



Greater Manchester

Critical Care

SKILLS INSTITUTE **NHS**

# Maternal Critical Care 2017

# 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 1
- 2.4 ITU admission per 1000 maternities (ICNARC, 2016)2
- Majority of ITU admissions recently pregnant not currently pregnant 2
- Haemorrhage leading cause of admission to ITU in recently pregnant ♀ 2
- Respiratory failure leading cause in currently pregnant ♀ 2

# 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)

# Which women are at risk?

## Indirect

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

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



# Altered physiology - BREATHING

- Oxygen consumption  $\uparrow$   
 $\uparrow$ 20-30% (A/N)  $\uparrow$ 100% (I/P)  $\uparrow$ 200%  
(2<sup>nd</sup> stage)
- Respiratory rate  $\uparrow$  20-24  
breaths/min
- Tidal volume  
 $\uparrow$ 600mL/breath
- Minute ventilation  $\uparrow$ 7-  
4L/min  $\uparrow$ 40%
- Functional residual capacity  
 $\downarrow$ 1700 to 1350mL (10-20%)
- 0
- Pregnancy ABG's – mild  
respiratory alkalosis
- Increased oxygen requirements  
– uterine, fetal & placental  
demand
- Decreased thoracic cavity with  
gravid uterus.
- Progesterone causes relaxation  
of bronchial smooth muscle-  
decreased airway resistance
- Flared rib cage (hormonal  
response). Hypertrophied  
breasts – poor visibility of chest  
movements
- Increased gastric secretions  $\rightarrow$   
 $\uparrow$ greater risk of aspiration

# Normal Pregnancy ABG values

Normal Pregnancy Arterial Blood Gases	
Arterial blood gas	Range (non pregnant range)
pH	7.40-7.45 (7.4)
Arterial carbon dioxide tension PaCO <sub>2</sub>	27 – 32 (35 – 45)mmHg
Arterial Oxygen tension PaO <sub>2</sub>	104 -108 (80 – 100)mmHg
Bicarbonate (HCO <sub>3</sub> )	18 – 22 (22 - 26)
Arterial O <sub>2</sub> saturation (SaO <sub>2</sub> )	≥ 95 (94 - 100)%

# 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

# 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

# Altered physiology – CIRCULATION (postpartum )

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

# 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 150,000-400,000 $\mu$ l
- ↑ Fibrinogen levels by 30-50%
- ↑ coagulation factor levels
- ↓ Fibrinolytic activity

# Altered physiology -RENAL

- Activation of the renin–angiotensin – aldosterone system maintains blood pressure & retains Na & H<sub>2</sub>O 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%

# Altered physiology - GI; Hepatobiliary;

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



# 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

# Altered physiology – Immune system

- Altered immune function but not generalised maternal immunosuppression

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- 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

# 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

# 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  $\pm$  Epigastric RUQ pain/Severe headaches/Hypereflexia/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,  $\pm$  jaundice
- ? variant or complication of pre-eclampsia
- Activation of the coagulation cascade
- Fibrin crosslinked networks form in small blood vessels
  - microangiopathic haemolytic anaemia → fragmentation &  $\downarrow$ RBCs &  $\uparrow$ 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 1 .
  - 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



# Amniotic Fluid Embolism (AFE) – Anaphylactoid syndrome of pregnancy

- Incidence
  - 1:80,000 births
  - Assc. mortality rate 60% +
- S&S/presentation
  - Dyspnoea/tachycardia, tachypnoea, hypotension,  $\pm$  cyanosis, hypoxia, pulmonary crackles, Coagulopathy , ( $\pm$  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  $\geq 500$ mls NVD or  $\geq 1000$ mls LSCS
- Massive PPH  $\geq 30$ -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-eclamosia, 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%

# 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



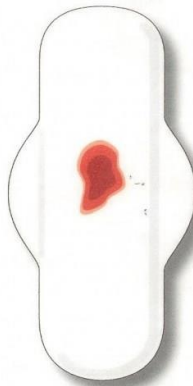
# Abdomen

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



# Lochia

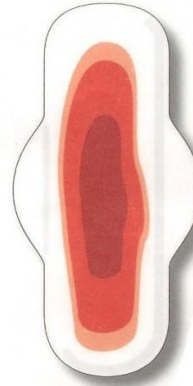
- Lochia rubra – blood, membranes, decidua, vernix 0-5 days red
- Lochia alba - serous exudate, erythrocytes & mucous 3-10 days red/brown
- Lochia serosa –leucocytes, epithelial cells 5-25days



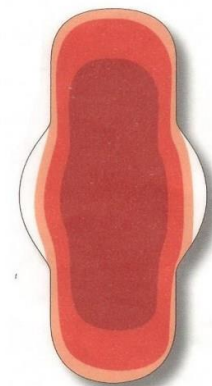
**Scant amount**  
Blood only on tissue when wiped or less than one-inch stain on maxi pad within one hour.



**Light amount**  
Less than four-inch stain on maxi pad within one hour.



**Moderate amount**  
Less than six-inch stain on maxi pad within one hour.



**Heavy amount**  
Saturated maxi pad within one hour.

# Perineum

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



# 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

- Belfort MA, Saade, G.R., Foley, M.R., Phelan, J.P. and Dildy III, G.A. (Eds.) (2010) *Critical care obstetrics*. John Wiley & Sons.
- Centre for Maternal and Child Enquiries (CMACE), 2011. Saving mothers' lives: Reviewing maternal deaths to make motherhood safer: 2006-2008. The Eighth Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG*, 118, pp.1-203.
- Dob D, Cooper G, Holdcroft A. (2007) *Crises in Childbirth - Why Mothers Survive: Lessons from the Confidential Enquiries into Maternal Deaths*. London. Routledge
- Knight M, Nair M, Tuffnell D, Kenyon S, Shakespeare J, Brocklehurst P, Kurinczuk JJ (Eds.) (2016) 'on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care - Surveillance of maternal deaths in the UK 2012-14 and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009-14. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2016.
- MCC EMC working Party (2016) *Enhanced Standards for the Sick Mother – Standards for Maternal Critical Care* .

- McCarthy R & Mason Mitchell (2016) *The Principles of Maternity Care* in Peate I, Wilde K. & Nair M. (2016) *Nursing Practice, Knowledge and Care*. Wiley Blackwell.
- Soma-Pillay, P., Nelson-Piercy, C., Tolppanen, H. and Mebazaa, A., 2016. Physiological changes in pregnancy: review articles. *Cardiovascular journal of Africa*, 27(2), pp.89-94.
- Stables, D. and Rankin, J., 2010. *Physiology in Childbearing: with anatomy and related biosciences*. Elsevier Health Sciences.
- Wang Y, Zhao S. *Vascular Biology of the Placenta*. San Rafael (CA): Morgan & Claypool Life Sciences; 2010. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK53247/>