Maternal, Newborn and Infant Clinical Outcome Review Programme

MBRRACE-UK
Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK

Saving Lives, Improving Mothers' Care

Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2016-18

December 2020

HQIP Healthcare Quality Improvement Partnership
University of Leicester
University of Birmingham
The Newcastle upon Tyne Hospitals NHS Foundation Trust
TIMMS
Sands Stillbirth & neonatal death charity
Bradford Teaching Hospitals NHS Foundation Trust
NPEU
University of Oxford

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Foreword

I am delighted as President of the Faculty of Public Health to have been invited to do the Foreword to this important report.

The MBRRACE-UK Confidential Enquiries into Maternal Deaths and Morbidity have highlighted before the disparities in outcomes for women from different ethnic minority groups. This year's coronavirus pandemic has brought this disparity even more starkly to the fore, and we must not lose sight of the actions that are required to address systemic biases that impact on the care we provide for ethnic minority women.

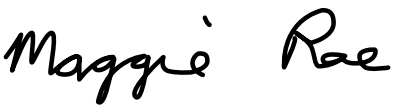
However, what these MBRRACE-UK reports continue to highlight are the multiple and complex problems that affect women who die in pregnancy – social, physical and mental. Women who live in more deprived areas continue to be at greater risk of dying during or after pregnancy, and many of the complex factors underlying this increased risk need action much more widely than in maternity services, and beyond the health sector, and often long before pregnancy. We will need to address this challenge of wider system actions in order to reduce deaths of women during or after pregnancy as well as their babies.

Clear examples jump out which emphasise the importance of wider public health actions. More than half of women who die are overweight or obese – we need actions in schools, communities and by governments to reduce our obesogenic environment and address weight management before women enter pregnancy. Linked to this, cardiac disease – mostly acquired, remains the leading cause of women's deaths during and after pregnancy.

This need for action beyond maternity services is picked up by the recurring need identified in these reports for pre-pregnancy counselling. This should include not only optimisation of medication for pregnancy, but also culturally appropriate lifestyle advice to help optimise pregnancy outcomes. The statistically significant increase in maternal deaths from SUDEP – sudden unexpected death in epilepsy – alongside new guidance on valproate use in women of reproductive age - emphasises the importance of effective pre-pregnancy medication adjustment. This applies equally to women with pre-existing mental health problems – maternal suicide remains the leading direct cause of maternal death between six weeks and a year after the end of pregnancy.

The deaths of women from epilepsy emphasise the importance of joint working across both health and social care sectors to make sure simple actions such as access to accommodation with a shower can be instigated to reduce women's risk.

The infographic summary alongside this report emphasises the 'constellation of biases' affecting the care of women with multiple and complex problems spanning different health and social care sectors. Siloed systems represent structural biases preventing women receiving the care they need. To these biases we must add the misconception that actions to prevent maternal deaths can only take place within maternity services. Wider public health actions are equally important and I commend the authors' of the report for ensuring this is an area of focus.



Professor Maggie Rae, PrFPH, FRSPH, FRCP (Hon) FRSM

President, Faculty of Public Health

Key messages from the report 2020

MBRRACE-UK
Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK

In 2016-18, **217 women died** during or up to six weeks after pregnancy, from causes associated with their pregnancy, among 2,235,159 women giving birth in the UK.
9.7 women per 100,000 died during pregnancy or up to six weeks after childbirth or the end of pregnancy.

We need to talk about SUDEP

Act on:

Night-time seizures

Uncontrolled seizures

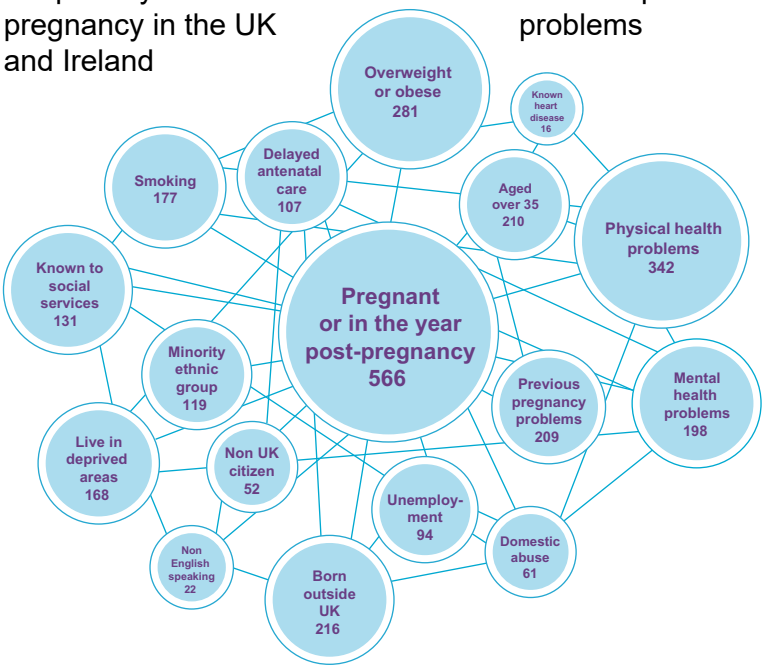
Ineffective treatment

to prevent **Sudden Unexpected Death in EPilepsy**

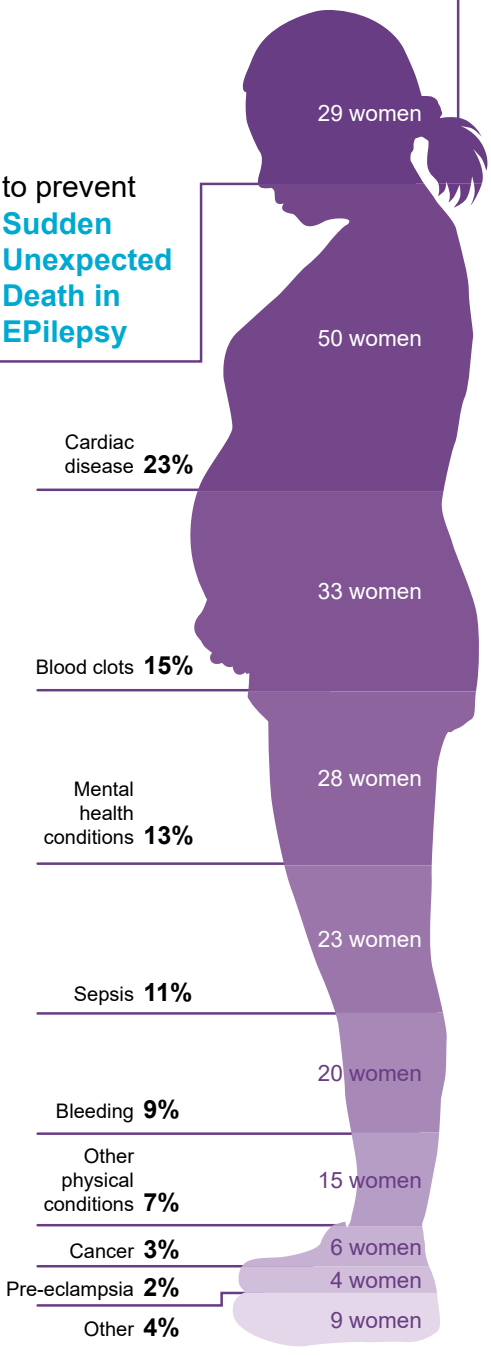
A constellation of biases

566 women died during or up to a year after pregnancy in the UK and Ireland

510 women (90%) had multiple problems



Systemic Biases due to pregnancy, health and other issues prevent women with complex and multiple problems receiving the care they need



Executive Summary

Introduction

This report, the seventh MBRRACE-UK annual report of the Confidential Enquiry into Maternal Deaths and Morbidity, includes surveillance data on women who died during or up to one year after pregnancy between 2016 and 2018 in the UK. In addition, it also includes Confidential Enquiries into the care of women who died between 2016 and 2018 in the UK and Ireland from epilepsy and stroke, general medical and surgical disorders, anaesthetic causes, haemorrhage, amniotic fluid embolism and sepsis.

The report also includes a Morbidity Confidential Enquiry into the care of women with pulmonary embolism.

Surveillance information is included for 547 women who died during or up to one year after the end of pregnancy between 2016 and 2018. The care of 34 women with pulmonary embolism was reviewed in depth for the Confidential Enquiry chapter.

This report can be read as a single document; each chapter is also designed to be read as a standalone report as, although the whole report is relevant to maternity staff, service providers and policy-makers, there are specific clinicians and service providers for whom only single chapters are pertinent. There are seven different chapters which may be read independently, the topics covered are: 1. Surveillance of maternal deaths 2. Neurological conditions 3. Medical and general surgical disorders 4. Anaesthesia 5. Morbidity from pulmonary embolism 6. Haemorrhage and amniotic fluid embolism 7. Sepsis.

Methods

Maternal deaths are reported to MBRRACE-UK, NIMACH or to MDE Ireland by the staff caring for the women concerned, or through other sources including coroners, procurators fiscal and media reports. In addition, identification of deaths is cross-checked with records from the Office for National Statistics, Information Services Division Scotland and National Records of Scotland. Full medical records are obtained for all women who die as well as those identified for the Confidential Enquiry into Maternal Morbidity, and anonymised prior to undergoing confidential review. The anonymous records are reviewed by a pathologist, together with an obstetrician or physician as required to establish a woman's cause of death. Each woman's care is examined by between ten and fifteen multidisciplinary expert reviewers and assessed against current guidelines and standards (such as that produced by NICE or relevant Royal Colleges and other professional organisations). Subsequently the expert reviews of each woman's care are examined by a multidisciplinary writing group to enable the main themes for learning to be drawn out for the MBRRACE-UK report. These recommendations for future care are presented here, alongside a surveillance chapter reporting three years of UK statistical surveillance data.

NOTE: Relevant actions are addressed to all health professionals as silo working leading to compromised care is a recurring theme identified in these enquiries. Some actions may be more pertinent to specific professional groups than others but all should nonetheless be reviewed for relevance to practice by each group.

Causes and trends

There was a statistically non-significant increase in the overall maternal death rate in the UK between 2013-15 and 2016-18 which suggests that continued focus on implementation of the recommendations of these reports is needed to achieve a reduction in maternal deaths. Assessors judged that 29% of women who died had good care. However, improvements in care which may have made a difference to the outcome were identified for 51% of women who died. **ACTION: Policy makers, service planners/commissioners, service managers, all health professionals**

There remains a more than four-fold difference in maternal mortality rates amongst women from Black ethnic backgrounds and an almost two-fold difference amongst women from Asian ethnic backgrounds compared to white women, emphasising the need for a continued focus on action to address these disparities. **ACTION: Policy makers, service planners/commissioners, service managers, all health professionals**

Eight percent of the women who died during or up to a year after pregnancy in the UK in 2016-18 were at severe and multiple disadvantage. The main elements of multiple disadvantage were a mental health diagnosis, substance use and domestic abuse.

Cardiac disease remains the largest single cause of indirect maternal deaths. Neurological causes (epilepsy and stroke) are the second most common indirect cause of maternal death, and the third commonest cause of death overall. There has been a statistically significant increase in maternal mortality due to Sudden Unexpected Death in Epilepsy (SUDEP).

Maternal deaths from direct causes are unchanged with no significant change in the rates between 2013-15 and 2016-18. Thrombosis and thromboembolism remains the leading cause of direct maternal death during or up to six weeks after the end of pregnancy. Maternal suicide remains the leading cause of direct deaths occurring within a year after the end of pregnancy.

Key messages to improve care

The majority of recommendations which MBRRACE-UK assessors have identified to improve care are drawn directly from existing guidance or reports and denote areas where implementation of existing guidance needs strengthening. In a small number of instances, actions are needed for which national guidelines are not available, and these are presented separately here for clarity.

New recommendations to improve care

For professional organisations:

1. Develop guidance to ensure SUDEP awareness, risk assessment and risk minimisation is standard care for women with epilepsy before, during and after pregnancy and ensure this is embedded in pathways of care. **[ACTION: Royal Colleges of Obstetricians and Gynaecologists, Physicians]**.
2. Develop guidance to indicate the need for definitive radiological diagnosis in women who have an inconclusive VQ scan **[ACTION: Royal Colleges of Physicians, Radiologists, Obstetricians and Gynaecologists**].
3. Produce guidance on which bedside tests should be used for assessment of coagulation and the required training to perform and interpret those tests **[ACTION: Royal Colleges of Anaesthetists, Obstetricians and Gynaecologists, Physicians]**
4. Establish a mechanism to disseminate the learning from this report, not only to maternity staff, but more widely to GPs, emergency department practitioners, physicians and surgeons **[ACTION: Academy of Medical Royal Colleges**].

For policy makers, service planners/commissioners and service managers:

5. Develop clear standards of care for joint maternity and neurology services, which allow for: early referral in pregnancy, particularly if pregnancy is unplanned, to optimise anti-epileptic drug regimens; rapid referral for neurology review if women have worsening epilepsy symptoms; pathways for immediate advice for junior staff out of hours; postnatal review to ensure anti-epileptic drug doses are appropriately adjusted **[ACTION: NHSE/I and equivalents in the devolved nations and Ireland]**.
6. Ensure each regional maternal medicine network has a pathway to enable women to access their designated epilepsy care team within a maximum of two weeks. **[ACTION: Maternal Medicine Networks and equivalent structures in Ireland and the devolved nations]**.
7. Ensure all maternity units have access to an epilepsy team **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
8. Establish pathways to facilitate rapid specialist stroke care for women with stroke diagnosed in inpatient maternity settings **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
9. Provide specialist multidisciplinary care for pregnant women who have had bariatric surgery by a team who have expertise in bariatric disorders **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
10. Use the scenarios identified from review of the care of women who died for 'skills and drills' training **[ACTION: Hospitals/Trusts/Health Boards]**.
11. Ensure early senior involvement in the care of women with extremely preterm prelabour rupture of membranes and a full explanation of the risks and benefits of continuing the pregnancy. This should include discussion of termination of pregnancy **[ACTION: Hospitals/Trusts/Health Boards]**.

For health professionals:

12. Regard nocturnal seizures as a 'red flag' indicating women with epilepsy need urgent referral to an epilepsy service or obstetric physician **[ACTION: All Health Professionals]**.
13. Ensure that women on prophylactic and treatment dose anticoagulation have a structured management plan to guide practitioners during the antenatal, intrapartum and postpartum period **[ACTION: All Health Professionals]**.
14. Ensure at least one senior clinician takes a 'helicopter view' of the management of a woman with major obstetric haemorrhage to coordinate all aspects of care **[ACTION: All Health Professionals]**.

15. Ensure that the response to obstetric haemorrhage is tailored to the proportionate blood loss as a percentage of circulating blood volume based on a woman's body weight **[ACTION: All Health Professionals]**.
16. Do not perform controlled cord traction if there are no signs of placental separation (blood loss and lengthening of the cord) and take steps to manage the placenta as retained **[ACTION: All Health Professionals]**.
17. Be aware that signs of uterine inversion include pain when attempting to deliver the placenta, a rapid deterioration of maternal condition and a loss of fundal height without delivery of the placenta **[ACTION: All Health Professionals]**.

Recommendations identified from existing guidance requiring improved implementation

Maternity Networks should work with their member organisations and professional groups to support all relevant healthcare professionals to deliver care for pregnant women in line with these recommendations. **Original source of each recommendation indicated in brackets.**

Care of women with neurological complications

Women with epilepsy taking antiepileptic drugs who become unexpectedly pregnant should be able to discuss therapy with an epilepsy specialist on an urgent basis. It is never recommended to stop or change antiepileptic drugs abruptly without an informed discussion [RCOG green-top guideline 68] **ACTION: All Health Professionals, Service Managers.**

Pregnant women who are recent migrants, asylum seekers or refugees, or who have difficulty reading or speaking English, may not make full use of antenatal care services. This may be because of unfamiliarity with the health service or because they find it hard to communicate with healthcare staff. Healthcare professionals should help support these women's uptake of antenatal care services by: using a variety of means to communicate with women; telling women about antenatal care services and how to use them; undertaking training in the specific needs of women in these groups [NICE guideline CG110] **ACTION: All Health Professionals.**

Offer antihypertensive treatment to pregnant women who have chronic hypertension and who are not already on treatment if they have: sustained systolic blood pressure of 140 mmHg or higher; or sustained diastolic blood pressure of 90 mmHg or higher [NICE Guideline NG133] **ACTION: All Health Professionals.**

In women with chronic hypertension who have given birth: aim to keep blood pressure lower than 140/90 mmHg; continue antihypertensive treatment, if required [NICE Guideline NG133] **ACTION: All Health Professionals.**

Care of women with medical and general surgical disorders

Women with pre-existing medical conditions should have pre-pregnancy counselling by doctors with experience of managing their disorder in pregnancy [Saving Lives, Improving Mothers' Care 2014] **ACTION: All Health Professionals, Service Managers.**

Services providing care to pregnant women should be able to offer all appropriate methods of contraception, including long-acting reversible contraception, to women before they are discharged from the service [Faculty of Sexual and Reproductive Health Guideline Contraception After Pregnancy] **ACTION: All Health Professionals, Service Managers.**

Women admitted with sickle cell crisis should be looked after by the multidisciplinary team, involving obstetricians, midwives, haematologists and anaesthetists [RCOG green-top guideline 61] **ACTION: All Health Professionals, Service Managers.**

Critical care support can be initiated in a variety of settings. Critical care outreach nurses can work in partnership with midwives to provide care before transfer to the critical care unit. Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care [Saving Lives, Improving Mothers' Care 2016] **ACTION: All Health Professionals, Service Managers.**

Anaesthetic Care

Pregnant women with complex needs or a complex medical history should have timely antenatal multi-disciplinary planning, and an experienced obstetric anaesthetist should contribute to the planning [Saving Lives, Improving Mothers' Care 2019] **ACTION: All Health Professionals, Service Managers.**

Prompt action and good communication within and between teams are crucial when dealing with sudden unexpected catastrophes, especially when the diagnosis is not immediately clear [Saving Lives, Improving Mothers' Care 2014] **ACTION: All Health Professionals, Service Managers.**

In sudden onset severe maternal shock e.g. anaphylaxis, the presence of a pulse may be an unreliable indicator of adequate cardiac output. In the absence of a recordable blood pressure or other indicator of cardiac output, the early initiation of external cardiac compressions may be life-saving [Saving Lives, Improving Mothers' Care 2017] **ACTION: All Health Professionals, Service Managers.**

Pregnant or postpartum women recovering from anaesthesia require the same standard of postoperative monitoring, including documentation, as non-obstetric patients [Saving Lives, Improving Mothers' Care 2014] **ACTION: All Health Professionals, Service Managers.**

Prevention and treatment of thromboembolism

There is clear evidence that doctors and midwives find existing risk scoring systems difficult to apply consistently in practice. There is a need for development of a tool to make the current risk assessment system simpler and more reproducible [Saving Lives, Improving Mothers' Care 2018] **ACTION: NHSE/I and equivalents in the devolved nations and Ireland.**

Audits should be conducted not only to assess whether thromboembolism risk assessment was performed, but also whether the calculated risk score was correct [Saving Lives, Improving Mothers' Care 2018] **ACTION: All Health Professionals, Service Managers.**

Reassessment of VTE risk after miscarriage or ectopic pregnancy to consider whether thromboprophylaxis is required is as important as reassessment of risk after giving birth [RCOG Green-top guideline 37a] **ACTION: All Health Professionals.**

Thrombolysis or surgical embolectomy should be considered for pregnant women with high-risk PE [ESC Guidelines for the diagnosis and management of acute pulmonary embolism 2019] **ACTION: All Health Professionals.**

Women should be offered a choice of LMWH or oral anticoagulant for postnatal therapy after discussion about the need for regular blood tests for monitoring of warfarin, particularly during the first 10 days of treatment [RCOG Green-top guideline 37b] **ACTION: All Health Professionals.**

Women should be advised that neither heparin (unfractionated or LMWH) nor warfarin is contraindicated in breastfeeding [RCOG Green-top guideline 37b] **ACTION: All Health Professionals.**

Postnatal review for women who develop VTE during pregnancy or the puerperium should, whenever possible, be at an obstetric medicine clinic or a joint obstetric haematology clinic [RCOG Green-top guideline 37b] **ACTION: All Health Professionals.**

Care of women with haemorrhage or amniotic fluid embolism

Haemorrhage (which might be concealed) should be considered when classic signs of hypovolaemia are present (tachycardia and/or agitation with hypotension often a late sign) even in the absence of revealed bleeding [RCOG Green-top guideline 52] **ACTION: All Health Professionals.**

When there has been a massive haemorrhage and the bleeding is ongoing, or there are clinical concerns, then a massive haemorrhage call should be activated [RCOG Green-top guideline 52] **ACTION: Service Managers, All Health Professionals.**

In major PPH (blood loss greater than 1000 ml) and ongoing haemorrhage or clinical shock monitor temperature every 15 minutes [RCOG Green-top guideline 52]. **ACTION: All Health Professionals.**

One member of the team should be assigned the task of recording events, fluids, drugs, blood and components transfused, and vital signs [RCOG Green-top guideline 52] **ACTION: Service managers, All Health Professionals.**

Resort to hysterectomy sooner rather than later (especially in cases of placenta accreta or uterine rupture) [RCOG Green-top guideline 52] **ACTION: All Health Professionals.**

Coagulation factors should be administered promptly after multidisciplinary discussion in accordance with the principles in RCOG Green-top Guideline 52. **ACTION: All Health Professionals**

Prevention and treatment of infection

Offer influenza vaccine to pregnant women at any stage of pregnancy (first, second or third trimesters) [Immunisation against infectious disease: the green book 2019] **ACTION: All Health Professionals.**

Provide the woman with an interpreter (who may be a link worker or advocate and should not be a member of the woman's family, her legal guardian or her partner) who can communicate with her in her preferred language. When giving spoken information, ask the woman about her understanding of what she has been told to ensure she has understood it correctly [NICE Guideline CG110] **ACTION: Service managers, All Health Professionals.**

"Think Sepsis" at an early stage when presented with an unwell pregnant or recently pregnant woman, take the appropriate observations and act on them [Saving Lives, Improving Mothers' Care 2014] **ACTION: All Health Professionals.**

In the postnatal period health professionals must perform and record a full set of physiological vital signs, pulse, blood pressure, temperature and respiratory rate, in any woman with symptoms or signs of ill health [RCOG Green-top guideline 64b] **ACTION: All Health Professionals.**

Midwives and others carrying out postnatal checks in the community should have a thermometer to enable them to check the temperature of women who are unwell [Saving Lives, Improving Mothers' Care 2017] **ACTION: All Health Professionals.**

When assessing a woman who is unwell consider her condition in addition to her MEOWS score [Saving Lives, Improving Mothers' Care 2017] **ACTION: All Health Professionals.**

Conclusions

Almost three quarters of women who died during pregnancy or up to six weeks after pregnancy in 2016-18 had a pre-existing physical or mental health condition. We have no similar information on the overall proportion of pregnant women with pre-existing physical or mental health conditions and cannot therefore quantify the absolute risk of maternal mortality in these women. It is likely there is a hidden disparity in maternal mortality rates between women with pre-existing health conditions and those without.

This report has identified a concerning rise in the number of women who are dying from Sudden Unexplained Death in Epilepsy (SUDEP). One of the major findings when reviewing the care of these women was the low proportion whose medications were optimised either before or during pregnancy. Clear and rapid pathways of access to neurology and/or epilepsy teams with expertise in caring for women before and during pregnancy need to be established. Repeatedly it was identified that women with both epilepsy and other conditions were stopping medicines, either of their own volition or on the advice of a health professional, or receiving inappropriate medications, simply because they were pregnant. The conversation has changed and it is now recognised that disparity in maternal mortality simply because of a woman's ethnicity is unacceptable. The conversation now also has to encompass the recognition that it is equally unacceptable for women with pre-existing medical conditions such as epilepsy to receive a lower standard of care simply because they are pregnant.

Acknowledgements

It is with grateful thanks that the MBRRACE-UK collaboration would like to acknowledge the contribution of the many healthcare professionals and staff from the health service and other organisations who were involved in the notification of maternal deaths, the provision of data and the assessment of individual deaths in both the UK and Ireland. Without the generous contribution of their time and expertise it would not have been possible to produce this report. It is only through this collaborative effort that it has been possible to conduct this confidential enquiry and to continue the UK tradition of national self-audit to improve care for women, babies and their families in the future. We would particularly like to thank all MBRRACE-UK Lead Reporters and other staff in Trusts and Health Boards across the UK and Ireland who provided the information about women who died to enable the enquiry to be conducted.

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Sarah Corcoran, Team leader, Maternal and Infant Health, Scottish Government
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Karen Jewell, Nursing Officer for Maternity and Early Years, Welsh Government
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Healthcare Quality Improvement Partnership

Tina Strack, Associate Director for Quality and Development, National Clinical Audit and Patient Outcomes Programme
Vivien Seagrove, Project Manager
Sue Latchem, Director of Operations

Key to colour coding

Vignettes concerning the care of women who died are described in blue boxes

Vignettes concerning the care of women who had severe morbidity but survived are described in purple boxes with the character M in the corner M

The majority of recommendations arise from existing national guidelines or previous reports and the source of these recommendations are cited within green boxes. Example:

Existing guidance requiring improved implementation is presented in green boxes

NICE 2345

Recommendations based on improvements in care noted by MBRRACE reviewers for which there is no current national guidance and which has not been noted in previous guidance or reports are shown in purple boxes. Example:

New recommendations are presented in purple boxes with the character N in the corner. N

The recommendations identified by MBRRACE reviewers as the most frequently needed improvements are highlighted in the key messages section at the start of each chapter. The specific individuals or professional groups who need to take action are indicated alongside the key messages, where appropriate.

Glossary of terms

AED	Anti-epileptic drug
AFE	Amniotic Fluid Embolism
AIP	Abnormally Invasive Placenta
ALSO	Advanced Life Support in Obstetrics
BMI	Body Mass Index
BP	Blood pressure
BTS	British Thoracic Society
CEMD	Confidential Enquiries into Maternal Deaths
CEMM	Confidential Enquiries into Maternal Morbidity
CI	Confidence interval
CMACE	Centre for Maternal and Child Enquiries
COVID-19	Coronavirus disease 2019
CPR	Cardiopulmonary resuscitation
CT	Computerised Tomography
CTPA	Computerised Tomography Pulmonary Angiogram
CXR	Chest X-ray
DIC	Disseminated intravascular coagulation
DNA	Deoxyribonucleic acid
DVT	Deep venous thrombosis
ECMO	Extracorporeal membrane oxygenation
ECG	Electrocardiogram
E coli	Escherichia coli
ESC	European Society for Cardiology
EWS	Early warning scores
FAST	Face Arm Speech Test
FFP	Fresh frozen plasma
GAS	Group A Streptococcus
GCS	Glasgow Coma Score
GP	General practitioner
GLOSS	Global Maternal Sepsis Study
HES	Hospital Episode Statistics
HIV	Human Immunodeficiency Virus
HLH	Haemophagocytic lymphohistiocytosis
HQIP	Healthcare Quality Improvement Partnership
HSE	Health Service Executive
HSV	Herpes simplex Virus
ICD	International Classification of Diseases
ICD-MM	International Classification of Diseases – Maternal Mortality
ICU	Intensive Care Unit
IMD	Index of Multiple Deprivation
IOL	Induction of labour
IV	Intravenous
IVF	In vitro fertilisation
LARC	Long-acting reversible contraception
LMWH	Low molecular weight heparin
MBRRACE-UK	Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK
MDE	Maternal Death Enquiry
MEmO	Medical Emergencies in Obstetrics
MEOWS	Modified Early Obstetric Warning Score
MMR	Maternal Mortality Ratio
mMOET	Managing Medical and Obstetric Emergencies and Trauma
MNI-CORP	Maternal Newborn and Infant Clinical Outcome Review Programme
MRI	Magnetic Resonance Imaging
NOAC	Novel oral anticoagulant
NCAPOP	National Clinical Audit and Patient Outcomes Programme
NCEPOD	National Confidential Enquiry into Patient Outcome and Death
NCISH	National Confidential Inquiry into Suicide and Safety in Mental Health
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NIMACH	Northern Ireland Maternal and Child Health
NMCRR	National Mortality Case Record Review
NMPA	National Maternal and Perinatal Audit
NSAIDS	Non-steroidal anti-inflammatory drugs
PDPH	Post-dural puncture headache
PE	Pulmonary embolism
PMCS	Perimortem caesarean section
PPH	Postpartum haemorrhage
RCOG	Royal College of Obstetricians and Gynaecologists
RCP	Royal College of Physicians
RCPath	Royal College of Pathologists
ROSC	Return of spontaneous circulation
ROSIER	Recognition of Stroke In the Emergency Room
ROTEM	Rotational thromboelastometry
RR	Rate ratio
RRR	Ratio of relative risks
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SIGN	Scottish Intercollegiate Guidelines Network
SUDEP	Sudden unexpected death in epilepsy
TB	Tuberculosis
TEG	Thromboelastogram
TIA	Transient ischaemic attack
TTP	Thrombotic thrombocytopenic purpura
UKOSS	UK Obstetric Surveillance System
VAE	Venous air embolism
VQ	Ventilation-perfusion
VTE	Venous thromboembolism
WHO	World Health Organisation

Contents

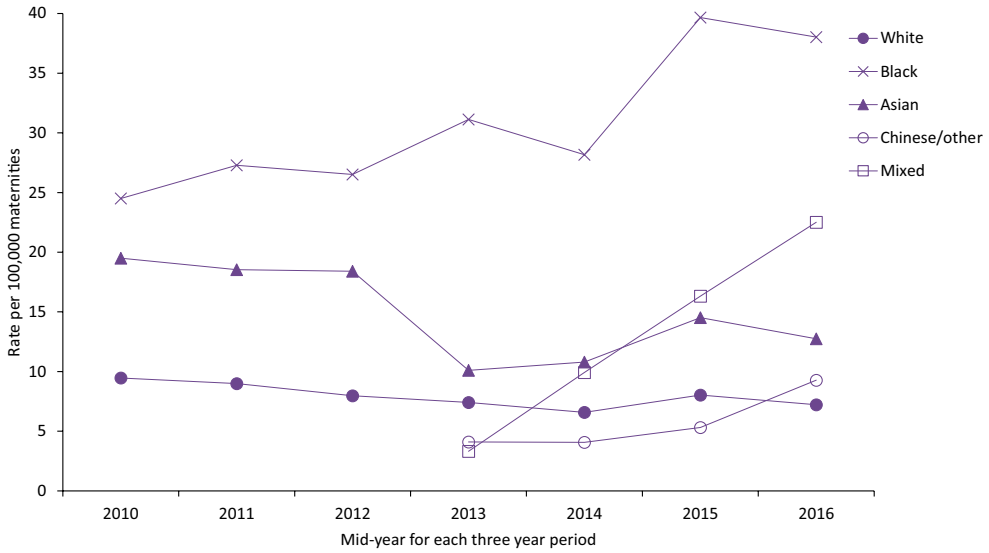
1. Introduction and methodology

Marian Knight

1.1 The 2020 Saving Lives, Improving Mothers' Care report

As others have noted, disparities in maternal mortality rates amongst women from different ethnic groups have been documented for many years. However, the 2020 analysis of the information contained in these reports showed, for the first time, the recent widening of this gap between women from Black and white ethnic groups (Figure 1.1). In both the 2018 and 2019 reports, we highlighted the five times higher maternal mortality rate amongst women from Black ethnic groups compared with white (Knight et al. 2018, Knight et al. 2019). Many women have found these figures very worrying and it is important always to qualify such stark statistics with absolute numbers - in 2016-18 in the UK 34 Black women died among every 100,000 giving birth, 15 Asian women died among every 100,000 giving birth, and 8 white women died among every 100,000 giving birth. These figures are fundamentally unchanged from those documented in the 2019 report, but the response to the disparity has changed dramatically. Individuals, groups of individuals, third sector organisations, research units, professional societies and NHS and government bodies have responded positively with actions varying from the first national Black Women's Maternal Health Awareness Week to a new Race Equality Taskforce. Some of these actions are captured in section 1.2.

Figure 1.1: Figure 1.1 Maternal mortality rates 2009-17 among women from different ethnic groups in the UK (reproduced from Knight et al. Paediatric and Perinatal Epidemiology 2020 (Knight et al. 2020b))

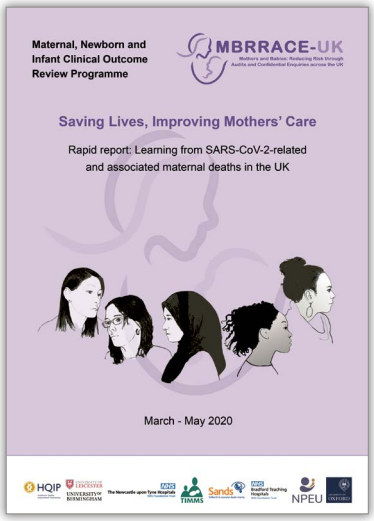


However, there are hidden disparities which cannot be illustrated in numbers because we do not have easily available accurate information on the number of women with these characteristics who give birth. Almost three quarters of women who died during pregnancy or up to six weeks after pregnancy in 2016-18 had a pre-existing physical or mental health condition. We have no similar information on the overall proportion of pregnant women with pre-existing physical or mental health conditions and cannot therefore quantify the absolute risk of maternal mortality in these women. It is likely there is a hidden disparity in maternal mortality rates between women with pre-existing health conditions and those without. Access to high quality information about the wider characteristics of women who give birth would allow us to quantify the disparities and begin to address them, across the whole health and care sector and not simply within maternity.

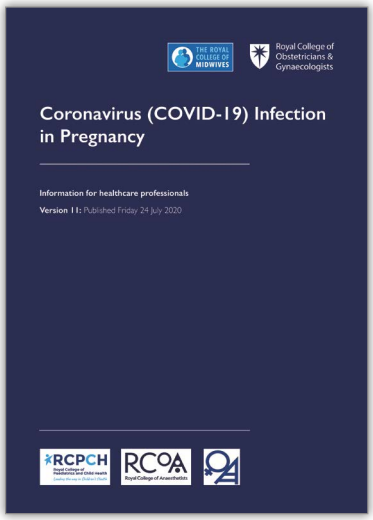
This report has identified a concerning rise in the number of women who are dying from Sudden Unexplained Death in Epilepsy (SUDEP). One of the major findings when reviewing the care of these women was the low proportion whose medications were optimised either before or during pregnancy. Clear and rapid pathways of access to neurology and/or epilepsy teams with expertise in caring for women before and during pregnancy need to be established. Repeatedly in other chapters it was identified that women were stopping medicines, either of their own volition or on the advice of a health professional, or receiving inappropriate medications, simply because they were pregnant. This

inequity in care has to stop. The conversation has changed and it is now recognised that disparity in maternal mortality simply because of a woman's ethnicity is unacceptable. The conversation now also has to encompass the recognition that it is equally unacceptable for women to receive a lower standard of care simply because they are pregnant.

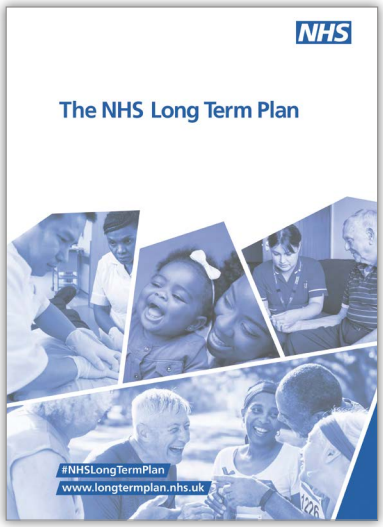
1.2 Actions following the release of the 2014-2020 reports



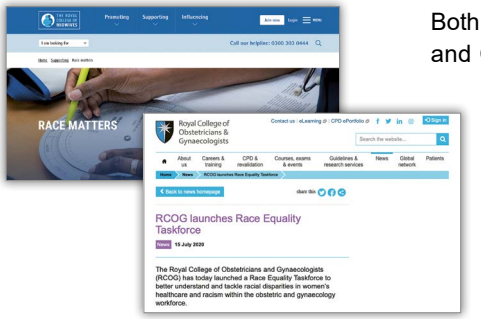
The initial multidisciplinary chapter writing groups for this 2020 annual report met in early March 2020, and almost immediately afterwards most assessors were directly dealing with the NHS and HSE response to the SARS-CoV-2 pandemic. However, recognising the importance of these Enquiries, many contributed to a rapid review of the care of all women who died with confirmed or suspected SARS-CoV-2 infection during or up to one year after pregnancy, and any women who died from mental health-related causes or domestic violence, which might have been influenced by public health measures introduced to control the epidemic such as lockdown (Knight et al. 2020a). This section therefore includes actions following the release of this 2020 'rapid report' as well as previous annual reports. Direct liaison with MBRRACE-UK throughout the course of this rapid review enabled the Royal College of Obstetricians and Gynaecologists/ Royal College of Midwives/Obstetric Anaesthetists Association/Royal College of Paediatrics and Child Health COVID-19 Guideline Development Group to make immediate changes to their guidance on the basis of the messages identified, as well as on the basis of results from the UK Obstetric Surveillance System (UKOSS) national surveillance study (Knight et al. 2020c).



It is almost impossible to capture the very wide range of actions that many groups have undertaken to address the ethnic disparities in maternal health first identified in these reports. We noted in last year's report actions taken by Action on Pre-eclampsia and the Royal College of Anaesthetists/ Obstetric Anaesthetists Association. 'The NHS Long Term Plan' (NHS England 2019) set out the aim that 'by 2024, 75% of women from Black and minority ethnic communities and a similar percentage of women from the most deprived groups will receive continuity of care from their midwife throughout pregnancy, labour and the postnatal period' with the aim of reducing the disparity in both maternal and perinatal mortality. Further actions followed the evidence that Black and other ethnic minority women were disproportionately severely affected by COVID-19 with NHS maternity units in England requested to take four specific actions to minimise COVID-19 risk for Black and minority ethnicity women and their babies. Actions included increased support, tailored communications, discussion of nutrition and ensuring all providers record on maternity information systems the ethnicity of every woman, as well as other risk factors, such as living in a deprived area (postcode), co-morbidities, BMI and aged 35 years or over, to identify those most at risk of poor outcomes. These latter actions, and access to the resulting information will be particularly important going forward to allow MBRRACE-UK to produce the nuanced analyses needed to help prevent Black and other minority ethnic group women from dying.

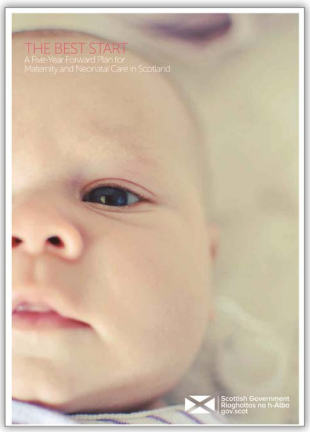


September saw the first Black Women's Maternal Health Awareness Week organised by the Five X More campaign, with a wide range of activities supporting and empowering Black women to make informed choices throughout their pregnancies to after childbirth, and to advocate for themselves.



Both the Royal College of Midwives and the Royal College of Obstetricians and Gynaecologists have begun work to address racial disparities and racism in maternity. The Royal College of Midwives 'Race Matters' initiative sets out a five point plan including 'supporting research and championing positive change in outcomes for pregnant women from Black, Asian and minority ethnic backgrounds'. The RCOG Taskforce aims to 'highlight where health disparities exist, improve our understanding of the causes behind inequalities and collaborate with government to create meaningful solutions to improve healthcare experiences and outcomes for all ethnic minority women'.

The 2019 report called for development of an appropriate evidence-based early warning score for pregnant and postpartum women (Knight et al. 2019). Consensus MEOWS are already used in Scotland, Northern Ireland and the Republic of Ireland. Taking an alternative approach using newly described centiles for physiological measures during pregnancy (Green et al. 2020) NHS England/Improvement are rapidly developing a chart for use in England, coupled with a clear response pathway to ensure appropriate escalation of care.



These reports have emphasised that women who die have multiple vulnerabilities and require individually tailored care. The Best Start: A Five-Year Forward Plan for Maternity and Neonatal Care in Scotland, recommends that all women, and in particular those with additional complex needs, are supported with compassion and with advice and services to promote lifestyle changes during their pregnancy to improve their own health and the health of their baby. A key recommendation is that all women receive continuity of carer from a primary midwife, supported by a small team.

This section can only produce a snapshot of the many impacts following the publication of these Confidential Enquiry reports. The adult national morbidity and mortality programmes (Learning Disabilities Mortality Review Programme (LeDeR), National Confidential Inquiry into Suicide and Safety in Mental Health (NCISH), Medical and Surgical Clinical Outcome Review and the Child Health Clinical Outcome Programmes (NCEPOD), National Mortality Case Record Review Programme (NMCRR) and MBRRACE-UK) have worked together to produce a review of the broad range of impacts the programmes have had and identified substantial impact (Heslop et al. 2020). However, the review noted that 'Each of the clinical outcome review programmes is contracted to deliver a process of information gathering only; none are currently funded to assess the outcome and impact of the recommendations they make or to deliver a programme of change. What happens to the recommendations made by each of the programmes is therefore dependent on political will or committed practitioners.' That so many actions and changes occur in response to the recommendations in these reports is testament to the commitment of the many individuals and organisations who have taken them forward to drive change.

1.3 Topics covered in MBRRACE-UK maternal reports 2014-20

Since 2014 the programme has involved the production of annual CEMD reports. Reports were previously produced on a triennial basis, because the number of maternal deaths from individual causes is small, and three years' worth of data is required to identify consistent lessons learned for future care and to maintain anonymity and confidentiality. Clearly the need to undertake annual reporting does not change this requirement, therefore, each topic-specific chapter which appeared in the previous triennial report now appears in an annual report once every three years on a cyclical basis, alongside a surveillance chapter reporting three years of statistical data. All causes of maternal death have now been covered twice in two three-year cycles; this report is the first in the third three-year cycle:

- **2014 report:** Surveillance data on maternal deaths from 2009-12. Confidential Enquiry reports on severe morbidity and deaths from sepsis, deaths from haemorrhage, amniotic fluid embolism (AFE), anaesthesia, neurological, respiratory, endocrine and other indirect causes.
- **2015 report:** Surveillance data on maternal deaths from 2011-13. Confidential Enquiry reports on deaths from psychiatric causes, deaths due to thrombosis and thromboembolism, malignancy, homicides and late deaths.
- **2016 report:** Surveillance data on maternal deaths from 2012-14. Confidential Enquiry reports on deaths and severe morbidity from cardiac causes, deaths from pre-eclampsia and eclampsia and related causes and deaths in early pregnancy, messages for critical care.

- **2017 report:** Surveillance data on maternal deaths from 2013-15. Confidential Enquiry reports on severe morbidity from psychosis, severe morbidity and deaths from epilepsy, deaths from haemorrhage, amniotic fluid embolism (AFE), anaesthesia, stroke, respiratory, endocrine and other indirect causes.
- **2018 report:** Surveillance data on maternal deaths from 2014-16. Confidential Enquiry reports on deaths from psychiatric causes, deaths due to thrombosis and thromboembolism, malignancy and homicides, and morbidity from major obstetric haemorrhage.
- **2019 report:** Surveillance data on maternal deaths from 2015-17. Confidential Enquiry reports on deaths from cardiac causes, deaths from pre-eclampsia and eclampsia and related causes, accidental deaths and deaths in early pregnancy, morbidity from newly diagnosed breast cancer and messages for critical care.
- **2020 (this report):** Surveillance data on maternal deaths from 2016-18. Confidential Enquiry reports on severe morbidity from pulmonary embolism and deaths from epilepsy, stroke, haemorrhage, amniotic fluid embolism (AFE), anaesthesia, respiratory, endocrine and other indirect causes.

Note that maternal deaths associated with SARS-CoV-2 between March and May 2020 were included in an additional rapid report (Knight et al. 2020a). Alongside the confidential enquiries into maternal deaths we also conduct enquiries into maternal morbidity topics, which can be proposed by anyone. Proposals for topics are accepted annually between October and December. Further details are available at *https://www.npeu.ox.ac.uk/mbrrace-uk/topics*.

1.4 The MBRRACE-UK Confidential Enquiries into Maternal Deaths and Morbidity Methods

Maternal Deaths

The methods for the Confidential Enquiry into maternal deaths remain unchanged, and readers are therefore referred to the 2016 report (Knight et al. 2016) for a full description of the methods (*https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/MBRRACE-UK%20Maternal%20Report%202016%20-%20website.pdf*).

Maternal Morbidity

Women are identified for the Confidential Enquiries into Maternal Morbidity in different ways according to the topic. The women with pulmonary embolism were identified from an existing UKOSS study of pulmonary embolism in pregnancy and immediately postpartum, which identified women fulfilling the criteria in Box 1.1 between March 2015 and September 2016 (Goodacre et al. 2019).

All surviving women notified nationally were used as the sampling frame. A geographically representative sample of 40 women was drawn at random from this group. A full set of medical records was requested from each hospital and general practice concerned. The anonymised records then underwent expert assessment in exactly the same way as the records of the women who died. Consent was requested from women in Northern Ireland to participate, since legislation does not exist to allow inclusion of their data without consent. Hospitals provided only 34 of 40 requested sets of records; the care of these 34 women is described in Chapter 4.

Box 1.1: Case definition used in the UKOSS pulmonary embolism (PE) study

Any pregnant or postpartum woman meeting one of the following criteria:

EITHER: PE confirmed using suitable imaging (angiography, computed tomography, echocardiography, magnetic resonance imaging or ventilation-perfusion scan) showing a high probability of PE

OR: PE is confirmed at surgery or post-mortem

OR: A clinician has made a diagnosis of PE with signs and symptoms consistent with PE present AND the patient has received a course of anticoagulation therapy (>1 week)

2. Maternal Mortality in the UK 2016-18: Surveillance and Epidemiology

Kathryn Bunch, Jennifer J Kurinczuk and Marian Knight

2.1 Key points

There was a statistically non-significant increase in the overall maternal death rate in the UK between 2013-15 and 2016-18 which suggests that continued focus on implementation of the recommendations of these reports is needed to achieve a reduction in maternal deaths. **ACTION: Policy makers, service planners/commissioners, service managers, all health professionals**

There remains a more than four-fold difference in maternal mortality rates amongst women from Black ethnic backgrounds and an almost two-fold difference amongst women from Asian ethnic backgrounds compared to white women, emphasising the need for a continued focus on action to address these disparities. **ACTION: Policy makers, service planners/commissioners, service managers, all health professionals**

Eight percent of the women who died during or up to a year after pregnancy in the UK in 2016-18 were at severe and multiple disadvantage. The main elements of multiple disadvantage were a mental health diagnosis, substance use and domestic abuse.

Cardiac disease remains the largest single cause of indirect maternal deaths. Neurological causes (epilepsy and stroke) are the second most common indirect cause of maternal death, and the third commonest cause of death overall. There has been a statistically significant increase in maternal mortality due to Sudden Unexpected Death in Epilepsy (SUDEP).

Maternal deaths from direct causes are unchanged with no significant change in the rates between 2013-15 and 2016-18. Thrombosis and thromboembolism remains the leading cause of direct maternal death during or up to six weeks after the end of pregnancy. Deaths due to maternal suicide and obstetric haemorrhage occur as frequently as each other and are the next commonest causes of maternal death.

Maternal suicide remains the leading cause of direct deaths occurring within a year after the end of pregnancy.

2.2 Causes and trends

Overall, 242 women died in 2016-18 during or within 42 days of the end of pregnancy in the UK. The deaths of 25 women were classified as coincidental. Thus in this triennium 217 women died from direct and indirect causes, classified using ICD-MM (World Health Organisation 2012), among 2,235,159 maternities, a maternal death rate of 9.71 per 100,000 maternities (95% CI 8.46 – 11.09). This compares to the rate of 9.16 per 100,000 maternities (95% CI 7.96 – 10.50) in 2015-17. As in previous MBRRACE-UK maternal reports, information about deaths from the Republic of Ireland is not included in this chapter and therefore rates and numbers presented here are comparable with all previous UK reports.

Table 2.1 and Figure 2.1 show rolling three-yearly maternal death rates since 2003 using ICD-MM. There remains an overall decrease in maternal death rates between 2003-05 and 2016-18 (rate ratio (RR) 0.70, 95% CI 0.58-0.83, p=0.002 for trend in rolling rates over time). The direct maternal death rate has decreased by 39% since 2003-05 with a RR of 0.61 (95% CI 0.46-0.80 p<0.001) and there was a 22% decrease in the rate of indirect maternal deaths (RR 0.78, 95% CI 0.61 to 0.98, p=0.037).

However, the rates of overall mortality, direct and indirect maternal death in the 2016-18 triennium were once again not significantly different from the rates in 2013-15, the immediately preceding triennium (RR for overall mortality = 1.11, 95% CI 0.91 to 1.35, p=0.293; RR for direct deaths = 1.08, 95% CI 0.80 to 1.46, p=0.613; RR for indirect deaths = 1.13, 95% CI 0.87to 1.47, p=0.342).

It is reassuring that there is no evidence of an increase in maternal mortality rates, either overall, direct or indirect. However, mortality rates still appear higher than the nadir in the overall UK maternal mortality rate which was observed in 2012-14, and this highlights further the challenge of achieving the Government ambition of reducing maternal deaths in England by 50% by 2025 (Department of Health 2017).

Triennial rates are shown in Table 2.2 and Figure 2.2, and suggest that the rate of decrease in maternal mortality has slowed or is static (Table 2.2 and Figure 2.2 are unchanged from the 2019 report).

Table 2.1: Three-year rolling average direct and indirect maternal mortality rates per 100,000 maternities, deaths classified using ICD-MM; UK 2003-18.

3-year period	Total UK maternities	Direct deaths			Indirect deaths			Total Direct and Indirect deaths		
		n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI
2003–05	2 114 004	143	6.76	5.70 - 7.97	152	7.19	6.09 - 8.43	295	13.95	12.45–15.64
2004–06	2 165 909	124	5.73	4.76 - 6.83	148	6.83	5.78 - 8.03	272	12.56	11.15–14.14
2005–07	2 220 979	120	5.40	4.48 - 6.46	139	6.26	5.26 - 7.39	259	11.66	10.32–13.17
2006–08	2 291 493	120	5.24	4.34 - 6.26	141	6.15	5.18 - 7.26	261	11.39	10.09–12.86
2007-09	2 331 835	112	4.80	3.95 - 5.78	142	6.09	5.13 - 7.18	254	10.89	9.59-12.32
2008-10	2 366 082	99	4.18	3.40 - 5.09	162	6.85	5.83 - 7.99	261	11.03	9.73-12.45
2009-11	2 379 014	90	3.78	3.04 - 4.65	163	6.85	5.84 - 7.99	253	10.63	9.36–12.03
2010-12	2 401 624	89	3.71	2.98 - 4.56	154	6.41	5.44 - 7.51	243	10.12	8.89–11.47
2011-13	2 373 213	83	3.50	2.79 - 4.34	131	5.52	4.62 - 6.55	214	9.02	7.85–10.31
2012–14	2 341 745	81	3.46	2.75 – 4.30	119	5.08	4.21 – 6.08	200	8.54	7.40 – 9.81
2013-15	2 305 920	88	3.82	3.06 – 4.70	114	4.94	4.08 – 5.94	202	8.76	7.59 – 10.05
2014-16	2 301 628	98	4.26	3.46 – 5.19	127	5.52	4.60 – 6.57	225	9.78	8.54 – 11.14
2015-17	2 280 451	87	3.82	3.06 – 4.71	122	5.35	4.44 – 6.39	209	9.16	7.96 – 10.50
2016-18	2 235 159	92	4.12	3.32 – 5.05	125	5.59	4.66 – 6.66	217	9.71	8.46 – 11.09

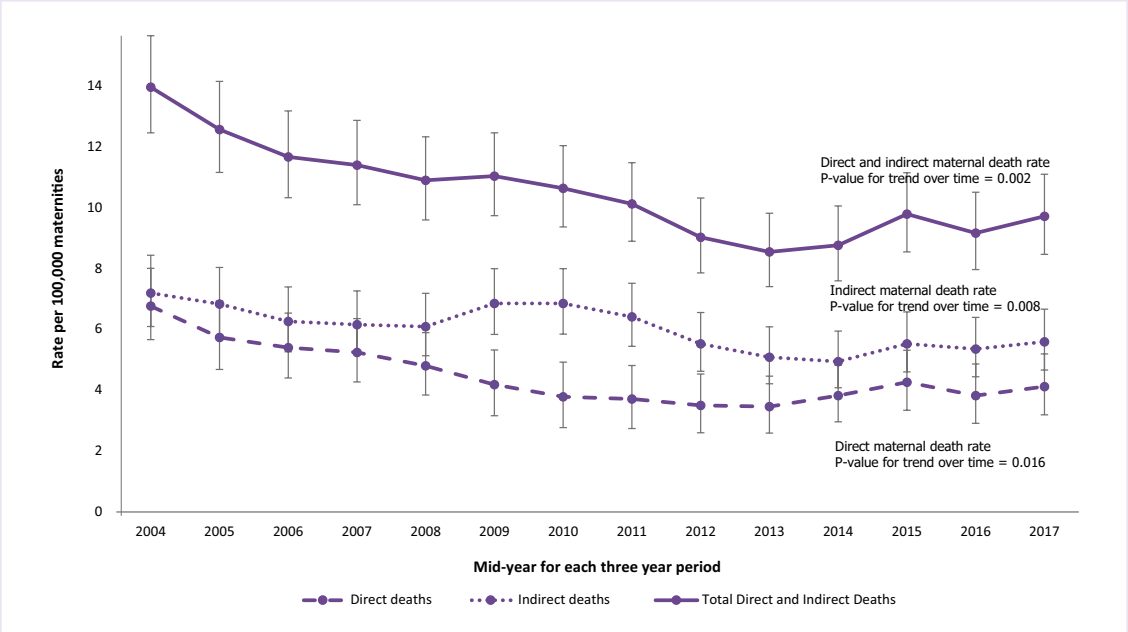
Sources: CMACE, MBRRACE-UK, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency

Table 2.2: Direct and Indirect maternal deaths and mortality rates per 100,000 maternities by discrete triennia, UK using ICD-MM; UK 2003-17.

Triennium	Indirect deaths recorded			Total Direct and Indirect			Total Direct and Indirect deaths		
	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI
2003–05	143	6.76	5.70 - 7.97	152	7.19	6.09 - 8.43	295	13.95	12.45–15.64
2006–08	120	5.24	4.34 - 6.26	141	6.15	5.18 - 7.26	261	11.39	10.09–12.86
2009-11	90	3.78	3.04 - 4.65	163	6.85	5.84 - 7.99	253	10.63	9.36–12.03
2012–14	81	3.46	2.75 – 4.30	119	5.08	4.21 – 6.08	200	8.54	7.40 – 9.81
2015-17	87	3.82	3.06 – 4.71	122	5.35	4.44 – 6.39	209	9.16	7.96 – 10.50

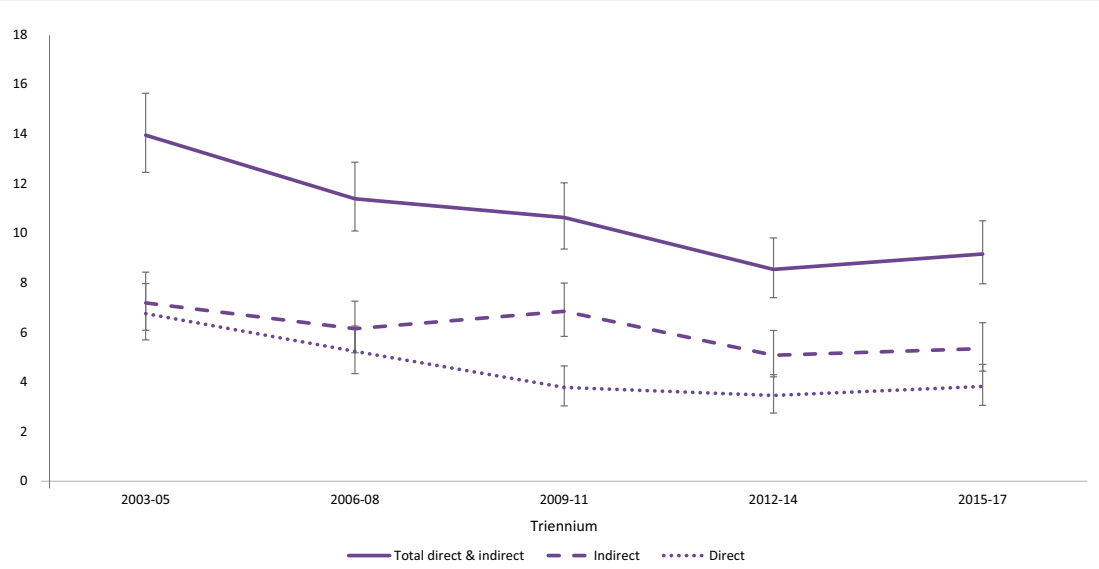
Sources: CMACE, MBRRACE-UK, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency

Figure 2.1: Figure 2.1: Direct and indirect maternal mortality rates per 100,000 maternities using ICD-MM and previous UK classification systems; three-year rolling average rates 2003-2018



Sources: CMACE, MBRRACE-UK

Figure 2.2: Direct and Indirect maternal mortality rates per 100,000 maternities by discrete triennia; UK 2003-2017 (using ICD-MM)

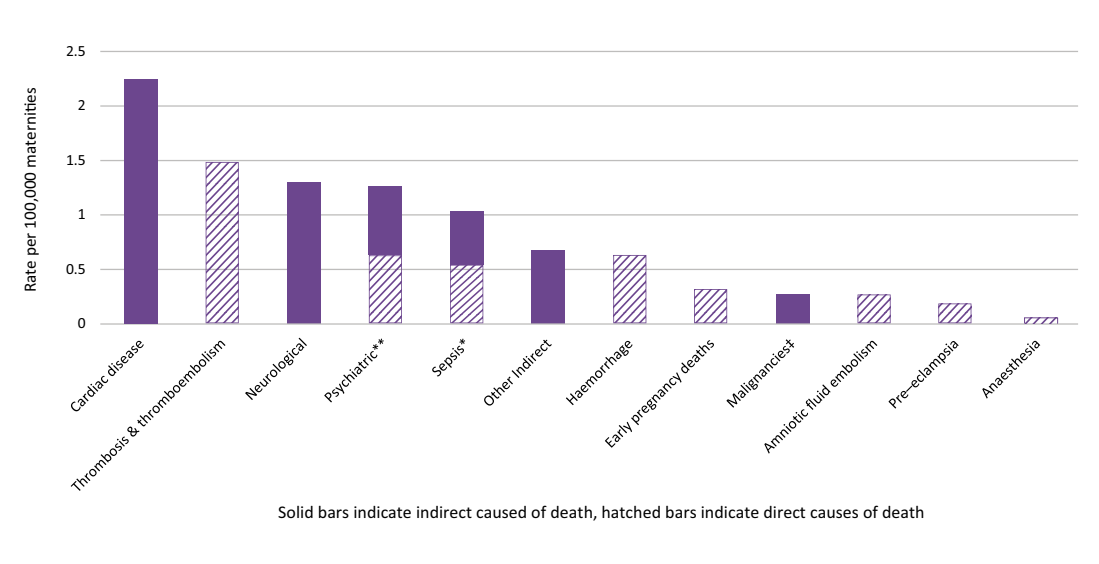


Sources: CMACE, MBRRACE-UK

Deaths due to individual causes

Maternal deaths by cause are shown in Tables 2.3 and 2.4, and Figure 2.3. Rolling three year rates for individual causes are presented for five overlapping triennial reporting periods (2012-14, 2013-15, 2014-16, 2015-17 and 2016-18) (Table 2.3 and Figure 2.3) and for discrete, non-overlapping triennial periods between 1985-7 and 2015-17 (Table 2.4). Last year's report was the final report in a three-year cycle, therefore Table 2.4 was newly updated last year with the latest triennial figures and is unchanged this year; deaths by suicide have been included amongst indirect deaths in Table 2.4 to allow for comparability to earlier years. Three-year rolling rates for causes of death classified according to ICD-MM sub-groups are presented in Table 2.5.

Figure 2.3: Maternal mortality by cause 2016-18



Hatched bars show direct causes of death, solid bars indicate indirect causes of death;
*Rate for direct sepsis (genital tract sepsis and other pregnancy related infections) is shown in hatched and rate for indirect sepsis (influenza, pneumonia, others) in solid bar
**Rate for suicides (direct) is shown in hatched and rate for indirect psychiatric causes (drugs/alcohol) in solid bar
‡Rate for direct malignancies (choriocarcinoma) shown in hatched and rate for indirect malignancies (breast/ovary/cervix) in solid bar
Source: MBRRACE-UK

Table 2.3: Maternal mortality rates per 100.000 maternities, by cause, by overlapping triennia, 2012 to 2018

	2012-14			2013-15			2014-16			2015-17			2016-18		
	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI
All Direct and Indirect deaths	200	8.54	7.40 – 9.81	202	8.76	7.59 – 10.05	225	9.78	8.54 - 11.14	209	9.16	7.96 – 10.50	217	9.71	8.46 – 11.09
Direct deaths															
Pregnancy related infections - Sepsis*	7	0.29	0.12 – 0.61	10	0.43	0.21 – 0.79	11	0.48	0.24 – 0.86	10	0.44	0.21 – 0.81	12	0.54	0.28 - 0.94
Pre-eclampsia and eclampsia	2	0.08	0.01 – 0.31	3	0.13	0.03 – 0.38	6	0.26	0.10 – 0.57	5	0.22	0.07 – 0.51	4	0.18	0.05 - 0.46
Thrombosis and thromboembolism	20	0.85	0.52 - 1.32	26	1.13	0.74 – 1.65	32	1.39	0.95 – 1.96	34	1.49	1.03 – 2.08	33	1.48	1.02 - 2.07
Amniotic fluid embolism	16	0.68	0.39 – 1.11	8	0.35	0.15 – 0.68	9	0.39	0.18 – 0.74	6	0.26	0.10 – 0.57	6	0.27	0.10 - 0.58
Early pregnancy deaths	7	0.29	0.12 – 0.61	4	0.17	0.05 – 0.44	3	0.13	0.03 – 0.38	4	0.18	0.05 – 0.45	7	0.31	0.13 - 0.65
Haemorrhage	13	0.56	0.29 – 0.95	21	0.91	0.56 – 1.39	18	0.78	0.46 – 1.24	11	0.48	0.24 – 0.86	14	0.63	0.34 -1.05
Anaesthesia	2	0.09	0.01 – 0.31	2	0.09	0.01 – 0.31	1	0.04	0.001 – 0.24	1	0.04	0.001 – 0.24	1	0.05	0.001 - 0.25
Psychiatric causes - Suicides	14	0.60	0.33 – 1.00	12	0.52	0.27 – 0.91	16	0.70	0.40 – 1.13	13	0.57	0.30 – 0.98	14	0.63	0.34 - 1.05
Malignancy - direct							1	0.04	0.001 – 0.24	1	0.04	0.001 – 0.24	-	-	-
Unascertained - direct	-	-	-	2	0.09	0.01 – 0.31	1	0.04	0.001 – 0.24	2	0.09	0.01 – 0.32	1	0.05	0.001 - 0.25
All Direct	81	3.46	2.75 – 4.30	88	3.82	3.06 – 4.70	98	4.26	3.46 – 5.19	87	3.82	3.06 – 4.71	92	4.12	3.32 - 5.05
Indirect															
Cardiac disease	51	2.18	1.62 – 2.86	54	2.34	1.76 – 3.06	55	2.39	1.80 – 3.11	48	2.10	1.55 – 2.79	50	2.24	1.66 - 2.95
Indirect Sepsis - Influenza	1	0.04	0.001 – 0.24	1	0.04	0.001 – 0.24	2	0.09	0.01 – 0.31	1	0.04	0.001 – 0.24	2	0.09	0.01 - 0.32
Indirect Sepsis – Pneumonia/ others	14	0.60	0.33 – 1.00	3	0.13	0.03 – 0.38	6	0.26	0.10 – 0.57	9	0.39	0.18 – 0.75	9	0.40	0.18 - 0.76
Other Indirect causes	23	0.98	0.62 – 1.47	26	1.13	0.74 – 1.65	26	1.13	0.74 – 1.66	23	1.01	0.64 – 1.51	15	0.67	0.38 - 1.11
Indirect neurological conditions	22	0.94	0.59 – 1.42	19	0.82	0.49 – 1.29	24	1.04	0.67 – 1.55	27	1.18	0.78 – 1.72	29	1.30	0.87 - 1.86
Psychiatric causes – Drugs/alcohol/others	4	0.17	0.05 – 0.44	4	0.17	0.05 – 0.44	6	0.26	0.10 – 0.57	7	0.31	0.12 – 0.63	14	0.63	0.34 – 1.05
Indirect malignancies	4	0.17	0.05 – 0.44	7	0.30	0.12 – 0.63	8	0.35	0.15 – 0.69	7	0.31	0.12 – 0.63	6	0.27	0.10 – 0.58
All Indirect	119	5.08	4.21 – 6.08	114	4.94	4.08 – 5.94	127	5.52	4.60 – 6.57	122	5.35	4.44 – 6.39	125	5.59	4.66 - 6.66
Coincidental															
Homicide	9	0.38	0.18 – 0.73	9	0.39	0.18 – 0.74	10	0.43	0.21 – 0.80	7	0.31	0.12 – 0.63	5	0.22	0.07 - 0.52
Other coincidental	32	1.37	0.94 - 1.93	29	1.26	0.84 – 1.81	24	1.04	0.67 – 1.55	20	0.88	0.54 – 1.35	20	0.90	0.55 - 1.38
All coincidental	41	1.75	1.26 – 2.38	38	1.65	1.17 – 2.26	34	1.48	1.02 – 2.06	27	1.18	0.78 – 1.72	25	1.12	0.72 - 1.65
Late deaths	323	13.79	12.33 – 15.38	326	14.14	12.64 – 15.76	286	12.43	11.03 – 13.95	313	13.73	12.25 – 15.33	305	13.65	12.16 - 15.27

*Genital/ urinary tract sepsis deaths, including early pregnancy deaths as a result of genital/urinary tract sepsis. Other deaths from infectious causes are classified under indirect causes.

Source: MBRRACE-UK, Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency.

Table 2.4: UK Maternal deaths and mortality rates per 100,000 maternities by cause, by discrete triennia, 1985-2017 (Maternal deaths by suicide classified as indirect for comparability)

Cause of death	Numbers										Rates per 100,000 maternities											
	1985-87	1988-90	1991-93	1994-96	1997-99	2000-02	2003-05	2006-08	2009-11	2012-14	2015-17	1985-87	1988-90	1991-93	1994-96	1997-99	2000-02	2003-05	2006-08	2009-11	2012-14	2015-17
All Direct and Indirect deaths	223	238	228	268	242	261	295	261	253	200	209	9.83	10.08	9.85	12.19	11.4	13.07	13.95	11.39	10.63	8.54	9.16
Direct deaths																						
Sepsis*	9	17	15	16	18	13	18	26	16	7	10	0.40	0.72	0.65	0.73	0.85	0.65	0.85	1.13	0.63	0.29	0.44
Pre-eclampsia and eclampsia	27	27	20	20	16	14	18	19	10	2	5	1.19	1.14	0.86	0.91	0.75	0.70	0.85	0.83	0.42	0.08	0.22
Thrombosis and thromboembolism	32	33	35	48	35	30	41	18	30	20	34	1.41	1.40	1.51	2.18	1.65	1.50	1.94	0.79	1.26	0.85	1.49
Amniotic fluid embolism	9	11	10	17	8	5	17	13	7	16	6	0.40	0.47	0.43	0.77	0.38	0.25	0.80	0.57	0.29	0.68	0.26
Early pregnancy deaths	16	24	17	15	17	15	14	11	4	7	4	0.71	1.02	0.73	0.68	0.80	0.75	0.66	0.48	0.17	0.29	0.18
Haemorrhage	10	22	15	12	7	17	14	9	14	13	11	0.44	0.93	0.65	0.55	0.33	0.85	0.66	0.39	0.59	0.56	0.48
Anaesthesia	6	4	8	1	3	6	6	7	3	2	1	0.26	0.17	0.35	0.05	0.14	0.30	0.28	0.31	0.12	0.09	0.04
Other Direct‡	27	17	14	7	7	8	4	4	0	0	3	1.19	0.72	0.60	0.32	0.33	0.40	0.19	0.17	-	-	0.13
All direct	139	145	128	134	106	106	132	107	82	67	74	6.13	6.14	5.53	6.10	4.99	5.31	6.24	4.67	3.49	2.84	3.24
Indirect deaths																						
Cardiac disease	23	18	37	39	35	44	48	53	51	51	48	1.01	0.76	1.60	1.77	1.65	2.20	2.27	2.31	2.14	2.18	2.10
Other Indirect causes	43	45	38	39	41	50	50	49	72	38	33	1.90	1.91	1.64	1.77	1.93	2.50	2.37	2.14	3.03	1.62	1.45
Indirect neurological conditions	19	30	25	47	34	40	37	36	30	22	27	0.84	1.27	1.08	2.14	1.60	2.00	1.75	1.57	1.26	0.94	1.18
Psychiatric causes	†	†	†	9	15	16	18	13	13	18	20	†	†	†	0.41	0.71	0.80	0.85	0.57	0.55	0.77	0.88
Indirect malignancies	†	†	†	†	11	5	10	3	4	4	7	†	†	†	†	0.52	0.25	0.47	0.13	0.17	0.17	0.31
All Indirect	84	93	100	134	136	155	163	154	170	133	135	3.70	3.94	4.32	6.10	6.40	7.76	7.71	6.59	7.15	5.68	5.92
Coincidental	26	39	46	36	29	36	55	50	22	41	27	1.15	1.65	1.99	1.64	1.37	1.80	2.60	2.18	0.98	1.75	1.18

*Including early pregnancy deaths as a result of sepsis

‡Acute fatty liver and genital tract trauma; included with pre-eclampsia and eclampsia and haemorrhage respectively from 2009 onwards

†Deaths from these causes not included in reports from earlier years

Sources: CMACE, MBRRACE-UK

Table 2.5: Maternal mortality rates per 100,000 maternities, by cause, by overlapping triennia, using ICD-MM classification, 2012 to 2018

Cause of death	2012-14			2013-15			2014-16			2015-17			2016-18		
	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI	n	Rate	95% CI
Direct causes															
Group 1: Pregnancy with abortive outcome	7	0.29	0.12 – 0.62	4	0.17	0.05 – 0.44	3	0.13	0.03 – 0.38	4	0.18	0.05 – 4.49	7	0.31	0.13 – 0.65
Group 2: Hypertensive disorders	2	0.08	0.01 – 0.31	3	0.13	0.03 – 0.38	6	0.26	0.10 – 0.57	5	0.22	0.07 – 0.51	4	0.18	0.05 - 0.46
Group 3: Obstetric Haemorrhage	13	0.56	0.29 – 0.95	21	0.91	0.56 – 1.39	18	0.78	0.46 – 1.24	11	0.48	0.24 – 0.86	14	0.63	0.34 – 1.05
Group 4: Pregnancy-related infection	7	0.29	0.12 – 0.61	10	0.43	0.21 – 0.79	11	0.48	0.24 – 0.86	10	0.44	0.21 – 0.81	12	0.54	0.28 - 0.94
Group 5: Other obstetric complications	50	2.14	1.58 – 2.81	48	2.08	1.53 – 2.76	59	2.56	1.95 – 3.31	56	2.46	1.85 – 3.19	54	2.42	1.81 – 3.15
Group 6: Unanticipated complications of management	2	0.09	0.01 – 0.31	2	0.09	0.01 – 0.31	1	0.04	0.001 – 0.24	1	0.04	0.001 – 0.24	1	0.05	0.001 – 0.25
Indirect causes															
Group 7: Non-obstetric complications	119	5.08	4.21 – 6.08	114	4.94	4.08 – 5.94	127	5.52	4.60 – 6.57	122	5.35	4.44 – 6.39	125	5.59	4.66 to 6.66
Group 8: Unknown/ undetermined	0	0	-	0	0	-	0	-	-	0	-	-	0	-	-
Coincidental causes															
Group 9: Coincidental causes	41	1.75	1.26 – 2.38	38	1.65	1.17 – 2.26	34	1.48	1.02 – 2.06	27	1.18	0.78 – 1.72	25	1.12	0.72 – 1.65

Source: MBRRACE-UK, Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency.

Direct deaths

There was no statistically significant change in the rate of direct maternal deaths from any cause between 2009 and 2018. Thrombosis and thromboembolism continues to be the leading cause of direct deaths occurring within 42 days of the end of pregnancy, followed by deaths by suicide and deaths due to obstetric haemorrhage (Figure 2.3). The maternal mortality rate from thrombosis and thromboembolism remains at the same level as it was in 1985-87; as there is known to be an increased prevalence of risk factors for VTE in the UK maternity population, improved detection of risk and better prevention may nevertheless underlie this static rate. Messages identified from review of the care of women who survived PE, described in Chapter 4, are therefore particularly pertinent. Maternal death rates from suicide continue to remain unchanged.

The statistically non-significant decrease in the rate of maternal mortality from haemorrhage seen in last year's report has not persisted which underlines the importance of the messages from the review of these deaths in Chapter 7. The maternal death rate from pre-eclampsia and eclampsia continues to be low but remains non-significantly higher than the lowest observed rate, in 2012-14. Although maternal mortality rates from early pregnancy causes remain low there has been a non-significant increase in the rate since last year's report which emphasises the importance of lessons learned to prevent future deaths. The mortality rate for pregnancy related sepsis has increased steadily, although not statistically significantly, since its nadir in 2012-14. The rate is now equivalent to that in 2010-12 highlighting the importance of the messages from the review of care reported in Chapter 8. Mortality rates from amniotic fluid embolism and anaesthesia remain essentially unchanged with continuing extremely low rates due to anaesthetic causes.

Indirect deaths

Deaths due to indirect causes still remain the major proportion (58%) of direct and indirect maternal deaths in the UK. As in previous reports, cardiac disease remains the largest single cause of indirect maternal deaths (Figure 2.3). There has been no significant change in the maternal mortality rate from cardiac disease since enhanced case ascertainment was introduced (RR 0.97, 95% CI 0.64-1.46 when comparing 2016-18 with 2003-05). Neurological causes are the second most common indirect cause of maternal death, with a statistically non-significant increase in mortality rate with a rate now equivalent to the rate in 2010-12. Chapter 3 highlights that there has been an increase particularly in maternal deaths from SUDEP and identifies a number of areas for improved care. Mortality rates from other indirect causes which are discussed in detail in chapter 5 have declined slightly although non-significantly.

International comparison

For international comparison, data from the 2019 report is presented in Table 2.6 to highlight the maternal mortality ratios estimated for the UK using routinely reported data. The rate estimate from routine sources of data is much lower (about half) than the actual rates as identified through the UK CEMD, which uses multiple sources of death identification. This emphasises the importance of the additional case identification and checking undertaken by the MBRRACE-UK team to give an accurate maternal mortality estimate. New figures are not presented in this report, as there has not been a complete triennium since these ratios were calculated.

Table 2.6: Maternal mortality ratios* per 100,000 live births calculated based on deaths identified from routine sources of data, UK: 1985-2017

Triennium	No. of deaths identified through death certificates	Maternal mortality ratio	95% CI	Denominator number of live births
1985-87	174	7.67	6.61-8.90	2,268,766
1988-90	171	7.24	6.24-8.42	2,360,309
1991-93	150	6.48	5.52-7.60	2,315,204
1994-96	158	7.19	6.15-8.40	2,197,640
1997-99	128	6.03	5.70-7.17	2,123,614
2000-02	136	6.81	5.76-8.05	1,997,472
2003-05	149	7.05	6.00-8.27	2,114,004
2006-08	155	6.76	5.78-7.92	2,291,493
2009-11	134	5.57	4.67-6.60	2,405,251
2012-14	110	4.65	3.82-5.60	2,368,125
2015-17	95	4.10	3.32-5.01	2,317,363

Source: Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency

*Note that, for the purposes of international comparison, this table reports the Maternal Mortality Ratio and not the rate as elsewhere in the report.

Women who died between six weeks and one year after the end of pregnancy

In the triennium 2016-18, 305 women died between six weeks and one year after the end of pregnancy, representing a mortality rate of 13.7 per 100,000 maternities (95% CI 12.2 – 15.3). There has been no change in the rate of late pregnancy-related deaths since the first MBRRACE-UK confidential enquiry report. Rolling rates of late deaths are shown in Figure 2.4 and causes of late death in Figure 2.5. Maternal suicides continue to be the leading cause of direct deaths occurring between six weeks and one year after the end of pregnancy.

Figure 2.4: Pregnancy-associated maternal mortality rates six weeks to one year after the end of pregnancy, UK, 2009-2018

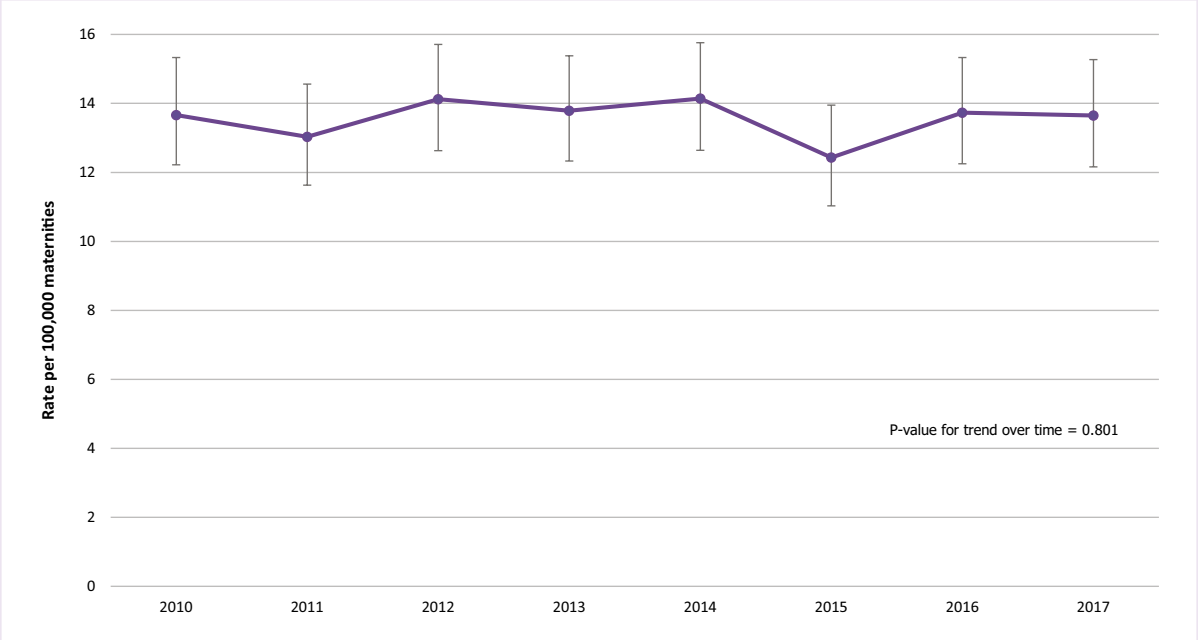
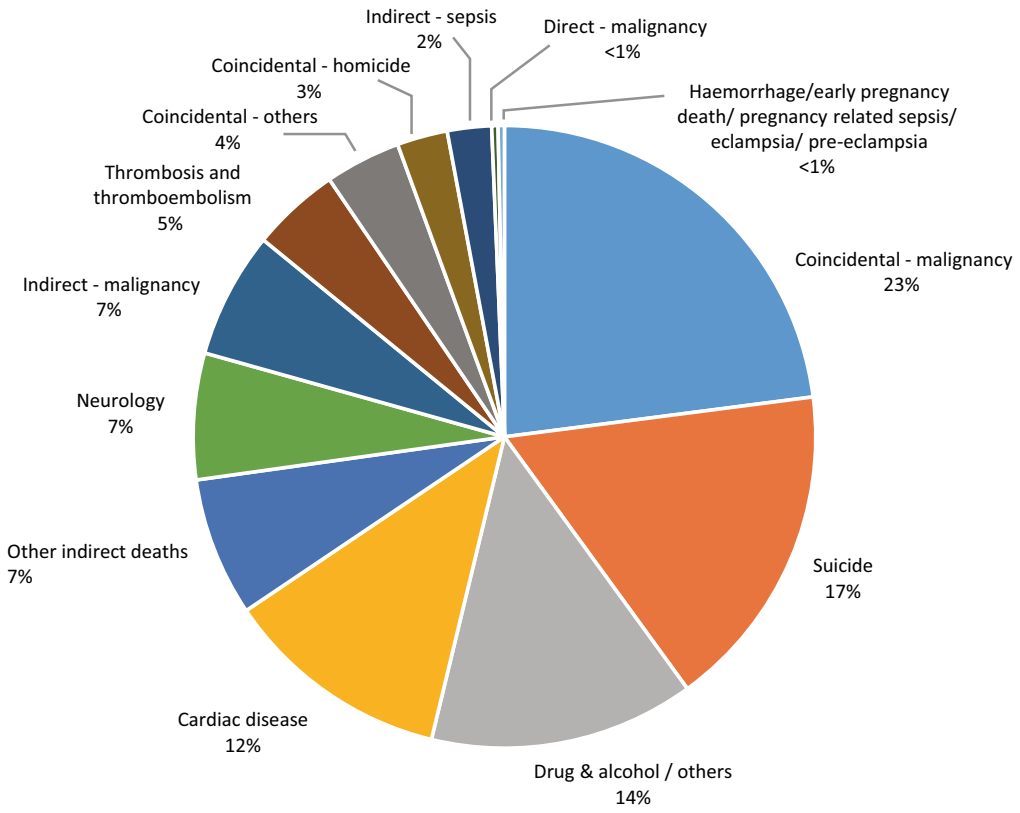


Figure 2.5: Causes of death amongst women who died between six weeks and one year after the end of pregnancy, UK 2016-18



2.3 The characteristics of women who died 2016-18

The women and babies

Of the 217 women who died from direct and indirect causes during or up to 42 days after the end of their pregnancy in 2016-18, 32% (70 women) were still pregnant at the time of their death and of these women 51% were ≤20 weeks' gestation (Table 2.7). Seventeen (8%) women had a pregnancy loss at ≤20 weeks' gestation. The remaining 130 women gave birth to a total of 139 infants, 97 (70%) survived, 42 died (36 babies were stillborn and 6 died in the neonatal period). The 217 women who died left behind a further 259 children, thus a total of 356 motherless children remain. The majority of the 129 women who gave birth did so in hospital (81%); 15% of women gave birth in an emergency department or an ambulance, and 5% at home (Table 2.8). In this triennium 81 (62%) of the women who died had a caesarean birth, 33% of these were perimortem as part of attempted resuscitation of the woman. A total of 34 babies were born by perimortem caesarean section of which 10 (29%) were born after 32 weeks of gestation. Five out of the 10 babies born after 32 weeks' gestation survived (4 were stillborn and 1 died in the neonatal period) as did three out of the remaining 24 born at 32 weeks or less (18 were stillborn and 3 died in the neonatal period). Thus 8 (24%) of the total of 34 babies born by perimortem caesarean section survived, 22 (65%) were stillborn and 4 (12%) died in the neonatal period.

Table 2.7: Timing of maternal deaths in relation to pregnancy 2016-18

Time period of deaths in the pregnancy care pathway	Direct (n=92) Frequency (%)	Indirect (n=125) Frequency (%)	Total (n=217) Frequency (%)
Antenatal period			
≤20 weeks	12 (13)	24 (19)	36 (17)
>20 weeks	9 (10)	25 (20)	34 (16)
Postnatal on day of delivery	26 (28)	18 (14)	44 (20)
Postnatal 1-41 days after delivery	45 (49)	58 (46)	103 (47)

Table 2.8: Place of childbirth amongst women >20 weeks' gestation who died after giving birth 2016-18

	Direct (n=58) Frequency (%)	Indirect (n=71) Frequency (%)	Total (n=129) Frequency (%)
Home	1 (2)	5 (7)	6 (5)
Hospital (except A&E)	50 (86)	54 (76)	104 (81)
Emergency Department or ambulance	7 (12)	12 (17)	19 (15)

Socio-demographic characteristics

The socio-demographic characteristics of women who died in 2016-18 are shown in Table 2.9. Around a third of the women's records (30%) did not have information on whether they were subject to domestic abuse before or during pregnancy, this is an improvement on the 53% in last years' report. Nevertheless this remains a substantial proportion of women who were not asked about domestic abuse despite guidance that it is important to enquire about this at booking and throughout pregnancy.

The rates of maternal mortality varied by age, socioeconomic status and ethnic background of the women, factors which are known to be independently associated with an increased risk of maternal death in the UK (Nair et al. 2015, Nair et al. 2016). Maternal mortality rates are higher amongst older women, those living in the most deprived areas and amongst women from particular ethnic minority groups (Table 2.10). There remain statistically significant differences in the maternal mortality rates between women living in the most deprived areas and those living in the least deprived areas. As noted in the 2016 report, we are no longer able to obtain denominator figures for specific ethnic groups, instead aggregate rates using larger ethnicity groupings are presented in Tables 2.10 and 2.11. The risk of maternal death in 2016-18 was statistically significantly over four-fold higher among women from Black ethnic minority backgrounds compared with white women (RR 4.35; 95% CI 2.77 to 6.62); this represents a non-significant reduction from the five-fold difference reported last year. Women from Asian backgrounds also continued to be at higher risk than white women (RR 1.86, 95% CI 1.19 to 2.83), as were women from mixed ethnic backgrounds (RR 3.19, 95% CI 1.35-6.50). In the comparison of relative risks between 2013-15 and 2016-18 the estimated ratios of relative risk (RRR) of maternal death in the different age, socioeconomic and ethnic groups did not show any statistically significant differences (Table 2.11). Nevertheless there is an overall tendency suggesting that the inequality gap is increasing with a number of the RRR increasing from the comparison between 2012-14 and 2015-17 presented in last year's report (Figure 2.6). As noted in 2018 and 2019, further research is needed to fully understand the reasons for these disparities and hence to develop actions to address them.

Figure 2.6: Maternal mortality rates 2009-18 among women from different ethnic groups in the UK

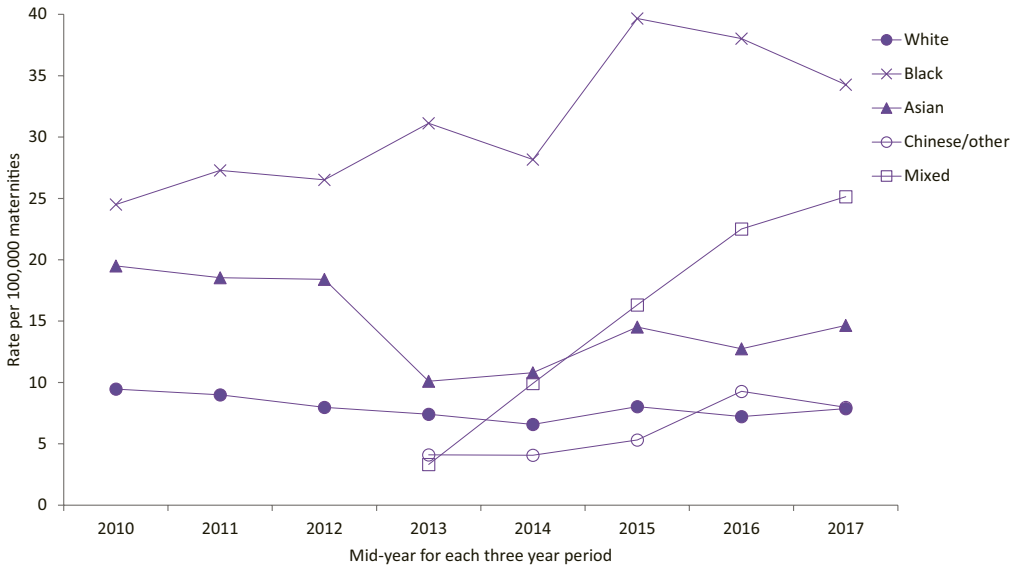


Table 2.9: The socio-demographic characteristics of women who died 2016-18

Characteristics	Direct (n=92) Frequency (%)	Indirect (n=125) Frequency (%)	Total (n=217) Frequency (%)
Age (years)			
<20	4 (4)	4 (3)	8 (4)
20 – 24	8 (9)	11 (9)	19 (9)
25 – 29	23 (25)	34 (27)	57 (26)
30 – 34	19 (21)	33 (26)	52 (24)
35 – 39	25 (27)	30 (24)	55 (25)
≥ 40	13 (14)	13 (10)	26 (12)
Parity			
0	35 (38)	44 (35)	79 (36)
1 to 2	42 (46)	53 (43)	95 (44)
≥3	11 (12)	21 (17)	32 (15)
Missing	4 (4)	7 (6)	11 (5)
UK citizen			
Yes	74 (80)	106 (85)	180 (83)
No	10 (11)	10 (8)	20 (9)
Missing	8 (9)	9 (7)	17 (8)
Ethnicity			
White European	60 (65)	80 (64)	140 (65)
Indian	6 (7)	6 (5)	12 (6)
Pakistani	4 (4)	2 (2)	6 (3)
Bangladeshi	1 (1)	4 (3)	5 (2)
Other Asian	4 (4)	5 (4)	9 (4)
Black Caribbean	4 (4)	4 (3)	8 (4)
Black African	5 (5)	14 (11)	19 (9)
Others/ Mixed	4 (4)	9 (7)	13 (6)
Missing	4 (4)	1 (1)	5 (2)
Woman's region of birth			
United Kingdom	61 (66)	83 (66)	144 (66)
Eastern Europe	6 (7)	4 (3)	10 (5)
Western Europe	0 (0)	0 (0)	0 (0)
Asia	9 (10)	8 (6)	17 (8)
Africa	4 (4)	14 (11)	18 (8)
Australia and North America	0 (0)	1 (1)	1 (<1)
Central & South America & Caribbean	3 (3)	1 (1)	4 (2)
Missing	9 (10)	14 (11)	23 (11)
Socioeconomic status (Index of Multiple Deprivation (IMD) of postcode of residence)			
First quintile (Least deprived)	4 (4)	12 (10)	16 (7)
Second quintile	10 (11)	11 (9)	21 (10)
Third quintile	10 (11)	15 (12)	25 (12)
Fourth quintile	17 (18)	23 (18)	40 (18)
Fifth quintile (Most deprived)	34 (37)	47 (38)	81 (37)
Missing	17 (18)	17 (14)	34 (16)
Socioeconomic status (Occupational classification)			
Employed (Either woman or partner)	61 (66)	79 (63)	140 (65)
Unemployed (Both)	19 (21)	22 (18)	41 (19)
Missing	12 (13)	24 (19)	36 (17)
Able to speak/understand English			
Yes	86 (93)	120 (96)	206 (95)
No	5 (5)	5 (4)	10 (5)
Missing	1 (1)	0 (0)	1 (<1)
Living arrangements			
With partner	71 (77)	90 (72)	161 (74)
Living alone	9 (10)	15 (12)	24 (11)
With parents/extended family	8 (9)	10 (8)	18 (8)
Others	0 (0)	3 (2)	3 (1)
Missing	4 (4)	7 (6)	11 (5)
Domestic abuse (prior to pregnancy/ during pregnancy)			
Yes	10 (11)	9 (7)	19 (9)
No	55 (60)	77 (62)	132 (61)
Missing	27 (29)	39 (31)	66 (30)
History of abuse as a child			
Yes	3 (3)	2 (2)	5 (2)
No	39 (42)	57 (46)	96 (44)
Missing	50 (54)	66 (53)	116 (53)
Known to social services			
Yes	19 (21)	24 (19)	43 (20)
No	67 (73)	91 (73)	158 (73)
Missing	6 (7)	10 (8)	16 (7)

Table 2.10: Maternal mortality rates amongst different population groups 2016-18

	Total maternities 2016-18	Total deaths	Rate per 100,000 maternities	95% CI	Relative risk (RR)	95% CI
Age (years)						
<20	69,229	8	11.56	4.99 to 22.77	1.96	0.74 to 4.68
20–24	321,515	19	5.91	3.56 to 9.23	1 (Ref)	-
25–29	623,882	57	9.14	6.92 to 11.84	1.55	0.91 to 2.75
30–34	715,725	52	7.27	5.43 to 9.53	1.23	0.71 to 2.20
35–39	410,130	55	13.41	10.10 to 17.46	2.27	1.33 to 4.05
≥ 40	94,629	26	27.48	17.95 to 40.26	4.65	2.48 to 8.89
IMD Quintiles (England only)						
I (Least deprived/ highest 20%)	263,348	15	5.70	3.19 to 9.39	1 (Ref)	-
II	301,545	19	6.30	3.79 to 9.84	1.11	0.53 to 2.34
III	337,250	23	6.82	4.32 to 10.23	1.20	0.60 to 2.47
IV	404,353	34	8.41	5.82 to 11.75	1.48	0.78 to 2.92
V (Most deprived/ lowest 20%)	484,514	74	15.27	11.99 to 19.17	2.68	1.53 to 5.03
Ethnic group (England only)						
White (inc. not known)	1,486,428	117	7.87	6.51 to 9.43	1 (Ref)	-
Asian	191,145	28	14.65	9.73 to 21.17	1.86	1.19 to 2.83
Black	81,704	28	34.27	22.77 to 49.53	4.35	2.77 to 6.62
Chinese/ others	75,270	6	7.97	2.93 to 17.35	1.01	0.36 to 2.27
Mixed	31,823	8	25.14	10.85 to 49.53	3.19	1.35 to 6.50

Table 2.11: Comparison of the relative risk of maternal death among different population groups between 2013-15 and 2016-18

	2013-15		2016-18		Ratio of the relative risks (RRR) (comparing 2016-18 with 2013-1)	95% CI	P-value
	Relative risk (RR)	95% CI	Relative risk (RR)	95% C			
Age (years)							
<20	1.41	0.55 to 3.25	1.96	0.74 to 4.68	1.39	0.39 to 5.00	0.699
20–24	1 (Ref)	-	1 (Ref)	-	-	-	-
25–29	1.08	0.65 to 1.86	1.55	0.91 to 2.75	1.44	0.67 to 3.08	0.353
30–34	1.21	0.74 to 2.05	1.23	0.71 to 2.20	1.02	0.47 to 2.18	0.966
35–39	2.10	1.27 to 3.57	2.27	1.33 to 4.05	1.08	0.51 to 2.31	0.841
≥ 40	3.17	1.64 to 6.03	4.65	2.48 to 8.89	1.47	0.59 to 3.65	0.410
IMD Quintiles (England only)							
I (Least deprived/ highest 20%)	1 (Ref)	-	1 (Ref)	-	-	-	-
II	1.09	0.45 to 2.68	1.11	0.53 to 2.34	1.02	0.32 to 3.25	0.976
III	1.88	0.90 to 4.22	1.20	0.60 to 2.47	0.64	0.22 to 1.82	0.401
IV	2.69	1.37 to 5.76	1.48	0.78 to 2.92	0.55	0.21 to 1.46	0.230
V (Most deprived/ lowest 20%)	2.36	1.21 to 5.03	2.68	1.53 to 5.03	1.14	0.45 to 2.87	0.788
Ethnic group (England only)							
White (inc. not known)	1 (Ref)	-	1 (Ref)	-	-	-	-
Asian	1.64	0.98 to 2.62	1.86	1.19 to 2.83	1.13	0.59 to 2.18	0.707
Black	4.28	2.65 to 6.69	4.35	2.77 to 6.62	1.02	0.54 to 1.92	0.960
Chinese/ others	0.62	0.13 to 1.86	1.01	0.36 to 2.27	1.63	0.32 to 8.21	0.554
Mixed	1.51	0.31 to 4.53	3.19	1.35 to 6.50	2.11	0.45 to 10.00	0.346

Just over a quarter of women who died in 2016-18 (26%) whose place of birth was known were born outside the UK; 36% of these women were not UK citizens. Overall 9% of the women who died were not UK citizens although this may be an underestimate since it is important to note that citizenship was not recorded for 8%. Women who died who were born abroad and who were not UK citizens had arrived in the UK a median of 5.5 years before they died (range 0 to 18 years). Women who died who were born abroad were from Asia (34%, mainly India, China and Bangladesh) and Africa (36%, mainly Nigeria), Eastern Europe (20%, Romania and multiple other countries) with the remainder (10%) from other parts of Europe, the Americas and the Caribbean. Table 2.12 shows the rates of death amongst women born in selected countries with the highest number of deaths. Similar to the previous triennium, overall there was no statistically significant difference in maternal death rate between women born in the UK and those born outside the UK in 2016-18. However, women born in certain specific countries had a significantly higher

risk of death compared to women born in the UK (Table 2.12). Of the 18 women who were not UK citizens and were born outside the UK, five were refugees/asylum seekers (28%), two (11%) were recently arrived wives of UK residents, two were European Union citizens (11%) and nine (50%) had another or unknown status.

It is also of note that 20% of women who died were known to social services. This proportion is unchanged from the 2019 report but has increased steadily from 12% in 2012-2014, highlighting further the vulnerability of many women who died.

Table 2.12: Maternal mortality rates according to mother's country of birth (selected countries) 2016-18

Woman's country of birth**	Maternities 2016-18	Total Deaths	Rate per 100,000 maternities	95% CI	Relative risk (RR)	95% CI
UK	1,669,097*	133	7.97	6.67 to 9.44	1 (Ref)	-
Outside the UK	611,354*	48	7.85	5.79 to 10.41	0.99	0.69 to 1.38
Specific countries						
Bangladesh	11,203‡	3	26.78	5.52 to 78.24	3.36	0.68 to 10.04
China	42,399‡	4	9.43	2.57 to 24.15	1.18	0.32 to 3.10
India	20,469‡	10	48.85	23.43 to 89.83	6.13	2.87 to 11.63
Nigeria	53,491‡	4	7.48	2.04 to 19.15	0.94	0.25 to 2.46

*Estimates based on proportions of births to UK and non-UK born mothers applied to number of maternities

‡Estimates based on ratio of maternities to births applied to number of births recorded to mothers born in stated country

**Country of birth not recorded for 23 women who died

It has been increasingly noted in these enquiries that women at severe disadvantage appear to be over-represented amongst the women who die. Severe and multiple disadvantage amongst pregnant women has been defined in other work (Birthrights and Birth Companions 2019). Not all elements of this definition were available in MBRRACE data, but of the 547 women who died in the UK in 2016-18 during or up to one year after pregnancy, 42 (8%) were of women considered to be at severe and multiple disadvantage on the basis of the data available (Table 2.13) compared with 6% in 2015-17. The main elements of multiple disadvantage were a mental health diagnosis (either current or in the past) (41/42 women with multiple disadvantage), substance use (37/42 women with multiple disadvantage) and domestic abuse (36/42 women with multiple disadvantage). However, this must be regarded as a minimum estimate, since these three factors are amongst the most poorly recorded, with information missing about mental health diagnoses for 12% of women who died, on substance use for 6% and on domestic abuse for 30%.

Table 2.13: Severe and multiple disadvantage among women who died 2016-18

	Direct (n=92) Frequency (%)	Indirect (n=124) Frequency (%)	Coincidental (n=25) Frequency (%)	Late Deaths (n=306) Frequency (%)	Total (n=547) Frequency (%)
No	83 (90)	117 (94)	23 (92)	282 (92)	505 (92)
Yes	9 (10)	8 (6)	2 (8)	23 (8)	42 (8)

*Three or more of: substance abuse, domestic abuse, abuse in childhood, arrival in UK within last 5 years, refugee or asylum seeker, mental health diagnosis, female genital mutilation, and known learning difficulties

Medical and pregnancy-related characteristics

Studies have shown that 66% of the increased risk of maternal death in the UK could be attributed to medical comorbidities (Nair et al. 2016). Two-thirds (66%) of the women who died in 2016-18 were known to have pre-existing medical problems (Table 2.14) and 35% were known to have pre-existing mental health problems. Of note for 11% of women who died in 2016-18 it was reported to be unknown whether they had previous or pre-existing mental health problems, this proportion is unchanged from the previous triennium. Over a quarter (29%) of the women who died in this triennium were obese and a further 26% were overweight (Table 2.14). In this triennium, 10 women (5%) who died during or up to six weeks after pregnancy in the UK in 2016-18 had a pregnancy as a result of an assisted conception procedure (Table 2.15), this compares to 6 women (3%) in 2013-15.

The pregnancy-related characteristics of the women who died in 2016-18 are shown in Table 2.15.

Table 2.14: Selected medical conditions and characteristics identified amongst women who died 2016-18

Medical condition/characteristic	Direct (n=92) Frequency (%)	Indirect (n=125) Frequency (%)	Total (n=217) Frequency (%)
Body mass index (BMI)			
<18	1 (1)	1 (1)	2 (1)
18 – 24	34 (37)	41 (33)	75 (35)
25 – 29	23 (25)	34 (27)	57 (26)
≥ 30	27 (29)	35 (28)	62 (29)
Missing	7 (8)	14 (11)	21 (10)
Mental health problems or psychiatric disorders			
Yes	31 (34)	44 (35)	75 (35)
No	53 (58)	64 (51)	117 (54)
Missing	8 (9)	17 (14)	25 (12)
Pre-existing cardiac problems			
Yes	3 (3)	4 (3)	7 (3)
No	87 (95)	117 (94)	204 (94)
Missing	2 (2)	4 (3)	6 (3)
Any pre-existing medical problem (excluding obesity)			
Yes	59 (64)	84 (67)	143 (66)
No	31 (34)	37 (30)	68 (31)
Missing	2 (2)	4 (3)	6 (3)

Table 2.15: Pregnancy-related characteristics of the women who died 2016-18

Medical condition/characteristic	Direct (n=92) Frequency (%)	Indirect (n=125) Frequency (%)	Total (n=217) Frequency (%)
Pregnancy known to be as a result of assisted reproductive technologies			
Yes	6 (7)	4 (3)	10 (5)
No	86 (93)	121 (97)	207 (95)
Multiple pregnancy			
Yes	2 (2)	3 (2)	5 (2)
No	90 (98)	122 (98)	212 (98)
Previous caesarean section			
Yes	21 (23)	24 (19)	45 (21)
No	66 (72)	95 (76)	161 (74)
Missing	5 (5)	6 (5)	11 (5)
Previous caesarean numbers (among women who had a previous caesarean section)			
1	13 (62)	19 (79)	32 (71)
≥2	8 (38)	5 (21)	13 (29)

Other characteristics of women who died

Inadequate utilisation of antenatal care services and substance misuse have been shown to be associated with increased risk of maternal death in the UK (Nair et al. 2015, Nair et al. 2016). The prevalence of these risk factors among women who died in 2016-18 did not differ from that noted in the previous reports (Table 2.16) and the proportion who received recommended levels of antenatal care still remains low. Fewer than a third (29%) of women who received antenatal care, received the recommended level of care according to NICE antenatal care guidelines (booking at 10 weeks or less and no routine antenatal visits missed) (National Institute for Health and Care Excellence 2017).

Table 2.16: Other characteristics of women who died in 2016-18

Characteristics	Direct (n=92) Frequency (%)	Indirect (n=125) Frequency (%)	Total (n=217) Frequency (%)
Smoking			
Smoker	23 (25)	40 (32)	63 (29)
Non-smoker	59 (64)	71 (57)	130 (60)
Missing	10 (11)	14 (11)	24 (11)
Substance user			
Yes	11 (12)	22 (18)	33 (15)
No	77 (84)	95 (76)	172 (79)
Missing	4 (4)	8 (6)	12 (6)
Received any antenatal care*			
Yes	81 (88)	106 (85)	187 (86)
No	11 (12)	18 (14)	29 (13)
Not known	0 (0)	1 (1)	1 (<1)
Gestational age at booking (among women who received any antenatal care) (weeks)			
≤10	30 (37)	49 (46)	79 (42)
11 – 12	24 (30)	32 (30)	56 (30)
>12	20 (25)	22 (21)	42 (22)
Missing	7 (9)	3 (3)	10 (5)
Received *recommended* antenatal care† (among women who received any antenatal care)			
Yes	25 (31)	30 (28)	55 (29)
No	46 (57)	68 (64)	114 (61)
Missing	10 (12)	8 (8)	18 (10)
Received a minimum level of antenatal care† (among women who received any antenatal care)			
Yes	47 (58)	66 (63)	113 (60)
No	22 (27)	28 (26)	50 (27)
Missing	12 (15)	12 (11)	24 (13)

*Includes 7 women who died in early pregnancy. †NICE recommended antenatal care: booked at 10 weeks or less and no antenatal visits missed. Minimum level of care: booked at less than 13 weeks and 3 or fewer antenatal visits missed.

Classification of quality of care

This section includes information on women who died between 2016 and 2018 and are included in the confidential enquiry chapters of this report (including women who died between six weeks and a year after the end of pregnancy and women from the Republic of Ireland), along with the 34 women who were diagnosed with pulmonary embolism but survived and are included in the morbidity enquiry. Table 2.17 shows the classification of care as agreed by the assessors for the 136 women who died and whose case notes were available with sufficient information for an in-depth review. Among the women who died, 29% were assessed to have received good care, but detailed assessment showed that for another 51% improvements in care may have made a difference to their outcome. Opportunities to improve care were identified amongst three quarters (73%) of women who survived a pulmonary embolism; in 29% was it thought that improvements may have made a difference to outcome, but of note, improvements to care which would have made no difference to outcome were identified in 44%.

Table 2.17: Classification of care received by women who died or survived a pulmonary embolism (morbidity enquiry) and for whom case notes were available for an in-depth review and are included in the confidential enquiry chapters, UK and Ireland (2016-18)

Classification of care received	Women who died (n=136)* Number (%)	Women with newly diagnosed breast cancer (n=34) Number (%)*
Good care	40 (29)	9 (26)
Improvements to care which would have made no difference to outcome	26 (19)	15 (44)
Improvements to care which may have made a difference to outcome	70 (51)	10 (29)

*includes only women whose case notes were available with sufficient information for an in-depth review considered in chapters 3 to 8.

Local clinicians' reports

The proportion of reports received from local clinicians of those requested for the confidential enquiry remains static at around 80% (Table 2.18). Local clinicians' reports are absolutely essential to allow MBRRACE-UK assessors to fully take account of any local factors impacting on care, and we urge clinicians to return these in a timely manner.

Table 2.18: Percentages of local clinicians' reports received for women whose care was examined for the confidential enquiry chapters in this report

Specialty group	Percentage of reports requested that were received
Obstetricians	77
Anaesthetists	79
Midwives	80
Critical Care Clinicians	77
Emergency Medicine Specialists	66
GPs	84
Physicians	72
Psychiatrists	100*
Total	78

*n=1

Postmortem examination

There was substantial variation in the proportion of women who had a post-mortem examination, according to the cause of death. For women with records available, overall a post-mortem examination was carried out in less than three quarters (73%) (Table 2.19). However, the figure was 90% for women who died from direct causes, 84% amongst women who died from indirect causes, 73% amongst women who died from coincidental causes and only 60% amongst women who died between six weeks and one year after the end of pregnancy. As noted in previous reports, and once again in Chapter 3, establishing the cause of women's death with a high quality autopsy is essential not only to improve future care, but to ensure any family counselling or testing is appropriate.

Table 2.19: Post-mortem information for maternal deaths in the UK 2016-18

Specialty group	Direct (n=92) Frequency (%)	Indirect (n=125) Frequency (%)	Coincidental (n=25) Frequency (%)	Late Deaths (n=305) Frequency (%)	Total (n=547) Frequency (%)
No post mortem	8 (9)	20 (16)	6 (24)	103 (34)	137 (25)
Post mortem completed	83 (90)	105 (84)	17 (68)	159 (52)	364 (67)
Hospital	6 (7)	7 (7)	0 (0)	20 (13)	33 (9)
Coroner/ Procurator Fiscal	77 (93)	98 (93)	17 (100)	139 (87)	331 (91)
Records not available	1 (1)	0 (0)	2 (8)	43 (14)	46 (8)

2.4 Morbidity Enquiry - women with pulmonary embolism

A national cohort study was undertaken through the UK Obstetric Surveillance System between March 2015 and September 2016, identifying all pregnant and postpartum women diagnosed with pulmonary embolism (Goodacre et al. 2019). As described in section 1.4, a sample of 34 of these women who survived were included in the morbidity Confidential Enquiry. The characteristics of the women who survived and were selected for inclusion in the Confidential Enquiry into Maternal Morbidity are shown in Table 2.20. It is worth noting that, in contrast to the women who died overall, these women were on average younger, more likely to be having their second or subsequent pregnancy, to be white European and employed, and less likely to be overweight or obese with a small proportion who smoked. Around half (53%) had a pre-existing medical or mental health problem compared with 73% (159/217) of women who died.

Table 2.20: Characteristics of women who survived after pulmonary embolism

Characteristics	Total (n=34) Frequency (%)
Age (years)	
<25	7 (21)
25-34	19 (56)
≥35	8 (24)
Parity	
0	8 (24)
≥1	26 (76)
Ethnicity	
White European	30 (88)
Other	4 (12)
Socioeconomic status (Occupational classification)	
Employed (Either woman or partner)	28 (82)
Unemployed (Both)	5 (15)
Missing	1 (3)
Body mass index (BMI)	
18-24	20 (59)
25-29	11 (32)
≥30	3 (9)
Smoking status	
Yes	6 (18)
No	28 (82)
Any pre-existing medical or mental health problem (excluding obesity)	
Yes	18 (53)
No	16 (47)

3. Learning from neurological complications

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3.1 Key messages

New recommendations

Develop guidance to ensure SUDEP awareness, risk assessment and risk minimisation is standard care for women with epilepsy before, during and after pregnancy and ensure this is embedded in pathways of care. **ACTION: Royal Colleges of Obstetricians and Gynaecologists, Physicians.**

Develop clear standards of care for joint maternity and neurology services, which allow for

- Early referral in pregnancy, particularly if pregnancy is unplanned, to optimise anti-epileptic drug regimens
- Rapid referral for neurology review if women have worsening epilepsy symptoms
- Pathways for immediate advice for junior staff out of hours
- Postnatal review to ensure anti-epileptic drug doses are appropriately adjusted

ACTION: NHSE/I and equivalents in the devolved nations and Ireland.

Ensure all maternity units have access to an epilepsy team. **ACTION: Hospitals/Trusts/Health Boards.**

Ensure each regional maternal medicine network has a pathway to enable women to access their designated epilepsy care team within a maximum of two weeks. **ACTION: Maternal Medicine Networks and equivalent structures in Ireland and the devolved nations.**

Regard nocturnal seizures as a 'red flag' indicating women with epilepsy need urgent referral to an epilepsy service or obstetric physician. **ACTION: All Health Professionals.**

Establish pathways to facilitate rapid specialist stroke care for women with stroke diagnosed in inpatient maternity settings. **ACTION: Hospitals/Trusts/Health Boards.**

Existing guidance and recommendations requiring improved implementation

Women with epilepsy taking antiepileptic drugs who become unexpectedly pregnant should be able to discuss therapy with an epilepsy specialist on an urgent basis. It is never recommended to stop or change antiepileptic drugs abruptly without an informed discussion. **ACTION: All Health Professionals, Service Managers.**

Pregnant women with epilepsy should have access to regular planned antenatal care with a designated epilepsy care team. **ACTION: All Health Professionals, Service Managers.**

Women with epilepsy should be informed that the introduction of a few safety precautions may significantly reduce the risk of accidents and minimise anxiety. **ACTION: All Health Professionals.**

In women with epilepsy with active seizures, advising on care to minimise the period of time they go unobserved should be considered. Individuals with unwitnessed seizures are at high risk of Sudden Unexpected death in Epilepsy (SUDEP), with nocturnal seizures being an independent risk factor. **ACTION: All Health Professionals.**

Pregnant women who are recent migrants, asylum seekers or refugees, or who have difficulty reading or speaking English, may not make full use of antenatal care services. This may be because of unfamiliarity with the health service or because they find it hard to communicate with healthcare staff. Healthcare professionals should help support these women's uptake of antenatal care services by:

- using a variety of means to communicate with women
- telling women about antenatal care services and how to use them
- undertaking training in the specific needs of women in these groups.

ACTION: All Health Professionals.

Pregnancy should not alter the standard of care for stroke. **ACTION: All Health Professionals.**

Offer antihypertensive treatment to pregnant women who have chronic hypertension and who are not already on treatment if they have:

- sustained systolic blood pressure of 140 mmHg or higher
- or sustained diastolic blood pressure of 90 mmHg or higher.

ACTION: All Health Professionals.

When using medicines to treat hypertension in pregnancy, aim for a target blood pressure of 135/85 mmHg. **ACTION: All Health Professionals.**

For women with gestational hypertension who did not take antihypertensive treatment and have given birth, start antihypertensive treatment if their blood pressure is 150/100 mmHg or higher. **ACTION: All Health Professionals.**

In women with chronic hypertension who have given birth:

- aim to keep blood pressure lower than 140/90 mmHg
- continue antihypertensive treatment, if required. **ACTION: All Health Professionals.**

Use a validated tool, such as FAST (Face Arm Speech Test), outside hospital to screen people with sudden onset of neurological symptoms for a diagnosis of stroke or transient ischaemic attack (TIA). **ACTION: All Health Professionals.**

For [women] who are admitted to the emergency department with a suspected stroke or TIA, establish the diagnosis rapidly using a validated tool, such as ROSIER (Recognition of Stroke in the Emergency Room). **ACTION: All Health Professionals.**

3.2 Caring for women with epilepsy

Background

As highlighted in the 2017 report, more women now die from epilepsy during or after pregnancy than die as a result of pregnancy hypertensive disorders (Knight et al. 2017). This dramatic decrease in maternal deaths from pregnancy hypertensive disorders can be directly related to uptake of recommendations from the Confidential Enquiry into guidelines and subsequent implementation (Conti-Ramsden et al. 2019). The RCOG green-top guideline on epilepsy in pregnancy was first issued in mid-2016, thus it was in effect throughout most of the period in which these women died and could be expected to impact on the care women received (Royal College of Obstetricians and Gynaecologists 2016b). However, over a similar period, guidance on prescribing of valproate for women and girls changed dramatically with increased understanding of the extent of risks of developmental disorders amongst children exposed to valproate during pregnancy (Medicines and Healthcare products Regulatory Agency 2018). This necessitated a change in medication use amongst a large number of women of reproductive age with epilepsy and the findings of this report must be seen in this context.

The women who died

Twenty-two women died during or up to a year after the end of pregnancy in the UK and Ireland in 2016-18 from causes related to epilepsy, a mortality rate of 0.91 per 100,000 maternities (95% CI 0.57-1.38). This compares to 13 women in 2013-15, a mortality rate of 0.52 per 100,000 maternities (95% CI 0.28-0.8, RR 1.75 comparing 2016-18 with 2013-15 (95% CI 0.84-3.79, p=0.1082)). Of particular concern, 18 women died from Sudden Unexpected Death in Epilepsy (SUDEP) in 2016-18 in the UK and Ireland (mortality rate 0.74 per 100,000 maternities, 95% CI 0.44-1.18), compared to 8 women in 2013-15 (mortality rate 0.32 per 100,000 maternities, 95% CI 0.14-0.63). This represents a more than doubling of the rate of SUDEP between 2013-15 and 2016-18 (RR 2.33, 95% 0.96-6.19, p=0.04).

The care of the women who died with epilepsy is described in Table 3.1, together with their anti-epileptic drug (AED) use. Of the 19 women for whom details were available, four were not taking any medication, and notably lamotrigine, levels of which fall significantly in pregnancy, was the drug most commonly used (by 8 out of 15 women who were taking medication). Very few women had documented pre-pregnancy counselling, the majority had uncontrolled epilepsy pre-pregnancy and yet fewer than half had specialist review during pregnancy.

Table 3.1: Summary of the care of the women with epilepsy who died UK and Ireland 2016-2018 and whose records were available for detailed review*

Cause of death	Timing of death	Pre-pregnancy counselling	Epilepsy controlled pre-pregnancy	Specialist review during pregnancy	Medication	Improvements in care identified which would have changed outcome
Drowning	2nd trimester	No	Yes	No	None	Yes
Drowning	2nd trimester	Unclear	Yes	Yes	Lamotrigine	No
SUDEP	3rd trimester	No	No	Yes	Lamotrigine	Yes
SUDEP	1st trimester	Yes	No	No	Lamotrigine	Yes
SUDEP	>6 weeks PN	No	No	Yes	Topiramate, Ethosuximide	Yes
SUDEP	1st trimester	No	No	Unknown	None (previously on Lamotrigine, Levetiracetam)	No
SUDEP	2nd trimester	No	No	Yes	Lamotrigine, Clobazam, Levetiracetam	Yes
SUDEP	2nd trimester	Yes	Yes	Yes	Lamotrigine	Yes
SUDEP	2nd trimester	Unclear	No	No	Valproate, Pregabalin	Yes
SUDEP	2nd trimester	Unclear	No	No	Lamotrigine	Yes
SUDEP	1st trimester	No	No	No	None (previously on Lamotrigine)	Yes
SUDEP	3rd trimester	No	No	No	Lamotrigine	Yes
SUDEP	2nd trimester	Yes	No	Yes	Valproate, Levetiracetam, Clobazam	Yes
SUDEP	>6 weeks PN	Unclear	No	No	Lamotrigine, Levetiracetam, Clobazam	No
SUDEP	3rd trimester	Unclear	No	No	Carbamazepine, Phenytoin	No
SUDEP	1st trimester	Unclear	No	No	Oxcarbazepine	Yes
SUDEP	>6 weeks PN	Unclear	No	No	None recorded	No
Status Epilepticus	>6 weeks PN (terminal event in 3rd trimester)	No	No	No	Levetiracetam, Clobazam, Phenytoin, Sertaline	Yes
Status Epilepticus	<6 weeks PN (terminal event in 3rd trimester)	Yes	No	No	Carbamazepine	No

* Records of three women who died more than six months after the end of pregnancy were not available for detailed review.

"We need to talk about SUDEP"

The majority of women who died, as shown in Table 3.1, had clear risk factors for SUDEP (Box 3.1), including uncontrolled seizures, tonic-clonic seizures, nocturnal seizures and epilepsy which had started in childhood. Most had not had pre-pregnancy counselling and the majority had no specialist review during pregnancy. There was very little documented evidence that SUDEP had been discussed with women or their families, nor were their risks assessed and nor were risk minimisation strategies put in place. Some women were living or sleeping alone. Pregnancy itself is a known risk factor for SUDEP and it is imperative that it is discussed with women and their families and prevention measures put in place. The RCOG green-top guideline on epilepsy in pregnancy (Royal College of Obstetricians and Gynaecologists 2016b) does not include specific recommendations about discussion of SUDEP and risk minimisation; there is a clear need for such guidance and to ensure it is embedded in pathways of care. Structured discussions with people with epilepsy has been shown to significantly reduce individual modifiable risk factors (Shankar et al. 2018). This impact seems to be higher in those who are at current higher risk, as was the situation for most of the women who died.

Develop guidance to ensure SUDEP awareness, risk assessment and risk minimisation is standard care for women with epilepsy before, during and after pregnancy and ensure this is embedded in pathways of care. Clinicians need to talk to women and their partners or carers about the risk of SUDEP and how to minimise it **N**

Box 3.1 SUDEP Risk Awareness (adapted from *https://sudep.org*)

Known risk factors:

Seizure-related factors:

- Uncontrolled seizures
- Tonic clonic seizures
- Nocturnal seizures
- Epilepsy starting before the age of 16
- Increasing frequency of seizures

Treatment factors:

- Infrequent epilepsy reviews and engagement with an epilepsy clinician
- Ineffective AED treatment
- Frequent medication changes
- Sub-therapeutic doses of AEDs

Individual factors:

- Living alone or sleeping alone
- Not taking medication as prescribed
- Sleep deprivation
- Stress
- Alcohol or substance misuse
- Learning disability

Overview of care and lessons to be learned

Clear referral and escalation pathway

A young woman had an increased seizure frequency after the birth of her first child and was advised at the neurology clinic to increase her lamotrigine dose. A few weeks later she presented to the GP in early pregnancy with a further increase in fits. The GP advised her to contact the neurology clinic and book for antenatal care with the midwife. She died from SUDEP two weeks later. It is unclear whether she contacted either the neurology clinic or her midwife.

This woman's pregnancy was high risk, and availability of a rapid referral route to the neurology service may have allowed her medication to be adjusted. Several other women died from SUDEP early in pregnancy, and an increased seizure frequency only became evident after their deaths. Women with epilepsy and their primary care team need to know who to contact when they get pregnant. There needs to be a proactive route to fast track women in early pregnancy with epilepsy into specialist epilepsy services, even before they are booked for maternity care, to ensure that adherence with medication can be assessed and their medication adjusted where appropriate as soon as possible in the event of increased seizure frequency. This review does not necessarily need to be face to face, but there should be recognition of the speed with which it is needed.

A woman with a history of poorly controlled epilepsy on lamotrigine was referred to a neurologist urgently after her booking visit as her seizures had increased. Her dose of lamotrigine was increased twice over the next three months. She attended in the third trimester with reduced fetal movements following a seizure. The obstetric registrar discussed her seizures with the medical registrar who was reluctant to change her medication as she was under the care of a neurologist and awaiting a follow up appointment. The local neurology service was in a different hospital. The obstetric registrar tried unsuccessfully to expedite the neurology appointment by telephone. Letters requesting a further neurology appointment were sent by both the obstetric registrar and the woman's GP. She was seen in the neurology clinic three weeks later after a further admission to the maternity unit following a seizure. Her lamotrigine dose was increased again and levels were due to be checked ten days later. She died from SUDEP the following week.

The fact that maternity and neurology services were located in different hospitals was a clear barrier to this woman receiving effective care when control of her epilepsy was worsening. Good communication between obstetric and medical teams caring for women with medical conditions in pregnancy is essential, especially when the woman's medical condition and pregnancy are being managed in different locations. Previous reports have recommended consultant to consultant telephone conversations. This can be very effective but may have limitations if either lead consultant is on leave or if the woman is seen out of hours by junior doctors. A negotiated robust way of communicating for specialties with regular joint patients, including planning for situations when escalation is needed as a matter of urgency, should be established at the beginning of pregnancy for women who are jointly cared for. A regular multidisciplinary team discussion between colleagues in different specialties in different locations to discuss all jointly cared for pregnant woman can be helpful in breaking down barriers and facilitate immediate contact when urgent advice is needed. The Royal College of Obstetricians and Gynaecologists Green-top guideline 68 describes some possible models of joint care for women with epilepsy (Royal College of Obstetricians and Gynaecologists 2016b), but six years after the first MBRRACE-UK report on deaths of women with epilepsy highlighted this as a problem, women are still dying due to an urgent need to access specialist neurology care and evident communication problems still exist between maternity and neurology teams. This suggests clear standards of care are needed.

Women with epilepsy taking antiepileptic drugs who become unexpectedly pregnant should be able to discuss therapy with an epilepsy specialist on an urgent basis. It is never recommended to stop or change antiepileptic drugs abruptly without an informed discussion.

Pregnant women with epilepsy should have access to regular planned antenatal care with a designated epilepsy care team.

RCOG Green-top guideline 68 (Royal College of Obstetricians and Gynaecologists 2016b)

Develop clear standards of care for joint maternity and neurology services, which allow for

- **Early referral in pregnancy, particularly if pregnancy is unplanned, to optimise anti-epileptic drug regimens**
- **Rapid referral for neurology review if women have worsening epilepsy symptoms**
- **Pathways for immediate advice for junior staff out of hours**
- **Prompt postnatal review to ensure anti-epileptic drug doses are appropriately adjusted.** **N**

Access to specialist neurological opinion

At booking a woman on lamotrigine was noted to have 'uncontrolled' epilepsy with an increasing number of seizures, and was referred for a neurology opinion. At a neurology appointment she was said to be 'fit free' and no neurology follow up was planned until after delivery. Her seizures became daily occurrences associated with urinary incontinence, and yet it was felt by the maternity team that she was on maximum therapy and nothing further could be done. Lamotrigine levels were never measured. An urgent neurology referral was made with no response, and a further chase up also seems to have been ineffective. It is unclear how this was done or why this communication failed. She died of SUDEP in the third trimester. Levels of lamotrigine were subtherapeutic at post-mortem.

The team caring for this woman seem to have focussed on obtaining a neurology opinion concerning this woman's care, without considering seeking the advice of an Epilepsy Nurse Specialist or an obstetric physician. Not all maternity services have access to an Epilepsy Nurse Specialist nor do they have a specialist epilepsy midwife. Urgent neurology services are not provided at most hospitals. However, with developing maternal medicine networks, all maternity units should have access to advice from an obstetric physician. Epilepsy remains the commonest serious neurological disease, and ability to manage epilepsy in pregnancy must be a core competence for obstetric physicians. All obstetric physicians should have completed an appropriate obstetric medicine credential which includes training in this area.

Ensure all maternity units have access to an epilepsy team

Ensure each regional maternal medicine network has a pathway to enable women to access their designated epilepsy care team within a maximum of two weeks **N**

Anti-epileptic drug management

Many women who died were managed with Lamotrigine, as noted in Table 3.1. Several women, as in the previous vignette, had low blood levels of AED measured and increased seizure frequency but doses were not increased. There was clear evidence of reluctance to increase doses because of concerns over increasing fetal risk with increased doses, when the risk/benefit equation in this instance is strongly in favour of the benefit of increasing the dose. It is unclear whether this is in relation to confusion over the AntiEpileptic drug Monitoring in PREgnancy (EMPiRE) study results (Thangaratinam et al. 2018), or because women had been moved from sodium valproate on which they had previously been well controlled, or simply due to the lack of access to specialist advice. The RCOG guideline is clear that while polytherapy and valproate exposure should be minimised, women should be maintained on the lowest effective dose of an AED. Minimising exposure through use of an ineffective AED drug or dose will benefit neither the woman nor her fetus. Increase in dose needs to be more responsive to the clinical picture, and should not await blood level results, which may take 2-3 weeks to obtain.

The lowest effective dose of the most appropriate antiepileptic drug should be used.

Exposure to sodium valproate and other antiepileptic drug polytherapy should be minimised by changing the medication prior to conception, as recommended by an epilepsy specialist after a careful evaluation of the potential risks and benefits.

Based on current evidence, routine monitoring of serum antiepileptic drug levels in pregnancy is not recommended although individual circumstances may be taken into account.

RCOG Green-top guideline 68 (Royal College of Obstetricians and Gynaecologists 2016b)

As has been noted before in these enquiries, some women discontinued their AEDs, or had them discontinued, and no-one recognised the significance or urgency of the situation.

A woman with learning difficulties had increased seizure frequency in the first trimester. She had discontinued her Lamotrigine over concerns that it might harm her baby. She was referred to the emergency department by her midwife because of her self-reported increased seizure frequency. No change in management was made and she was referred to her GP. She was risk assessed in relation to seizures and was deemed to be at high risk of seizures and their consequences. A referral was made for further assessment. She died from SUDEP two days later before seeing either a neurologist or an obstetrician.

This woman was vulnerable through a learning disability and self-discontinued her epilepsy medication. This was not identified or adequately addressed. She should have been seen by appropriate medical staff earlier in pregnancy, ideally as soon as possible after it was known she was pregnant. The reaction by multiple carers to her unstable epilepsy was wholly inadequate.

Women with epilepsy should be provided with verbal and written information on prenatal screening and its implications, the risks of self-discontinuation of antiepileptic drugs and the effects of seizures and antiepileptic drugs on the fetus and on the pregnancy, breastfeeding and contraception.

In the antenatal period, women with epilepsy should be regularly assessed for the following: risk factors for seizures, such as sleep deprivation and stress; adherence to antiepileptic drugs; and seizure type and frequency.

RCOG Green-top guideline 68 (Royal College of Obstetricians and Gynaecologists 2016b)

Safety advice

A woman drowned in the bath while alone in the house in the second trimester of pregnancy. After her death it emerged that she had several fainting episodes which were probably fits. It is unclear whether these were not diagnosed or not disclosed, but it was reported that the woman was concerned over the possibility of losing her driving licence. It was documented that she was 'aware of safety advice' but it is not clear what advice she received.

As noted in previous reports, several women were not given safety advice. This was not solely an issue with regards to drowning in the bath; several women died from SUDEP while sleeping alone. In one instance funding for a personal alarm for a single mother to use in the event of a fit was denied by social services as this was a 'health' need. In other instances, where women had no access to shower facilities and could only take a bath, no attempt seems to have been made to involve social services and consider the possibility of alternative accommodation and/or installation of a wet room.

Women with epilepsy should be informed that the introduction of a few safety precautions may significantly reduce the risk of accidents and minimise anxiety.

RCOG Green-top guideline 68 (Royal College of Obstetricians and Gynaecologists 2016b)

Involve social services in planning safe accommodation for women with epilepsy where necessary **N**

Nocturnal seizures

A woman with nocturnal seizures was managed with sodium valproate and pregabalin. Her epilepsy was poorly controlled but her GP had not referred her to a neurologist for review about her valproate. A few days before her booking visit she had a grand mal seizure. Her midwife referred her urgently to the consultant obstetric clinic because of her epilepsy. The obstetrician advised her GP to consider increasing her valproate, stating that it could not be changed to an alternative drug as the woman was already pregnant, and to refer her to a neurologist. She died from SUDEP a month later while sleeping alone.

The over-representation of nocturnal seizures amongst women who died is a new theme in this report. Nocturnal seizures are high risk and this was not recognised. This woman's recent daytime seizure and use of valproate were additionally not recognised as important. She should have been referred for review of her medication prior to pregnancy, or, at the very least, as a matter of urgency in early pregnancy (Medicines and Healthcare products Regulatory Agency 2018), since she was taking valproate. Her recent breakthrough daytime seizure should also have triggered an urgent referral. Referral to neurology via the GP led to further delay, coupled with incorrect advice about medication which meant her epilepsy remained uncontrolled.

This woman died while her partner was working a night shift; it is unclear whether the significance of his occupation was recognised or discussed by staff caring for her. Her midwife or doctor could have requested a change in duties for him to ensure that she did not sleep alone at night.

Regard nocturnal seizures as a 'red flag' indicating women with epilepsy need urgent referral to an epilepsy service or obstetric physician **N**

In women with epilepsy with active seizures, advising on care to minimise the period of time they go unobserved should be considered. Individuals with unwitnessed seizures are at high risk of SUDEP, with nocturnal seizures being an independent risk factor. This may include advising women with epilepsy who are at reasonable risk of seizures to not to sleep alone at night. Inpatient nursing should be in an environment in which continuous care from a partner or nursing observations takes place.

RCOG Green-Top Guideline 68 (Royal College of Obstetricians and Gynaecologists 2016b)

Pre-pregnancy and contraception advice

A young woman with complicated epilepsy became pregnant shortly after transferring to the adult epilepsy service. There is no evidence that she received pre-pregnancy or contraception advice as part of her transitional care. Her epilepsy remained very poorly controlled throughout pregnancy and she died following an emergency caesarean birth for fetal concerns following refractory seizures.

This woman's pregnancy was unplanned. Several other women whose pregnancies were unplanned died in early pregnancy before they had accessed maternity care. Planning pregnancy and advice about effective contraception to avoid unplanned pregnancy will allow for optimisation of medication to give the best outcomes for both women and their babies and the green-top guidelines are clear that this is essential. It should not be neglected in either adult or transitional services.

Women with epilepsy should be offered effective contraception to avoid unplanned pregnancies.

The risks of contraceptive failure and the short- and long-term adverse effects of each contraceptive method should be carefully explained to the woman. Effective contraception is extremely important with regard to stabilisation of epilepsy and planning of pregnancy to optimise outcomes.

RCOG Green-Top Guideline 68 (Royal College of Obstetricians and Gynaecologists 2016b)

Stigma and interpretation

A woman migrated to the UK in the third trimester of pregnancy. She was booked and had antenatal care on several occasions with a professional interpreter. She was specifically asked, and answered in the negative, about any significant medical history. Her history of epilepsy, and seizure-like episodes only became apparent after her death from SUDEP.

If this woman's history of epilepsy had been known, then investigation, treatment and on-going management may have led to a different outcome. There appear to have been several opportunities to declare such a history in her own language during her care. This woman's care highlights the need to make sure that all questions are answered with full understanding of the term and variations (for example, asking about epilepsy may not trigger a response about absences or seizures). In this instance, it was suggested that epilepsy was associated with stigma in the woman's country of origin, which may have led to a reluctance to disclose the diagnosis. There is a need to ensure that women are able to disclose diagnoses in a confidential manner, with a cultural understanding of any associated stigma. Addressing these issues, along with language around different types of epilepsy, may require complex and nuanced interpreting.

Pregnant women who are recent migrants, asylum seekers or refugees, or who have difficulty reading or speaking English, may not make full use of antenatal care services. This may be because of unfamiliarity with the health service or because they find it hard to communicate with healthcare staff.

Healthcare professionals should help support these women's uptake of antenatal care services by:

- **using a variety of means to communicate with women**
- **telling women about antenatal care services and how to use them**
- **undertaking training in the specific needs of women in these groups.**

Provide the woman with an interpreter (who may be a link worker or advocate and should not be a member of the woman's family, her legal guardian or her partner) who can communicate with her in her preferred language.

When giving spoken information, ask the woman about her understanding of what she has been told to ensure she has understood it correctly.

NICE CG110 Pregnancy and complex social factors (National Institute for Health and Care Excellence 2010)

3.3 The neuropathological investigation of deaths in epilepsy

Sebastian Lucas, Samantha Holden and Esther Youd

This section assesses how women's deaths were examined pathologically. In 2019 the Royal College of Pathologists (RCPath) issued guidance covering all deaths in epilepsy (Royal College of Pathologists 2019); this updated similar guidelines that had been available on the RCPath website since 2005. A basic recommendation is that ideally in all cases, the brain should be examined by a specialist neuropathologist: to identify particularly hippocampal sclerosis, cortical and vascular malformations, old contusions, and tumours.

Twenty-two women died from epilepsy; detailed records were not available for three of these women and a further three did not have an autopsy. Sixteen had a coronial autopsy in accordance with the general agreement that all deaths in epilepsy require further examination. One of the three women who did not undergo autopsy was already known to have a severe inherited disorder causing severe seizures; another died eight days following the fatal epilepsy attack, and reasonably it was judged that this would render detailed neuropathology of little value (as CT scan had excluded a brain tumour or other gross significant lesion); in the third instance, it is not clear why the woman, who had severe regular seizures despite anti-epilepsy medication, had had no evident brain scan performed, and died eight months post-partum, was not autopsied. The deaths of a further three women are included in this review; these women were known to have epilepsy, but their deaths are included in other chapters either because the quality of their post-mortem was such that a cause of death could not be clearly ascribed, or because the autopsy and clinic pathological correlation suggested another primary cause for their deaths. The assessment reported here thus includes an evaluation of the pathological care of 19 women.

All but one of the women were known to have epilepsy, or a brain disease likely to cause epilepsy, prior to death. The autopsy diagnoses for the 19 concluded with SUDEP in the majority; three women died in the bath at home; two women had brain primary tumours, and one had hippocampal malformation associated with sudden death (HMASD) syndrome. No other underlying brain pathologies were identified.

> A woman with epilepsy and taking lamotrigine died at home a few months after giving birth. The pathologist did a gross examination but did not open the skull and look at the brain, and no histology from any organ was taken. Although blood was taken for toxicology and AED levels, the lack of neuropathological examination meant that assessors could not clearly ascribe the cause of this woman's death.

Two autopsy reports were incomplete and one woman's brain could not be studied due to the length of time after death. In the 16 remaining women who had 'complete' autopsies, all but the one woman described above had brain examinations, and in seven (44%) a specialist neuropathologist had studied the women's brain. The majority of these autopsy tissue evaluations were good, and it is important to emphasise that a diagnosis of SUDEP can only be made if a complete autopsy with histology and a toxicology screen is performed: SUDEP is a diagnosis of exclusion.

Seventeen autopsied women with epilepsy were known to have been prescribed AEDs; all but one had their AED levels determined on autopsy blood, as well as alcohol and an illicit drug screen. In two women, amphetamine was identified, but judged not relevant to death. None had drunk alcohol at time of death. The AED prescriptions and levels identified at autopsy are shown in Table 3.2. The majority were low or sub-therapeutic.

Summary

Overall, the majority of the autopsies were performed satisfactorily, and nearly half the brains were examined by a specialist neuropathologist. Evaluating AED blood levels in autopsy blood was done in nearly all women and the majority of women on AEDs had low or sub-therapeutic blood levels at the time of death. However, the quality of autopsy in some women meant their cause of death could not be clearly ascribed.

Recommendations for pathology

Neuropathologists should be involved in all autopsy examinations of patients with epilepsy and the RCPath Autopsy Guideline followed

Measuring AEDs in autopsy blood is essential to identify those apparently taking sub-therapeutic doses. Actual drug levels should be indicated in the autopsy reports along with reference levels

RCPath guideline G175 (Royal College of Pathologists 2019)

Table 3.2: AED evaluations at the 19 autopsy examinations

Prescribed	Autopsy blood data – AED levels	Comment
Never on AED	Not done	Never on AED
Lamotrigine	Lamotrigine – 'high-therapeutic level'	Satisfactory
Lamotrigine	Lamotrigine 1.7mg/L	Probable low therapeutic level
Lamotrigine	Lamotrigine 2.6mg/L	Probable low therapeutic level
Lamotrigine	Lamotrigine – 'therapeutic level'	Satisfactory
Topiramate,	1st trimester	No
Ethosuximide	Not done – laboratory unable to test	Unknown whether AEDs taken
Levetiracetam,	2nd trimester	Yes
Lamotrigine	None detected	AEDS not taken
Desmethylclobazam,	2nd trimester	Unclear
Lamotrigine	Desmethylclobazam 55µg/L,	No
Lamotrigine <1mg/L	Both low or sub- therapeutic level	No
Lamotrigine	Lamotrigine <1mg/L	Sub-therapeutic level
Valproate,	>6 weeks PN	Unclear
Pregabalin	Valproate 'low therapeutic level'	Low therapeutic level
Lamotrigine	Lamotrigine 1.7mg/L	Low therapeutic level
Lamotrigine	Lamotrigine 'low therapeutic level'	Low therapeutic level
Lamotrigine	Lamotrigine 1.4mg/L	Low therapeutic level
Valproate	17.1mg/L	Subtherapeutic level
Valproate, Carbamazepine, Pregabalin	Carbamazepine 1.4mg/L	Subtherapeutic level
Carbamazepine	None detected	Stopped taking in 1st trimester
Carbamazepine	Carbamazepine 2.6mg/L	Subtherapeutic level
Oxcarbazepine	Oxcarbazepine 'therapeutic level'	Satisfactory
Not on AEDs	PM report incomplete	Probably never on AED

Laboratory reference blood level ranges

Lamotrigine - vary: cited are 1-10, 1-14, 3-15mg/L.

Valproate: therapeutic efficacy blood level: 40-80mg/L

Carbamazepine: therapeutic efficacy blood level: 4-12mg/L

Desmethylclobazam: therapeutic efficacy blood level: 30-300µg/L

3.4 Messages for stroke care

Summary of the key findings 2016-18

Alongside epilepsy, stroke represents the other major neurological cause of maternal death in the UK. In the UK and Ireland in 2016-18 there were 15 women who died from stroke during or up to six weeks after pregnancy, 7 from subarachnoid haemorrhage, 5 from intracerebral haemorrhage and 3 from thrombotic strokes. This represents an overall maternal mortality rate directly due to intracranial haemorrhage of 0.62 per 100,000 maternities (95% CI 0.35 to 1.02 per 100,000 maternities). Note that this does not include women who died from intracranial haemorrhage following pre-eclampsia; improvements to their care were considered in the pre-eclampsia chapter in the 2019 report (Knight et al. 2019).

A further 13 women died from neurological causes between six weeks and one year after the end of pregnancy (7 subarachnoid haemorrhage, 4 intracerebral haemorrhage, 1 thrombotic stroke and 1 other); the care of 11 of these women was reviewed for the purposes of this section, thus the care of a total of 26 women was reviewed.

Overview of care and lessons to be learned

Blood pressure management

A multiparous woman was hypertensive at her booking visit. Throughout her pregnancy, her blood pressure was recorded at between 140-155/85-100 mmHg but this was attributed to 'white coat hypertension'. A few days postnatally it was again recorded as 150/100 mmHg but no further action was taken. Two weeks later she had a witnessed seizure followed by bizarre behaviour, which was assumed by the ambulance crew to be functional. She was not therefore triaged for urgent review and was not examined for 90 minutes after arrival in the Emergency Department. She was assumed to have eclampsia and was managed with magnesium sulphate initially prior to diagnosis of her subarachnoid haemorrhage. She underwent endovascular coiling but continued to deteriorate and died.

Three other women had raised blood pressure postnatally which was recorded but not acted on prior to the strokes from which they died. The 2019 NICE guideline on hypertension in pregnancy emphasises the importance of management of newly diagnosed chronic hypertension, in line with NICE guideline NG136 Hypertension in adults, to reduce cardiovascular disease (including stroke) risk (National Institute for Health and Care Excellence 2019c).

Offer antihypertensive treatment to pregnant women who have chronic hypertension and who are not already on treatment if they have:

- **sustained systolic blood pressure of 140 mmHg or higher**
- **or sustained diastolic blood pressure of 90 mmHg or higher .**

When using medicines to treat hypertension in pregnancy, aim for a target blood pressure of 135/85 mmHg.

NICE Guideline NG133 Hypertension in pregnancy: diagnosis and management (National Institute for Health and Care Excellence 2019c)

The woman described in the vignette above was not assessed using the FAST (Face Arm Speech Test) to screen her for a diagnosis of stroke, potentially because she was known to be postnatal and therefore her symptoms were assumed to be pregnancy-related. Although pregnancy-associated hypertensive disorders are common, assessment for, and treatment of, stroke is time critical and should not be neglected in favour of an assumed diagnosis of pre-eclampsia or eclampsia. These enquiries have reiterated in many circumstances that pregnant and postpartum women should be treated the same as non-pregnant women unless there is a clear reason not to, and assessment for potential stroke is no exception.

Use a validated tool, such as FAST (Face Arm Speech Test), outside hospital to screen people with sudden onset of neurological symptoms for a diagnosis of stroke or transient ischaemic attack (TIA).

For [women] who are admitted to the emergency department with a suspected stroke or TIA, establish the diagnosis rapidly using a validated tool, such as ROSIER (Recognition of Stroke in the Emergency Room.)

NICE NG128 Stroke and transient ischaemic attack in over 16s: diagnosis and initial management (National Institute for Health and Care Excellence 2019b)

Symptoms of cerebral irritation/raised intracranial pressure

The acute confusion that the woman described in the previous vignette exhibited was probably a manifestation of cerebral irritation due to her subarachnoid haemorrhage. This was not recognised and her diagnosis and management was subsequently delayed. Other women who died from stroke also had symptoms and signs of intracranial pathology which were not recognised or were ascribed to pregnancy hypertensive disorders.

A previously normotensive woman presented to the emergency department a week postpartum with a sudden onset headache but was diverted to maternity triage. She was noted to be severely hypertensive and bradycardic and was treated with antihypertensives and magnesium sulphate. Fundoscopy was not performed. She deteriorated while awaiting a CT scan and was intubated and ventilated. She underwent surgery for her intracranial haemorrhage but died in spite of best supportive care.

These enquiries have noted before the concerning features associated with headaches (Box 3.1). This woman presented with a sudden onset, severe headache which should have been recognised as a 'red flag' requiring urgent assessment. Fundoscopy is a key part of the neurological examination in this situation.

Neurological examination including fundoscopy is mandatory in all women with new onset headaches or headache with atypical symptoms

Saving Lives, Improving Mothers' Care 2015 (Knight et al. 2015)

Box 3.1: Red flags in the history and examination of a pregnant patient presenting with headaches:

- Sudden-onset headache / thunderclap or worst headache ever
- Headache that takes longer than usual to resolve or persists for more than 48 hours
- Has associated symptoms – fever, seizures, focal neurology, photophobia, diplopia
- Excessive use of opioids

RCP Acute care toolkit 15 Managing acute medical problems in pregnancy (Royal College of Physicians 2019)

A multiparous woman complained of posterior chest pain a few days following a vaginal birth. She was found to be markedly hypertensive and bradycardic. The obstetric registrar suspected aortic dissection which was excluded at CT thorax. The hypertension and bradycardia were ascribed to 'pain and stress' by a medical registrar who advised over the telephone not to treat the hypertension. The woman was admitted with a tentative diagnosis of atypical pre-eclampsia. The following morning she complained of a severe headache, developed a hemiplegia and decreased conscious level. A CT scan showed massive intracranial haemorrhage. She was admitted to intensive care but declared brain dead the following morning.

The significance of bradycardia as a sign of raised intracranial pressure was not recognised in either of these women. Both were assumed initially to have pre-eclampsia despite neither having been hypertensive during pregnancy and both being several days postpartum. Neither had fundoscopy performed which may have revealed their raised intracranial pressure. The first woman was likely to have been hypertensive as a consequence of her intracerebral bleed, and the diversion to maternity probably delayed her diagnosis and treatment. It is less clear whether the second woman had already experienced an intracerebral haemorrhage at the time of her presentation, but the bradycardia suggests her intracranial pressure may already have been raised. Nevertheless, not treating her hypertension may have exacerbated the situation. Attention to urgent treatment of severe hypertension in pregnancy has led to a dramatic reduction in maternal deaths from hypertensive disorders of pregnancy (Conti-Ramsden et al. 2019); attention to severe hypertension in the postpartum period is equally important.

For women with gestational hypertension who did not take antihypertensive treatment and have given birth, start antihypertensive treatment if their blood pressure is 150/100 mmHg or higher

In women with chronic hypertension who have given birth:

- **aim to keep blood pressure lower than 140/90 mmHg**
- **continue antihypertensive treatment, if required**

NICE Guideline NG133 Hypertension in pregnancy: diagnosis and management (National Institute for Health and Care Excellence 2019c)

Inpatient stroke care pathway

A woman developed mild pregnancy induced hypertension in the third trimester, managed with labetolol and induction of labour. She had a normal birth and was discharged home on day 2. Her blood pressure was labile postnatally and she was recommenced on labetolol. Two weeks postnatally she presented to hospital in the middle of the night with visual and speech disturbance and very raised blood pressure. An initial CT was normal, and her symptoms were attributed to pregnancy hypertensive disorder. Fundoscopy was not performed. A few hours later she deteriorated with signs of raised intracranial pressure and an MRI scan suggested cerebral infarction due to emboli from a vertebral artery dissection. She was referred to the regional neuroscience centre but was not transferred for several hours. Mechanical thrombectomy was not considered appropriate and she continued to deteriorate and died.

As previously noted in these reports, the significance of a new mother leaving their baby because they feel so unwell and presenting to hospital in the middle of the night was not recognised. Several women, similar to this one, had their stroke diagnosed or suspected after admission either to an obstetric or medical ward. As a consequence, there did not appear to be as rapid a response to the suspected diagnosis as there would have been if the woman had been admitted directly from the community. NICE guideline NG128 states 'Admit everyone with suspected stroke directly to a specialist acute stroke unit after initial assessment, from either the community, the emergency department, or outpatient clinics', but does not specify this level of care for people diagnosed in inpatient settings (National Institute for Health and Care Excellence 2019b). Not all maternity units are co-located with a hyperacute stroke unit, nor are all hyperacute stroke units co-located with a maternity unit. Pathways to facilitate rapid specialist stroke care for women diagnosed in inpatient maternity settings are needed to ensure pregnant and postpartum women with stroke receive the rapid specialist care they need. Training to recognise stroke for staff in maternity settings should be considered as a priority.

Establish pathways to facilitate rapid specialist stroke care for women with stroke diagnosed in inpatient maternity settings

Thrombolysis and thrombectomy

A woman had a normal birth followed by a postpartum haemorrhage requiring a two unit red cell transfusion. She had a previous history of a DVT and was discharged home postnatally with prophylactic low molecular weight heparin. A few days postnatally she was noted to have a hemiplegia and was appropriately rapidly admitted and underwent a CT scan which showed a thrombotic stroke. Thrombolysis was considered contraindicated due to her postpartum haemorrhage and some possible early ischaemic changes on CT. She was transferred to a neighbouring hospital which had a neurosurgery department. Neither hospital stroke unit could perform thrombectomy out of hours. At the second hospital, her deteriorating condition was not recognised until late, and decompressive surgery was consequently delayed and she deteriorated further and died.

Neither the postpartum haemorrhage more than a week beforehand nor the early ischaemic change were contraindications to thrombolysis. Although most units only operate a 9-5 service, mechanical thrombectomy should have been considered if available, but the delay in transfer to a unit without a 24 hour service, coupled with delayed recognition of her deterioration meant that she did not receive any potentially life-saving interventions. Once the transfer had been arranged, there seemed to be a lack of recognition of the need for acute stroke care. An early, urgent, multidisciplinary team discussion should have resolved any concerns over thrombolysis and allowed this woman to receive the appropriate early intervention she needed.

Pregnancy should not alter the standard of care for stroke

Neither pregnancy, caesarean section nor the immediate postpartum state are absolute contraindications to thrombolysis (intravenous or intra-arterial), clot retrieval or craniectomy

Saving Lives, Improving Mothers' Care 2014 (Knight et al. 2014)

3.5 Conclusions

There is a concerning rise in the mortality rate from epilepsy during or up to one year after the end of pregnancy, and in particular due to SUDEP. While this report cannot causally relate this to changes in clinical care, this rise occurred over the time period during which many women who were previously prescribed valproate had their medications changed. Multiple improvements in care for women with epilepsy were identified by reviewers, and this is reflected in the assessment that for 68% of women with epilepsy (Table 3.3), different care may have led to a different outcome. There were many gaps in pathways of care emphasising the need for standards of care for joint maternity and neurology services and an important role for regional maternal medicine networks to improve future care for women with epilepsy. Assessors felt that the majority of women who died from stroke received good care, or improvements in care were noted which would not have made a difference to women's outcome. Nevertheless, the pathway of care for women who had a stroke while they were inpatients was unclear and hindered some receiving the rapid specialist stroke care they needed.

Table 3.3: Classification of care received by women who died from neurological causes and for whom case notes were available for an in-depth review, UK and Ireland, 2016-18

Classification of care received	Women who died from epilepsy Number (%) N=19*	Women who died from stroke Number (%) N=26*
Good care	2 (11)	10 (38)
Improvements to care which would have made no difference to outcome	4 (21)	7 (27)
Improvements to care which may have made a difference to outcome	13 (68)	9 (35)

* Insufficient information available to classify care of 3 women who died from epilepsy and 2 women who died from other neurological causes more than six months after the end of pregnancy

4. Messages for the care of women with medical and general surgical disorders

Sarah Vause, Bernard Clarke, Marian Knight and Cathy Nelson-Piercy on behalf of the MBRRACE-UK indirect chapter-writing group

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4.1 Key messages

New recommendations

Establish a mechanism to disseminate the learning from this report, not only to maternity staff, but more widely to GPs, emergency department practitioners, physicians and surgeons **ACTION: Academy of Medical Royal Colleges.**

Ensure a thorough history is obtained from women with a pre-existing medical disorder to ascertain its severity **ACTION: All Health Professionals.**

Provide specialist multidisciplinary care for pregnant women who have had bariatric surgery by a team who have expertise in bariatric disorders **ACTION: Hospitals/Trusts/Health Boards**.

Existing guidance and recommendations requiring improved implementation

Women with pre-existing medical conditions should have pre-pregnancy counselling by doctors with experience of managing their disorder in pregnancy **ACTION: All Health Professionals, Service Managers.**

Services providing care to pregnant women should be able to offer all appropriate methods of contraception, including long-acting reversible contraception, to women before they are discharged from the service **ACTION: All Health Professionals, Service Managers.**

The emphasis should be on making a diagnosis, not simply excluding a diagnosis **ACTION: All Health Professionals.**

Repeated presentation in pregnancy or postnatally with pain and/or pain requiring opiates should be considered a 'red flag' and warrants a thorough assessment of the woman to establish the cause **ACTION: All Health Professionals.**

Women admitted with sickle cell crisis should be looked after by the multidisciplinary team, involving obstetricians, midwives, haematologists and anaesthetists **ACTION: All Health Professionals, Service Managers.**

Counsel women with asthma regarding the importance and safety of continuing their asthma medications during pregnancy to ensure good asthma control **ACTION: All Health Professionals.**

Critical care support can be initiated in a variety of settings. Critical care outreach nurses can work in partnership with midwives to provide care before transfer to the critical care unit. Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care **ACTION: All Health Professionals, Service Managers.**

In women over 20 weeks of gestation, if there is no response to correctly performed cardiopulmonary resuscitation within 4 minutes of maternal collapse or if resuscitation is continued beyond this, then perimortem caesarean section should be undertaken to assist maternal resuscitation. Ideally, this should be achieved within 5 minutes of the collapse **ACTION: All Health Professionals.**

4.2 Background

Deaths resulting from medical and surgical disorders (not the result of direct obstetric causes), but which were aggravated by the physiological effects of pregnancy, continue to form the greatest proportion of maternal deaths, with overall 139 out of 217 women (64%) dying from medical, surgical or mental health disorders during or up to six weeks after the end of pregnancy in the UK in 2016-18. This chapter examines in detail these deaths, with the excep-

tion of deaths from cardiac disease, malignancy, neurological disorders, psychiatric disease and sepsis which are considered within separate chapters of this report or other MBRRACE-UK reports during the triennial cycle (Knight et al. 2018, Knight et al. 2019).

Since the women described in this chapter had general medical or general surgical disorders it is of the utmost importance to disseminate the learning more widely than the maternity community of practitioners, and ensure that the messages and recommendations reach physicians, surgeons, emergency departments and others.

4.3 Summary of the key findings 2016-18

In the UK and Ireland there were 18 women who died during pregnancy or up to 42 days after pregnancy from other indirect causes between 2016-2018. This represents an overall mortality rate of 0.74 (95% CI 0.44-1.18) per 100,000 maternities in the UK and Ireland. A further 22 women died between 42 days and a year after the end of pregnancy, for whom records were available for 18 for detailed review.

Table 4.1: Causes of death for women who died during pregnancy or up to a year after the end of pregnancy from medical or general surgical disorders, UK and Ireland, 2016-18

Cause of death	Number of women (%) N=40
Endocrine	5 (13)
Gastrointestinal	11 (28)
Haematological	11 (28)
Respiratory	10 (25)
Unascertained	3 (8)

4.4 Overview of care and lessons to be learned

Endocrine disorders

Five women died from endocrine causes: three had diabetes, one had Conn's syndrome and one had hypokalaemia of unknown cause (possibly Gitelman's syndrome). Of the five women two had a history of substance misuse and difficulties with treatment adherence. Two women were suspected to be subject to domestic violence or in controlling relationships which affected their ability to manage their medication.

Of the three women with diabetes two died from diabetic ketoacidosis and one from hypoglycaemia.

> A woman with Type 1 diabetes had a history of difficulties with treatment adherence. She had established microvascular complications and had had multiple miscarriages. During her previous pregnancy she had tried very hard to improve her adherence and had tested her blood glucose over 25 times per day. Sadly that pregnancy miscarried. She died shortly after her next pregnancy was confirmed, from hypoglycaemia. This was thought to be due to an overzealous attempt by the woman to attain tight glycaemic control and probable hypoglycaemia unawareness.

In the last triennial report where deaths from diabetes were considered there were no deaths from hypoglycaemia, but this vignette again stresses the importance of support and care for women with diabetes between pregnancies, and in early pregnancy. Women with type 1 diabetes who have poor glycaemic control and hypoglycaemia unawareness may benefit from new continuous glucose monitoring equipment and insulin pumps. Support from specialist diabetes midwives / nurses is an essential part of the care of women with diabetes and this should begin ideally pre-pregnancy but certainly early in the first trimester.

> A pregnant woman who had recurrent hypokalaemia was not investigated for this, but simply prescribed potassium supplements. Her sister was known to have Gitelman's syndrome, a genetic renal disorder leading to severe hypokalaemia. She was found dead at home, with an extremely low serum potassium. It was presumed a cardiac arrhythmia had lead to her death.

Although it is uncertain what the underlying reason for this woman's death was, it is extremely unusual for a young woman to require potassium supplementation, and the underlying reason for this should have been investigated to establish a diagnosis. As recommended in previous reports, the need to positively establish a diagnosis is essential.

The emphasis should be on making a diagnosis, not simply excluding a diagnosis

Saving Lives, Improving Mothers' Care 2016 (Knight et al. 2016)

Gastrointestinal disorders

There were eleven women who died from gastrointestinal disorders; six of whom died between six weeks and one year after the end of pregnancy. Of the 11, five died from pancreatitis (or its complications); four died from bowel perforations or ulcers; one died following a volvulus and one woman from hyperemesis.

During her first pregnancy a woman repeatedly complained of abdominal pain, loss of appetite, bloating and vomiting. She had four admissions to hospital with these symptoms and also made several visits to her GP. A variety of common diagnoses were suggested including gastroesophageal reflux, pelvic girdle pain and abnormal fetal lie, but her symptoms were not investigated further. Antacids, analgesia and crutches were prescribed. She was induced and had a difficult labour and birth. A few weeks after giving birth, she was re-admitted to hospital with further pain and was found to have pancreatitis, secondary to multiple gallstones. She developed sepsis and disseminated intravascular coagulopathy and died, despite admission to intensive care and transfer to a specialist unit.

Previous MBRRACE-UK reports have emphasised the need to investigate women who present recurrently with pain, breathlessness, and more recently mental health concerns (Knight et al. 2016, Knight et al. 2018, Knight et al. 2020a). Had this woman's symptoms been investigated the gallstones would have been diagnosed during her pregnancy. Whilst they may have been managed conservatively in pregnancy, it is likely that she would have received more proactive treatment in the postnatal period.

Repeated presentation in pregnancy or postnatally with pain and/or pain requiring opiates should be considered a 'red flag' and warrants a thorough assessment of the woman to establish the cause

Saving Lives, Improving Mothers' Care 2018 (Knight et al. 2018)

One woman died from a volvulus and whilst it may have been incidental, the post mortem suggested that it was likely to be a consequence of her obstetric management.

An obese multiparous woman with previous vaginal births had a difficult second stage caesarean birth for fetal bradycardia followed by a major haemorrhage. In the postnatal period the woman had recurrent abdominal and chest pain which was investigated by ultrasound and upper GI endoscopy. A few months after giving birth she collapsed and resuscitation was unsuccessful. Post mortem revealed a volvulus, thought to be due to adhesions from the caesarean section.

Although this was a multiparous woman who had previous vaginal births and was progressing quickly in labour, no consideration appears to have been given to an instrumental vaginal birth. As the fetal head was low in the pelvis, it seems likely that vaginal birth would have been achievable. Instead a difficult caesarean section was performed and the subsequent adhesions precipitated the volvulus. Whilst this is an unusual complication, the learning point is that an unnecessary caesarean section may result in avoidable mortality.

Two women who died had perforations of their bowel at the site of the anastomosis from a gastric bypass.

A morbidly obese woman had previous uneventful pregnancies. She then had gastric bypass surgery and had a normal weight by the time she became pregnant. She had a spontaneous preterm birth with antenatal steroids given for fetal lung maturation and received non-steroidal anti-inflammatory drugs (NSAIDs) in the postnatal period. A few days after giving birth she collapsed and at laparotomy was found to have a perforation at the site of the previous gastrojejunal anastomosis. She died of subsequent multiorgan failure.

Women with previous bariatric surgery should be regarded as high risk during pregnancy. In the literature there are multiple reports of marginal ulcers at the site of the gastrojejunal anastomosis following gastric bypass surgery. Risk factors for ulcers include stress, steroids and NSAIDs, all of which this woman had experienced. Gastric bypass surgery should therefore be regarded as a relative contraindication to the prescription of NSAIDs in the postnatal period.

With increasing rates of obesity and a growing body of evidence supporting the health benefits of bariatric surgery, the number of women becoming pregnant following bariatric surgery is increasing. There is a variety of different operations, all with different benefits and risks. Complications include malabsorption syndromes, gastric dumping or anastomotic ulceration. Whilst the rate of adverse pregnancy outcomes is reduced in women who have undergone bariatric surgery compared to morbidly obese women, their risk of complications is greater than that of women of similar weight who have not undergone such surgery. A learning point from this report is that women who have had bariatric surgery should be regarded as high risk and be cared for by a multidisciplinary team with expertise in bariatric disorders (Shawe et al. 2019).

Provide specialist multidisciplinary care for pregnant women who have had bariatric surgery by a team who have expertise in bariatric disorders **N**

Haematology

In this triennium (2016-2018) eleven women died due to haematological causes. Four women died due to sickle cell disease; three due to thrombotic thrombocytopenic purpura (TTP); two due to haemophagocytic lymphohistiocytosis (HLH); one with a myeloproliferative disorder; and one due to vasculitis with cardiac involvement. Six women died while pregnant or within a few days after giving birth. The four women dying from sickle cell disease compares to only one in the previous triennium. Both women who died from HLH were from ethnic minority groups. Notably, in the last report when deaths from HLH were considered (Knight et al. 2017) all four women who died from HLH were from ethnic minorities. Given the disparity in mortality between white women and those from ethnic minority groups, it remains important to be aware of, and respond to, suspected HLH. This condition has a 50% case fatality and survival is more likely with prompt diagnosis and appropriate treatment. However, it is a complex condition and variable presentation may make it difficult to diagnose (Fardet et al. 2014). An 'H score' has now been validated which allows assessment of the probability that a woman has HLH based on features including known underlying immunosuppression, temperature, hepatomegaly or splenomegaly, cytopenias, high ferritin, high triglycerides, low fibrinogen, high serum glutamic oxaloacetic transaminase and the presence of haemophagocytosis on bone marrow aspirate (Fardet et al. 2014) *(http://saintantoine.aphp.fr/score/)*.

A woman with sickle cell disease developed chest syndrome in her first pregnancy, and had a delayed transfusion reaction. This made her reluctant to accept blood transfusions. In her second pregnancy she agreed to a transfusion in the third trimester. A few days later she attended the Emergency Department with abdominal and limb pain, chest signs and was hypoxic and tachycardic having developed hyperhaemolysis syndrome. It took several hours for the medical team to review her and she spent 10 hours in the Emergency Department, during which time she was not given oxygen or intravenous fluids. Neither the obstetric nor haematology teams were asked to review her. She was then transferred to the labour ward, and it was a further 7 hours before she was transferred to ICU as a bed was not available. A fetal bradycardia occurred leading to an emergency caesarean birth. She had a complicated postoperative course culminating in cardiac arrest and her death.

There were multiple delays in initiating treatment for this critically sick woman, and during the hours she was waiting in the emergency department her sickling would have worsened due to hypoxia and dehydration. The need for prompt multidisciplinary input at a senior level for critically sick pregnant women has been emphasised in all of the previous MBRRACE reports. Previous reports have also highlighted that critical care is a management modality, not a place, and that prompt initiation and continuation of treatment is mandatory irrespective of where the woman is situated. Assessment and treatment should not be delayed by the lack of bed availability on ICU. Critical Care outreach teams can facilitate both assessment and initiation of treatment.

Women admitted with sickle cell crisis should be looked after by the multidisciplinary team, involving obstetricians, midwives, haematologists and anaesthetists.

RCOG Green-top guideline 61 (Royal College of Obstetricians and Gynaecologists 2011)

Critical care support can be initiated in a variety of settings. Critical care outreach nurses can work in partnership with midwives to provide care before transfer to the critical care unit. Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care (Knight et al. 2016).

Critical care outreach or an equivalent service should be available to ill women, and provide support and education to healthcare professionals delivering enhanced maternal care.

Care of the critically ill woman in childbirth; enhanced maternal care 2018 (Maternal Critical Care/Enhanced Maternity Care Standards Development Working Group 2018)

An older multiparous woman, who had not received the 'flu vaccine, presented with 'flu-like symptoms in the early second trimester. She had been prescribed oseltamivir by her GP. She had grossly deranged renal and liver function, with a profound thrombocytopenia (platelets 19 x 10^9/l). She was given fluids and antibiotics and was reviewed by a physician, with input from a microbiologist, but not a haematologist. She deteriorated overnight with little response from clinicians. The following morning a haematologist made the diagnosis of TTP. She became increasingly unstable with a falling blood pressure. A caesarean section was considered but not performed. Ultrasound showed intrauterine fetal death. She had a cardiac arrest and could not be resuscitated. Perimortem caesarean section was not performed as part of the resuscitation as the fetus had demised. Her 'flu swab' was negative.

This woman's story re-emphasises many of the messages from previous reports. In particular it highlights the importance of the need to recognise deterioration in a woman's condition, and that whilst MEOWS scores can help to identify these women, timely escalation of treatment is needed in response. Whilst there was involvement of some senior members of the multidisciplinary team, a haematologist was not involved in her care initially despite the profound thrombocytopenia. Had the haematologist been involved earlier it is likely that the diagnosis of TTP would have been made sooner. This woman had not had the 'flu vaccine and it is possible that a broader range of differential diagnoses would have been considered, if she had. Previous reports have highlighted that perimortem caesarean section is an integral part of maternal resuscitation. However, a caesarean section was not performed for this woman as the fetus had already demised. It is important to stress that a perimortem caesarean section is done to facilitate maternal resuscitation, and should therefore be performed irrespective of whether the fetus is alive or not. This is reflected in the alternative term resuscitative hysterotomy, which defines the primary purpose of the procedure and may help to avoid the erroneous assumption that the procedure is performed for fetal reasons.

In women over 20 weeks of gestation, if there is no response to correctly performed cardiopulmonary resuscitation within 4 minutes of maternal collapse or if resuscitation is continued beyond this, then perimortem caesarean section should be undertaken to assist maternal resuscitation. Ideally, this should be achieved within 5 minutes of the collapse.

RCOG Green-Top Guideline 56 (Royal College of Obstetricians and Gynaecologists 2019)

Respiratory

Ten women died from respiratory disorders; 6 from asthma (2 early, 4 late) and 4 from cystic fibrosis (3 early, 1 late). Although still small, the number of women dying from cystic fibrosis is increasing (2 in the 2013-2015 triennium, 2 in the four year period 2009-12 and none in 2006-8). This may reflect better care for women with this condition, and more women with cystic fibrosis choosing to embark on pregnancy. The incidence of cystic fibrosis in pregnancy in the UK has been estimated at 4.4 per 100 000, with women with poor lung function having poorer pregnancy outcomes (Ashcroft et al. 2020).

A woman with cystic fibrosis and associated poor lung function and poor venous access, with complex psychosocial circumstances, became pregnant. She had not had any formal pre-pregnancy counselling. She had comprehensive multidisciplinary care during her pregnancy, but a preterm birth was necessary because of her deteriorating health. A chest X-Ray request was declined because of her pregnancy, and this was not challenged by the team caring for her. A contraceptive implant was inserted two weeks after she had given birth. The woman died four months later from her underlying lung disease.

This woman appeared to have had no pre-pregnancy counselling or contraception advice, despite having severe disease and difficult social circumstances. The need for pre-pregnancy consultation and contraceptive advice for women with long term medical co-morbidities has been highlighted in previous reports. Shortly after giving birth long acting reversible contraception (LARC) was provided. This was good practice and should be available in all maternity units as described in the Faculty of Reproductive and Sexual Health guideline 'Contraception after Pregnancy' (Faculty of Sexual and Reproductive Healthcare 2017).

Services providing care to pregnant women should be able to offer all appropriate methods of contraception, including LARC, to women before they are discharged from the service.

Faculty of Sexual and Reproductive Health Guideline: Contraception after Pregnancy (Faculty of Sexual and Reproductive Healthcare 2017)

Women with pre-existing medical conditions should have pre-pregnancy counselling by doctors with experience of managing their disorder in pregnancy (Knight et al. 2014)

It was inappropriate for the request for the chest X-ray to be declined by the radiology department, as the radiation risk is minimal (equates to 3 days of background radiation). Equally, the team caring for her should have challenged this, if they felt that the X-ray was clinically indicated.

With few exceptions, radiation exposure through radiography, computed tomography (CT) scan, or nuclear medicine imaging techniques is at a dose much lower than the exposure associated with fetal harm. If these techniques are necessary in addition to ultrasonography or MRI or are more readily available for the diagnosis in question, they should not be withheld from a pregnant patient.

American College of Obstetricians and Gynecologists Committee Opinion No. 723: Guidelines for Diagnostic Imaging During Pregnancy and Lactation (Committee on Obstetric Practice 2017)

A young woman with learning difficulties was admitted to hospital in the first trimester with an exacerbation of asthma and was prescribed a beclomethasone and formoterol inhaler and a 5 day course of oral steroids. She had an uncomplicated pregnancy and birth. Several weeks after giving birth she took NSAIDs and died from an acute asthma attack.

This woman's story highlights the increased vulnerability of women with learning difficulties. Prior to her pregnancy there does not appear to have been a discussion about contraception, with an assumption being made that she was not sexually active. During her pregnancy an assessment of the severity of her asthma, treatment and adherence was not documented. This may have been that the assessment was not attempted, or it may have been that the woman was unable to provide this information due to her learning difficulties. If the woman was unable to provide the information it should have been sought from the GP. Electronic access should facilitate the sharing of medical records between primary and secondary care, but at present this is not available in many areas. The woman's admission during the first trimester, and her need for oral steroid therapy should have alerted the team to the severity of her asthma, and prompted a more comprehensive assessment and support. It seems likely that an unsupported woman with learning difficulties would not realise that NSAIDs would exacerbate her asthma. Women with learning difficulties need increased support during and after pregnancy, as they may be unable to recount their history, understand or retain advice.

Asthma is an extremely common respiratory condition, but has a wide range of severity. Studies have shown that many patients do not understand the respective roles of their reliever or preventer treatment, or how to escalate their therapy to control worsening symptoms. In pregnancy many women will reduce or stop their medication. Informed discussion with women about their treatment plays an important role in ensuring adherence and guidance on the management of asthma in pregnancy is available (BTS/SIGN 2019).

Women should be advised of the importance of maintaining good control of their asthma during pregnancy to avoid problems for both mother and baby.

Counsel women with asthma regarding the importance and safety of continuing their asthma medications during pregnancy to ensure good asthma control.

BTS-SIGN 158 British guidelines on the management of asthma (BTS/SIGN 2019)

Ensure a thorough history is obtained from women with a pre-existing medical disorder to ascertain its severity **N**

Unascertained

There were three woman where the cause of death was unascertained. There will sadly always be a small number of women where either there are several possible underlying reasons for their deaths, or the low quality or absence of a post-mortem examination means a diagnosis cannot be established, and therefore where the family's questions are unanswered and the learning from their deaths is limited.

4.5 Conclusions

Many of the women in this chapter had uncommon medical disorders, but at times the level of complexity and/or severity was not recognised. There were examples where women died despite excellent multidisciplinary care, but in almost a quarter of these women improvements to their care, may have made a difference to their outcome.

There were examples where the medical complexity of the woman was compounded by mental health conditions, difficult social circumstances or learning difficulties. These women should be regarded as extremely vulnerable as their ability to comply with treatment may be compromised. NSAIDs were implicated in the death of at least two of the women. Care should be taken when prescribing these in the postnatal period, and relative contraindications considered.

It is likely that the number of pregnant women who have had bariatric surgery will increase, and these women should be regarded as a high risk group, both during pregnancy and in the postnatal period.

Many of the messages from previous reports appear again. This represents a missed opportunity for learning, improvement in care and prevention of maternal deaths. Mechanisms need to be established to disseminate the learning from this report, not only to the maternity community of clinicians, but more widely to GPs, Emergency Department practitioners, physicians and surgeons

Establish a mechanism to disseminate the learning from this report, not only to maternity staff, but more widely to GPs, emergency department practitioners, physicians and surgeons **N**

Table 4.2: Classification of care received by women who died from other indirect causes and for whom case notes were available for an in-depth review, UK and Ireland, 2016-18

Classification of care received	Number of women (%) N=36*
Good care	19 (53)
Improvements to care which would have made no difference to outcome	9 (25)
Improvements to care which may have made a difference to outcome	8 (22)

* Insufficient information to assess for 4 women who died more than 6 months after the end of pregnancy

5. Improving anaesthetic care

James Bamber and Nuala Lucas on behalf of the MBRRACE-UK anaesthetic care chapter-writing group

Chapter writing group members: James Bamber, Nuala Lucas, Kathryn Bunch, Rhiannon D'Arcy, Malcolm Griffiths, Sara Kenyon, Marian Knight, Jenny Kurinczuk, Sebastian Lucas, Alison Rodger, Frank Schroeder, Sarah Wheatly.

Peer review: Philip Banfield, David Churchill

5.1 Key messages

New recommendations

Ensure that women on prophylactic and treatment dose anticoagulation have a structured management plan to guide practitioners during the antenatal, intrapartum and postpartum period. Identify clear lines of responsibility to facilitate prescribing of thromboprophylaxis when indicated in the plan. **ACTION: All Health Professionals.**

Ensure maternity units have protocols to support decision-making in the provision of neuraxial analgesia and anaesthesia to women who may be at risk of having abnormal coagulation. **ACTION: Hospitals/Trusts/Health Boards.**

Where there is concern about a woman's condition during recovery after surgery the anaesthetist has a responsibility to make a full assessment, diagnosis and a plan of care which may include escalation measures and seeking senior advice. The anaesthetist has a responsibility to ensure the plan of care has been implemented and to reassess the woman's condition. **ACTION: Anaesthetists.**

Existing recommendations requiring improved implementation

Pregnant women with complex needs or a complex medical history should have timely antenatal multi-disciplinary planning, and an experienced obstetric anaesthetist should contribute to the planning. **ACTION: All Health Professionals, Service Managers.**

Prompt action and good communication within and between teams are crucial when dealing with sudden unexpected catastrophes, especially when the diagnosis is not immediately clear. **ACTION: All Health Professionals, Service Managers.**

In sudden onset severe maternal shock e.g. anaphylaxis, the presence of a pulse may be an unreliable indicator of adequate cardiac output. In the absence of a recordable blood pressure or other indicator of cardiac output, the early initiation of external cardiac compressions may be life- saving. **ACTION: All Health Professionals, Service Managers.**

Pregnant or postpartum women recovering from anaesthesia require the same standard of postoperative monitoring, including documentation, as non-obstetric patients. **ACTION: All Health Professionals, Service Managers.**

5.2 Background

Anaesthetists are essential members of the multidisciplinary team in hospital maternity care. The quality of care contributed by anaesthetists impacts directly on maternal morbidity and mortality beyond the confines of administering anaesthesia.

In the UK it is estimated that, within a triennium covered by a chapter in these reports, anaesthetists will have provided anaesthesia for 577,000 caesarean sections (50,400 under general anaesthesia) and sited epidurals for labour analgesia to 477,000 women (Bamber and Lucas 2017).

Fifty years ago, in the Report for the 1970-72 triennium (Arthure et al. 1975), there were 37 maternal deaths in England and Wales attributed to anaesthesia representing 10% of all maternal deaths due to direct causes. The administration of general anaesthesia was involved in over 90% of these deaths. We report on one maternal death in this triennium which is directly attributed to anaesthesia. There are myriad reasons for the reduction in maternal deaths attributed to anaesthesia. These include changes in practice (e.g. greater use of neuraxial anaesthesia for caesarean section, and the use of lower concentrations of local anaesthetic for epidural analgesia) and better patient monitoring. Most importantly, better training of anaesthetists in obstetric anaesthesia and the leadership of

senior anaesthetists with recognised subspecialty interest in obstetric anaesthesia has minimised fatalities when complications from anaesthesia in pregnancy do occur. Findings from earlier CEMD reports have made a substantial contribution to these changes in practice.

In the preparation of this report, anaesthetists have reviewed 295 maternal deaths. This provides an opportunity to seek out lessons in how anaesthetists can contribute to further improving the care delivered to women. We have evaluated all these reports to draw out these lessons.

5.3 Summary of the key findings 2016-18

A woman who was asthmatic and treated for impaired glucose tolerance had an elective repeat caesarean section for which she had spinal anaesthesia. Soon after the birth of her baby the woman had difficulty breathing. She was given a general anaesthetic and intubated. However, after intubation ventilation was difficult and the endotracheal tube was replaced but with little improvement of ventilation. Hypoxaemia persisted despite treatment with adrenaline, antihistamines and salbutamol. She had a cardiac arrest and a prolonged period of CPR. During this period, she underwent a hysterectomy for an atonic uterus and her haematological indices suggested the onset of disseminated intravascular coagulation. Later investigations confirmed brainstem death due to hypoxia. Her death was attributed to an air embolism.

One woman's death was attributed to anaesthesia due to an air embolus. Assessors did not feel that improvements in care would have made a difference to her outcome. Venous air embolism (VAE) during caesarean section may be an under-recognised but common phenomenon, with an incidence of between 10-97% depending on the method used for detection (Kim et al. 2008). It rarely leads to catastrophic cardiorespiratory collapse. In women having caesarean section under neuraxial anaesthesia the symptoms of VAE may include chest tightness and breathlessness with or without decreased pulse oximetry reading and hypotension. During general anaesthesia other signs may include acute decrease in end tidal carbon dioxide concentrations and increased end-tidal nitrogen concentrations. These symptoms and signs are common in other embolic complications such as amniotic fluid embolism and those complications that result in acute hypotension such as haemorrhage, anaphylaxis and cardiac failure.

Technologies suggested to aid diagnosis of VAE include echocardiography (e.g. transthoracic echocardiography) and precordial doppler ultrasound. The use of transthoracic echocardiography in the obstetric theatre is limited by accessibility and training in its use. Precordial doppler ultrasound may be more readily available in the obstetric theatre but it has a low specificity and would also require some experience in its use. For those women who have general anaesthesia the detection of an increase in end-tidal nitrogen may be the most sensitive method, but this mode of measurement is not commonly available in anaesthesia monitors (Kim et al. 2008). The incidence of VAE during caesarean section may be reduced by use of 5 degrees head up (reverse Trendelenburg) during open abdominal surgery if this is not precluded by other clinical considerations or priorities (Fong et al. 1991).

Prompt action and good communication within and between teams are crucial when dealing with sudden unexpected catastrophes, especially when the diagnosis is not immediately clear

Saving Lives, Improving Mothers' Care 2014 (Knight et al. 2014)

In the severe circumstances of low cardiac output and difficult ventilation early external chest compressions may assist cardiac output and contribute to the breakup of intraventricular air and its transit through the pulmonary circulation. The role of early implementation of chest compressions in situations of low cardiac output and difficult ventilation (e.g. anaphylaxis) was highlighted in the anaesthesia chapter in the 2017 report (Bamber and Lucas 2017) and in a recent publication recommending consideration of initiating cardiac compressions if the systolic blood pressure is <50mmHg (Harper et al. 2020).

In sudden onset severe maternal shock e.g. anaphylaxis, the presence of a pulse may be an unreliable indicator of adequate cardiac output. In the absence of a recordable blood pressure or other indicator of cardiac output, the early initiation of external cardiac compressions may be life saving

Saving Lives, Improving Mothers' Care 2017 (Knight et al. 2017)

5.4 Overview of care and lessons to be learned

There were many instances in which the anaesthetic care was exemplary, and the anaesthetist initiated prompt and vital care in women with previously unrecognised critical illness. This emphasises that good maternity care depends on the anaesthetist being fully involved as part of the multidisciplinary team and why a senior anaesthetist should be involved in all serious incident reviews in maternity care.

There were, however, some instances in which the reviews of care by the anaesthetic assessors highlighted opportunities where care could have been improved.

Thromboprophylaxis

There were several occasions where there was an opportunity for the anaesthetist to review a woman's risk of venous thromboembolism (VTE) and to prescribe thromboprophylaxis in accordance with national guidelines. The review of the care of women who survived a pulmonary embolism, described in Chapter 6 of this report, highlighted a number of instances when there were gaps in women's thromboprophylaxis around the time of giving birth and highlighted a need to ensure that women on prophylactic or treatment dose anticoagulation have a structured management plan to guide clinicians during the antenatal, intrapartum and postpartum. While prescription of low molecular weight heparin (LMWH) should not be expected to be the sole responsibility of the anaesthetist, there may be opportunities for anaesthetists to ensure that management plans are followed.

Ensure that women on prophylactic and treatment dose anticoagulation have a structured management plan to guide practitioners during the antenatal, intrapartum and postpartum period.

Identify clear lines of responsibility to facilitate prescribing of thromboprophylaxis when indicated in the plan. **N**

Antenatal review of women with complex health needs and comorbidities

As highlighted in previous reports some of the women who died had complex health needs or significant comorbidities and should have been referred for antenatal review by an anaesthetist to facilitate planning of intrapartum care. This includes women with a history of substance use in whom vascular access and pain management may be difficult and require planning, or women with co-morbidities that may be associated with aortopathies e.g. Turner syndrome.

Pregnant women with complex needs or a complex medical history should have timely antenatal multidisciplinary planning, and an experienced obstetric anaesthetist should contribute to the planning.

Saving Lives, Improving Mothers' Care 2019 (Knight et al. 2019)

Timely provision of neuraxial analgesia in labour

A woman with moderate pre-eclampsia was admitted for induction of labour. When she was in active labour she requested epidural analgesia but this was delayed for several hours pending the results of a full blood count and a coagulation screen that had been requested by the anaesthetist. The woman's blood pressure was difficult to control and she required several doses of antihypertensive drugs. Her platelet count and coagulation screen were normal.

Effective neuraxial analgesia in labour may contribute to blood pressure management in a woman with pre-eclampsia. Timely planning for neuraxial analgesia or anaesthesia is required as soon as a woman is admitted for delivery. The assessment of platelet count and coagulation should not cause excessive delay for the provision of neuraxial analgesia when a woman is in labour. Maternity units should have protocols to support decision-making in the provision of neuraxial analgesia and anaesthesia to women who may be at risk of having abnormal coagulation e.g. pre-eclampsia.

Ensure maternity units have protocols to support decision-making in the provision of neuraxial analgesia and anaesthesia to women who may be at risk of having abnormal coagulation **N**

Anaesthetic management of major obstetric haemorrhage

Lessons for care in major obstetric haemorrhage are included in Chapter 7 of this report. It is important to reiterate the crucial role of the anaesthetist in the resuscitation, management and post-operative care of women who have obstetric haemorrhage. However, there were several instances of maternal haemorrhage where the care provided by the anaesthetist could have been improved. The relevant messages and themes have been highlighted in previous reports and include:

1. The impact of body weight on blood volume: smaller women can only tolerate smaller volumes of blood loss.
2. The importance of seeking senior support early.
3. The importance of ensuring adequate intravenous access to facilitate fluid resuscitation
4. The need to use appropriate rapid fluid warming devices during fluid resuscitation and transfusion.
5. The key role of immediately accessible protocols for the management of major haemorrhage and adherence to these protocols.
6. Regular monitoring of the effectiveness of resuscitation by point of care testing of haematological parameters (haemoglobin) and biochemical parameters (lactate and base deficit) alongside repeated samples for laboratory testing.
7. If viscoelastic monitoring is used to guide management of coagulation, the anaesthetist needs to have available an agreed guideline that is simple to use for interpreting the results to manage care appropriately.
8. The importance of ensuring that there is evidence that there has been adequate resuscitation of a woman who has had an obstetric haemorrhage and that the haemorrhage has ceased prior to extubation.
9. The appropriate choice of anaesthesia (general versus neuraxial) for the management of haemorrhage.

Recognition of the woman whose condition is deteriorating in the recovery room

On some occasions, the anaesthetist either did not recognise or acknowledge that a woman's condition was deteriorating while she was being recovered after anaesthesia for a theatre procedure. The significance of symptoms such as pain were not recognised; pain that is disproportionate to that which would be expected or that is difficult to manage maybe a sign of acute deterioration (e.g. bleeding or sepsis) and warrants anaesthetic or obstetric review.

After extubation following general anaesthesia for an emergency caesarean section, a woman was drowsy, tachycardic, hypothermic and hypoxaemic. The anaesthetist was asked by the recovery staff to review the woman. Occult blood loss was suspected by the anaesthetist who ordered the administration of a small fluid bolus as well as an ECG and blood gas. The anaesthetist then left the woman. There was a delay in giving the intravenous fluid and the woman's condition deteriorated. She was taken back to theatre for examination under general anaesthesia. She had massive obstetric haemorrhage requiring multiple transfusions and hysterectomy but had a fatal intraoperative cardiac arrest.

After extubation following a general anaesthetic for a category one caesarean section with minimal blood loss, a woman had a persistently elevated respiratory rate. After being asked to review the woman the anaesthetist gave the woman a further dose of reversal for neuromuscular blockade. There was no further assessment or investigations. The woman later had a cardiac arrest and returned to theatre for a laparotomy for suspected intraabdominal bleeding, but none was found. The woman was later found to have streptococcus sepsis.

Pregnant or postpartum women recovering from anaesthesia require the same standard of postoperative monitoring, including documentation, as non-obstetric patients.

Saving Lives, Improving Mothers' Care 2014 (Knight et al. 2014)

Where there is concern about a woman's condition during recovery after surgery, the anaesthetist has a responsibility to make a full assessment, diagnosis and a plan of care which may include escalation measures and seeking senior advice. The anaesthetist should ensure that the plan of care has been implemented including a reassessment of the woman's condition. **N**

Appropriate management of failed neuraxial anaesthesia

A woman had unsatisfactory labour epidural analgesia. She required a trial of assisted delivery in theatre but there were failed attempts at spinal anaesthesia. The obstetrician gave a pudendal block for an assisted vaginal birth of a large baby complicated by shoulder dystocia and perineal tear. The woman was given general anaesthesia for repair of the tear.

There should be appropriate local guidance available on how to manage situations when there have been failed attempts at providing neuraxial anaesthesia or when neuraxial anaesthesia has failed. Reliance on local anaesthetic infiltration or peripheral nerve blocks by the obstetrician may be insufficient if complications develop.

Appropriate management of post-dural puncture headache

During the period covered by this report, the assessors identified some instances where the management of post-dural puncture headache (PDPH) deviated significantly from accepted practice, although none were related to a maternal death. PDPH was associated with two maternal deaths in the 2014 MBRRACE-UK report (Knight et al. 2014). Guidance on the management of PDPH was published in 2019 to support a standardised approach to the management of this problem (Russell et al. 2019a, Russell et al. 2019b).

5.5 Conclusions

Maternal mortality directly attributed to anaesthesia continues to be rare. Detailed anaesthetic review of all maternal deaths undertaken by the MBRRACE-UK enquiries provides a unique opportunity to evaluate all aspects of the care received by women included in this report. There were many examples of excellent anaesthetic care provided. However, there were also examples where the anaesthetic input provided, while not directly contributing to a woman's death, could have been improved. MBRRACE-UK assessments identify lessons learned so that anaesthetic practice can continue to be improved through awareness and education. Many of these lessons will be familiar to experienced obstetric anaesthetists, but the need for their continued reiteration highlights the crucial role that MBRRACE-UK reports play in the education of subsequent generations of obstetric anaesthetists.

6. Messages for the prevention and treatment of thromboembolism

Marian Knight, Teresa Kelly, Laura Magee, Robin Russell and Cathy Nelson-Piercy on behalf of the MBRRACE-UK VTE morbidity chapter-writing group

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6.1 Key messages

New recommendations

Be aware that pulmonary embolism can occur in women receiving thromboprophylaxis. Follow RCOG guidelines for investigation and treatment of venous thromboembolism if women receiving thromboprophylaxis develop symptoms and signs suggestive of PE **ACTION: All Health Professionals.**

Develop guidance to indicate the need for definitive radiological diagnosis in women who have an inconclusive VQ scan. **ACTION: Royal Colleges of Physicians, Radiologists, Obstetricians and Gynaecologists**.

Ensure that women on prophylactic and treatment dose anticoagulation have a structured management plan to guide practitioners during the antenatal, intrapartum and postpartum period. **ACTION: All Health Professionals.**

Ensure that a consultant reviews and prioritises women prescribed prophylactic and treatment dose anticoagulation waiting for induction of labour in order to reduce the time these women are not receiving low molecular weight heparin. **ACTION: All Health Professionals.**

Existing recommendations requiring improved implementation

There is clear evidence that doctors and midwives find existing risk scoring systems difficult to apply consistently in practice. There is a need for development of a tool to make the current risk assessment system simpler and more reproducible. **ACTION: NHSE/I and equivalents in the devolved nations and Ireland.**

Audits should be conducted not only to assess whether thromboembolism risk assessment was performed, but also whether the calculated risk score was correct. **ACTION: All Health Professionals, Service Managers.**

Reassessment of VTE risk after miscarriage or ectopic pregnancy to consider whether thromboprophylaxis is required is as important as reassessment of risk after giving birth. **ACTION: All Health Professionals.**

Thrombolysis or surgical embolectomy should be considered for pregnant women with high-risk PE. **ACTION: All Health Professionals.**

Women should be offered a choice of LMWH or oral anticoagulant for postnatal therapy after discussion about the need for regular blood tests for monitoring of warfarin, particularly during the first 10 days of treatment. **ACTION: All Health Professionals.**

Women should be advised that neither heparin (unfractionated or LMWH) nor warfarin is contraindicated in breastfeeding. **ACTION: All Health Professionals.**

Postnatal review for women who develop VTE during pregnancy or the puerperium should, whenever possible, be at an obstetric medicine clinic or a joint obstetric haematology clinic. **ACTION: All Health Professionals.**

6.2 Background

Venous thromboembolism (VTE) has been the leading direct cause of maternal death in the UK for more than 20 years. While this partly reflects more women entering pregnancy with risk factors for VTE, previous reports have identified clear opportunities to improve prevention and treatment. An estimated 50 women have a pulmonary embolism (PE) during pregnancy for every woman who dies (Goodacre et al. 2019), frequently with associated long-term morbidity. This morbidity enquiry aimed to identify whether further messages for prevention and treatment could be identified through review of the care of women who survived following PE during pregnancy or immediately postpartum.The women who died

6.3 The women included

As noted in Chapter 2, the 34 women whose care was examined for the purposes of this chapter were a sample of women identified in a UKOSS study of women with PE during or shortly after pregnancy conducted between 1st March 2015 and 31st August 2016 (Goodacre et al. 2019). All women whose care was reviewed were from the UK; women from the Republic of Ireland were not included. All women were alive at the time of their inclusion in the UKOSS study and did not die in the year following the end of pregnancy.

Table 6.1: Characteristics of women who survived after a pulmonary embolism

Characteristics	N=34 Number (%)
Age (in Years)	
<25	7 (21)
25-34	19 (56)
≥35	8 (24)
Parity	
0	8 (24)
≥1	26 (76)
Ethnicity	
White European	30 (88)
Other	4 (12)
Socioeconomic status (Occupational classification)	
Employed (Either woman or partner)	28 (82)
Unemployed (Both)	5 (15)
Missing	1 (3)
Body mass index (BMI)	
18-24	20 (59)
25-29	11 (32)
≥30	3 (9)
Smoking status	
Yes	6 (18)
No	28 (82)
Any pre-existing medical or mental health problem (excluding obesity)	
Yes	18 (53)
No	16 (47)

6.4 Overview of care and lessons to be learned

Risk factors

Many of the messages identified from review of the care of women who died from venous thromboembolism (VTE) (Knight et al. 2018) were evident amongst women who had a pulmonary embolism (PE) but survived. Despite guidance, VTE risk assessments were not performed at booking visits, on hospital admission or postnatally, and scoring errors in VTE risk assessments were common. This was particularly noted when women were admitted to settings other than maternity (gynaecology or acute medicine) or gave birth outside hospital.

An older woman was admitted to a gynaecology ward with a suspected ectopic pregnancy following assisted reproduction. No venous thromboembolism risk assessment was undertaken on admission. She underwent a laparoscopic salpingectomy. No venous thromboembolism risk assessment was undertaken prior to discharge and she was discharged home with no thromboprophylaxis. She was readmitted with breathlessness a week later when a pulmonary embolism was diagnosed. M

This woman had two risk factors for VTE at the time of admission (age over 35 and assisted reproduction) and following surgery should have received at least 10 days of thromboprophylaxis.

Reassessment of VTE risk after miscarriage or ectopic pregnancy to consider whether thromboprophylaxis is required is as important as reassessment of risk after giving birth.

Any surgical procedure in pregnancy or the puerperium gives a score of 3 in the RCOG thromboprophylaxis guidance, indicating that 10 days of postnatal thromboprophylaxis should be considered

RCOG Green-top Guideline 37a (Royal College of Obstetricians and Gynaecologists 2015a).

A woman in her fifth pregnancy with known medical co-morbidities and a family history of VTE gave birth at home. No VTE risk assessment was undertaken postnatally. She attended the emergency department a week later with leg pain which was considered musculoskeletal in origin and she was discharged. She represented a few days later with ongoing leg pain and breathlessness, when her extensive DVT and PE were diagnosed. M

On the basis of her history alone, this woman should also have received ten days of thromboprophylaxis immediately postpartum, and this emphasises the importance of postnatal VTE assessment across all birth settings.

Risk assessment for venous thrombosis (VTE) should be undertaken at booking and repeated at any hospital admission, intrapartum or immediately postpartum in all birth settings, and before discharge from hospital. (Knight et al. 2015)

A woman with a chronic inflammatory condition became pregnant following in vitro fertilisation. She was admitted several times in pregnancy with complications of her condition to both obstetric and acute medical settings. She had three different VTE risk scores documented but did not receive antenatal thromboprophylaxis. In the early third trimester she presented with pleuritic chest pain and shortness of breath when a PE was diagnosed. M

VTE scoring inconsistencies and inaccuracies were common. This woman had a score of 4 from early pregnancy and should have received antenatal thromboprophylaxis. The varying scores in her records probably reflect a lack of understanding of the risk of her inflammatory condition, but even without this understanding, her repeated admissions should have triggered discussions about consideration of thromboprophylaxis. As highlighted elsewhere in this report and previous reports (Knight et al. 2020a), new maternal medicine networks in England, and equivalent structures in the devolved nations, provide an ideal route to obtain advice about medical treatment of pregnant and postpartum women. Staff in non-maternity settings need to be aware of these networks as a route to obtain expert advice.

Audits should be conducted not only to assess whether thromboembolism risk assessment was performed, but also whether the calculated risk score was correct.

Saving Lives, Improving Mothers' Care 2018 (Knight et al. 2018)

However, even when performed correctly, VTE risk assessment will not identify all women who are destined to have VTE, emphasising the need to maintain a broad differential diagnosis during clinical evaluation of symptoms. A few women whose care was examined for the purposes of this chapter had no apparent risk factors prior to their PE and it is important that the diagnosis is not discounted in this situation. Even the best prediction model for postnatal VTE risk screening identifies only two thirds of women with VTE (Sultan et al. 2016).

A woman in her first pregnancy with no VTE risk factors developed shortness of breath and chest pain in the second trimester. She attended her GP and was treated with antibiotics and advised to return in three days if she had no improvement. When she returned she was referred to hospital by her GP when her PE was diagnosed. She was treated with low molecular weight heparin and had a clear documented plan for anti-coagulation throughout her pregnancy, labour and postpartum. She had a normal birth and uneventful recovery postpartum. M

This woman's symptoms were recognised and acted upon and it is important to remember that pregnancy itself is a risk factor for VTE. Her GP appropriately managed her initially for a suspected infection, but with safety-netting in the event of a lack of improvement. If clinical assessment raises a high suspicion of infection and the woman is well, it is appropriate to treat empirically with antibiotics for presumed pneumonia. However, clear plans for re-presentation for re-evaluation, and follow-up, at minimum by phone, should be feasible and in place. The clear documented plan for anticoagulation ensured that she received appropriate treatment throughout pregnancy, labour and the puerperium without additional risk periods when she was not anticoagulated.

Assessors noted that incorrect assessment of risk could also have major long term consequences on the basis of diagnostic mislabelling.

A woman who was heterozygous for factor V Leiden was inappropriately prescribed LMWH thromboprophylaxis from early pregnancy on the advice of her haematologist. She had no previous episodes of VTE and no history of VTE in first degree relatives. She had two episodes of respiratory failure during pregnancy requiring intensive care unit admission, and although she was also treated with antibiotics, both episodes were assumed to be due to PE without any imaging being undertaken. She recovered, but was discharged on long-term anticoagulation. M

This woman's antenatal risk assessment was incorrect and she should not have received antenatal thromboprophylaxis. This may have been because the local risk assessment form differed from that in RCOG guidance. Her presumed risk of VTE led to bias in thinking and an assumption that PE was the underlying cause of her symptoms. Imaging was not undertaken because of a perceived risk of breast cancer. The postnatal clinic letter from haematology fails to point out that no imaging was performed in order to diagnose PE, and it leaves the woman with a lifelong definite label of PE. Assessors felt this woman's symptoms were most likely caused by infection and associated sepsis. Since the diagnosis of PE was not clarified with appropriate imaging, the diagnosis will now be presumed for the rest of her life.

Thromboprophylaxis

An older multiparous woman became unwell and was admitted with an infection in the third trimester. She received thromboprophylaxis while an inpatient. Two weeks after discharge she reattended with a two day history of shortness of breath. The initial diagnosis was presumed to be pneumonia but further investigations revealed a pulmonary embolism. M

As this woman shows, PE may develop despite receipt of thromboprophylaxis. In this woman and two others, the fact that they were receiving or had received thromboprophylaxis initially led to the possibility of PE being discounted. Although low molecular weight heparin (LMWH) reduces risk by over 90%, it does not completely eliminate risk (Roeters van Lennep et al. 2011, Lazo-Langner et al. 2018, Cox et al. 2019).

There is clear evidence that doctors and midwives find existing risk scoring systems difficult to apply consistently in practice. There is a need for development of a tool to make the current risk assessment system simpler and more reproducible.

Saving Lives, Improving Mothers' Care 2018 (Knight et al. 2018)

Diagnosis/imaging

The acute presentation of PE is associated with non-specific symptoms that could represent a variety of cardiorespiratory diagnoses, including but not limited to PE. Few women (<5%) with suspected PE actually have this diagnosis confirmed following diagnostic imaging (Chan 2018). As such, clinicians must consider a broad differential diagnosis, and not be convinced or dissuaded from further PE investigations because of a prior risk score that indicates high or low risk.

An older woman had a complicated caesarean birth followed by major obstetric haemorrhage and two further laparotomies. She appropriately received mechanical and pharmacological thromboprophylaxis. A week later she developed tachypnoea and was assumed to have sepsis. The diagnosis of PE was not considered and was only identified coincidentally two days later on abdominal CT. Following confirmation by CTPA she was fully anticoagulated. M

If the diagnosis of PE is considered most likely, there is no clinical decision rule that has been found to be useful in replacing the radiological evaluation of women with suspected PE, whether focussed on sensitivity, specificity, or optimisation of both (Goodacre et al. 2019, Goodacre et al. 2020).

Be aware that pulmonary embolism can occur in women receiving thromboprophylaxis. Follow RCOG guidelines for investigation and treatment of venous thromboembolism if women receiving thromboprophylaxis develop symptoms and signs suggestive of PE. **N**

A woman with no risk factors for PE presented to the emergency department with chest pain in the third trimester. She had a VQ scan and this showed an intermediate possibility of a PE. She was commenced on anticoagulation for the remainder of her pregnancy and puerperium. M

Ten months later this woman experienced similar symptoms which were not thought to be due to PE. A second woman with a similarly inconclusive VQ scan declined CTPA because of concerns over the risks. If radiological investigations are declined or inconclusive, every effort should be made to reach a diagnosis, as a history of VTE has lifelong implications for women. The risks of either VQ or CTPA are small and must be considered against the risks of unnecessary anticoagulation and diagnostic mislabelling. A multidisciplinary team meeting will help to resolve diagnostic uncertainties.

Women with suspected PE should be advised that, compared with CTPA, V/Q scanning may carry a slightly increased risk of childhood cancer but is associated with a lower risk of maternal breast cancer; in both situations, the absolute risk is very small.

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

Develop guidance to indicate the need for definitive radiological diagnosis in women who have an inconclusive VQ scan. **N**

Management of acute VTE

A young woman with no antenatal risk factors was appropriately risk-assessed after emergency caesarean birth and discharged with ten days of postnatal LMWH. She collapsed at home a month later. A CT scan indicated a saddle embolus and she underwent thrombolysis and made an uneventful recovery. M

This woman received good care and appropriate thrombolysis. However, it was notable that thrombolysis was not undertaken for any of the other women whose care was reviewed for the purposes of this chapter, and did not appear to have been considered for several pregnant women in whom it would have been appropriate. As noted before in these reports, pregnant women should receive the same standard of care as women who are not pregnant unless there is a clear reason that it should differ. Thrombolytic therapy leads to more rapid improvement in pulmonary obstruction and relief of right heart strain, and is recommended in pregnancy by both the European Respiratory Society (Konstantinides et al. 2020) and the RCOG (Royal College of Obstetricians and Gynaecologists 2015b).

Thrombolysis or surgical embolectomy should be considered for pregnant women with high-risk PE.

2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism (Konstantinides et al. 2020)

If massive PE is confirmed, or in extreme circumstances prior to confirmation, immediate thrombolysis should be considered.

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

It was evident that several women received inappropriately low doses of LMWH prophylaxis or treatment. This may be due, at least in part, to the weight-based dosing of heparin and the prevalence of obesity. The relevant thromboprophylaxis and therapeutic anticoagulation doses of LMWH are shown in Box 6.1 (Royal College of Obstetricians and Gynaecologists 2015a, Royal College of Obstetricians and Gynaecologists 2015b).

Box 6.1: Suggested thromboprophylactic and treatment doses for antenatal and postnatal LMWH (Adapted (Royal College of Obstetricians and Gynaecologists 2015a, National Institute for Health and Care Excellence 2020))

	Enoxaparin	Dalteparin	Tinzaparin
Standard prophylactic dose			
Weight < 50 kg	20 mg daily	2500 units daily	3500 units daily
Weight 50–90 kg	40 mg daily	5000 units daily	4500 units daily
Weight 91–130 kg	60 mg daily*	7500 units daily	7000 units daily*
Weight 131–170 kg	80 mg daily*	10 000 units daily	9000 units daily*
Weight > 170 kg	0.6 mg/kg/day*	75 u/kg/day	75 u/kg/day*
High prophylactic dose			
Weight 50–90 kg	40 mg 12 hourly	5000 units 12 hourly	4500 units 12 hourly
Treatment dose			
Calculated by weight	1 mg/kg/day in 2 divided doses	200 u/kg/day in 2 divided doses	175 u/kg once daily
*may be given in 2 divided doses			

Assessors noted additionally that anti-Xa monitoring was frequently performed to guide anticoagulation dose. This is not recommended except in women with low or high body weight (<50kg or ≥90kg), or those with other complicating factors, such as chronic kidney disease (due to reduced clearance) or recurrent VTE (due to elevated risk).

Routine measurement of peak anti-Xa activity for patients on LMWH for treatment of acute VTE in pregnancy or postpartum is not recommended except in women at extremes of body weight (less than 50 kg and 90 kg or more) or with other complicating factors (for example, with renal impairment or recurrent VTE).

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

Planning anticoagulation around birth and postpartum

Management plan

A woman in her first pregnancy, who had no risk factors for VTE at booking, was diagnosed with a PE in the late third trimester. She was admitted with tightenings a week later and LMWH was omitted for 24 hours. Induction of labour was then initiated to 'plan anticoagulation'. Induction was prolonged and resulted in LMWH being omitted for over 48 hours. Postnatally, she remained on LMWH twice a day with no consideration of switching to oral anticoagulation. M

When women are started on LMWH in pregnancy it is important to document a clear management plan including adjustments to the anticoagulation medication prior to the commencement of labour or birth. The management plan should document whether the women has been prescribed prophylactic or therapeutic dose LMWH. This is important as the same dose of LMWH maybe prophylactic, high prophylactic or therapeutic depending on the woman's booking or early pregnancy weight. The plan should cover different eventualities, including spontaneous labour, induction, emergency and elective caesarean section. Plans for LMWH and neuraxial blocks should be clear; Box 6.2 shows the UK guidance from the Association of Anaesthetists concerning the timing of neuraxial blocks in the context of anticoagulation. The management plan should be discussed and agreed with the woman and filed in her hand-held and hospital notes, to ensure that it is available to staff on each admission.

Ensure that women on prophylactic and treatment dose anticoagulation have a structured management plan to guide practitioners during the antenatal, intrapartum and post-natal period. N

A woman on LMWH should be advised that once she is in established labour or thinks that she is in labour, she should not inject any further heparin.

Where delivery is planned, either by elective caesarean section or induction of labour, LMWH maintenance therapy should be discontinued 24 hours prior to planned delivery.

Regional anaesthetic or analgesic techniques should not be undertaken until at least 24 hours after the last dose of therapeutic LMWH.

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

Box 6.2: Recommendations on timing of neuraxial blocks related to prophylactic and therapeutic heparin, and timing of subsequent administration (adapted from (Association of Anaesthetists of Great Britain and Ireland and Obstetric Anaesthetists Association 2013))

	Acceptable time after drug for block performance	Acceptable time after block performance or catheter removal for next drug dose
Unfractionated heparin: subcutaneous prophylaxis	4h or normal aPTT	1h
Unfractionated heparin: intravenous treatment	4h or normal aPTT	4h
LMWH: prophylaxis	12h	4h†
LMWH: treatment	24h	4h*

†LMWH is commonly given in prophylactic doses twice daily after surgery, but many clinicians recommend that only one dose be given in the first 24 h after neuraxial blockade has been performed

*consider increasing to 24 h if block performance is traumatic

aPTT activated Partial Thromboplastin Time

Induction of labour

Treatment with low molecular weight heparin is not a sole indication for induction of labour. Induction often takes more time than spontaneous labour and may result in additional interventions, especially if induction is commenced before 39 weeks. These may increase the risk of postpartum haemorrhage, which in turn, increases the risk of thromboembolism.

Where women on low molecular weight heparin are being induced or are awaiting caesarean section, delays in the process should be minimised where possible. It is important that a consultant should review all women waiting when there is a delay in the induction pathway and prioritise, in order to reduce the time women are not receiving low molecular weight heparin, thus reducing the risk to the women.

Ensure that a consultant reviews and prioritises women prescribed prophylactic and treatment dose anticoagulation waiting for induction of labour in order to reduce the time women are not receiving low molecular weight heparin **N**

Labour and birth

Time off treatment is an important consideration especially when a VTE has occurred near to term. It is undesirable to reduce or omit LMWH especially when a VTE has occurred within two weeks of giving birth. Intravenous unfractioned heparin may be an alternative when labour occurs, or if birth is indicated in this situation. Specialist advice should be sought about IV heparin dosing, if necessary from a regional centre if there is a lack of local specialist experience.

For women who are prescribed therapeutic low molecular weight heparin, the dose should be reduced to a prophylactic dose during labour where possible. Women should receive clear instructions as to the timing and dose prior to a planned admission for delivery. During induction of labour and in established labour, low molecular weight heparin should be reviewed before each dose is due, bearing in mind the guidance in Box 6.2. It may be appropriate to administer a dose depending on the clinical situation.

When VTE occurs at term, consideration should be given to the use of intravenous unfractionated heparin which is more easily manipulated (Royal College of Obstetricians and Gynaecologists 2015b).

Guidance from the Association of Anaesthetists (Box 6.2)should be followed concerning timings of heparin doses and neuraxial blocks (Association of Anaesthetists of Great Britain and Ireland and Obstetric Anaesthetists Association 2013)

A young woman in her first pregnancy, who was low risk for VTE, developed severe pre-eclampsia at term. During induction, there was concern about deterioration in her condition, particularly as her platelets were falling (to 50 x 109/L). A decision was made for an emergency caesarean birth. Low molecular weight heparin was prescribed after the birth, however, it was withheld because her platelets were 47 x 109/L. A decision was made not to commence low molecular weight heparin until her platelets were over 90 x 109/L. The platelets did not reach this threshold until day 2 postpartum, when a prophylactic dose of low molecular weight heparin was administered. On that day, she developed breathlessness and a CXR was ordered. On day 3 she developed a cough and haemoptysis. On day 4, CTPA confirmed PE. M

Low molecular weight heparin is safe to give when a woman's platelets are 50 x 109/L or more. Delayed administration of LMWH increases the risk of a venous thromboembolism, especially in women with multiple risk factors. Of particular note, in pre-eclampsia a woman's platelets may not rise for several days after she has given birth, during which time a venous thromboembolism may develop. Flowtrons and compression stockings are not as effective as LWMH in preventing a VTE.

It is important to restart LMWH promptly and appropriately after birth. Most women will be able to start low molecular weight heparin soon after delivery (4 hours after a spinal block or removal of an epidural catheter, after discussion with the anaesthetist). The time of the dose should be detailed in the antenatal plan and when a woman gives birth in theatre, the time of the first dose after giving birth should be confirmed and prescribed at the surgical sign out. Where the woman gives birth on a labour ward, the LMWH dose should be confirmed and prescribed within two hours of the birth and before the woman leaves the delivery unit.

Breastfeeding

A woman who gave birth by emergency caesarean section had a VTE score of 8 and was given 3 days of LMWH at a dose lower than was indicated by her weight. She was discharged home without LMWH. Eight days later, she was admitted with bilateral proximal PEs. A novel oral anticoagulant (NOAC) was commenced and she was (wrongly) told to stop breastfeeding. Neither therapeutic LMWH nor warfarin were offered, either of which would have been compatible with breastfeeding M

It is important, for women and their babies, that breastfeeding is initiated and women are supported to continue breastfeeding. Being diagnosed with a VTE is frightening and it is important to ensure that women can continue to care for themselves and their babies normally. Therapeutic anticoagulation must be continued until at least 6 weeks postnatally and for at least 3 months in total. To maximise compliance treatment should be offered that is most acceptable for the woman.

Novel anticoagulants (NOAC) may be considered for use in women who have chosen not to breastfeed. However, women who are breast feeding should be offered warfarin and should not be told to stop breastfeeding so that a NOAC can be prescribed. As with many medications the British National Formulary does not provide sufficient detail about prescribing in pregnancy and breastfeeding. However, there are other resources which can support safe prescribing. Lactmed, for example, provides more detailed safety advice which will support safe prescribing (*https://www.ncbi.nlm.nih.gov/books/NBK501922/*).

Women should be offered a choice of LMWH or oral anticoagulant for postnatal therapy after discussion about the need for regular blood tests for monitoring of warfarin, particularly during the first 10 days of treatment.

Postpartum warfarin should be avoided until at least the fifth day and for longer in women at increased risk of postpartum haemorrhage.

Women should be advised that neither heparin (unfractionated or LMWH) nor warfarin is contraindicated in breastfeeding

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

An older woman who had a PE in her first pregnancy had a VTE risk assessment score of 7 at booking but did not receive thromboprophylaxis. A PE was confirmed on VQ scan at 34 weeks, following an episode of breathlessness and blurred vision. Following an induction of labour at 37 weeks, for which the indication was unclear, she had an uncomplicated birth. There was no record of when anticoagulation was given, stopped or restarted after she gave birth. She was discharged by a newly qualified doctor with only 6 weeks of LMWH instead of the 3-6 months indicated. There was no evidence of consultant input postnatally and no post-natal obstetric follow-up or contraceptive advice documented. The woman had a further PE 3 years later and is now on life-long anticoagulation. M

A post-natal plan for anticoagulation should be clear and communicated with both the woman and her GP. A GP will not be able to support or advise appropriately on treatment, unless the plan has been shared with them. Although there were clear examples of good practice where women were discharged with their full postnatal course of LMWH, some women stopped medication when the amount supplied by the hospital ran out.

Women are more likely to discontinue their medication if they are given inadequate supplies or a repeat prescription is difficult to obtain. On discharge from hospital, enough medication should be given to cover the period of planned treatment, unless a change in medication or dose is expected.

Therapeutic anticoagulant therapy should be continued for the duration of the pregnancy and for at least 6 weeks postnatally and until at least 3 months of treatment has been given in total. Before discontinuing treatment, the continuing risk of thrombosis should be assessed.

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

Novel oral anticoagulants

A woman was diagnosed with a PE at 32 weeks' gestation. She gave birth by elective caesarean section and was changed from low molecular weight heparin one week after delivery to a novel oral anticoagulant (NOAC). She discontinued the NOAC one week later. M

Unlike warfarin, NOACs do not require blood test monitoring (which may help to optimise adherence). While this woman chose to stop her medication, it is important that women and GPs understand that anticoagulation is required for 3- 6 months after a VTE, and the risks of stopping it early are explained to the woman and documented. It is vital that sufficient medication is given so that a woman does not stop anticoagulant when the medication runs out or is difficult to obtain.

Future pregnancy planning and contraceptive advice

A 30-year-old woman with no risk factors for VTE, was diagnosed with bilateral pulmonary emboli 15 days after an uncomplicated vaginal delivery. As she was not breast feeding, she was treated with Apixaban (NOAC). Primary care initiated long acting reversible contraception following the diagnosis of pulmonary embolism. M

Contraception and plans for the next pregnancy were rarely documented and the good care this woman received was unusual. Without prompt contraception, women may conceive quickly after delivery, increasing their risk of future VTE. Contraception should be started or arranged before discharge from hospital. In most instances it can be agreed and documented in the antenatal plan.

Review at six weeks in a joint obstetric haematology clinic or maternal medicine clinic, should include a documented plan, shared with the woman and her GP, for a subsequent pregnancy in addition to ensuring that the woman is using contraception. This means that a pregnancy is more likely to be planned and the GP can start VTE prophylaxis promptly and appropriately following conception.

Postnatal review for women who develop VTE during pregnancy or the puerperium should, whenever possible, be at an obstetric medicine clinic or a joint obstetric haematology clinic.

RCOG Green-top Guideline 37b (Royal College of Obstetricians and Gynaecologists 2015b)

6.5 Conclusions

This Enquiry has highlighted three main areas where care could be improved. Perhaps the clearest finding, in common with the findings of the Enquiry into the care of women who died from PE (Knight et al. 2018), was the number of errors and inconsistencies in VTE risk scoring, suggesting a need for additional actions to ensure consistent risk assessment. Errors in risk assessment were present in the majority of the 29% of women in whom differences in care may have made a difference to outcome. Secondly, assessors felt that in several women, the diagnosis of PE was unclear, principally due to inconclusive imaging. There is a need to recognise the importance of conclusive imaging if women are to be fully anticoagulated and labelled as having had a PE. Finally, to avoid unnecessary intervention and minimise periods at risk without anticoagulation, all women should have a documented management plan for anticoagulation during pregnancy, birth and postnatally.

Table 6.2: Classification of care received by women with pulmonary embolism, UK and Ireland, 2016-18

Classification of care received	Women who died Number (%) N=34
Good care	9 (26)
Improvements to care which would have made no difference to outcome	15 (44)
Improvements to care which may have made a difference to outcome	10 (29)

7. Lessons for care of women with haemorrhage or amniotic fluid embolism

Derek Tuffnell and Marian Knight on behalf of the MBRRACE-UK haemorrhage and AFE chapter-writing group

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7.1 Key messages

New recommendations

Ensure at least one senior clinician takes a 'helicopter view' of the management of a woman with major obstetric haemorrhage to coordinate all aspects of care ACTION: All Health Professionals.

Produce guidance on which bedside tests should be used for assessment of coagulation and the required training to perform and interpret those tests **ACTION: Royal Colleges of Anaesthetists, Obstetricians and Gynaecologists, Physicians.**

Ensure clear protocols are in place with ambulance services to ensure rapid transfer when there is obstetric haemorrhage outside a consultant unit **ACTION: Hospitals/Trusts/Health Boards.**

Ensure that the response to obstetric haemorrhage is tailored to the proportionate blood loss as a percentage of circulating blood volume based on a woman's body weight **ACTION: All Health Professionals.**

Do not perform controlled cord traction if there are no signs of placental separation (blood loss and lengthening of the cord) and take steps to manage the placenta as retained **ACTION: All Health Professionals.**

Be aware that signs of uterine inversion include pain when attempting to deliver the placenta, a rapid deterioration of maternal condition and a loss of fundal height without delivery of the placenta **ACTION: All Health Professionals.**

Use the scenarios identified from review of the care of women who died for 'skills and drills' training **ACTION: Hospitals/Trusts/Health Boards.**

Existing guidance and recommendations requiring improved implementation

Haemorrhage (which might be concealed) should be considered when classic signs of hypovolaemia are present (tachycardia and/or agitation with hypotension often a late sign) even in the absence of revealed bleeding. **ACTION: All Health Professionals.**

When there has been a massive haemorrhage and the bleeding is ongoing, or there are clinical concerns, then a massive haemorrhage call should be activated. **ACTION: Service Managers, All Health Professionals**

In major PPH (blood loss greater than 1000 ml) and ongoing haemorrhage or clinical shock monitor temperature every 15 minutes. **ACTION: All Health Professionals.**

One member of the team should be assigned the task of recording events, fluids, drugs, blood and components transfused, and vital signs. **ACTION: Service Managers, All Health Professionals.**

Resort to hysterectomy sooner rather than later (especially in cases of placenta accreta or uterine rupture). **ACTION: All Health Professionals.**

Coagulation factors should be administered promptly after multidisciplinary discussion in accordance with the principles in RCOG Green-top Guideline 52. **ACTION: All Health Professionals.**

7.2 Background

Major obstetric haemorrhage is a frequent event on labour wards in the United Kingdom and Ireland but mortality is rare in contrast to the situation in many other parts of the world. When deaths from haemorrhage occur they are largely preventable, whereas deaths from amniotic fluid embolism (AFE) are harder to avoid. In the previous report, the deaths from haemorrhage were from two main causes – abnormal placentation and atonic postpartum haemorrhage. In this report the causes are more disparate but there are still important general messages and areas have been identified where care could generally be improved.

7.3 The women who died

In the UK and Ireland there were 14 women who died from obstetric haemorrhage during or up to six weeks after the end of pregnancy in 2016-18. This represents an overall mortality rate of 0.63 per 100,000 maternities (95% CI 0.32-0.97). This is a decrease from the last triennium, although not statistically significant (RR 0.64, 95% CI 0.33-1.24), and is still higher than 2006-8 when nine women died. In this triennium there were two deaths associated with uterine inversion. There had only been one other death associated with uterine inversion since 2000 (in 2006-2008).

Table 7.1: Direct deaths by type of obstetric haemorrhage 1994-2018

Time period	Placental Abruption	Placenta Praevia/ accreta	Postpartum haemorrhage		Uterine inversion	Total	Direct haemorrhage death rate per 100,000 maternities	
			Atony	Genital Tract Trauma			Rate	CI
1994-6	4	3	5	5	0	17	0.77	0.45-1.24
1997-99	3	3	1	2	0	9	0.42	0.19-0.80
2000-2	3	4	10	1	0	18	0.9	0.53-1.42
2003-5	2	3	9	3	0	17	0.8	0.47-1.29
2006-8	2	2	3 +1	(0/1)	1	9	0.39	0.18-0.75
2009-12†	2	1	7	7	0	17	0.49	0.29-0.78
2013-15†	3	9	9	1	0	22	0.88	0.55 - 1.33
2016-18†	3	3	2	4	2	14	0.58	0.32 – 0.97

†Figures for UK and Ireland. All other figures are UK only.

Eight women died from AFE, a mortality rate of 0.33 (95% CI 0.14-0.65), not statistically significantly different from the mortality rate from AFE in 2013-15. Six of the eight women died within 12 hours of collapse.

7.4 Overview of care and lessons to be learned

Overall haemorrhage management

Massive obstetric haemorrhage requires a multidisciplinary approach and this has led to the routine use of a 'Massive Obstetric Haemorrhage' call system. However this is only effective if implemented early and appropriately. The involvement of senior staff in obstetrics, anaesthesia, midwifery and haematology is required to provide the correct assessment, treatment of the underlying cause and supportive measures whilst haemorrhage is ongoing. Judgements are needed about the correct fluid replacement and how much blood and blood products are required. This can be facilitated by ensuring at least one senior clinician takes an overview, a 'helicopter view' taking into account all the information available so as to direct the appropriate care. Part of the 'helicopter view' is to make sure that the appropriate information is being gathered. This should include trends in maternal observations, a continuing update of fluid balance, ensuring appropriate tests are organised with results obtained promptly and making sure supportive treatments such as fluid and patient warming as well as oxygen supplementation are in place. This allows judgements to be made about the need for and appropriateness of interventions, such as hysterectomy or interventional radiology, in a timely way with an ongoing massive haemorrhage. The 'lethal triad' of acidosis, coagulopathy and hypothermia is well known to be associated with risk of death in trauma and it is just as important, as part of the 'helicopter view' to recognise deterioration in any of these parameters in obstetric haemorrhage. Amongst the women who died, it was common for this overview to be lacking, leading to one or more of the elements of care being missed.

A woman had extensive tears after a caesarean section in the early third trimester for breech at full dilatation despite the use of a fetal pillow. The woman had an intraoperative tachycardia that settled and went to the neonatal unit to see her baby postnatally. When she returned she had a tachycardia and a scan showed intraperitoneal fluid. A further laparotomy identified significant intraperitoneal bleeding. There was no overall assessment of blood loss and as a consequence insufficient replacement of fluid and blood products. The massive obstetric haemorrhage call was 'stood down'. She subsequently developed an acidosis and coagulopathy. She had two cardiac arrests after surgery and a laparotomy and hysterectomy was performed but she did not recover.

The objective measurement of cumulative blood loss and the clear communication of this is a vital role which cannot be the responsibility of the operating surgeon or the anaesthetist. Clear communication requires periodic, out loud updates of the key physiological and resuscitation related blood test parameters to the whole team. This woman's concealed haemorrhage was not considered and no clinician took a 'helicopter' view to take into account the whole picture with regards to bleeding and fluid replacement. Under-replacement of fluid and blood products leads to acidosis and a spiral of decline. This woman became cold, which also exacerbated her decline, and a hysterectomy was only considered when she was severely compromised.

Haemorrhage (which might be concealed) should be considered when classic signs of hypovolaemia are present (tachycardia and/or agitation with hypotension often a late sign) even in the absence of revealed bleeding.

When there has been a massive haemorrhage and the bleeding is ongoing, or there are clinical concerns, then a massive haemorrhage call should be activated

In major PPH (blood loss greater than 1000 ml) and ongoing haemorrhage or clinical shock monitor temperature every 15 minutes

One member of the team should be assigned the task of recording events, fluids, drugs, blood and components transfused, and vital signs

Resort to hysterectomy sooner rather than later (especially in cases of placenta accreta or uterine rupture)

RCOG Green-top Guideline 52 (Royal College of Obstetricians and Gynaecologists 2016a)

An underweight woman had a massive postpartum haemorrhage after a preterm birth. She became hypothermic with a temperature of 31oC before warming measures were started. She developed a coagulopathy but cryoprecipitate was not given, based on a thromboelastogram (TEG) rather than formal clotting tests. In retrospect, the TEG was not correctly interpreted. Her coagulopathy worsened but haematology advice was not sought until very late. There was a continued reliance on the TEG and some blood products were not transfused. She had a blood loss of over 7 litres before hysterectomy was performed, as it was thought she was too unstable to operate on. She had become severely acidotic by this point. She deteriorated further and care was withdrawn.

There was no 'helicopter view' and consultant input was intermittent.

This woman's care demonstrates the effect of fragmentation of decision making without an overall consideration of the need to ensure implementation of all parts of the package of good care that are required to achieve a satisfactory outcome.

Ensure at least one senior clinician takes a 'helicopter view' of the management of a woman with major obstetric haemorrhage to coordinate all aspects of care. **N**

Coagulation

In major obstetric haemorrhage and AFE replacement of coagulation factors is required to optimise outcome. The importance of early coagulation replacement has been emphasised in RCOG guidance on postpartum haemorrhage, but many women who died had delayed or inadequate correction of their coagulopathy. In some women there was a delay in provision of coagulation products whilst waiting for coagulation testing and authorisation from a haematologist. Haematologists have a key role in advice about coagulation products but must be aware that with

that responsibility comes the need to ensure that products are provided promptly and in appropriate amounts. In some instances there was inadequate provision of coagulation products, particularly fibrinogen or cryoprecipitate. Also, as in the vignette above, bedside testing of coagulation led to insufficient replacement of coagulation products. TEG and rotational thromboelastometry (ROTEM) can minimise delays but need to be interpreted correctly. It is important for the whole team to act in a multidisciplinary way to ensure that the correct amount and type of coagulation products are provided in a timely manner.

A woman presented with an intrauterine fetal death and bleeding. The presumptive diagnosis was placental abruption. Her labour was induced with excessive doses of misoprostol at a weekend. There was senior review initially but then, despite the woman's condition worsening during her labour, senior involvement was by phone until she deteriorated shortly before she gave birth. There was no record of fluid balance despite ongoing bleeding. Her coagulation was significantly abnormal with very low fibrinogen yet haematology advice was not to use fibrinogen. Blood tests were taking over an hour to get to the laboratory which may have influenced decision making about clotting replacement. There was massive bleeding after the birth and despite good care at that time the woman died.

When women have an intrauterine fetal death maternal monitoring in labour needs to be considered carefully. As previous reports have highlighted, misoprostol needs to be given in correct dosages (Knight et al. 2014, Knight et al. 2017). Senior review is important and intervention in labour for maternal reasons may be needed. Clotting tests need to be transported urgently to the laboratory and coagulation products administered in line with the results.

Produce guidance on which bedside tests should be used for assessment of coagulation and the required training to perform and interpret those tests **N**

Coagulation factors should be administered promptly after multidisciplinary discussion in accordance with the principles in RCOG Green-top Guideline 52:

- **If no haemostatic results are available and bleeding is continuing, then, after 4 units of red blood cells, fresh frozen plasma (FFP) should be infused at a dose of 12–15 ml/kg until haemostatic test results are known.**
- **If no haemostatic tests are available, early FFP should be considered for conditions with a suspected coagulopathy, such as placental abruption or amniotic fluid embolism, or where detection of PPH has been delayed.**
- **If prothrombin time/activated partial thromboplastin time is more than 1.5 times normal and haemorrhage is ongoing, volumes of FFP in excess of 15 ml/kg are likely to be needed to correct coagulopathy.**
- **Clinicians should be aware that these blood components must be ordered as soon as a need for them is anticipated, as there will always be a short delay in supply because of the need for thawing.**
- **A plasma fibrinogen level of greater than 2 g/l should be maintained during ongoing PPH.**
- **Cryoprecipitate should be used for fibrinogen replacement.**
- **Consideration should be given to the use of tranexamic acid in the management of PPH.**

RCOG Green-top Guideline 52 (Royal College of Obstetricians and Gynaecologists 2016a)

Transfer Arrangements

A woman gave birth to her first baby in a freestanding midwifery unit. She had a retained placenta and uterine inversion. She became shocked and had to be transferred to a consultant unit. No attempt was made to replace the uterus. There were delays in calling the ambulance and in the arrival of the ambulance. She had nearly 5 litres of intravenous clear fluid despite a body weight of less than 50kg. Fluid overload contributed to her death.

If women have a major obstetric haemorrhage in a place of birth outside an obstetric unit prompt transfer is needed to ensure resuscitation and the provision of blood products. Maternal haemorrhage is an emergency. The ambulance transfer should always be on the shortest possible timescale. The administration of large amounts of clear fluid before blood products are given can result in fluid overload.

Ensure clear protocols are in place with ambulance services to ensure rapid transfer when there is obstetric haemorrhage outside a consultant unit **N**

As has previously been noted in these reports, several of the women who died, including the woman described here, were small. It is likely that the significance of their blood loss was underestimated as it was not assessed as a proportion of their circulating blood volume. The circulating blood volume varies with body weight, and the response to haemorrhage must be tailored to the proportionate loss rather than the actual volume. Table 7.2, expanded from the 2014 report (Knight et al. 2014) shows estimated proportionate blood losses for women of different body weights. This emphasises that what may only be a moderate haemorrhage in a woman of 100kg represents a severe, and potentially life-threatening, haemorrhage in a woman of 50kg. The response requires appropriate blood product replacement and the avoidance of excessive crystalloid.

Ensure that the response to obstetric haemorrhage is tailored to the proportionate blood loss as a percentage of circulating blood volume based on a woman's body weight **N**

Table 7.2: Estimated blood volumes and proportionate losses according to body weight

Weight	Total blood volume*	15% blood volume loss (moderate haemorrhage)	30% blood volume loss (severe haemorrhage)	40% blood volume loss (life-threatening haemorrhage)
50kg	5000ml	750ml	1500ml	2000ml
60kg	6000ml	900ml	1800ml	2400ml
70kg	7000ml	1050ml	2100ml	2800ml
80kg	8000ml	1200ml	2400ml	3200ml
90kg	9000ml	1350ml	2700ml	3600ml
100kg	10000ml	1500ml	3000ml	4000ml

*Based on 100mls/kg blood volume in pregnancy but may overestimate blood volume in obese women (Lemmens et al. 2006)

Uterine Inversion

Two women died from haemorrhage related to uterine inversion. In both women it was clear that the placenta had not separated but clinicians persisted with controlled cord traction. Avoidance should be the aim but if uterine inversion occurs prompt replacement is vital. In both women, a delay in replacing the uterus led to significant deterioration. Whilst anaesthesia may be necessary, recovery is faster if the uterus is replaced immediately. Clinicians should be aware that signs of uterine inversion include pain when attempting to deliver the placenta, a rapid deterioration of maternal condition and a loss of fundal height without delivery of the placenta.

Be aware that signs of uterine inversion include pain when attempting to deliver the placenta, a rapid deterioration of maternal condition and a loss of fundal height without delivery of the placenta **N**

Controlled cord traction should not be undertaken until a uterotonic has been given, the uterus has contracted and there are signs of placental separation. If there are no signs of placental separation the management should be on the basis that the placenta is retained. Counter-traction should be applied when controlled cord traction is applied. Controlled cord traction should be smooth and not jerky.

Perform controlled cord traction as part of active management only after administration of oxytocin and signs of separation of the placenta.

NICE Intrapartum Care guideline 2019 (National Institute for Health and Care Excellence 2019a)

Do not perform controlled cord traction if there are no signs of placental separation (blood loss and lengthening of the cord) and take steps to manage the placenta as retained. **N**

After rapid replacement of the uterus, it remains essential, as highlighted earlier, that a senior clinician maintains a 'helicopter' view with regards to bleeding and fluid replacement and ensuring correction of coagulopathy. Uterine inversion is not a benign condition and prompt action is essential.

Amniotic Fluid embolism

Eight women died following an amniotic fluid embolism. All eight died followed induction of labour. In some women the indications for induction were unclear. Six of the women died in the first few hours after their initial collapse and period of resuscitation. Two women were admitted to intensive care after initial resuscitation but subsequently died. The same themes described above around delay in recognising haemorrhage, delays in senior staff involvement, inappropriate fluid replacement, misinterpretation of coagulation tests and delays in performing hysterectomy were apparent in these women.

7.5 Conclusions

Assessors felt that for the majority of these women there were improvements in care which may have made a difference to outcome (Table 7.3). There is clear scope for reducing maternal deaths from haemorrhage in the UK and Ireland further, and to replicate the success of actions to prevent maternal deaths from pre-eclampsia. With this intention, assessors identified particular scenarios which could be the focus of 'skills and drills' training based on the messages for care learned from review of these women's deaths (Box 7.1). While many of the recommendations of these reports focus on improving care of women with physical and mental health co-morbidities, we should not lose sight of the key actions to improve safety of maternity care around the time of birth and prevent women from dying from haemorrhage and AFE.

Use the scenarios identified from review of the care of women who died for 'skills and drills' training N

Table 7.3: Classification of care received by women who died from haemorrhage and AFE, UK and Ireland, 2016-18

Classification of care received	Women who died from haemorrhage Number (%) N=14	Women who died from AFE Number (%) N=8
Good care	1 (7)	1 (13)
Improvements to care which would have made no difference to outcome	2 (14)	0
Improvements in care which may have made a difference to outcome	11 (79)	7 (88)

Box 7.1: Scenarios for 'skills and drills' training identified from review of the care of women who died from haemorrhage and AFE

There are a number of specific messages from the review of the care these women received that could be incorporated into local drills.

In particular, drills should practice the principle of a senior clinician taking the 'helicopter view' role to provide the necessary overview of women's management.

The following should also be covered:

- The value of a scribe in supporting the overview of the management
- Uterine inversion – recognition and how to replace promptly and safely
- Assessing blood loss and the correct volume of fluid replacement taking into account the woman's weight
- Blood product replacement and interpretation of clotting tests
- Timing of, and technique for, peripartum hysterectomy

8. Messages for prevention and treatment of infection

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8.1 Key messages

New recommendations

Ensure early senior involvement in the care of women with extremely preterm prelabour rupture of membranes and a full explanation of the risks and benefits of continuing the pregnancy. This should include discussion of termination of pregnancy. **ACTION: Hospitals/Trusts/Health Boards.**

Ensure risk assessment and counselling in relation to extremely preterm prelabour rupture of membranes includes consideration that there is a risk of maternal mortality and serious morbidity with impact on future pregnancies. **ACTION: All Health Professionals.**

Existing recommendations requiring improved implementation

Offer influenza vaccine to pregnant women at any stage of pregnancy (first, second or third trimesters) **ACTION: All Health Professionals.**

Provide the woman with an interpreter (who may be a link worker or advocate and should not be a member of the woman's family, her legal guardian or her partner) who can communicate with her in her preferred language. **ACTION: Service managers, All Health Professionals.**

When giving spoken information, ask the woman about her understanding of what she has been told to ensure she has understood it correctly. **ACTION: All Health Professionals.**

"Think Sepsis" at an early stage when presented with an unwell pregnant or recently pregnant woman, take the appropriate observations and act on them **ACTION: All Health Professionals.**

In the postnatal period health professionals must perform and record a full set of physiological vital signs, pulse, blood pressure, temperature and respiratory rate, in any woman with symptoms or signs of ill health **ACTION: All Health Professionals.**

Midwives and others carrying out postnatal checks in the community should have a thermometer to enable them to check the temperature of women who are unwell. **ACTION: All Health Professionals.**

When assessing a woman who is unwell consider her condition in addition to her MEOWS score. **ACTION: All Health Professionals.**

The key actions for diagnosis and management of sepsis are:

- Timely recognition
- Fast administration of intravenous antibiotics
- Quick involvement of experts - senior review is essential **ACTION: All Health Professionals.**

Critical care support can be initiated in a variety of settings. Critical care outreach nurses can work in partnership with midwives to provide care before transfer to the critical care unit. Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care **ACTION: All Health Professionals, Service Managers.**

8.2 Background

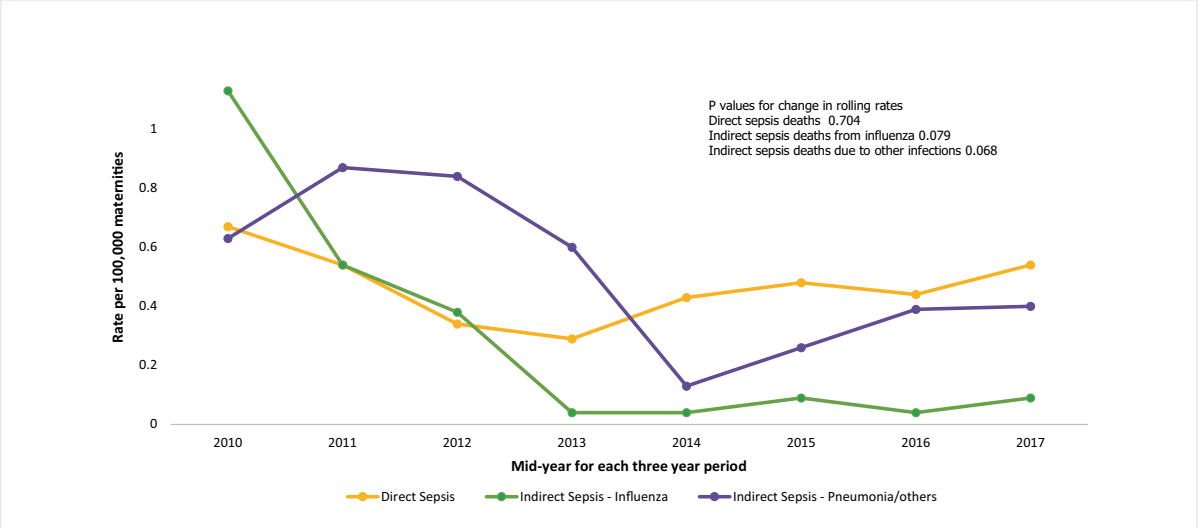
Sepsis has been a significant focus over the last decade with guidance produced by NICE in 2016 (National Institute for Health and Care Excellence 2016) and the 'Surviving Sepsis campaign' (Rhodes et al. 2017) as well as the earlier Royal College of Obstetricians and Gynaecologist Green Top guidelines on Bacterial Sepsis in and following pregnancy in 2012 (Royal College of Obstetricians and Gynaecologists 2012a, Royal College of Obstetricians and Gynaecologists 2012b). The WHO (World Health Organisation 2017) described maternal sepsis as "a life threatening condition defined as organ dysfunction resulting from infection during pregnancy, childbirth, post-abortion or postpartum period." The recently published GLOSS study (WHO Global Maternal Sepsis Study Research Group 2020) in 52 countries identified 70·4 (95% CI 67·7–73·1) hospitalised women per 1000 livebirths had a maternal infection, and 10·9 (9·8–12·0) women per 1000 livebirths presented with infection-related (underlying or contributing cause) severe maternal outcomes. It is estimated that at least 10.7% of maternal deaths in low and middle income countries and 4.7% of deaths in high income countries are due to sepsis (Say et al. 2014).

Maternal deaths from sepsis can be due to direct causes, such as genital tract infection or wound infections, or indirect causes, such as influenza or meningitis. The last report highlighted the need to prevent deaths by vaccination against influenza and presciently noted "embedding the messages around influenza vaccination and treatment remains essential to prevent death as well as in preparation for any future pandemic". At the time of writing this report the COVID-19 pandemic continues to have a significant impact on the care of pregnant and postpartum women and readers are referred to the messages contained within the MBRRACE-UK rapid report into SARS-CoV2-associated maternal deaths which occurred between March and May 2020 (Knight et al. 2020a), which echo some of the findings reported here.

8.3 Summary of the key findings 2016-18

In the UK and Ireland 31 women died from sepsis during this period, defined in the broadest sense as death from a primary infective cause. Eight of these women died more than 42 days after the end of pregnancy (late deaths). This represents a maternal mortality rate from sepsis during or up to 6 weeks after pregnancy in the UK and Ireland of 0.95 per 100,000 maternities (95% CI 0.60 to 1.43 per 100,000 maternities). The change in maternal mortality rate due to sepsis in the UK is shown in Figure 8.1.

Figure 8.1: Maternal mortality rate due to sepsis per 100,000 maternities, UK 2009-18



Women who died from genital tract and other direct causes of sepsis

In total, thirteen women died from direct causes.

Ten women died from genital tract sepsis. Four women died from postnatal Group A Streptococcus (GAS) infection; two of these women had a caesarean section but had the infection prior to birth and two women with Group A Streptococcus died after an unassisted vaginal birth. Six women died after mid trimester chorioamnionitis from Escherichia Coli (E coli); three of these six women had preterm prelabour rupture of the membranes, one had a cervical suture with a short cervix, one had had an amniocentesis and one a septic miscarriage. Deaths from mid trimester sepsis predominantly account for the apparent rise in the mortality rate from direct sepsis seen since the nadir in 2012-14 (Figure 8.1).

Three further women died from sepsis after caesarean section, one from a Group A Streptococcus wound infection, one from E Coli and in one woman no clear organism was identified. One of these women died more than six weeks after giving birth but from complications arising after her caesarean section. No women died from urinary sepsis.

Sepsis due to other causes

Influenza

Two women died from influenza, one from influenza B and one from H1N1. Both died during or up to six weeks after the end of pregnancy.

Other causes

Three women died from tuberculosis, two from disseminated Herpes simplex virus in the late third trimester, two from pneumonia, one from pneumococcal meningitis and one from CD8 encephalitis associated with HIV infection.

Late deaths

Three women died due to pneumococcal disease, two from Group A Streptococcus, one from staphylococcal pneumonia and one from encephalitis between six weeks and one year after the end of pregnancy.

8.4 Overview of care and lessons to be learned

Influenza

Vaccination is still important to prevent influenza, and this is even more important with the emergence and continuing impact of COVID-19. One woman who was vaccinated died from influenza but she was immunosuppressed and it is important to remember that this can affect the response to the vaccine. One woman who died was not vaccinated.

Offer influenza vaccine to pregnant women at any stage of pregnancy (first, second or third trimesters)

Immunisation against infectious disease: the Green Book 2019 (Public Health England 2019)

Extremely Preterm Prelabour Rupture of Membranes

The high risk nature of mid trimester rupture of membranes is highlighted by the six women who died from mid-trimester sepsis. Three women died from sepsis after rupture of membranes at less than 20 weeks' gestation, one woman died after a mid-trimester cervical suture with a short cervix and ruptured membranes, one after amniocentesis and another woman had a septic miscarriage at home. In contrast, only one woman died from mid-trimester genital tract sepsis in 2013-15. All the women reported here died from E coli sepsis; in pregnancy rapid progression to septic shock is known to be more likely with both E coli and Group A Streptococcus (Acosta et al. 2014). The 2014 report emphasised that the prophylactic dose of erythromycin given to women with preterm prelabour rupture of membranes should not be considered effective for the treatment of established infection (Knight et al. 2014); established infection requires additional immediate therapeutic treatment beyond prophylaxis.

There are challenging decisions around whether to continue a pregnancy with very early rupture of membranes. Recent guidelines from the British Association of Perinatal Medicine (British Association of Perinatal Medicine 2019) consider the care of infants around the limits of viability and when to offer active resuscitation and neonatal intensive care. However, it should be recognised that the mother's life is paramount and must be considered in any risk assessment and counselling that takes place. When counselling women with mid trimester rupture of membranes there should always be an explanation of the risks to the woman, and to future pregnancies, of sepsis. Any signs of infection should be treated seriously and intervention by emptying the uterus should be strongly recommended.

Even when signs of sepsis develop (with or without rupture of the membranes) and a decision is made to end the pregnancy the best way to achieve this is unclear. There is a balance between using medical methods which take longer and the use of surgical techniques. The skill set to perform mid trimester evacuation of the uterus may not be available and hysterotomy carries additional risks. However early 'source control' is essential to help resolve sepsis. If medical management is anticipated then it needs to be considered early and reassessed frequently based on the condition of the woman, with an early and rapid move to surgical intervention if required. A wider study of extremely preterm prelabour rupture of membranes is underway using the UKOSS methodology and will help the development of guidance in this difficult area.

A few days after a cervical suture a woman presented with signs of sepsis and rupture of membranes. Initial sepsis management was appropriate but no consultant was involved. The woman agreed to removal of the suture but not to termination. She went to theatre three hours later for removal of the suture and it was identified that there was no fetal heartbeat. The plan was for misoprostol. It took two hours for the fetus to deliver. The woman deteriorated and died the same day.

This woman demonstrates the rapid deterioration that can occur with sepsis.

A woman was admitted with rupture of membranes at 16 weeks. She was given antibiotics but active management was not discussed for 48 hours by which time she had early signs of sepsis. Despite fetal parts presenting through the cervix, termination was not commenced or performed surgically. She deteriorated prior to the delivery of the fetus and although termination was performed she died later that day. There was a lack of senior involvement.

This woman's care has echoes of other women who died and who were described in previous reports where an inevitable miscarriage was not treated actively before it was too late.

Ensure early senior involvement in the care of women with extremely preterm prelabour rupture of membranes and a full explanation of the risks and benefits of continuing the pregnancy. This should include discussion of termination of pregnancy.

Ensure risk assessment and counselling in relation to extremely preterm prelabour rupture of membranes includes consideration that there is a risk of maternal mortality and serious morbidity with impact on future pregnancies. N

Think Sepsis

A woman presented to her GP with postnatal mastitis. She was given oral antibiotics. She re-presented some days later unwell with a pyrexia and hypotension. The GP gave further oral antibiotics. The woman presented herself to hospital later that day, by which time she was in extremis. The care in hospital was of high quality with rapid triage, sepsis diagnosis, prompt senior involvement, appropriate sepsis management and intensive care but she deteriorated and died from her streptococcal infection.

A woman presented with an intrauterine fetal death in the late second trimester with a pyrexia, tachycardia and hypotension. A diagnosis of placental abruption was made. Sepsis was not considered initially and antibiotics were delayed, appropriate blood tests were not performed and source control was not initiated. There was delayed involvement of the intensive care team. Group A Streptococcal sepsis was diagnosed after her death.

In women who present critically ill it is essential to consider the differential diagnosis and ensure management covers all appropriate possible diagnoses. There are continuing messages from the 2014 and 2017 reports about the importance of early recognition of sepsis, treatment with antibiotics, source control and involvement of senior staff when sepsis is recognised; this approach can only be adopted if clinicians consider the diagnosis and severity of illness in the first place.

Senior involvement is vital in managing the critically ill pregnant woman. In several instances, junior medical staff did not escalate to consultants. This seemed to cluster around bank holidays and weekends. Whilst the numbers of women who die is too low to provide clear evidence of a 'weekend effect' units should consider how best to ensure that prompt senior involvement is available around holidays and outside usual working hours. In this triennium, it was apparent that even when consultant staff were involved, there was a lack of confidence in decision making where women presented with unusual or atypical symptoms or infections. It is entirely appropriate, even at consultant level, to ask for advice from a colleague, from either the same or a different specialty.

There should be an urgent referral to the critical care team in severe or rapidly deteriorating sepsis, and the involvement of a consultant obstetrician.

The expert advice of a consultant microbiologist or infectious disease physician should be sought urgently when serious sepsis is suspected.

RCOG Green-top Guideline 64a (Royal College of Obstetricians and Gynaecologists 2012a)

A woman of Eastern European origin who spoke little English presented with early preterm prelabour rupture of membranes. There were delays in senior review at presentation and in recognising when she became septic. The focus upon delivery of the fetus led to a delay in involving the anaesthetists and intensive care team by which time she had deteriorated significantly. She died from her E coli infection.

When women are critically ill intensive care support can be vitally important. However, if the management requires delivery of the fetus then planning around the place of care is required. Critical care can be initiated in a variety of settings with support from critical care teams. This is also the case when bed pressures in critical care could otherwise lead to a delay in admission. Multidisciplinary team work to ensure the care is appropriate for the severity of illness requires clinicians to communicate promptly and clearly to identify the support needed and how that support is going to be delivered.

"Think Sepsis" at an early stage when presented with an unwell pregnant or recently pregnant woman, take the appropriate observations and act on them (Chan 2018)

The key actions for diagnosis and management of sepsis are:

- **Timely recognition**
- **Fast administration of intravenous antibiotics**
- **Quick involvement of experts - senior review is essential (NHS England 2014)**

Critical care support can be initiated in a variety of settings. Critical care outreach nurses can work in partnership with midwives to provide care before transfer to the critical care unit. Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care (Knight et al. 2016).

Postnatal Care

A woman started to feel unwell a few days after a normal birth and was admitted in extremis four days later. She had had a raised pulse and temperature during labour. She had been discharged home with a borderline tachycardia as her MEOWS score was only yellow. No observations were recorded at community postnatal checks when she reported she felt unwell. The day after her second postnatal check she contacted health services and was reassured she had a 'tummy bug'. A GP answerphone message indicated that home visits were only for those too ill to attend. She died from overwhelming Group A Streptococcal sepsis.

There were a number of opportunities to increase clinical observations and for review of this woman to have taken place. Clearer communication between elements of the service would have led to further observations and appropriate action. The recognition that a woman is unwell can be difficult and so it is important to consider the woman's history and symptoms, as well as any clinical signs. In the community setting it is not routine to perform full observations in a well woman. If a woman says she is physically unwell, observations perform a vital role in identifying features of concern and it is easy to undertake a respiratory and pulse rate even if equipment to take a temperature or blood pressure measurement are lacking. Respiratory rate does not alter very much in pregnancy so an unexplained tachypnoea needs further medical assessment. NICE guidance on Postnatal Care is currently in the process of being updated and at the time of writing (September 2020) an updated version is expected to be published in April 2021. Implementation of this will assist with identifying when observations are required and when women need further review. It is important to be aware that normal observations do not exclude significant illness and in the presence of significant symptoms or family concerns referral to secondary care is still appropriate.

This woman's care also raises again the place of MEOWS. MEOWS is only one element of assessment and the reviewers felt that on several occasions there was over-reliance on, and false reassurance from MEOWS.

In the postnatal period health professionals must perform and record a full set of physiological vital signs, pulse, blood pressure, temperature and respiratory rate, in any woman with symptoms or signs of ill health

(National Institute for Health and Care Excellence 2006, Royal College of Obstetricians and Gynaecologists 2012b)

When assessing a woman who is unwell consider her condition in addition to her MEOWS score.

Midwives and others carrying out postnatal checks in the community should have a thermometer to enable them to check the temperature of women who are unwell.

Saving Lives, Improving Mother's Care 2017 (Knight et al. 2017)

Awareness of 'non-obstetric' infection

A woman presented to her GP with a cough in the first trimester of pregnancy. She had night sweats. The cough did not improve with antibiotics and despite multiple presentations no investigations were performed. A Chest X-ray was considered but not performed because of pregnancy. Onward referral was not considered. She died suddenly at home two months after her initial consultation. The post mortem made the diagnosis of tuberculosis.

The pregnant population is at as much risk as the general population of developing infection from a variety of causes, and at greater risk of some infections such as listeriosis. More importantly, pregnant women are at risk of more severe disease after acquiring other infections, with good evidence for increased severity of influenza and Herpes simplex virus (HSV) infection, for example. Pregnant women who acquire primary HSV infection have an increased risk of dissemination and hepatitis (an otherwise rare complication in immunocompetent adults), especially during the third trimester when cellular immunity, in particular, is low. These risks are highlighted by the deaths of a number of women from tuberculosis and also viral infections including Herpes simplex. Pregnant women require prompt investigation when they present and referral to appropriate specialists to ensure a prompt correct diagnosis is made.

The concerning disparity in maternal mortality rates between white women and women from Black and other minority ethnic groups has been highlighted previously (Knight et al. 2018, Knight et al. 2019, Knight et al. 2020b). A number of the women who died, particularly from infections which are less common in the UK-born population, were Black or other minority ethnicity women who did not have English as a first language. Communication difficulty seems to have been magnified as the women became more unwell, because of their inability to express themselves or misinterpretation by healthcare workers of different cultural expressions of illness. Ensuring appropriate communication is necessary to identify the severity of illness and any significant symptoms or signs. The need for appropriate interpreting services is not a new recommendation, highlighted most recently in the COVID-19 rapid report (Knight et al. 2020a), but these women's deaths emphasise that such interpretation needs to be high quality and nuanced. This may take additional time and consideration should be given to longer appointments in these circumstances.

Provide the woman with an interpreter (who may be a link worker or advocate and should not be a member of the woman's family, her legal guardian or her partner) who can communicate with her in her preferred language.

When giving spoken information, ask the woman about her understanding of what she has been told to ensure she has understood it correctly.

NICE CG110 Pregnancy and complex social factors (National Institute for Health and Care Excellence 2010)

8.5 Conclusions

Sepsis is still an important cause of maternal mortality, and these reviews identified opportunities to improve care which may have changed the outcome for 68% of women. Prompt recognition and response to sepsis is required to optimise outcomes. The apparent rise in maternal mortality due to direct causes of sepsis related to extremely preterm prelabour rupture of membranes and sepsis in mid-trimester pregnancies emphasises the importance of expert counselling of women in these circumstances. Women need a full explanation, with a senior clinician, of the risks and benefits of continuing the pregnancy.

The COVID-19 pandemic has highlighted that pregnant women from Black and other ethnic minority groups are more likely to be hospitalised with infection than white women (Knight et al. 2020c). The majority of women who died from SARS-CoV-2 infection during or up to six weeks after pregnancy between March and May 2020 were from ethnic minority groups (Knight et al. 2020a). This review of the care of women who died from infectious causes between 2016 and 2018 has emphasised the need to consider a range of possible infections, particularly in migrant ethnic minority women. In some instances there was a delay in women receiving appropriate diagnosis and treatment of their infection in the UK and Ireland. Clinicians need to remain aware of global causes of infection and adjust their differential diagnosis based on women's individual circumstances and possible exposures. All UK and Ireland doctors should be able to diagnose conditions such as TB and should be able to recognise when a woman is ill. If they are unsure of the cause of a woman's symptoms it is imperative to refer women urgently for further specialist input.

Table 8.1: Classification of care received by women who died from infective causes, UK and Ireland, 2016-18

Classification of care received	Women who died Number (%) N=31
Good care	7 (23)
Improvements to care which would have made no difference to outcome	3 (10)
Improvements in care which may have made a difference to outcome	21 (68)

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