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.

Conceptual: FLUID SHIFT

- **Starling's equation:**

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

- $K_f$: 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

How is starling law in preeclampsia?
Anatomical Effects

- Airway edema
- Friability
- Widened AP and Transverse diameter
- Elevated Diaphragm
- Widened Subcostal angle
- Enlarging uterus

Functional Effects

- Increased respiratory drive
- Minimal change in TLC
- Increased Minute ventilation
- Reduced FRC
- Increased cardiac output
- Normal diaphragmatic Fxn
- Increased $O_2$ consumption and $CO_2$ production

Respiratory in Healthy Pregnancy

www.medtau.org
Cardiovascular in Healthy Pregnancy

Labour process:
- Uterine contraction
- Pain
- Positioning
- Bleeding
- Fatigue
- Postpartum fluid shift
- Autotransfusion

Predisposing to the risk Acute Pulmonary edema

<table>
<thead>
<tr>
<th>Kategori</th>
<th>Faktor Risiko Spesifik</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penyakit saat Hamil</td>
<td>Penyakit kardiovaskuler (hipertensi, penyakit jantung iskemik, penyakit jantung kongenital, penyakit jantung katup, aritmia, kardiomiopati)</td>
</tr>
<tr>
<td></td>
<td>Penyakit spesifik saat kehamilan</td>
</tr>
<tr>
<td></td>
<td>Pre-eklampsia</td>
</tr>
<tr>
<td></td>
<td>Kardiomyopati</td>
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<tr>
<td></td>
<td>Sepsis</td>
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<td></td>
<td>Preterm labour</td>
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<tr>
<td></td>
<td>Amniotic fluid embolism</td>
</tr>
<tr>
<td></td>
<td>Pulmonary embolism</td>
</tr>
</tbody>
</table>
## RISK FACTOR PULMONARY EDEMA

<table>
<thead>
<tr>
<th>Kategori</th>
<th>Faktor Risiko Spesifik</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zat Farmakologi</td>
<td>Zat tokolitik β-Adrenergik</td>
</tr>
<tr>
<td></td>
<td>Kortikosteroid</td>
</tr>
<tr>
<td></td>
<td>Magnesium sulphate</td>
</tr>
<tr>
<td></td>
<td>Cocaine</td>
</tr>
<tr>
<td>Terapi cairan iatrogenic</td>
<td>Positive fluid balance &gt; 2000 ml</td>
</tr>
<tr>
<td>Kondisi Janin</td>
<td>Multiple gestation</td>
</tr>
</tbody>
</table>
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

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 euvoletic “

Strategy management: Reverse blood from pulmonary circulation to peripheral circulation

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

(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

Pulmonary circulation

(b) Pregnant woman with acute pulmonary oedema

Systemic circulation
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 of pulmonary edema
- Decreased left ventricular preload
- Decreased left ventricular afterload
- Prevent myocardial ischemia
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)
<table>
<thead>
<tr>
<th>DEVICE</th>
<th>FLOW RATE</th>
<th>DELIVERY O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal canula</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 L/min</td>
<td>21% - 24%</td>
</tr>
<tr>
<td></td>
<td>2 L/min</td>
<td>25% - 28%</td>
</tr>
<tr>
<td></td>
<td>3 L/min</td>
<td>29% - 32%</td>
</tr>
<tr>
<td></td>
<td>4 L/min</td>
<td>33% - 36%</td>
</tr>
<tr>
<td></td>
<td>5 L/min</td>
<td>37% - 40%</td>
</tr>
<tr>
<td></td>
<td>6 L/min</td>
<td>41% - 44%</td>
</tr>
<tr>
<td>Simple oxygen face mask</td>
<td>6-10 L/min</td>
<td>35% - 60%</td>
</tr>
<tr>
<td>Face mask w/ O2 reservoir</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nonrebreathing mask)</td>
<td>6 L/min</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>7 L/min</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>8 L/min</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>9 L/min</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>10-15 L/min</td>
<td>95% - 100%</td>
</tr>
<tr>
<td>Ventury mask</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-8 L/min</td>
<td>24% - 35%</td>
</tr>
<tr>
<td></td>
<td>10-12 L/min</td>
<td>40% - 50%</td>
</tr>
</tbody>
</table>
# Pemantauan Suplementasi Oksigen

<table>
<thead>
<tr>
<th>Pulse oximetry reading</th>
<th>Interpretation</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% - 100%</td>
<td>Desired range</td>
<td>O2 4 l/min – nasal canule</td>
</tr>
<tr>
<td>90% - &lt;95%</td>
<td>Mild-moderate hypoxia</td>
<td>Face mask</td>
</tr>
<tr>
<td>85% - &lt;90%</td>
<td>Moderate-severe hypoxia</td>
<td>Face mask w/ O2 reservoir → assisted ventilation</td>
</tr>
<tr>
<td>&lt;85%</td>
<td>Severe to life-threatening hypoxia</td>
<td>Assisted ventilation</td>
</tr>
</tbody>
</table>
REBREATHEING 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/rhythm/ECG
  - fluid balance
- Fetal
  - Heart rate
  - Gestation
- Intravenous access
  - full blood examination
  - assess renal function
  - assess liver function
  - cardiac enzymes
- Transthoracic echocardiography
- Continuous monitoring
Management of pulmonary edema in Pregnancy

- Hypertension?
  - Yes: SBP > 140 mmHg and/or DBP > 90 mmHg
    - Hypertensive
      - Consider cause -
        - Preeclampsia
        - Endocrine disorder
        - Illicit drug intake
        - Intravenous fluids
        - Other
      - Administer drugs -
        - Nitroglycerin
        - Frusemide
        - Morphine ± MgSO₄
        - Calcium channel antagonist
    - No
      - Normotensive/hypotensive
        - Consider cause -
          - Cardiac disease
          - Sepsis
          - Tocolysis
          - Amniotic fluid embolism
          - Aspiration
          - Intravenous fluids
          - Other
        - Administer drugs -
          - Furosemide ± vasodilator
          - ± inotropic support
          - ± mechanical support

- Stabilise, plan safe birth, transfer to intensive care environment
Immediate Management

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

**MANAGEMENT**

**Immediate Management**

- **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 occur at a rate approximately 30 mmHg over 3-5 min followed by slower reduction to BP approximately 140/90 mmHg

Immediate Management

- **Intravena Furosemid** (bolus 20–40 mg over 2 minutes) 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/hr (level 1 evidence)

MANAGEMENT

Immediate Management

- If hypertension persistent
  - Combination nitroglycerin 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)

Fluid management

- Multi-organ endothelial injury
- Increased vasomotor tone
- Hipoalbuminemia
- Relative 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.
EXCESSIVE POSITIVE BALANCE = pulmonary damage
How to know optimal PERFUSION?

-MAKROCIRCULATION
-MIKROCIRCULATION
-CELLULAR SIGNAL
Short term Management

- Close observasi:
  - High Care Unit (HCU)
  - Continuous 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
Long term Management

• Due to risk Cardiovascular, stroke and renal complication:
  - They should be closely monitored and BP controlled regularly.
  - Angiotensin-converting enzymes can be used in postpartum period.
  - Modification of diet, cessation of smoking, and regular exercise 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
HEMODIALISIS
FLUID REMOVAL 15 LITER
Thank you
Normal cardiac

(a)

Pressure

Volume

Systolic curve
Contractility

Mean arterial pressure

End-diastolic volume

Diastolic curve
Lusitropy

End-systolic volume
(b) Pregnant woman with acute pulmonary oedema

Systemic circulation

kidneys

brain

Preload

Lungs

Altered permeability

Increased $P_{mv}$

Reduced $COP_{mv}$

Utero-placental-fetal circulation

Increased afterload

Reduced contractility

Increased preload