Denise Cole, MS, RNC-NIC, C-ONQS

Newborn Transition

Transition Defined

- The period in which a fetus becomes a neonate, becoming an independent organism
- Adaptation to extrauterine life
- Carried out over hours (or days)
- Most difficult period in the human life cycle


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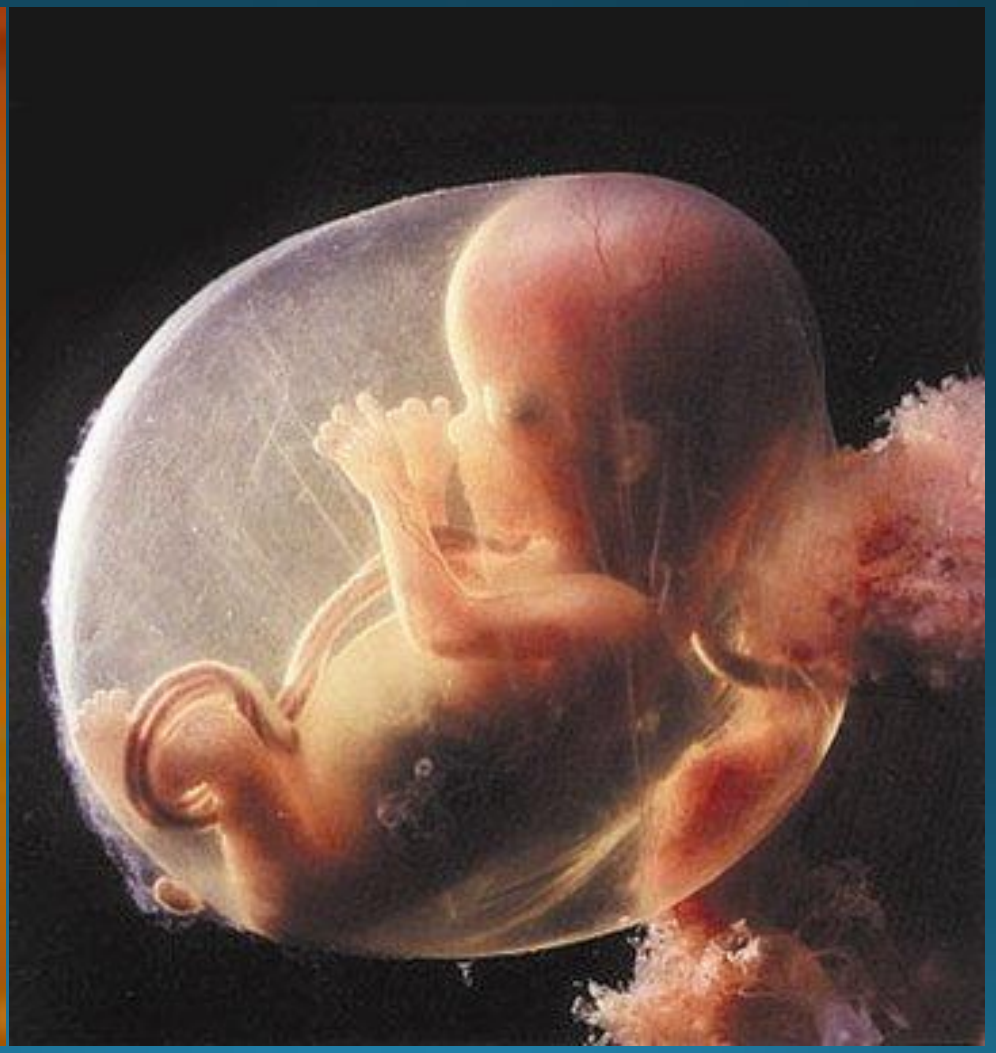
55058

Stages of Transition

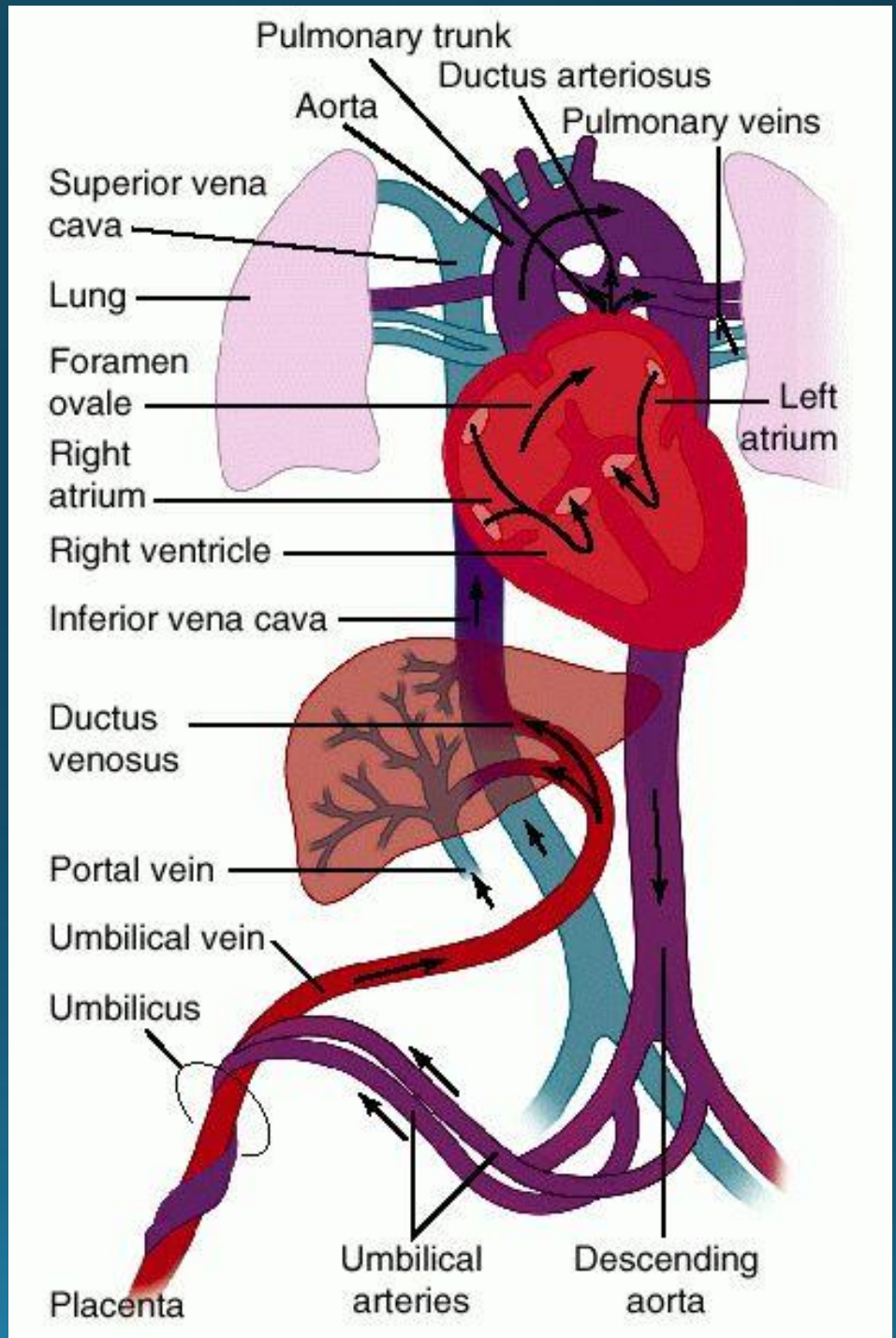
- Triggers of labor
  - Fetal adrenaline
  - Stress of labor (vaginal delivery of the head)
- Pressure changes related to loss of amniotic fluid and uterine contractions
- Entrance into the world, exposed to new stimuli
- First breath
- Clamping the cord

In the beginning . . .

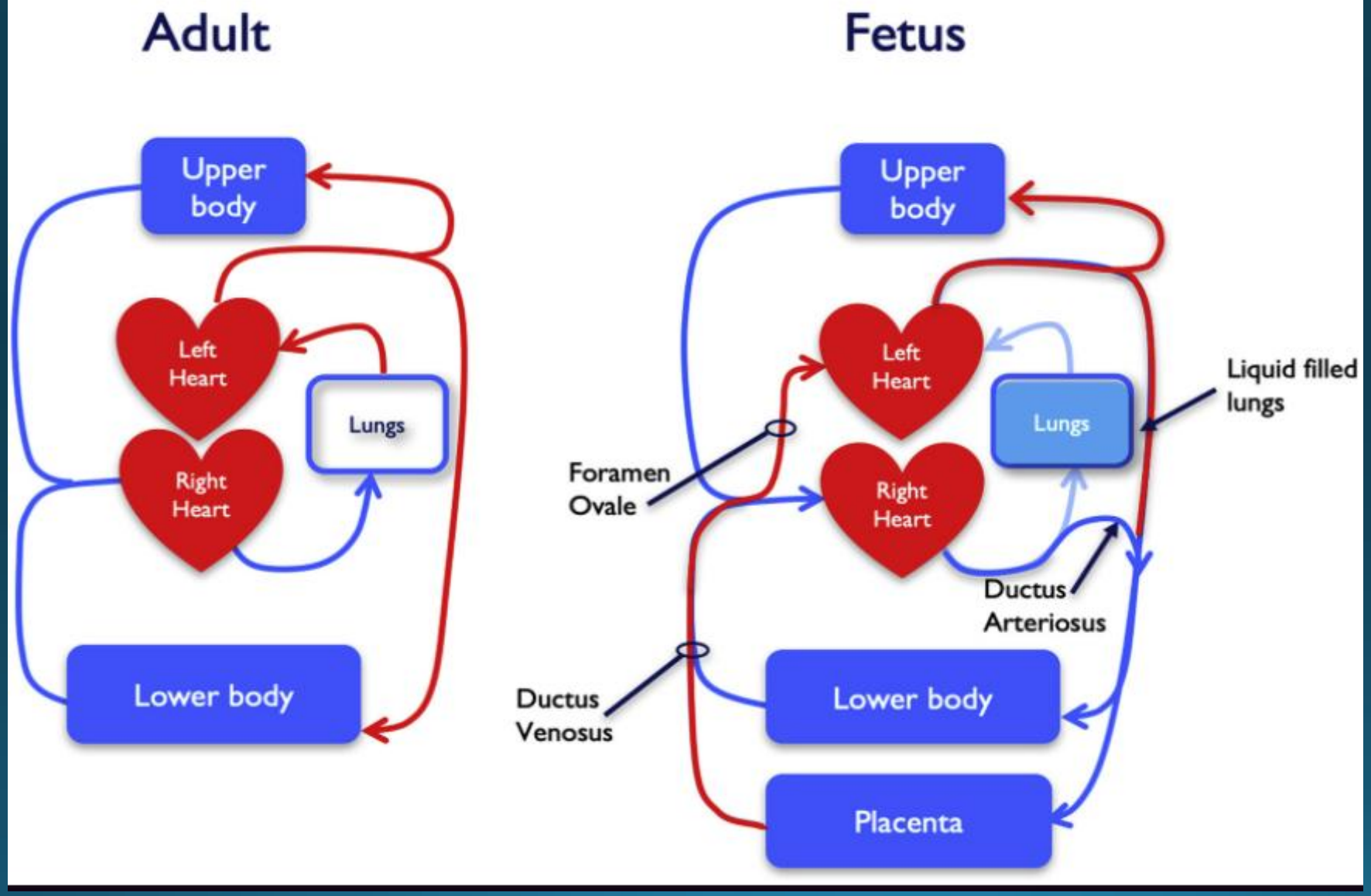


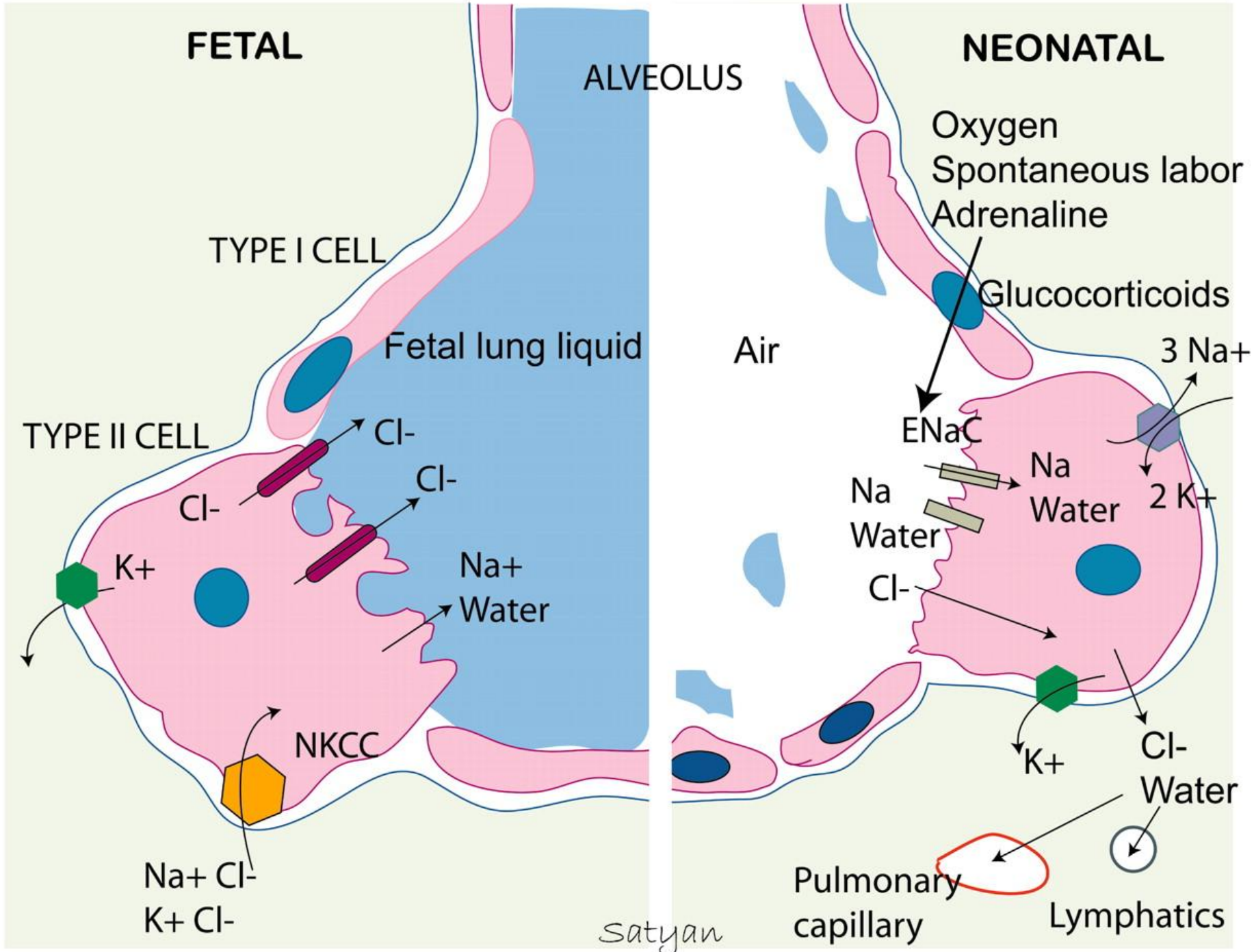
Fetal Circulation

- Lower PaO_2
  - Enters UV at 30-35 mmHg
  - Leaves UAs at 20-25 mmHg
- Fetal Hemoglobin (HbF)
- Presence of 3 ducts:
  - Ductus venosus
  - Foramen ovale
  - Ductus arteriosus



Fetal and Adult circulations




FETAL
ALVEOLUS
NEONATAL
TYPE I CELL
Fetal lung liquid
Air
Oxygen
Spontaneous labor
Adrenaline
Glucocorticoids
TYPE II CELL
Cl-
Cl-
Cl-
K+
Na+
Water
NKCC
Na+ Cl-
K+ Cl-
ENaC
3 Na+
Na
Water
Na
Water
2 K+
Cl-
K+
Cl-
Water
Pulmonary
capillary
Lymphatics
Satyan

Transition of the Cardiovascular System

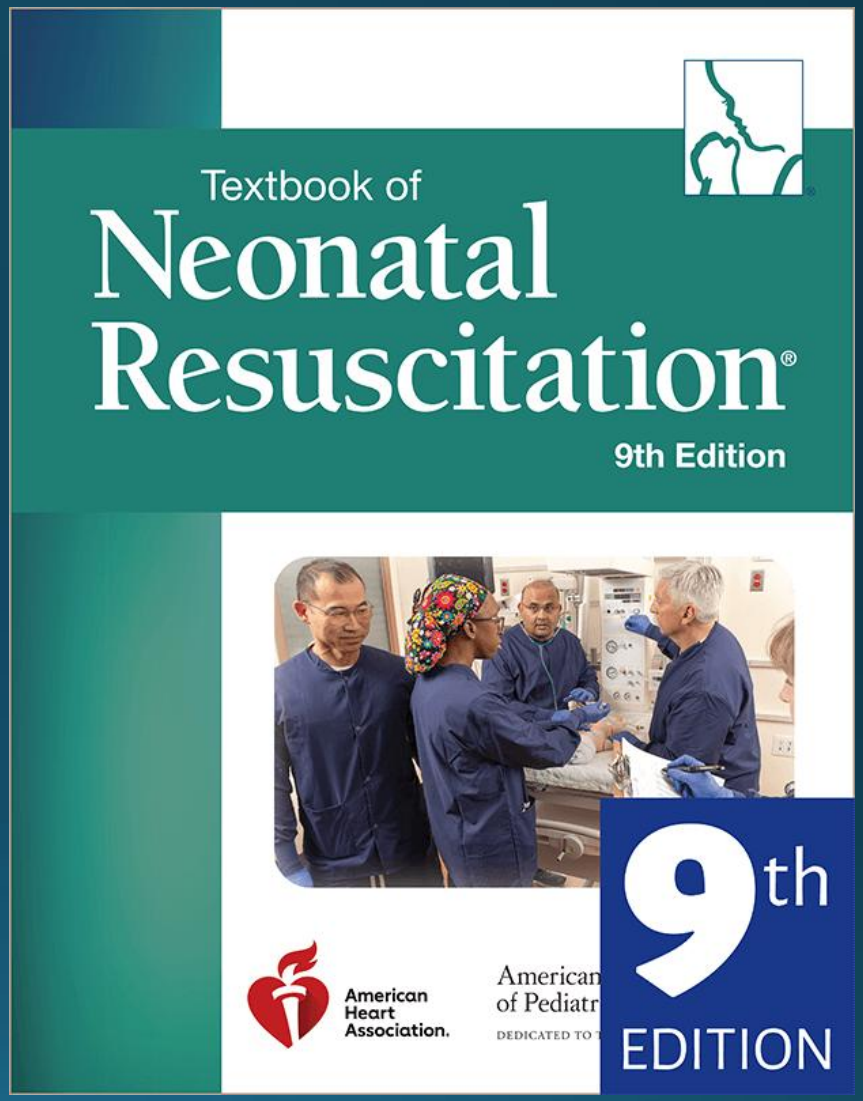
- Onset of ventilation
- Loss of placental circulation
  - Results in increase in systemic vascular resistance
- Rise in blood oxygen content
  - Causes drop in pulmonary vascular resistance
  - Flow through DA dramatically decreases

Speaking of the cord . . .

When should it be clamped?

“For most newborn infants who do not require immediate resuscitation, clamping the umbilical cord should be deferred for at least 60 seconds”

“Early (immediate) cord clamping is indicated when the placental circulation is not intact, such as after a placental abruption, bleeding placental previa, or cord avulsion”



9th Ed., 2025

ACOG
The American College of Obstetricians and Gynecologists

CLINICAL PRACTICE UPDATE

SEPTEMBER 2025

An Update to Clinical Guidance for Delayed Umbilical Cord Clamping After Birth in Preterm Neonates

This Clinical Practice Update was developed by the American College of Obstetricians and Gynecologists Committee on Clinical Consensus–Obstetrics in collaboration with Mark Turrentine, MD, Allison Bryant, MD, Adetola F. Louis-Jacques, MD, Jessica L. Illuzzi, MD, and Christopher M. Zahn, MD. The American College of Nurse-Midwives and the Association of Women's Health, Obstetrics and Neonatal Nurses endorse this Clinical Practice Update. The American Academy of Family Physicians affirms the value of this Clinical Practice Update.

CLINICAL RECOMMENDATIONS

Based on these findings, obstetrician–gynecologists and other obstetric care professionals should:

- Defer umbilical cord clamping for at least 60 seconds in preterm neonates born at less than 37 weeks of gestation who are deemed not to require immediate resuscitation at birth.
- In preterm neonates born at 28 0/7–36 6/7 weeks of gestation who do not receive deferred cord clamping, umbilical cord milking is a reasonable alternative to immediate cord clamping to improve neonatal hematologic outcomes.

Benefits of Delayed Cord Clamping

- Preterm:
  - improved transitional circulation
  - better establishment of red blood cell volume
  - decreased need for blood transfusion
  - lower incidence of necrotizing enterocolitis and intraventricular hemorrhage
  - Reduced incidence of death

- Term:
  - increases hemoglobin levels at birth and improves iron stores in the first several months of life
  - Favorable effects of developmental outcomes
  - Increased transfer of immunoglobulins and stem cells

Box 1. Clinical Situations in Which Immediate Umbilical Cord Clamping Should Be Considered or Care Should Be Individualized*

- Neonates requiring resuscitation at birth or those deemed nonvigorous
- Multiple gestations
- Fetal congenital malformations
- Placenta previa
- Antepartum hemorrhage
- Diabetes during pregnancy
- Hypertensive disorders of pregnancy
- Umbilical cord abnormalities
- Fetal growth restriction
- Category III fetal heart rate tracings
- Meconium-stained amniotic fluid

What about during Cesarean Delivery?

AHA/AAP FOCUSED UPDATE

2023 American Heart Association and American Academy of Pediatrics Focused Update on Neonatal Resuscitation: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Nicole K. Yamada, MD, MS; Edgardo Szyld, MD, MSc, Co-Chair; Marya L. Strand, MD, MS; Emer Finan, MB, MEd; Jessica L. Illuzzi, MD, MS; Beena D. Kamath-Rayne, MD, MPH; Vishal S. Kapadia, MD, MSCS; Susan Niermeyer, MD, MPH; Georg M. Schmölzer, MD, PhD; Amanda Williams, RN, CNS, MSN; Gary M. Weiner, MD; Myra H. Wyckoff, MD; Henry C. Lee, MD, Co-Chair; on behalf of the American Heart Association and American Academy of Pediatrics

Cord Milking

Cord Milking

- For term and late preterm newborn infants ≥34 weeks' gestation who do not require resuscitation, intact cord milking is not known to be beneficial compared with delayed cord clamping (≥30 seconds)
- For nonvigorous term and late preterm newborn infants (35–42 weeks' gestation), intact cord milking may be reasonable compared with early cord clamping (<30 seconds).
- For preterm newborn infants between 28 and 34 weeks' gestation who do not require resuscitation and in whom delayed cord clamping cannot be performed, intact cord milking may be reasonable.
- For preterm newborn infants <28 weeks' gestation, intact cord milking is *not* recommended.

https://players.brightcove.net/6056665225001/default_default/index.html?videoId=6377357155112

Textbook of Neonatal Resuscitation®, 9th Edition

Neonatal Resuscitation Program®

Video 3.3

Cord Milking for Non-vigorous Term Infant

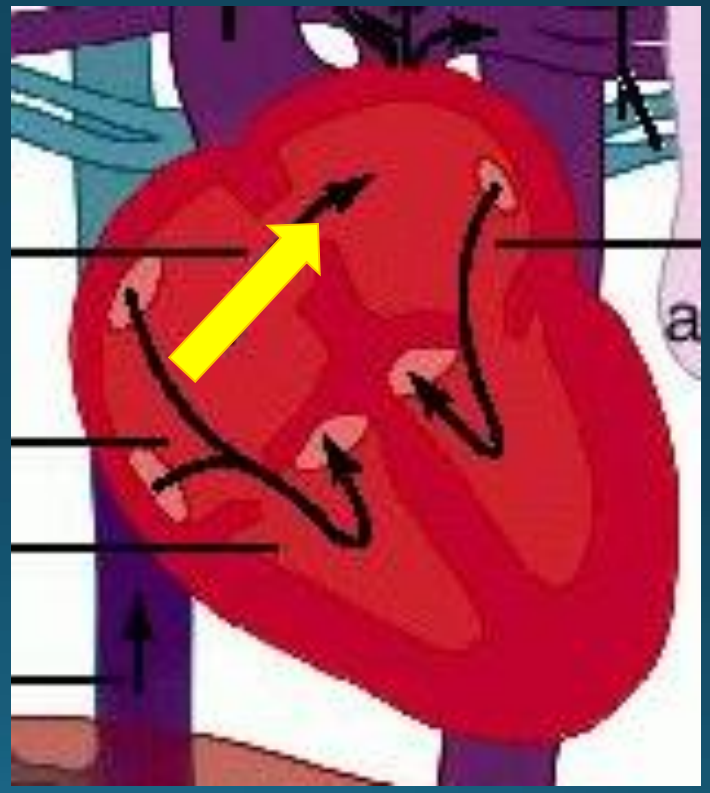
American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

American Heart Association.

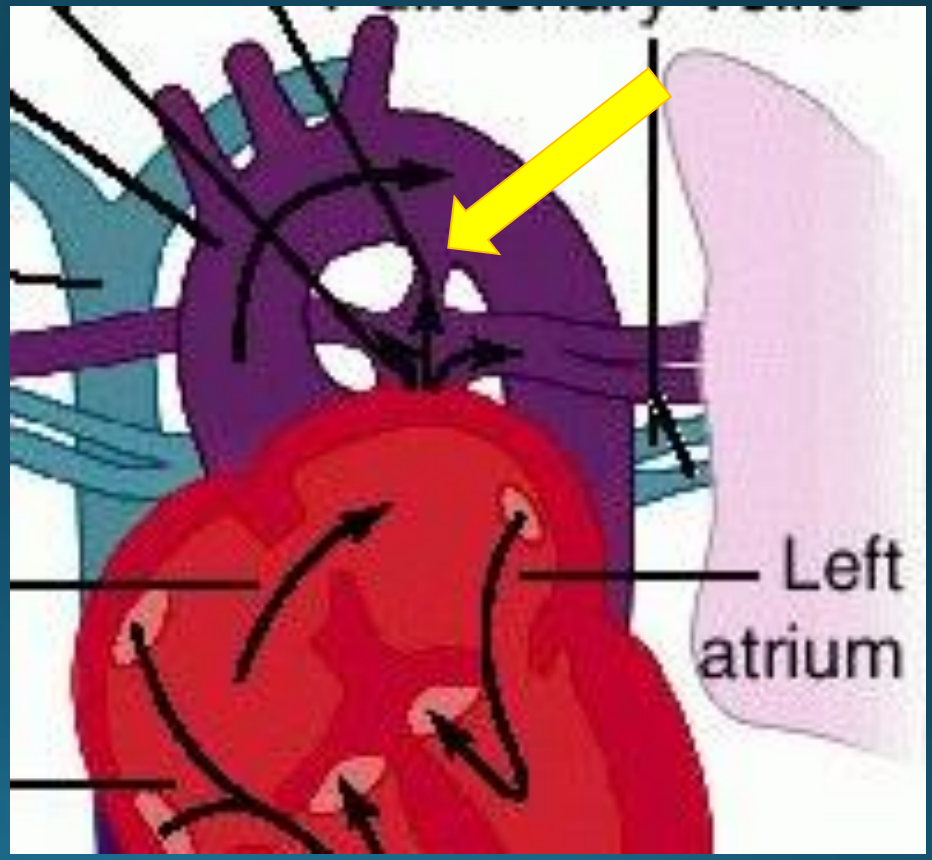
Closure of the Foramen Ovale

- After clamping the cord, left atrial pressure rises above that of right atrial pressure and the flap valve closes
- Anatomically closed by 1 month
- May remain patent in some individuals



Closure of the Ductus Arteriosus

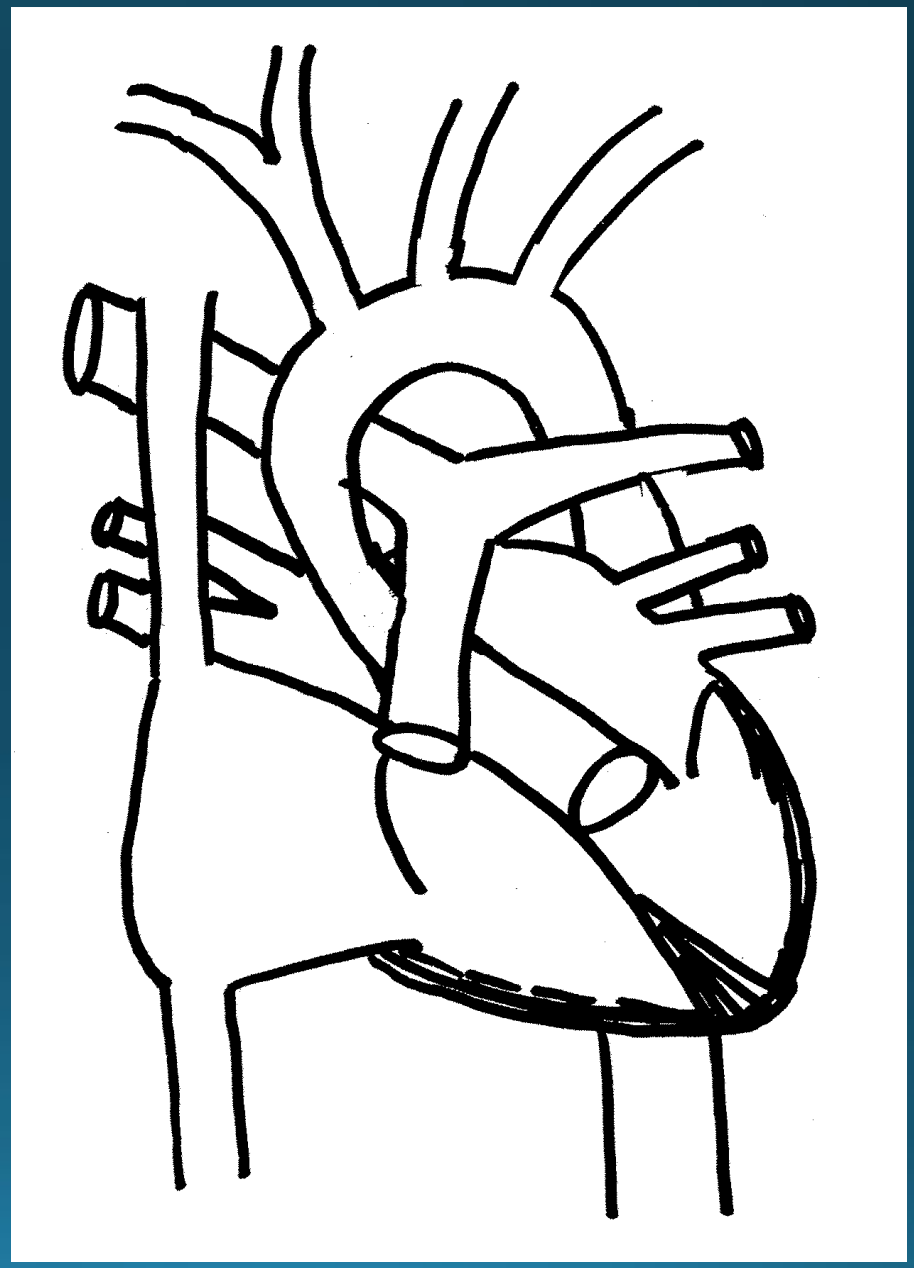
- Flow through the DA reverses due to increasing SVR
- Functionally closed by most at 12-14 hours of extrauterine life
  - Closed in 96 hours in nearly all infants
- Murmur may be auscultated during closure
- Anatomically closed at 2-3 months



Label the Heart

1. Right Common Carotid
2. Left Common Carotid
3. Right Subclavian
4. Left Subclavian

5. Ductus Arteriosus



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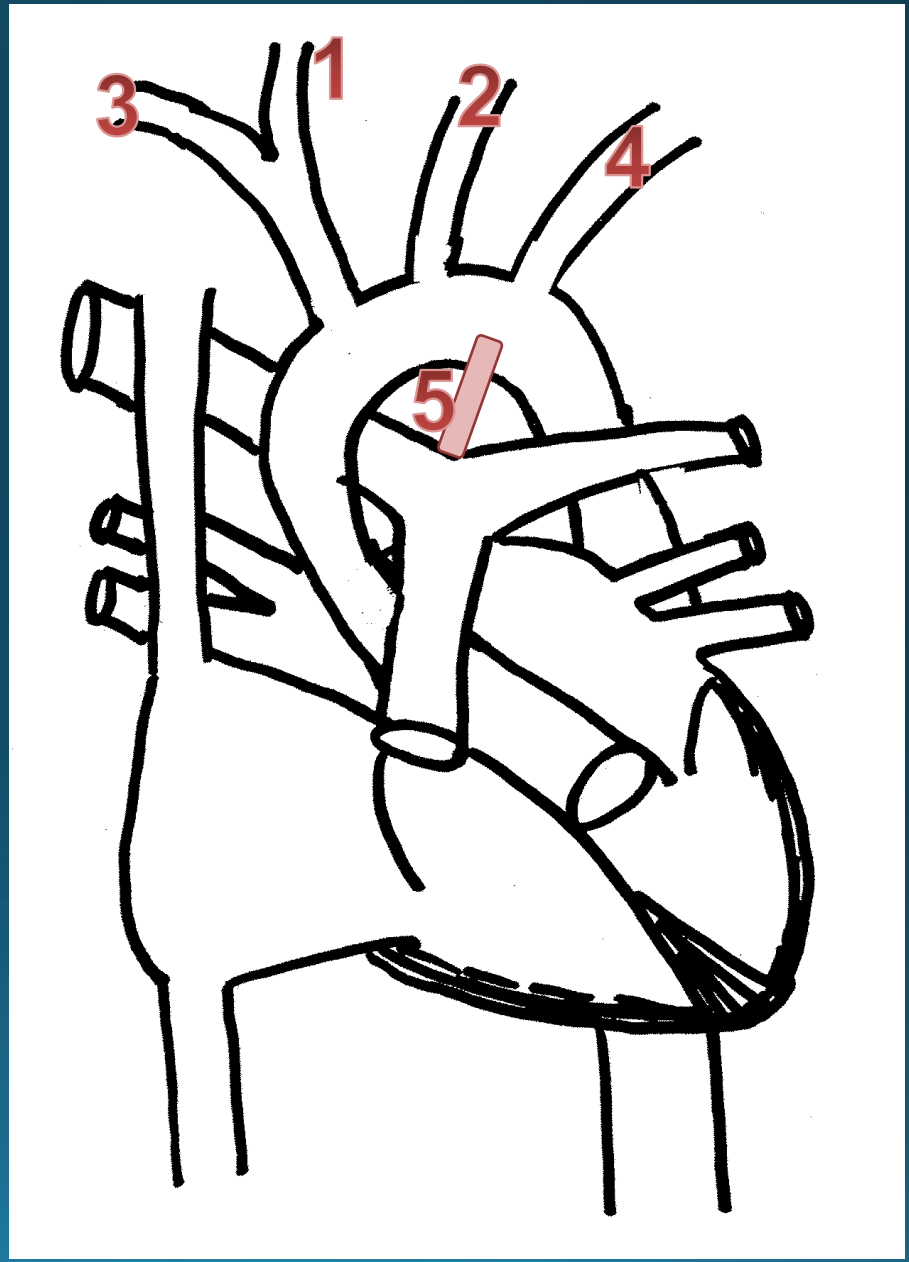
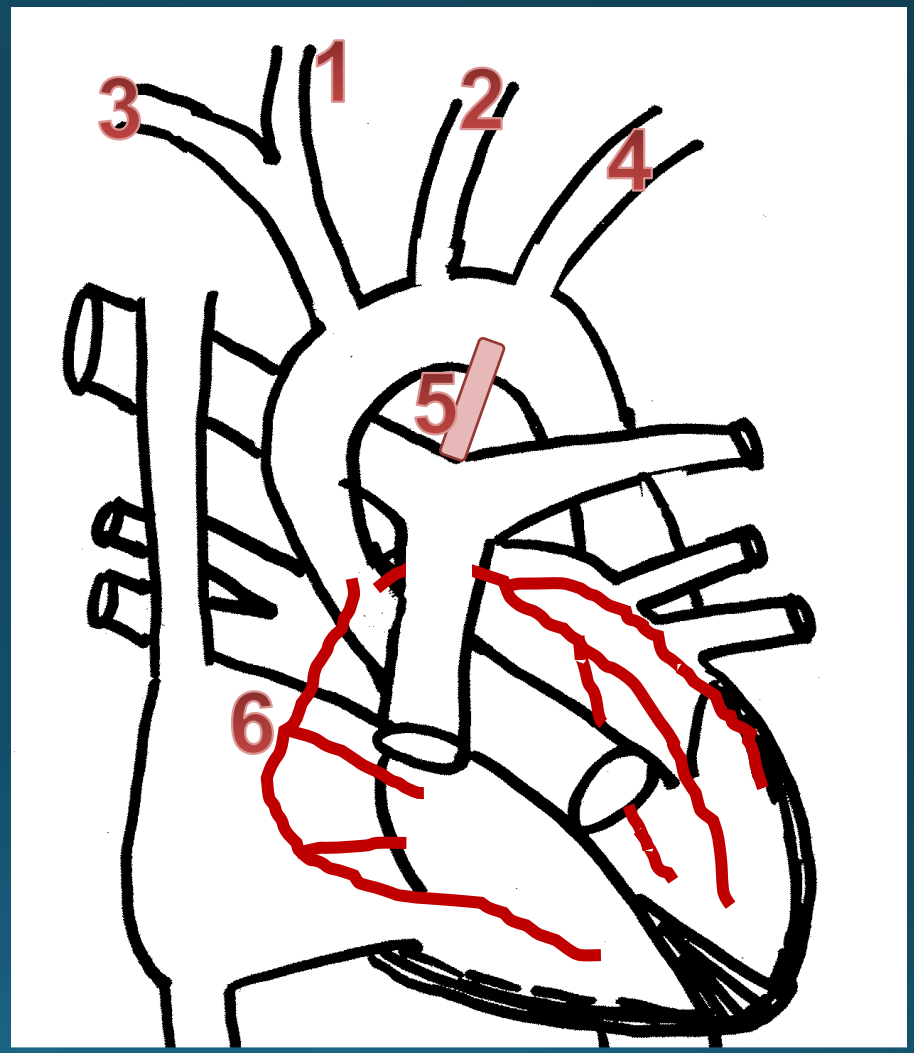


Label the Heart

1. Right Common Carotid
2. Left Common Carotid
3. Right Subclavian
4. Left Subclavian

5. Ductus Arteriosus

6. Coronary Arteries
   - Most oxygenated blood
   - HR good indicator of O_2 status



Transition of the Respiratory System

- First breath is extremely critical in all of transition processes
  - Must occur within seconds of placental separation
  - Interdependent with cardiovascular events
  - Only term, healthy babies can do this well
- Lungs begin absorbing fluid as opposed to secreting fluid
  - Begins in early labor
  - Expedited by increased pulmonary blood flow

8th IFAC Symposium on Biological and Medical Systems
The International Federation of Automatic Control
August 29-31, 2012. Budapest, Hungary

Analysis of the First Cry of the Newborns in Case of Vaginal Delivery and Caesarean Section

Zita Makoi *, Gyorgy Takacs *

**Budapest, Hungary; (e-mail: zita.makoi@gmail.com).*
***Peter Pazmany Catholic University Budapest, Hungary, (e-mail: takacs.gyorgy@itk.ppke.hu)*

Abstract: Nearly all of the newborns are coming into the world with crying. The first cry carries significant information about the baby's wellbeing, about his successful adaptation to the extrauterin life. The quality of first cry is a part of the Apgar score system which is used to assess the condition of newborns after delivery. The powerful first cry can carry the message for parents about the arrival of a healthy baby or the feeble cry immediately arises anxiety. In many countries the number of caesarean section has been increasing. The differences in the first cry can represent a subtle parameter which can reflect the start of life in a different way. The first cry samples of 10 vaginally born babies and 10 babies born by caesarean section were analysed. The analysis took place by subjective test with the participation

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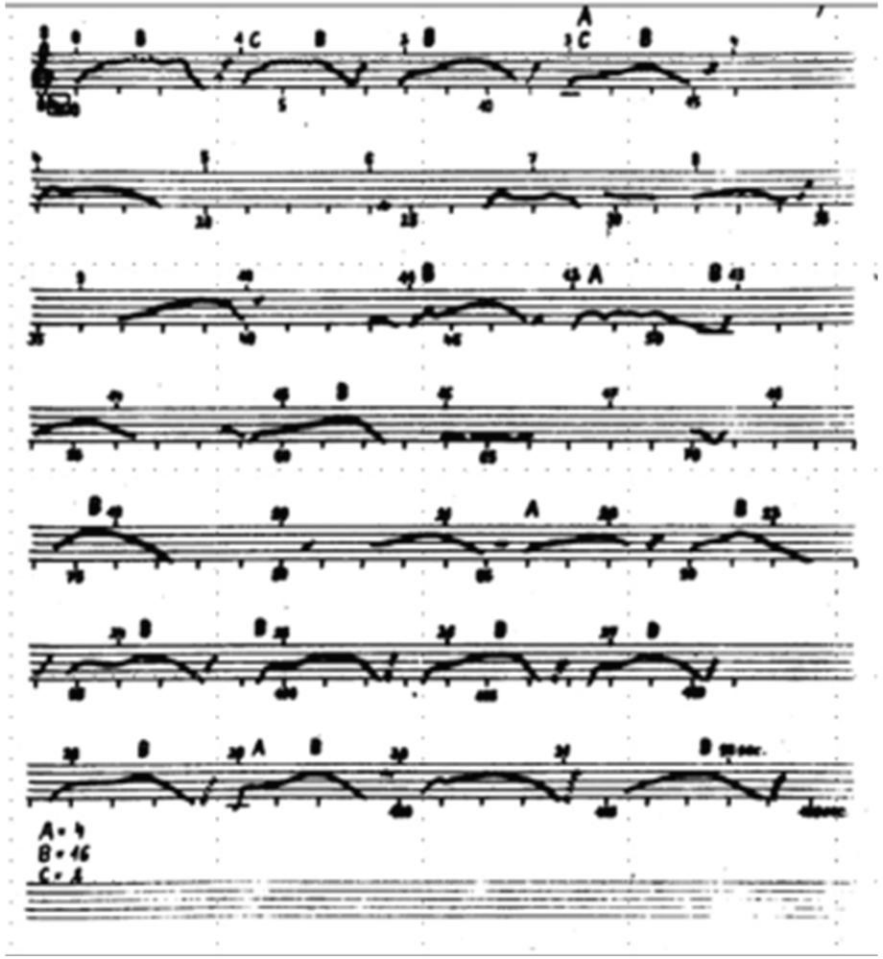
4.2 *Analysis of first cry in case of delivery by natural wa*
and by caesarean section



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Speech Communication 77 (2016) 28–52

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Cry-based infant pathology classification using GMMs

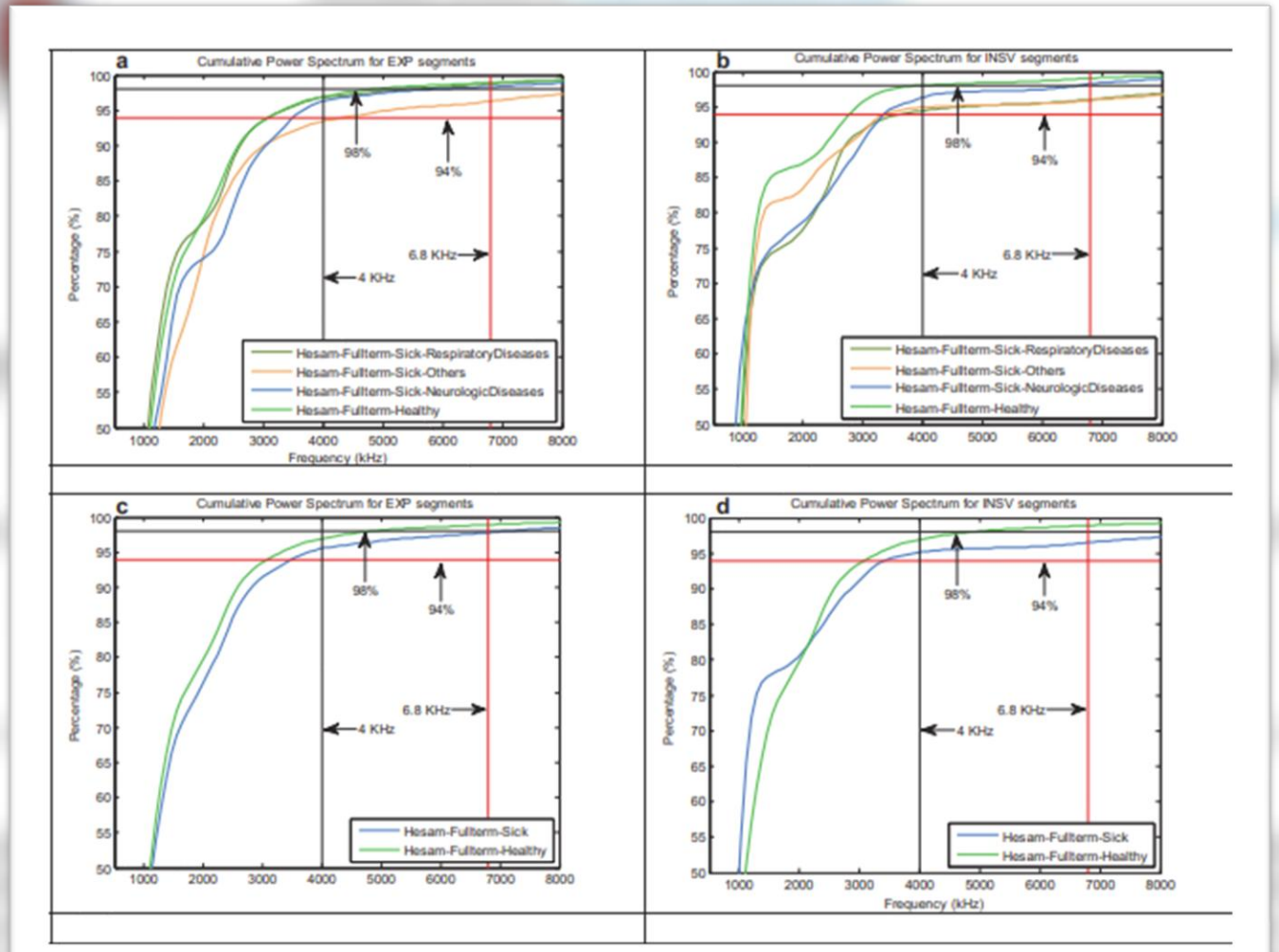
Hesam Farsaie Alaie[1,*], Lina Abou-Abbas, Chakib Tadj

MMS Lab, Department of Electrical Engineering, École de Technologie Supérieure, Université du Québec, 1100 rue Notre-Dame Ouest, Montréal, QC, Canada, H3C 1K3

Received 1 February 2015; received in revised form 13 October 2015; accepted 2 December 2015
Available online 11 December 2015

Abstract

Traditional studies of infant cry signals focus more on non-pathology-based classification of infants. In this paper, we introduce a noninvasive health care system that performs acoustic analysis of unclean noisy infant cry signals to extract and measure certain cry characteristics quantitatively and classify healthy and sick newborn infants according to only their cries. In the conduct of this newborn cry-based diagnostic system, the dynamic MFCC features along with static Mel-Frequency Cepstral Coefficients (MFCCs) are selected and extracted for both expiratory and inspiratory cry vocalizations to produce a discriminative and informative feature vector. Next, we create a unique cry pattern for each cry vocalization type


a
Cumulative Power Spectrum for EXP segments
Percentage (%)
Frequency (kHz)
98%
94%
6.8 KHz
4 KHz
Hesam-Fullterm-Sick-RespiratoryDiseases
Hesam-Fullterm-Sick-Others
Hesam-Fullterm-Sick-NeurologicDiseases
Hesam-Fullterm-Healthy
b
Cumulative Power Spectrum for INSV segments
Percentage (%)
98%
94%
6.8 KHz
4 KHz
Hesam-Fullterm-Sick-RespiratoryDiseases
Hesam-Fullterm-Sick-Others
Hesam-Fullterm-Sick-NeurologicDiseases
Hesam-Fullterm-Healthy
c
Cumulative Power Spectrum for EXP segments
Percentage (%)
98%
94%
6.8 KHz
4 KHz
Hesam-Fullterm-Sick
Hesam-Fullterm-Healthy
d
Cumulative Power Spectrum for INSV segments
Percentage (%)
Frequency (kHz)
98%
94%
6.8 KHz
4 KHz
Hesam-Fullterm-Sick
Hesam-Fullterm-Healthy

the iterative formula can be derived to adapt the model parameters. The adapted parameters, $\hat{\lambda}_K = (\hat{c}_i, \hat{\Phi}_i,\ i = 1, \ldots.., K)$, can be estimated in the $(n+1)$th$^{\text{th}}$ equation as follows:

$$w^n(X_t) = \frac{f_k\left(X_t \middle| \Phi_k^{(n)}\right)}{c_k^n f_k\left(X_t \middle| \Phi_k^{(n)}\right) + \left(1 - c_k^n\right) F_{k-1}\left(X_t \middle| \lambda_{k-1}\right)} = \frac{f_k\left(X_t \middle| \Phi_k^{(n)}\right)}{F_k\left(X_t \middle| \lambda_k\right)}$$

$$\gamma_t\left(\Phi_k^{(n)}\right) = \frac{w^n\left(X_t\right)}{\sum_{t=1}^{T} w^n\left(X_t\right)}$$

$$\hat{c}_k^{n+1} = \frac{1}{T} \sum_{t=1}^{T} \hat{c}_k^n w^n\left(X_t\right)$$

$$\hat{\mu}_k^{n+1} = \sum_{t=1}^{T} \gamma_t\left(\Phi_k^{(n)}\right).X_t$$

$$\hat{\Sigma}_k^{n+1} = \sum_{t=1}^{T} \gamma_t\left(\Phi_k^{(n)}\right).\left(X_t - \hat{\mu}_k^{n+1}\right)\left(X_t - \hat{\mu}_k^{n+1}\right)^{Tr} \qquad (11)$$

The First Cry

- Bottom line: it matters

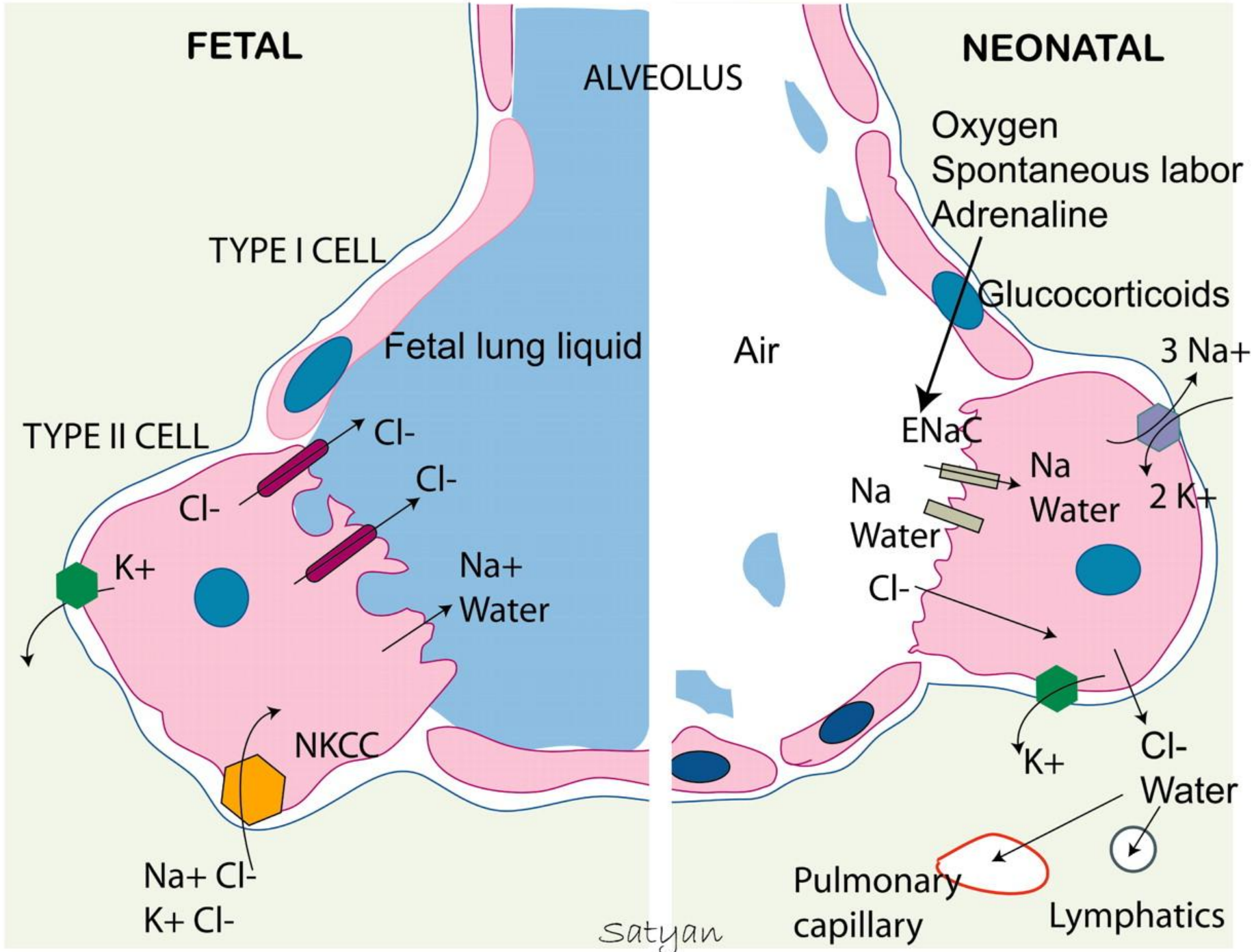
↑ fluid clearance

↑ gas exchange

↑ PaO_2

↓ PVR

↑ pulmonary blood flow


FETAL
ALVEOLUS
NEONATAL
TYPE I CELL
Fetal lung liquid
Air
Oxygen
Spontaneous labor
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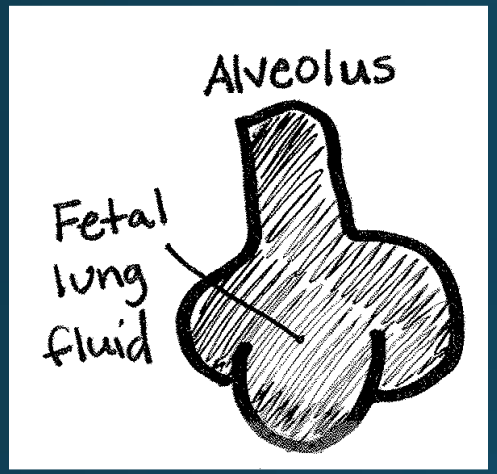
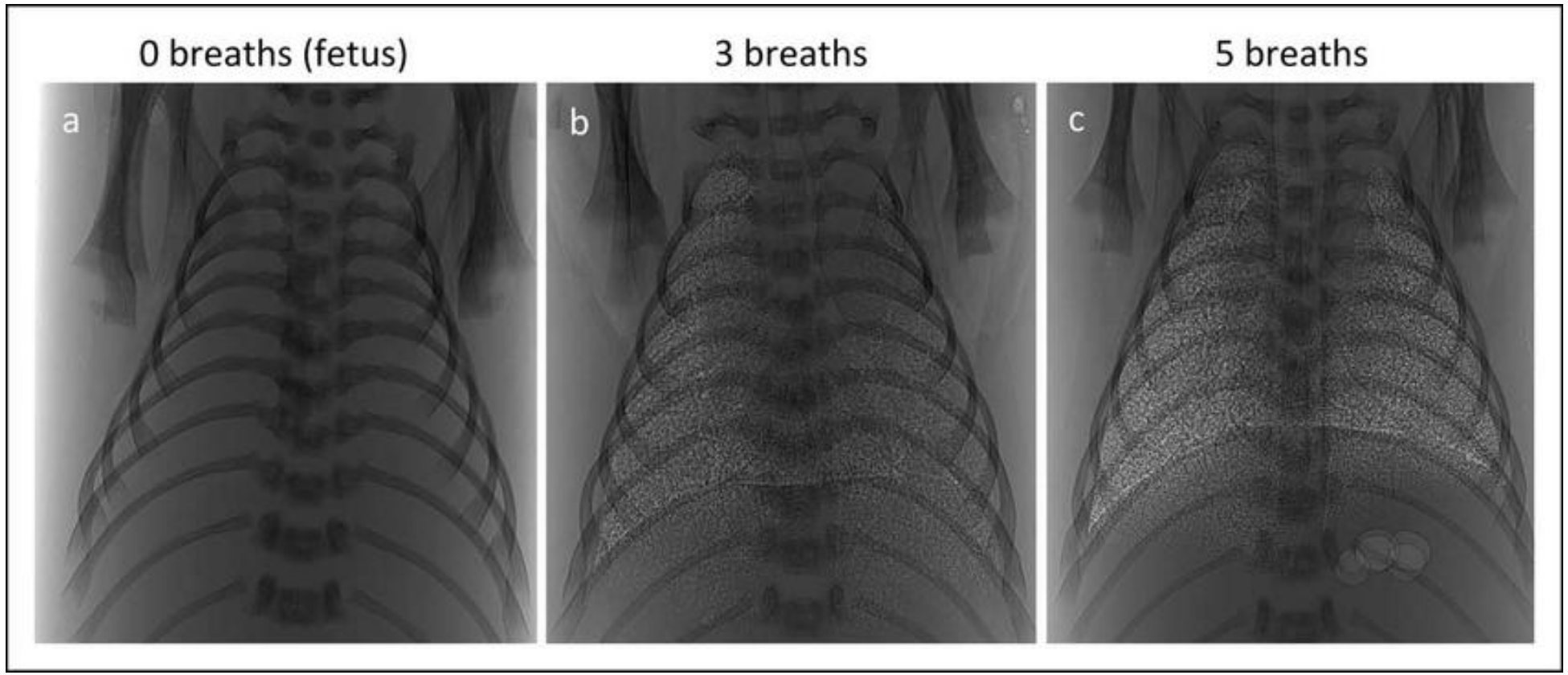
TYPE II CELL
Cl-
Cl-
Cl-
K+
Na+
Water
NKCC
Na+ Cl-
K+ Cl-
ENaC
3 Na+
Na
Water
Na
Water
2 K+
Cl-
K+
Cl-
Water
Pulmonary
capillary
Lymphatics
Satyan

Fetal Lung Fluid Clearance



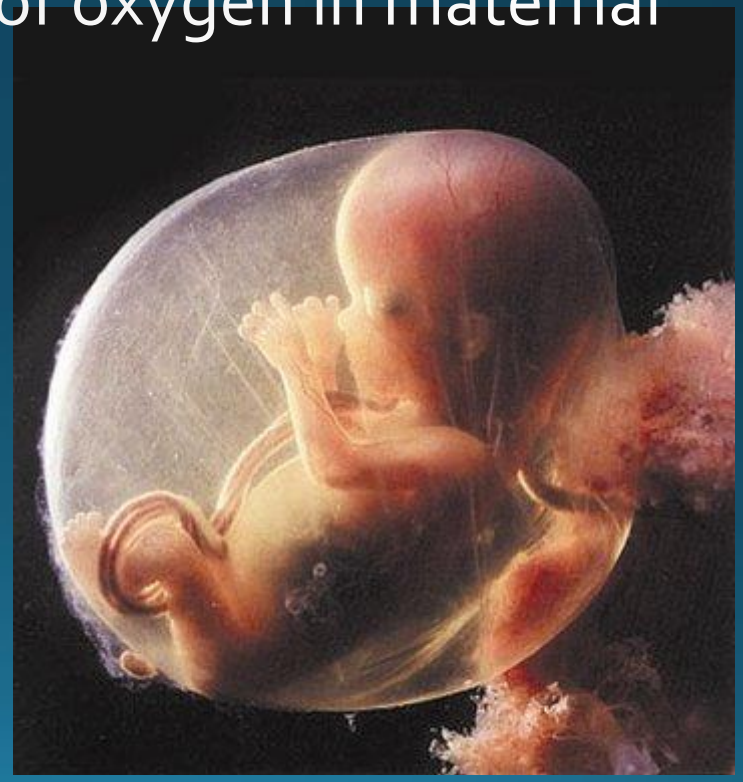


Hooper, Stuart & Pas, Arjan & Lewis, R. & Morley, Colin. (2010). Establishing Functional Residual Capacity at Birth. NeoReviews. 11. e474-e483. 10.1542/neo.11-9-e474.

Let's talk about Oxygen . . .

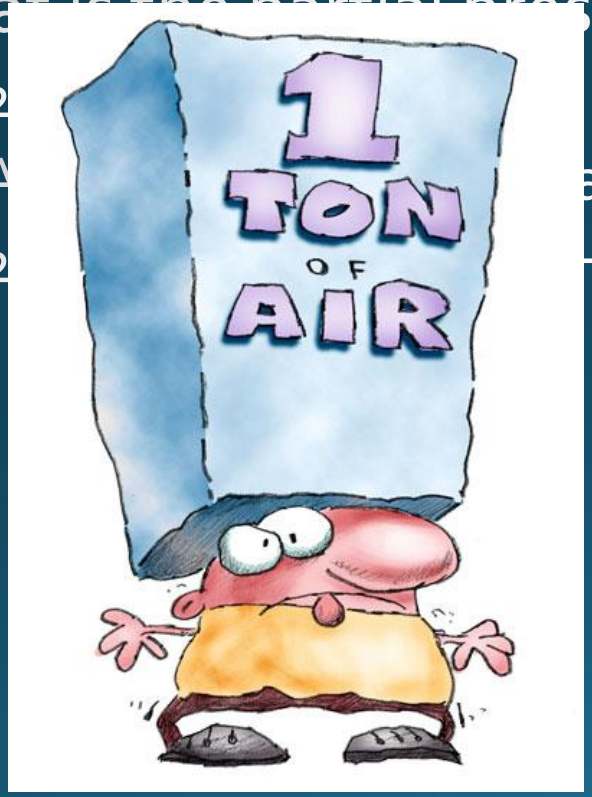
- Where does the fetus get his oxygen from?
- What is the partial pressure of oxygen in maternal mixed venous blood?
  - About 40 mmHg
  - Placenta takes some,

  fetus gets about 30-35 mmHg
- What is the fetal SpO_2?
  - About 60%



Let's talk about Oxygen . . .

- After birth, where does the newborn get his oxygen?
- What is the partial pressure of oxygen in room air?
  - 2
  - A at sea level = 760 mmHg
  - 2 Hg



FETUS

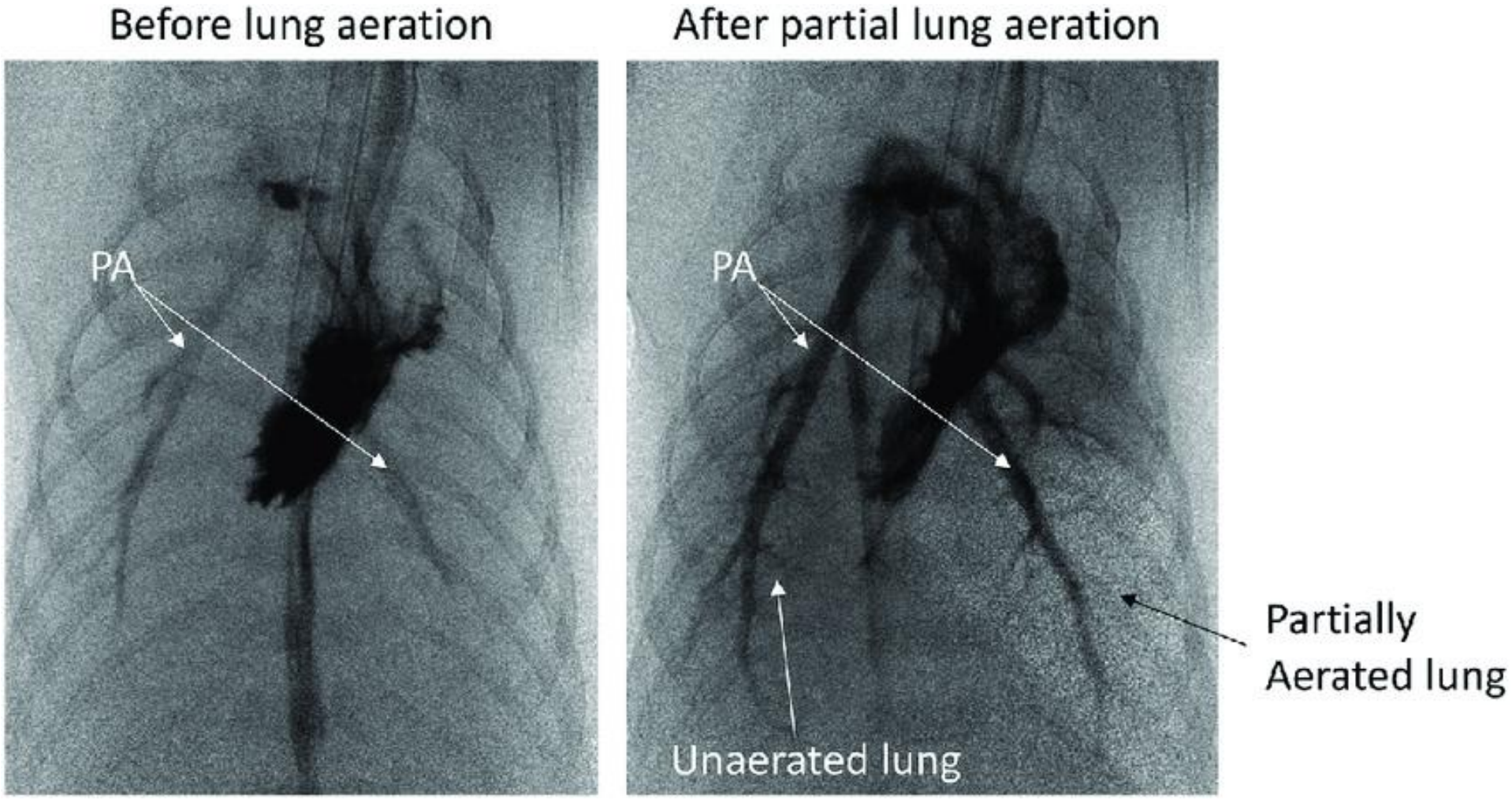
- Source of oxygen:
  - Umbilical Artery
- PaO_2 = ?
  - **30-35 mmHg**

NEWBORN

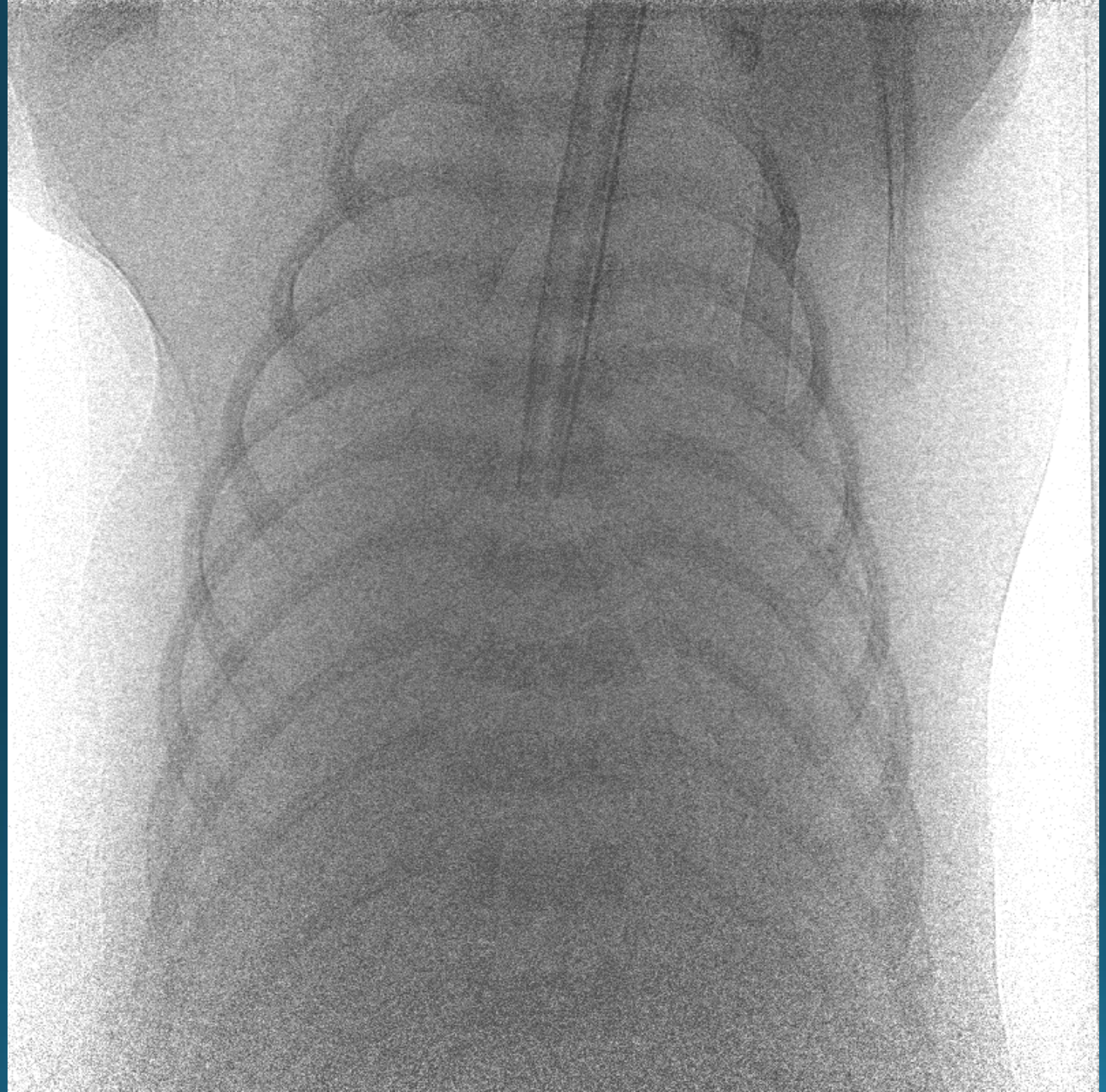
- Source of oxygen:
  - Room Air
- PaO_2 = ?
  - **160 mm HG**

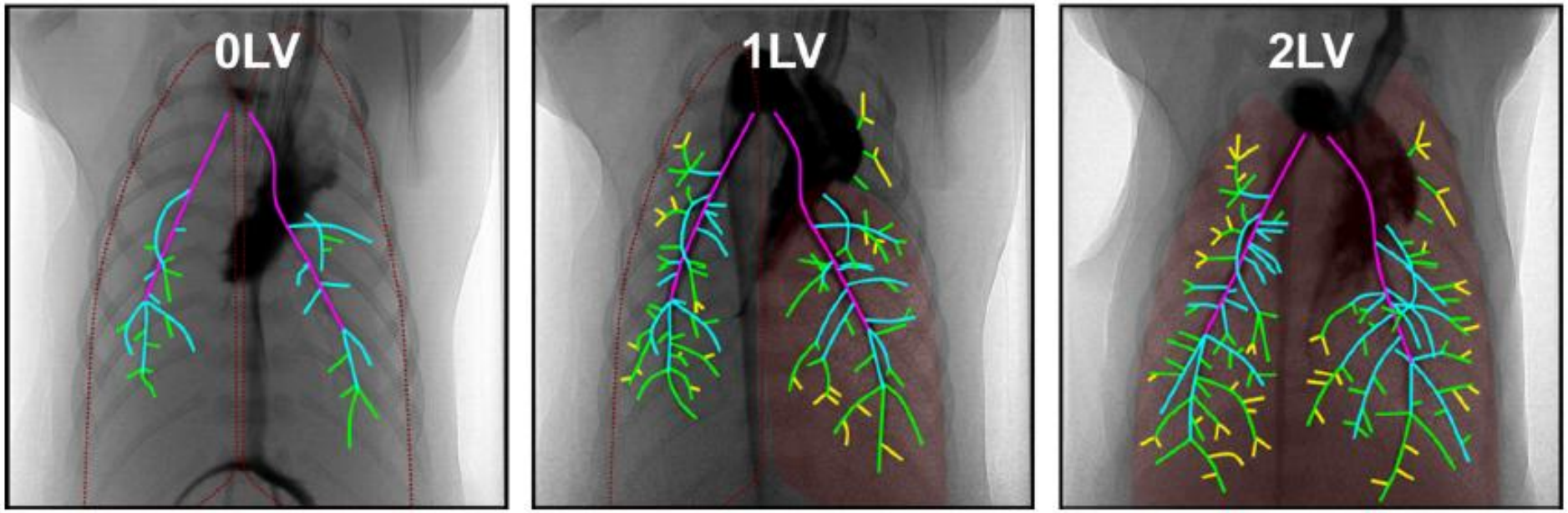
The newborn doesn't necessarily need supplemental oxygen . . .

VENTILATION



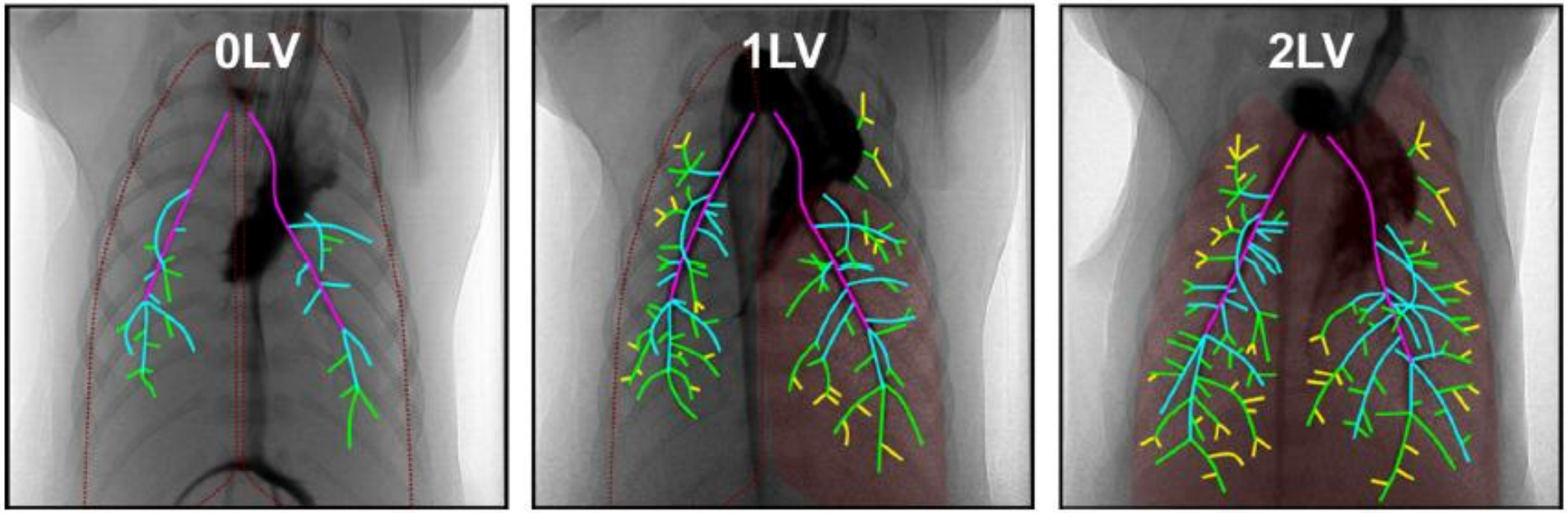
Hooper, Stuart & Roberts, Calum & Dekker, Janneke & Pas, Arjan. (2019). Issues in cardiopulmonary transition at birth. Seminars in Fetal and Neonatal Medicine. 24. 101033. 10.1016/j.siny.2019.101033.



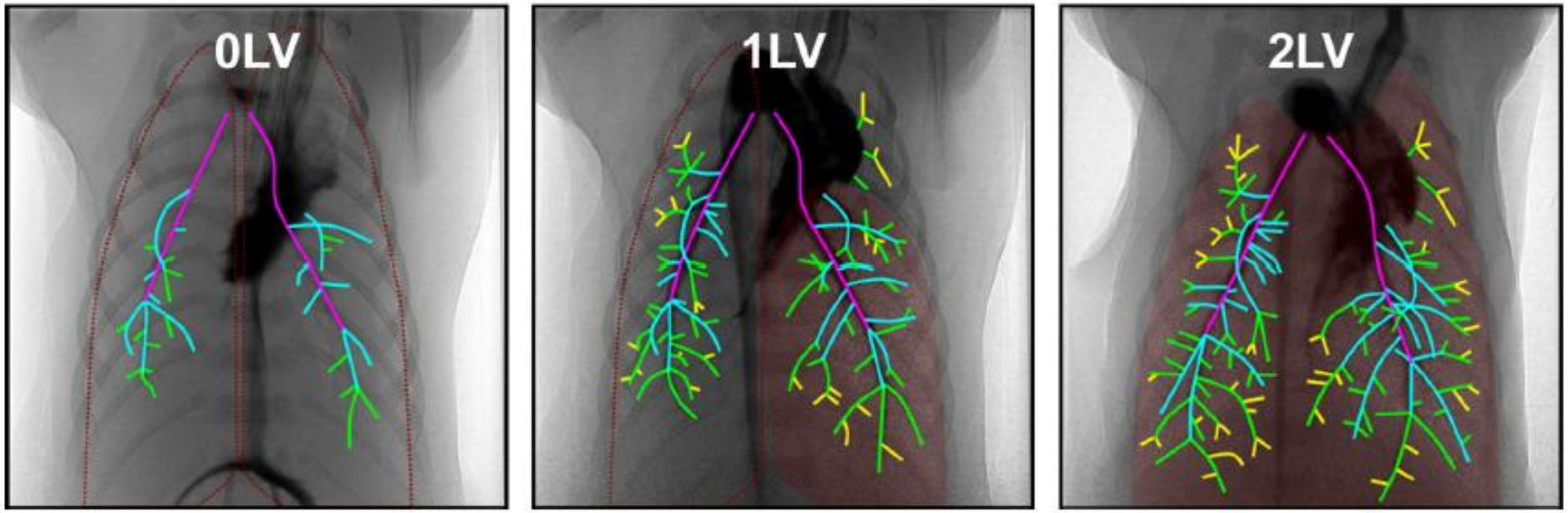


Traced overlay of all visible blood vessels (filled with iodine) superimposed over the X-ray images of the lung acquired before ventilation onset (0LV), during unilateral ventilation of the right lung (1LV), and during ventilation of both lungs (2LV) in the same kitten. Outlined are the approximate boundaries of nonaerated regions of the lungs (red dotted line) and aerated regions of the lungs (solid red background).

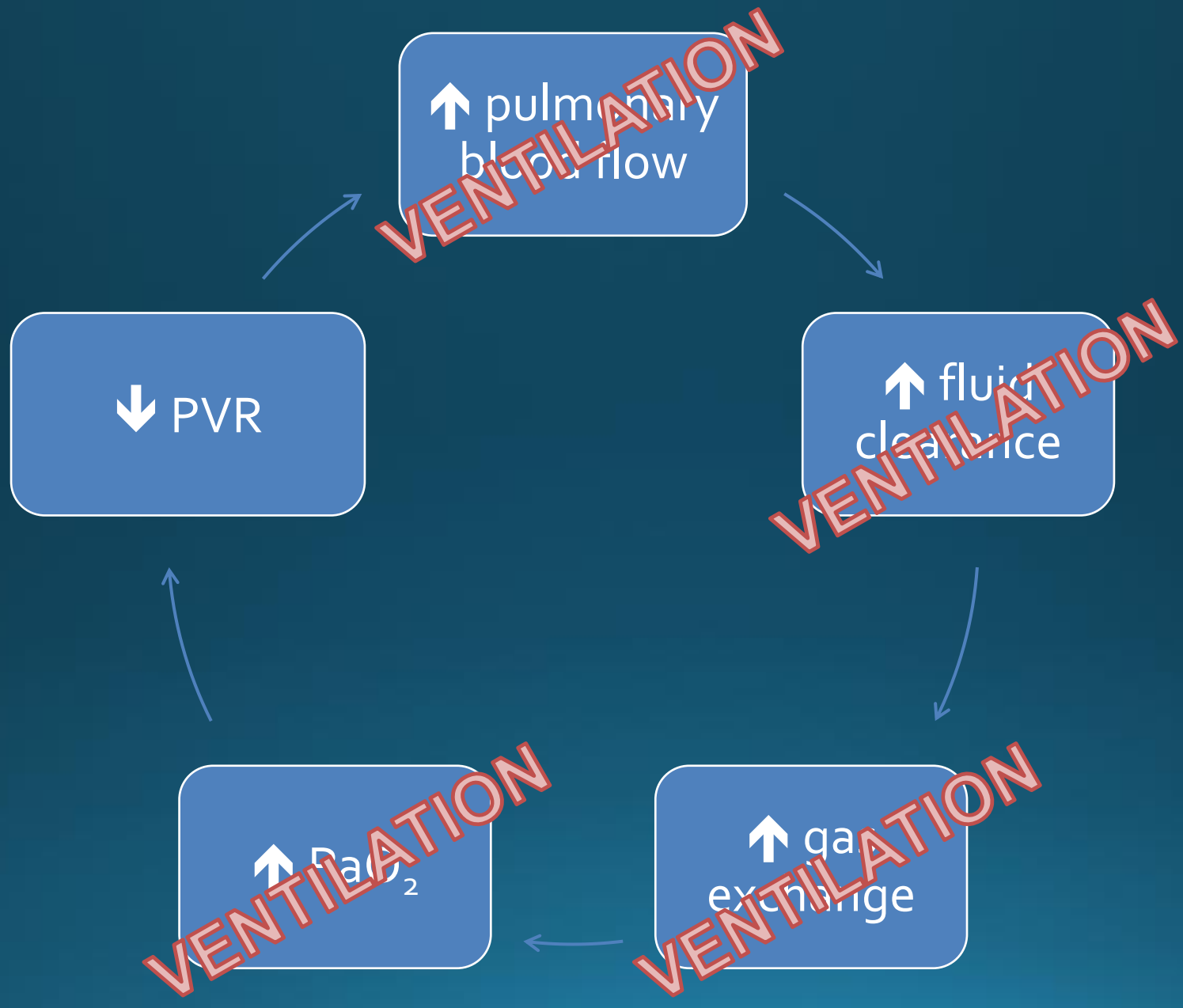
- **L&R pulmonary arteries**
- **1st generation branches**
- **2nd generation branches**
- **3rd generation branches**



Stuart Hooper: “The message is quite simple. That is, **lung aeration** stimulates the increase in pulmonary blood flow at birth and even if only part of the lung is aerated, pulmonary blood flow increases even in both aerated and unaerated lung regions.”



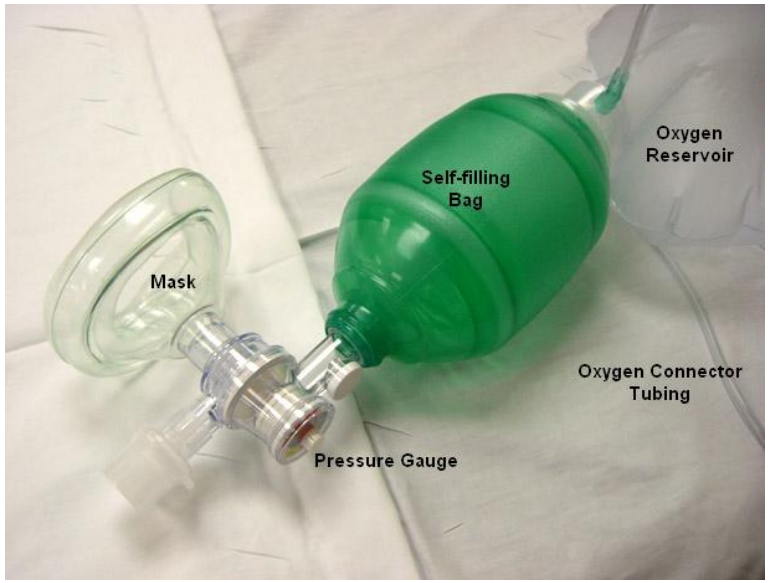
. . . aerating the lung and increasing pulmonary blood flow **before umbilical cord clamping** (known as physiological based cord clamping), can avoid the loss of preload and reduction in cardiac output that normally accompanies immediate cord clamping


↑ pulmonary blood flow
VENTILATION
↑ fluid clearance
VENTILATION
↑ gas exchange
VENTILATION
↑ PaO_2
VENTILATION
↓ PVR

VENTILATION

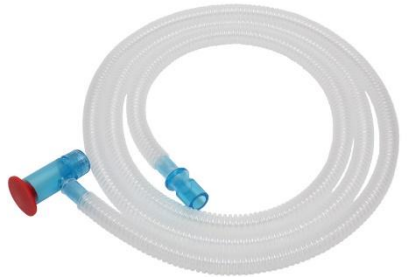
Self-inflating mask (bvm)

- valve between mask and bag
- can provide positive pressure ventilation (PPV)
- a pressure relief valve prevents overinflation of the lungs



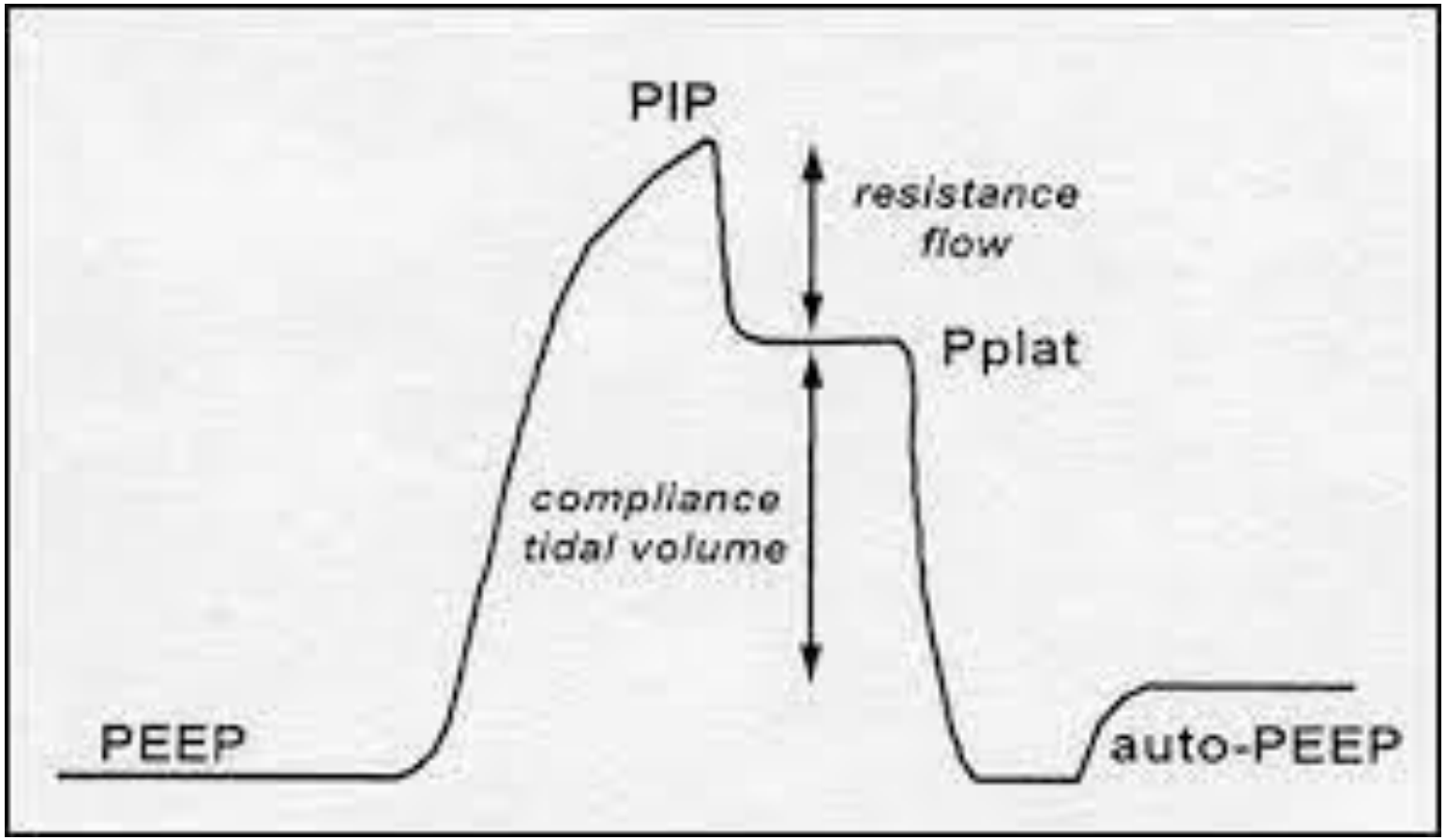
T-piece devices

- gas flows through a T-piece
- can give PPV and be adjusted to a set PIP and PEEP
- good device to give CPAP to a breathing infant
- Neo-Tee is disposable, easily transported
- Neopuff is bigger and more cumbersome




I
O
L/min
% O2
L/min

PEEP vs PIP



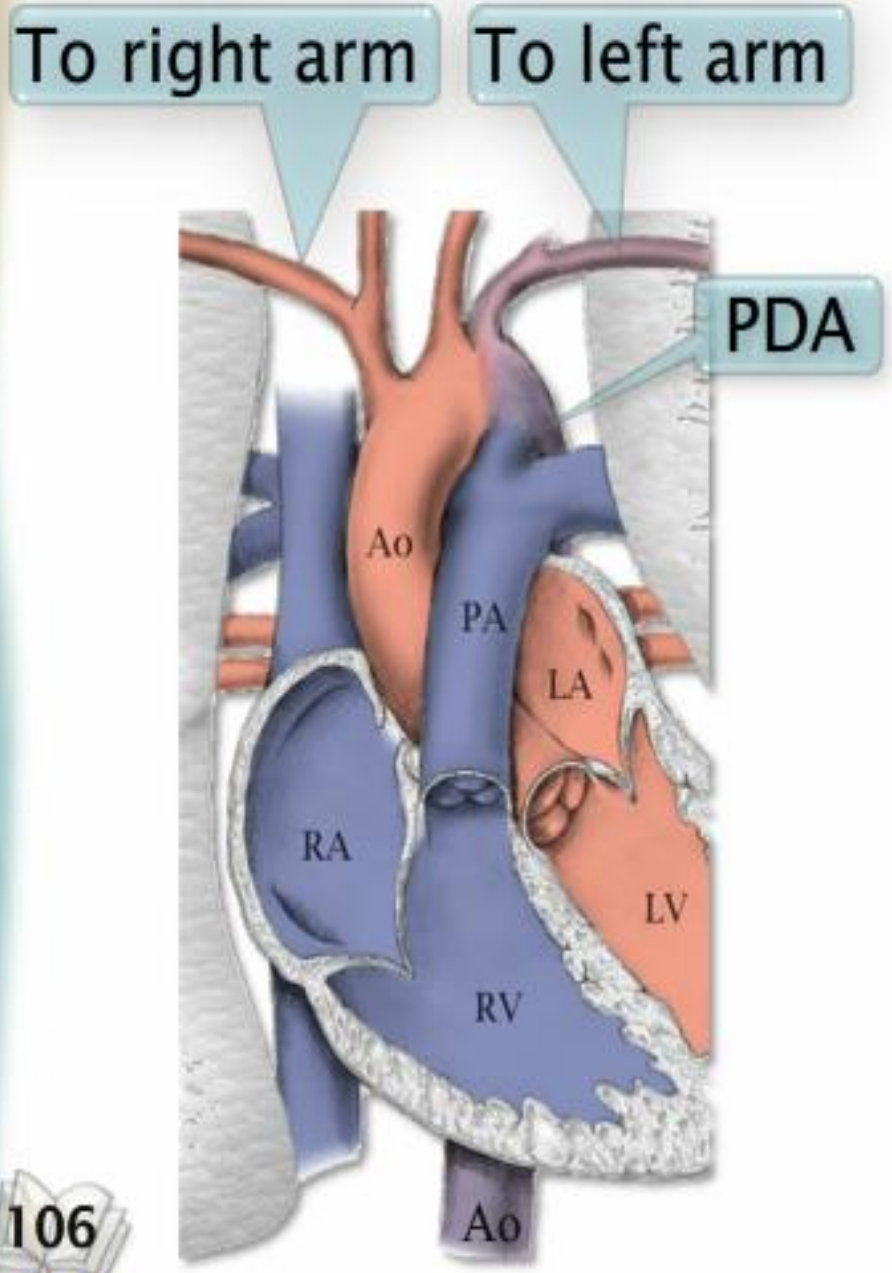
Positive **E**nd **E**xpiratory **P**ressure

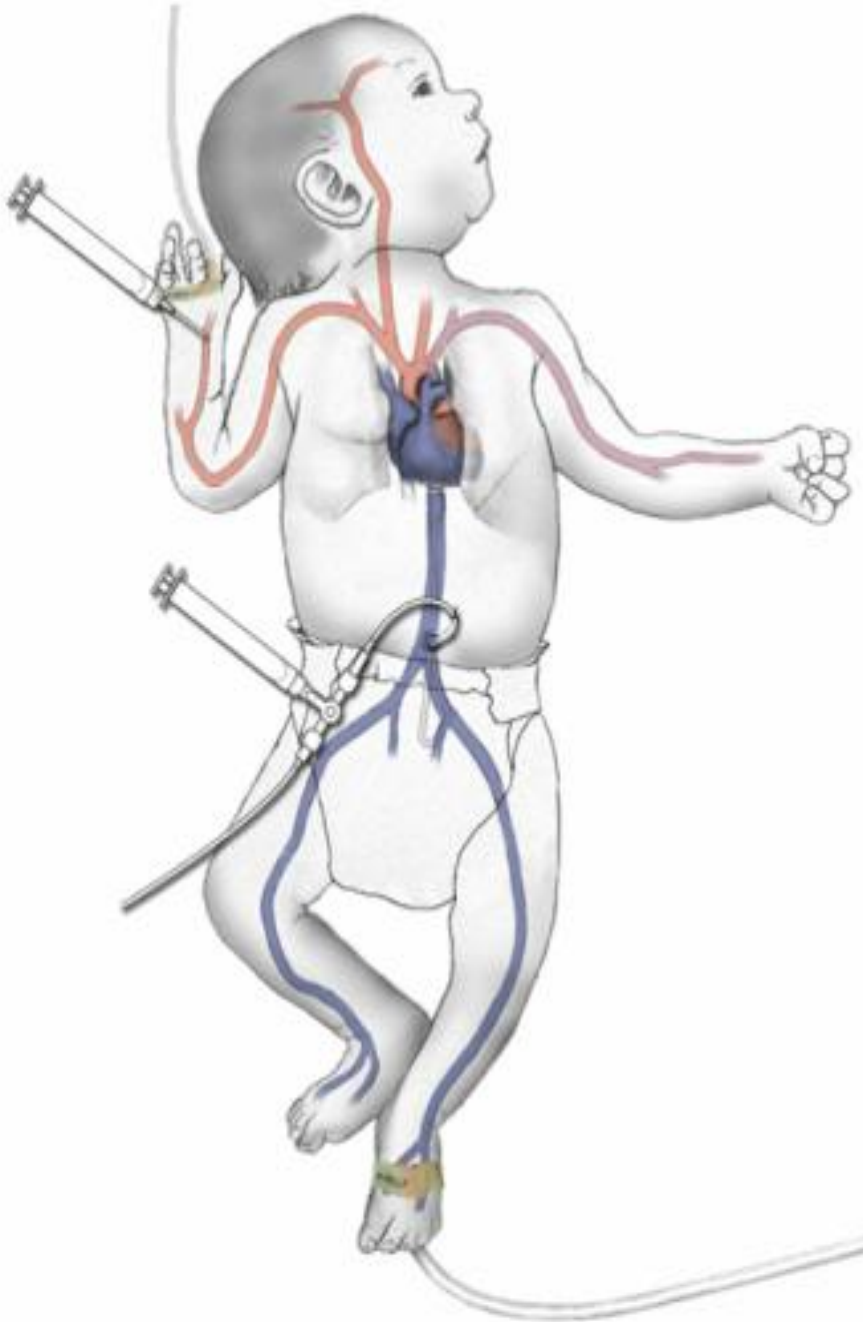
Peak **I**nspiratory **P**ressure

CPAP

- **C**ontinuous **P**ositive **A**irway **P**ressure (start at 5 cm h2o)
- Usually delivered at equivalent of PEEP to maintain PEEP
- Prevents collapse of alveoli following expiration
- Not delivered with PIP, patient must be breathing spontaneously with a HR > 100

How do you know if the newborn needs oxygen?





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Normal SpO_2 Values

- 2 minute: 65%
- 3 minutes: 70%
- 4 minutes: 75%
- 5 minutes: 80%
- 10 minutes: 85%

Oxygen for ≥ 35 weeks

- Recommendations—Updated 2019
- In term and late-preterm newborns (≥35 weeks of gestation) receiving respiratory support at birth, the initial use of 21% oxygen is reasonable (Class 2a; Level of Evidence B-R).

- 100% oxygen should not be used to initiate resuscitation because it is associated with excess mortality (Class 3: Harm; Level of Evidence B-R).

Escobedo, et al. (2019). American Heart Association Focused Update on Neonatal Resuscitation: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, *Circulation*, 140(24),

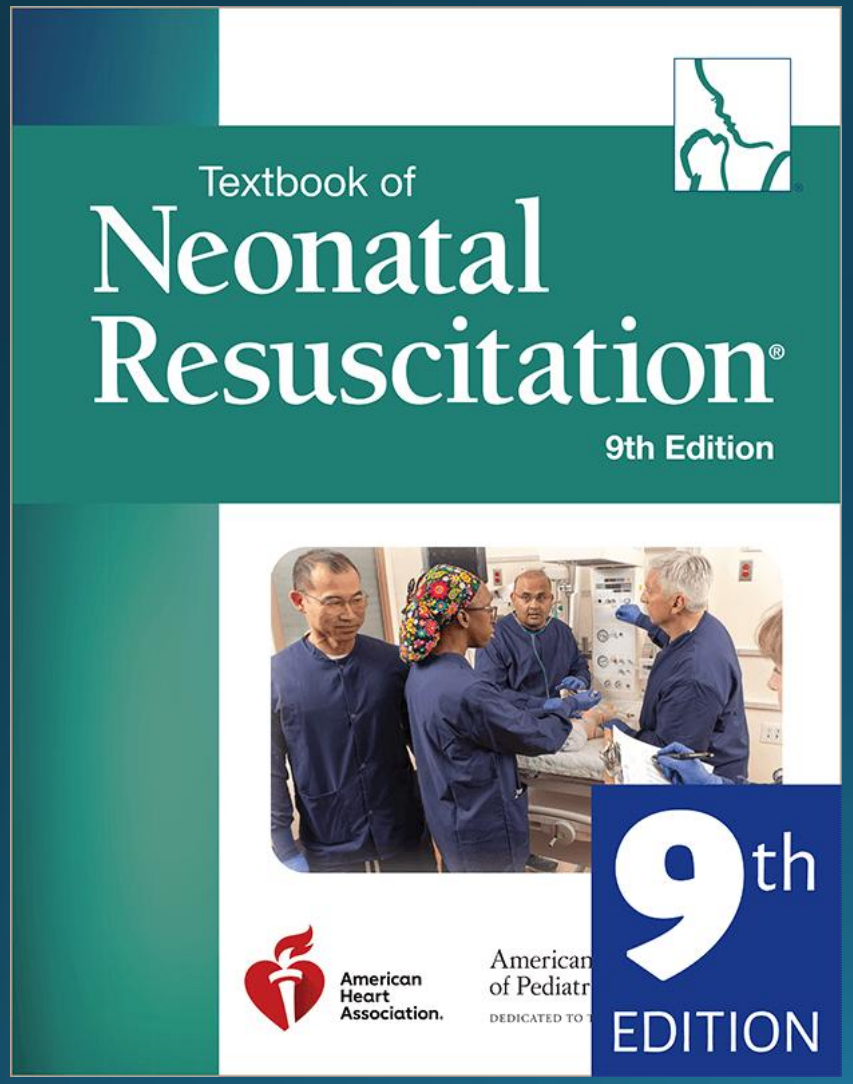
Oxygen for <35 weeks

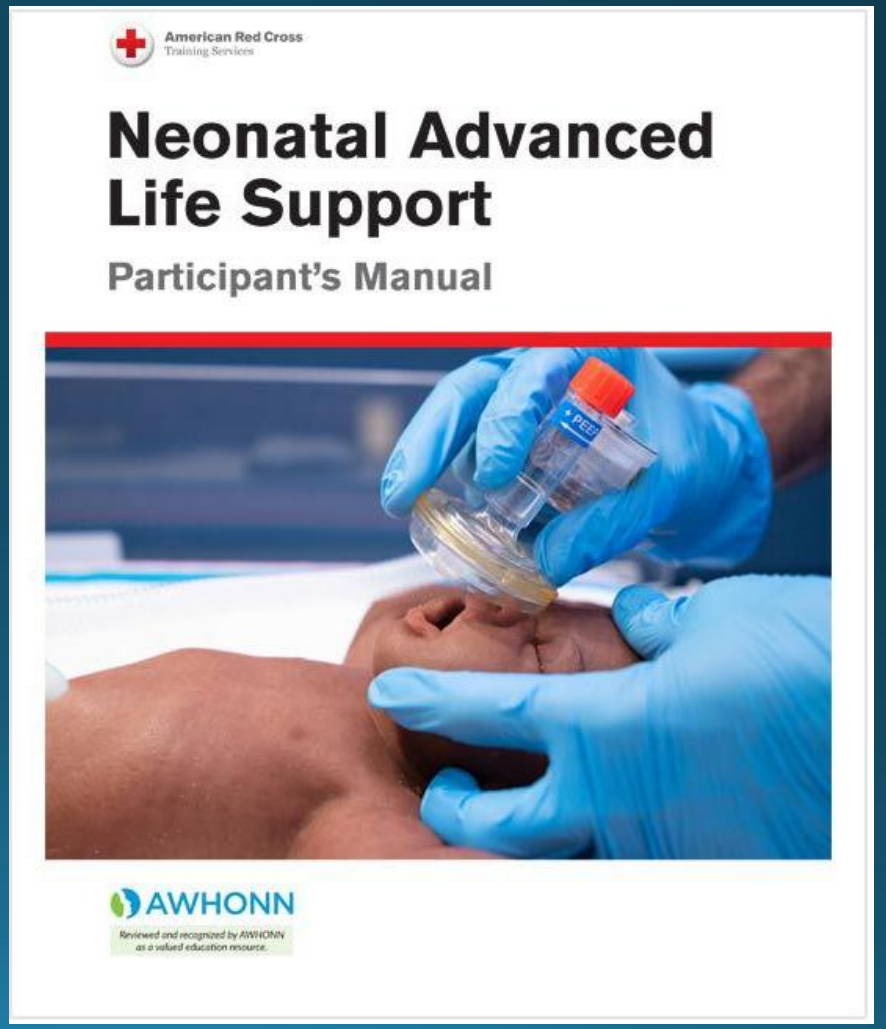
- Recommendations—Updated 2019
- In preterm newborns (<35 weeks of gestation) receiving respiratory support at birth, it may be reasonable to begin with 21% to 30% oxygen with subsequent oxygen titration based on pulse oximetry (Class 2b; Level of Evidence C-LD).

Escobedo, et al. (2019). American Heart Association Focused Update on Neonatal Resuscitation: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, *Circulation*, 140(24),

Providing supplemental oxygen

Putting it together





Preparing for resuscitation

Team and equipment preparation: the “brief”

4 pre-birth questions

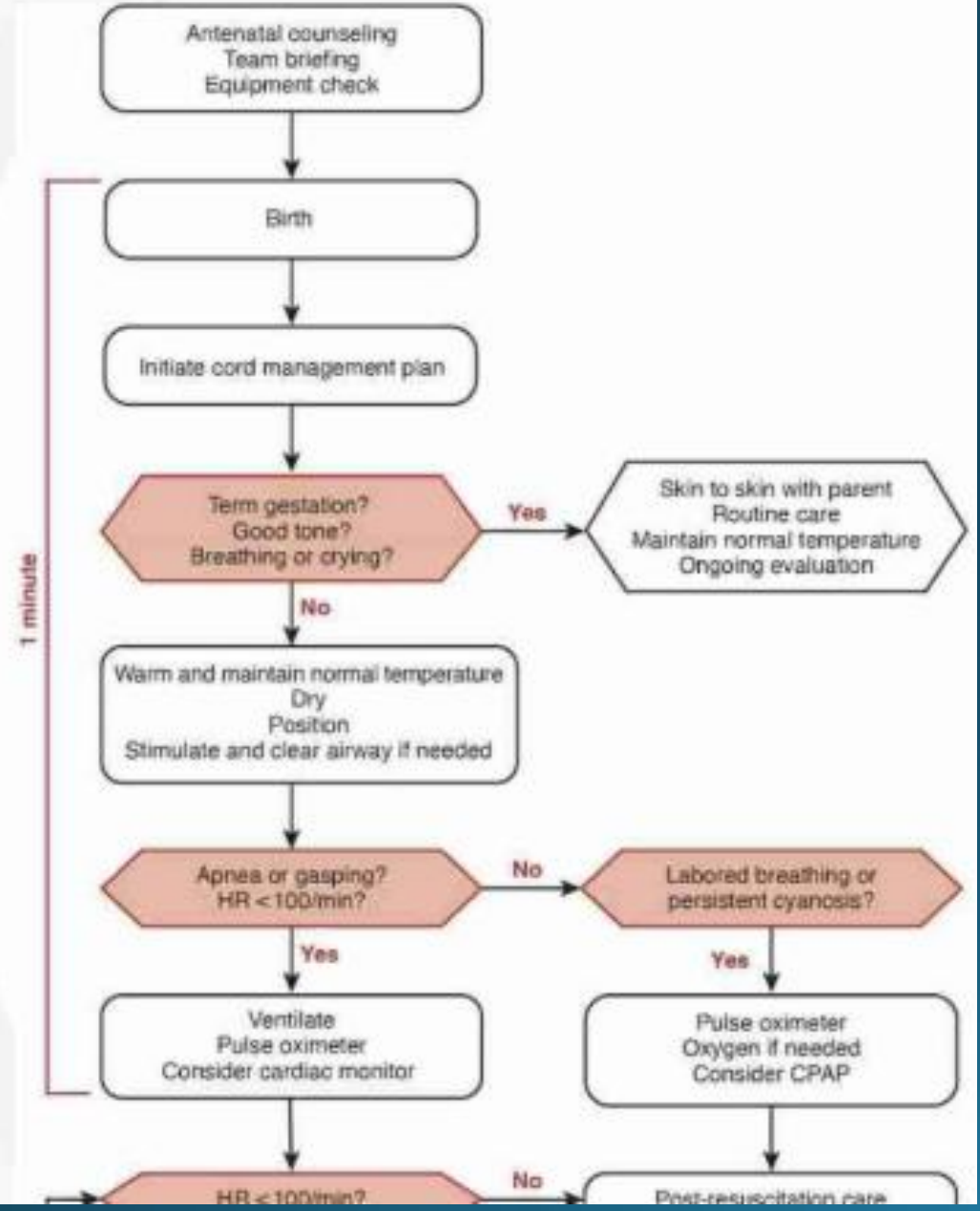
- Expected gestational age
- Is the AF clear ?
- Any additional risk factors?
- *Umbilical cord management plan*

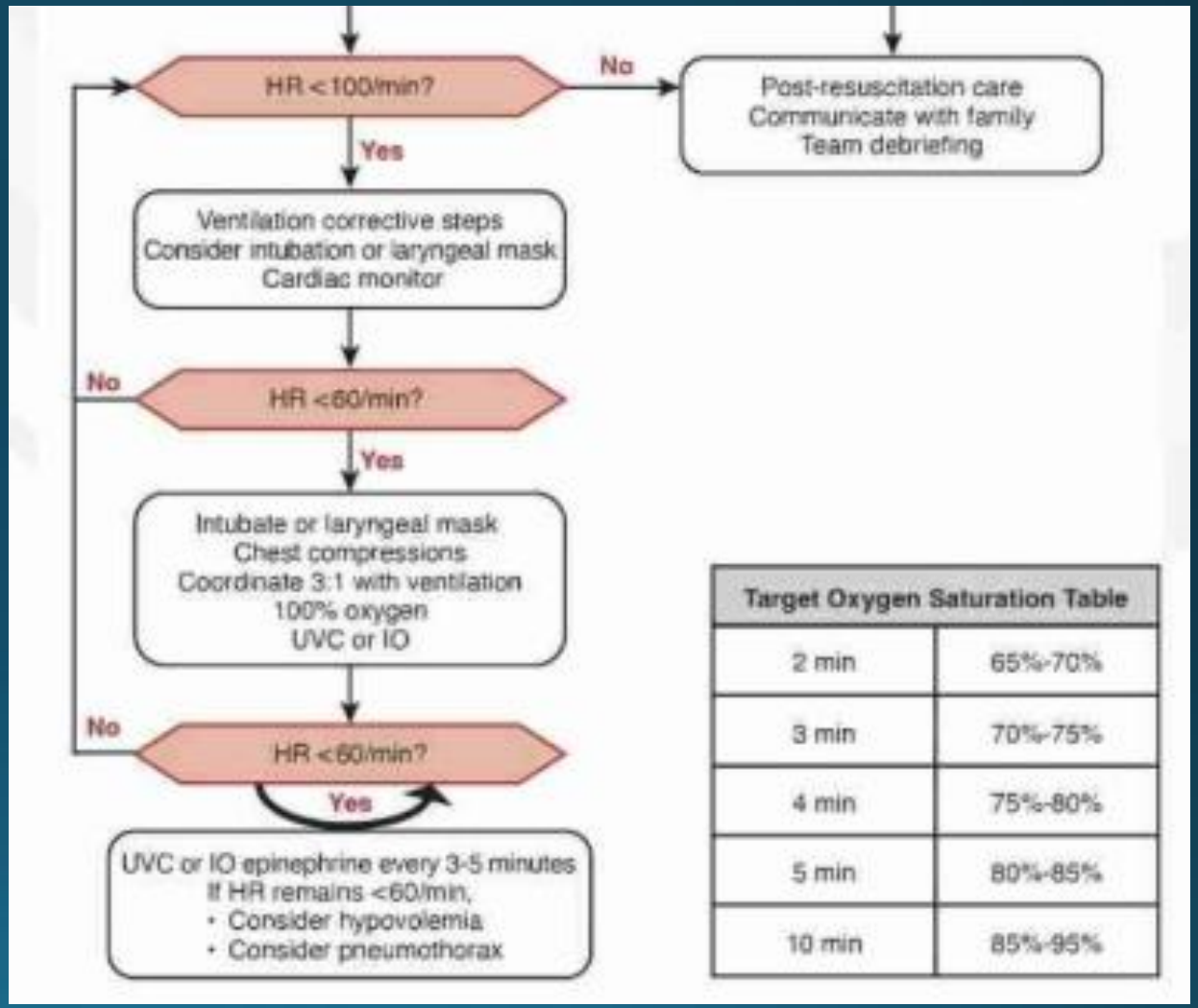
Neonatal Resuscitation Program

American Heart Association.

Indian Academy of Pediatrics

The NRP 9th Edition Algorithm





Target Oxygen Saturation Table	
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

https://globalhealthmedia.org/video/helping-babies-breathe-at-birth/

Neonatal Ventilation Videos

- Ventilation Administration
- T-Piece: https://bcove.video/4mU7JxF
- T-piece set-up: https://bcove.video/45k3Jk5
- Heart Rate Assessment during PPV: https://bcove.video/3J94Hqw
- MR SOPA: https://bcove.video/41yRYnc

References

Part 5: Neonatal Resuscitation 2025 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Henry Lee, et al. *Pediatrics* Oct 2025, 157 (1) e2025074352; **DOI:** https://doi.org/10.1542/peds.2025-074352

Hooper, Stuart & Roberts, Calum & Dekker, Janneke & Pas, Arjan. (2019). Issues in cardiopulmonary transition at birth. Seminars in Fetal and Neonatal Medicine. 24. 101033. 10.1016/j.siny.2019.101033.

Askin, D.F. (2002). Complications in the transition from fetal to neonatal life. *JOGNN, 31*(3), 318-327.

Jain, L., & Eaton, D.C. (2006). Physiology of fetal lung fluid clearance and the effect of labor. *Seminars in Perinatology*, 30, 34-33.

References

Blackburn, S.T. (2013). *Maternal, fetal, and neonatal physiology: A clinical perspective* (4th ed.). St. Louis: Mosby.

Escobedo, et al. (2019). American Heart Association Focused Update on Neonatal Resuscitation: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, *Circulation*, 140(24), e922–e930. DOI: https://doi.org/10.1161/CIR.0000000000000729

Sansoucie, D.A., & Cavaliere, T.A. (1997). Transition from fetal to extrauterine circulation. *Neonatal Network, 16*(2), 5-12.

Delayed umbilical cord clamping after birth. ACOG Committee Opinion No. 814. American College of Obstetricians and Gynecologists. Obstet Gynecol 2020;136:e100–6.

An Update to Clinical Guidance for Delayed Umbilical Cord Clamping After Birth in Preterm Neonates. Obstetrics & Gynecology ():10.1097/AOG.0000000000006020, July 24, 2025. | DOI: 10.1097/AOG.0000000000006020