Objectives

- Provide an overview of Maternal Critical Care (MCC) incidence, risk and admission to ITU
- Review altered maternal physiology - general system overview
- Identify the main causes for ITU admission
- Provide an overview of the conditions unique to pregnancy which can result in critical illness
- Essentials of maternity care
  - Abdomen
  - Uterine involution
  - Lochia
  - Breast changes and care
  - Perineal care
  - Bonding
Maternal Critical Care (MCC) - overview

• 1:20 ♀ get sick
• 1:400 ♀ go to ITU
• For every maternal death: 70 ♀ severe maternal morbidity
• 2.4 ITU admission per 1000 maternities (ICNARC, 2016)
• Majority of ITU admissions recently pregnant not currently pregnant
• Haemorrhage leading cause of admission to ITU in recently pregnant ♀
• Respiratory failure leading cause in currently pregnant ♀
Which women are at risk?

Direct

• Thrombosis and thromboembolism (26)
• Genital tract sepsis (12)
• Haemorrhage (11)
• Pre-eclampsia and eclampsia (9)
• Amniotic fluid embolism (8)
• Early pregnancy deaths (8)
• Anaesthesia (4)

Knight et al., 2016, MBRRACE, 2016
Which women are at risk?

**Indirect**

- Cardiac disease (54)
- Other indirect causes* (61)
- Indirect neuro conditions (31)
- Psychiatric causes (16)
- Indirect malignancies (3)

Knight et al., 2016; MBRRACE, 2016
Pregnancy represents a profound mechanism of system-wide hormonal, haemodynamic, and metabolic reprogramming.
Altered physiology - AIRWAY

- Engorgement and swelling of the nasal, oropharyngeal, laryngeal and tracheal mucosa
- Mucosal oedema and hypervascularity
- Epistaxis
- Circulating volume ↑ & vasodilatory effect of progesterone

Stables and Rankin, 2010
Altered physiology - BREATHING

- Oxygen consumption ↑
  ↑20-30% (A/N) ↑100% (I/P) ↑200% (2nd stage)
- Respiratory rate ↑ 20-24 breaths/min
- Tidal volume ↑600mL/breath
- Minute ventilation ↑7-4L/min ↑40%
- Functional residual capacity ↓1700 to 1350mL (10-20%)
- Progesterone causes relaxation of bronchial smooth muscle - decreased airway resistance
- Flared rib cage (hormonal response). Hypertrophied breasts – poor visibility of chest movements
- Increased oxygen requirements – uterine, fetal & placental demand
- Decreased thoracic cavity with gravid uterus.
- Pregnancy ABG’s – mild respiratory alkalosis
- Increased gastric secretions → ↑greater risk of aspiration

Stables & Rankin, 2010
# Normal Pregnancy ABG values

<table>
<thead>
<tr>
<th>Normal Pregnancy Arterial Blood Gases</th>
<th>Range (non pregnant range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial blood gas</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.40-7.45 (7.4)</td>
</tr>
<tr>
<td>Arterial carbon dioxide tension PaCO₂</td>
<td>27 – 32 (35 – 45) mmHg</td>
</tr>
<tr>
<td>Arterial Oxygen tension PaO₂</td>
<td>104 -108 (80 – 100) mmHg</td>
</tr>
<tr>
<td>Bicarbonate (HCO₃⁻)</td>
<td>18 – 22 (22 - 26)</td>
</tr>
<tr>
<td>Arterial O₂ saturation (SaO₂)</td>
<td>≥ 95 (94 - 100)%</td>
</tr>
</tbody>
</table>

Soma Millay et al., 2016
Altered physiology – CIRCULATION

- Circulating volume ↑ 1200ml (40-50%)
- Cardiac output (CO) ↑ 40-50% (6-7L/min)
- Stroke volume (SV) ↑ 21-30% (78-130ml)
- Plasma volume ↑ 40-50% but red blood cell mass (RBC) ↑ 20%
- Heart rate ↑ 15bpm
- Systemic vascular resistance (SVR) ↓ by up to 30%
- ↑ demand of uterus, fetus and placenta
- haemodilution
- Vasodilatory effect of progesterone

Soma Millay et al., 2016
Altered physiology – CIRCULATION (labour)

- Uterine blood flow at term 800mls (600-700mls → placenta)
- Max cardiac output (CO) ↑15-65% with additional ↑15% each contraction
- ↑ heart rate and preload
  - caused by uterine contractions,
  - ↑ circulating catecholamines,
  - & autotransfusion of 300–500 mL blood from the uterus into the maternal circulation
- Supine at term IVC almost completely occluded
- Regional anaesthesia → ↓ pre-load and BP

Wang, ZHao & San Raphael 2010
Altered physiology – CIRCULATION (postpartum)

- Max cardiac output (CO) ↑80% as uterus involutes and mechanical compression of IVC is relieved.
- ↑ heart rate and preload
  - caused by uterine contractions,
  - ↑circulating catecholamines,
  - & autotransfusion of 300–500 mL blood from the uterus into the maternal circulation
- Regional anaesthesia →↓ pre-load and BP

Wang, ZHao & San Raphael 2010
Altered physiology - HAEMATOLOGY

• Hypercoagulable state –
• Thrombosis risk 4–10 fold higher in pregnancy – Factors VII, X, VIII, fibrinogen & von Willebrand factor ↑ throughout gestation.
• Normal Platelet count 150,000-400,000µl
• ↑Fibrinogen levels by 30-50%
• ↑ coagulation factor levels
• ↓Fibinolytic activity

Soma Millay et al., 2016
Altered physiology - RENAL

- Activation of the renin–angiotensin – aldosterone system maintains blood pressure & retains Na & H₂O maternal systemic and renal arterial dilation → ‘underfilled’ cardiovascular system.
- Renal blood flow ↑ 50%
- Creatinine clearance enhanced 0.5-0.7mg/dL
- Blood urea nitrogen 9-11mg/dL
- ↓ renal threshold - glycosuria present in 20%

Soma Millay et al., 2016
Altered physiology - GI; Hepatobiliary;

- Displacement of GI organs and ↑ intragastric pressure due to pressure from gravid uterus
- Progesterone mediated smooth muscle relaxation → oesophageal sphincter tone ↓ and ↓ gastric /bowel motility/emptying
- Dilation of gallbladder and ↓ motility & stasis of bile and biliary duct system
- Spider nevi, palmar erythema ? ↑ oestrogen

Soma Millay et al., 2016
Altered physiology - endocrine

• Enlarged pituitary ↑plasma growth hormone, ↑prolactin
• Enlarged thyroid – deranged TFT’s
• Adrenal glands ↑Cortisol, ↑ aldosterone ↑ androgens
• Pancreas - ↑insulin secretion & increase peripheral resistance to circulating insulin

Soma Millay et al., 2016
Altered physiology – Immune system

• Altered immune function but not generalised maternal immunosuppression

±

• Conceptus is not immunogenic doesn’t invoke an immunologic response

• Pregnancy alters systemic maternal immune response to prevent immune rejection

• Uterus is an immunologically privileged site

• The placenta is an effective immunologic barrier between mother and fetus

Belfort et al., 2010
Pregnancy specific causes of ITU admission

- Pregnancy induced Hypertension (PIH) Eclampsia
- Haemolysis, elevated liver enzymes, low platelets (HELLP)
- Ante/postpartum haemorrhage
- Acute Fatty liver of pregnancy
- Amniotic Fluid Embolism
- Peripartum cardiomyopathy
- Complications of tocolytic therapy

ICNARC, 2015
Pregnancy induced Hypertension (PIH) Eclampsia

• Incidence
  – Pre-eclampsia -2-8: 100 maternities
  – severe pre-eclampsia is 1:200 maternities
  – Eclampsia 5:10,000 pregnancies

• S&S/presentation
  – Hypertension/Proteinuria ± Epigastric RUQ pain/Severe headaches/Hyporeflexia/Oliguria-anuria/ Oliguria-anuria/ Dizziness/Nausea&vomiting/Vision changes.

• Spectrum disorder ranging from PIH, pre-eclampsia, eclampsia, HELLP, DIC.

• Multi organ/system disorder - originates from the placenta (trophoblast invasion of spiral arteries fails)
Pregnancy induced Hypertension (PIH) Eclampsia

• Arterial and venous vasospasm due to increased/abnormal sensitivity of vascular smooth muscle to vasoactive substances

• Vasospasm → endothelial damage, platelet aggregation, RBC fragmentation & ↓intravascular volume
Haemolysis, elevated liver enzymes, low platelets (HELLP)

• Incidence
  – 0.1%-0.6% of all pregnancies
  – 4%-12% of ♀ pre-eclampsia & 20% of severe pre-eclampsia

• S&S/presentation
  – Acute N&V, abdominal discomfort, ± jaundice

• ? variant or complication of pre-eclampsia

• Activation of the coagulation cascade

• Fibrin crosslinked networks form in small blood vessels
  → microangiopathic haemolytic anaemia → fragmentation & ↓ RBCs & ↑ platelet consumption

• Liver main site of ischaemia

• HELLP → Disseminated Intravascular coagulation
Disseminated Intravascular Coagulation (DIC)

- Incidence
  - 0.03-0.35%
  - 12.5:10,000

- S&S/presentation
  - VT/PE – deranged clotting: Platelet count, PT, PTT, plasma fibrinogen, D-dimer
  - Bleeding

- Systemic inflammatory response, → activation cytokine network & subsequent activation of coagulation (eg, in sepsis or major trauma)

- Release or exposure of pro-coagulant substance (thromboplastin like cytokine from the placental system) into the bloodstream (eg. abruptio placentae, AFE, FDIU, PET)
Acute Fatty liver of pregnancy (AFLP)

• Incidence
  – 1:6,000-20,000
  – High maternal and perinatal mortality

• S&S/presentation
  – N&V/abdominal pain/jaundice/deranged LFTs

• Acute hepatic failure – Variant of pre-eclampsia

• Mitochondrial dysfunction in oxidation of fatty acids
  → accumulation in hepatocytes

• infiltration of fatty acids causes acute liver insufficiency

British Liver Trust 2016; Barsoom, 2015
Amniotic Fluid Embolism (AFE) – Anaphylactoid syndrome of pregnancy

- **Incidence**
  - 1:80,000 births
  - Associated mortality rate 60% +

- **S&S/presentation**
  - Dyspnoea/tachycardia, tachypnoea, hypotension, ± cyanosis, hypoxia, pulmonary crackles, Coagulopathy, (± uterine atony & fetal distress)

- **Tear in fetal membranes and/or uterine vessel** \(\rightarrow\) **AF in uterine venous circulation** \(\rightarrow\) **maternal pulmonary arterial circ.**

- **Presence of AF debris in maternal circulation** \(\rightarrow\) **surge of thromboplastin like substances** \(\rightarrow\) **coagulopathy** \(\rightarrow\) **DIC-hypoxia, hypotension, haemodynamic collapse & coagulopathy**
Postpartum haemorrhage (PPH)

- **Incidence**
  - UK: 2011-2013 - 13 direct deaths
  - Global: 600,000 deaths per year
- **Blood loss ≥ 500mls NVD or ≥ 1000mls LSCS**
- **Massive PPH ≥ 30-40% circulating volume (1500-2000mls)**
- **Tx: identify cause, arrest bleeding, mgt hypovolaemia, anaemia and coagulopathy**
- **Oxytocin, ergometrine, prostaglandin, misoprostyl, tranexamic acid**
- **Tamponade, brace suture, iliac or uterine artery ligation, arterial embolisation, hysterectomy**
- **Sequelae of massive transfusion**
PPH

• 4 T’s – Tone, Tissue, Trauma, Thrombin
• **Tone** – uterine atony, placenta praevia, inversion, polyhydramnios, fibroids, mult. preg
• **Tissue** - retained placenta or products of conception
• **Trauma** – genital tract trauma inc. broad ligament haematoma
• **Thrombin** – coagulation failure – abruption, Pre-eclamposia, sepsis, coagulopathies
Cardiac disease/Peripartum cardiomyopathy (PPCM)

• Incidence
  – Cardiac disease 1-4% in western developed countries
  – Assc. Mat mortality 10-25%

• Peripartum cardiomyopathy
  – 1:3000-4000 live births. Assc. mat mortality 25-50%
  – Heart failure with no identifiable cause (eg, MI, valvular disorder) final trimester of pregnancy and 6 /12 postpartum in patients without a previous heart disorder

• S&S/Presentation
  – mild dyspnea, systolic murmurs, jugular venous distention, tachycardia, oedema, mild cardiomegaly seen on chest x-ray

• Heart chamber enlarge, muscle weakens→↓blood ejected from L ventricle → Ejection fraction ↓45%

Belfort, 2010
Non pregnancy specific causes of ITU admissions

- Sepsis
- Pre-existing cardiac disease
- Pulmonary hypertension
- status asthmaticus/exacerbation of asthma
- Trauma
- Neurological disease
- Malignancies
- Pneumonia
- Diabetic ketoacidosis
Obstetric causes of shock

Haemorrhagic
• Placental abruption
• Ruptured ectopic pregnancy
• Placenta praevia
• Placenta Accreta/Increta/percreta
• Post partum haemorrhage (PPH)

Septic
• Chorioamnionitis
• Endometritis
• PROM
• Infected RPOC
• Pyelonephritis
Postnatal exam

- Breasts – engorgement, colostrum, milk
- Abdomen –
  - Fundus: location, consistency, tenderness
  - Muscle tone: diastasis
  - Incision: dressing, redness, erythema, exudate
- Lochia – type, amount, odour
- Perineum – redness inflammation, oedema, approximation of tissues, bruising, varicosities
Breasts

- Engorgement, blocked duct, mastitis, abscess

- Colostrum, breast milk
Abdomen

- Fundus: location, consistency, tenderness
- Muscle tone: diastasis recti
- Incision: dressing, redness, erythema, exudate

McCarthy & Mason Mitchell, 2016
Lochia

- Lochia rubra – blood, membranes, decidua, vernix 0-5 days red
- Lochia alba - serous exudate, erythrocytes & mucous 3-10 days red/brown
- Lochia serosa – leucocytes, epithelial cells 5-25 days

McCarthy & Mason Mitchell, 2016
Perineum

- Redness
- Inflammation
- Oedema
- Approximation of tissues
- Bruising
- Vulval varicosities

McCarthy & Mason Mitchell, 2016
Bonding

• Early skin-to-skin contact/facilitate physical closeness
• Family-centred care
• Visiting hours
• Baby diaries – filling in the blanks
• Perinatal mental health
Any Questions?
Summary

• Critical illness is uncommon, but is potentially devastating
• 1:20 ♀ get sick-1:400 ♀ go to ITU
• 1 maternal death = 70 ♀ severe maternal morbidity
• 2.4 ITU admission per 1000 maternities (ICNARC, 2016)
• Majority ITU admissions not currently pregnant
• Haemorrhage leading cause (recently pregnant). Respiratory failure leading cause pregnancy
• Obstetric population is changing - older mothers with pre-existing disorders and advanced chronic medical conditions
• Multidisciplinary approaches are essential
References


