ACUTE PULMONARY EDEMA IN PREECLAMPSIA

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overview

1. Pulmonary oedema in preeclampsia
2. Physiology and pathophysiology pulmonary oedema in preeclampsia
3. Management of pulmonary oedema

What is pulmonary edema?

- **Pulmonary edema is fluid accumulation in the lungs, which collects in alveoli.**
- **Impaired gas exchange and may cause respiratory failure.**
- Approximately 3% of women with pre-eclampsia, with 70% of cases occurring after birth

Accumulation of fluid in the air sacs (alveoli) in the lungs

Ware LB, Matthay MA (December 2005). "Clinical practice. Acute pulmonary edema". *N. Engl. J. Med*. **353** (26): 2788–96.

Conceptual : FLUID SHIFT

- Starling's equation :

$$\text{Transcapillary fluid filtration rate} \propto K_f[(P_{mv} - P_t) - (COP_{mv} - COP_t)]$$

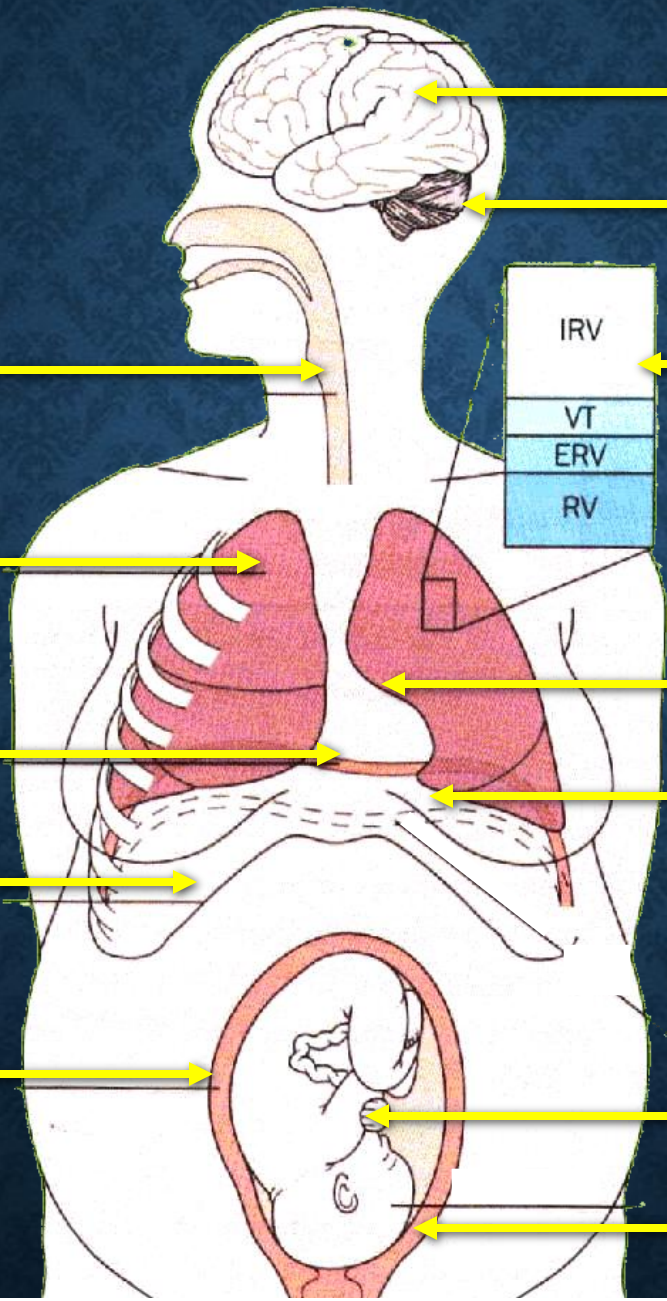
Kf : Ultrafiltration coefficient, capillary permeability
P_{mv} : Micvasculature pressure
P_t : Tissue hydrostatic pressure
COP_{mv} : Microvasculature colloid osmotic pressure
COP_t : Tissue colloid osmotic pressure

Berne R, Levy M. Cardiovascular Physiology, 1st edn. St.Louis: Mosby Year Book, Inc, 1992.

How is starling law in preeclampsia?

Anatomical Effects

Functional Effects



Airway edema
friability

Widened AP and
Transverse diameter

Elevated
Diaphragm

Widened Subcostal
angle

Enlarging uterus

Increased respiratory drive

Minimal change in TLC
Increased Minute ventilation
Reduced FRC

Increased cardiac output

Normal diaphramatic Fxn

Increased O_2 consumption
and CO_2 production

Respiratory in Healthy Pregnancy

www.medtau.org

Cardiovascular in Healthy Pregnancy

- Increased CO,
- Increased HR,
- Increased TBV
- Anemia
- Decreased SVR
- Low colloid osmotic pressure

Labour process :

- Uterine contraction
- Pain
- Positioning
- Bleeding
- Fatique
- Postpartum fluid shift
- Autotransfusion

Predisposing to the risk Acute Pulmonary edema

Regitz-Zagrosek V, Lundqvist CB, Borghi C, *et al.* ESC Guidelines on the management of cardiovascular diseases during pregnancy: The Task Force on the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology

RISK FACTOR PULMONARY EDEMA

Kategori	Faktor Risiko Spesifik
Penyakit saat Hamil	Penyakit kardiovaskuler (hipertensi, penyakit jantung iskemik, penyakit jantung kongenital, penyakit jantung katup, aritmia, kardiomiopati) Obesitas Usia pasien Penyakit endokrin (*phaeochromocytoma* dan hipertiroid)
Penyakit spesifik saat kehamilan	Pre-eklampsia Kardiomyopati Sepsis *Preterm labour* *Amniotic fluid embolism* *Pulmonary embolism*

RISK FACTOR PULMONARY EDEMA

Kategori	Faktor Risiko Spesifik
Zat Farmakologi	Zat tokolitik β-Adrenergik Kortikosteroid Magnesium sulphate Cocaine
Terapi cairan iatrogenic	Positive fluid balance > 2000 ml
Kondisi Janin	Multiple gestation

Conceptual : Pulmonary edema

- ↑Hydrostatic pressure :
  - Preload
  - Heart rate
  - Contractility
  - Lusitopy
  - After load
  - Arterial venous tone
- ↓Oncotic pressure :
  - Intravascular volume
  - Albumin
- ↑Capillary :
  - Permeability endothelial function

Change of these variable will promote Acute Pulmonary edema

Gao Y, Raj JU. Role of veins in regulation of pulmonary circulation. *American Journal of Physiology Lung Cellular and Molecular Physiology* 2005; **288**: L213–26.

Pulmonary edema IN PREECLAMPSIA

- ↑ Hydrostatic pressure
- ↓ Oncotic pressure
- ↑ Permeability capillary

Unique : Relative Hypovolemia

pulmonary edema in preeclampsia :

“a new paradigm”

“ Fluid ***redistribution*** from the **systemic circulation** to **pulmonary circulation** due to venoconstriction or vasoconstriction in a person who is euvolemic “

Strategy management : Reverse blood from pulmonary circulation to peripheral circulation

Ford LE. Acute hypertensive pulmonary edema: a new paradigm. *Canadian Journal of Physiology and Pharmacology* 2010; **88:** 9–13.

Classification of Pulmonary edema

1. Normotensive pulmonary edema
2. Hypertensive pulmonary edema

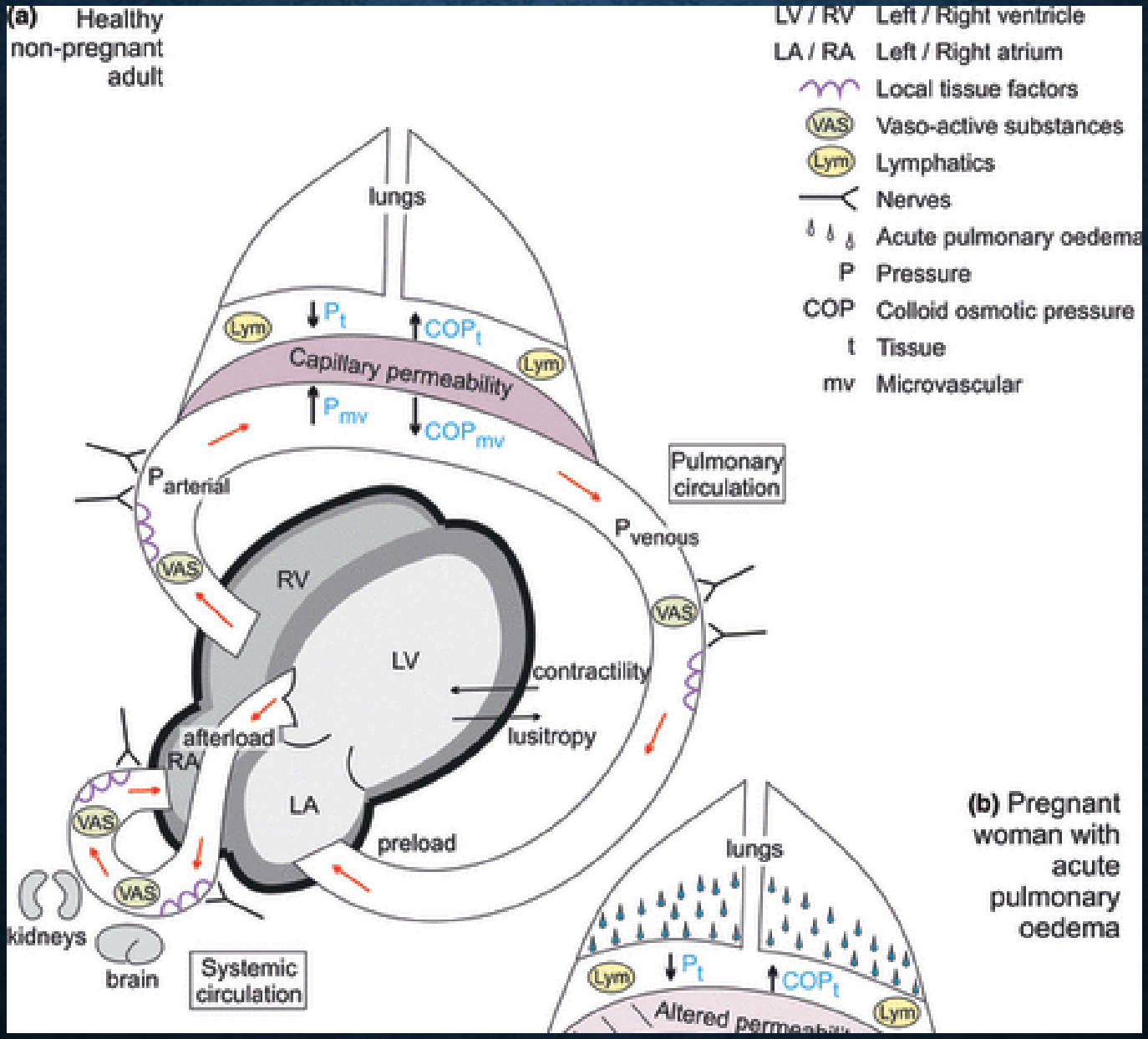
   (most common : Preeclampsia)

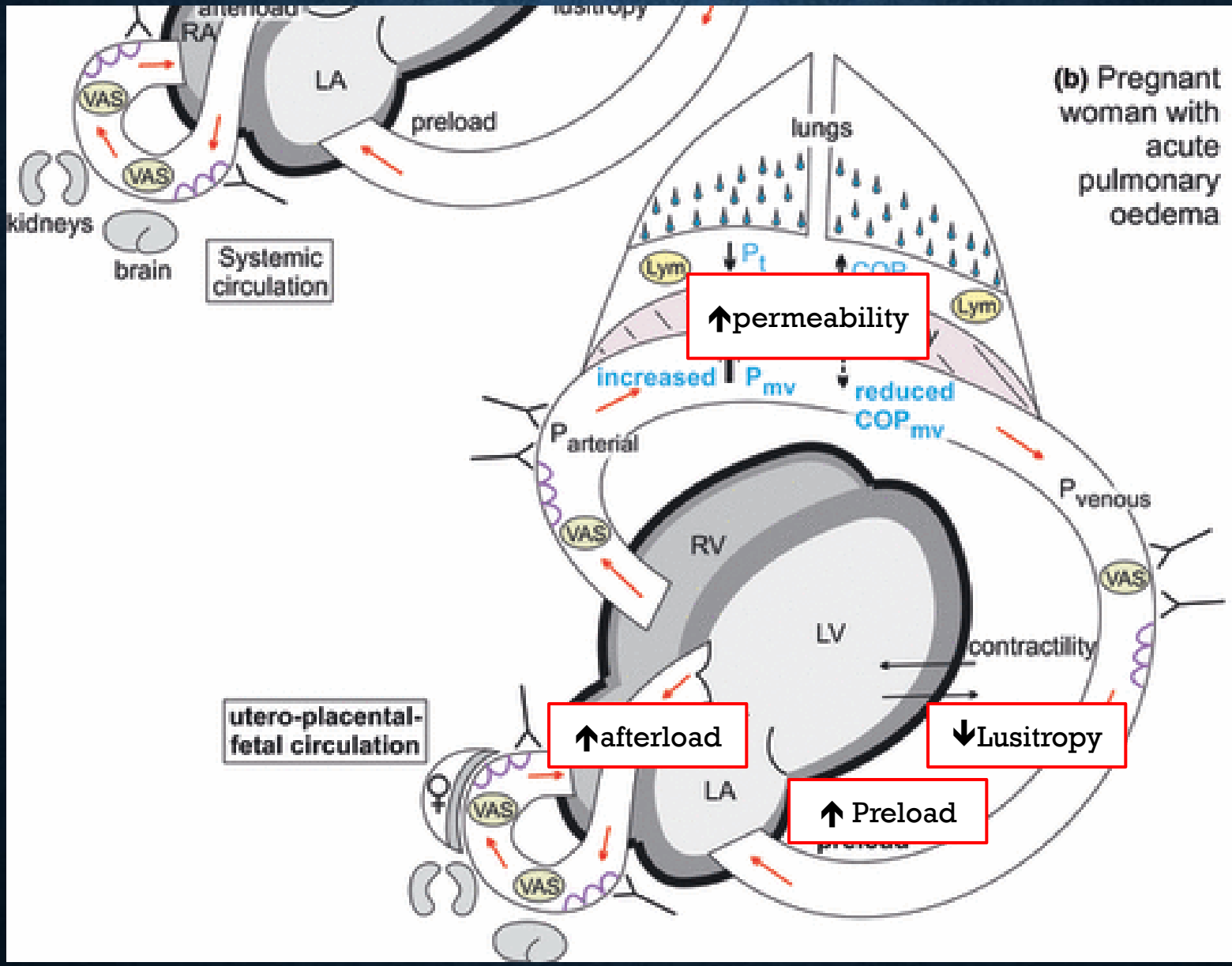
CARDIOVASCULAR changing In Preeclampsia

- Pathophysiology of cardiovascular are :
  - Increased CO with Increased SVR
  - Decreased CO with increased SVR
  - Diastolic cardiac function
  - Pericardial effusion
  - Decreased colloid osmotic pressure
  - Altered endothelial permeability
  - Acute vaso and venoconstriction

Underlying mechanism OF PULMONARY EDEMA depends on haemodynamic state of pregnant woman

Sibai BM, Mabie BC, Harvey CJ, Gonzalez AR. Pulmonary edema in severe preeclampsia-eclampsia: *American Journal of Obstetrics and Gynecology* 1987; **156**: 1174–9.


(a) Healthy non-pregnant adult
LV / RV Left / Right ventricle
LA / RA Left / Right atrium
Local tissue factors
VAS Vaso-active substances
Lym Lymphatics
Nerves
Acute pulmonary oedema
P Pressure
COP Colloid osmotic pressure
t Tissue
mv Microvascular
lungs
Lym
P_t
COP_t
Capillary permeability
P_{mv}
COP_{mv}
$P_{arterial}$
Pulmonary circulation
P_{venous}
VAS
RV
LV
contractility
lusitropy
afterload
RA
LA
preload
kidneys
brain
Systemic circulation
(b) Pregnant woman with acute pulmonary oedema
lungs
Altered permeability


(b) Pregnant woman with acute pulmonary oedema
lungs
RA
LA
preload
VAS
kidneys
brain
Systemic circulation
Lym
P_t
↑permeability
increased P_{mv}
reduced COP_{mv}
$P_{arterial}$
P_{venous}
RV
LV
contractility
utero-placental-fetal circulation
↑afterload
↓Lusitropy
↑ Preload

Diagnostic

- Subjective :
  - Dyspneu, orthopneu, anxiety
- Objective
  - Nostrill
  - Tachypneu , ↓Spo2
  - Ronchi bilateral basal, media, apex
  - Gallop
- X – ray : Infiltral bilateral

- USG lung
- Echo cardiography
- BNP
- Thermodilution

MANAGEMENT OF PULMONARY EDEMA IN PREECLAMPSIA

GOAL OF MANAGEMENT are :

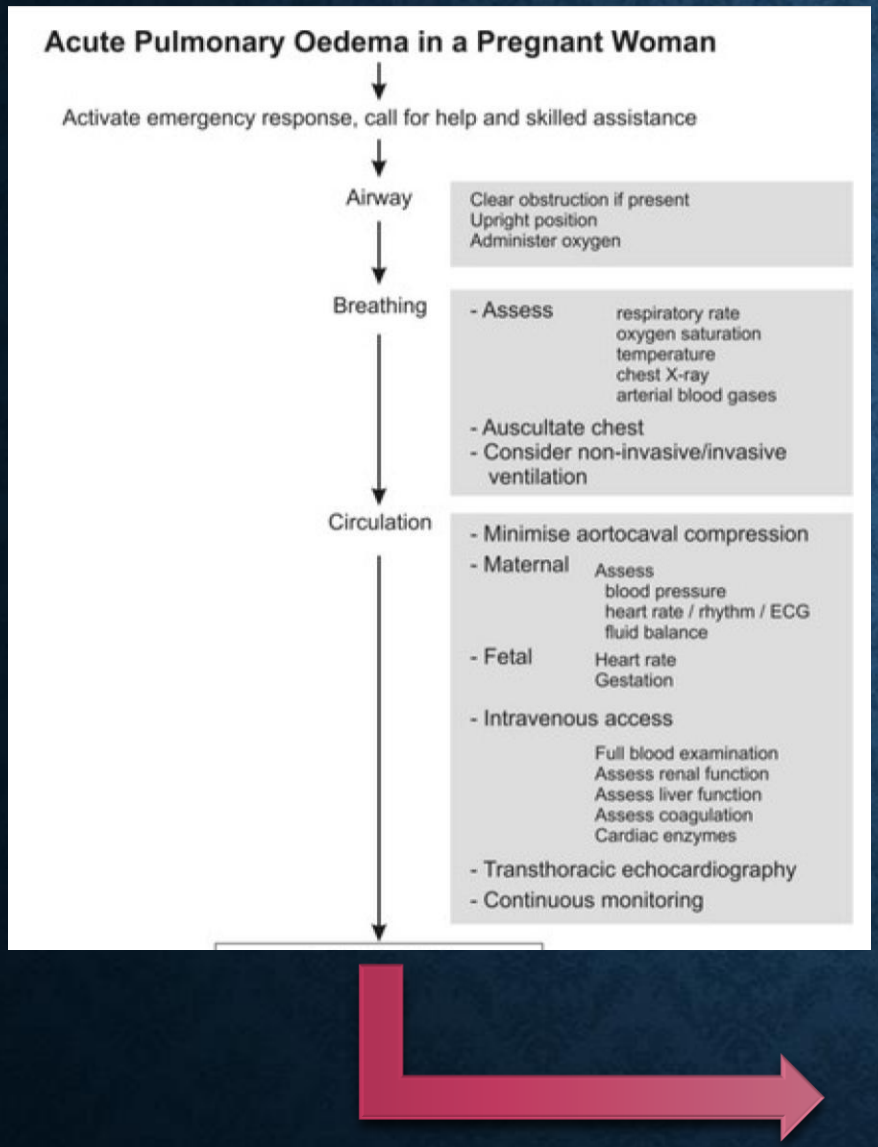
Maintain adequate oxygenation and ventilation with clearance pulmonary edema

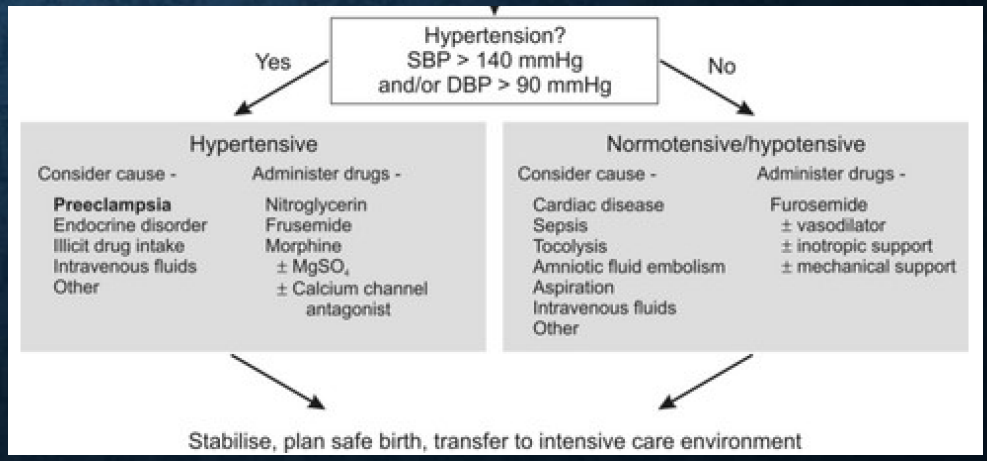
Decreased left ventricel preload

Decreased left ventricular afterload

Prevent myocardial ischemia

Management of pulmonary edema i Pregnancy





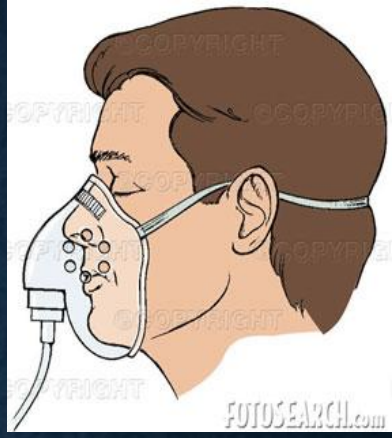
MANAGEMENT OF PULMONARY EDEMA IN PREGNANCY

Airway :

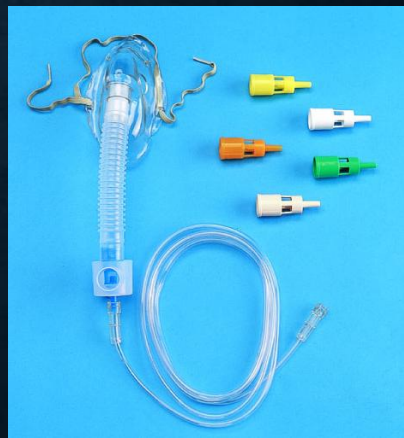
- Clear obstruction if present
- Upright position
- Administer oxygen

Breathing :

- Asses : Respiratory rate
  oxygen saturation
  temperature
  chest X-Ray
  Arterial blood gas
- Auscultation chest
- Consider Non Invasive/invasive



Alat Suplementasi Oksigen (dasar)



DEVICE	FLOW RATE	DELIVERY O2
Nasal canula	1 L/min 2 L/min 3 L/min 4 L/min 5 L/min 6 L/min	21% - 24% 25% - 28% 29% - 32% 33% - 36% 37% - 40% 41% - 44%
Simple oxygen face mask	6-10 L/min	35% - 60%
Face mask w/ O2 reservoir (nonrebreathing mask)	6 L/min 7 L/min 8 L/min 9 L/min 10-15 L/min	60% 70% 80% 90% 95% - 100%
Ventury mask	4-8 L/min 10-12 L/min	24% - 35% 40% - 50%

Pemantauan Suplementasi Oksigen

Pulse oximetry reading	Interpretation	Intervention
95% – 100%	Desired range	O2 4 l/min – nasal canule
90% – <95%	Mild-moderate hypoxia	Face mask
85% – <90%	Moderate-severe hypoxia	Face mask w/ O2 reservoir → assisted ventilation
<85%	Severe to life-threatening hypoxia	Assisted ventilation

REBREATHING MASK

- Head up position
- Increased 30 % TLC
- Increased FRC

Mechanical Ventilation

Early pulmonary oedema

Non Invasive

- Increased oxygen concentration
- Displaced fluid from the alveoli
- Decreased work Of breathing
- Decreased need for intubation

Mechanical Ventilation

Late pulmonary oedema

Invasive

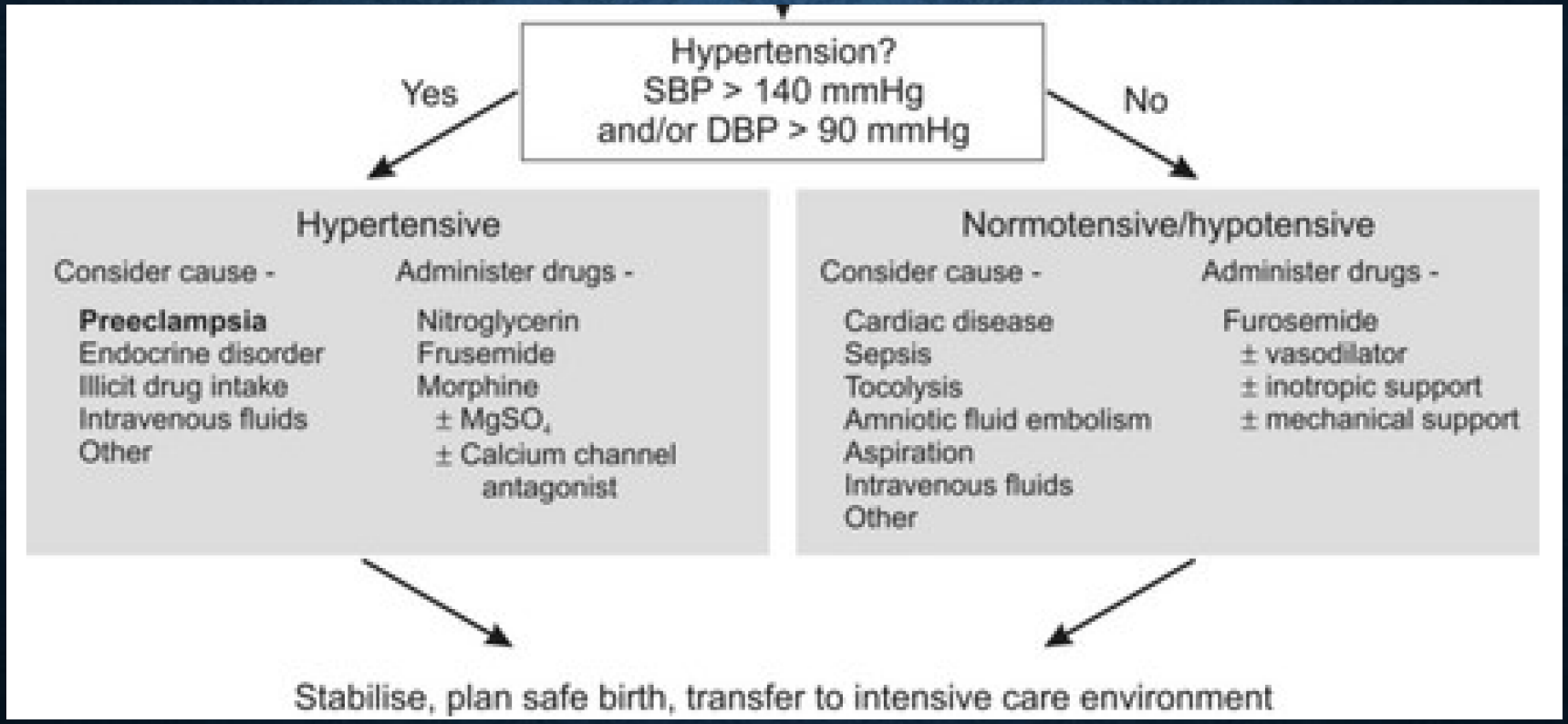
- Intubation
- Decreased consciousness
- Low tidal volume
- Risk pneumonia
- Risk difficult airway

MANAGEMENT OF PULMONARY EDEMA IN PREGNANCY

Circulation :

- Minimise aortocaval compression
- Maternal
    - blood pressure
    - heart rate/rhytm/ECG
    - fluid balance
- Fetal
    - Heart rate
    - Gestation
- Intavenous acces
    - full blood examination
    - assess renal function
    - assess liver function
    - cardiac enzymes
- Transthoracic echocardiography
- Continuous monitroring

Management of pulmonary edema in Pregnancy



MANAGEMENT

Immediate Management

- Emergency response with expert team (level 3 evidence)
  - Possibility deterioreting to cardiac arest, should prepare Advanced Life Support and consider perimortem sectio cesaria
  - *Transthoracic echocardiography* colud help differetiate low cardiac output and high cardiac output, and other
- Despite risk aspiration , *non-invasive ventilation* should be tried, before intubation
- Avoid *aortocaval compression*

Fonseca C, Morais H, Mota T, *et al.* The diagnosis of heart failure in primary care: value of symptoms and signs. *European Journal of Heart Failure* 2004; **6**: 795–800.

MANAGEMENT

Immediate Manajemen

- **Nitroglycerin** (glyceryl trinitrate) : *drug of choice in preeclampsia associated with pulmonary oedema*
  - Dosis kontinyu : 5 mcg/menit, ditingkatkan bertahap 3-5 menit hingga 100 mcg/menit
- **Nitroprusside** as alternative agent
  - Dosis kontinyu : 0.25–5.0 mcg/kgBB/menit
- Reduction systolic and diastolic blood pressure should accur at a rate aproximately 30 mmHg over 3-5 min followed by slower reduction to BP aproximately 140/90 mmHg

Regitz-Zagrosek V, Lundqvist CB, Borghi C, *et al.* ESC Guidelines on the management of cardiovascular diseases during pregnancy: The Task Force on the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology, 2011

MANAGEMENT

Immediate Management

- Intravena Furosemid (bolus 20–40 mg over 2 menit) is used to promote venodilatation and diuresis
  - Repeated dose : 40–60 mg after 30 min if there is inadequate diuretic response
  - Maximum dose 120 mg/hrs (level 1 evidence))

Nieminen MS, Bohm M, Cowie MR, *et al.* Executive summary of the guidelines on the diagnosis and treatment of acute heart failure: the Task Force on Acute Heart Failure of the European Society of Cardiology. *European Heart Journal* 2005; **26**: 384–416.

MANAGEMENT

Immediate Management

- If hypertension persisten
  - Combination nitrogliserin or nitroprusside, dan furosemide
  - Consider Calcium Channel Blocker (Nicardipine, nifedipine) and hydralazine (level 1 evidence)

- Intravenous Morphine 2-3 mg as arteri dilator and anxiolytic (level 1 evidence)

Nieminen MS, Bohm M, Cowie MR, *et al.* Executive summary of the guidelines on the diagnosis and treatment of acute heart failure: the Task Force on Acute Heart Failure of the European Society of Cardiology. *European Heart Journal* 2005; **26**: 384–416.

Fluid management

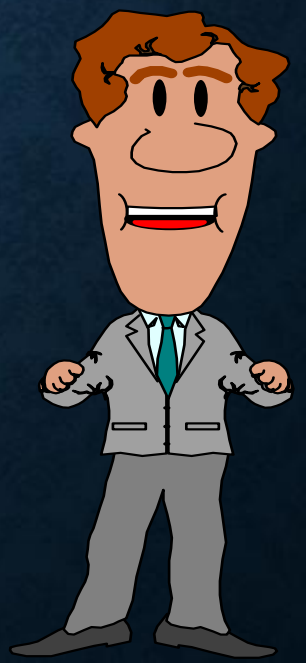
Multi-organ endotelial injury
Increased vasomotor tone
hipoalbuminemia
Realtive hipovolemia

→

Less tolerant to volume shift
-Pulmonary oedema
-Ascites
-Peripheral oedema

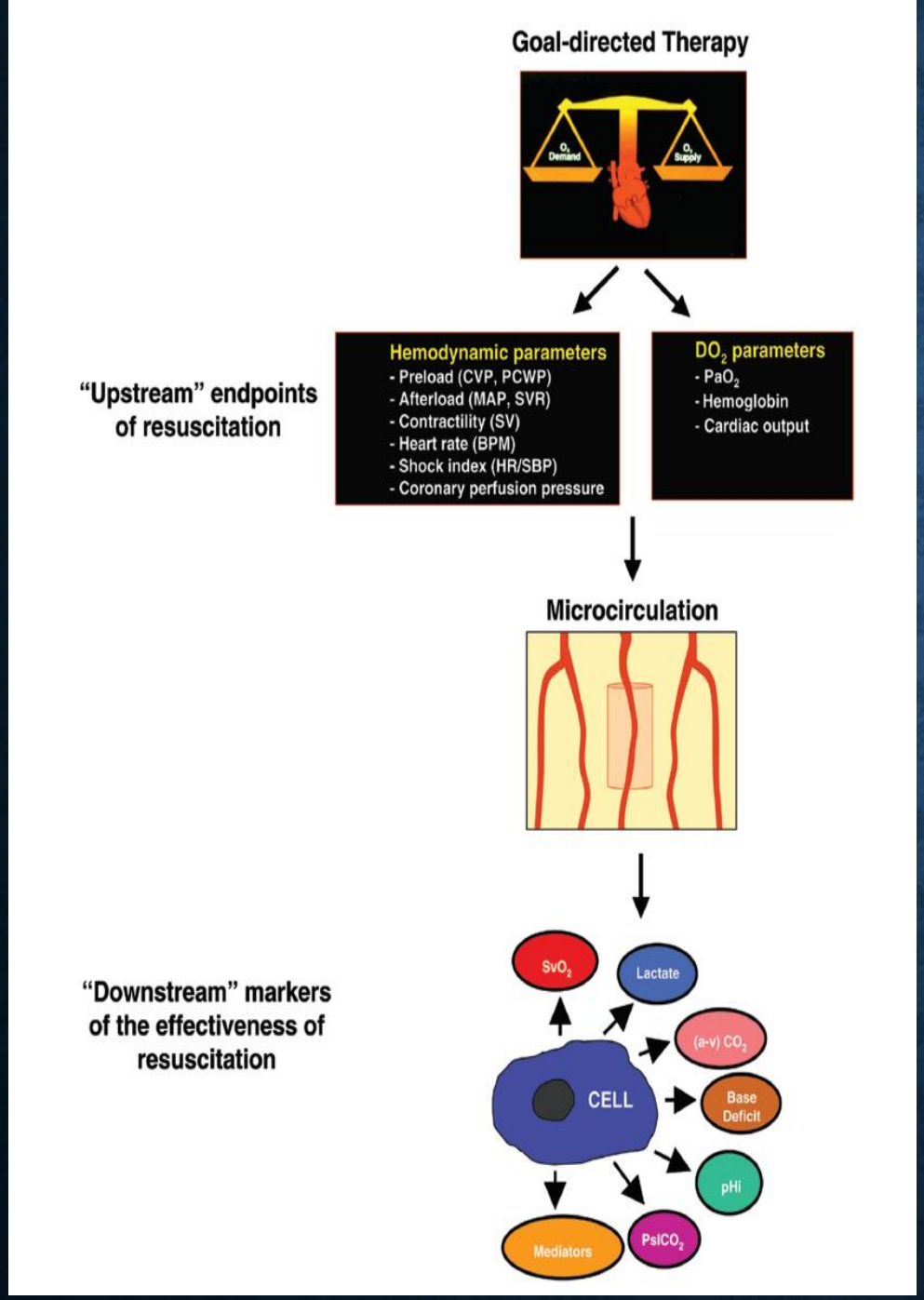
Good management

Monitoring :
CVP
PCWP
Fluid Responsiveness (PPV)
PICCO2
USG AND ECHO



REMEMBER

NEGATIVE BALANCE=vasoconstriction.
EXCESIVE POSITIVE BALANCE= pulmonary damage



How to know optimal PERFUSI?

-MAKROCIRCULATION
-MIKROCIRCULATION
-CELLULER SIGNAL

MANAGEMENT

Short term Management

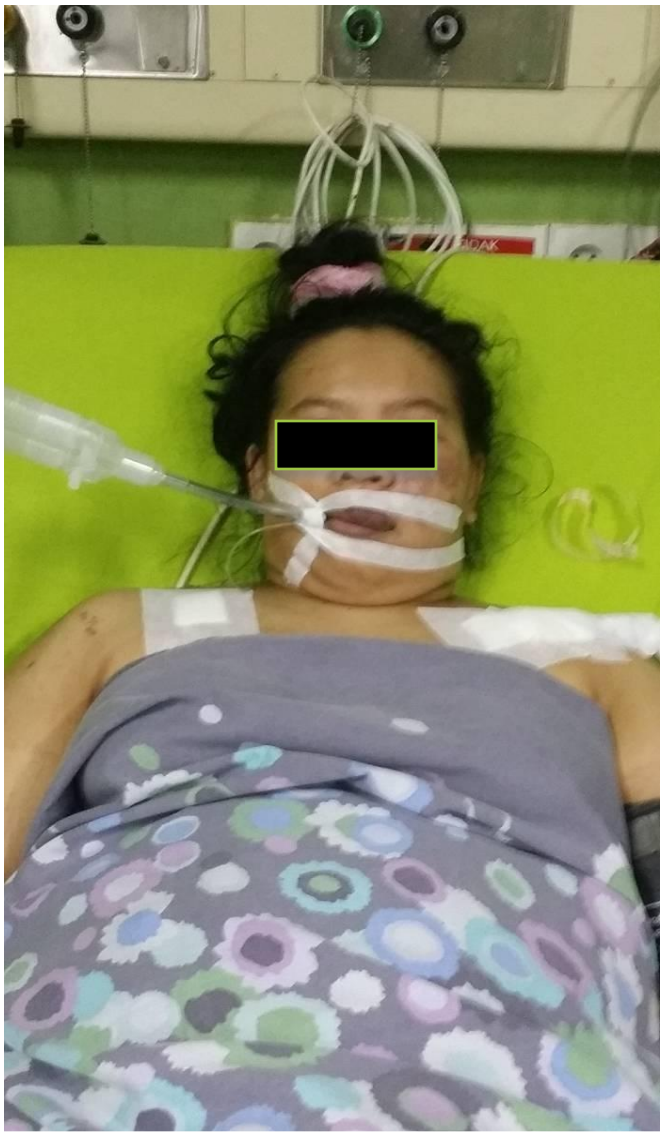
- Close observasi :
  - High Care Unit (HCU)
  - Contineous monitoring vital sign
  - Serial monitoring fungsi organ
  - Assessment of fetal wellbeing and multidisciplinary planning for safe birth if acute occurs antenatally
- Avoidance of precipitants : strict fluid balance and fluid restriction
- Early intervention : control blood pressure (level 1 evidence)
- Prevention of further complication :
  - Prophylaxis MgSO4
  - Preventive DVT and PE
  - Preventive stress ulcer

MANAGEMENT

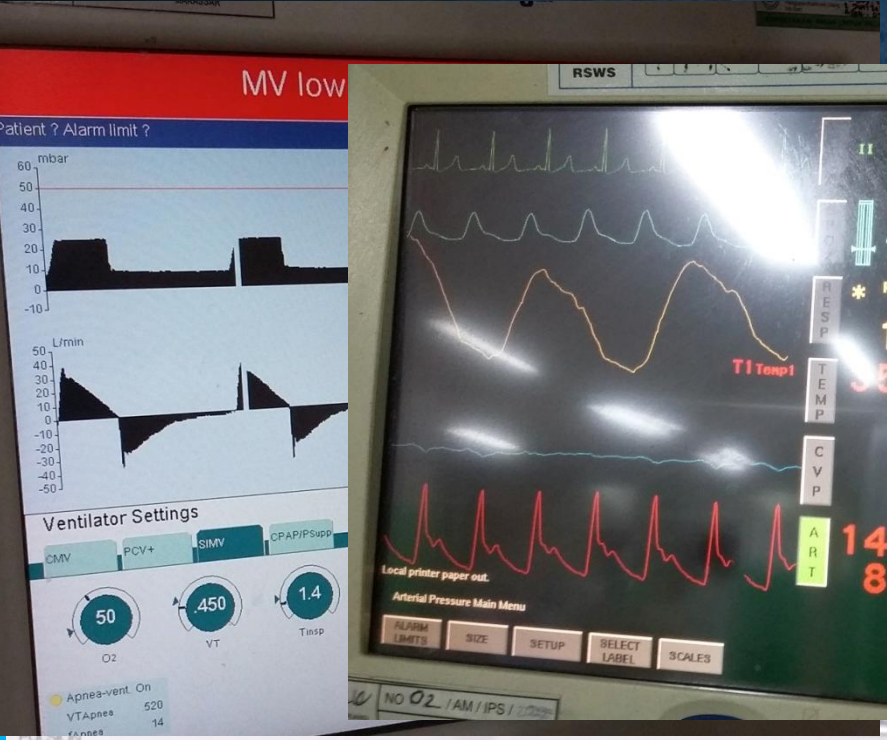
Long term Management

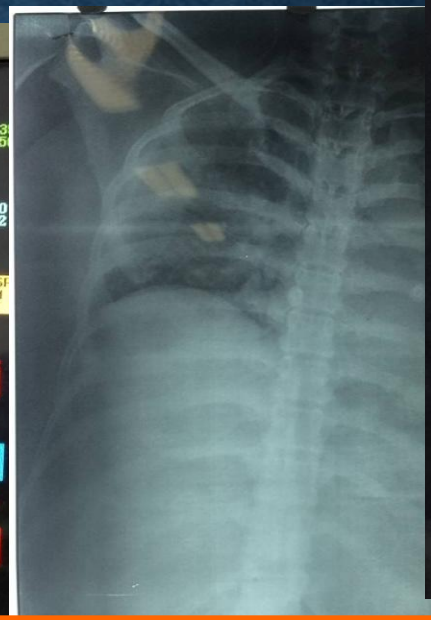
- Due to risk Cardiovascular, stroke and renal complication :
  - They should be closed monitor BPPerlu kontrol TD dan follow up regularly
    - Angiotensin-converting enzymes can be used in post partum periode
    - Modification diet, cessation smoking, sport regularly are recommended

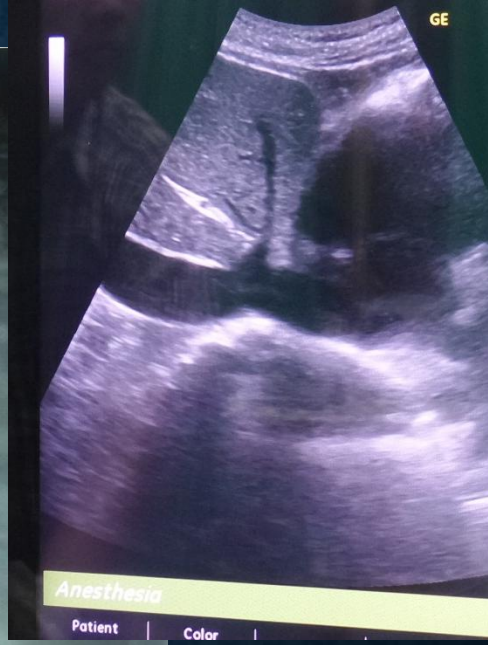
CASE REPORT

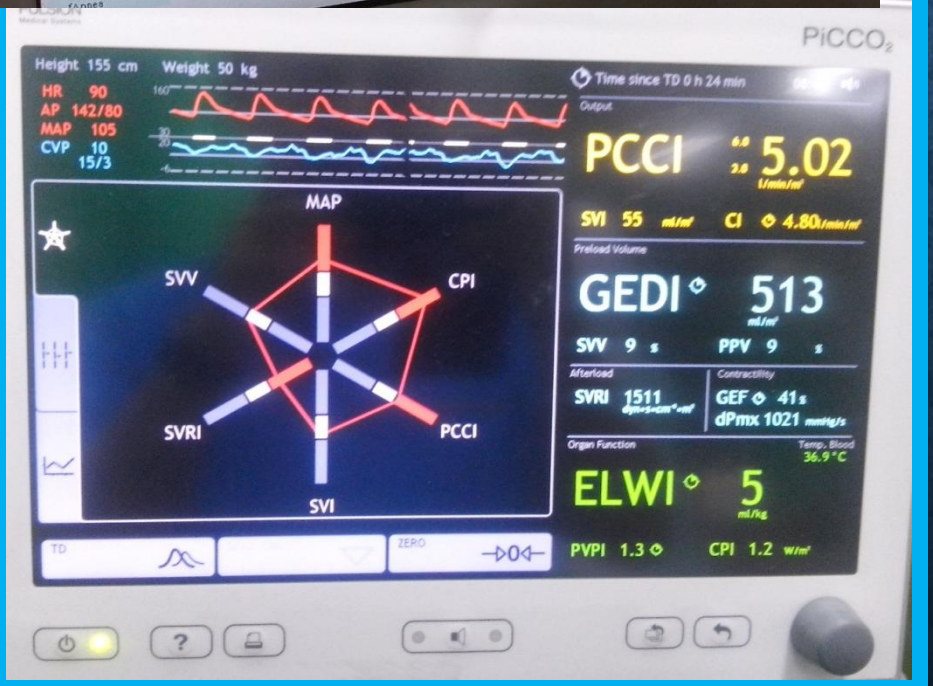


- POST PARTUM PEB, Gavid 28 mgg
- GAGAL NAFAS
- HIPERTENSI KRISIS
- GCS 10
- STRESS ULCER AND ASCITES
- AKI STAGE 4→ HD
- APACHE SCORE > 25









UDEM PARU AKUT

HIPERTENSI KRISIS

NORMOVOLEMIK

CARDIAC :

- HIGH CARDIAC OUTPUT
- HIGH CARDIAC INDEX
- HIGH SVR

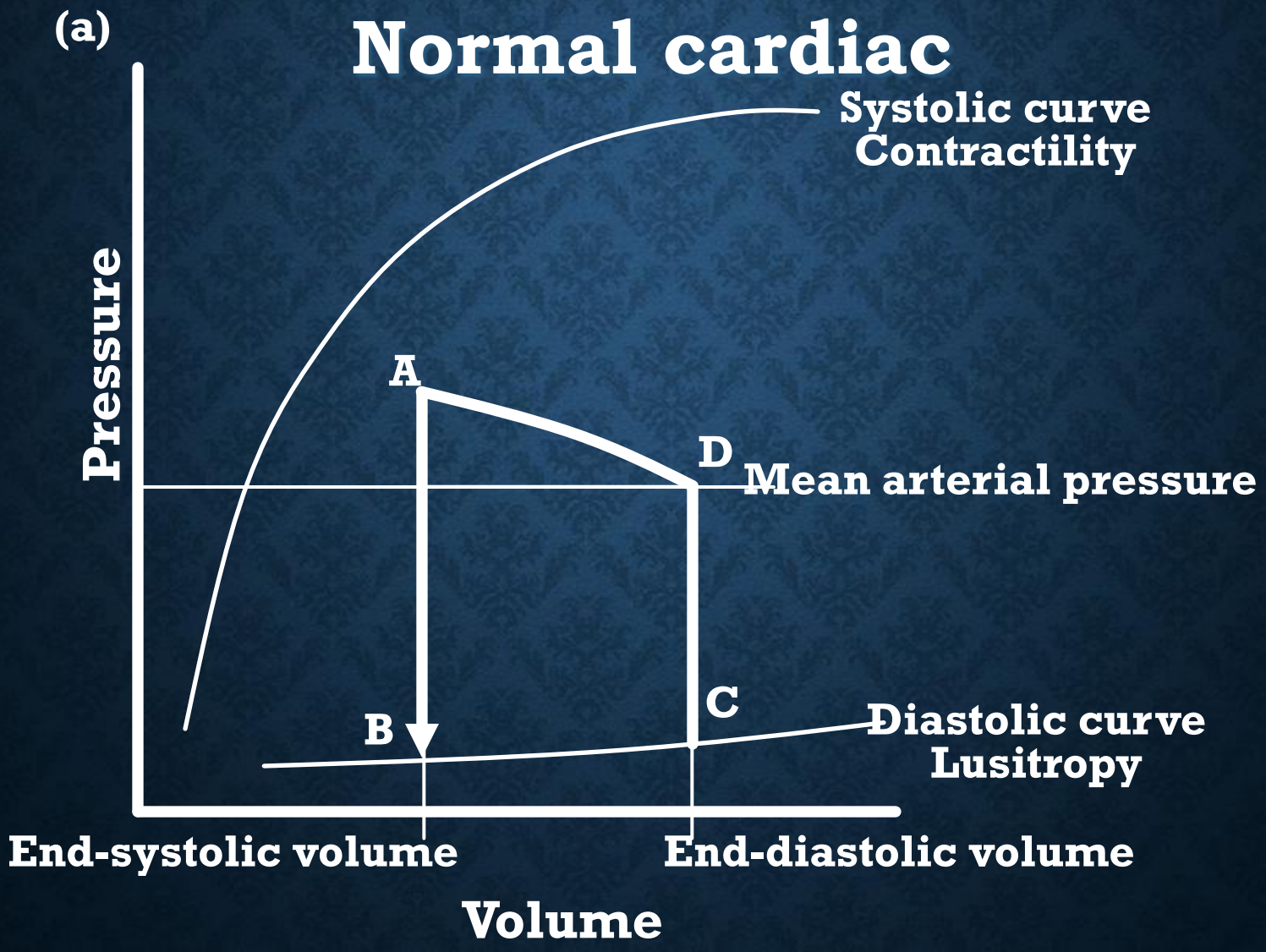
FLUID OVERLOAD

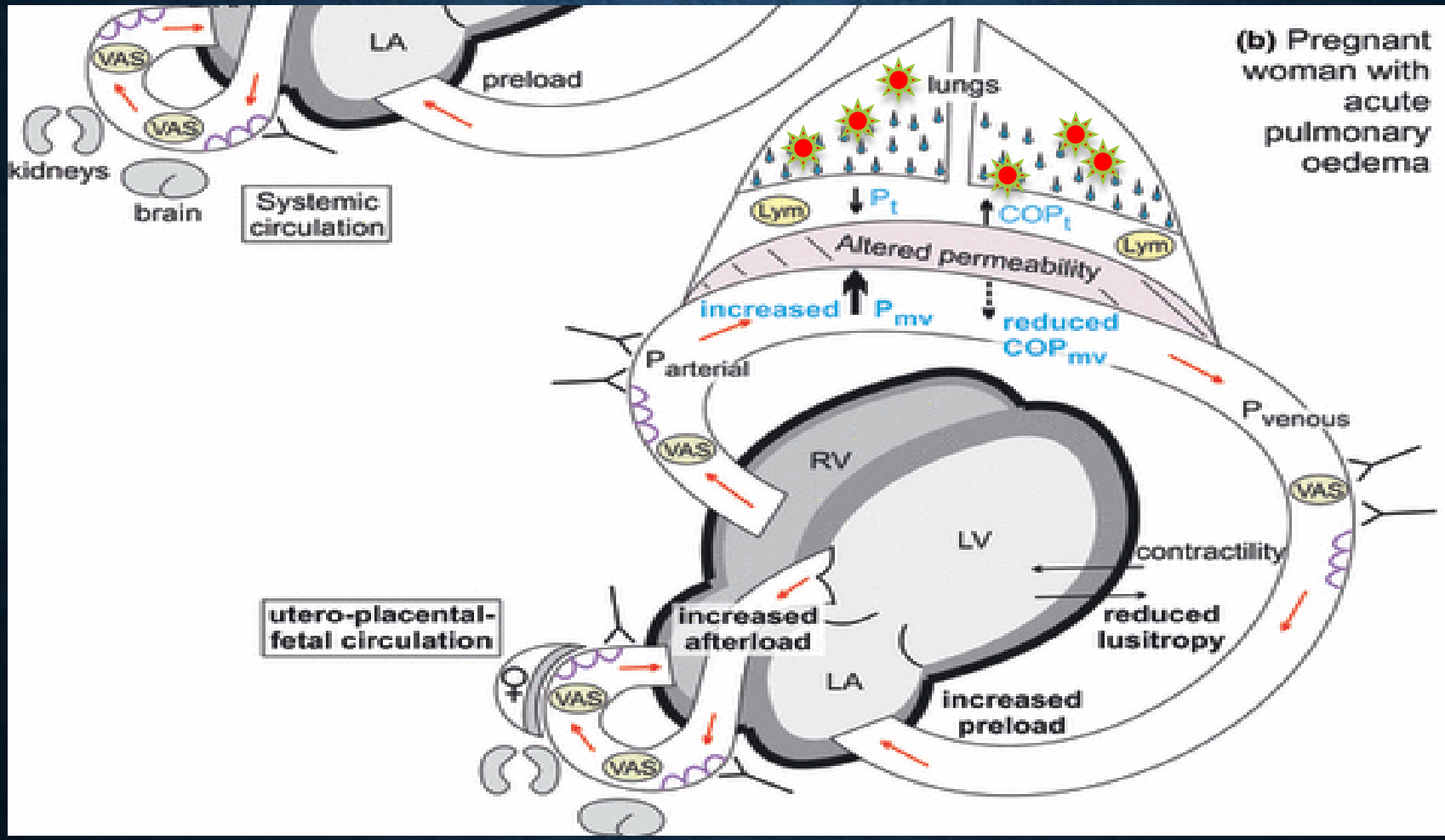
AKI PRE RENAL

CASE REPORT

OKSIGENASI
VENTILATOR
FLUID MONITORING
USG DAN ECHO
KONTROL HIPERTENSI
FORCE DIURETIK
HEMODIALIS
FLUID REMOVAL ***15 LITER***

Thank you


(a)
Normal cardiac
Systolic curve
Contractility
Pressure
A
D
Mean arterial pressure
B
C
Diastolic curve
Lusitropy
End-systolic volume
End-diastolic volume
Volume


(b) Pregnant woman with acute pulmonary oedema
LA
preload
lungs
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VAS
kidneys
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Systemic circulation
Lym
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Altered permeability
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LV
contractility
utero-placental-fetal circulation
increased afterload
reduced lusitropy
LA
increased preload
VAS
VAS