

Respiratory Failure in Pregnancy



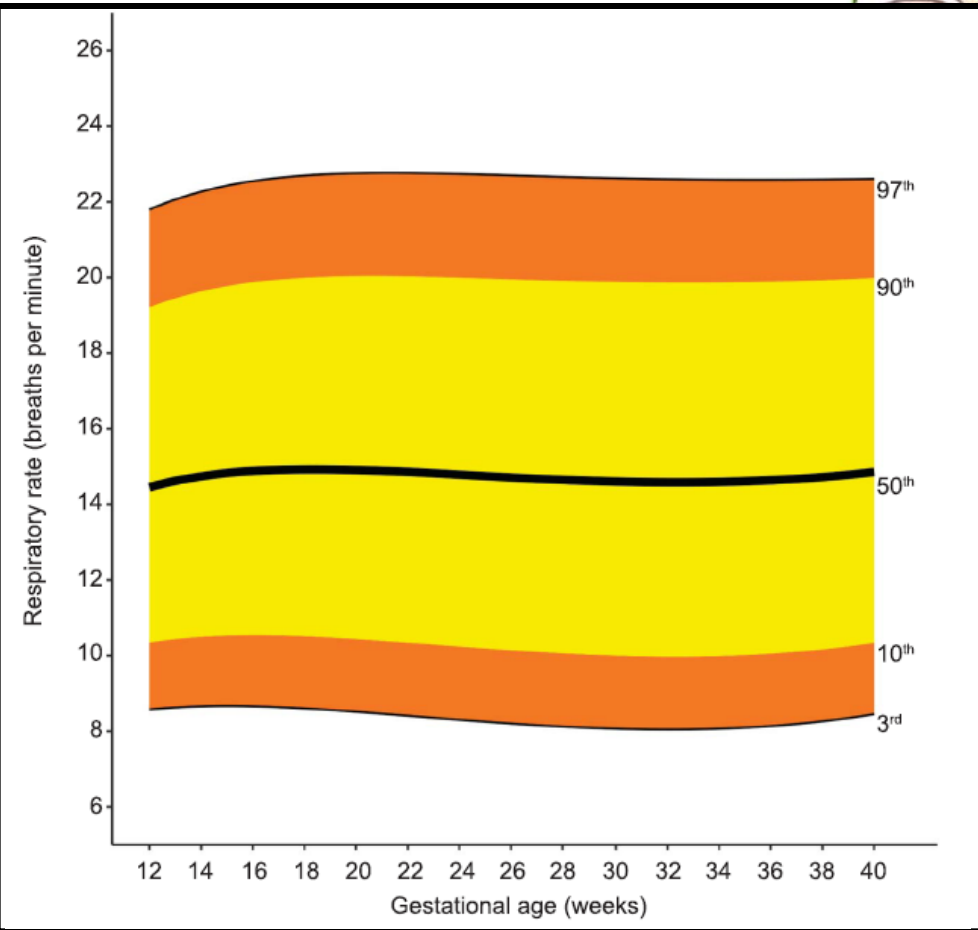
Stephen E. Lapinsky

*Mount Sinai Hospital
Toronto, Canada*

Respiratory Failure in Pregnancy

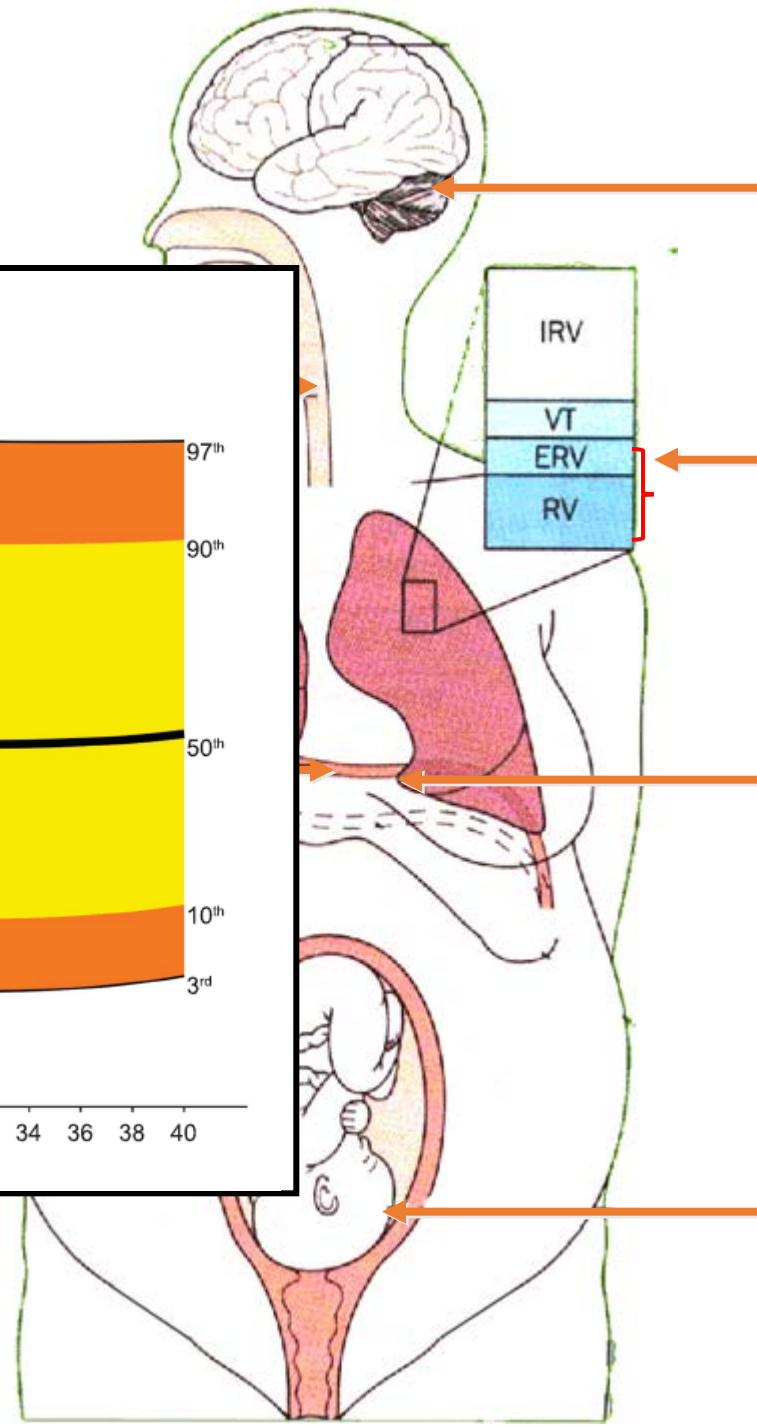
- Physiology in pregnancy
- Conditions causing respiratory failure in pregnancy
- Management of respiratory failure in pregnancy

Anatomic effects



Green et al. Obstet Gynecol 2020; 135:653

Functional effects



increased respiratory drive

increased V_t (not rate)

minimal change in TLC
reduced FRC

normal diaphragmatic
function

increased O_2 consumption
and CO_2 production

Anatomic effects

Functional effects

airway edema,
friability

widened AP and
transverse diam.

elevated diaphragm

widened subcostal
angle

enlarging uterus

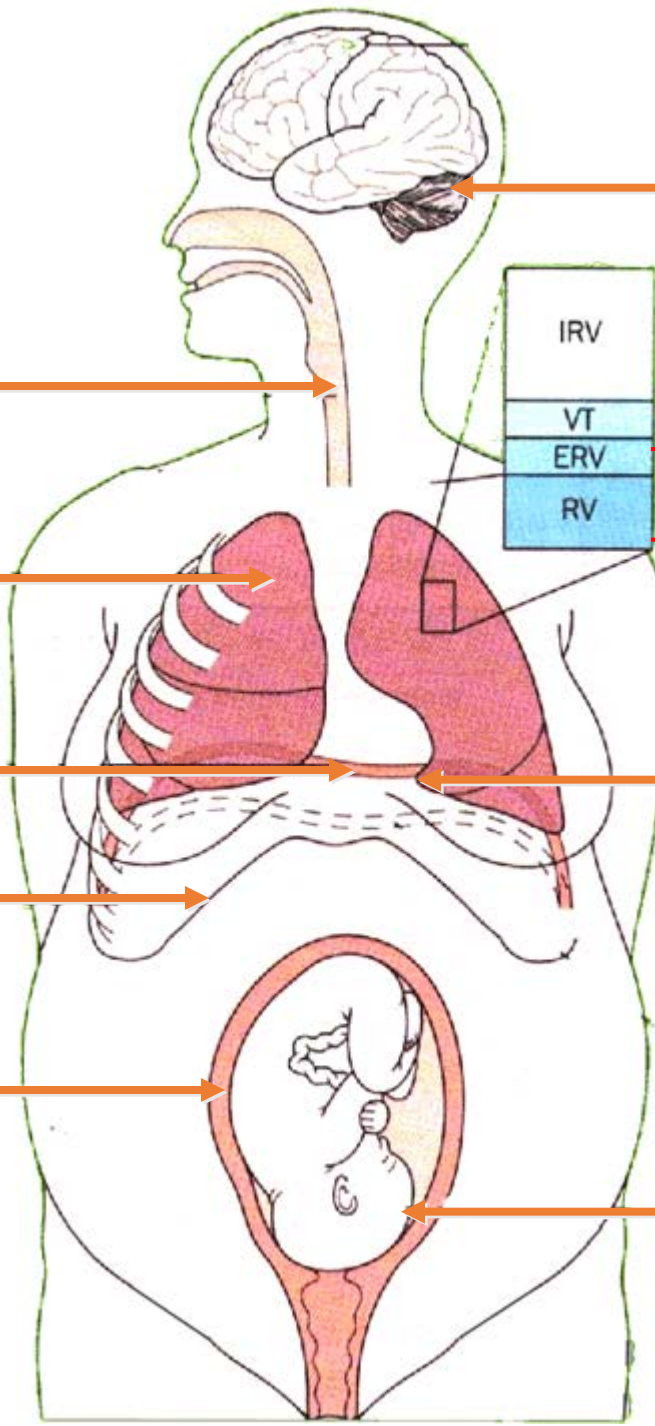
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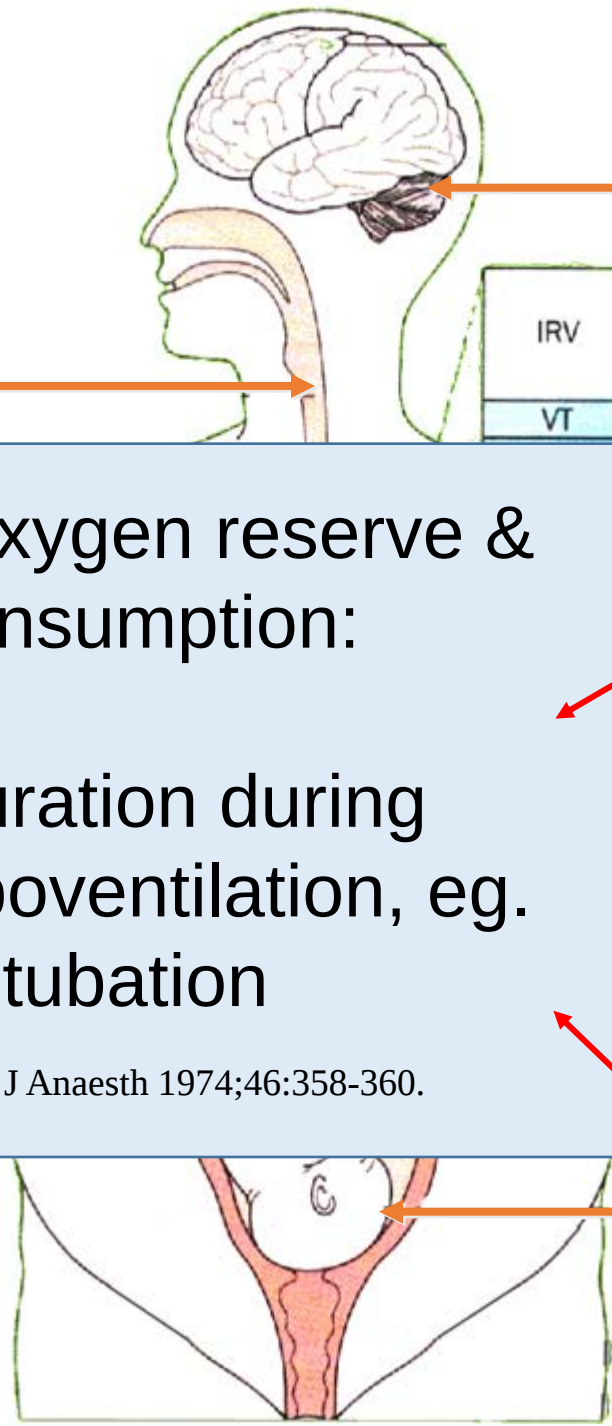
normal diaphragmatic
function

increased O_2 consumption
and CO_2 production

Decreased oxygen reserve &
increased consumption:

Rapid desaturation during
apnea or hypoventilation, eg.
during RSI intubation

Archer GW: Br J Anaesth 1974;46:358-360.



Blood gases in late pregnancy

pH	7.43
PaCO ₂	30 mmHg (4 kPa)
PaO ₂	105 mmHg (14 kPa)
HCO ₃ ⁻	20 mEq/L

Non-
pregnant

40 mmHg

- hyperventilation

100 mmHg

- normal a-A gradient

24 mEq/L

- renal compensation

Blood gases in late pregnancy

pH	7.43	pH	7.25
PaCO ₂	30 mmHg (4 kPa)	PaCO ₂	40 mmHg (5.3 kPa)
PaO ₂	105 mmHg (14 kPa)	PaO ₂	100 mmHg (13.3 kPa)
HCO ₃ ⁻	20 mEq/L	HCO ₃ ⁻	20 mEq/L



Not a metabolic acidosis!

This is a respiratory acidosis in the pregnant patient

Respiratory Failure in Pregnancy

Causes of respiratory failure in pregnancy

Pregnancy - specific

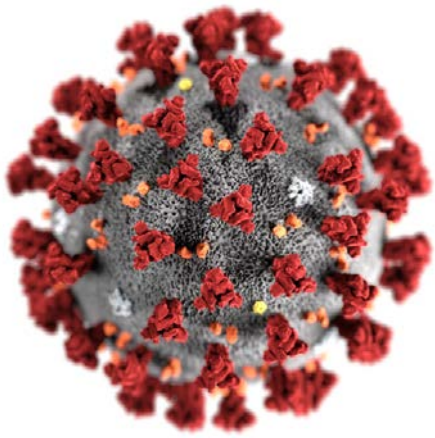
- Preeclampsia (pulmonary edema)
- Amniotic fluid embolism
- Tocolytic pulmonary edema
- Septic ARDS (chorioamnionitis)
- Fetal intrauterine surgery

Aggravated by pregnancy

- Gastric acid aspiration
- Venous thromboembolism
- Pyelonephritis (producing ARDS)
- Sepsis
- Pneumonia (influenza, COVID, varicella)
- Connective tissue disease
- Cardiac failure

Non - specific

- Trauma
- Non-obstetric infections
- Restrictive lung disease
- Other



Severe COVID in Pregnancy

COVID-19 in pregnancy

- CANCOVID-Preg: observational surveillance, March 2020 – Oct 2021
- 6,012 pregnancies with COVID-19

JAMA | Original Investigation

Association of SARS-CoV-2 Infection During Pregnancy With Maternal and Perinatal Outcomes

Elisabeth McClymont, PhD; Arianne Y. Albert, PhD; Gillian D. Alton, PhD; Isabelle Boucoiran, MD; Eliana Castillo, MD; Deshayne B. Fell, PhD; Verena Kuret, MD; Vanessa Poliquin, MD; Tiffany Reeve, MSc; Heather Scott, MD; Ann E. Sprague, PhD; George Carson, MD; Krista Cassell, MD; Joan Crane, MD; Chelsea Elwood, MD; Chloe Joynt, MD; Phil Murphy, MS; Lynn Murphy-Kaulbeck, MD; Sarah Saunders, MD; Prakesh Shah, MD; John W. Snelgrove, MD; Julie van Schalkwyk, MD; Mark H. Yudin, MD; Deborah Money, MD; for the CANCOVID-Preg Team

McClymont et al. JAMA 2022;327(20):1983-1991

COVID-19 in pregnancy

- CANCOVID-Preg: observational surveillance, 03/2020 – 10/2021
- 6,012 pregnancies with COVID-19

Outcome:

Outcome	Pregnant COVID	Comparator	
		♀ 20-49yr COVID	Pregnant non-COVID
Hospitalization	7.8%	2.9%	-
ICU admission	2.0%	0.37%	-
Preterm birth	11.1%	-	6.8%

No adverse maternal outcomes if 2x vaccinated

COVID drug therapy in pregnancy

Drug	Indication (non-pregnant)
Steroids	Moderately ill patients: hospitalized, needing oxygen Dexamethasone 6mg daily x 10d

Usual COVID regimen: dexamethasone 6mg daily x 10d

RECOVERY trial

COVID drug therapy in pregnancy

Drug	Indication (non-pregnant)
Steroids	Moderately ill patients: hospitalized, needing oxygen Dexamethasone 6mg daily x 10d

Usual COVID regimen: dexamethasone 6mg daily x 10d

RECOVERY trial

Most corticosteroids do not cross the placenta and affect the fetus:

- enzymatic conversion in placenta to inactive metabolites
- retrograde transport

BUT **dexamethasone** and **betamethasone** do cross placenta

COVID drug therapy in pregnancy

Drug	Indication (non-pregnant)
Steroids	Moderately ill patients: hospitalized, needing oxygen Dexamethasone 6mg daily x 10d

Usual COVID regimen: dexamethasone 6mg daily x 10d

RECOVERY trial

For pregnancy, prefer steroid not crossing placenta, eg.
Methylprednisolone 32 mg (= dexamethasone 6mg)

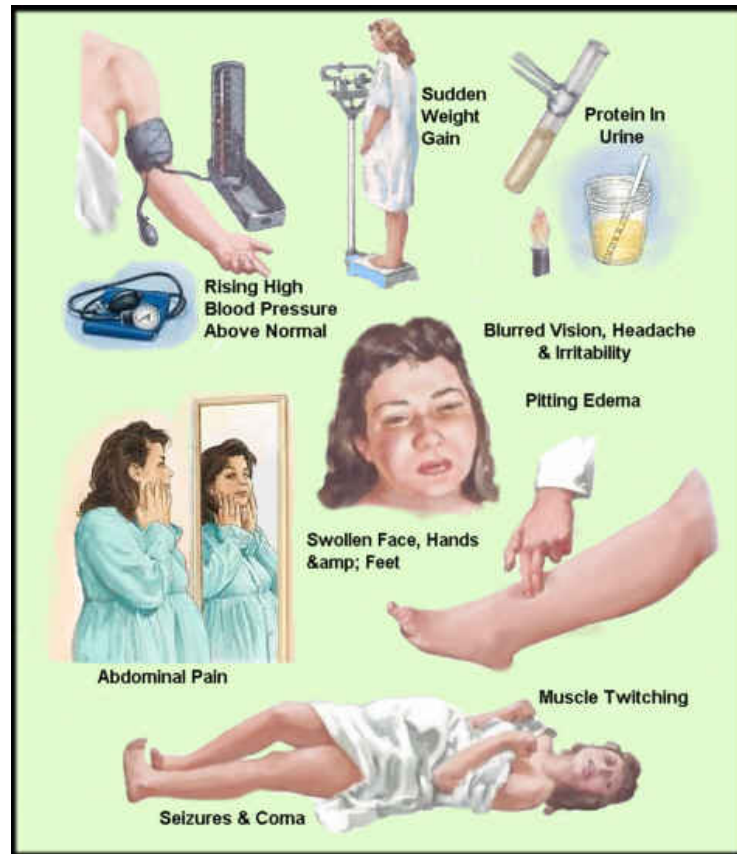
If fetal lung maturation indication:

- start with dexamethasone 6mg BID (or betamethasone) x 48hr
- complete 10 days with methylprednisolone

Other COVID therapy in pregnancy

Drug	Indication (non-pregnant)	Use in pregnancy
Tocilizumab	Moderately ill with disease progression - Increase oxygen despite steroids - Elevated CRP (>75mg/L) 400mg IV x 1 dose	Similar use in pregnancy Safety data from use in rheumatoid arthritis
Paxlovid	Patients who are at high risk for progression to severe COVID-19 (e.g. pregnancy) (Reduced severe illness & death by 89%)	Probably safe in pregnancy Study of 47 pts (28 wks gest) <i>JAMA Netw Open</i> 2022; 5:e2244141 ACOG, SMFM recommend
DVT prophylaxis	Non-ICU: therapeutic dose ICU: prophylactic dose	Similar use in pregnancy?
Mechanical ventilation	Indications no different to other conditions	No different in pregnancy

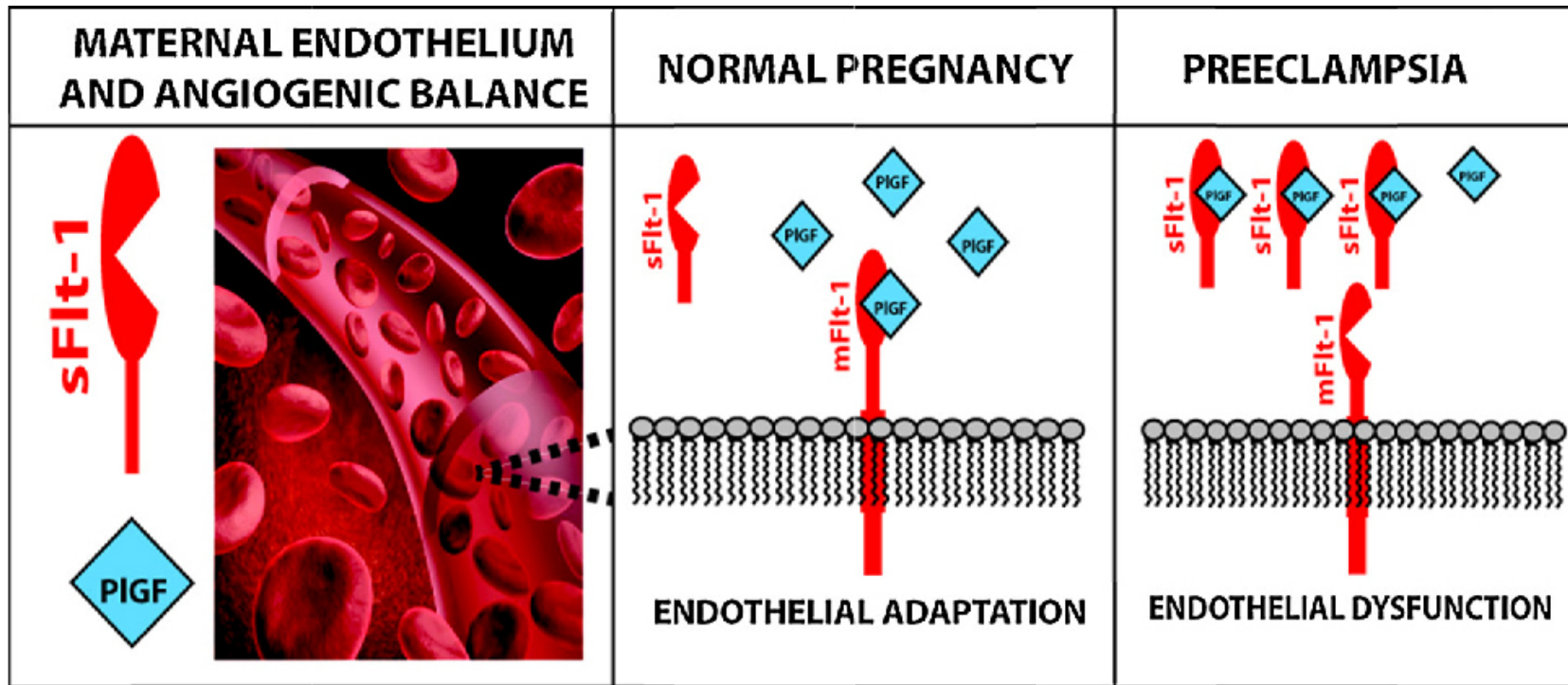
Preeclampsia in the ICU



Hypertensive crisis
Pulmonary edema
Renal failure
Cerebral edema
Eclampsia
HELLP

Preeclampsia - Etiology

Abnormal placentation $\Rightarrow$ defective vascularization $\Rightarrow$ inflammatory response



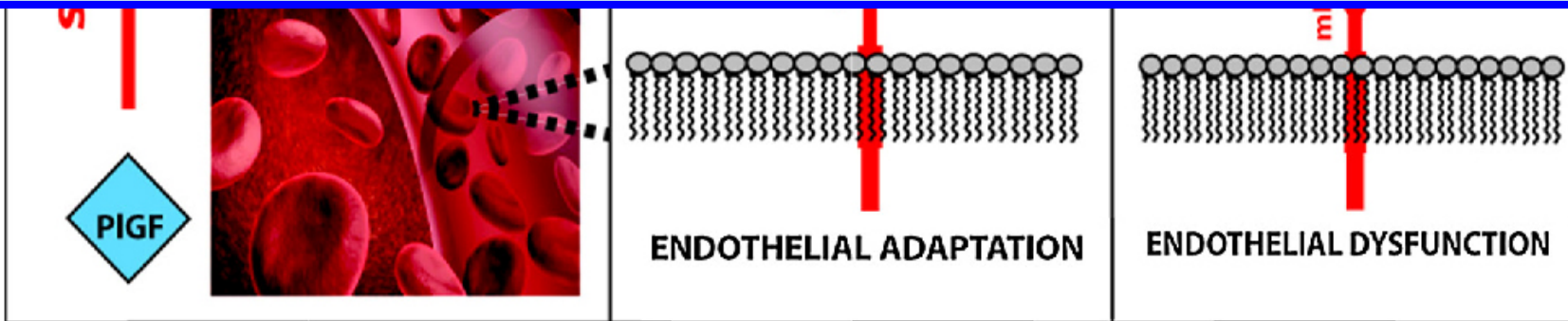
Preeclampsia - Etiology

Abnormal placentation $\Rightarrow$ defective vascularization $\Rightarrow$ inflammatory response

sFlt1 (from fetal side of placenta) blocks **VEGF** and **PlGF**



maternal endothelial effects



Preeclampsia - Hemodynamics

Preeclampsia hemodynamic subgroups:

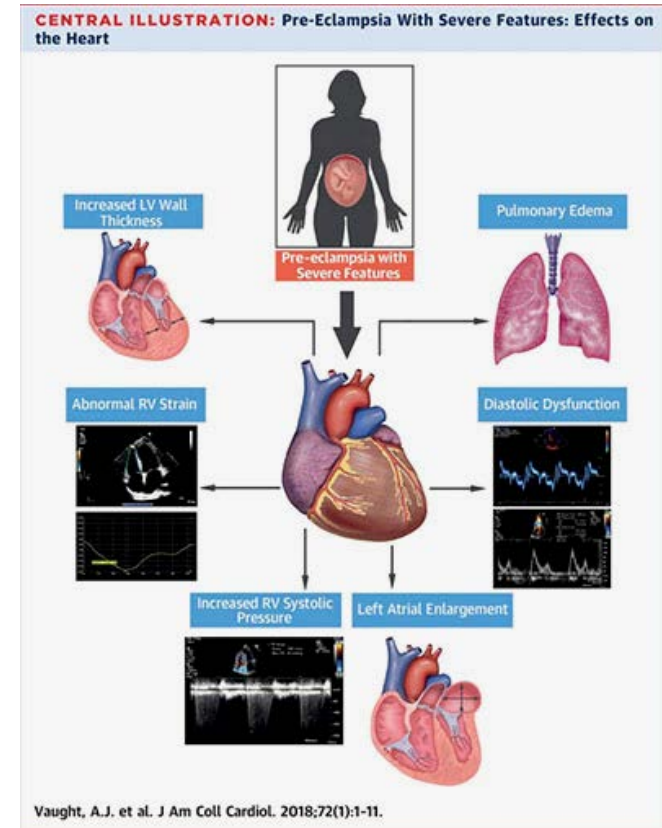
	hypodynamic	hyperdynamic
Cardiac output	decreased	increased
SVR	high	low
other associations	early preeclampsia? SGA?	late preeclampsia obesity?

Preeclampsia pulmonary edema

- 3% of preeclamptics develop pulmonary edema

- Mechanism

- increased afterload
- Diastolic dysfunction
- decreased serum albumin
- volume administration
- uterine contraction



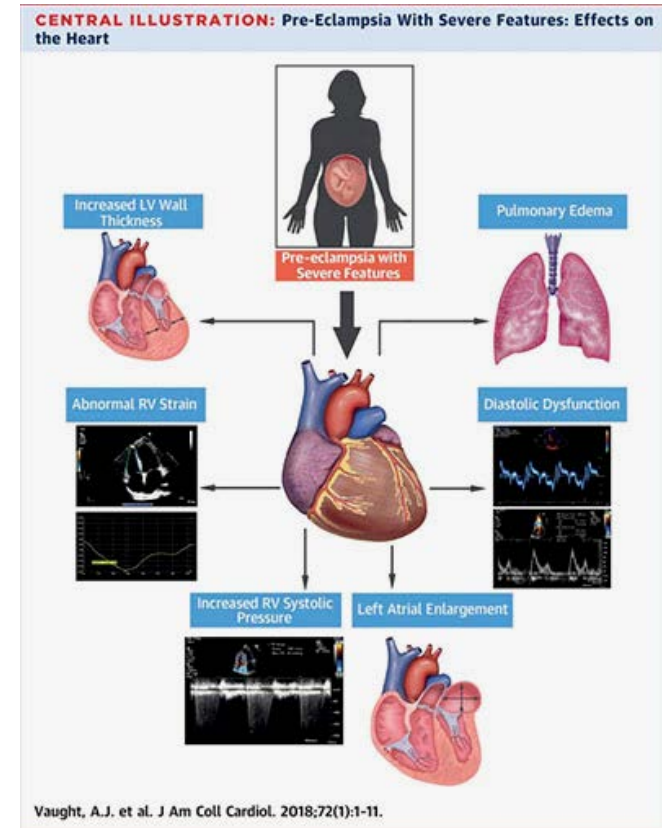
- Pulmonary edema is more common in obese, hypertensive patients

Preeclampsia pulmonary edema

- **TREATMENT:**

- oxygen, diuresis
- ventilatory support: NIV?
- PA catheter ? - if oliguric, hypertensive

- **Avoid overdiuresis:** may compromise placental perfusion



Amniotic Fluid Embolism

- **Rare:** Incidence varies according to diagnostic criteria:
2 – 6.6 /100,000
- **Catastrophic:** mortality 11 - 30%
- **Presentation:** cardiorespiratory collapse
fetal distress
cardiac arrest, seizures
- **Late effects:** ARDS & DIC

Knight et al. BMC Pregnancy Childbirth 2012; 12:7
Conde-Agudelo Am J Obstet Gynecol 2009; 201:445e1

Amniotic Fluid Embolism

Pathophysiology:

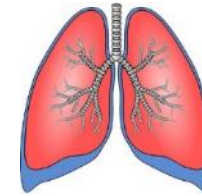
amniotic fluid and fetal antigens enter maternal venous circulation



Abnormal activation of humoral and immunological mechanisms

Release of vasoactive and procoagulant substances

Leukotrienes
Histamine
Prostaglandins



ARDS

Pulmonary hypertension



RV & LV dysfunction



DIC & bleeding

•Amniotic Fluid Embolism Management

- Supportive:
 - Ventilation
 - Inotropes
 - blood products
 - Steroids?
- Anticipate ARDS & DIC
- Extracorporeal life support



Amniotic Fluid Embolism Testing

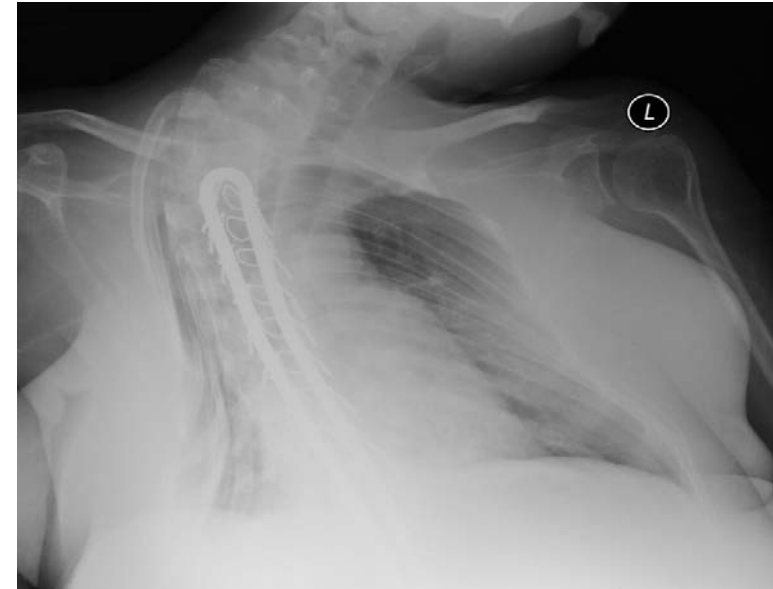
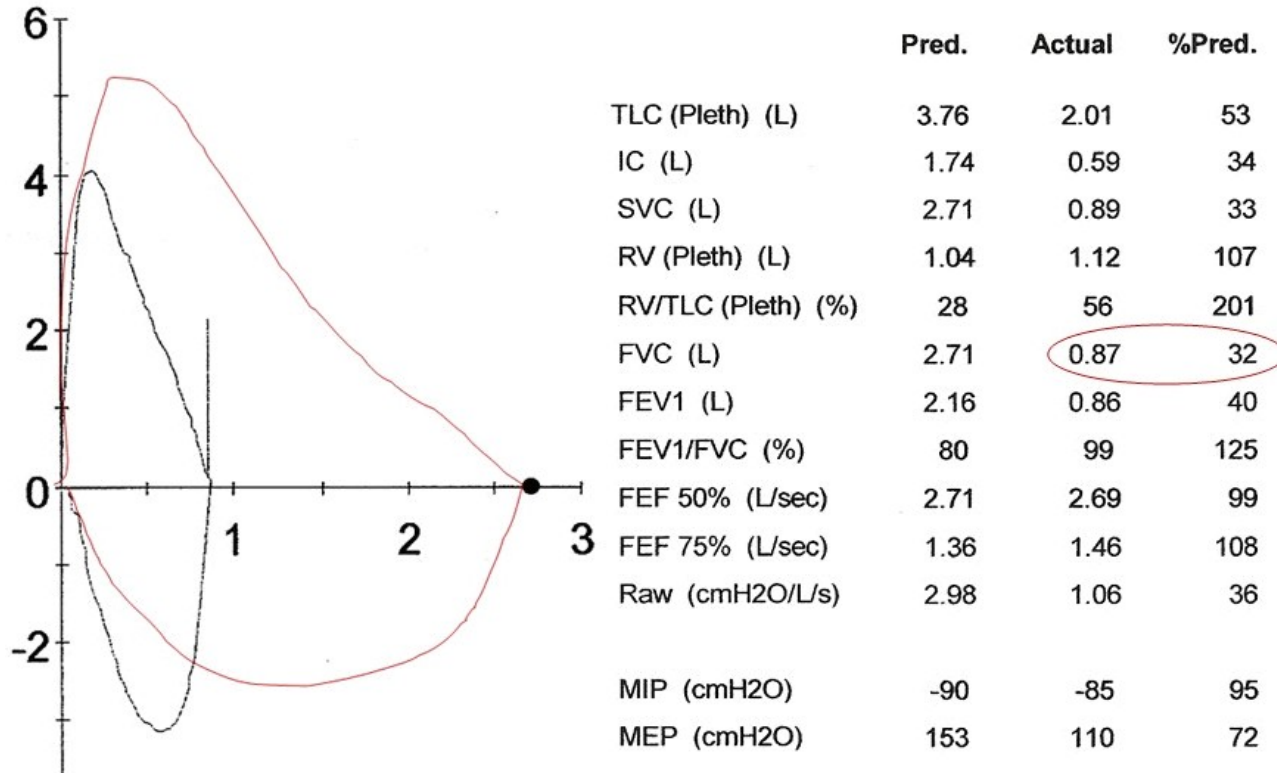
- Usually diagnosis of exclusion
- Not yet adequately validated:
 - Tryptase (ie. anaphylaxis)
 - Fetal squames and debris in pulmonary capillaries
 - Complement levels
 - Zinc coproporphyrin
 - Sialyl Tn antigen
 - **C1 esterase inhibitor**

Tamura et al. Crit Care Med. 2014;42(:1392-6

Todo et al. Clin Case Rep. 2015;3:673-5

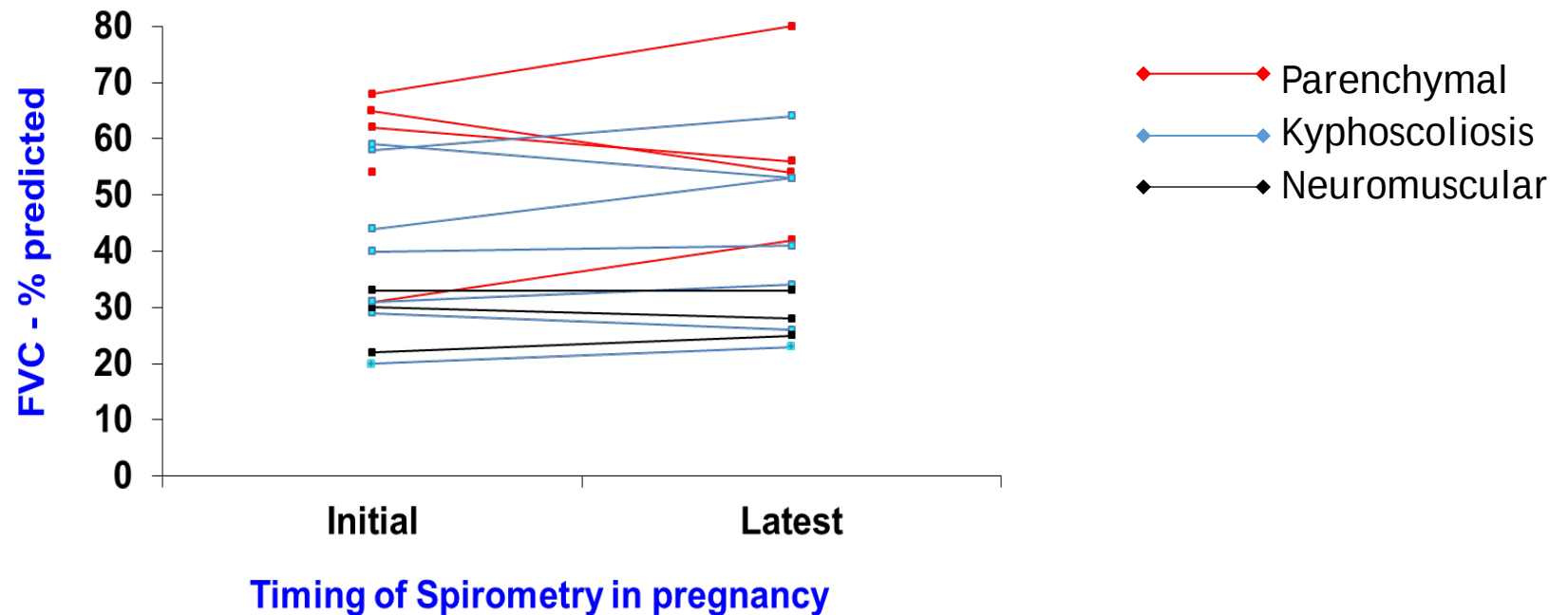
Levels lower in fatal versus non-fatal cases
Case reports of effective treatment

Restrictive lung disease in pregnancy



Restrictive lung disease

Retrospective review of 15 pregnancies in women with restrictive lung disease



Lapinsky et al. Chest. 2014;145:394-8

Interstitial lung disease

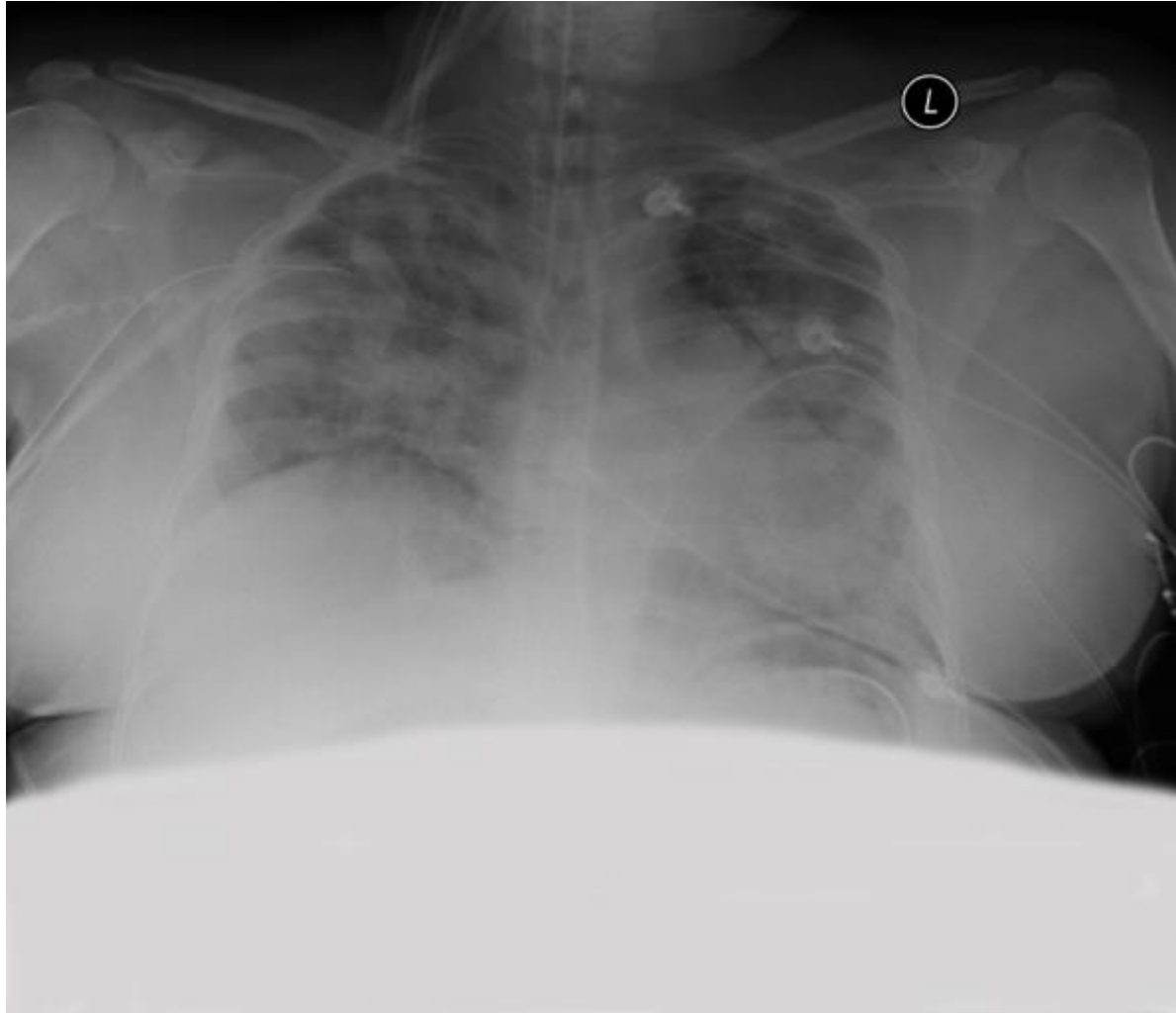
- Risks:
 - **oxygenation:** check DLCO, 6MW
may need supplemental oxygen
 - **ventilation:** check clinically, ABG
may need eg. nocturnal BiPAP
 - **pulmonary hypertension:** check Echo
 - **LAM and SLE may deteriorate:** monitor, Rx

Pulmonary edema in pregnancy

- **Causes:**

- **preeclampsia** – multifactorial mechanisms
- **cardiac** - underlying valvular disease
 - peripartum cardiomyopathy
- **fluid overload** - iatrogenic
 - uterine blood to central circulation
- **tocolytic pulmonary edema** – not common now
- **ARDS** - multiple causes

ARDS in pregnancy



ARDS in pregnancy

- **Important cause of maternal death**
- **Pregnant women appear more susceptible:**
 - Reduced serum albumin
 - Increased blood volume
 - Upregulation of components of the inflammatory response
- **ARDS occurs in pregnancy 10x > general population**

Smith, et al. West J Med 1990, 153:508

Catanzarite, Obstet Gynecol Survey 1997, 52:381

Sheng et al. Crit Care Med. 2012 May;40(5):1570-7

ARDS in pregnancy

- pre-eclampsia
- pneumonia (eg. influenza, COVID)
- obstetric sepsis
- amniotic fluid embolism
- aspiration
- major hemorrhage (TRALI)
- placental abruption



Smith, et al. West J Med 1990, 153:508

Catanzarite, Obstet Gynecol Survey 1997, 52:381

Management of Respiratory failure in pregnancy

Prepare the ICU for Emergencies in Pregnancy



Respiratory failure in pregnancy

- **Be Prepared:**

- **Drugs:** oxytocin, Hemabate, ergotamine
- **Blood compat:** send q4 days
- **Equipment:** Vaginal delivery
Caesarean delivery
Neonatal resuscitation
- **Decisions:** fetal resuscitation status
- **Contact details:** OB, anesthesia, neonatology

Non-invasive Ventilation

- Advantages

- avoids the upper airway
- avoids sedation

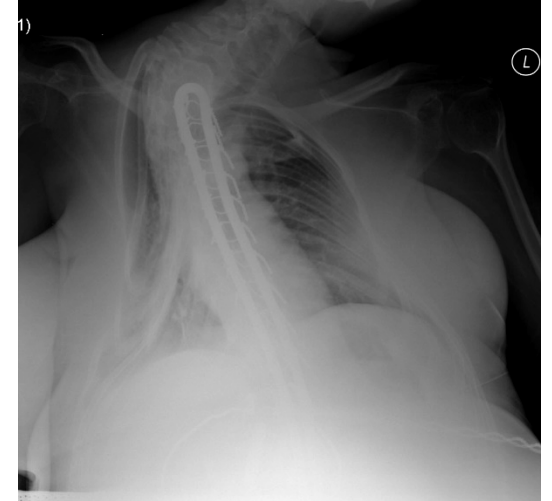
- Concerns

- nasal congestion
- reduced lower esophageal sphincter tone
- aspiration



Non-invasive Ventilation

- Acute respiratory failure
 - Pulmonary edema (preeclampsia, cardiogenic)
 - Other (eg. asthma, pneumonia)
- Chronic respiratory failure
 - Neuromuscular disease
 - Kyphoscoliosis
 - Bronchiectasis



Endotracheal intubation in pregnancy



Failed intubation 8x more common than non-pregnant patient

Affected by

- anatomical changes
- aspiration risk
- weight gain
- reduced oxygen reserve
- preeclampsia

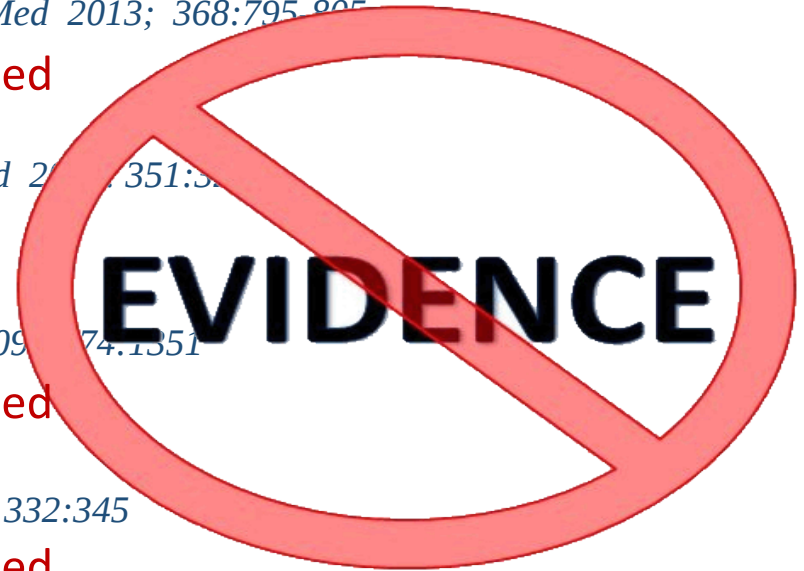
Mechanical Ventilation in Pregnancy

Intubation

- Indications Remember normal PaCO₂ levels
- Tube size eg. 6.5 to 7.5
- Airway friability Avoid nasal route
- Aspiration delayed gastric emptying, increased abdominal pressure
- Oxygen desaturation reduced O₂ reserves

Evidence-based Mechanical ventilation

- ARDSnet trial (Vt 6 ml/kg) *N Engl J Med 2000; 342:1301-1308*
 - pregnant patients excluded
- Oscillate (HFO) trial *N Engl J Med 2013; 368:795-805*
 - pregnant patients not mentioned
- High v. low PEEP *N Engl J Med 2010; 363:1293-1301*
 - pregnant patients excluded
- Cesar (ECMO trial) *Lancet 2009; 374:1351*
 - pregnant patients not mentioned
- Weaning trial *N Engl J Med 1995; 332:345*
 - pregnant patients not mentioned
- ICU sedation trial *JAMA 2012; 308:1985*
 - pregnant patients not mentioned



Conventional Ventilation

Evidence free zone

- **Tidal volume**
 - seems reasonable to follow usual guidelines, 6 ml/kg PBW (PBW = based on height)
- **Pressures**
 - Perhaps accept higher plateau pressures?
(but some data suggesting higher incidence of barotrauma)
- **Sedation and analgesia:**
 - limit sedation as in all ICU patients
 - opiates generally safe
 - some concern with benzodiazepines (1st trimester)
 - short term data on safety of propofol

Less Conventional Ventilation

- Prone positioning
 - case reports & arterial flow studies suggest safe

Kenn et al. In J Obstet Anesth 2009; 18:268

Nakai et al. Acta Obstet Gynecol Scan 1998; 77:967

Prone positioning in pregnancy



Video 1 Prone positioning in awake pregnant patient. Created by Mary Catherine Tolcher, MD, MSc, and Jennifer R. McKinney, MD, MPH. Used with permission.



Video 2 Prone positioning in intubated pregnant patient. Created by Mary Catherine Tolcher, MD, MSc, and Jennifer R. McKinney, MD, MPH. Used with permission.



Less Conventional Ventilation

- **Prone positioning**

- case reports & arterial flow studies suggest safe

Kenn et al. In J Obstet Anesth 2009; 18:268

Nakai et al. Acta Obstet Gynecol Scan 1998; 77:967

- **Nitric oxide**

- case reports in Pulmonary HTN

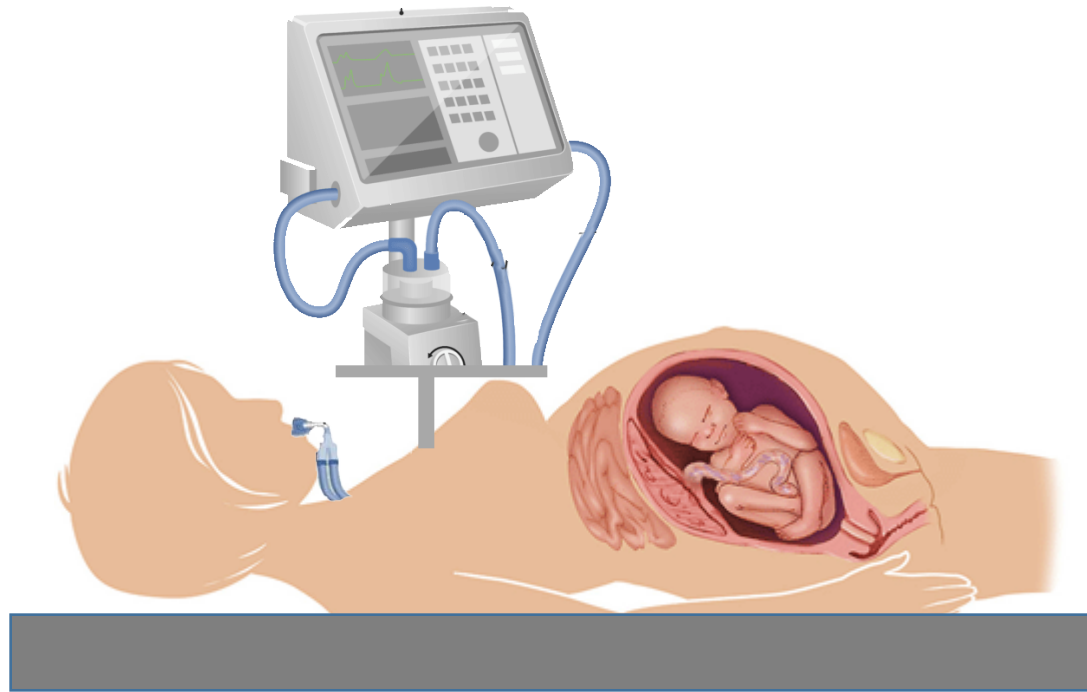
- **ECMO**

- Australian case-series during H1N1
 - More recent COVID data

Nair et al, Intensive Care Med. 2011;37:648-54.

ANZICS. BMJ. 2010 Mar 18;340:c1279

Risk to the fetus of a maternal ICU stay



Risks to the fetus of a maternal ICU stay

- Hypoxia
- Hypercapnia
- Radiology
- Drug therapy
- Premature delivery



Blood gas targets in pregnancy

- What should we target for O_2 and CO_2 ?



Blood gas targets in pregnancy

Often see suggested e.g. $\text{SpO}_2 > 95\%$

Although a PaO_2 of 55 mm Hg and an SaO_2 of 88% would be tolerated in the general population, adequate fetal oxygenation requires a PaO_2 of ≥ 70 mm Hg, which corresponds to a maternal SaO_2 of about 95%.

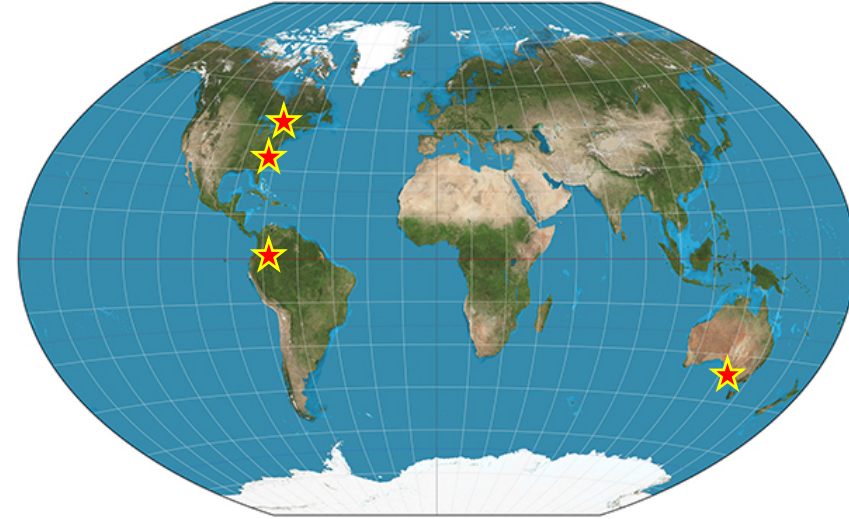


ELSEVIER
www.obstetananesthesia.com

ORIGINAL ARTICLE

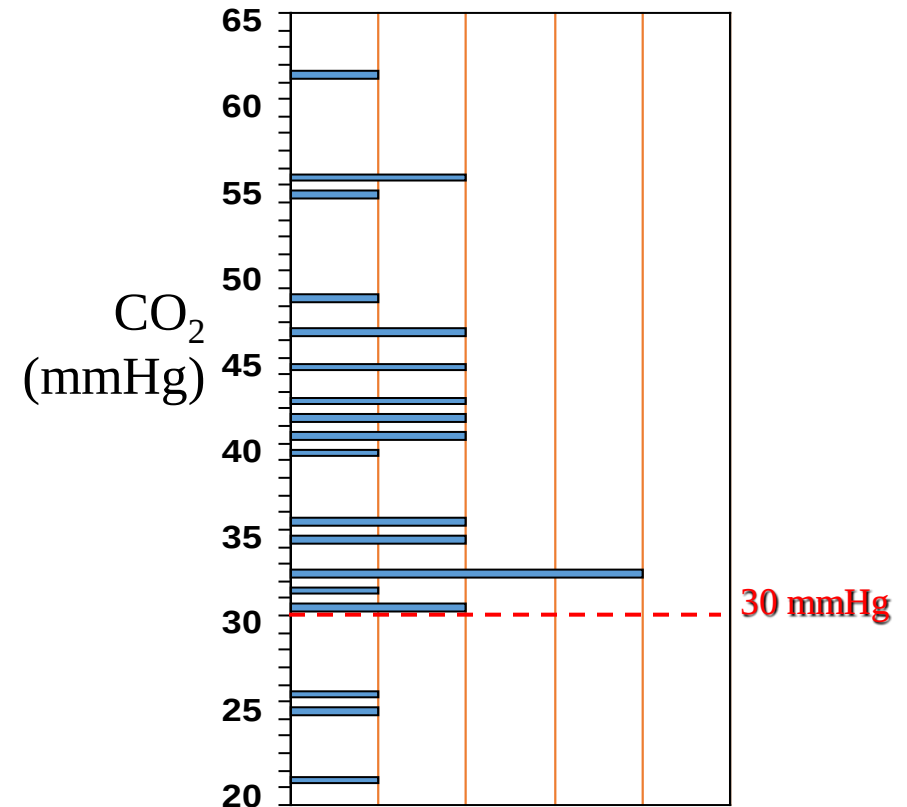
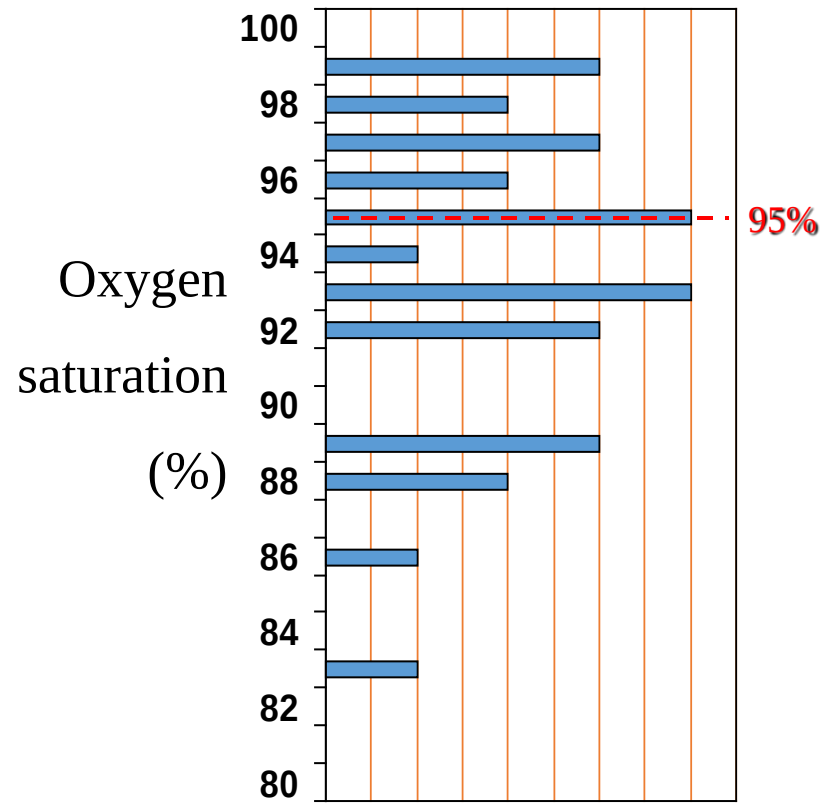
Mechanical ventilation in critically-ill pregnant women: a case series

S.E. Lapinsky,^{a,b} J.A. Rojas-Suarez,^{c,d} T.M. Crozier,^{e,f} D.N. Vasquez,^g N. Barrett,^f
K. Austin,^a G.A. Plotnikow,^g K. Orellano,^{d,h} G. Bourjeily^{i,j}



- Retrospective chart review, 29 patients
- 4 ICUs, 2004 – 2013
- Maternal, ventilation and outcome data
- Effects of delivery on maternal respiratory parameters

Distribution of worst blood gases in first 48 hr



Blood gas targets in pregnancy

- **Determinants of oxygenation**
 - placental function
 - uterine oxygen delivery



Blood gas targets in pregnancy

- **Determinants of oxygenation**

- placental function

- uterine oxygen delivery

- Maternal oxygen content

X

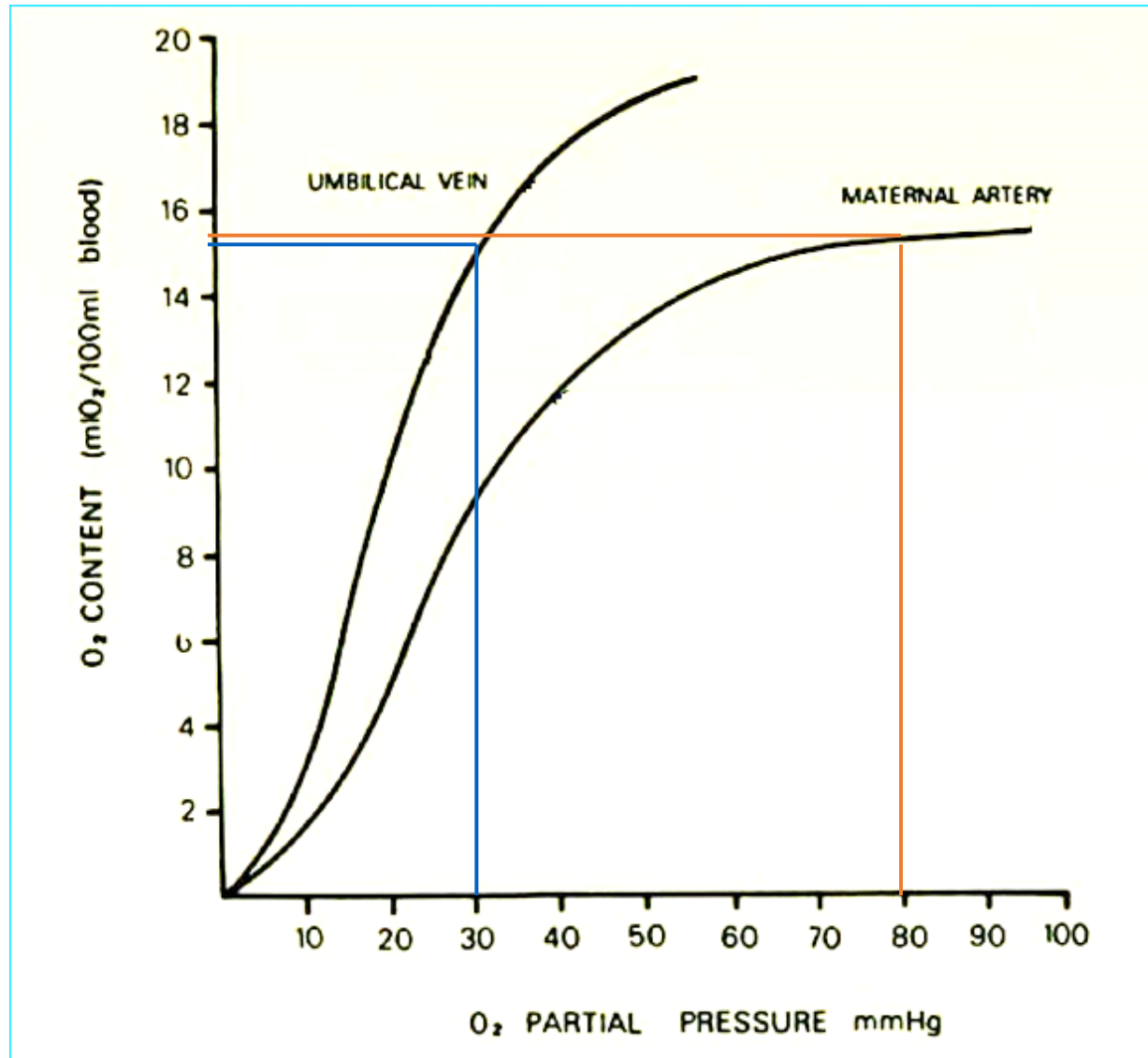
- Uterine blood flow

C.O. : 5 – 25 L/min

- normally maximally dilated
 - no significant autoregulation
 - decreased by catecholamines
alkalosis
hypotension
contractions

Hgb 70 – 140 g/L
SpO₂ 85% - 100%

Fetal Oxygenation



Blood gas targets in pregnancy

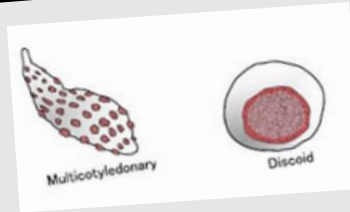
Maternal hypoxemia (10% O₂):

monitoring

Obstet Gynecol. 1995;86:795

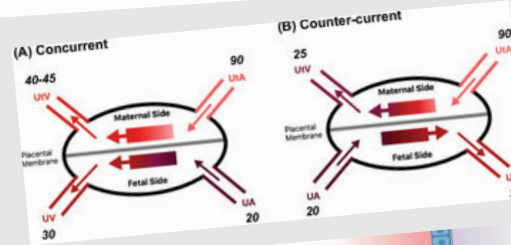
Gross anatomy

- discoid: human, primates
- multicotyledonary: sheep
- Surface area differences



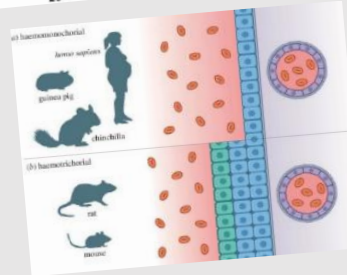
Placental blood flow

- concurrent: human, sheep, dog
- countercurrent: guinea-pig, rabbit



Cell layers separating maternal and fetal blood:

- Guinea-pig 2
- human 3
- sheep 5



Saini et al, In: Lapinsky & Plante, Respiratory Disease in Pregnancy

Blood gas targets in pregnancy



Maternal hypoxemia (10% O₂):

- no adverse effect on fetal monitoring

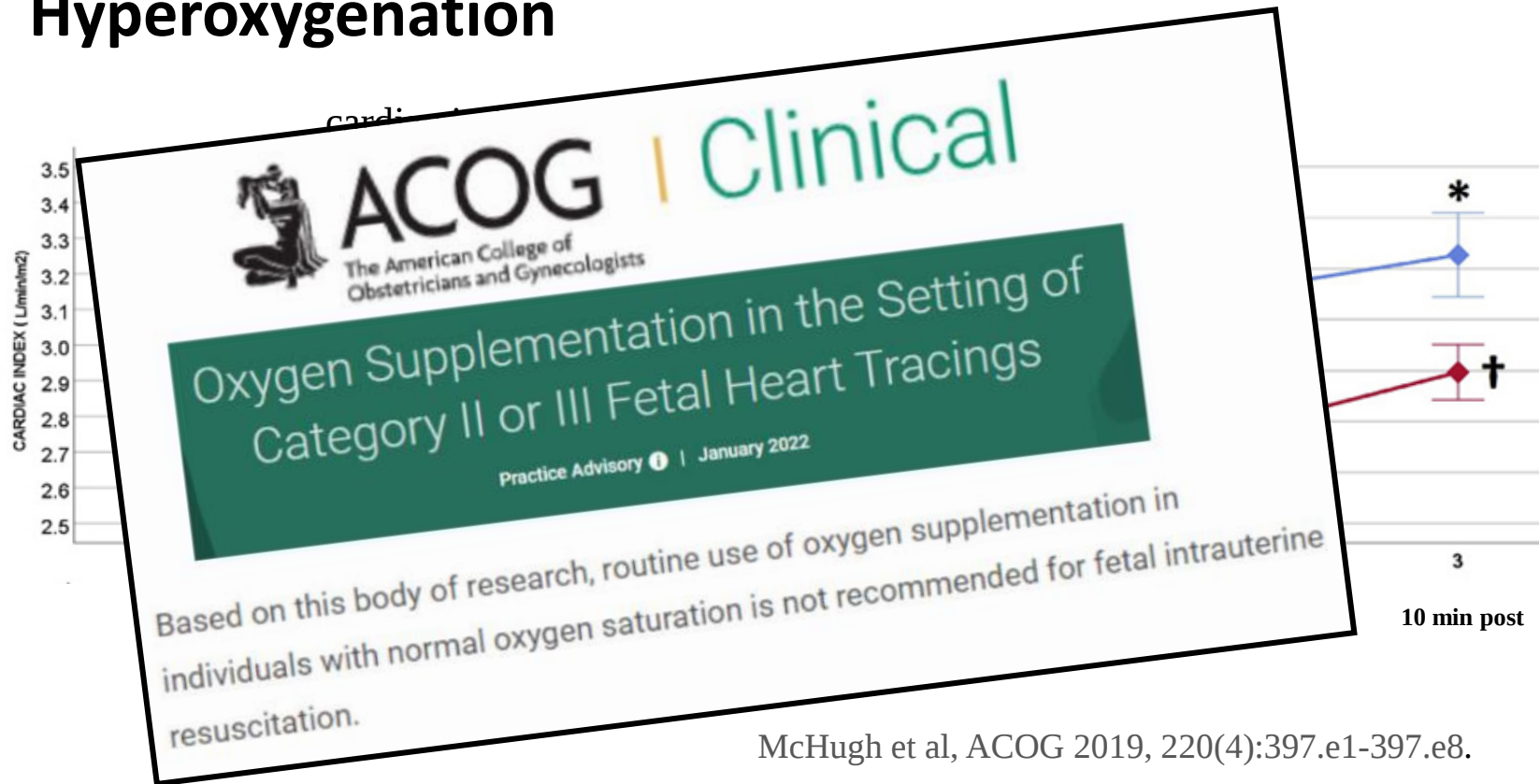
Polvi et al. Obstet Gynecol. 1995;86:795

Animal studies: but interspecies differences in placental anatomy, blood flow and function

Blood flow (placental and umbilical)
may be more important than pO₂

Blood gas targets in pregnancy

Hyperoxygenation



McHugh et al, ACOG 2019, 220(4):397.e1-397.e8.

Oxygen Targets in Pregnancy

Hypoxia likely dangerous to the fetus:
(Precise level and duration are unclear)

We use similar targets to nonpregnant patient

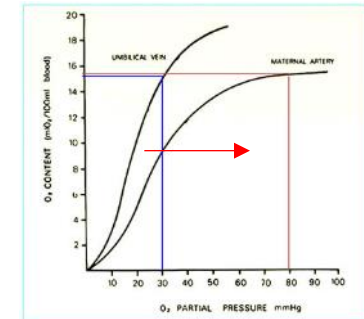
Hyperoxia also dangerous!

CO₂ Targets in Pregnancy

High CO₂

PHYSIOLOGICALLY:

- Right-shift of fetal oxygen dissociation curve
- Cardiovascular effect of acidosis?
- Effect on maternal & fetal blood flow?

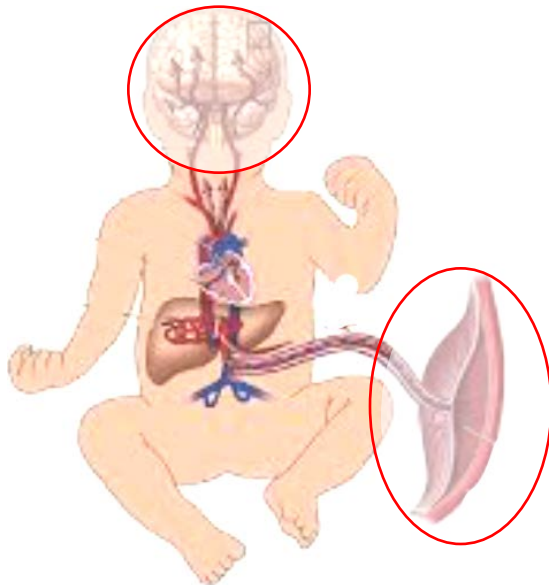


CO₂ Targets in Pregnancy

Low CO₂

Over-ventilation reduces uteroplacental blood flow

Maternal hypocapnia may reduce fetal cerebral blood flow



Levinson et al. Anesthesiology. 1974;40:340-7
Tomimatsu et al. J. Obstet. Gynaecol. Res 2013; 39, 1–6

CO₂ Targets in Pregnancy

- **Low CO₂ is dangerous:** reduces placental blood flow
reduces fetal cerebral blood flow
- **High CO₂:** unclear?
moderate levels may be tolerated
balance between injurious ventilation & hypercapnia
many of our COVID patients: 40-60 mmHg

Risks to the fetus of a maternal ICU stay

- Hypoxia
- Hypercapnia
- Radiology
- Drug therapy
- Premature delivery



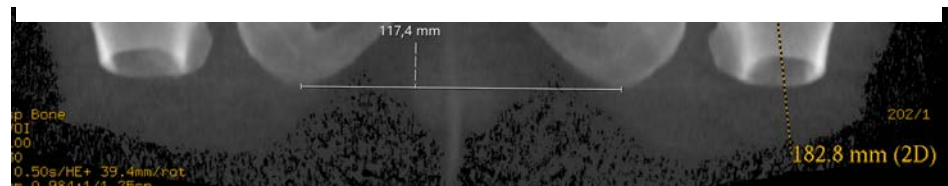
Br. J. Cancer (1975) 31, 271

PRE-NATAL IRRADIATION AND CHILDHOOD MALIGNANCY: A REVIEW OF BRITISH DATA FROM THE OXFORD SURVEY

J. F. BITHELL AND A. M. STEWART*

*From the D.H.S.S. Childhood Cancer Research Group, Old Radcliffe Observatory,
43 Woodstock Road, Oxford OX2 6JN*

Received 15 November 1974. Accepted 5 December 1974



Risks to the fetus of a maternal ICU stay

- Hypoxia
- Hypercapnia
- **Radiology**
- Drug therapy
- Premature delivery

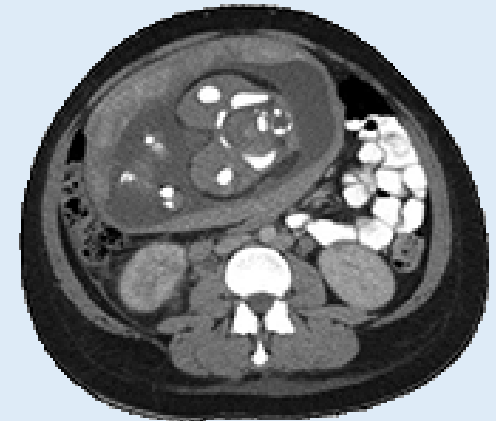
X-ray risks: *Carcinogenic (leukemia)*

Teratogenesis

Neurological development

Depends on gestation
> 50 – 100 mGy

Chest X-ray	0.01 mGy
Chest CT	0.05 - 0.2 mGy
Abdominal CT	10 – 50 mGy



Do not avoid radiological procedures
necessary for management of the mother

Risks to the fetus of a maternal ICU stay

- Hypoxia
- Hypercapnia
- Radiology
- Drug therapy
- Premature delivery

Drug therapy:

Risks include:

- Hemodynamic alterations
- Sedative effects
- Teratogenic effects

But a well mother is best for the fetus!

**Do not avoid drug therapy
necessary for management of the mother**

Risks to the fetus of a maternal ICU stay

- Hypoxia
- Hypercapnia
- Radiology
- Drug therapy
- Premature delivery

Occurs as a result of:

- Multiple pregnancy (twins, triplets)
- Trauma
- Underlying chronic illness
- Acute illness/sepsis (particularly obstetric sepsis)
- Iatrogenic: in the hope of improving mother

**Do not deliver the baby
outside of accepted obstetric indications**

Delivery of the fetus

- Given the physiological changes, it may be considered that delivery of the pregnant women with respiratory failure is beneficial to the mother

Delivery of the fetus

- Given the physiological changes, it may be considered that delivery of the pregnant women with respiratory failure is beneficial to the mother
- NOT always an improvement:
 - Small oxygenation improvement
 - Little change in compliance or PEEP requirement

Delivery of the fetus

- Given the physiological changes, it may be considered that delivery of the pregnant women with respiratory failure is beneficial to the mother
- NOT always an improvement:
 - Small oxygenation improvement
 - Little change in compliance or PEEP requirement
- Is there data?

Delivery of the fetus

Case report of improved oxygenation and extubation within 18 hr of delivery

Daily et al. Anesthesiol 1990; 72:383

Retrospective review of 10 women delivered while on mechanical ventilation

Respiratory outcomes:

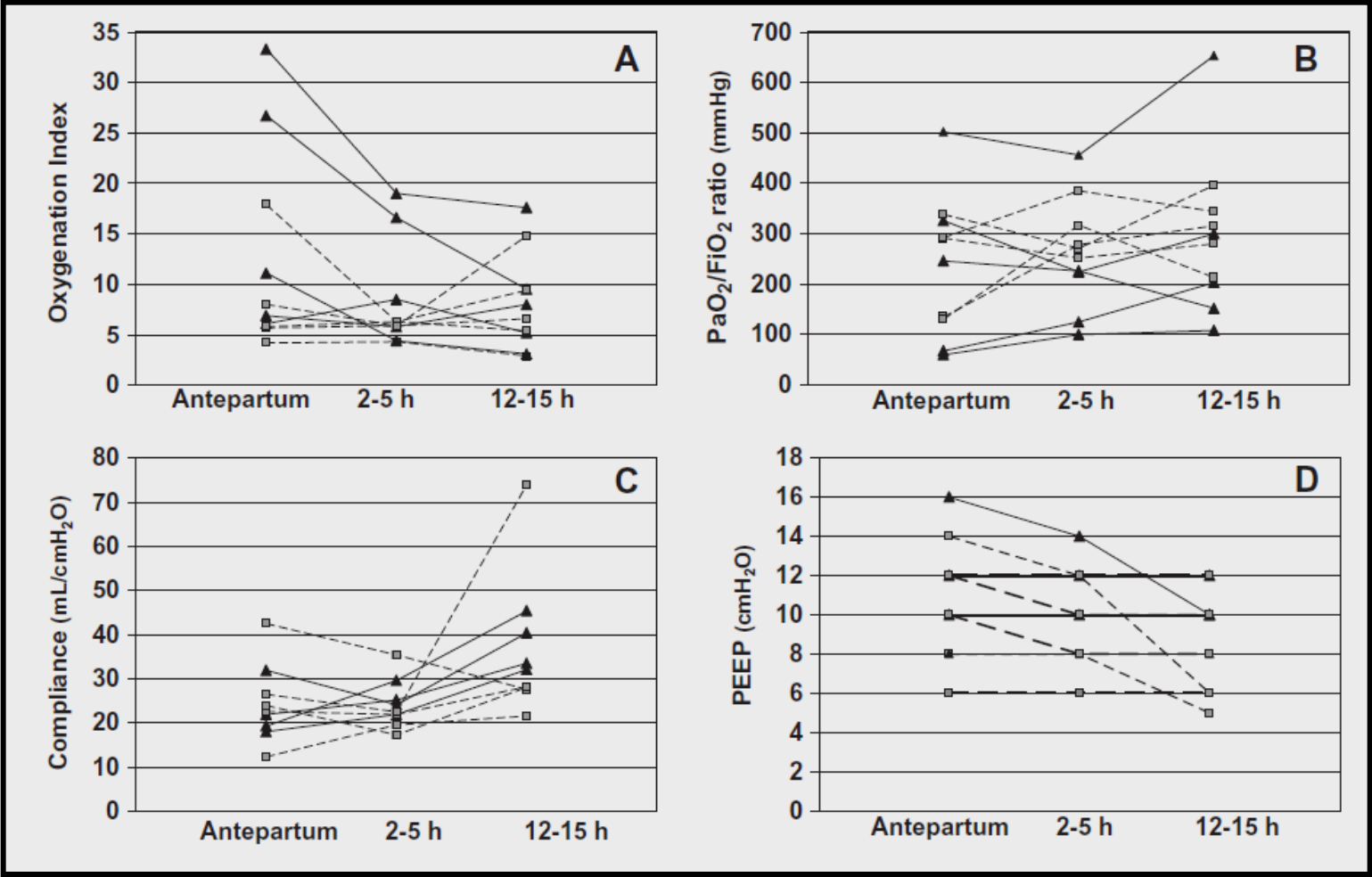
FiO₂ reduced from mean 65% to 48%

No change in V_t, PEEP, plateau pressure, compliance

Postpartum ventilation for 2.6 days (range 1-19 days)

Tomlinson et al. Obstet Gynecol 1998; 91:108

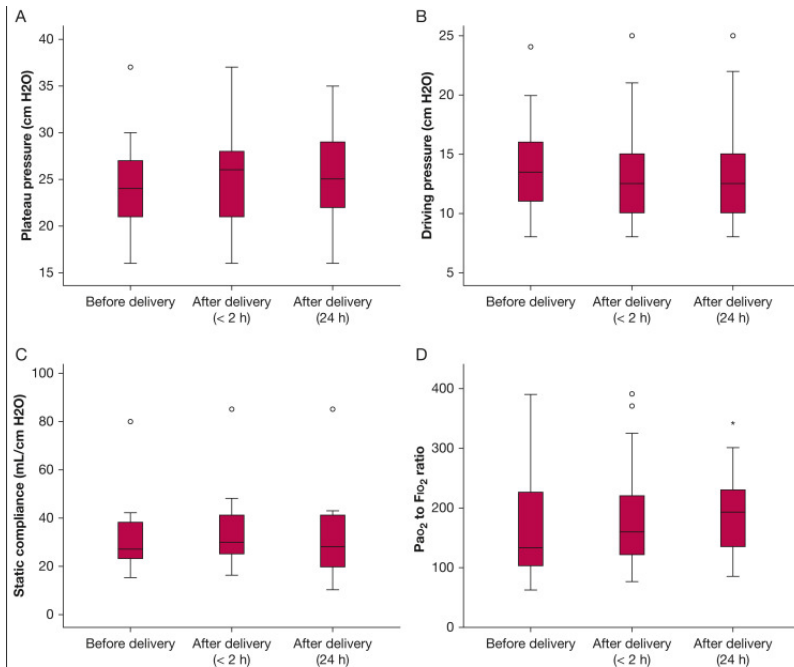
Delivery of the fetus



ARDS & delivery – COVID studies

Prospective data on 91 ventilated pregnant patients:

- Lung mechanics similar to non-pregnant
- 47 delivered:
 - small improvement in oxygenation
 - no improvement in driving pressure
 - no improvement in compliance

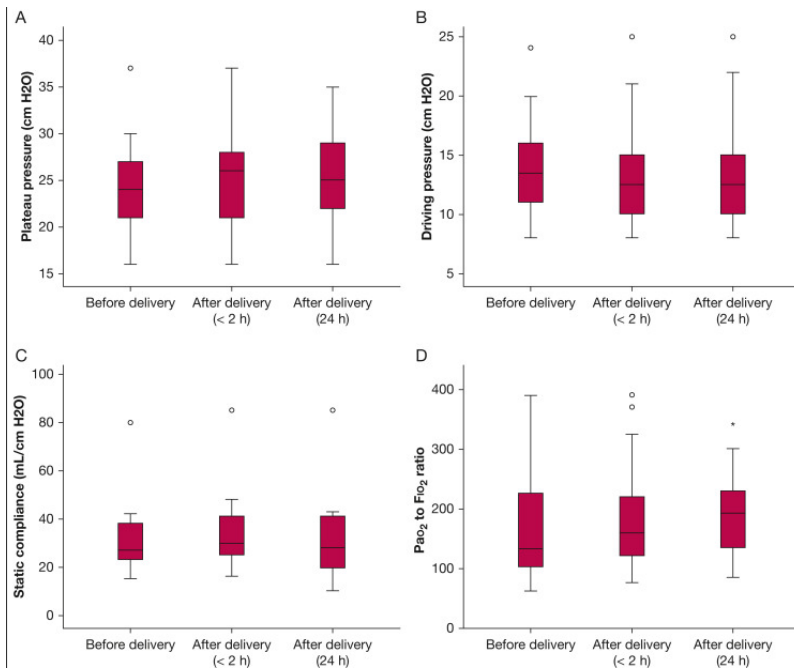


Vasquez et al. Chest 2022

ARDS & delivery – COVID studies

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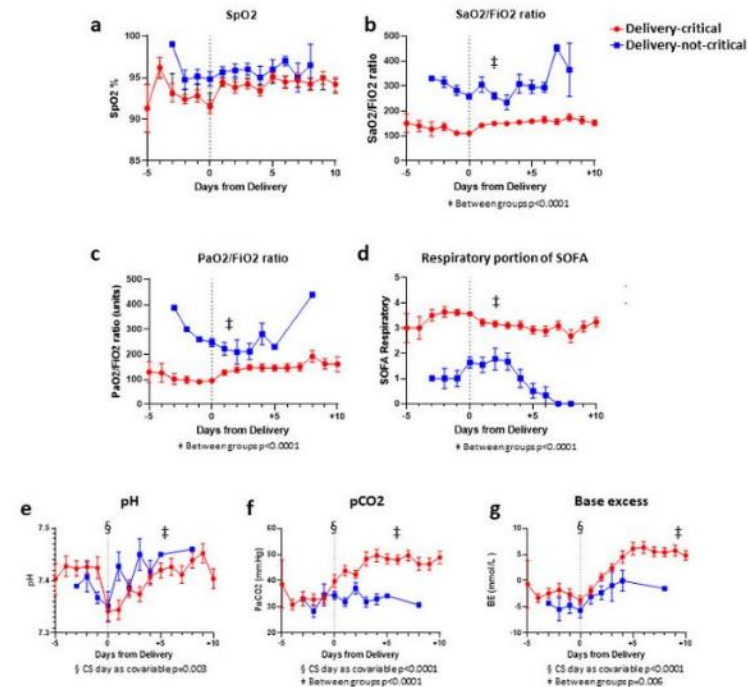
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Vasquez et al. Chest 2022

80 pregnant patients in 13 ICUs:

- no respiratory improvement associated with delivery in those requiring ventilator support



Fatnic et al. Lancet Respir Med Feb 2023

ARDS & delivery

- Delivery:
 - Mother's well-being comes first

DELIVERY - HARMS

- Increase central circulation:
 - Flood lungs
 - Overload stressed RV
- Drop Hgb = decrease VO_2
- Stress of surgery

ARDS & delivery

- Delivery:

- Mother's well-being comes first

DELIVERY - HARMS

- Increase central circulation:

Flood lungs

Overload stressed RV

DELIVERY - BENEFITS

- Drop
- Stress
- Reduce O_2 consumption
- Improve chest wall compliance
- Simplify management:
 - drug therapy
 - imaging

Individualized
decision:
NOT routine



Our pregnant COVID experience at  Sinai Health



Our pregnant COVID experience at



11 ventilated pregnant patients with COVID:

Admission P/F ratio – median (range)	112 (76 – 291)
Peak pressure – median (range) cmH ₂ O	31 (23 – 41)
Tidal volume (ml/kg PBW) – median (range) ml	
1st 24 hr	6.5 (4.4 – 9.1)
2 nd 24 hr	6.2 (4.2 – 10.7)
Prone positioning	6 (55%)
ECLS	1
Duration ventilation – median (range) days	10 (4 – 47)
Highest PaCO₂ – median (range) mmHg	55 (44 – 87)

Our pregnant COVID experience at



	Total (N = 21)	Ventilated (N = 11)	Not ventilated (N = 10)
<i>Delivery (n = 6)</i>			
Deliveries during ICU care	6 (29%)	5	1
<i>Primary indication</i>			
Non-reassuring fetal status	4	4	0
Spontaneous labor	1	0	1
Intrauterine fetal demise	1	1	0
<i>Location</i>			
Labor & delivery unit	4	3	1
ICU	2	2	0
<i>Mode of delivery</i>			
Cesarean delivery	5	4	1
Vaginal delivery	1	1	0
<i>Mean gestational age at delivery, weeks (range)</i>			
Delivery during ICU (liveborn)	34.2 (28.8–37.8)		
Delivery after ICU stay	38.1 (32.7–40.9)		
<i>Timing, median (range) days</i>			
Intubation to delivery	1 (0–20)		
Delivery to extubation	5 (1–19)		

Our pregnant COVID experience at



Outcomes		n=21
Maternal outcome		
Maternal mortality		0
Anoxic brain injury		1
Renal failure		1
Venous thromboembolism		2
Postpartum cardiomyopathy		1
Mean gestational age at delivery, weeks (range)		
Delivery during ICU stay (liveborn)		34.2 (28.8-37.8)
Delivery after ICU stay		38.1 (32.7 – 40.9)
Admission to NICU		8



Managing critical illness in pregnancy



Treat women who may become pregnant, are pregnant or who have recently been pregnant **the same** as a non-pregnant person, **unless there is a very clear reason not to.**



  @StephenLap