>16 (4)</td>
<td>16 (3)</td>
<td>16 (5)</td>
</tr>
<tr>
<td>Total time from birth to first data (seconds)</td>
<td>74 (22)</td>
<td>71 (20)</td>
<td>75 (23)</td>
</tr>
</tbody>
</table>

Healthy term and preterm infants—low cardiac output can reduce signal

You can get it on, but it takes TEAM work!!

What are Normal **Preductal** $O_2$ Sats in Vigorous Term Newborns at Birth?

- 1 min 63% (53-68%)
- 2 min 70% (58-78%)
- 3 min 76% (64-87%)
- 4 min 81% (71-91%)
- 5 min 90% (79-91%)


Pre ductal readings seem more reliable—not affected by shunting. After 5-10 minutes target levels might be those used in NICU.
The Practice: Term and Late Preterm babies

- Use Oximeter when:
  - Resuscitation anticipated
  - PPV continues beyond a few breaths
  - Cyanosis is persistent
  - Supplemental oxygen is being given

- Place probe on baby first, on RUE
- Attach to oximeter
- Cover probe to reduce extraneous light
# Preductal oxygen saturation targets

<table>
<thead>
<tr>
<th>Time</th>
<th>Target Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 minute</td>
<td>60-65%</td>
</tr>
<tr>
<td>2 minutes</td>
<td>65-70%</td>
</tr>
<tr>
<td>3 minutes</td>
<td>70-75%</td>
</tr>
<tr>
<td>4 minutes</td>
<td>75-80%</td>
</tr>
<tr>
<td>5 minutes</td>
<td>80-85%</td>
</tr>
<tr>
<td>10 minutes</td>
<td>85-95%</td>
</tr>
</tbody>
</table>
The Practice: Term and Late Preterm babies

- Monitor saturations, compare at interval times to posted chart. Team monitoring works best.
- Adjust oxygen as needed to achieve target saturation range
- Oximeter often helpful to monitor pulse
- Oximetry often not usable when cardiac output is low.
Prematures are different

- Neither Room Air or 100% oxygen are optimal
- Something in between is just right.
Resuscitation of ELBWs with 90% vs 30% oxygen

Escrig et al. Pediatrics 2008; 121;875-881
Resuscitation of premature infants with 100% oxygen or Room Air

Wang et al. Pediatrics 2008; 121: 1083-1089
Resuscitation of Preterm Newborns with RA versus 100% O$_2$
Use of Oxygen During Resuscitation in Preterm Infants

- To provide adequate, but avoid excessive tissue oxygenation in very preterm baby (less than ~32 weeks) during resuscitation at birth:
  - Use an O₂ blender and pulse oximeter during resuscitation.
  - Begin PPV or “blow-by” O₂ with some concentration between room air and 100%, but not either extreme.
  - No studies justify starting at any particular concentration. **Why is 60% a reasonable starting point?**
  - Adjust O₂ concentration up or down to achieve an O₂ saturation that gradually increases toward 90%, in a pattern like that of term babies.
  - Decrease O₂ as saturations rise over 93-95%.
# Preductal oxygen saturation targets

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<td>80-85%</td>
</tr>
<tr>
<td>10 minutes</td>
<td>85-95%</td>
</tr>
</tbody>
</table>
Use of Oxygen During Resuscitation of Preterm Infants

- If the heart rate does not respond by increasing rapidly to > 100 beats per minute, correct any ventilation problem and use 100% oxygen.

- If an oxygen blender and pulse oximeter is not available in the delivery room the resources and oxygen management described for a term baby are appropriate.

- There is no convincing evidence that a brief period of 100% oxygen during resuscitation will be detrimental to the preterm infant.
Optimal respiratory support

- Two large studies compared CPAP vs. intubation in delivery room:
- COIN trial compared CPAP with intubation in spontaneously breathing babies
- SUPPORT trial compared CPAP with intubation in large cohort
CPAP or intubation at birth

- COIN trial compared nasal CPAP or intubation at birth in babies 25-28 weeks gestation, mean BW ~950g
- 610 infants, spontaneously breathing at 5 minutes but with need for support
- Randomized to CPAP 8 cm or intubation and ventilation
- Intubation for unresponsive apnea, acidosis, or FiO₂ >.6
## Death or Need for Oxygen Treatment or Respiratory Support at 36 Weeks' Gestational Age, According to Gestational Age at Birth

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All Infants (25 to 28 Weeks' Gestation)</th>
<th>25 or 26 Weeks' Gestation</th>
<th>27 or 28 Weeks' Gestation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CPAP (N=307)</td>
<td>Intubation (N=303)</td>
<td>CPAP (N=100)</td>
</tr>
<tr>
<td>Death or oxygen treatment</td>
<td>33.9%</td>
<td>38.9%</td>
<td>53.0%</td>
</tr>
<tr>
<td>Death, oxygen treatment, or respiratory</td>
<td>35.2%</td>
<td>40.3%</td>
<td>55.3%</td>
</tr>
<tr>
<td>support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death before 36 weeks' gestation</td>
<td>6.5%</td>
<td>5.9%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Survivors treated with oxygen</td>
<td>29.3%</td>
<td>35.1%</td>
<td>46.0%</td>
</tr>
</tbody>
</table>

* Odds ratios are for the comparison between infants receiving nasal continuous positive airway pressure (CPAP) and those receiving intubation and ventilation.
Results

- No difference in death or BPD at 36 weeks corrected GA
- CPAP resulted in lower risk of death or oxygen at 28 days, but more pneumothoraces
- CPAP reduced surfactant
- Overall CPAP is not detrimental
CPAP or PPV

- SUPPORT Trial
  - 1310 Infants 24.0 - 27.6 weeks
  - I. CPAP +5 cm via T-piece resuscitator
  - II. Intubation in DR, surfactant < 1 hour
  - Strict criteria defined CPAP failure or extubation
  - All infants assigned to a treatment group
**Outcomes**

No difference in death or BPD incidence

No difference in incidence of complications or air leak

Lower rate of death in CPAP group among infants born at < 26 weeks

**Conclusion:**

CPAP is a reasonable alternative to intubation and surfactant in delivery room.
Results

- Two studies addressed somewhat different populations
- From each we can conclude that CPAP is a reasonable alternative to intubation and surfactant
- There may be benefits in some respiratory parameters, but also some increased risk
- Optimal respiratory support for most of these babies can be provided with CPAP or mechanical ventilation (PPV).
Medications—the list is short

- Rarely needed, ventilation is primary issue
- Epinephrine: No proven efficacy via endotracheal route, even at higher doses. May be considered while IV access is established
- Volume expansion for known or suspected blood loss
- Isotonic crystalloid solution or blood