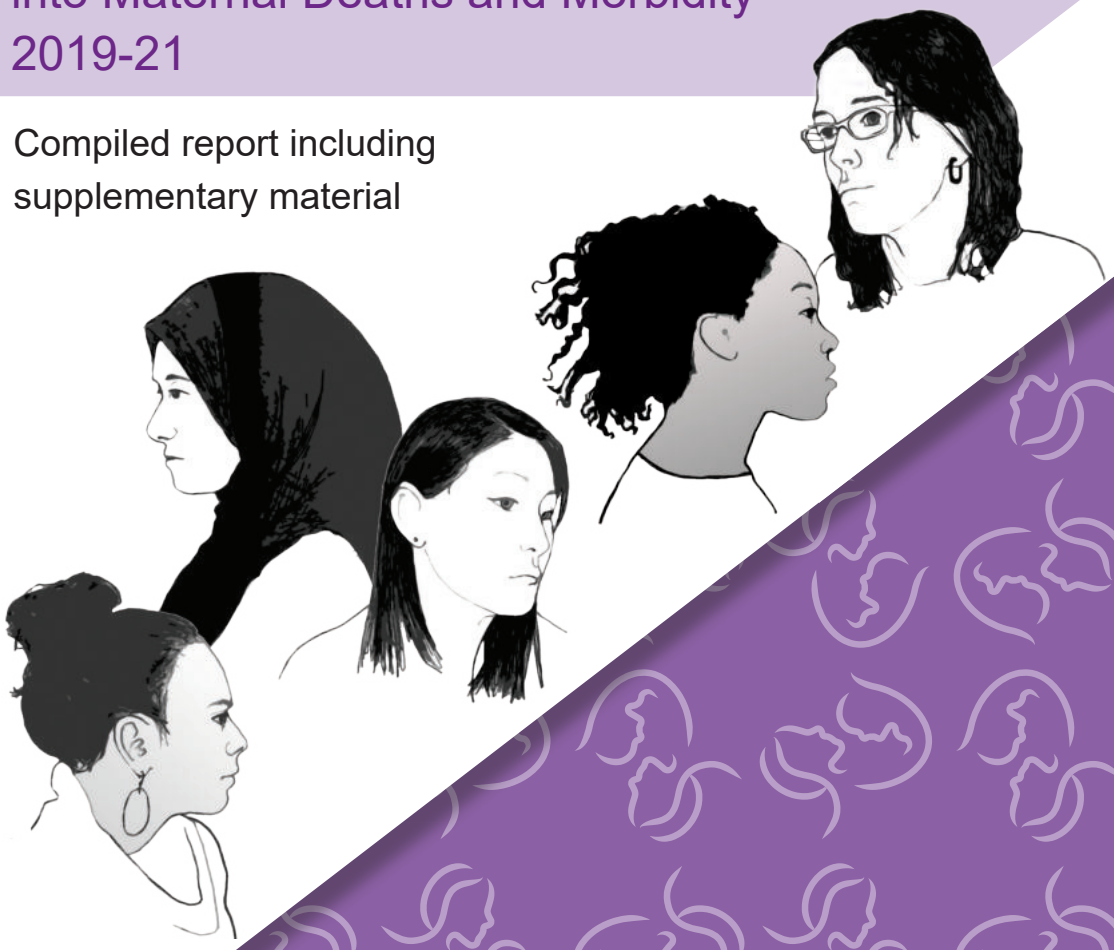
Maternal, Newborn and Infant Clinical Outcome Review Programme

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 2019-21

Compiled report including supplementary material



October 2023

HQIP Healthcare Quality Improvement Partnership
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Marian Knight, Kathryn Bunch, Allison Felker, Roshni Patel, Rohit Kotnis, Sara Kenyon, Jennifer J Kurinczuk (Eds.)

October 2023

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The Maternal, Newborn and Infant Clinical Outcome Review Programme, delivered by MBRRACE-UK, is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing, and National Voices. Its aim is to promote quality improvement in patient outcomes. The Clinical Outcome Review Programmes, which encompass confidential enquiries, are designed to help assess the quality of healthcare, and stimulate improvement in safety and effectiveness by systematically enabling clinicians, managers, and policy makers to learn from adverse events and other relevant data. HQIP holds the contract to commission, manage, and develop the National Clinical Audit and Patient Outcomes Programme (NCAPOP), comprising around 40 projects covering care provided to people with a wide range of medical, surgical and mental health conditions. The Maternal, Newborn and Infant Clinical Outcome Review Programme is funded by NHS England, the Welsh Government, the Health and Social Care division of the Scottish government, The Northern Ireland Department of Health, and the States of Jersey, Guernsey, and the Isle of Man ***www.hqip.org.uk/national-programmes***.

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Key messages

from the surveillance report 2023

MBRRACE-UK
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In 2019-21, **241 women died** during or up to six weeks after pregnancy among 2,066,997 women giving birth in the UK.

11.7 women per 100,000 died during pregnancy or up to six weeks after childbirth or the end of pregnancy.

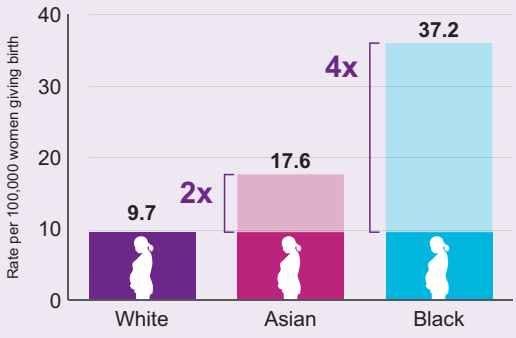
Causes of women's deaths

33 women	COVID-19	14%
33 women	Cardiac disease	14%
33 women	Blood clots	14%
25 women	Mental health conditions	10%
23 women	Sepsis	10%
22 women	Epilepsy and stroke	9%
19 women	Other physical conditions	8%
17 women	Bleeding	7%
9 women	Pre-eclampsia	4%
4 women	Cancer	2%
23 women	Other	10%

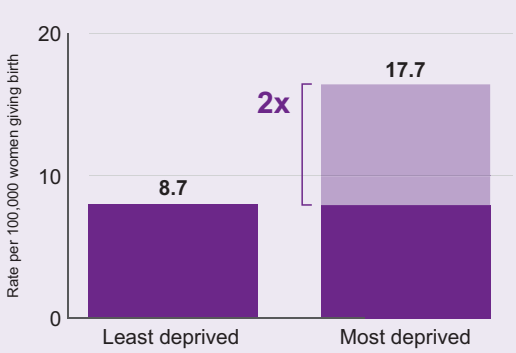
When maternal deaths due to COVID-19 are excluded, **10.1 women** per 100,000 died during pregnancy or up to six weeks after childbirth or the end of pregnancy

Inequalities in maternal mortality

Ethnic group



Living in more deprived areas



Key messages

from the themed morbidity enquiry report 2023

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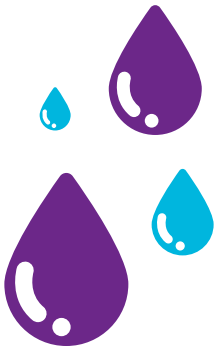
Recognition and management of bleeding

Assess blood loss early and regularly



Don't rely on a single bedside measurement of clotting or haemoglobin

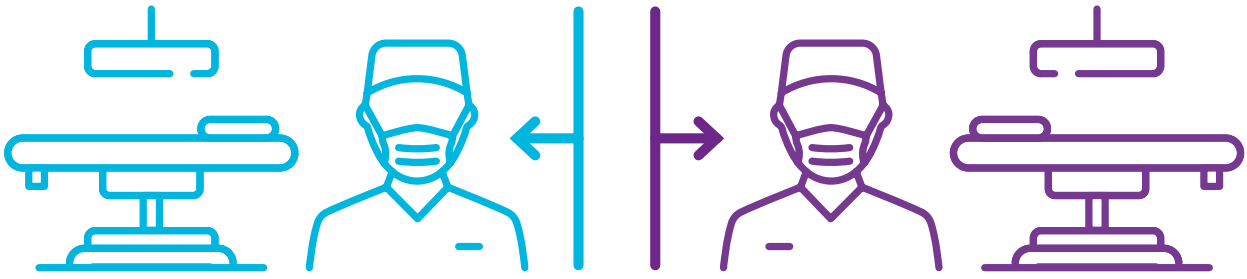
Consider and exclude concealed bleeding

Pulse rate and blood pressure are typically maintained until 30% of circulating volume is lost

A **raised pulse rate** or **drop in blood pressure** should prompt clinical evaluation of blood loss

National recommendation

Manage operating teams for urgent and elective caesarean sections separately



Category 1-3

Category 4

Key messages

from the themed mortality enquiry report 2023

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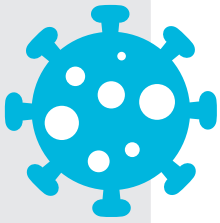
Treat pregnant, recently pregnant, and breastfeeding women the same as a non-pregnant person unless there is a very clear reason not to.

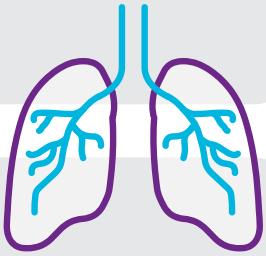
Prepare a route for rapid delivery of advice and data on new vaccines and treatments



Include in medicine and vaccine research

Tailor care after pregnancy to a woman's individual needs

Equity for pregnant and breastfeeding women



Include in guidance for admission to ECMO* services

*ECMO = Extracorporeal membrane oxygenation

Ensure staff in maternal medicine networks have the skills to care for complex physical, mental and social care needs

Develop training resources to promote shared decision making and counselling on medication use

Summary, key messages and recommendations

Introduction

This report, the tenth 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 2019 and 2021 in the UK. In addition, it also includes confidential enquiries into the care of women who died between 2019 and 2021 in the UK and Ireland from obstetric haemorrhage, amniotic fluid embolism, anaesthetic causes, infection, general medical and surgical disorders and epilepsy and stroke.

The report also includes a Morbidity Confidential Enquiry into the care of women with morbidity following repeat caesarean birth.

Surveillance information is included for 572 women who died during or up to one year after the end of pregnancy between 2019 and 2021. The care of 32 women with morbidity following repeat caesarean birth was reviewed in depth for the Morbidity Confidential Enquiry chapter.

Following changes to funder requirements, this complied report includes the contents of the three national State of the Nation reports as well as supplementary material concerning additional data and areas of existing guidance needing improved implementation. It can be read as a single document, but 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 that may be read independently, the topics covered are: 1. Introduction and methodology 2. Surveillance of maternal deaths 3. Haemorrhage and amniotic fluid embolism 4. Anaesthesia 5. Morbidity after repeat caesarean birth 6. Infection 7. General medical and surgical disorders 8. Neurological conditions.

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, National Records of Scotland and Public Health 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. Each woman's care is examined by multidisciplinary expert reviewers and assessed against current guidelines and standards (such as those 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.

IMPORTANT NOTE: Lessons for care are addressed to all health professionals involved in the care of women who are pregnant, have recently been pregnant or likely to become pregnant in the future as silo working leading to compromised care is a recurring theme identified in these enquiries. Some lessons 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 2016-18 and 2019-21. When deaths due to COVID-19 in 2020 and 2021 were excluded, maternal death rates were very similar for the two periods, which suggests that an even greater focus on implementation of the recommendations of these reports is needed to achieve a reduction in maternal deaths.

There remains a nearly 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. Twelve percent of the women who died during or up to a year after pregnancy in the UK in 2019-21 were at severe and multiple disadvantage. The main elements of multiple disadvantage were a mental health diagnosis, substance use and domestic abuse. Women living in the most deprived areas continue to have the highest maternal mortality rates, emphasising the need for a continued focus on action to address these disparities.

Cardiovascular disorders and thrombosis and thromboembolism are now responsible for the same number of maternal deaths in the UK, followed by psychiatric disorders; together, these three causes represent 38% of maternal deaths. During 2020 and 2021, maternal mortality directly attributable to COVID-19 was at a rate well in excess of that due to any other single cause.

There was a significant 33% increase in maternal death rates from direct causes between 2016-18 and 2019-21 (95% confidence interval 0%-45%, p=0.043). Thrombosis and thromboembolism remains the leading cause of direct maternal death during or up to six weeks after the end of pregnancy.

Deaths from mental health-related causes as a whole account for nearly 40% of deaths occurring between six weeks and a year after the end of pregnancy with maternal suicide remaining the leading cause of direct deaths in this period.

Key messages to improve care

The majority of recommendations that 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. All recommendations based on existing guidance are presented in full chapters. New national recommendations from the two themed State of the Nation confidential enquiry reports are presented below.

New national recommendations to improve care

1. Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day. **ACTION: National Institute for Health and Care Excellence (NICE)**
2. Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists, Royal College of Physicians, Obstetric Anaesthetists Association**
3. Review guidance on when to use balloon tamponade to control haemorrhage, how to insert the balloon and inflate it. Resources such as postpartum haemorrhage checklists should include when not to use balloon tamponade and when to abandon it and move on to a different haemostatic technique. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists**
4. Review and revise the service specification for centres providing specialist services for managing abnormally invasive placentation to ensure that all specialist units can provide appropriate equipment, facilities and appropriately skilled personnel in an emergency situation occurring at any time of day or night. **ACTION: NHS England, Scottish, Welsh and Irish governments**
5. Clarify that review of the care of women who return to theatre may provide important safety learning but should not be perceived as a performance metric after caesarean birth, as re-operation may be the appropriate response to control internal haemorrhage. **ACTION: NHS England, Scottish, Welsh and Irish governments**
6. Ensure that pregnant and breastfeeding women are not excluded inappropriately from research, including new vaccine and treatment research, and ensure that messaging about benefits and risks of medication and vaccine use is clear and well informed with involvement of key opinion leaders and representatives of communities at risk from an early stage. Prepare a route to enable rapid dissemination of updated advice and data concerning new vaccines and treatments to both women and their clinicians in the future. **ACTION: Department of Health and Social Care and equivalents in Scotland, Wales and Ireland, UK Health Security Agency and equivalents in Scotland, Wales and Ireland, National Institute for Health Research and other funding agencies, Royal College of Obstetricians and Gynaecologists, Royal College of Midwives, Royal College of Physicians, Royal College of General Practitioners**
7. Update guidance on ECMO for severe acute respiratory failure in adults to include specific information on referral and admission of pregnant and recently pregnant women with respiratory failure to ECMO services. **ACTION: National Institute for Health and Care Excellence (NICE)**
8. Ensure that staff working within maternal medicine networks are equipped with the skills to care for the complex and multiple medical, surgical, mental health and social care needs of the current maternity population. **ACTION: Maternal Medicine Networks**
9. Ensure that guidance on care for pregnant women with complex social factors is updated to include a role for networked maternal medical care and postnatal follow-up to ensure that it is tailored to women's individual needs and that resources in particular target vulnerable women with medical and mental health co-morbidities and social complexity. **ACTION: National Institute for Health and Care Excellence (NICE)**

10. Develop training resources concerning shared decision making and counselling regarding medication use in pregnancy and breastfeeding, including specific information on the benefits and risks of different medications and non-adherence. **ACTION: Royal College of Obstetricians and Gynaecologists, Royal College of Midwives, Royal College of Physicians, Royal College of General Practitioners, Medicines and Healthcare Products Regulatory Agency**

Conclusions

This report includes the surveillance information for women who died during and after pregnancy for 2019-21, which includes two years of the COVID-19 pandemic, when there were many service-related changes. The clearest impact of the pandemic on maternal mortality rates has been evidence of health systems under pressure, a theme which recurred across several chapters in this report. If women who died from COVID-19 are excluded, the maternal mortality rate is lower than the corresponding rate for 2018-20, but not significantly so; the care of women who died from COVID-19 is discussed chapter 6. The lessons learned from the care of women who died from COVID-19 emphasise the need to ensure that pregnant and breastfeeding women are not excluded from research and that they receive the same level of evidence-based care as non-pregnant women. The majority of women who died from COVID-19 in 2020 and 2021 were from ethnic minority groups and this is reflected in higher overall maternal mortality rates amongst women from Black and Asian ethnic groups compared to White women. This is a finding that is consistently emphasised in MBRRACE-UK reports. Similarly, disparities in maternal mortality rates continue to exist amongst women who live in the most deprived areas compared to those living in the least deprived areas. Assessors also identified important messages concerning the care of women with multiple adversity and multiple morbidities, who are once again over-represented among maternal deaths. As in the 2022 report, deaths from mental-health related causes continue to contribute significantly to the maternal mortality rate, particularly in the period between six weeks and a year after the end of pregnancy. Addressing these disparities, complexities and mental health concerns must remain an important focus.

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.

We would particularly like to thank Sebastian Lucas who has stepped down as lead pathology assessor and who has made an invaluable contribution to the Confidential Enquiry into Maternal Deaths over many years, ensuring that high quality autopsy and pathological investigation remain central to the assessment of maternal deaths.

Our grateful thanks also go to Kathryn Bunch who has conducted the epidemiological analyses for the last five years, and to Jenny Kurinczuk, who led the MBRRACE-UK collaboration from its inception until her retirement in June 2023 and who has been integral to ensuring the programme continues to generate messages to help save the lives of both women and babies.

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Royal College of Midwives
Royal College of Paediatrics and Child Health
Royal College of Emergency Medicine
Royal College of Psychiatrists
Faculty of Public Health
Royal Society of Medicine
Royal College of Anaesthetists
Obstetric Anaesthetists' Association
Royal College of General Practitioners
Royal College of Nursing
Royal College of Pathologists
British Association of Perinatal Medicine
British Maternal & Fetal Medicine Society

Glossary of terms

AFE	Amniotic fluid embolism
BMI	Body mass index
BP	Blood pressure
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
CT	Computerised tomography
E. Coli	Escherichia coli
ECMO	Extracorporeal membrane oxygenation
FAST	Face Arm Speech Test
FAST Scan	Focused Assessment with Sonography in Trauma Scan
FFP	Fresh frozen plasma
GAS	Group A Streptococcus
GCS	Glasgow coma scale
GP	General practitioner
HbA1c	Glycated haemoglobin (A1c)
HIV	Human immunodeficiency virus
HLH	Haemophagocytic lymphohistiocytosis
HQIP	Healthcare Quality Improvement Partnership
ICD-MM	International Classification of Diseases – Maternal Mortality
ICP	Intracranial pressure
ICU	Intensive care unit
IMD	Index of Multiple Deprivation
IV	Intravenous
LCR	Local clinician report
MBRRACE-UK	Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK
MDE Ireland	Maternal Death Enquiry Ireland
MEOWS	Modified Early Obstetric Warning Score
MEWS	Maternity Early Warning Score
MMN	Maternal medicine network
MMR	Maternal mortality ratio
MRI	Magnetic resonance imaging
NCAPOP	National Clinical Audit and Patient Outcomes Programme
NEWS	National Early Warning Score
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NIMACH	Northern Ireland Maternal and Child Health
PAS	Placenta accreta spectrum
PPH	Postpartum haemorrhage
RCM	Royal College of Midwives
RCOG	Royal College of Obstetricians and Gynaecologists
RH	Resuscitative hysterotomy
ROSIER	Recognition of Stroke in the Emergency Room
RR	Rate ratio (or Relative risk)
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
TIA	Transient ischaemic stroke
TTP	Thrombotic thrombocytopenic purpura
UKOSS	UK Obstetric Surveillance System
VP	Ventriculoperitoneal
VTE	Venous thromboembolism

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1. Introduction and methods

Allison Felker and Marian Knight

1.1 The 2023 Saving Lives, Improving Mothers' Care report

This compiled report of the MBRRACE-UK Confidential Enquiry into Maternal Deaths and Morbidity (CEMD) is the first produced following a change in funder requirements, which required that the findings be presented as multiple outputs instead of one report as produced previously. The following outputs have been produced and are available online: ***www.npeu.ox.ac.uk/mbrrace-uk***

1. A Data Brief with basic statistics concerning maternal mortality published online in advance of the reports. In 2023 this includes information on women who died between 2019 and 2021.
2. A State of the Nation surveillance report with selected additional details concerning maternal mortality and the characteristics of women who died. In 2023 this includes information on women who died between 2019 and 2021.

   This State of the Nation report, along with supplemental material and full data can be found in chapter 2 (surveillance and epidemiology) of this compiled report.
3. A State of the Nation themed confidential enquiry report with new national recommendations concerning women who died from specific causes and from selected severe morbidities. In 2023 this includes information on women who died from obstetric haemorrhage, amniotic fluid embolism and anaesthetic causes between 2019 and 2021 and women with morbidity following repeat caesarean birth and five national recommendations.

   This State of the Nation report, along with supplementary material, including detailed enquiries and messages for care, can be found in chapters 3 (haemorrhage and amniotic fluid embolism), 4 (anaesthetic care) and 5 (morbidity after repeat caesarean birth) of this compiled report.
4. A State of the Nation themed confidential enquiry report with new national recommendations concerning women who died from specific causes. In 2023 this includes information on women who died from infection, haematological, respiratory, endocrine, gastrointestinal and general surgical causes, and neurological causes between 2019 and 2021 and five national recommendations.

   This State of the Nation report, along with supplementary material, including detailed enquiries and messages for care, can be found in chapters 6 (infection), 7 (general medical and surgical conditions) and 8 (neurological complications) of this compiled report.

The Data Brief and individual State of the Nation reports are available online at: ***www.npeu.ox.ac.uk/mbrrace-uk***

In addition to the content of each State of the Nation report and supplementary material, including full data and detailed enquiry chapters with associated messages for care, this compiled report also includes the background, aims and scope of work, details of methods and author lists.

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

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

All existing guidance requiring improved implementation is presented in green boxes NICE 2345

1.2 Topics covered in MBRRACE-UK maternal reports

The Maternal, Newborn and Infant Clinical Outcome Review Programme requires the production of annual CEMD reports. As the number of maternal deaths from individual causes is small, three years' worth of data is required to maintain anonymity and confidentiality and to identify consistent lessons learned for future care. As such, topic-specific chapters appear in annual reports once every three years on a cyclical basis alongside a surveillance chapter reporting three years of statistical data and a selected morbidity enquiry on a topic decided on by the MBRRACE-UK Independent Advisory Group.

All causes of maternal death are covered once in a three-year cycle; the current planned three-year cycle of topic specific chapters is shown below, noting that if concerning trends are observed in specific causes of death, reviews concerning particular causes of death may be expedited and the cyclical plan may change:

- **Year 1 (2023)**: Confidential enquiry reports on deaths from haemorrhage, amniotic fluid embolism, anaesthesia, infection (direct and indirect), deaths in women with general medical and surgical disorders (other indirect deaths) and deaths from neurological complications **(THIS REPORT)**
- **Year 2 (2024)**: Confidential enquiry reports on deaths due to thrombosis and thromboembolism and malignancy (direct, indirect and coincidental), deaths in early pregnancy
- **Year 3 (2025)**: Confidential enquiry reports on deaths from psychiatric causes (suicide and non-suicide), cardiac causes, pre-eclampsia and eclampsia, accidental deaths and homicide

1.3 The MBRRACE-UK Confidential Enquiries into Maternal Deaths methods

Identifying maternal deaths

All deaths of women in the UK during or up to one year after pregnancy are identified through a variety of sources. The majority are notified to the MBRRACE-UK office directly from the unit in which the maternal death occurred by nominated staff members. We request that all such deaths are notified to us within one week of the death occurring. Other deaths are notified to MBRRACE-UK from a variety of individuals such as coroners/procurators fiscal or pathologists, Local Supervising Authority Midwifery Officers and members of the public. Reports are also identified by the central MBRRACE-UK team from the media, for example, when the results of inquests are reported.

Ascertainment of deaths is cross-checked with records from the Office for National Statistics and National Records of Scotland. Both these sources provide details of registered deaths of any women in which pregnancy, or a pregnancy-specific cause, is listed on the death certificate. In addition, maternal details in birth records are linked to deaths of women of reproductive age occurring over the following 12 months in order to identify maternal deaths where pregnancy or pregnancy-specific causes are not listed on the death certificate. The deaths identified from these additional sources are then compared with the deaths reported to MBRRACE-UK; when an unreported death is identified, the hospitals where the birth and death occurred are contacted and asked to provide records.

Collecting information about maternal deaths in the UK

The data collection and assessment process following the report of a maternal death is illustrated in Figure 1.1.

Following the report of a maternal death, a notification pack is sent to the relevant unit in which the death occurred. This includes a surveillance form to collect basic demographic and clinical details about the woman, her death and the infant, as well as a form requesting the contact details of the clinicians involved in managing the woman's care. The MBRRACE-UK hospital contact is asked to return the surveillance form and clinicians' contact details, along with a full copy of the woman's medical records, within one month of the death occurring.

In addition to case records and notes from the unit in which the woman died, the MBRRACE-UK team also seek records from other units and health care providers that cared for her during and up to one year after pregnancy. This can include other antenatal units or centres such as general practices, mental health services, ambulance services and specialist services (e.g. cancer centres, neurology). In addition, they seek copies of the post-mortem report and a copy of the local review (Serious Incident review, Root Cause Analysis or similar), if one has been undertaken, to provide identified messages for future care at a local level.

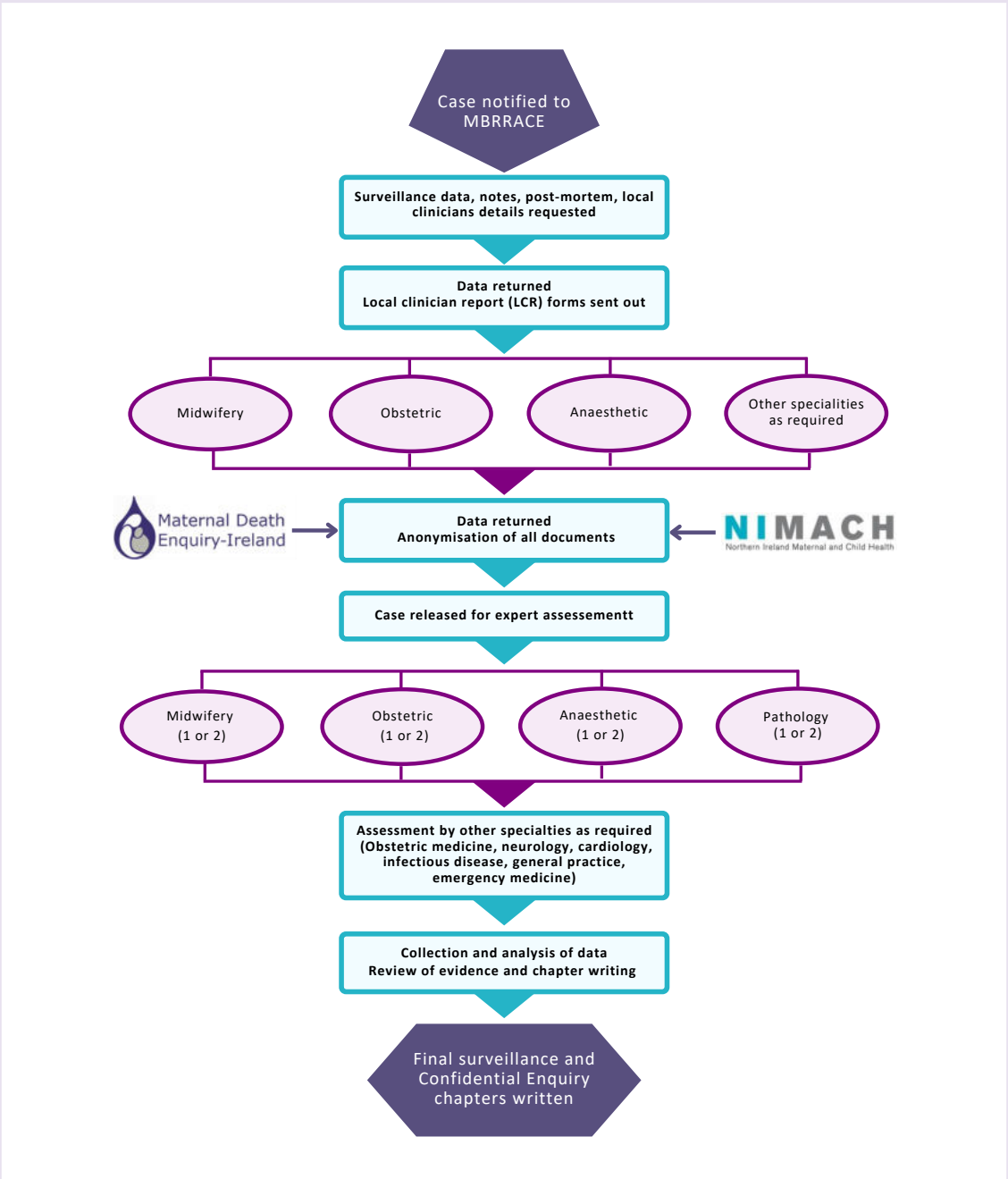
Once all the requested documents are received by the MBRRACE-UK team, local clinician report (LCR) forms are sent to the clinical staff involved in the woman's care. These forms ask for the staffs' perspectives on the care of the woman including the identification of any lessons learned for future care. All documents received from units/practitioners are fully anonymised by the MBRRACE-UK team, scanned and uploaded onto a secure viewing system. Our

aim is to have all data complete and ready for expert review by MBRRACE-UK trained assessors by three months from the date of a woman's death. In complex cases involving multiple trusts or ongoing investigations it may take longer to obtain all the data required for assessment.

Identifiable information about maternal deaths in England, Wales and Scotland is collected directly by the MBRRACE-UK office in Oxford. Privacy issues in Northern Ireland are such that identifiable information about women who have died during or after pregnancy cannot be transferred out of the Province. All the case records and surveillance data are therefore collected by the staff of the Northern Ireland Maternal and Child Health (NIMACH) office of the Public Health Agency of Northern Ireland. Fully anonymised records are then transferred securely to the MBRRACE-UK office in Oxford for analysis and expert review.

The surveillance information about each death is entered into a bespoke database and entries are double checked by a member of the MBRRACE-UK team. Queries about missing or unclear data items are sent back to units to ensure that the data are of high quality. In addition, some data items may be extracted directly from the maternal death records by MBRRACE-UK team staff. Once the data are complete, a dataset is extracted and cleaned prior to analysis by the MBRRACE-UK epidemiology team based in the National Perinatal Epidemiology Unit, University of Oxford.

Figure 1.1: MBRRACE-UK Confidential Enquiry Methods



The Maternal Death Enquiry Ireland

Deaths from the UK and Ireland are assessed together in a joint confidential enquiry process. The Maternal Death Enquiry (MDE) Ireland was established in 2009 with the remit to carry out surveillance and confidential enquiries into maternal deaths in Ireland (Confidential Maternal Death Enquiry in Ireland 2012). In order to enhance the generalisability of the messages for care, whilst maintaining confidentiality and anonymity, maternal deaths occurring in Ireland are assessed alongside UK deaths using the same processes (Figure 1.1). Expert assessors from the Irish Republic have joined the pool of UK assessors and contribute to assessment in the same way as UK assessors. Data for Ireland are collected by staff from the MDE Ireland office in Cork; fully anonymised records are then transferred to the MBRRACE-UK office for upload onto the secure viewing system. The MDE Ireland continues to analyse and publish surveillance data for Ireland independently (O'Hare, Manning et al. 2022), therefore surveillance information for the Republic of Ireland is not included in this report and the trends described in chapter 2 refer only to the UK. The number of deaths reported in each confidential enquiry chapter will thus differ from the number recorded in the surveillance chapter.

Expert review by assessors

MBRRACE-UK has over 100 assessors from various speciality groups, including pathology, midwifery, obstetrics, anaesthetics, intensive care, psychiatry, general practice, emergency medicine and other medical specialities, such as obstetric physicians, cardiologists, infectious diseases physicians and neurologists. Assessors are appointed in a selection process organised by the relevant Royal Colleges or professional organisations, which require specific skills and experience. All assessors are volunteers and do not receive financial remuneration for their work, although they are able to classify their MBRRACE-UK work as part of continuing professional development. All assessors undergo a training process and are provided with guidance detailing relevant standards of care against which deaths are assessed. Where possible, the guidance is drawn from national sources such as the National Institute for Health and Care Excellence (NICE), the Scottish Intercollegiate Guidelines Network (SIGN) or professional organisations such as the Royal College of Obstetricians and Gynaecologists and the Association of Anaesthetists of Great Britain and Ireland.

Once the complete records concerning the care of a particular woman are received and anonymised, they are reviewed by assessors in four core areas: pathology, obstetrics, midwifery and anaesthetics. This establishes the most likely cause of the woman's death and allows her records to be allocated to the appropriate speciality assessors based on the circumstances of the woman's death. When recommended by core assessors, the woman's care is also assessed by other specialists, including psychiatrists, general practitioners, physicians, emergency medicine specialists and intensive care specialists. For each woman, a primary assessor completes an independent review of her care, highlighting the lessons to be learned to improve care in the future. When specific issues are identified, a second, independent assessor in the relevant specialty also reviews the woman's care. Expert assessors are located in all areas of the UK and Ireland. To maintain anonymity, assessors are only asked to review the care of women who have died outside their region or country. The assessment process and all individual findings are strictly confidential and all assessors are required to sign a confidentiality agreement.

As part of the review, expert assessors give their opinion on the quality of care according to the three criteria shown in Box 1.1.

Box 1.1: Assessment of quality of care

Good care; no improvements identified

Improvements in care* identified which would have made no difference to the outcome

Improvements in care* identified which may have made a difference to the outcome

*Improvements in care are interpreted to include adherence to guidelines, where these exist and have not been followed, as well as other improvements that would normally be considered part of good care, where no formal guidelines exist.

Assessors are also asked to identify whether any woman's death should be flagged as a Cause for Concern for Communication to the Trust Medical Director and Healthcare Quality Improvement Partnership (HQIP), which has a standard protocol for all the Clinical Outcome Review Programmes to escalate major concerns about care where it is clear these concerns have not been addressed at a local level. Deaths are notified to HQIP if there is consensus among assessors that they meet one of the criteria outlined in Box 1.2.

Box 1.2: Cause for Concern escalated to HQIP – standard procedure for all Clinical Outcome Review Programmes

A death (child or adult) attributable to abuse or neglect, but no indication of cross-agency involvement (i.e. no mention of safeguarding, social services, police or Local Safeguarding Children Board).

A staff member displaying the following behaviours (and where it is unclear if the incident has been reported to senior staff):

- Abusive behaviour (including allegations of sexual assault)
- Serious professional misconduct
- Dangerous lack of competency

Standards in care that indicate a dysfunctional or dangerous department or organisation, or grossly inadequate service provision.

Reviewing the evidence and reaching conclusions

Once data collection is complete and all women's care has undergone expert assessment, chapter writing groups are convened. These multidisciplinary groups consist of representatives from all the relevant specialist assessor groups depending on the topics for that year's confidential enquiries. Each chapter writing group discusses the care of all of the women who died in the triennium from a specific cause of death. Initially, the cause of death and classification of care is discussed to ensure that all deaths are appropriately classified. Subsequently, the expert assessments of each woman's care are examined to identify the main themes for learning for the MBRRACE-UK report. Lead members of each chapter writing group draft the confidential enquiry chapter, which is then edited by one of the MBRRACE-UK collaborators and reviewed by all the other group members and editors (as well as external peer reviewers, if required), prior to reaching a final agreed version. Where possible, recommendations are linked to national guidance from organisations such as NICE and SIGN.

Definitions and statistical methods

A maternal death is defined internationally as a death of a woman while pregnant or within 42 days (six weeks) after the end of pregnancy, from causes associated with, or exacerbated by, pregnancy or its management, irrespective of the duration of the pregnancy and whether the pregnancy ended by termination, miscarriage or a birth, or was an ectopic pregnancy (World Health Organisation 2010). A late maternal death is one that occurs more than six weeks but less than one year after the end of pregnancy. Maternal deaths can be further subdivided on the basis of cause into: direct deaths, from pregnancy-specific causes such as pre-eclampsia; indirect deaths, from other medical conditions exacerbated by pregnancy such as cardiac disease; or coincidental deaths, where the cause of death is considered to be unrelated to pregnancy, such as road traffic accidents. These definitions are summarised in Box 1.3

Box 1.3. Definitions of maternal deaths (World Health Organisation 2010)

Maternal death	The death of a women while pregnant or within 42 days of the end of the pregnancy* from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes
Direct	Maternal deaths resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above
Indirect	Maternal deaths resulting from previous existing disease, or disease that developed during pregnancy and which was not the result of direct obstetric causes, but which was aggravated by the physiological effects of pregnancy
Late	Maternal deaths occurring between 42 days and one year after the end of pregnancy* that are the result of Direct or Indirect maternal causes
Coincidental	Maternal deaths from unrelated causes which happen to occur in pregnancy or the puerperium

*The end of pregnancy includes termination, miscarriage or birth and ectopic pregnancies

For the purposes of MBRRACE-UK, maternal mortality rates with 95% confidence intervals (CI) are calculated using national data on the number of maternities (women giving birth, including stillbirths, at or beyond 24 weeks' gestation) as the denominator. This differs from quoted standard international maternal mortality ratios (MMR), which use live births as the denominator; a calculated MMR is provided among the surveillance data for comparison purposes. Total maternities for the UK for each triennium are obtained from the annually reported birth data for England and Wales (Office for National Statistics), Scotland (National Records Scotland) and Northern Ireland (Northern Ireland Statistics and Research Agency). These data are used to calculate overall mortality rates and rate ratios (RR) as well as the cause of death, age and country of birth specific mortality rates and RR. Denominator data on the place of delivery and multiple pregnancies for the maternities in England and Wales (Office for National Statistics) are used to calculate maternal mortality rates and RR by place of delivery and plurality. As noted previously (Knight, Nair et al. 2016), the estimated mortality rates and RR for specific ethnic and socio-economic groups (Index of Multiple Deprivation (IMD) quintiles) are calculated using Hospital Episode Statistics maternity data for England as the denominator (note that the Hospital Episode Statistics maternity data does not include out of hospital births). Maternities for which ethnicity was not stated are included in the 'White' group because the re-distributed proportions match with the estimated ethnic profiles in the UK population census (NHS Digital 2023).

The characteristics of women who die are tabulated and compared where possible with national population data. Characteristics are also compared with other population based data sources, such as from existing UK Obstetric Surveillance System (UKOSS) studies if there are no other possible sources of comparative data.

A non-parametric test for trend across ordered groups is used to investigate the change in three-yearly rolling maternal mortality rates over time, and linear regression is used to analyse the change in non-overlapping triennial rates. Rate ratios with 95% CI are calculated to compare maternal death rates between groups of women. The data in this report were analysed using STATA version 17 (Statacorp).

1.4 The Confidential Enquiry into Maternal Morbidity

In addition to carrying out CEMDs, MBRRACE-UK also undertakes Confidential Enquiries into Maternal Morbidity (CEMM). Topics for CEMM are proposed by clinicians, policy-makers, third sector organisations and members of the public in an annual open application process. The final topic is chosen by the MBRRACE-UK Independent Advisory Group. The same organisations and individuals can propose multiple topics as long as they are suitable. Topics that require epidemiological studies to estimate the incidence and prevalence of a condition or investigate risk factors, are generally not suitable for confidential enquiry. Women are identified for the CEMM in different ways according to the topic.

The topic chosen for inclusion in the 2023 report is morbidity following repeat caesarean birth. For this topic, women were identified from an existing UKOSS study of re-exploration after caesarean birth conducted between June 2021 and May 2022. The case definition for women included in the UKOSS study is: any woman who had a caesarean birth and who returned to theatre and had either an exploration of the wound with the rectus sheath re-opened, or a formal laparotomy (opening of the peritoneum) within 28 days of the caesarean section.

Regardless of the topic, for each CEMM, a full set of each woman's medical records is requested from all units concerned. The records then undergo anonymisation and expert assessment in the exact same way as the records of the women who died. For the 2023 CEMM, the records for all 36 women from the UKOSS study were requested; records were received for 32 women whose care was reviewed for chapter 5 of this report.

2. Maternal Mortality in the UK 2019-21: Surveillance and Epidemiology

Kathryn Bunch and Marian Knight

2.1 National summary data

There was a statistically non-significant increase in the overall maternal death rate in the UK between 2016-18 and 2019-21. When deaths due to COVID-19 in 2020 and 2021 were excluded, maternal death rates were very similar for the two periods, which suggests that an even greater focus on implementation of the recommendations of these reports is needed to achieve a reduction in maternal deaths.

There remains a nearly 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. Twelve percent of the women who died during or up to a year after pregnancy in the UK in 2019-21 were at severe and multiple disadvantage. The main elements of multiple disadvantage were a mental health diagnosis, substance use and domestic abuse. Women living in the most deprived areas continue to have the highest maternal mortality rates, emphasising the need for a continued focus on action to address these disparities.

Cardiovascular disorders and thrombosis and thromboembolism are now responsible for the same number of maternal deaths in the UK, followed by psychiatric disorders; together, these three causes represent 38% of maternal deaths. During 2020 and 2021, maternal mortality directly attributable to COVID-19 was at a rate well in excess of that due to any other single cause.

There was a significant 33% increase in maternal death rates from direct causes between 2016-18 and 2019-21 (95% confidence interval 0%-45%, p=0.043). Thrombosis and thromboembolism remains the leading cause of direct maternal death during or up to six weeks after the end of pregnancy.

Deaths from mental health-related causes as a whole account for nearly 40% of deaths occurring between six weeks and a year after the end of pregnancy with maternal suicide remaining the leading cause of direct deaths in this period.

2.2 Causes and trends

Overall, 261 women died in 2019-21 during or within 42 days of the end of pregnancy in the UK. The deaths of 20 women were classified as coincidental. Thus, in this triennium, 241 women died from direct and indirect causes, classified using ICD-MM (World Health Organisation 2012), among 2,066,997 maternities, a maternal death rate of 11.66 per 100,000 maternities (95% CI 10.23 – 13.23). This compares to the rate of 10.90 per 100,000 maternities (95% CI 9.53 – 12.40) in 2018-20 (rate ratio (RR) 1.07, 95% CI 0.89-1.29, p=0.463). Nine of the deaths which occurred between March and December 2020 and 24 of those during 2021 were directly attributable to SARS-CoV-2 infection. If these COVID-19 attributable deaths were excluded, the maternal mortality rate for 2019-21 would be 10.06 (95% CI 8.74 – 11.53), lower than the corresponding rate for 2018-20 (10.47 (95%CI 9.13-11.95) but not significantly so (RR 0.96 (95%CI 0.79 – 1.17), p=0.684). 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 2019-21 (RR 0.84, 95% CI 0.70-0.99, p=0.038 for trend in rolling rates over time). The direct maternal death rate has decreased by 19% since 2003-05 (RR 0.81, 95% CI 0.63-1.04, p=.090) and there was a 14% decrease in the rate of indirect maternal deaths (RR 0.86, 95% CI 0.68-1.10, p=0.213).

The progress towards the Government ambition to reduce maternal mortality by 50% between 2010 and 2025 (Department of Health 2017) can be assessed by comparing maternal death rates between the 2009-11 and 2019-21 triennia. Over this time, maternal mortality has increased by 15%, (RR 1.15, 95% CI 0.96-1.38). Even when maternal deaths directly attributable to COVID-19 are excluded, maternal mortality over this period has decreased by just 1% (RR 0.99, 95% CI 0.82-1.20).

The rates of overall mortality and indirect maternal deaths in the 2019-21 triennium were not statistically significantly different from those in 2016-18, the immediately preceding triennium, though maternal deaths due to direct causes were significantly increased (RR for overall mortality = 1.20, 95% CI 1.00 to 1.45, p=0.050; RR for direct deaths 1.33,

95% CI 1.00 to 1.77, p=0.0431; RR for indirect deaths = 1.11, 95% CI 0.86 to 1.43, p=0.418). Excluding deaths attributable to COVID-19 reduced the rate increases for maternal mortality overall and indirect maternal deaths: RR for overall mortality = 1.03, 95% CI 0.84 to 1.25, p=0.788; RR for indirect deaths = 0.82, 95% CI 0.62 to 1.08, p=0.149).

Discrete triennial rates are shown in Table 2.2 and Figure 2.2. Note that these figures are unchanged from those reported in the 2022 report as there has not been a complete new triennium since.

Table 2.1: Three-year rolling average direct and indirect maternal mortality rates per 100,000 maternities, deaths classified using ICD-MM; UK 2003-21

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
2017-19	2 173 810	78	3.59	2.84 – 4.48	113	5.20	4.28 – 6.25	191	8.79	7.58 – 10.12
2018-20	2,101,829	109	5.19	4.26 – 6.26	120	5.71	4.73 – 6.83	229	10.90	9.53 – 12.40
2019-21	2,066,997	113	5.47	4.51 – 6.57	128	6.19	5.17 – 7.36	241	11.66	10.23 –13.23

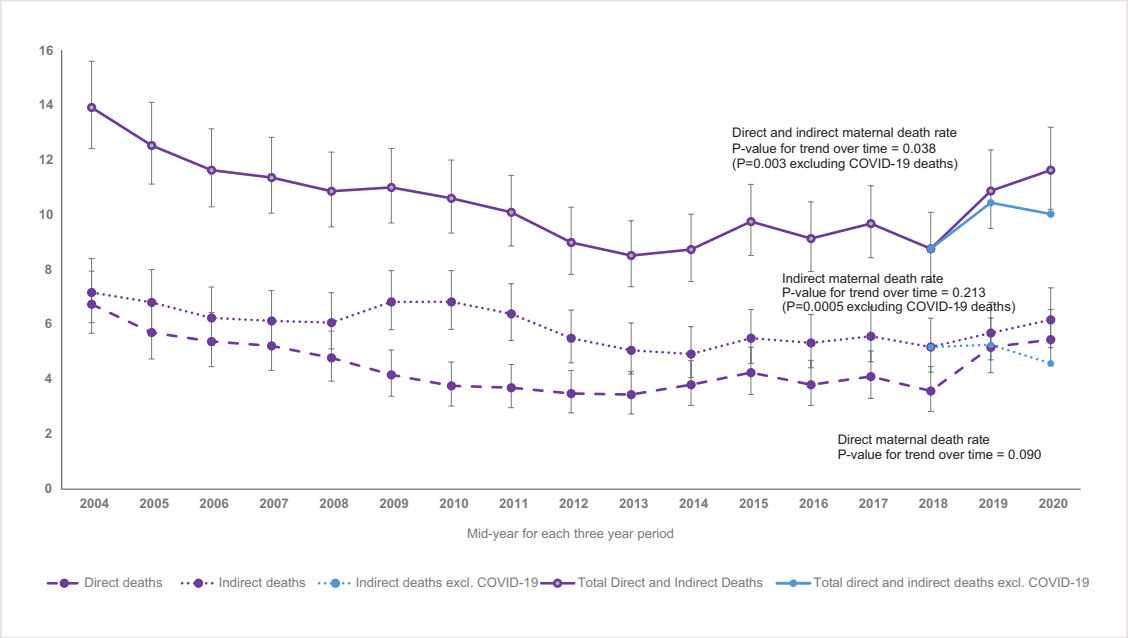
Sources: CMACE, MBRRACE-UK, Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency

Table 2.2: Direct and Indirect maternal deaths and mortality rates per 100,000 maternities by discrete triennia, UK using ICD-MM; UK 2003-20

Triennium	Direct deaths recorded			Indirect deaths recorded			Total Direct and Indirect deaths recorded		
	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
2018-20	109	5.19	4.26 – 6.26	120	5.71	4.73 – 6.83	229	10.90	9.53 – 12.40

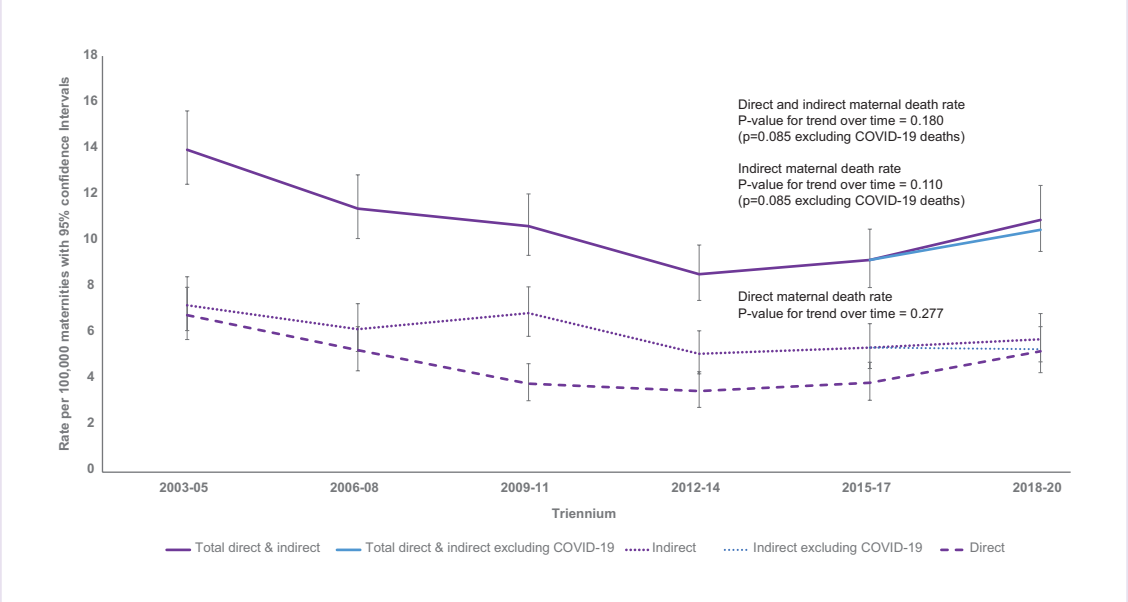
Sources: CMACE, MBRRACE-UK, Office for National Statistics, National Records Scotland, Northern Ireland Statistics and Research Agency

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 2003-2021



Sources: CMACE, MBRRACE-UK

Figure 2.2: Direct and Indirect maternal mortality rates per 100,000 maternities by discrete triennia; UK 2003-2020 (using ICD-MM)

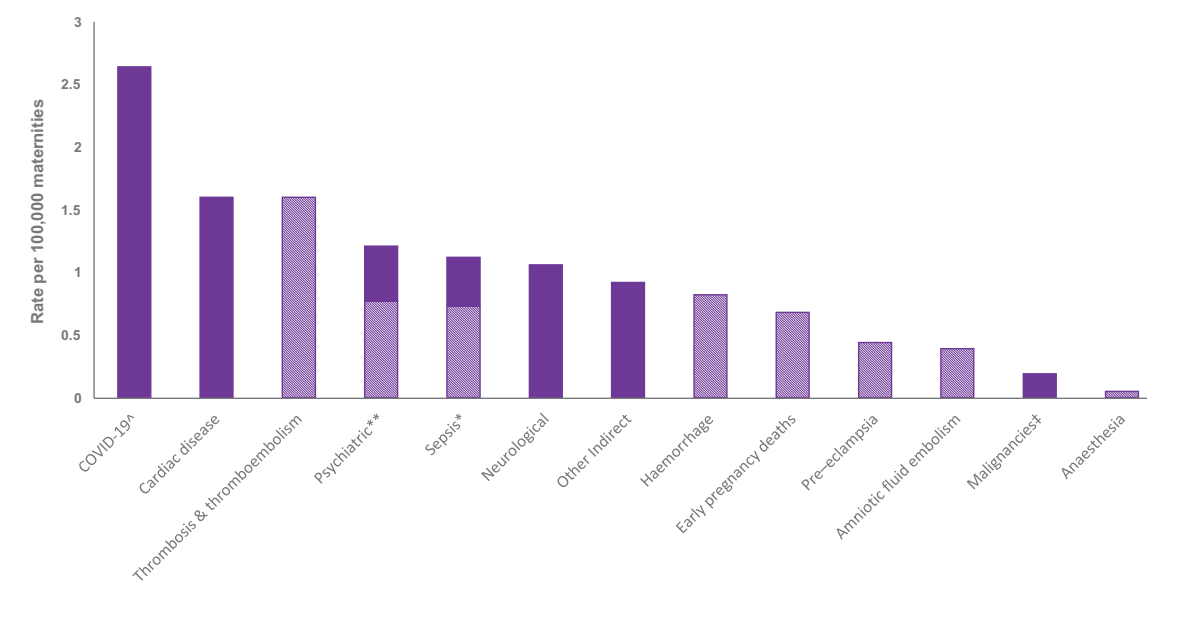


Sources: CMACE, MBRRACE-UK

Deaths due to individual causes

Maternal deaths by cause are shown in Figure 2.3 and Tables 2.3 and 2.4. Rolling three-year rates for individual causes are presented for five overlapping triennial reporting periods (2015-17, 2016-18, 2017-19, 2018-20 and 2019-21) (Table 2.3) and for discrete, non-overlapping triennial periods between 1985-7 and 2018-20 (Table 2.4). This current report is the first report in a three-year cycle, therefore Table 2.4 is unchanged from the 2022 report. 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 and Figure 2.4.

Figure 2.3: Maternal mortality by cause UK 2019-20



Hatched bars show direct causes of death, solid bars indicate indirect causes of death

^Rate for COVID-19 deaths calculated using maternities March 2020 to December 2021 as denominator

**Rate for suicides (direct) is shown in hatched and rate for indirect psychiatric causes (drugs/alcohol) in solid bar

*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 indirect malignancies (breast/ovary/cervix)

Source: MBRRACE-UK

Table 2.3: Maternal mortality rates per 100,000 maternities, by cause, by overlapping triennia, 2015 to 2021

	2015-17			2016 - 2018			2017-19			2018-20			2019-21		
	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	209	9.16	7.96 – 10.50	217	9.71	8.46 – 11.09	191	8.79	7.58 – 10.12	229	10.90	9.53 – 12.40	241	11.66	10.23 – 13.23
Direct deaths															
Pregnancy related infections - Sepsis*	10	0.44	0.21 – 0.81	12	0.54	0.28 - 0.94	13	0.60	0.32 -1.02	17	0.81	0.47 -1.29	15	0.73	0.41 – 1.20
Pre-eclampsia and eclampsia	5	0.22	0.07 – 0.51	4	0.18	0.05 - 0.46	6	0.28	0.10 – 0.60	8	0.38	0.16 – 0.75	9	0.44	0.20 – 0.83
Thrombosis and thromboembolism	34	1.49	1.03 – 2.08	33	1.48	1.02 - 2.07	20	0.92	0.56 – 1.42	29	1.38	0.92 – 1.98	33	1.60	1.10 – 2.24
Amniotic fluid embolism	6	0.26	0.10 – 0.57	6	0.27	0.10 - 0.58	7	0.32	0.13 – 0.66	9	0.43	0.20 – 0.81	8	0.39	0.17 – 0.76
Early pregnancy deaths	4	0.18	0.05 – 0.45	7	0.31	0.13 - 0.65	7	0.32	0.13 – 0.66	9	0.43	0.20 – 0.81	14	0.68	0.37 – 1.14
Haemorrhage	11	0.48	0.24 – 0.86	14	0.63	0.34 -1.05	14	0.64	0.35 – 1.08	16	0.76	0.44 – 1.24	17	0.82	0.48 – 1.32
Anaesthesia	1	0.04	0.001 – 0.24	1	0.05	0.001 - 0.25	1	0.05	0.001 – 0.26	1	0.05	0.001 – 0.27	1	0.05	0.001 – 0.27
Psychiatric causes - Suicides	13	0.57	0.30 – 0.98	14	0.63	0.34 - 1.05	10	0.46	0.22 – 0.85	20	0.95	0.58 – 1.47	16	0.77	0.44 – 1.26
Malignancy - direct	1	0.04	0.001 – 0.24	-	-	-	-	-	-	-	-	-	-	-	-
Unascertained - direct	2	0.09	0.01 – 0.32	1	0.05	0.001 - 0.25	-	-	-	-	-	-	-	-	-
All Direct	87	3.82	3.06 – 4.71	92	4.12	3.32 - 5.05	78	3.59	2.84 – 4.48	109	5.19	4.26 – 6.26	113	5.47	4.51 – 6.57
Indirect															
Cardiac disease	48	2.10	1.55 – 2.79	50	2.24	1.66 - 2.95	36	1.66	1.16 – 2.29	34	1.62	1.12 – 2.26	33	1.60	1.010– 2.24
Indirect Sepsis - Influenza	1	0.04	0.001 – 0.24	2	0.09	0.01 - 0.32	2	0.09	0.01 – 0.33	2	0.10	0.01 – 0.34	1	0.05	0.001 – 0.27
Indirect Sepsis – Pneumonia/ others	9	0.39	0.18 – 0.75	9	0.40	0.18 - 0.76	8	0.37	0.16 – 0.73	6	0.29	0.11 – 0.62	7	0.34	0.14 – 0.70
Indirect Sepsis – COVID-19										9	1.60	0.73 – 3.04	33	2.64	1.82 – 3.71
Other Indirect causes	23	1.01	0.64 – 1.51	15	0.67	0.38 - 1.11	19	0.87	0.53 – 1.36	24	1.14	0.73 – 1.70	19	0.92	0.55 – 1.44
Indirect neurological conditions	27	1.18	0.78 – 1.72	29	1.30	0.87 - 1.86	33	1.52	1.04 – 2.13	27	1.28	0.85 – 1.87	22	1.06	0.67 – 1.61
Psychiatric causes – Drugs/alcohol/others	7	0.31	0.12 – 0.63	14	0.63	0.34 – 1.05	10	0.46	0.22 – 0.85	14	0.67	0.36 – 1.12	9	0.44	0.20 – 0.83
Indirect malignancies	7	0.31	0.12 – 0.63	6	0.27	0.10 – 0.58	5	0.23	0.07 – 0.54	4	0.19	0.05 – 0.49	4	0.19	0.05 – 0.50
All Indirect	122	5.35	4.44 – 6.39	125	5.59	4.66 - 6.66	113	5.20	4.28 – 6.25	120	5.71	4.73 – 6.83	128	6.19	5.17 – 7.36
Coincidental															
Homicide	7	0.31	0.12 – 0.63	5	0.22	0.07 - 0.52	4	0.18	0.05 – 0.47	4	0.19	0.05 – 0.49	5	0.24	0.08 – 0.57
Other coincidental	20	0.88	0.54 – 1.35	20	0.90	0.55 - 1.38	16	0.74	0.42 – 1.20	14	0.67	0.36 – 1.12	15	0.73	0.41 – 1.20
All coincidental	27	1.18	0.78 – 1.72	25	1.12	0.72 - 1.65	20	0.92	0.56 – 1.42	18	0.86	0.51 – 1.35	20	0.97	0.559– 1.49
Late deaths	313	13.73	12.25 – 15.33	305	13.65	12.16 - 15.27	284	13.06	11.59 – 14.68	289	13.75	12.21 – 15.43	311	15.05	13.42 – 16.81

*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, 1985-2020 (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	2018-20	1985-87	1988-90	1991-93	1994-96	1997-99	2000-02	2003-05	2006-08	2009-11	2012-14	2015-17	2018-20
All Direct and Indirect deaths	223	238	228	268	242	261	295	261	253	200	209	229	9.83	10.08	9.85	12.19	11.4	13.07	13.95	11.39	10.63	8.54	9.16	10.90
Direct deaths																								
Sepsis*	9	17	15	16	18	13	18	26	16	7	10	17	0.40	0.72	0.65	0.73	0.85	0.65	0.85	1.13	0.63	0.29	0.44	0.81
Pre-eclampsia and eclampsia	27	27	20	20	16	14	18	19	10	2	5	8	1.19	1.14	0.86	0.91	0.75	0.70	0.85	0.83	0.42	0.08	0.22	0.38
Thrombosis and thromboembolism	32	33	35	48	35	30	41	18	30	20	34	29	1.41	1.40	1.51	2.18	1.65	1.50	1.94	0.79	1.26	0.85	1.49	1.38
Amniotic fluid embolism	9	11	10	17	8	5	17	13	7	16	6	9	0.40	0.47	0.43	0.77	0.38	0.25	0.80	0.57	0.29	0.68	0.26	0.43
Early pregnancy deaths	16	24	17	15	17	15	14	11	4	7	4	9	0.71	1.02	0.73	0.68	0.80	0.75	0.66	0.48	0.17	0.29	0.18	0.43
Haemorrhage	10	22	15	12	7	17	14	9	14	13	11	16	0.44	0.93	0.65	0.55	0.33	0.85	0.66	0.39	0.59	0.56	0.48	0.76
Anaesthesia	6	4	8	1	3	6	6	7	3	2	1	1	0.26	0.17	0.35	0.05	0.14	0.30	0.28	0.31	0.12	0.09	0.04	0.05
Other Direct‡	27	17	14	7	7	8	4	4	0	0	3	0	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	89	6.13	6.14	5.53	6.10	4.99	5.31	6.24	4.67	3.49	2.84	3.24	4.23
Indirect deaths																								
Cardiac disease	23	18	37	39	35	44	48	53	51	51	48	34	1.01	0.76	1.60	1.77	1.65	2.20	2.27	2.31	2.14	2.18	2.10	1.62
Other Indirect causes	43	45	38	39	41	50	50	49	72	38	33	41	1.90	1.91	1.64	1.77	1.93	2.50	2.37	2.14	3.03	1.62	1.45	1.95
Indirect neurological conditions	19	30	25	47	34	40	37	36	30	22	27	27	0.84	1.27	1.08	2.14	1.60	2.00	1.75	1.57	1.26	0.94	1.18	1.28
Psychiatric causes	†	†	†	9	15	16	18	13	13	18	20	34	†	†	†	0.41	0.71	0.80	0.85	0.57	0.55	0.77	0.88	1.62
Indirect malignancies	†	†	†	†	11	5	10	3	4	4	7	4	†	†	†	†	0.52	0.25	0.47	0.13	0.17	0.17	0.31	0.19
All Indirect	84	93	100	134	136	155	163	154	170	133	135	140	3.70	3.94	4.32	6.10	6.40	7.76	7.71	6.59	7.15	5.68	5.92	6.66
Coincidental	26	39	46	36	29	36	55	50	22	41	27	18	1.15	1.65	1.99	1.64	1.37	1.80	2.60	2.18	0.98	1.75	1.18	0.86

*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

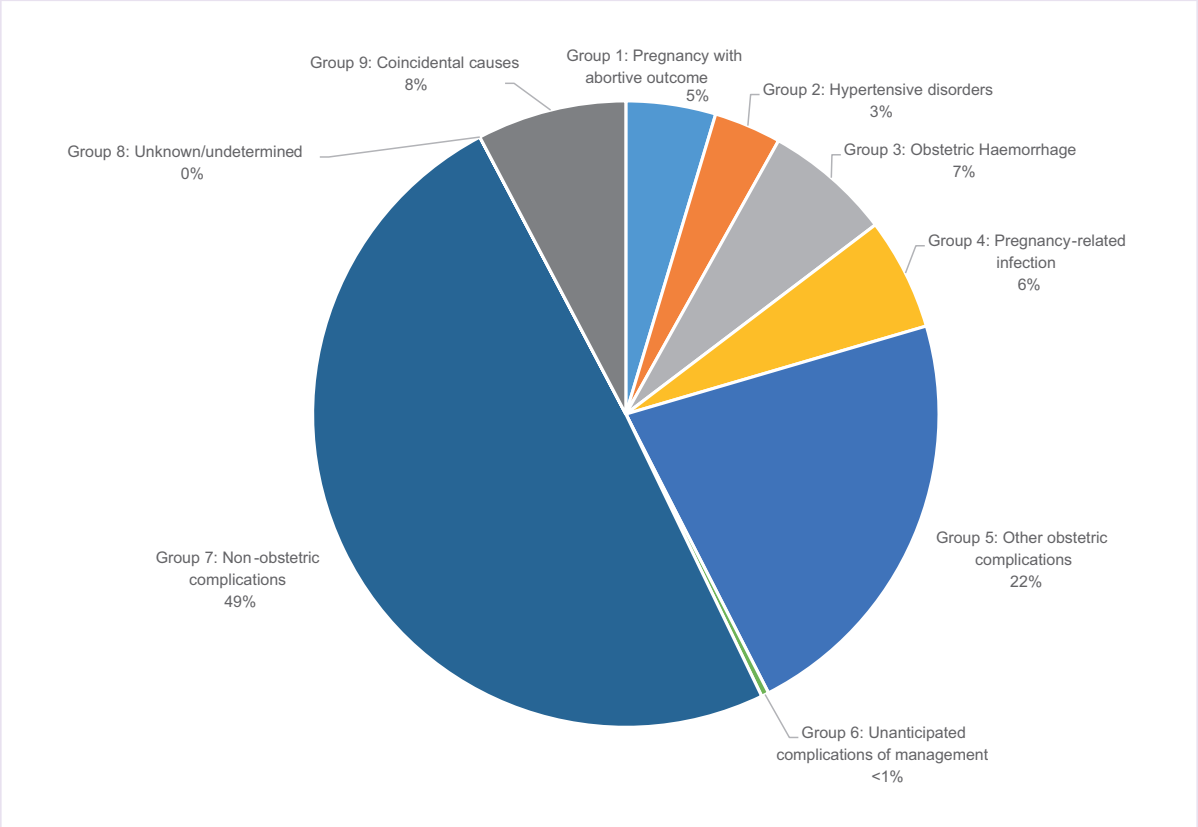
Sources: CMACE, MBRRACE-UK

Table 2.5: Maternal mortality rates per 100,000 maternities, by cause, by overlapping triennia, using ICD-MM classification, 2015 to 2021

Cause of death	2015-17			2016-18			2017-19			2018-20			2019-21		
	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	4	0.18	0.05 – 4.49	7	0.31	0.13 – 0.65	7	0.32	0.13 – 0.66	9	0.43	0.20 – 0.81	14	0.68	0.37 – 1.14
Group 2: Hypertensive disorders	5	0.22	0.07 – 0.51	4	0.18	0.05 - 0.46	6	0.28	0.10 – 0.60	8	0.38	0.16 – 0.75	9	0.44	0.20 – 0.83
Group 3: Obstetric Haemorrhage	11	0.48	0.24 – 0.86	14	0.63	0.34 – 1.05	14	0.64	0.35 – 1.08	16	0.76	0.44 – 1.24	17	0.82	0.48 – 1.32
Group 4: Pregnancy-related infection	10	0.44	0.21 – 0.81	12	0.54	0.28 - 0.94	13	0.60	0.32 – 1.02	17	0.81	0.47 -1.29	15	0.73	0.41 – 1.20
Group 5: Other obstetric complications	56	2.46	1.85 – 3.19	54	2.42	1.81 – 3.15	37	1.70	1.20 – 2.35	58	2.76	2.10 – 3.57	57	2.76	2.09 –3.57
Group 6: Unanticipated complications of management	1	0.04	0.001 – 0.24	1	0.05	0.001 – 0.25	1	0.05	0.001 – 0.26	1	0.05	0.001 – 0.27	1	0.05	0.001 – 0.27
Indirect causes															
Group 7: Non-obstetric complications	122	5.35	4.44 – 6.39	125	5.59	4.66 to 6.66	113	5.20	4.28 – 6.25	120	5.71	4.73 – 6.83	128	6.19	5.17 – 7.36
Group 8: Unknown/ undetermined	0	-	-	0	-	-	0	-	-	0	-	-	-	-	-
Coincidental causes															
Group 9: Coincidental causes	27	1.18	0.78 – 1.72	25	1.12	0.72 – 1.65	20	0.92	0.56 – 1.42	18	0.86	0.51 – 1.35	20	0.97	0.559– 1.49

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

Figure 2.4: Maternal mortality proportions by ICD-MM classification UK 2019-21



Direct deaths

Thrombosis and thromboembolism (VTE) continues to be the leading cause of direct deaths occurring within 42 days of the end of pregnancy (Figure 2.3 and Table 2.3). The maternal mortality rate from VTE remains at a similar rate to 2016-18, suggesting that several of these deaths could be prevented with improvements to care.

Deaths due to obstetric haemorrhage, suicide and sepsis are the next most frequent direct causes of maternal death. Note that, as described in previous reports, the majority of maternal suicide deaths occur between six weeks and a year after pregnancy. The rate of maternal mortality from haemorrhage continues to marginally increase. This is not statistically significantly increased, but emphasises the importance of messages in chapters 3 and 5 of this report. The mortality rate for pregnancy related sepsis remains higher than at its nadir in 2012-14 though not significantly so, highlighting the continuing need to "think sepsis" as described in chapter 6. The maternal death rate from pre-eclampsia and eclampsia remains more than five times higher than the lowest observed rate in 2012-14. Mortality rates from amniotic fluid embolism (AFE) and anaesthesia remain essentially unchanged with consistent extremely low rates due to anaesthetic causes.

Indirect deaths

Deaths due to indirect causes comprise just over half (53%) of direct and indirect maternal deaths in the UK. Between March and December 2021, 33 deaths of women who were either pregnant or within six weeks of the end of pregnancy were directly attributable to COVID-19. Based on the number of maternities for the same period, this represents a maternal mortality rate of 2.64 per 100,000 maternities (95% CI 1.82-33.71). Relevant messages for care of women with COVID-19 are highlighted in chapter 6 and in the previously-released rapid reports (Knight, Bunch et al. 2020a, Knight, Bunch et al. 2021a). If deaths directly attributable to COVID-19 are not considered, as in previous reports, cardiac disease remains the largest single cause of indirect maternal deaths (Figure 2.3 and Table 2.3). There has been a decrease in the maternal mortality rate from cardiac disease since enhanced case ascertainment was introduced, but this is not statistically significant (RR 0.70, 95% CI 0.44-1.12 when comparing 2019-21 with 2003-05). Across the 2019-21 triennium as a whole, neurological causes are the third most common indirect cause of maternal death, with a statistically non-significant decrease in mortality from 2016-18. Messages for neurological care are highlighted in chapter 8. Mortality rates from other indirect causes have increased although non-significantly since 2016-18 (RR 1.37, 95% CI 0.66-2.90), stressing the importance of lessons for care described in chapter 7.

International comparison

For international comparison, data are presented in Table 2.6 to highlight the maternal mortality ratios (MMR) estimated for the UK using routinely reported data. The rate estimate from routine sources of data is much lower (just over half) than the actual rates as identified through the UK Confidential Enquires into Maternal Deaths (CEMD), which use 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.

Table 2.6: Maternal mortality ratios* per 100,000 live births calculated based on deaths identified from routine sources of data, UK: 1985-2020

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
2018-20	129	6.04	5.04-7.18	2,136,242

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 MMR 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 2019-21, 311 women died between six weeks and one year after the end of pregnancy, representing a mortality rate of 15.05 per 100,000 maternities (95% CI 13.42 – 16.81). There has been no change in the rate of late pregnancy-related deaths since the first MBRRACE-UK confidential enquiry report. This compares to a late pregnancy-related mortality rate of 13.66 per 100,000 maternities in 2009-11. The rate of late deaths has risen in both in 2019-21 and 2018-20 which, although not statistically significant, might suggest an emerging trend. Rolling rates of late deaths are shown in Figure 2.5 and causes of late death in Figure 2.6. Maternal suicides continue to be the leading cause of direct deaths occurring between six weeks and one year after the end of pregnancy and deaths from psychiatric causes as a whole account for 39% of maternal deaths during this period.

Figure 2.5: Pregnancy-associated maternal mortality rates six weeks to one year after the end of pregnancy, UK, 2009-2021

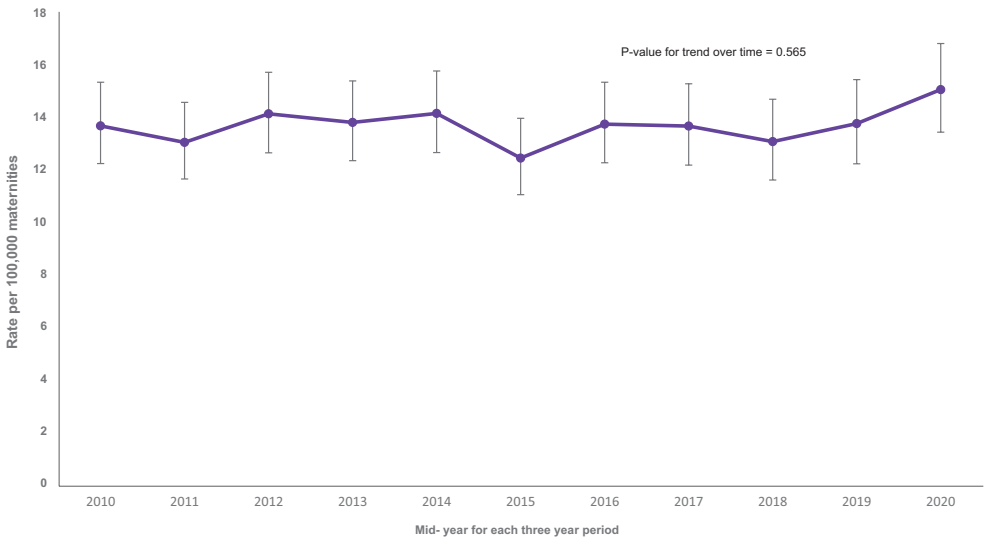
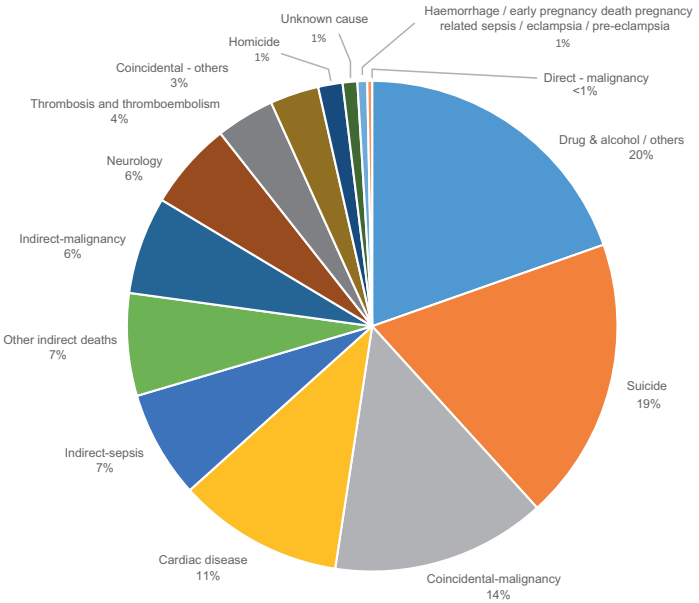


Figure 2.6: Causes of death amongst women who died between six weeks and one year after the end of pregnancy, UK 2019-21



2.3 The characteristics of women who died 2019-21

The women and babies

Of the 241 women who died from direct and indirect causes during or up to 42 days after the end of their pregnancy in 2019-21, 26% (62 women) were still pregnant at the time of their death and of these women 66% were ≤20 weeks' gestation (Table 2.7). Twenty-five (10%) women had a pregnancy loss at ≤20 weeks' gestation. The remaining 154 women gave birth to a total of 155 infants, 116 (75%) survived, 39 died (30 babies were stillborn and 9 died in the neonatal period). The 241 women who died left behind a further 288 children, thus a total of 404 motherless children remain. The majority of the 154 women who gave birth did so in hospital (84%); 10% of women gave birth in an emergency department or an ambulance, and 6% at home (Table 2.8). In this triennium 109 (71%) of the women who gave birth at 20 or more weeks gestation had a caesarean birth; 35% of these were a resuscitative hysterotomy (RH) as part of attempted resuscitation of the woman. A total of 39 babies were born following RH of which 19 (49%) were born after 32 weeks of gestation. Six out of the 19 babies born after 32 weeks' gestation survived (9 were stillborn and 4 died in the neonatal period). Of the 20 babies delivered at 32 weeks or less, 4 survived, 12 were stillborn and 4 died in the neonatal period. Thus, 10 (26%) of the total of 39 babies born following RH survived, 21 (54%) were stillborn and 8 (21%) died in the neonatal period.

Table 2.7: Timing of maternal deaths in relation to pregnancy 2019—21

Time period of deaths in the pregnancy care pathway	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Total (n=241) Frequency (%)
Antenatal period			
≤20 weeks	24 (21)	17 (13)	41 (17)
>20 weeks	6 (5)	15 (12)	21 (9)
Postnatal on day of delivery	30 (27)	23 (18)	53 (22)
Postnatal 1-41 days after delivery	53 (47)	73 (57)	126 (52)

Table 2.8: Place of childbirth amongst women >20 weeks' gestation who died after giving birth 2019-21

	Direct (n=69) Frequency (%)	Indirect (n=85) Frequency (%)	Total (n=154) Frequency (%)
Home	4 (6)	5 (6)	9 (6)
Hospital (except A&E)	60 (87)	69 (81)	129 (84)
Emergency Department or ambulance	5 (7)	11 (13)	16 (10)

Socio-demographic characteristics

The socio-demographic characteristics of women who died in 2019-21 are shown in Table 2.9 and Figure 2.7. 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 similar to the proportion noted in the last three years' reports. 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.

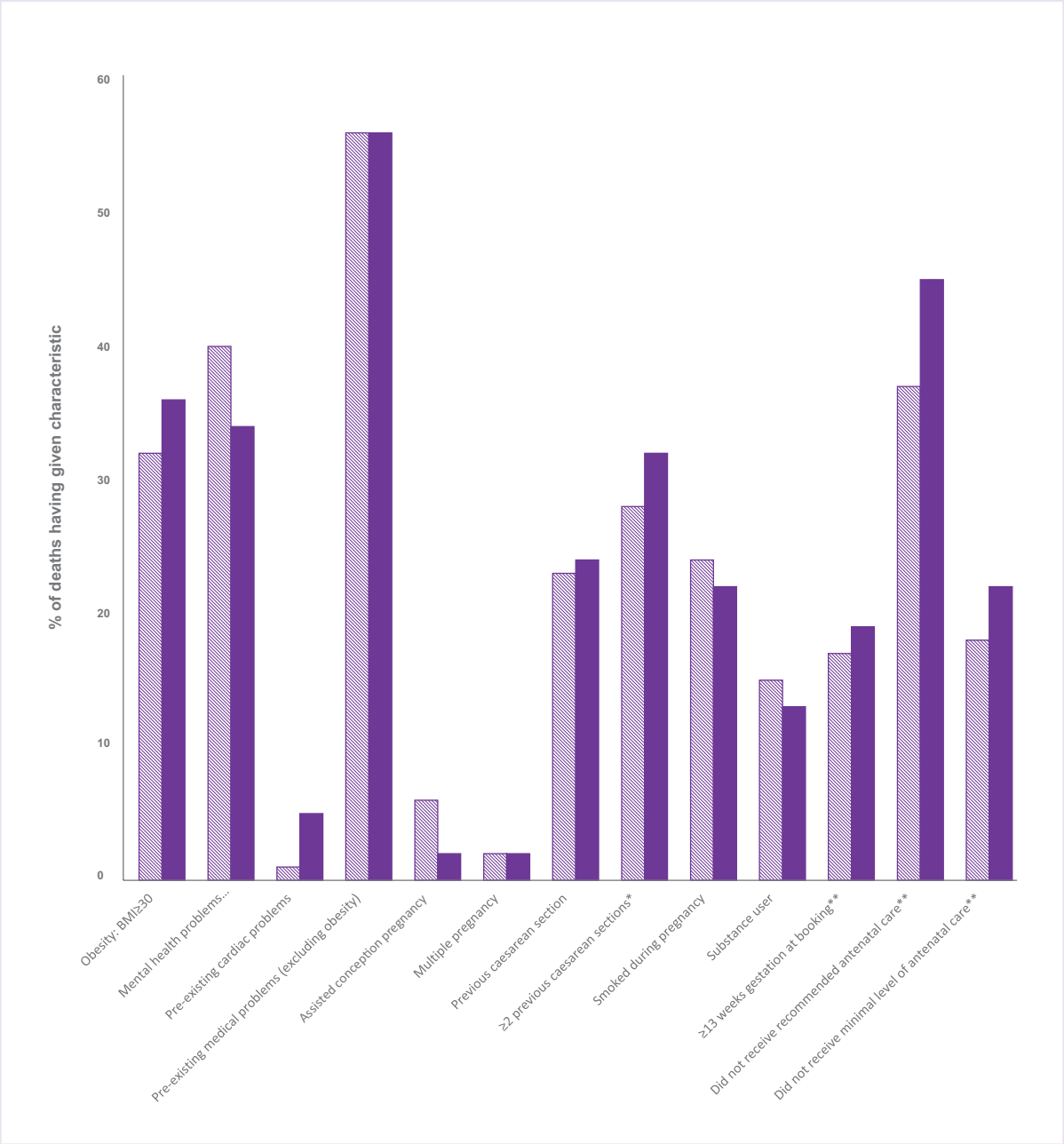
The rates of maternal mortality varied by age, socio-economic status and ethnic background of the women; factors that are known to be independently associated with an increased risk of maternal death in the UK (Nair, Kurinczuk et al. 2015, Nair, Knight et al. 2016). Maternal mortality rates are higher amongst older women and those under 20 as well as amongst women from particular ethnic minority groups and those living in the most deprived areas (based on Index of Multiple Deprivation (IMD) of postcode of residence) (Table 2.10). While women living in the most deprived areas continue to have the highest maternal mortality rates, there has been an increase in recent years in maternal mortality in women living in the least deprived areas (Figure 2.8). This increase in mortality rate of the group used as the baseline needs to be borne in mind when interpreting the RR and ratio of relative risks (RRR) (Tables 2.10 and 2.11).

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 and Figure 2.9. The risk of maternal death in 2019-21 was statistically nearly four times higher among women from Black ethnic minority backgrounds compared with White women (RR 3.84; 95% CI 2.48 to 5.78); this is slightly higher than the figure reported in the 2022 report (Figure 2.9). This change is partly driven by a disproportionate number of maternal deaths from COVID-19 amongst women from ethnic minority groups, but represents a non-significant reduction from the 4.35 fold difference reported for 2016-18. Women from Asian backgrounds also continued to be at higher risk than White women (RR 1.82, 95% CI 1.21 to 2.67). Of the 33 women who died from COVID-19, 14 were Asian (11 of Pakistani origin) and 5 were Black. In the comparison of RR between 2016-18 and 2019-21 the estimated RRR of maternal death in the different age, socio-economic and ethnic groups did not show any statistically significant differences (Table 2.11).

Table 2.9: The socio-demographic characteristics of women who died 2019-21

Characteristics	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Total (n=241) Frequency (%)
Socio-demographic			
Age (years)			
<20	6 (5)	2 (2)	8 (3)
20 – 24	12 (11)	12 (9)	24 (10)
25 – 29	26 (23)	27 (21)	53 (22)
30 – 34	32 (28)	40 (31)	72 (30)
35 – 39	25 (22)	34 (27)	59 (25)
≥ 40	12 (11)	13 (10)	25 (10)
Parity			
0	39 (35)	44 (34)	83 (34)
1 to 2	47 (42)	63 (49)	110 (46)
≥3	19 (17)	20 (16)	39 (16)
Missing	68(7)	1 (1)	9(4)
UK citizen			
Yes	95 (84)	108 (84)	203 (84)
No	6 (5)	9 (7)	15 (6)
Missing	12 (11)	11 (9)	23 (10)
Ethnicity			
White European	76 (67)	84 (66)	160 (66)
Indian	6 (5)	7 (5)	13 (5)
Pakistani	2 (2)	13 (10)	15 (6)
Bangladeshi	3 (3)	1 (1)	4 (2)
Other Asian	4 (4)	2 (2)	6 (3)
Black Caribbean	2 (2)	5 (4)	7 (3)
Black African	5 (4)	12 (9)	17 (7)
Others/ Mixed	11 (10)	4 (3)	15 (6)
Missing	4 (4)	0 (0)	4 (2)
Woman's region of birth			
United Kingdom	77 (68)	91 (71)	168 (70)
Eastern Europe	5 (4)	4 (3)	9 (4)
Western Europe	2 (2)	1 (1)	3 (1)
Asia	8 (7)	15 (12)	23 (10)
Africa	6 (5)	11 (9)	17 (7)
Australia and North America	2 (2)	0 (0)	2 (1)
Central & South America & Caribbean	1 (1)	0 (0)	1 (<1)
Missing	12 (11)	6 (5)	18 (7)
Socioeconomic status (Index of Multiple Deprivation (IMD) of postcode of residence)			
First quintile (Least deprived)	15 (13)	10 (8)	25 (10)
Second quintile	13 (12)	13 (10)	26 (11)
Third quintile	21 (19)	21 (16)	42 (17)
Fourth quintile	20 (18)	28 (22)	48 (20)
Fifth quintile (Most deprived)	37 (33)	51 (40)	88 (37)
Missing	7 (6)	5 (4)	12 (5)
Socioeconomic status (Occupational classification)			
Employed (Either woman or partner)	77 (68)	94 (73)	171 (71)
Unemployed (Both)	12 (11)	15 (12)	27 (11)
Missing	24 (21)	19 (15)	43 (18)
Able to speak/understand English			
Yes	103 (91)	122 (95)	225 (93)
No	6 (5)	6 (5)	12 (5)
Missing	4 (4)	0 (0)	4 (2)
Living arrangements			
With partner	78 (69)	95 (74)	173 (72)
Living alone	8 (7)	12 (9)	20 (8)
With parents/extended family	12 (11)	9 (7)	21 (9)
Others	6 (5)	7 (5)	13 (5)
Missing	9 (8)	5 (4)	14 (6)
Domestic abuse (prior to pregnancy/ during pregnancy)			
Yes	20 (18)	14 (11)	34 (14)
No	56 (50)	79 (62)	135 (56)
Missing	37 (33)	35 (27)	72 (30)
History of abuse as a child			
Yes	14 (12)	4 (3)	18 (7)
No	54 (48)	73 (57)	127 (53)
Missing	45 (40)	51 (40)	96 (40)
Known to social services			
Yes	25 (22)	26 (20)	51 (21)
No	70 (62)	87 (68)	157 (65)
Missing	18 (16)	15 (12)	33 (14)

Figure 2.7: Selected characteristics of women who died from direct or indirect causes 2019-21



Hatched bars show women who died from direct causes of death, solid bars indicate those who died from indirect causes of death

*Amongst women who had a previous caesarean birth

**NICE recommended antenatal care: booked at ten weeks or less and no antenatal visits missed. Minimum level of care: booked at less than 13 weeks and three or fewer antenatal visits missed

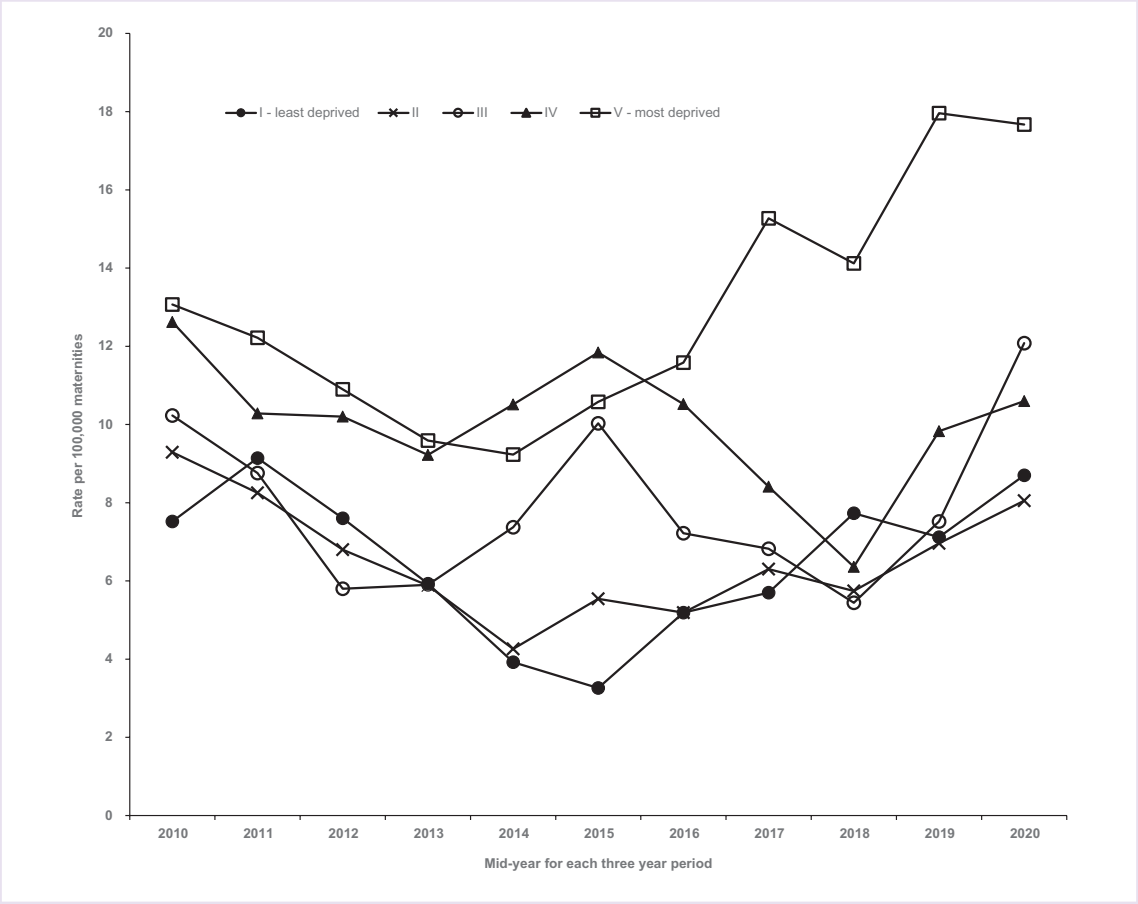
Table 2.10: Maternal mortality rates amongst different population groups 2019-21 (illustrated in Figures 2.8 and 2.9)

	Total maternities 2019-21	Total deaths	Rate per 100,000 maternities	95% CI	Relative risk (RR)	95% CI
Age (years)						
<20	52,658	8	15.19	6.56 to 29.93	1.69	0.66 to 3.89
20–24	266,851	24	8.99	5.76 to 13.38	1 (Ref)	-
25–29	552,531	53	9.59	7.19 to 12.55	1.07	0.65 to 1.81
30–34	696,563	72	10.34	8.09 to 13.02	1.15	0.72 to 1.91
35–39	401,481	59	14.70	11.19 to 18.96	1.63	1.00 to 2.75
≥ 40	96,727	25	25.85	16.73 to 38.15	2.87	1.57 to 5.26
IMD Quintiles (England only)						
I (Least deprived/ highest 20%)	252,874	22	8.70	5.45 to 13.17	1 (Ref)	-
II	285,773	23	8.05	5.10 to 12.08	0.93	0.49 to 1.74
III	314,490	38	12.08	8.55 to 16.58	1.39	0.80 to 2.47
IV	368,005	39	10.60	7.54 to 14.49	1.22	0.70 to 2.16
V (Most deprived/ lowest 20%)	430,171	76	17.67	13.92 to 22.11	2.03	1.25 to 3.43
Ethnic group (England only)						
White (inc. not known)	1,352,794	131	9.68	8.10 to 11.49	1 (Ref)	-
Asian	193,041	34	17.61	12.20 to 24.61	1.82	1.21 to 2.67
Black	77,982	29	37.19	24.91 to 53.40	3.84	2.48 to 5.78
Chinese/ others	71,625	6	8.38	3.07 to 18.23	0.87	0.31 to 1.93
Mixed	34,607	3	8.67	1.79 to 25.33	0.90	0.18 to 2.67

Table 2.11: Comparison of the relative risk of maternal death among different population groups between 2016-18 and 2019-21 (illustrated in Figures 2.8 and 2.9)

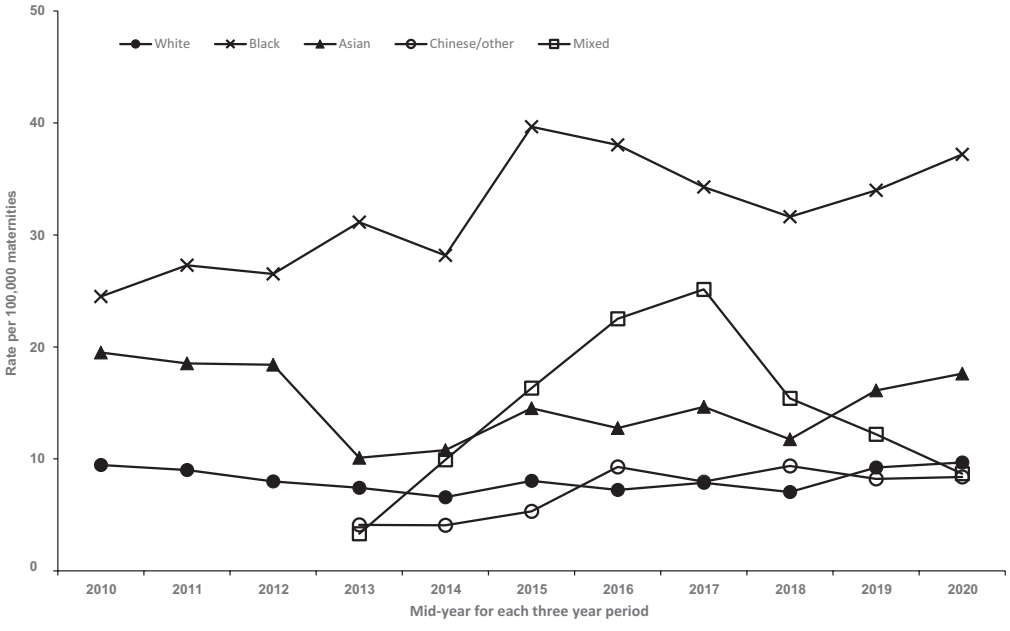
	2016-18		2019-21		Ratio of the relative risks (RRR) (comparing 2019-21 with 2016-18)	95% CI	P-value
	Relative risk (RR)	95% CI	Relative risk (RR)	95% C			
Age (years)							
<20	1.96	0.74 to 4.68	1.69	0.66 to 3.89	0.86	0.24 to 3.10	0.820
20–24	1 (Ref)	-	1 (Ref)	-	-	-	-
25–29	1.55	0.91 to 2.75	1.07	0.65 to 1.81	0.69	0.32 to 1.47	0.336
30–34	1.23	0.71 to 2.20	1.15	0.72 to 1.91	0.93	0.44 to 1.97	0.860
35–39	2.27	1.33 to 4.05	1.63	1.00 to 2.75	0.72	0.34 to 1.52	0.389
≥ 40	4.65	2.48 to 8.89	2.87	1.57 to 5.26	0.62	0.26 to 1.49	0.282
IMD Quintiles (England only)							
I (Least deprived/ highest 20%)	1 (Ref)	-	1 (Ref)	-	-	-	-
II	1.11	0.53 to 2.34	0.93	0.49 to 1.74	0.84	0.32 to 2.22	0.723
III	1.20	0.60 to 2.47	1.39	0.80 to 2.47	1.16	0.47 to 2.86	0.750
IV	1.48	0.78 to 2.92	1.22	0.70 to 2.16	0.82	0.35 to 1.96	0.663
V (Most deprived/ lowest 20%)	2.68	1.53 to 5.03	2.03	1.25 to 3.43	0.76	0.35 to 1.65	0.486
Ethnic group (England only)							
White (inc. not known)	1 (Ref)	-	1 (Ref)	-	-	-	-
Asian	1.86	1.19 to 2.83	1.82	1.21 to 2.67	0.98	0.54 to 1.76	0.943
Black	4.35	2.77 to 6.62	3.84	2.48 to 5.78	0.88	0.48 to 1.62	0.688
Chinese/ others	1.01	0.36 to 2.27	0.87	0.31 to 1.93	0.86	0.24 to 3.15	0.822
Mixed	3.19	1.35 to 6.50	0.90	0.18 to 2.67	0.28	0.06 to 1.34	0.112

Figure 2.8: Maternal mortality rates 2009-21 among women from different levels of socio-economic deprivation in England*



*Data for England only due to availability of denominator data

Figure 2.9: Maternal mortality rates 2009-21 among women from different ethnic groups in England*



*Data for England only due to availability of denominator data

A quarter of women who died in 2019-21 (25%) whose place of birth was known were born outside the UK; 27% of these women were known not to be UK citizens and citizenship was not recorded for a further 24%. Overall 6% of the women who died were not UK citizens although this may be an underestimate since citizenship was not recorded for 10% (Table 2.9). Women who died who were born abroad and who were not UK citizens, had arrived in the UK a median of 5 years before they died (range seven months to 19 years). Women who died who were born abroad were from Asia (42%, mainly Pakistan, India, and Bangladesh), Africa (31%, in particular Ghana, South Africa and Zimbabwe), Eastern Europe (16%, predominantly Romania and Poland) with the remainder (11%) from other parts of Europe, the Americas, Australasia and the Caribbean. Note that almost all of the deaths of women who were born in Pakistan were due to COVID-19. 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 2019-21. However, women born in certain specific countries had a statistically non-significant higher risk of death compared to women born in the UK (Table 2.12). Of the 15 women who died who were not UK citizens and were born outside the UK, one was known to be a refugee/asylum seeker (7%), four were European Union citizens (27%) and ten (67%) had another or unknown status.

It is also of note that 21% of women who died were known to social services (Table 2.9). This proportion is similar to that reported for 2016-18 (20%) but well above the 12% reported 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) 2019-21

Woman's country of birth	Maternities 2019-21	Total Deaths	Rate per 100,000 maternities	95% CI	Relative risk (RR)	95% CI
UK	1,494,914*	168	11.24	9.60 to 13.07	1 (Ref)	-
Outside UK	572,083*	55	9.61	7.24 to 12.51	0.86	0.62 to 1.17
Specific countries						
Bangladesh	20,451‡	4	19.56	5.33 to 50.07	1.74	0.47 to 4.654
India	44,068‡	5	11.35	3.68 to 26.48	1.01	0.32 to 2.40
Pakistan	50,258‡	7	13.93	5.60 to 28.70	1.24	0.49 to 2.61
Romania	49,013‡	3	6.12	1.26 to 17.89	0.54	0.11 to 1.62
Nigeria	9,044‡	3	33.17	6.84 to 96.91	2.95	0.66 to 8.78
Ghana	8,385‡	3	35.78	7.38 to 104.52	3.18	0.65 to 9.46

*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 18 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. Of the 572 women who died in the UK in 2019-21 during or up to one year after pregnancy, 69 (12%) were women considered to have multiple disadvantage on the basis of the data available (Table 2.13). This is a similar proportion to that reported for 2018-20 (11%) but a significant increase from the proportions reported for earlier triennia. Note, however, that this change may be a reflection of increasing disadvantage, better recording of data or a combination of both. The main elements of multiple disadvantage were a mental health diagnosis (either current or in the past) (all women with multiple disadvantage), substance use (60/69 women with multiple disadvantage) and domestic abuse (64/69 women with multiple disadvantage). This must continue to be regarded as a minimum estimate, since these three factors remain amongst the most poorly recorded. For all the women who died in pregnancy or within 42 days of delivery, including both those with and without multiple disadvantage, information was missing from 10% for mental health diagnoses, 9% for substance use and 30% for domestic abuse. Such information is even more likely to be missing for women dying between six weeks and one year after delivery.

Table 2.13: Multiple disadvantage among women who died 2019-21

	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Coincidental (n=20) Frequency (%)	Late Deaths (n=311) Frequency (%)	Total (n=572) Frequency (%)
Score* of <3	98 (87)	121 (95)	18 (90)	266 (86)	503 (88)
Score* of 3 or more	15 (13)	7 (5)	2 (10)	45 (14)	69 (12)

*Three or more of: substance abuse, domestic abuse, abuse in childhood, arrival in UK within last five 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 can be attributed to medical comorbidities (Nair, Knight et al. 2016). The pregnancy-related characteristics of the women who died in 2019-21 are shown in Figure 2.7 and Tables 2.14 and 2.15. Over half (56%) of the women who died in 2019-21 were known to have pre-existing medical problems and 37% were known to have pre-existing mental health problems (Figure 2.7 and Table 2.14). Of note, for 10% of women who died in 2019-21, it was reported to be unknown whether they had previous or pre-existing mental health problems; this proportion is an increase on the 8% missing reported for the previous triennium. Over a third (34%) of the women who died in this triennium were obese (Body Mass Index (BMI) ≥ 30kg/m^2) and a further 24% were overweight (Figure 2.7 and Table 2.14). In this triennium, 10 women (4%) who died during or up to six weeks after pregnancy in the UK in 2019-21 had a pregnancy as a result of an assisted conception procedure (Figure 2.7 and Table 2.15), this compares to 10 women (5%) in 2016-18.

Table 2.14: Selected medical conditions and characteristics identified amongst women who died 2019-21 (illustrated in Figure 2.7)

Medical condition/characteristic	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Total (n=241) Frequency (%)
Body mass index (BMI)			
<18	1 (1)	2 (2)	3 (1)
18 – 24	38 (34)	41 (32)	79 (33)
25 – 29	23 (20)	36 (28)	59 (24)
≥ 30	36 (32)	46 (36)	82 (34)
Missing	15 (13)	3 (2)	18 (7)
Mental health problems or psychiatric disorders			
Yes	45 (40)	44 (34)	89 (37)
No	55 (49)	72 (56)	127 (53)
Missing	13 (12)	12 (9)	25 (10)
Pre-existing cardiac problems			
Yes	1 (1)	7 (5)	8 (3)
No	105 (93)	118 (92)	223 (93)
Missing	7 (6)	3 (2)	10(4)
Any pre-existing medical problem (excluding obesity)			
Yes	63 (56)	72 (56)	135 (56)
No	43 (38)	53 (41)	96 (40)
Missing	7 (6)	3 (2)	10 (4)

Table 2.15: Pregnancy-related characteristics of the women who died 2019-21 (illustrated in Figure 2.7)

Medical condition/characteristic	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Total (n=241) Frequency (%)
Pregnancy known to be as a result of assisted reproductive techniques			
Yes	7 (6)	3 (2)	10 (4)
No	104 (92)	125 (98)	229 (95)
Missing	2 (2)	0 (0)	2 (1)
Multiple pregnancy			
Yes	2 (2)	2 (2)	4 (2)
No	111 (98)	126 (98)	237 (98)
Previous caesarean section			
Yes	25 (23)	31 (24)	56 (23)
No	77 (69)	93 (73)	170 (71)
Missing	11 (9)	4 (3)	15 (6)
Previous caesarean numbers (among women who had a previous caesarean section)			
1	18 (72)	21 (68)	39 (70)
≥2	7 (28)	10 (32)	17 (30)

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, Kurinczuk et al. 2015, Nair, Knight et al. 2016). The prevalence of substance misuse among women who died in 2018-20 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. Just over half (53%) of women who received antenatal care, received the recommended level of care according to NICE antenatal care guidelines (booking at ten weeks or less and no routine antenatal visits missed) (National Institute for Health and Care Excellence 2021) (Figure 2.7 and Table 2.16).

Table 2.16: Other characteristics of women who died in 2019-21 (illustrated in Figure 2.7)

Characteristics	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Total (n=241) Frequency (%)
Smoking			
Smoker	27 (24)	28 (22)	55 (23)
Non-smoker	67 (60)	83 (65)	150 (62)
Missing	19 (17)	17 (13)	36 (15)
Substance user			
Yes	17 (15)	17 (13)	34 (14)
No	79 (70)	105 (82)	184 (76)
Missing	17 (15)	6 (5)	23 (9)
Received any antenatal care*			
Yes	82 (73)	108 (84)	190 (79)
No	31 (27)	20 (16)	51 (21)
Gestational age at booking (among women who received any antenatal care) (weeks)			
≤10	55 (67)	71 (66)	126 (66)
11 – 12	9 (11)	16 (15)	25 (13)
>13	14 (17)	20 (19)	34 (18)
Missing	4 (5)	1 (1)	5 (3)
Received *recommended* antenatal care† (among women who received any antenatal care)			
Yes	46 (56)	54 (50)	100 (53)
No	30 (37)	49 (45)	79 (42)
Missing	6 (7)	5 (5)	11 (6)
Received a minimum level of antenatal care† (among women who received any antenatal care)			
Yes	61 (75)	77 (71)	138 (73)
No	15 (18)	24 (22)	39 (21)
Missing	6 (7)	7 (6)	13 (7)

*Includes fifteen women who died in early pregnancy.

†NICE recommended antenatal care: booked at ten weeks or less and no antenatal visits missed. Minimum level of care: booked at less than 13 weeks and three or fewer antenatal visits missed.

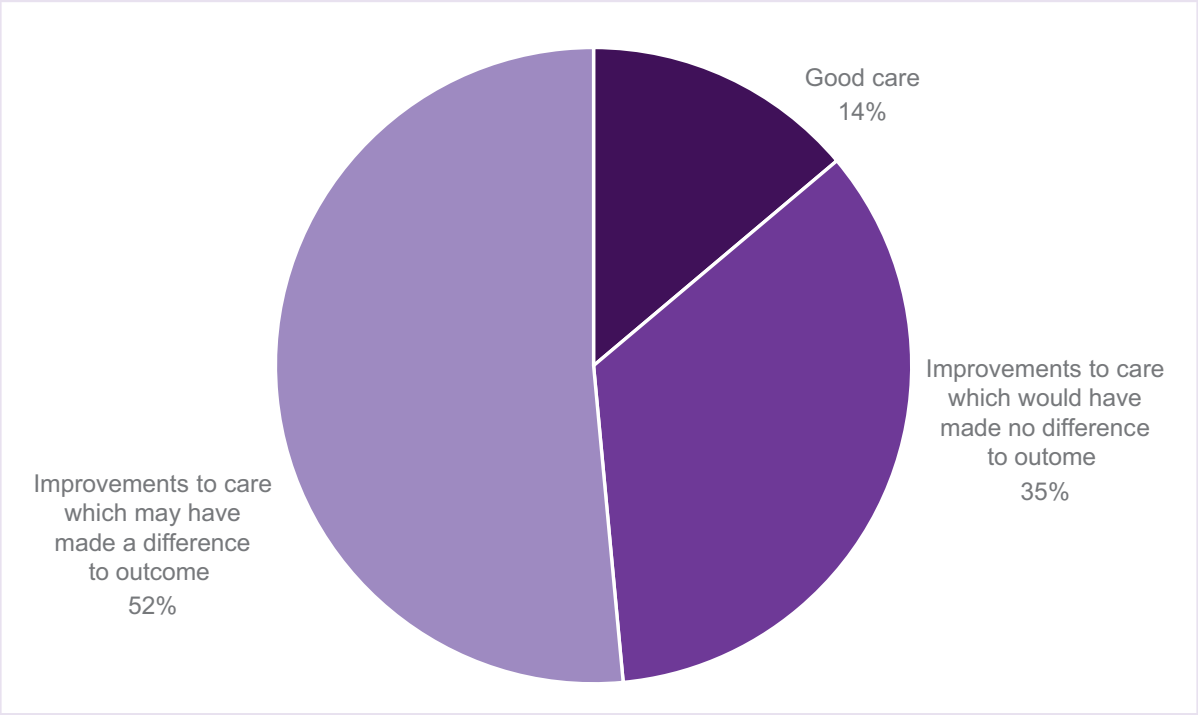
Classification of quality of care

This section includes information on women who died between 2019 and 2021 and are included in this year's confidential enquiry reports (including women who died between six weeks and a year after the end of pregnancy and women from the Republic of Ireland). Table 2.17 and Figure 2.10 show the classification of care as agreed by the assessors for the 190 women who died. Among the women who died, 14% were assessed to have received good care, but detailed assessment showed that, for another 52%, improvements in care may have made a difference to their outcome. Opportunities to improve care were identified amongst the majority of women who had morbidity associated with re-laparotomy after repeat caesarean birth (88%). It was thought that improvements to care may have made a difference to the outcome for 23 (72%) women (Table 2.17, Figure 2.11).

Table 2.17: Classification of care received by women who are included in the confidential enquiry chapters, UK and Ireland (2019-21) (illustrated in Figures 2.10 and 2.11)

Classification of care received	Women who died N=190 Number (%)	Women who had a re-laparotomy after caesarean n=32 Number (%)
Good care	26 (14)	4 (13)
Improvements to care which would have made no difference to outcome	66 (35)	5 (16)
Improvements to care which may have made a difference to outcome	98 (52)	23 (72)

Figure 2.10: Classification of care received by women who died and are included in the confidential enquiry into maternal deaths chapters, UK and Ireland (2019-21)



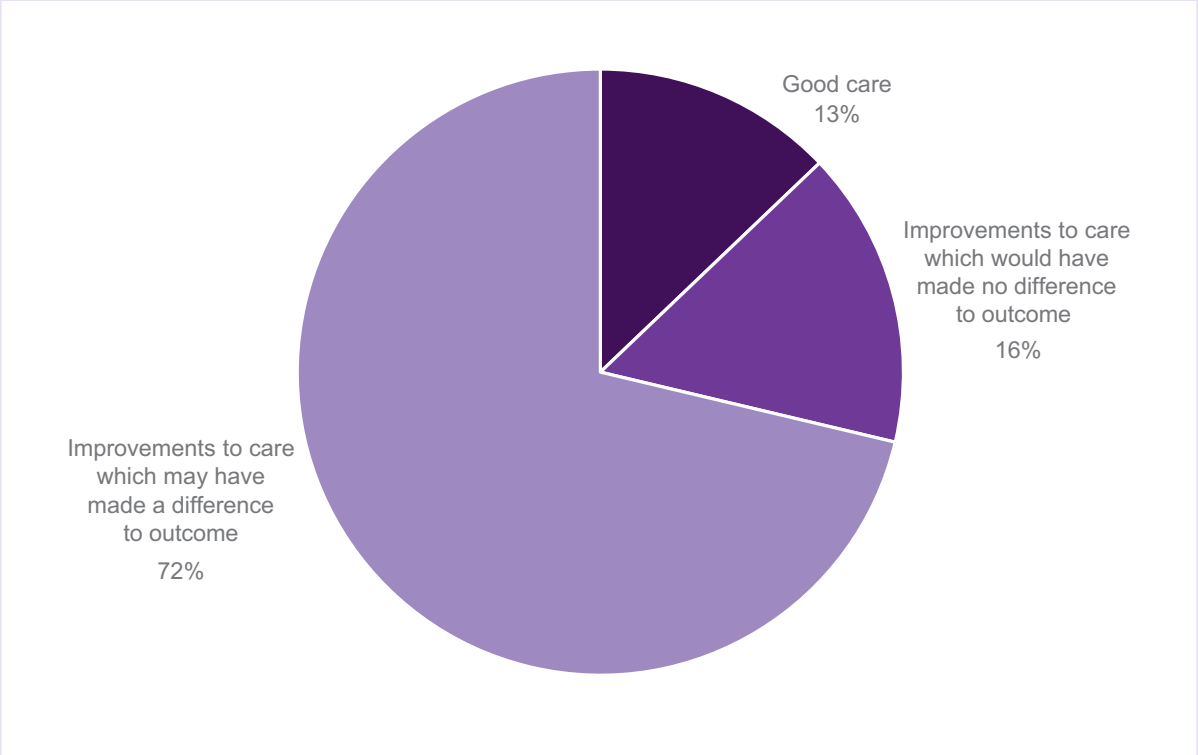
Local clinicians' reports

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 (LCR) are absolutely essential to allow MBRRACE-UK assessors to fully take account of any local system factors impacting on care, and we are particularly grateful at the effort and commitment to the enquiry this represents while clinicians have also been under pressure in the context of the pandemic. We urge clinicians to continue to return their reports 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	80
Anaesthetists	85
Midwives	84
Critical Care Clinicians	83
Emergency Medicine Specialists	78
GPs	92
Physicians	75
Psychiatrists	100
Total	84

Figure 2.11: Classification of care received by women who had a re-laparotomy after repeat caesarean birth and are included in the confidential enquiry into maternal morbidity chapter, UK (June 2021 to May 2022)



Post-mortem 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 only around two thirds (67%) (Table 2.19). The figure was 84% for women who died from direct causes, 63% amongst women who died from indirect causes, 55% amongst women who died from coincidental causes and 63% amongst women who died between six weeks and one year after the end of pregnancy. As noted in previous reports, establishing the cause of women's deaths 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 2019-21

	Direct (n=113) Frequency (%)	Indirect (n=128) Frequency (%)	Coincidental (n=20) Frequency (%)	Late Deaths (n=311) Frequency (%)	Total (n=572) Frequency (%)
No Post Mortem	17 (15)	47 (37)	9 (45)	114 (37)	187 (33)
Post Mortem Completed	95 (84)	81 (63)	11 (55)	196 (63)	383 (67)
Records not available	1 (1)	0 (0)	0 (0)	1 (<1)	2 (<1)

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

Hilde Engjom, Allison Felker, Felicity Plaat, Sarah Wheatly, Roshni Patel, Esther Youd and Marian Knight on behalf of the MBRRACE-UK haemorrhage and AFE chapter-writing group

Chapter writing group members: Kathryn Bunch, Lynne Campbell, Rohan D'Souza, Hilde Engjom, Fiona Hanrahan, Alison Kirkpatrick, Marian Knight, Jenny Kurinczuk, Laura Menzies, Roshni Patel, Felicity Plaat, Catherine Pritchard, Ceri Staples, Sarah Wheatly, Esther Youd

3.1 Key messages

New recommendations

Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day. **ACTION: National Institute for Health and Care Excellence (NICE)**

Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists, Royal College of Physicians, Obstetric Anaesthetists Association**

Review guidance on when to use balloon tamponade to control haemorrhage, how to insert the balloon and inflate it. Resources such as postpartum haemorrhage checklists should include when not to use balloon tamponade and when to abandon it and move on to a different haemostatic technique. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists**

Review and revise the service specification for centres providing specialist services for managing abnormally invasive placentation to ensure that all specialist units can provide appropriate equipment, facilities and appropriately skilled personnel in an emergency situation occurring at any time of day or night. **ACTION: NHS England, Scottish, Welsh and Irish governments**

Existing guidance and recommendations requiring improved implementation

All units are required to have escalation policies for periods of high activity. These policies should include a plan to obtain more and senior obstetric and anaesthetic assistance as well as considering midwifery staffing and diverting activity (Knight, Nair et al. 2017).

Produce guidance on which beside tests should be used for assessment of coagulation and the required training to perform and interpret those tests (Knight, Bunch et al. 2020b).

If no haemostatic tests are available, early fresh frozen plasma (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 (Royal College of Obstetricians and Gynaecologists 2016a).

Delivery for women diagnosed with placenta accreta spectrum should take place in a specialist centre with logistic support for immediate access to blood products, adult intensive care unit and neonatal intensive care unit by a multidisciplinary team with expertise in complex pelvic surgery (Royal College of Obstetricians and Gynaecologists 2018).

Patients with known placenta accreta spectrum disorders should be treated by multidisciplinary care teams (Kietaibl, Ahmed et al. 2023).

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 (Royal College of Obstetricians and Gynaecologists 2016a).

Early involvement of appropriate senior staff (including the anaesthetic team and laboratory specialists) is fundamental to the management of PPH (Royal College of Obstetricians and Gynaecologists 2016a).

One member of the team should be assigned the task of recording events, fluids, drugs, blood and components transfused and vital signs (Royal College of Obstetricians and Gynaecologists 2016a).

Every maternity unit should have a multidisciplinary protocol for the management of PPH (Royal College of Obstetricians and Gynaecologists 2016a).

Training for PPH should be multi-professional and include team rehearsals (Royal College of Obstetricians and Gynaecologists 2016a).

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 (Knight, Bunch et al. 2020b).

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 (Knight, Bunch et al. 2020b).

In the context of major haemorrhage, vasopressors should only be used in conjunction with rapid, warmed infusion of blood, plasma and clotting factors or fluids, used for as brief a time as possible and not relied upon to maintain tissue perfusion (Ghadimi, Levy et al. 2016).

High-volume resuscitation with crystalloids and colloids is associated with coagulopathy and adverse maternal outcomes in women with PPH (Kietaibl, Ahmed et al. 2023).

The dose [of misoprostol for women with late intrauterine fetal death] should be adjusted according to gestational age (100 micrograms 6-hourly before 26+6 weeks, 25-50 micrograms 4-hourly at 27+0 weeks or more, for up to 24 hours) (Royal College of Obstetricians and Gynaecologists 2010).

In a woman with an intrauterine fetal death and non-scarred uterus offer oral mifepristone 200mg followed by vaginal dinoprostone or oral or vaginal misoprostol (base the choice and dosage on clinical circumstances and national protocols) (National Institute for Health and Care Excellence 2021a).

Misoprostol should always be used with extreme caution for women with late intrauterine fetal death, especially in the presence of a uterine scar. In these women, particularly those with a scar, dinoprostone may be more appropriate (Knight, Nair et al. 2017).

In the absence of risk factors for preterm delivery in women with placenta accreta spectrum, planned delivery at 35+0 to 36+6 weeks of gestation provides the best balance between fetal maturity and the risk of unscheduled delivery (Royal College of Obstetricians and Gynaecologists 2018).

Any woman giving consent for caesarean section should understand the risks associated with caesarean section in general, and the specific risks of placenta accreta spectrum in terms of massive obstetric haemorrhage, increased risk of lower urinary tract damage, the need for blood transfusion and the risk of hysterectomy (Royal College of Obstetricians and Gynaecologists 2018).

The elective delivery of women with placenta accreta spectrum should be managed by a multidisciplinary team, which should include senior anaesthetists, obstetricians and gynaecologists with appropriate experience in managing the condition and other surgical specialties if indicated. In an emergency, the most senior clinicians available should be involved (Royal College of Obstetricians and Gynaecologists 2018).

3.2 Background

Obstetric haemorrhage is a common event on labour wards in the UK and Ireland. While mortality due to haemorrhage is rare, the number of women dying from obstetric haemorrhage is not decreasing, and deaths among women with abnormally invasive placentation remain prominent despite recent changes in service configuration. Mortality from AFE remains unchanged. Recurring themes identified in the care of women who died following haemorrhage centred on recognition of the clinical signs of significant blood loss, delays in treatment associated with systems under pressure and the need for situational awareness and senior leadership.

3.3 The women who died

In the UK and Ireland there were 17 women who died from obstetric haemorrhage during or up to six weeks after the end of pregnancy in 2019-21 (Table 3.1). A further woman died several weeks after a placental abruption. This represents an overall mortality rate of 0.80 per 100,000 maternities (95% CI 0.48-0.1.27). This is an increase from the last triennium, although not statistically significantly so (RR 1.39, 95% CI 0.65- 3.02). Twelve women (71%) died after a caesarean birth.

Eight women died following an AFE, a rate of 0.36 per 100,000 maternities (95% CI 0.15-0.70). Five of the women died followed induction of labour and three further women died after a caesarean section. Six of the women died on the day of giving birth and two further women died within three days of giving birth. One of these women was admitted to intensive care after initial resuscitation but subsequently died.

Table 3.1: Direct deaths by type of obstetric haemorrhage 1994-2021

Time period	Placental Abruption	Placenta Praevia / accreta	Postpartum haemorrhage		Uterine inversion	Total deaths from haemorrhage	Direct haemorrhage death rate per 100,000 maternities	
			Atony	Genital Tract Trauma			Rate	95% Confidence Interval (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
2019-21†	4	6*	4	4	0	18	0.80	0.48 – 1.27

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

*2 placenta praevia alone, 4 accreta/increta/percreta

3.4 Overview of care and new national messages

Systems under pressure

A woman with a previous caesarean birth was booked for an elective repeat caesarean at term. She was admitted in spontaneous labour 12 hours following rupture of membranes, two days before her planned caesarean date. She was seen on the ward and counselled and she agreed to a trial of vaginal birth and augmentation. However, the labour ward was busy and she did not commence oxytocin. She was reviewed again in the late evening and there was a decision not to start oxytocin until the following day as her membranes had been ruptured for less than 24 hours. The following morning she was contracting and complained of pain, including scar pain. A decision was made at the morning ward round for a category 3 caesarean birth. Due to a busy labour ward, and prioritisation of category 4 caesarean sections, she was transferred to theatre more than 12 hours later, in the late evening. Thirty minutes after her caesarean birth she had a massive obstetric haemorrhage and was transferred back to theatre. Further uterotonics were given and a Bakri balloon inserted along with a vaginal pack. She continued to bleed but there were delays in administering blood products, delays in calling senior obstetric staff, delays in them attending and a subtotal hysterectomy was carried out several hours later. Shortly following the procedure, she had a cardiac arrest and could not be resuscitated.

There was evidence of a maternity system under pressure in the care of many women who died. In particular, assessors observed that complex category 3 caesarean births were frequently undertaken late in the evening, with category 4 caesarean births prioritised during the day. Elective and emergency caesarean lists were not managed separately. In many instances, as in this woman's care, this led to a need for rescue surgery and additional staff being called in overnight, with consequent delays. Delays in blood product administration for this woman were compounded by a refusal by haematology to issue further blood products at the time of her hysterectomy.

Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day **N**

All units are required to have escalation policies for periods of high activity. These policies should include a plan to obtain more and senior obstetric and anaesthetic assistance as well as considering midwifery staffing and diverting activity (Knight, Nair et al. 2017)

Point of care coagulation testing

A morbidly obese primigravid woman was admitted at term with a history of prolonged rupture of membranes and irregular contractions. She was tachycardic and dehydrated with a raised BP. She was commenced on IV fluids and antibiotics. Her BP settled without treatment but a few hours later her urinary protein was reported to be raised and she had symptoms of pre-eclampsia. She remained oliguric over the next day and did not progress in labour. She had evidence of acute kidney injury. She had an emergency caesarean birth with a major obstetric haemorrhage. After 30 minutes in recovery, she was noted to be bleeding again and returned to theatre. Repeated attempts were made to place a Bakri balloon followed by a brace suture to control haemorrhage. Despite a measured blood loss of five litres, haematology advised that fibrinogen concentrate should not be given because of a normal point of care coagulation test. A decision was made to undertake a hysterectomy. Two consultant gynaecologists were contacted but were unable to reach the hospital in time to assist. Following the hysterectomy, the woman continued to deteriorate and died.

This woman underwent a complex caesarean birth with signs of sepsis late in the day. Assessors felt she was unlikely to have a vaginal birth following her admission with prolonged rupture of membranes, pre-eclampsia, meconium, a raised BMI and suspected sepsis, and that a caesarean birth earlier in the day should have been offered. It is unclear whether a high workload influenced this decision, but inducing labour allowed her to become sicker overnight. In the presence of infection a prolonged attempt at labour will have increased her risk of a postpartum haemorrhage (PPH). Also, similar to the previous woman, she was denied appropriate clotting products when she had clearly had a massive haemorrhage. Haematology staff should be aware that haematological decline in women undergoing obstetric haemorrhage can be very rapid and life threatening; early intervention is essential. Assessors noted that several women were similarly denied fibrinogen or cryoprecipitate on the basis of an apparently normal point of care coagulation test, or because laboratory measures of coagulation were not available in a timely fashion.

Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage **N**

Produce guidance on which beside tests should be used for assessment of coagulation and the required training to perform and interpret those tests (Knight, Bunch et al. 2020b)

If no haemostatic tests are available, early fresh frozen plasma (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.

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

Bakri balloon use

As in the care of the woman described above, repeated attempts to control haemorrhage using a Bakri balloon were made in many of the women who died from haemorrhage after a caesarean birth. Balloons were inserted incorrectly, use was attempted inappropriately, persisting haemorrhage with a balloon in place was not recognised, and there was evident uncertainty and delay in when to abandon the technique and move on.

Review guidance on when to use balloon tamponade to control haemorrhage, how to insert the balloon and inflate it. Resources such as postpartum haemorrhage checklists should include when not to use balloon tamponade and when to abandon it and move on to a different haemostatic technique **N**

Specialist care for women with abnormally invasive placentation

Following a diagnosis of abnormal placentation, the care of several women who died was noted to be fragmented. Care moved between local hospitals and specialist centres designated for abnormally invasive placenta specialist care, with gaps in communication and neither able to provide the care women needed at the moment they needed it. This was noted both amongst women who died and amongst women who had a re-laparotomy after a repeat caesarean birth whose care is described in chapter 5.

A woman with a complex abnormally invasive placenta underwent a planned caesarean section at a specialist centre based in a stand-alone maternity unit. There were unanticipated difficulties with the surgery. Due to the standalone location, facilities and specialist staff, such as vascular surgery, were not available. She died from uncontrolled haemorrhage.

A woman in her second pregnancy after a previous caesarean birth was noted to have a placenta praevia. No suspicion of abnormal placentation was seen on ultrasound but a planned MRI scan was not carried out. She was not referred to a specialist centre. At a planned caesarean birth at 39 weeks the placenta was found to be adherent and was removed piecemeal. She had a massive obstetric haemorrhage which was thought to have been controlled with balloon tamponade. She collapsed 15 minutes after returning to a room on the delivery unit for post-operative care. She was returned to theatre and after discussion between three consultants, a hysterectomy was carried out. She was going to be transferred to intensive care following the procedure however there was a disagreement among the staff and intensive care were 'tight' for beds. She remained on labour ward despite there being no midwives trained in enhanced care. M

It was evident that services for women with abnormally invasive placentation still vary widely. Specialist services were introduced in England in 2019 and most women were referred for specialist care. However, there was evidence of many similar recurring messages concerning their care in both the mortality and morbidity enquiries despite introduction of this specialist service. Of particular concern, there was evidence of a lack of advanced surgical skills, for example in carrying out caesarean hysterectomy, a lack of availability of appropriately trained midwives, and specialist services lacking all the required facilities and specialties to manage women with complex abnormally invasive placentation on a 24-hour basis. Pathways to ensure women requiring urgent care can reach appropriate specialist units are needed as centralisation of services means that skilled personnel may not be available in local centres.

Review and revise the service specification for centres providing specialist services for managing abnormally invasive placentation to ensure that all specialist units can provide appropriate equipment, facilities and appropriately skilled personnel in an emergency situation occurring at any time of day or night **N**

Delivery for women diagnosed with placenta accreta spectrum should take place in a specialist centre with logistic support for immediate access to blood products, adult intensive care unit and neonatal intensive care unit by a multidisciplinary team with expertise in complex pelvic surgery.

RCOG Green-top Guideline 27a (Royal College of Obstetricians and Gynaecologists 2018)

Patients with known placenta accreta spectrum disorders should be treated by multidisciplinary care teams.

ESAIC Guidelines, Second update 2022, Management of severe peri-operative bleeding (Kietaibl, Ahmed et al. 2023)

3.5 Recurring lessons to be learned

Recognising and responding to haemorrhage

A small multiparous woman was induced and had a spontaneous vaginal birth. She had persistent vaginal bleeding postpartum treated with oxytocin, tranexamic acid and misoprostol. No extra fluid was given until nearly two hours after her bleeding started, when clinical signs of shock were present and her estimated blood loss exceeded 25% of her circulating volume. Blood transfusion was commenced when her blood loss exceeded 30% of her circulating volume and she was cold and anuric with an unrecordable BP. A Bakri balloon and vaginal packs were inserted in theatre and she returned to the labour ward. The packs were noted to be soaked through and she was returned to theatre. General anaesthesia was delayed while an arterial line was inserted, and vasopressors were used to maintain her BP. Uterine compression sutures were applied with a plan to perform a hysterectomy, however there was a further delay of 90 minutes before a hysterectomy whilst waiting for blood products and inserting a central line. By this time the woman was profoundly anaemic and coagulopathic. Fluid resuscitation remained minimal and the infusions were not warmed. High doses of vasopressors were used. Following the hysterectomy, the woman was transferred to ICU, still in hypovolaemic shock, profoundly acidotic and coagulopathic. She died several hours later.

The severity of this woman's condition and the extent of her bleeding was underappreciated at all stages. In several women, as this woman's care illustrates, assessors noted a lack of situational awareness and disconnect in what should have been prioritised and what staff were concentrating on. Rather than focusing on controlling her blood loss and replacing fluid volume, staff were concentrating on specific tasks such as placing a Bakri balloon and invasive monitoring. In massive obstetric haemorrhage, situational awareness is imperative to accurately assess the overall situation and provide judgement on the optimal course of care. A multidisciplinary approach should be implemented early and include involvement of senior staff in obstetrics, anaesthesia, midwifery and haematology to provide appropriate assessment, treatment and support.

At least one senior clinician should take a hands off "helicopter view" to assess the overall situation (Knight, Bunch et al. 2020b). Part of the "helicopter view" is to consider all the information available to direct appropriate care. This may include trends in maternal observations, continuous updates on fluid balance, ensuring appropriate tests are organised and results are communicated promptly. This allows for timely and effective judgements to be made regarding the need and appropriateness of interventions.

The assessment of blood loss and judgements on the need for fluid replacement and blood or blood products should be clearly communicated. As emphasised in multiple guidelines and reports, a fall in systolic blood pressure (BP) is a late sign of haemorrhage, as pulse rate and BP are typically maintained until blood loss exceeds 1000mL, or when approximately 30% circulating volume is lost (Royal College of Obstetricians and Gynaecologists 2016a). As such, a raised pulse rate or drop in BP alone are not reliable indicators of blood loss. However, once the heart rate is greater than the systolic pulse pressure, it is likely that shock is present and there is an urgent need for fluid replacement and blood transfusion.

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.

Early involvement of appropriate senior staff (including the anaesthetic team and laboratory specialists) is fundamental to the management of PPH.

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

Every maternity unit should have a multidisciplinary protocol for the management of PPH.

Training for PPH should be multi-professional and include team rehearsals.

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

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 (Knight, Bunch et al. 2020b)

As highlighted in previous reports, estimated blood loss is often underestimated in women with a low BMI (Knight, Bunch et al. 2020b). This remained a theme in this report, as in the woman above. The development of charts or infographics detailing volume of blood loss related to a woman's weight could facilitate the assessment of significant blood loss, especially in women weighing less.

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 (Knight, Bunch et al. 2020b)

Vasopressors

A woman had a hysterectomy after a massive obstetric haemorrhage. Following an estimated blood loss of more than 50% of her blood volume, and when she was hypotensive, tachycardic and acidotic, a noradrenaline infusion was started and given at increasing rates. Fluid resuscitation was limited and included unwarmed fluids. Blood was administered late. The woman continued to deteriorate and had a cardiac arrest in ICU from which she could not be resuscitated.

For several women, as in the care of the woman described above, the assessors noted that there was inappropriate, excessive and/or prolonged use of vasopressors. Vasopressors, predominately phenylephrine and ephedrine, are used to treat or prevent hypotension due to vasodilation caused by spinal anaesthesia in the absence of hypovolaemia. In the context of hypovolaemia, prolonged use of vasopressor infusions to maintain the BP prior to, or instead of, replacing circulating volume can compromise organ perfusion. Using large doses of vasopressors on an underfilled circulation can worsen acidosis, which in association with hypothermia and coagulopathy, the so called "lethal triad", is associated with a high risk of mortality in people with trauma (Gupta, Garg et al. 2017). It is imperative to recognise deterioration in any of these parameters in massive obstetric haemorrhage. All fluids given quickly should be warmed, as fluids at room temperature and blood taken directly from a fridge will rapidly cause hypothermia, further exacerbating blood loss from coagulopathy.

In the context of major haemorrhage, vasopressors should only be used in conjunction with rapid, warmed infusion of blood, plasma and clotting factors or fluids, used for as brief a time as possible and not relied upon to maintain tissue perfusion (Ghadimi, Levy et al. 2016)

High-volume resuscitation with crystalloids and colloids is associated with coagulopathy and adverse maternal outcomes in women with PPH.

ESAIC Guidelines, Second update 2022, Management of severe peri-operative bleeding (Kietaibl, Ahmed et al. 2023)

Misoprostol

A grand-multiparous woman with previous uterine surgery had an induction of labour with mifepristone and misoprostol following an intrauterine death in the third trimester. The woman was tachycardic and complained of back and abdominal pain before she had a cardiac arrest. A resuscitative hysterotomy was performed and revealed a uterine rupture with significant intra-abdominal haemorrhage. Resuscitation was unsuccessful and she died.

As has been highlighted in previous reports (Knight, Kenyon et al. 2014) (Knight, Nair et al. 2017), the assessors once again noted concerns in relation to misoprostol use in induction of labour, with incorrect dosages used alongside a lack of appropriate formulations with a certified manufacture process. Misoprostol tablets were only available in 200 microgram formulations necessitating division and there were instances of local, non-pharmacist preparation of tablet fractions and suspensions of fractions. These practices increase the risk of adverse events from possible over dosage, such as uterine rupture or AFE, as well as the potential for women not to receive the appropriate treatment dose. Appropriate medicines in the recommended dosages and with certified preparation should be readily available in all units.

In the instance of the woman above, the assessors noted that the dosing and dosage of misoprostol was based on hospital guidelines rather than the current guidance from the Royal College of Obstetrics and Gynaecologists (RCOG) and National Institute for Health and Care Excellence (NICE) (Royal College of Obstetricians and Gynaecologists 2010, National Institute for Health and Care Excellence 2021a).

The dose [of misoprostol for women with late intrauterine fetal death] should be adjusted according to gestational age (100 micrograms 6-hourly before 26+6 weeks, 25-50 micrograms 4-hourly at 27+0 weeks or more, for up to 24 hours).

RCOG Green top guidelines 55 Later intrauterine fetal death and stillbirth (Royal College of Obstetricians and Gynaecologists 2010)

In a woman with an intrauterine fetal death and non-scarred uterus offer oral mifepristone 200mg followed by vaginal dinoprostone or oral or vaginal misoprostol (base the choice and dosage on clinical circumstances and national protocols).

NICE Guideline 207 Inducing labour (National Institute for Health and Care Excellence 2021a)

Misoprostol should always be used with extreme caution for women with late intrauterine fetal death, especially in the presence of a uterine scar. In these women, particularly those with a scar, dinoprostone may be more appropriate (Knight, Nair et al. 2017)

Abnormally invasive placentation

Several women with known abnormally invasive placentation died following caesarean births at 37 weeks or greater gestation. Guidance from the RCOG emphasises that women with known or suspected placenta accreta should have a planned caesarean birth prior to 37 weeks (Royal College of Obstetricians and Gynaecologists 2018). The importance of this practice of planned early delivery needs to be emphasised to reduce the risk of unscheduled delivery, which could result in lack of available experienced senior staff and equipment.

As highlighted above concerning specialist care for women with abnormally invasive placentation, the availability of capable staff and appropriate care facilities for the management of placenta praevia/accreta varies greatly, even within specialised care centres. The assessors also noted several examples of inappropriate allocation of postpartum monitoring responsibilities to staff who lacked relevant training and equipment. When women undergo complex surgical procedures with high blood loss, it is essential that all the staff involved the woman's care, including postoperative monitoring, receive appropriate skills training and are provided with adequate equipment and facilities to effectively handle any complications.

In the absence of risk factors for preterm delivery in women with placenta accreta spectrum, planned delivery at 35+0 to 36+6 weeks of gestation provides the best balance between fetal maturity and the risk of unscheduled delivery.

Any woman giving consent for caesarean section should understand the risks associated with caesarean section in general, and the specific risks of placenta accreta spectrum in terms of massive obstetric haemorrhage, increased risk of lower urinary tract damage, the need for blood transfusion and the risk of hysterectomy.

The elective delivery of women with placenta accreta spectrum should be managed by a multidisciplinary team, which should include senior anaesthetists, obstetricians and gynaecologists with appropriate experience in managing the condition and other surgical specialties if indicated. In an emergency, the most senior clinicians available should be involved.

RCOG Green-top Guideline 27a (Royal College of Obstetricians and Gynaecologists 2018)

Electronic records

The assessors noted that deficiencies in the design and interface of electronic records sometimes created barriers to access and assess information during emergencies. The models also varied across hospitals, creating further confusion. In several instances, the visibility of warning signs and red flags were difficult to recognise or took too long to find. In some systems, the electronic record displayed measures taken at booking rather than current findings, which led to misinterpretation in emergencies when there was not time to properly examine the medical history. It would be beneficial to facilitate user-friendly, clinically relevant interfaces that are more consistent across trusts, including opportunities for improved visual cues by enhancing warning signs and red flags.

Team training

In several instances, assessors emphasised the importance of multidisciplinary team training to ensure optimal PPH prevention, recognition and management (Royal College of Obstetricians and Gynaecologists 2016a, Knight, Bunch et al. 2020b).

The following are areas identified in this report that should be used as a focus for future team training:

- Estimation of blood loss and recognition of the signs and symptoms of severe bleeding and hypovolaemia.
- The avoidance of over-reliance on single point of care tests and initial clinical assessments of haemoglobin and/or early pulse or BP measurements, rather than clinical evaluation.
- Procedures for the control of haemorrhage and indications for their use with skills training for application of the procedures, including when to abandon certain techniques such as balloon tamponade and timeliness of the decision to move to hysterectomy.
- Assessors noted incidences of secondary trauma/victims among the staff who cared for the women who died. It is important that team training incorporates information on when and how to access services to help staff who may need support following a major obstetric haemorrhage.

3.6 Pathology of maternal deaths from obstetric haemorrhage with abnormal placentation

In this triennium six women died due to obstetric haemorrhage that involved abnormal placentation. Two women who died had placenta praevia and four women had placenta accreta spectrum (PAS) pathology.

Placenta praevia

Placenta praevia is a condition where the placenta is low lying, involving the lower uterine segment, or encroaching on, or covering, the cervical os. It is associated with an increased risk of antepartum haemorrhage and PPH. The incidence of placenta praevia at term is approximately 1 in 200 pregnancies (Royal College of Obstetricians and Gynaecologists 2018); however, determinations of the precise incidence are affected by differences in how placenta praevia is defined. The incidence of placenta praevia appears to be rising due to higher rates of caesarean section, increasing maternal age and more pregnancies conceived by assisted reproduction.

For the pathologist, a thorough obstetric history and detailed understanding of the events surrounding a woman's death will help correctly identify deaths related to placenta praevia. Importantly, the diagnosis of placenta praevia is made using an ultrasound scan, not by histology.

Placenta accreta spectrum

The consensus terminology adopted to describe the different categories of abnormally invasive placentation is PAS, which includes placenta accreta, placenta increta and placenta percreta.

In PAS there is abnormal adherence of the placenta to the uterine wall, without intervening decidua. The spectrum ranges from superficial to deep adherent placenta:

Placenta accreta - chorionic villi are superficially adherent to the myometrium without intervening decidua

Placenta increta - chorionic villi invade through the wall of the uterus up to the serosa

Placenta percreta - chorionic villi invade through the wall of the uterus and penetrate the serosa; this can involve adjacent structures such as the bladder

It is thought that PAS arises from defects in the developing endometrial/myometrial interface, leading to a failure of decidualisation. This is usually due to uterine scarring. As such, prior caesarean section is a leading risk factor for development of PAS.

It should be noted that not all retained placenta products indicate PAS. There are other causes of retained placenta including uterine atony, chronic abruption, uterine abnormalities and placental abnormalities including accessory lobes and placenta praevia. Similarly, the presence of an adherent placenta in a hysterectomy specimen does not necessarily indicate PAS. In these instances, gentle firm pressure on the cord should be applied to see if the placenta can be detached from its bed as usual.

A standardised approach in the terminology and criteria used for a diagnosis of PAS is required in order to provide consistent information to the multidisciplinary team to guide patient assessment and care. A classification and reporting consensus for PAS was proposed by an expert panel in 2020 that may provide a structure for standardised pathological diagnostic criteria and grading (Hecht, Baergen et al. 2020).

A pathological diagnosis of PAS requires a total or partial hysterectomy or deep myometrial resection. The diagnosis cannot be made from the placenta alone nor from curettings. In addition, multiple blocks of tissue are recommended for examination, as different areas of the uterine wall may show different levels of invasion.

Using a series of virtual PAS histology slides as a reference may be of interest or prove helpful to reporting pathologists (Hecht, Baergen et al. 2020). The general advice for pathologists dealing with maternal deaths involving PAS is to refer to a specialist gynaecological or paediatric pathologist with expertise in assessing PAS specimens.

Key points for pathologists:

- The incidence of placenta praevia and PAS is increasing
- There is an associated risk of antepartum or major postpartum haemorrhage and maternal death
- A consistent approach to the histological assessment of PAS is required
- Referral to a specialist gynaecological or paediatric pathologist with expertise in PAS is advised

3.7 Conclusions

There was sufficient information to assess care for all 26 women who died. Assessors felt that improvements to care might have made a difference to the outcome for 16 women (62%) (Table 3.2). While many of the messages for care noted in this chapter have been included in these reports before, assessors described important new messages concerning specialist care for women with abnormally invasive placentation, the management of obstetric haemorrhage and around the prioritisation of emergency versus elective caesarean births. Evidence was noted of the impact of a maternity system under pressure. Opportunities were nevertheless identified for team training and redesign of electronic records that could improve the safety of care.

Table 3.2: Classification of care received by women who died from haemorrhage and AFE, UK and Ireland, 2019-21

Classification of care received	Women who died from haemorrhage n=18 Frequency (%)	Women who died from AFE n=8 Frequency (%)
Good care	1 (6)	1 (13)
Improvements to care which would have made no difference to outcome	4 (22)	4 (50)
Improvements to care which may have made a difference to outcome	13 (72)	3 (38)

4. Improving anaesthetic care

Nuala Lucas, James Bamber, Allison Felker and Marian Knight on behalf of the MBRRACE-UK anaesthetic care chapter-writing group

Chapter-writing group members: James Bamber, Anita Banerjee, Kathryn Bunch, Lynne Campbell, Paula Chattington, Fiona Cross-Sudworth, Hilde Egrom, Becky Ferneyhough, Malcolm Griffiths, Samantha Holden, Marian Knight, Nuala Lucas, Roshni Patel, Robin Russell

4.1 Key messages

New recommendations

Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists, Royal College of Physicians, Obstetric Anaesthetists Association**

Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day. **ACTION: National Institute for Health and Care Excellence (NICE)**

Existing guidance and recommendations requiring improved implementation

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 (Knight, Kenyon et al. 2014).

The choice of tracheal tube for pregnant women should start at size 7.0 and proceed to smaller tube selections if needed (Mushambi, Kinsella et al. 2015).

[Women] with a Glasgow Coma Scale (GCS) ≤ 8, a significantly deteriorating conscious level, for example, a fall in GCS of two points or more, or a fall in motor score of one point or more, and requiring transfer should undergo tracheal intubation and mechanical lung ventilation (Nathanson, Andrzejowski et al. 2020).

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 (Knight, Nair et al. 2017).

All units are required to have escalation policies for periods of high activity. These policies should include a plan to obtain more and senior obstetric and anaesthetic assistance as well as considering midwifery staffing and diverting activity (Knight, Nair et al. 2017).

4.2 Background

The maternal death rate directly attributed to anaesthesia remains extremely low despite 59% of all women who give birth having an anaesthetic procedure. Over the past 40 years, there has been a dramatic decline in maternal deaths directly related to anaesthetic causes. Factors contributing to this decline in deaths include improved training of anaesthetists in obstetric anaesthesia and the development and advancement of obstetric anaesthesia as a distinct subspecialty. Anaesthetists are essential members of multidisciplinary teams in hospital maternity care, providing peri-operative analgesia and anaesthesia, and contributing to the delivery of good medical care and safety improvements for high-risk women. However, despite the rarity of direct deaths due to anaesthesia in the women whose care was reviewed for this triennium, there were several examples where the anaesthetic care provided could have been improved. Many of the lessons learned from this enquiry will be familiar to experienced obstetric anaesthetists, but the need for their continued reiteration highlights the valuable role that confidential enquiries play in the education of anaesthetists working in maternity care.

4.3 The women who died

Deaths in association with obstetric anaesthesia continue to be extremely uncommon. One woman died in association with obstetric anaesthesia in the UK between 2019 and 2021, a rate of 0.05/100,000 maternities (95% CI 0.001-0.27). The one anaesthesia-related death in this triennium occurred after the onset of bilateral tension pneumothoraces, the cause of which was unknown. Intraoperative pneumothoraces are rare, as are spontaneous pneumothoraces in pregnancy, with fewer than 100 cases reported in the literature (Lal, Anderson et al. 2007, Cardoso, Raposo et al. 2022). Patient-related risk factors are similar for both, including a history of lung disease predisposing to lung bullae that may rupture, particularly with positive pressure ventilation. The insertion of central venous lines, to assist with resuscitation, for example, may accidentally puncture the lung pleura; using ultrasound to help guide central line placement can help reduce this risk (Brass, Hellmich et al. 2015). Pneumothoraces can also occur if there has been trauma to the tracheobronchial tree. Therefore, it is important not to use tracheal tubes larger than 7mm internal diameter to minimise the risk of trauma during intubation and also to be gentle when airway introducers are used to facilitate endotracheal intubation (Mushambi, Kinsella et al. 2015).

Anaesthetists should also be alert to the inward migration of the tracheal tube, which may increase airway pressures due to inadvertent one-lung ventilation. Accidental bronchial intubation and one-lung ventilation are complications that can occur at intubation and become apparent shortly after. They may also occur when an intubated patient is transferred from the operating table to a bed. The most common sign of one-lung ventilation is sudden oxygen desaturation, which may be associated with increased airway pressures or reduced lung compliance (McCoy, Russell et al. 1997). When a woman collapses, it is important to systematically evaluate all possible causes of cardiac arrest (the 4Hs and 4Ts) to help ensure that reversible causes are recognised and treated promptly. The Resuscitation Council UK's Advanced Life Support Algorithm can help guide evaluation (Obstetric Anaesthetists' Association 2021).

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 (Knight, Kenyon et al. 2014)

The choice of tracheal tube for pregnant women should start at size 7.0 and proceed to smaller tube selections if needed (Mushambi, Kinsella et al. 2015)

4.4 Overview of care and lessons to be learned

Anaesthetic management of obstetric haemorrhage

Lessons for care in major obstetric haemorrhage are included in chapter 3 of this report. It is important to reiterate that the anaesthetist has a crucial role in resuscitation and management of women who have obstetric haemorrhage. There were several instances of obstetric haemorrhage where the anaesthetic management of resuscitation could have been improved or where there was delayed senior anaesthetic support and involvement in care.

A woman had a 1.5 litre blood loss after a vaginal birth and was transferred to theatre for further management. She was tachycardic and hypotensive. The woman received general anaesthesia and her hypotension was managed with an increased infusion rate of vasopressors. She did not receive a transfusion until more than an hour after the start of the haemorrhage, by which time the blood loss had increased significantly. She eventually had a two-unit blood transfusion but went into cardiac arrest and could not be resuscitated.

The relevant messages and themes regarding the care of women who experience major obstetric haemorrhage have been highlighted in this and previous reports and include:

1. *The importance of early senior support and involvement.* Senior anaesthetic support should always be available and competing senior clinical duties or commitments to areas outside maternity care must be avoided unless appropriate emergency contingency support plans are in place.
2. *The need to avoid false reassurance from point of care haemoglobin assessment devices*. A haemoglobin measurement without adequate fluid resuscitation will not reflect the magnitude of the haemorrhage or the need for transfusion. There should be serial repeat haemoglobin measurements taken during the resuscitation process, so staff are not reliant on a single measurement for clinical decision making.

3. *The appropriate use of vasopressors to support BP in the event of obstetric haemorrhage*. Vasopressors should not be used as an alternative to adequate and timely volume resuscitation. The excessive use of vasopressors can mask the clinical features hypovolaemia and delay recognition of its severity and treatment with appropriate volume replacement.
4. *Ventilator settings*. When shocked and metabolically acidotic people are ventilated, the ventilator settings should be adjusted to accommodate for the person's loss of their own respiratory compensation of their acidosis.

Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage N

Management of neurological emergencies

Neurological causes are the third most common cause of indirect maternal death. While neurological emergencies are rare in obstetric patients, timely appropriate management is key to optimising outcomes. Women who have a low or deteriorating consciousness level need emergency anaesthetic support, which may include tracheal intubation and ventilation to protect against the risk of lung aspiration and to provide neuroprotective care.

A woman with mild thrombocytopenia and abnormal liver function tests received syntometrine and diclofenac after a vaginal birth. Shortly after giving birth she developed neurological signs including vomiting, dysphasia, right sided weakness and a rapid reduction in Glasgow Coma Scale score. She was transferred to the radiology department where a CT scan showed evidence of intracranial haemorrhage. She was intubated following rapid sequence induction with only a hypnotic agent and muscle relaxant. She was transferred to the neurosurgical unit where she unfortunately died.

In some instances of neurological emergencies, as in the woman above, assessors highlighted the importance of taking the Glasgow Comma Scale (GCS) into account when delivering anaesthetic support. Recommendations state that people with low GCS scores (≤8) or significant deterioration of conscious level should be intubated prior to transfer (Nathanson, Andrzejowski et al. 2020). This woman was intubated prior to transfer to the neurosurgical unit but not when she was transferred to radiology despite a GCS of 5. The assessors stressed that this recommendation should also apply to intra-hospital transfers.

Neurological deterioration in an obstetric patient should be regarded as a medical emergency that should mandate senior multidisciplinary involvement, including anaesthesia.

[Women] with a Glasgow Coma Scale (GCS) ≤ 8, a significantly deteriorating conscious level, for example, a fall in GCS of two points or more, or a fall in motor score of one point or more, and requiring transfer should undergo tracheal intubation and mechanical lung ventilation (Nathanson, Andrzejowski et al. 2020)

Anaesthetic involvement in multidisciplinary care

A multiparous woman had an induction of labour following a preterm intrauterine death. Shortly after induction was started, she developed a heart rate of 110 and a respiratory rate of 20. Her BP was normal. Intravenous fluids were prescribed. Six hours later, she was again noted to be tachycardic with a heart rate of 150 and a systolic BP of less than 100 mmHg. Further IV fluids were prescribed but no other action was taken. The tachycardia settled but she was increasingly restless, which was attributed to labour progress, and no further action was taken. Two hours later, while in consultation with an anaesthetist regarding labour analgesia, she collapsed and became unresponsive. A perimortem caesarean section revealed a ruptured uterus.

A recurring theme highlighted in previous reports and arising from the reviews in this triennium, was the lack of timely involvement of anaesthetists in the care of women who became critically unwell or were at risk of becoming critically unwell. There were several instances of women with complex health needs or who had significant comorbidities who were not referred to an anaesthetist in the antenatal period, to allow for anaesthetic contribution to the multidisciplinary planning of good intrapartum care. There were also several examples where an anaesthetist was

only involved in the care of a woman at a relatively late stage of acute deterioration, and in several women there was no escalation to involve senior clinical staff. An anaesthetist was not involved in the care of this woman until she collapsed eight hours after induction despite several vital signs being outside the normal range, which should have prompted escalation of care.

Through their specialist training, obstetric anaesthetists can bridge multiple disciplines, including obstetrics, medicine and critical care, and they have valuable expertise to contribute to the management of acutely unwell pregnant women. Integrating anaesthetic expertise into maternity care through regular participation in multidisciplinary labour ward rounds and training can help embed anaesthetists in the core multidisciplinary team beyond the delivery of analgesia and anaesthesia services.

The participation of obstetric anaesthetists in all key aspects of maternity services relies on adequate resources for obstetric anaesthesia services. A survey of obstetric anaesthesia workload conducted in 2021 found that there was no consultant time provided for obstetric anaesthetic clinic work in 14% of UK units. The same survey identified that 16% of units did not have regular multidisciplinary ward rounds, and 6% of units did not have any multidisciplinary ward rounds (Bamber, Lucas et al. 2023).

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 (Knight, Nair et al. 2017)

Clinical vigilance and lack of diagnostic curiosity

A woman had a caesarean birth for delay in the first stage after which she was tachycardic and hypotensive. She was reviewed twice by the same clinician. She was prescribed a bolus of IV fluid and a full blood count was ordered. The tachycardia settled, but she continued to have hypotensive episodes. Medical review suggested that her BP was in an acceptable range, and there were no further investigations. She had a cardiac arrest three hours after hospital discharge due to cardiac tamponade.

The doctor who reviewed this woman did so twice but did not formulate a differential diagnosis or request further investigations, such as blood lactate or blood culture, beyond a full blood count at either visit. There were several women where assessors felt the care could have been improved by more clinical vigilance and diagnostic curiosity across the whole team. In the presence of persistently abnormal physiology, a doctor should formulate a diagnosis with a differential and use the available diagnostic tools. If there are concerns about the condition of a woman, midwives and junior medical staff must be actively encouraged to seek the advice and input of their senior colleagues, and senior doctors must attend wherever possible.

Management of category 3 caesarean birth

While not solely an anaesthetic issue, and as discussed in chapters 3 and 5 of this report, there were several examples where planning prior to caesarean birth could have been improved and postponement of caesarean birth contributed to women's deaths. This was particularly evident for women who required a category 3 caesarean birth (where there is no maternal or fetal compromise but an early birth is necessary). The caesarean birth rate continues to rise, but there is limited national guidance on how to organise and provide services to meet the needs of local populations. A recent survey on obstetric anaesthetic care in UK maternity units, demonstrated disparities in the provision of dedicated planned obstetric care. Notably, a significant proportion of maternity units did not have separate elective caesarean section lists, indicating inequity in the provision and scheduling of maternity services for caesarean birth compared to other types of elective and emergency surgical care (Bamber, Lucas et al. 2023). This can impact the safety and quality of care that women receive in maternity services.

A woman received a spinal anaesthetic for a category 3 caesarean birth that was delayed until late in the evening due to capacity issues. Following the birth, she had a massive obstetric haemorrhage. There was a delay in coagulation products being issued. She had a cardiac arrest and could not be resuscitated.

There is an urgent need for national guidance, including minimum standards, for the organisation and delivery of planned and emergency caesarean birth.

Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day **N**

All units are required to have escalation policies for periods of high activity. These policies should include a plan to obtain more and senior obstetric and anaesthetic assistance as well as considering midwifery staffing and diverting activity (Knight, Nair et al. 2017)

4.5 Conclusions

While anaesthetic-related deaths remain extremely uncommon, there are still opportunities for improved obstetric anaesthetic care, including early senior input, and in emergencies such as major obstetric haemorrhage. The obstetric anaesthetist is an important part of the multidisciplinary team and should be involved in planning at all stages of care, particularly in the care of women with complex and multiple problems. Multidisciplinary ward rounds as well as obstetric anaesthetic clinics allow for anaesthetic preparation and avoid the need for emergency anaesthetic input with no prior planning. Nevertheless, emergency and elective caesarean lists must be organised separately to ensure senior anaesthetic input is always available in an emergency situation.

5. Lessons on morbidity after repeat caesarean birth

Allison Felker, Hilde Engjom, Roshni Patel and Marian Knight on behalf of the MBRRACE-UK haemorrhage and AFE chapter-writing group

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5.1 Key messages

New recommendations

Review and revise the service specification for centres providing specialist services for managing abnormally invasive placentation to ensure that all specialist units can provide appropriate equipment, facilities and appropriately skilled personnel in an emergency situation occurring at any time of day or night. **ACTION: NHS England, Scottish, Welsh and Irish governments**

Clarify that review of the care of women who return to theatre may provide important safety learning but should not be perceived as a performance metric after caesarean birth, as re-operation may be the appropriate response to control internal haemorrhage. **ACTION: NHS England, Scottish, Welsh and Irish governments**

Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists, Royal College of Physicians, Obstetric Anaesthetists Association**

Review guidance on when to use balloon tamponade to control haemorrhage, how to insert the balloon and inflate it. Resources such as postpartum haemorrhage checklists should include when not to use balloon tamponade and when to abandon it and move on to a different haemostatic technique. **ACTION: National Institute for Health and Care Excellence (NICE), Royal College of Obstetricians and Gynaecologists**

Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day. **ACTION: National Institute for Health and Care Excellence (NICE)**

Existing guidance and recommendations requiring improved implementation

Risk awareness and early recognition of severe postpartum haemorrhage are essential (Kietaibl, Ahmed et al. 2023).

Haemorrhage (which might be concealed) should be considered when classic signs of hypovolaemia are present (tachycardia and/or agitation and the late sign of hypotension) even in the absence of revealed bleeding (Royal College of Obstetricians and Gynaecologists 2016a).

Early involvement of appropriate senior staff (including the anaesthetic team and laboratory specialists) is fundamental to the management of PPH (Royal College of Obstetricians and Gynaecologists 2016a).

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 (Knight, Bunch et al. 2020b).

Women seeking multiple (e.g. three or more) future pregnancies should be counselled that opting for elective repeat caesarean section may expose themselves to greater surgical risks for future pregnancies (Royal College of Obstetricians and Gynaecologists 2015).

All units are required to have escalation policies for periods of high activity. These policies should include a plan to obtain more and senior obstetric and anaesthetic assistance as well as considering midwifery staffing and diverting activity (Knight, Nair et al. 2017).

Ensure caesarean wound care includes assessing the wound for signs of infection (such as increasing pain, redness or discharge), separation or dehiscence (National Institute for Health and Care Excellence 2023a).

[After caesarean birth with general anaesthesia], if observations are not stable, or the woman has other risk factors or complications, carry out a medical review and increase the duration and frequency of observations (National Institute for Health and Care Excellence 2023a).

Carry out caesarean birth for pregnant women with antepartum haemorrhage, abruption or placenta praevia at a maternity unit with on-site blood transfusion service, as they are at an increased risk of blood loss of more than 1000mL (National Institute for Health and Care Excellence 2023a).

Early recognition of placenta praevia, adopting a multidisciplinary approach and informed consent are important considerations in the management of women with placenta praevia and previous caesarean delivery (Royal College of Obstetricians and Gynaecologists 2015).

Previous caesarean delivery and the presence of an anterior low-lying placenta or placenta praevia should alert the antenatal care team of the higher risk of placenta accreta spectrum (Royal College of Obstetricians and Gynaecologists 2018).

Women with a history of previous caesarean section seen to have an anterior low-lying placenta or placenta praevia at the routine fetal anomaly scan should be specifically screened for placenta accreta spectrum (Royal College of Obstetricians and Gynaecologists 2018).

Early recourse to hysterectomy is recommended if conservative medical and surgical interventions to control haemorrhage prove ineffective (Royal College of Obstetricians and Gynaecologists 2018).

Provide post-operative care in a specialist recovery area (a high dependency unit, a post-anaesthesia care unit or an intensive care unit) for people with a high risk of complications or mortality (National Institute for Health and Care Excellence 2020).

5.2 Background

The proportion of women undergoing caesarean births between 2019-21 was 31% in England (NHS England 2021), 29% in Wales (Welsh Government 2021), 35% in Scotland (Public Health Scotland 2021), 33% in Northern Ireland (Department of Health - Northern Ireland 2022) and 35% in the Republic of Ireland (National Women and Infants Health Programme 2021, National Women and Infants Health Programme 2022). Elective caesarean sections account for just under half of all caesarean births and rates of caesarean section appear to be increasing, resulting in a higher incidence of repeat caesarean births. Women with a history of caesarean birth are at an increased risk of morbidities in subsequent births including hysterectomy, blood transfusions, adhesions and surgical injury (Marshall, Fu et al. 2011, Royal College of Obstetricians and Gynaecologists 2015). The risk of critical care admission and morbidities due to caesarean section, including major obstetric haemorrhage and visceral or vessel damage, increases significantly with higher order repeat caesarean births compared to lower order (Cook, Jarvis et al. 2013). Often women who have higher order repeat caesarean births also require re-exploration, which exposes women to further anaesthetic and surgical risks. The focus of this MBRRACE-UK morbidity enquiry was to investigate lessons for care arising from review of the care of women who had re-exploration after repeat caesarean birth.

5.3 The women whose care was reviewed

The women whose care was reviewed were identified through a UK Obstetric Surveillance System (UKOSS) study of re-exploration after caesarean birth conducted between June 2021 and May 2022 (UKOSS 2023). Records for all 36 women who had a prior caesarean birth were sought for inclusion in the confidential enquiry. Records were not forthcoming for 4 women, thus the care of 32 women was examined for the purposes of this chapter. The socio-demographic characteristics of the women are shown in Table 5.1. Most women (n=21, 66%) had one prior caesarean birth, six women (19%) had two prior caesarean births and five women (16%) had three or more.

Fourteen women underwent re-laparotomy due to haemorrhage; ten had surgical bleeding in relation to the uterine incision, one had abnormal placentation and recurrent bleeding, and one had uterine atony. Two women had surgical bleeding in relation to the abdominal wall incision. Five women had wound dehiscence and/or infection. One woman had an emergency laparotomy for reasons unrelated to the caesarean section (biliary peritonitis).

Table 5.1: The socio-demographic characteristics of the women whose care was reviewed

Characteristics	Total (N=32) Frequency (%)
Age at childbirth (years)	
<25	2 (6)
25-29	6 (19)
30-34	11 (34)
35-39	10 (31)
≥40	3 (9)
Number of previous Caesarean Sections	
1	21 (66)
2	6 (19)
≥ 3	5 (16)
Ethnicity	
White European	21 (66)
Asian	6 (19)
Black	4 (13)
Other	1 (3)
Woman's Employment status	
Employed	13 (41)
Not employed	18 (56)
Missing	1 (3)
Body mass index (BMI) (kg/m^2)	
<18	1 (3)
18-24	5 (16)
25-29	16 (50)
≥30	10 (31)
Smoking status	
Yes	4 (13)
No	28 (88)
Any other previous medical problems	
Yes	16 (50)
No	16 (50)

5.4 Overview of care and new lessons to be learned

Specialist centres managing abnormally invasive placentation

Note that many of the messages identified for improving care of women with haemorrhage and AFE apply equally to women whose care was examined for the purposes of this chapter, notably the following new national recommendation concerning specialist centres managing abnormally invasive placentation:

Review and revise the service specification for centres providing specialist services for managing abnormally invasive placentation to ensure that all specialist units can provide appropriate equipment, facilities and appropriately skilled personnel in an emergency situation occurring at any time of day or night N

Further details underpinning this recommendation can be found in section 3.4.

Return to theatre

A multiparous woman had a category 1 caesarean section at 30 weeks under spinal anaesthesia for suspected chronic fetal hypoxia. The procedure was performed during the night by an obstetric trainee with an estimated blood loss of 400mls. The operation note described a 4cm broad ligament haematoma, which was not increasing in size. A drain was left in. She was reviewed the following morning when there was 200mls blood, described as 'bright red' in the drain. Her pre-operative haemoglobin was 130g/l and had fallen to 90g/l. Approximately ten hours later, she had a further 200mls of bright red blood in the drain and her haemoglobin was 70g/l. She was symptomatic (dizzy and felt unwell) and a decision was made to return to theatre for exploratory laparotomy. She was resuscitated with crystalloid and four units of both FFP and red cell concentrate. A broad ligament haematoma was drained and a bleeding vessel ligated. She went on to make an uneventful recovery M

This was a potentially difficult preterm caesarean birth. There was clearly some concern post-operatively as an intra-abdominal drain was left in. Her drop in haemoglobin was not in keeping with the 400mls blood loss recorded at the emergency caesarean section. The presence of fresh red blood in the drain eight hours later indicated ongoing bleeding. The doctor who reviewed her was suspicious of this, but there was a clear reluctance to return to theatre. When her observations deteriorated further, she was promptly taken to theatre and consultant staff involved.

A similar reluctance to return to theatre was noted in the care of several women, leading to a delay in management of internal haemorrhage until women were in extremis. In some instances, assessors felt that decisions to return to theatre were being adversely influenced by fear of performance metrics based on unscheduled re-operation rates. It is important to emphasise that surgical complications will inevitably occur after some caesarean births and early definitive management, including re-operation, is an appropriate response. Metrics should be chosen appropriately to ensure that they do not lead to delays in the correct management. It is more important that the care of all women who require a return to theatre are suitably reviewed so that lessons are learned.

Clarify that review of the care of women who return to theatre may provide important safety learning but should not be perceived as a performance metric after caesarean birth, as re-operation may be the appropriate response to control internal haemorrhage N

5.5 Recurring lessons to be learned

Recognising and managing haemorrhage after caesarean section

A small woman with three previous caesarean births underwent an elective caesarean section at term and tubal ligation was performed. The surgery was complicated by adhesions. Eight hours after giving birth she was dizzy and vomiting with minimal urine output. Ten hours later she complained of abdominal pain and shortness of breath. Her BP and haemoglobin had dropped and her abdomen was soft and distended. A provisional diagnosis of an ileus was made. Despite early requests for review by the midwives caring for her, she was not seen by a consultant until 24 hours post-operatively. Two hours after review, she returned to theatre for re-exploration. There was bleeding from the middle of the uterine incision and a 1.5 litre haemoperitoneum. The uterus was re-sutured, three units of blood and two of cryoprecipitate were given and haemostasis was secured. The woman was discharged home three days later. M

As in the woman described above, surgical haemorrhage related to the uterotomy was the most frequent indication for re-operation, and several recommendations from previous MBRRACE reports regarding care for women with obstetric haemorrhage were noted to need reinforcement (Royal College of Obstetricians and Gynaecologists 2010, Knight, Kenyon et al. 2014, Royal College of Obstetricians and Gynaecologists 2016a, Knight, Nair et al. 2017, Royal College of Obstetricians and Gynaecologists 2018, Knight, Bunch et al. 2020b, National Institute for Health and Care Excellence 2021a).

As discussed in chapter 3 of this report, prompt clinical recognition and treatment of haemorrhage was highlighted once again in the care of several women. As in the woman described above, assessors noted that staff did not appear to consider concealed haemorrhage despite clinical signs and symptoms. In some instances, early attempts at escalation and involvement of senior input were ignored or delayed.

Intra-abdominal bleeding is a recognised complication following a caesarean section, and plans should be in place for potential obstetric haemorrhage including senior input, helicopter overview and frequent situational reports to alert teams and coordinate responses. Several assessors highlighted learning potential from emergency trauma care: early recognition of bleeding and definitive care including surgical exploration with appropriate anaesthesia, early transfusion and use of other blood products, including early use of O-negative blood, easy access to coagulation tests, and warming of both patients and infusions.

Update guidance on the use of coagulation tests in the context of obstetric haemorrhage including the timelines for availability and how to interpret these, noting that women should not be inappropriately denied clotting products based on a single measure of coagulation in the face of ongoing haemorrhage **N**

Assessors also noted dependence on the use of vasopressors for hypovolaemic women without correction of their hypovolaemia or treatment of their concealed haemorrhage, a topic which recurred across several chapters. The inappropriate or incorrect use of Bakri balloons to control haemorrhage was also repeated in a number of women with haemorrhage after repeat caesarean births.

Review guidance on when to use balloon tamponade to control haemorrhage, how to insert the balloon and inflate it. Resources such as postpartum haemorrhage checklists should include when not to use balloon tamponade and when to abandon it and move on to a different haemostatic technique **N**

Risk awareness and early recognition of severe postpartum haemorrhage are essential.

ESAIC Guidelines, Second update 2022, Management of severe peri-operative bleeding (Kietaibl, Ahmed et al. 2023)

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

Early involvement of appropriate senior staff (including the anaesthetic team and laboratory specialists) is fundamental to the management of PPH.

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

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 (Knight, Bunch et al. 2020b)

Systems under pressure

An older woman in her seventh pregnancy had six previous caesarean births. She had an elective caesarean birth scheduled for 39 weeks. Upon arrival at hospital for surgery, she had a fever. Due to concerns around COVID-19, her caesarean section was delayed from the morning to the late afternoon at the end of the operating list. The caesarean was performed by a registrar with a consultant only present for part of the surgery due to a parallel emergency. She had persistent vaginal bleeding after she left theatre and attempts were made to place a Bakri balloon. A re-laparotomy was carried out after a documented three litres of blood loss. She had a hysterectomy complicated by dense adhesions to the bladder. A tear in the bladder was identified and repaired by urologists and the woman went on to have an uncomplicated recovery. M

The assessors noted that the hysterectomy and subsequent surgical complications in the woman above were handled well; however, there were concerns raised about the preparation for the birth and the operation itself. Notably, assessors felt that there was little advance planning for a high-risk caesarean as it was performed by a registrar, despite the woman being booked for consultant-led care. There was also no consideration of whether urology, general surgery

and/or interventional radiology should be available in case of a need for escalation. Indeed, assessors observed that in the care of several women there appeared to be a reluctance to acknowledge the impact of parallel emergencies with no plans in place to escalate concerns or access additional capacity if required.

As observed in the care of several women who had a re-laparotomy after a repeat caesarean birth, this woman's care illustrates evidence of a maternity system under pressure, also demonstrated elsewhere in this report. COVID-19 resulted in a loss of situational awareness in many units where all other risk factors, such as those that occur with high-order repeat caesarean deliveries, became secondary to the possibility of SARS-CoV-2 infection. In many instances, as described in chapters 3 and 4, it was also noted that elective procedures and category 4 caesarean births were prioritised over emergencies, such as complex category 3 caesarean births; complicated surgeries were postponed until later in the day when fewer staff were available and they were performed by staff with less experience. Assessors noted that system pressure left little space for reflective learning amongst the teams caring for these women.

Update guidance to make certain that category 4 caesarean section lists are managed separately from more urgent caesarean sections to ensure these operations are not delayed to late in the day **N**

Women seeking multiple (e.g. three or more) future pregnancies should be counselled that opting for elective repeat caesarean section may expose themselves to greater surgical risks for future pregnancies.

RCOG Green-top Guideline 45 (Royal College of Obstetricians and Gynaecologists 2015)

All units are required to have escalation policies for periods of high activity. These policies should include a plan to obtain more and senior obstetric and anaesthetic assistance as well as considering midwifery staffing and diverting activity (Knight, Nair et al. 2017)

Post-operative monitoring

In several instances, assessors noted that the NICE recommendations for the care of women after caesarean birth were not followed. This includes one-to-one observation of a woman until she is stable and able to communicate, and repeated observations post-operatively, including escalation and medical review, if there are other risk factors or complications. These observations should consider pain management, urinary catheter removal, wound care and the management of symptoms (National Institute for Health and Care Excellence 2023a). Follow-up appointments are needed for women who have undergone a critical incident during childbirth and any complications should be clearly communicated between healthcare professionals at transfer of care (National Institute for Health and Care Excellence 2021b).

A woman in her seventh pregnancy had had one prior caesarean birth and five vaginal births (three after her first caesarean). She had a preterm category 2 elective repeat caesarean section due to fetal concerns. Twenty-four hours after birth, abdominal wound dressings were heavily soaked, she had a significant drop in haemoglobin and concerns were expressed about inflammation and loose sutures. A further 24 hours later, senior review identified a small bowl loop dehiscence requiring return to theatre and bowel resection. M

It is not normal for wound dressings to be heavily soaked 24 hours after birth and, coupled with the significant drop in this woman's haemoglobin, care should have been escalated for senior review earlier. If review had not been delayed for 24 hours after initial concerns were expressed, this woman might not have required a bowel resection. If post-operative complications occur they should be promptly recognised and return to theatre should not be delayed. The care of this woman highlights the need to formalise senior clinical input in postnatal care with an allocated time to follow-up and availability of experienced face to face supervision.

Ensure caesarean wound care includes assessing the wound for signs of infection (such as increasing pain, redness or discharge), separation or dehiscence.

[After caesarean birth with general anaesthesia], if observations are not stable, or the woman has other risk factors or complications, carry out a medical review and increase the duration and frequency of observations.

NICE NG192 Caesarean birth (National Institute for Health and Care Excellence 2023a)

A woman in her 40s had a massive postpartum haemorrhage following her second caesarean section for placenta praevia. During the caesarean, the consultant obstetrician cut through the placenta to deliver the baby and the placenta was removed piecemeal. There was bleeding from the lower segment and a Bakri balloon was placed; uterotonics and vasopressors were given. Fifteen minutes after her transfer to the delivery unit for post-operative care, she became unresponsive and appeared to have a seizure. She was transferred back to the theatre for a hysterectomy. Post-hysterectomy, limited space in the ICU meant that she remained on the labour ward until her discharge four days later. M

This woman was high-risk due to her age, current placenta praevia and history of antepartum haemorrhage with placenta praevia. She was advised of the risks of bleeding during caesarean section and a consultant anaesthetist and obstetrician were involved in the birth as is recommended in RCOG guidelines; however, the caesarean section was scheduled at 39 weeks gestation, which is later than recommended (Royal College of Obstetricians and Gynaecologists 2018). While there were no initial features of a morbidly adherent placenta on imaging, a MRI was considered but not done. If an accreta was suspected, as is the case in 11-14% of women with placenta praevia and a prior caesarean birth (Royal College of Obstetricians and Gynaecologists 2015), the incision should have been made above the placenta. Initially, haemorrhage was thought to be controlled with a Bakri balloon, but control of bleeding had clearly not been appropriately established prior to her return to the labour ward. A 'seizure' under these circumstances is a sign of an under-perfused brain and should be seen as a sign of critical circulatory failure.

Carry out caesarean birth for pregnant women with antepartum haemorrhage, abruption or placenta praevia at a maternity unit with on-site blood transfusion service, as they are at an increased risk of blood loss of more than 1000mL.

NICE NG192 Caesarean birth (National Institute for Health and Care Excellence 2023a)

Early recognition of placenta praevia, adopting a multidisciplinary approach and informed consent are important considerations in the management of women with placenta praevia and previous caesarean delivery.

RCOG Green-top Guideline 45 (Royal College of Obstetricians and Gynaecologists 2015)

Previous caesarean delivery and the presence of an anterior low-lying placenta or placenta praevia should alert the antenatal care team of the higher risk of placenta accreta spectrum.

Women with a history of previous caesarean section seen to have an anterior low-lying placenta or placenta praevia at the routine fetal anomaly scan should be specifically screened for placenta accreta spectrum.

Early recourse to hysterectomy is recommended if conservative medical and surgical interventions to control haemorrhage prove ineffective.

RCOG Green-top Guideline 27a (Royal College of Obstetricians and Gynaecologists 2018)

After her return to the theatre for hysterectomy, the woman was not admitted to the intensive care unit (ICU) due to limited capacity, although the unit offered outreach support. Midwifery staff oversaw the woman's post-operative monitoring in the labour ward despite insufficient training in caring for arterial lines and staff shortages that prevented hourly observations as requested.

This is another example of "systems under pressure" that is a central theme in multiple sections of this report. The provision for recovery after anaesthesia for obstetric patients, especially those with complications such as this woman, should meet the same standards as in general recovery areas. Any escalation to critical care requires appropriately trained staff in the labour ward and clear pathways for referrals of maternity patients to the ICU. The care bundle for placenta praevia after previous caesarean section emphasises that there should be local availability of a level 2 critical care bed (Paterson-Brown and Singh 2010) and there should be contingency plans in place for any capacity restraints such as a lack of beds or availability of appropriately trained staff. The correct level of care should be provided regardless of location.

Provide post-operative care in a specialist recovery area (a high dependency unit, a post-anaesthesia care unit or an intensive care unit) for people with a high risk of complications or mortality.

NICE NG180 Peri-operative care in adults (National Institute for Health and Care Excellence 2020)

Assessors noted that neither of these women were counselled about contraception despite multiple, high-risk pregnancies.

5.6 Conclusions

Information was sufficient to assess care for all 32 women. Assessors felt that different care might have made a difference for 23 women (72%) (Table 5.2). Assessors observed that many of the messages for care were similar to those observed amongst women who died from haemorrhage, namely a need for early recognition, escalation and senior review and return to theatre for definitive management. Examples were observed again of "systems under pressure" and the importance of having a plan to access additional capacity in times when staff are dealing with multiple emergencies. It is important to re-emphasise that not all complications after repeat caesarean birth can be prevented, and review of the care of women who return to theatre may provide important safety learning; return to theatre should not be perceived as a performance metric. Metrics must be chosen appropriately and clearly communicated to ensure that they do not lead to delays in the correct management.

Table 5.2: Classification of care received by women who had a re-laparotomy after repeat caesarean birth

Classification of care received	Women who had a re-laparotomy after caesarean N=32 Number of women (%)
Good care	4 (13)
Improvements to care which would have made no difference to outcome	5 (16)
Improvements to care which may have made a difference to outcome	23 (72)

6. Messages for the prevention and treatment of infection

Steve Cantellow, Teresa Kelly, Allison Felker, Alison Rodger and Marian Knight on behalf of the MBRRACE-UK infection sepsis chapter-writing group

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6.1 Key messages

New recommendations

Ensure that pregnant and breastfeeding women are not excluded inappropriately from research, including new vaccine and treatment research, and ensure that messaging about benefits and risks of medication and vaccine use is clear and well informed with involvement of key opinion leaders and representatives of communities at risk from an early stage. Prepare a route to enable rapid dissemination of updated advice and data concerning new vaccines and treatments to both women and their clinicians in the future. **ACTION: Department of Health and Social Care and equivalents in Scotland, Wales and Ireland, UK Health Security Agency and equivalents in Scotland, Wales and Ireland, National Institute for Health Research and other funding agencies, Royal College of Obstetricians and Gynaecologists, Royal College of Midwives, Royal College of Physicians, Royal College of General Practitioners**

Update guidance on ECMO for severe acute respiratory failure in adults to include specific information on referral and admission of pregnant and recently pregnant women with respiratory failure to ECMO services. **ACTION: National Institute for Health and Care Excellence (NICE)**

Existing guidance and recommendations requiring improved implementation

At the first antenatal appointment discuss and give information on immunization for flu, pertussis, and other infections (including COVID-19) during pregnancy (National Institute for Health and Care Excellence 2021c).

Women who are pregnant, who are planning pregnancy or in the immediate postpartum should be recommended to receive COVID-19 immunisation (UK Health Security Agency 2020).

Inactivated influenza vaccine should be offered to pregnant women at any stage of pregnancy (UK Health Security Agency 2020).

Ensure care for pregnant and postpartum women with COVID-19 follows RCOG/RCM guidance (Knight, Bunch et al. 2021).

Ensure protocols for assessment and monitoring of pregnant women with COVID-19 in the community take account of known risk factors for severe disease in pregnancy (Knight, Bunch et al. 2021a).

Referrals to the NHS ECMO service should be made for pregnant women or women post-pregnancy using the same criteria as for other adult patients i.e. if worsening severe respiratory failure despite appropriate conventional ventilatory support, or for women in whom lung protective ventilation cannot be achieved because of the severity of hypoxaemia or hypercapnia, or significant air-leak (e.g. barotrauma or bronchopleural fistula) (Knight, Bunch et al. 2021a).

Take into account that women who are pregnant, have given birth or had a termination of pregnancy or miscarriage in the past six weeks are in a high-risk group for sepsis. In particular, women who have continued vaginal bleeding or an offensive vaginal discharge or who had prolonged rupture of membranes (National Institute for Health and Care Excellence 2016).

Genital tract sepsis may present with constant severe abdominal pain and tenderness unrelieved by usual analgesia, and this should prompt urgent medical review (Royal College of Obstetricians and Gynaecologists 2012a).

Community carers should be aware of the importance of early referral to hospital of recently delivered women who feel unwell and have pyrexia, and should be aware of the possibility of sepsis in the puerperium (Royal College of Obstetricians and Gynaecologists 2012b).

Infection must be suspected and actively ruled out when a recently delivered woman has persistent vaginal bleeding and abdominal pain. If there is any concern the woman must be referred back to the maternity unit as soon as possible (Royal College of Obstetricians and Gynaecologists 2012b).

Administration of intravenous broad spectrum antibiotics is recommended within one hour of suspicion of severe sepsis, with or without septic shock (Royal College of Obstetricians and Gynaecologists 2012a).

"Think sepsis" at an early stage when presented with an unwell pregnant or recently pregnant woman, take appropriate observations and act on them (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b).

All healthcare professionals should be aware of the symptoms and signs of maternal sepsis and critical illness and of the rapid, potentially lethal course of severe sepsis and septic shock (Royal College of Obstetricians and Gynaecologists 2012a).

The signs and symptoms of sepsis in pregnant women may be less distinctive than in the non-pregnant population and are not necessarily present in all cases; therefore, a high index of suspicion is necessary (Royal College of Obstetricians and Gynaecologists 2012a).

Monitoring of women with suspected severe sepsis or established sepsis should be multidisciplinary but preferably under the leadership of a single consultant. A senior obstetrician should be involved, in consultation with an intensivist, microbiologist or infectious disease clinician (Royal College of Obstetricians and Gynaecologists 2012b).

Ensure risk assessment and counselling in relation to extremely premature prelabour rupture of membranes includes consideration that there is a risk of maternal mortality and serious morbidity with impact on future pregnancies (Knight, Bunch et al. 2020b).

Suspicion of significant sepsis should trigger an urgent referral to secondary care (Royal College of Obstetricians and Gynaecologists 2012a).

There should be an urgent referral to the critical care team in severe or rapidly deteriorating sepsis, and the involvement of a consultant obstetrician (Royal College of Obstetricians and Gynaecologists 2012a).

The expert advice of a consultant microbiologist or infectious disease physician should be sought urgently when sepsis is suspected (Royal College of Obstetricians and Gynaecologists 2012a).

Women with sepsis in the puerperium are best managed in a hospital where diagnostic services are easy to access and intensive care facilities are readily available (Royal College of Obstetricians and Gynaecologists 2012b).

There should be adequate provision of appropriate critical care support for the management of a pregnant woman who becomes unwell. All consultant led delivery suites must have access to [level 2] critical care facilities that are appropriately equipped and staffed by teams of senior obstetricians, anaesthetists and midwives, skilled in looking after seriously ill women especially those with sepsis. Plans should be in place for provision of critical care on delivery units if this is the most appropriate setting for a woman with sepsis to receive care (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017).

Repeated presentation to the general practitioner or community midwife or alternatively repeated self-referral to the obstetric triage or day assessment unit should be considered a 'red flag' and warrant a thorough assessment of woman to investigate for signs of sepsis (Knight, Kenyon et al. 2014).

At each postnatal contact by a midwife, assess the woman's physical health. For women who have had a caesarean section assess wound healing and symptoms of wound infection (National Institute for Health and Care Excellence 2021b).

Consider initiating a multi-agency needs assessment, including safeguarding issues, so that the woman has a coordinated care plan (National Institute for Health and Care Excellence 2010).

Respect the woman's right to confidentiality and sensitively discuss her fears in a non-judgmental manner (National Institute for Health and Care Excellence 2010).

In order to facilitate discussion of sensitive issues, provide each woman with a one-to-one consultation, without her partner, a family member, or legal guardian present, on at least one occasion (National Institute for Health and Care Excellence 2010).

6.2 Background

Maternal infection from all causes remains a significant contributor to maternal mortality worldwide. In this triennium, infection continues to be one of the most frequent causes of maternal deaths. Pregnant women are uniquely at risk for infection as their immune system is modulated to support fetal development. They are also often exposed to a series of invasive procedures or surgery, which can further increase their risk of developing infection.

The COVID-19 pandemic has cast a spotlight on the susceptibility of pregnant women to infection and SARS-CoV-2 infection was the leading cause of maternal deaths in this triennium. The COVID-19 pandemic also exposed gaps in the healthcare system and created overwhelming pressures for services, systems and providers. Further, the pandemic reignited conversations around vaccination in pregnancy as confused messaging and public misinformation resulted in vaccine hesitancy, particularly in disadvantaged and minority groups. This is not unique to COVID-19, however, as just as in previous reports (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b), women are still dying from preventable diseases such as influenza. The need for consistent, coherent messaging and consultation on vaccination during pregnancy remains a recurring theme.

Other recurring themes in this report include the need to "think sepsis", the high-risk nature of preterm prelabour rupture of membranes and the importance of critical care and postnatal care.

6.3 The women who died

In the UK and Ireland 78 women died from sepsis during 2019 to 2021, defined in the broadest sense as death from a primary infective cause (Figure 6.1). Twenty-two of these women died more than 42 days after the end of pregnancy. This represents a maternal mortality rate from sepsis during or up to six weeks after pregnancy in the UK and Ireland of 2.50 per 100,000 maternities (95% CI 1.89 to 3.25 per 100,000).

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

In total, 16 women died from direct causes. Ten women died from genital tract sepsis: two women died from postnatal group A Streptococcus (GAS) infection, one after a miscarriage and one after an spontaneous vaginal birth; two women died following second trimester preterm prelabour rupture of the membranes, one from *E. coli* and one with no organism identified; three women died following a first trimester septic miscarriage, one caused by *E. coli, one Clostridium perfringens* and one an unknown organism; three further women died following chorioamnionitis at term. Two women died from sepsis after caesarean section. Two women died from intra-abdominal sepsis following feticide. One woman died from urinary sepsis and one from a uterine pyomyoma.

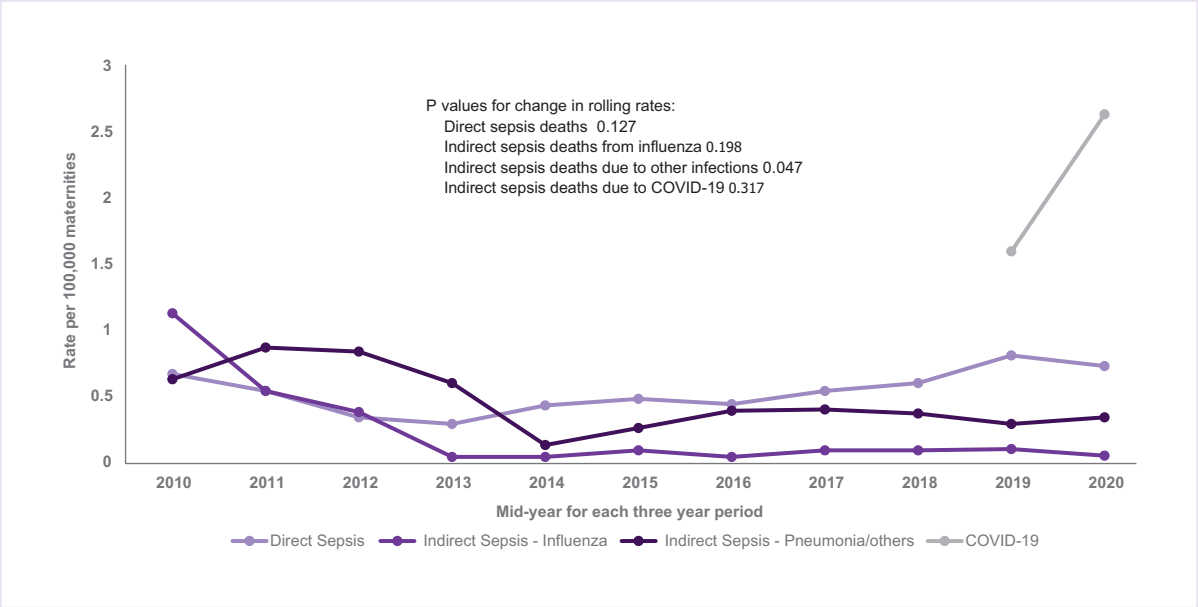
Sepsis due to indirect causes

In total, 62 women died due to indirect causes. Two women died from influenza, both from influenza A, and neither had received an influenza vaccine in pregnancy. One died during or up to six weeks after the end of pregnancy while the other died nearly a year after the end of pregnancy.

A total of 45 women died from COVID-19 pneumonitis between March 2020 and December 2021. Thirty-three of these women died during or up to six weeks after the end of pregnancy and a further 12 women died more than six weeks after the end of pregnancy. Five of these twelve women caught their infection during pregnancy or up to six weeks after pregnancy but had life-sustaining care lasting into the later postnatal period. Note that women with a coincidental SARS-CoV-2 infection, but who died from other causes are NOT included in these figures. There were no maternal deaths caused by SARS-CoV-2 vaccination.

Fifteen women died from other infections. Seven women died during or up to six weeks after the end of pregnancy: three women died from pneumonia (due to GAS, Pseudomonas and an unidentified viral infection); one woman died from GAS meningitis; one woman died from viral myocarditis; one from HIV; and one from disseminated staphylococcal infection. Eight women died from other causes of infection between six weeks and a year after the end of pregnancy: three women died due to pneumonia (one Pneumococcal, two unknown organisms); two from pneumococcal meningitis; one from varicella zoster; one from tuberculosis; and one from sepsis following a skin infection.

Figure 6.1: Maternal mortality rates from infectious causes, UK and Ireland 2019-21



6.4 Overview of care and new lessons to be learned

Vaccination

Neither woman who died from influenza had received influenza vaccination during pregnancy. Only one woman who died from COVID-19 pneumonitis had received any vaccine doses; she received a single dose of SARS-CoV-2 vaccine in the month before she died but would have been eligible to receive the vaccine six months prior to her death. She had asked about it several times during pregnancy.

An older ethnic minority woman, a long-term UK resident and English speaker, was admitted with COVID-19 pneumonitis in the third trimester of pregnancy four months after she became eligible for SARS-CoV-2 vaccination. She had received an influenza vaccination during pregnancy, but there was no record of SARS-CoV-2 vaccination ever having been discussed. She had an emergency caesarean birth but died a few weeks later.

A pregnant woman with known respiratory disease was eligible for SARS-CoV-2 vaccination early in the vaccination programme. Her respiratory physician advised her to contact her GP. SARS-CoV-2 vaccination was not discussed with her again until five months later, when she accepted it. She contracted COVID-19 and died shortly afterwards.

An extremely high-risk pregnant woman became eligible for SARS-CoV-2 vaccination very early in the vaccination programme. SARS-CoV-2 vaccination was discussed but she was undecided at this time. She died from COVID-19 pneumonitis three months later.

Twenty-seven women who died from COVID-19 pneumonitis were eligible for and could have received two doses of vaccine before they died. Some were documented to have received pertussis and/or influenza vaccines but either declined SARS-CoV-2 vaccination, or there was no documentation that SARS-CoV-2 vaccination had been discussed. Even late in the pandemic, discussion of SARS-CoV-2 vaccination was not documented, despite clear evidence of vaccination against other conditions being discussed and administered. The confused messaging due to lack of research evidence and consequent widespread vaccine hesitancy amongst clinicians and pregnant and postpartum women, notably amongst those from disadvantaged backgrounds and ethnic minority groups, has been well documented (Freeman, Loe et al. 2022, Mhereeg, Jones et al. 2022, Skirrow, Barnett et al. 2022, Stock, Carruthers et al. 2022). These women's deaths are evidence of the consequences. It is not clear, however, that plans are in place to prevent similar issues occurring in the future. Currently, three vaccinations, pertussis, influenza and SARS-CoV-2,

are recommended in pregnancy (National Institute for Health and Care Excellence 2021c) and it is likely that more vaccinations, for example for respiratory syncytial virus to produce immunity in the infant, will be recommended in pregnancy in the coming years. It is essential that the recommended vaccines are available in or close to antenatal clinics to allow easy access and to communicate the message that vaccination is safe and recommended during pregnancy. Vaccination has a major role in preventing maternal and neonatal illness and is an integral part of good antenatal care.

Ensure that pregnant and breastfeeding women are not excluded inappropriately from research, including new vaccine and treatment research, and ensure that messaging about benefits and risks of medication and vaccine use is clear and well informed with involvement of key opinion leaders and representatives of communities at risk from an early stage. Prepare a route to enable rapid dissemination of updated advice and data concerning new vaccines and treatments to both women and their clinicians in the future N

At the first antenatal appointment discuss and give information on immunisation for flu, pertussis, and other infections (including COVID-19) during pregnancy (National Institute for Health and Care Excellence 2021c)

Women who are pregnant, who are planning pregnancy or in the immediate postpartum should be recommended to receive COVID-19 immunisation (UK Health Security Agency 2020)

Inactivated influenza vaccine should be offered to pregnant women at any stage of pregnancy (UK Health Security Agency 2020)

Extracorporeal Membrane Oxygenation (ECMO)

An unvaccinated woman was admitted with worsening COVID-19 in the late second trimester of pregnancy. She had been eligible for vaccination for several months but there was no documented discussion about SARS-CoV-2 vaccination in her records. She underwent a category 3 caesarean birth in the late evening. She appeared to be improving initially, self-ventilating on high flow nasal oxygen but had a respiratory rate of 40-50 with worsening oxygen saturations, so non-invasive ventilation was commenced. She developed pneumomediastinum and a pneumothorax. On day five postnatally, an ECMO referral was declined because the ECMO team felt that maximal ventilation had not been achieved, so she was intubated and ventilated. When she deteriorated further and re-referral for ECMO was made, she was declined again because she had been ventilated for eight days by that point. Her condition continued to deteriorate, and she died of COVID-19 pneumonitis three weeks after giving birth.

The care and advice women received with regards to ECMO was highly variable, both amongst women who died from COVID-19 pneumonitis and from other causes of respiratory failure considered in different sections of this report, such as pancreatitis. Some women were never referred for consideration of ECMO. Some were referred and advised that it was too early in the course of their illness for ECMO to be considered, and then were re-referred, as for this woman, to be told that they were now too unwell or had received mechanical ventilation with high levels of inspired oxygen for seven days or more and so were no longer eligible according to referral criteria at the time. Others were referred very late in the course of their disease, at which stage the ECMO centre teams felt that they would be unlikely to benefit. This was coupled with ongoing highly variable medical management of COVID-19, with pregnant and recently pregnant women denied basic evidence-based medical treatments such as steroids and tocilizumab for COVID-19 (Horby, Lim et al. 2021, RECOVERY Collaborative Group 2021) simply because of pregnancy. There was significant uncertainty amongst medical teams not familiar with care of unwell pregnant and lactating women, with respect to both imaging and treatments. The role and value of ECMO, as well as medical management of COVID-19, once again illustrates the challenges in communication across specialties and geographical sites, which impacts negatively on care for pregnant women. Clear guidance concerning the management of COVID-19 in pregnancy existed (Royal College of Obstetricians and Gynaecologists and The Royal College of Midwives 2022), and a consensus statement concerning the referral and admission of the general population to the NHS ECMO service has been published (Camporota, Meadows et al. 2021). However, the highly variable practice observed after publication of these guidelines indicates that they are not applied equitably to pregnant and recently pregnant women. Data on COVID-19 from the Extracorporeal Life Support Organization registry suggests that pregnant women are more likely to need ECMO but are also more likely to survive to discharge (O'Neil, Lin et al. 2022, Byrne, Shamshirsaz et al. 2023). Data from the previous viral pneumonitis pandemic (influenza A H1N1) also show that maternal survival (75%) and live birth rate (70%) is good following ECMO (Saad, Rahman et al. 2016).

Update guidance on ECMO for severe acute respiratory failure in adults to include specific information on referral and admission of pregnant and recently pregnant women with respiratory failure to ECMO services **N**

6.5 Recurring lessons to be learned

Treatment of COVID-19 in pregnancy

Early in the COVID-19 pandemic, the RCOG worked alongside the Royal College of Midwives (RCM), the Royal College of Paediatrics and Child Health, the Royal College of Anaesthetists and the Obstetric Anaesthetists Association to establish and provide guidance on the management of SARS-CoV-2 infection in pregnancy. The first guidance materials were published on 9th March 2020 and updated rapidly as new evidence and guidance emerged. Each version was accompanied by a summary of changes for quick reference, and widely publicised to professional networks. All guidance produced was done so after detailed literature review and connections with UK-based research teams and the MBRRACE-UK collaboration. As such, this guidance was, and remains, the single definitive national source of evidence-based care guidance for pregnant and breastfeeding women and COVID-19 (Royal College of Obstetricians and Gynaecologists and The Royal College of Midwives 2022).

As highlighted in previous MBRRACE-UK rapid reports into COVID-19 related and associated maternal deaths (Knight, Bunch et al. 2021a), many of the women who died from complications of COVID-19 were not managed according to RCOG/RCM guidelines. As highlighted above, the care women did receive was typically inappropriate due to a lack of understanding of what interventions and treatments, such as steroids, tocilizumab or ECMO, could be used in pregnancy (Horby, Lim et al. 2021, RECOVERY Collaborative Group 2021, Royal College of Obstetricians and Gynaecologists and The Royal College of Midwives 2022). While obstetricians, obstetric physicians, obstetric anaesthetists and midwives should all be aware of the existing RCOG/RCM guidance, it is imperative that clinicians in all areas of the hospital are made aware that evidence-based guidance does exist for the care of pregnant women with COVID-19. If there is any uncertainty with regard to treatment, they should also know which members of the multidisciplinary maternity team to call for advice. Maternal medicine networks (MMN) can assist in providing this advice.

Ensure care for pregnant and postpartum women with COVID-19 follows RCOG/RCM guidance (Knight, Bunch et al. 2021a)

Ensure protocols for assessment and monitoring of pregnant women with COVID-19 in the community take account of known risk factors for severe disease in pregnancy (Knight, Bunch et al. 2021a)

Referrals to the NHS ECMO service should be made for pregnant women or women post-pregnancy using the same criteria as for other adult patients i.e. if worsening severe respiratory failure despite appropriate conventional ventilatory support, or for women in whom lung protective ventilation cannot be achieved because of the severity of hypoxaemia or hypercapnia, or significant air-leak (e.g. barotrauma or bronchopleural fistula) (Knight, Bunch et al. 2021a)

Think sepsis

This report highlights, as in previous reports, the necessity of early recognition and treatment of sepsis (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b).

A woman had a vaginal birth with one episode of pyrexia and tachycardia in labour that resolved postnatally. After discharge she complained of increasing abdominal pain, which was attributed by her community midwife to after pains. Her partner contacted her GP the same day and the woman was prescribed analgesia without further examination. Her partner later called an ambulance due to increased pain. On arrival of the ambulance her BP was unrecordable. The paramedic thought she had sepsis but on arrival in the emergency department she was treated for a PPH despite a high temperature, tachycardia, tachypnoea, vaginal discharge and modest vaginal bleeding. Sepsis was finally considered and the sepsis bundle initiated three hours after her arrival in hospital. She deteriorated rapidly and died from group A Streptococcus infection.

This woman's symptoms were dismissed in favour of a simple explanation, as has been frequently observed in these reports. After pains typically reduce in the hours following childbirth and do not develop after discharge. Pain after a vaginal birth that does not settle with simple analgesia should prompt a face to face review and a clinical examination including both abdominal and vaginal examination if indicated. This woman's general practitioner (GP) should not have prescribed analgesics without a more thorough review and examination.

Take into account that women who are pregnant, have given birth or had a termination of pregnancy or miscarriage in the past six weeks are in a high-risk group for sepsis. In particular, women who have continued vaginal bleeding or an offensive vaginal discharge.

NICE NG51 Sepsis: recognition, diagnosis and early management (National Institute for Health and Care Excellence 2016)

Genital tract sepsis may present with constant severe abdominal pain and tenderness unrelieved by usual analgesia, and this should prompt urgent medical review.

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

Community carers should be aware of the importance of early referral to hospital of recently delivered women who feel unwell and have pyrexia, and should be aware of the possibility of sepsis in the puerperium.

Infection must be suspected and actively ruled out when a recently delivered woman has persistent vaginal bleeding and abdominal pain. If there is any concern the woman must be referred back to the maternity unit as soon as possible.

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

A common recurring theme identified in many women whose care was reviewed for this report was a need to initiate antibiotics early when there are signs of sepsis, as should have been the case for this woman. The need for antibiotics should be reviewed regularly, at least daily. With regular review, they can be stopped if a bacterial infection has been excluded. There was evidence of many women who had sepsis red flags that were not acted on. For example, paracetamol was often given early for tachycardia or mild pyrexia, but antibiotics were delayed in women with clear signs of sepsis. It should be remembered that paracetamol will reduce a pyrexia and may help pain, but it will not modify the underlying cause of the pyrexia. Infection should be considered as the cause and investigated and treated.

Administration of intravenous broad spectrum antibiotics is recommended within one hour of suspicion of severe sepsis, with or without septic shock.

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

Emergency department staff assumed this woman was having a PPH because of her moderate vaginal bleeding. This was despite suspicions of sepsis being raised by the paramedic and without any further assessment of blood loss or a vaginal examination to confirm the diagnosis or cause of the bleeding.

In other women whose care was reviewed, confirmation bias also contributed to misdiagnoses and delayed identification of sepsis. There was evidence, for instance, of the attribution of symptoms of sepsis to other causes, such as vomiting occurring for the first time late in pregnancy being attributed to hyperemesis rather than an infection. Assessors also noted that, in some instances, a narrow clinical view meant that specialists only contributed to care according to their expertise without taking any action to clinically assess the situation. For example, an anaesthetist declined to administer an epidural for one woman's pain relief in labour because of leukocytosis without any attempt to assess the underlying cause.

The importance of obtaining a full clinical history and examination of possible sources of infection has been emphasised in past reports (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b). In all instances where there have been changes in condition, new symptoms or deterioration in women with a recent pregnancy, there should be a structured approach to ward review to seek, investigate and diagnose the cause of altered clinical status or abnormal observations. The UK Sepsis Trust has developed specific maternal sepsis toolkits that should be used to assess all women who are pregnant or within six weeks of their pregnancy who have a suspected infection or have altered or abnormal clinical observations (UK Sepsis Trust 2016).

"Think sepsis" at an early stage when presented with an unwell pregnant or recently pregnant woman, take appropriate observations and act on them (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b)

All healthcare professionals should be aware of the symptoms and signs of maternal sepsis and critical illness and of the rapid, potentially lethal course of severe sepsis and septic shock.

The signs and symptoms of sepsis in pregnant women may be less distinctive than in the non-pregnant population and are not necessarily present in all cases; therefore, a high index of suspicion is necessary.

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

Assessors noted that a number of women did not have appropriate involvement of senior clinicians and there was a lack of effective communication between specialists and at handover. The role of senior staff is vital in managing critically ill pregnant women. Their role is to step back and provide a "helicopter view" of the situation in order to guide staff and prioritise investigation and management. Often staff have to deal with more than one complex clinical situation at a time, which makes this role invaluable when providing comprehensive, safe care.

Using a tool such as SBAR (Situation-Background-Assessment-Recommendation) to refer a patient to another team or at handover between teams allows for communication to be structured and has been shown to increase patient safety (Müller, Jürgens et al. 2018). Its use should not be confined to nurses and midwives as it is likely to improve communication between specialists as well as between community and specialist teams. Additionally, closed-loop communication helps minimise medical error and encourages team collaboration. It has been shown to have a positive impact when used in obstetrics (Lippke, Derksen et al. 2021).

Monitoring of women with suspected severe sepsis or established sepsis should be multidisciplinary but preferably under the leadership of a single consultant. A senior obstetrician should be involved, in consultation with an intensivist, microbiologist or infectious disease clinician.

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

Preterm prelabour rupture of membranes

A woman who had conceived following assisted reproduction had premature rupture of membranes at 22 weeks gestation. After a delay in review, she was transferred to a tertiary unit with a neonatal intensive care facility. Upon arrival, the risks to the baby of premature birth were discussed extensively with her but the risks to her of serious infection were not discussed. She opted to delay birth. More than two days after her membranes ruptured, she developed signs of sepsis. The consultant was informed, but it was three hours before she was reviewed. Her white cell count was raised, which was attributed to steroids. Minutes later she had a temperature of 39°C and MEOWS of 5; she was transferred to the labour ward where the sepsis pathway was started but delivery was not expedited. A few hours later she had a spontaneous vaginal birth. Her condition continued to deteriorate and she died less than 12 hours after her symptoms of infection started. A placental swab grew *E. coli*.

Premature rupture of membranes carries a high risk of infection. This woman's family stated that the risks of continuing the pregnancy were never explained to her and she opted to delay birth to try and achieve viability for her baby. While the conversation around whether to continue a pregnancy with preterm prelabour rupture of membranes, especially at the limits of viability, is a difficult one, it should be recognised that a fetus is unlikely to survive chorioamnionitis. Thus, while the decision to end a pregnancy can be difficult, the woman and her family should be counselled on both the risk of serious maternal morbidity and mortality and the survival chances for a baby if the pregnancy continues. Women must be given the option of ending the pregnancy promptly if sepsis is suspected.

Ensure risk assessment and counselling in relation to extremely premature prelabour rupture of membranes includes consideration that there is a risk of maternal mortality and serious morbidity with impact on future pregnancies (Knight, Bunch et al. 2020b)

The NICE quality standard on emergency and acute medical care in over 16s (National Institute for Health and Care Excellence 2018) recommends that consultants assess adults face to face as soon as possible and always within 14 hours of hospital admission. Consultant review should be carried out daily including weekends and bank holidays. In maternity, this should apply to women admitted with pregnancy and postnatal complications and should include those not fit for discharge 24 hours after giving birth. Consultant ward rounds should include postnatal wards, which would reduce the delays in care seen postnatally. Consultant review is associated with a reduction in length of stay. Thus, while it may appear that services do not have the resources to allocate consultants to fulfil this standard, ensuring compliance is likely to improve patient flow, clinical safety and patient experience.

In this woman and others, there was a lack of urgency in delivering women at risk of sepsis who then deteriorated. Clinicians should be mindful that women with prolonged rupture of membranes or long induction of labour are at risk of infection because of interventions such as multiple vaginal examinations, or invasive procedures such as fetal scalp electrodes or cervical ripening balloons. Delaying delivery when women are well but have signs of sepsis, has little advantage and may lead to avoidable clinical deterioration.

Take into account that women who are pregnant, have given birth or had a termination of pregnancy or miscarriage in the past six weeks are in a high-risk group for sepsis. In particular, women who had prolonged rupture of membranes.

NICE NG51 Sepsis: recognition, diagnosis and early management (National Institute for Health and Care Excellence 2016)

Escalation, co-location of intensive care and maternity and transfer

A recurring theme identified by reviewers was that of hospital sites and services struggling in the face of significant demands, revealing vulnerabilities in the existing provisions for deteriorating and critically unwell maternity patients. There were several instances where the combination of being pregnant and being critically unwell appeared to confer a distinct disadvantage compared to the general adult population.

The importance of coherent care with women's needs placed at the centre was a recurring theme in the reviews and emphasises a need to ensure equity in facilities and services; this entails the right specialities available at a woman's point of care, timely senior review within and between teams and between services, such as specialists and community care.

A young primiparous woman had a caesarean section for failure to progress after induction of labour. She showed evidence of infection during labour including mild pyrexia and tachycardia treated with IV paracetamol. Post-caesarean, she developed puerperal sepsis requiring ICU care for organ support. After initial improvement, she was transferred to a different hospital for ongoing management of a persistent renal injury. She subsequently deteriorated further, and despite escalating efforts to achieve source-control culminating in a hysterectomy, she eventually died from multiorgan failure.

Maternal survival in sepsis is dependent on early recognition of clinical deterioration along with early diagnosis, treatment and organ support. For this to happen effectively, there must be clear processes for escalation, rapid senior multidisciplinary review, accessible critical care facilities and appropriately trained staff to look after women when critical illness is established. Once admitted to the ICU, it is essential that robust procedures are in place to ensure readiness for any obstetric emergencies that may occur. The woman described above was suspected of having retained products of conception, which resulted in her returning to the theatre three times culminating in a total abdominal hysterectomy when the uterus was found to be necrotic. Had this been undertaken earlier it may have altered the trajectory of her illness and prevented her death.

It should be remembered that where infection is suspected in a woman who is pregnant or who may have retained products of conception, definitive treatment involves promptly emptying the uterus. Women who are suspected of having infected retained products of conception should be given antibiotics and an evacuation performed promptly.

The value of having critical care co-located with maternity services cannot be overemphasised. In one woman, the physical distance between critical care facilities resulted in considerable challenges in being able to respond to an obstetric emergency. This is reminiscent of previous instances in earlier triennia, where patient deterioration occurred "in the wrong place." It is essential to have robust plans and systems in place to allow for safe transfer and to ensure that maternity services can be delivered to women after they are admitted to the ICU or when they are awaiting transfer to the ICU, regardless of location. While they uncommonly occur on the ICU, birth, haemorrhage and maternal cardiac arrest are predictable events in the obstetric population and it is important to be prepared with rapid access to

appropriately skilled teams along with the correct equipment, drugs and the ability to promptly perform a caesarean section or hysterotomy. Where critical care staff are deployed to the maternity unit or maternity staff are deployed to the ICU, robust lines of support must be in place.

In several instances, the transfer of critically unwell women was not well documented, both in terms of the decision-making stage and the conduct of transfer itself. A multidisciplinary team with expertise in obstetrics, obstetric anaesthesia, critical illness, transfer medicine and the relevant organ specialty should all be involved in carefully evaluating the risks and benefits involved. The transfer itself needs appropriate preparation to avoid predictable pitfalls. A detailed handover between all clinical teams involved in care is essential and can help reduce delays in advancing patient care upon arrival. Intra-hospital and cross-site transfers require practices as stringent as inter-facility transfers. Whenever prolonged critical care is anticipated for maternity patients, consultation with a supra-regional unit specialising in maternal critical care can be beneficial. Though transfer to a regional centre is not always the best option, it should be actively considered for pregnant or recently patients requiring ventilation beyond 48 hours (Maternal Critical Care/Enhanced Maternity Care Standards Development Working Group 2018). Equally, input and support from the regional centre can be beneficial where transfer is either not feasible or appropriate.

Suspicion of significant sepsis should trigger an urgent referral to secondary care.

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 sepsis is suspected.

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

Women with sepsis in the puerperium are best managed in a hospital where diagnostic services are easy to access and intensive care facilities are readily available.

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

There should be adequate provision of appropriate critical care support for the management of a pregnant woman who becomes unwell. All consultant led delivery suites must have access to [level 2] critical care facilities that are appropriately equipped and staffed by teams of senior obstetricians, anaesthetists and midwives, skilled in looking after seriously ill women especially those with sepsis. Plans should be in place for provision of critical care on delivery units if this is the most appropriate setting for a woman with sepsis to receive care (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017)

Care after invasive procedures including termination of pregnancy

Two women died after an invasive feticide procedure conducted as part of a late termination of pregnancy. An invasive procedure, a termination of pregnancy, or delays in the induction process should be considered amber flags for sepsis in women who are unwell, even if the symptoms are not immediately suggestive of infection (National Institute for Health and Care Excellence 2016). Both women had signs of sepsis but the response was delayed and the importance of source control, through emptying the uterus, was not recognised.

Confirmation bias

A woman had an early medical termination of pregnancy. She saw her GP a few days after the procedure feeling unwell with heavy vaginal bleeding. She was tachycardic and her white cell count was raised. She was thought to have COVID -19. A further week later she called her GP with nausea, pain, myalgia and fever. No treatment was given by the GP on either occasion. The following day she attended the emergency department where she was found to be severely neutropenic. Despite attempts to treat her, she deteriorated rapidly and died from a group A Streptococcus infection.

In this woman, the signs of infection following termination of pregnancy were not recognised by her GP. Had she been given appropriate antibiotics or been referred to secondary care on her first or second presentation the outcome may have been different. As has been repeatedly described in this chapter, many of this woman's initial symptoms were wrongly attributed to another cause, possible COVID-19 in this instance.

The need for pregnant and recently pregnant women to have prompt access to GP care in addition to an appropriate triaging assessment has been emphasised in previous reports (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b). The importance of clinical examination in all settings should not be underestimated.

Pregnant and recently pregnant women are generally young and fit and they will often not seek medical review unless their symptoms are significant. It must be remembered that there can be a narrow window of opportunity to investigate and treat younger patients who tend to compensate, despite significant illness, before they deteriorate rapidly.

In the majority of instances, it is inappropriate for antibiotics to be prescribed without a face to face review. Assessment by telephone does not allow for proper observations to be taken and can lead to women with significant pathology being overlooked because they have vague symptoms or because they are compensating as young and fit adults. The reviewers commented on barriers faced by women accessing care in the community due to limited primary care resources. Pregnancy should be recognised as a significant risk factor for infection, which should prompt timely face to face review.

In the women reviewed for this report who had deaths attributed to GAS, better management is likely to have made a difference to their outcome. Group A Streptococcus is a virulent organism that is a rare but devastating cause of puerperal sepsis (Hughes 2019). It often presents with vague symptoms, thus primary care clinicians should have a low threshold for treating women who are ill and pregnant or recently pregnant. They should make early referrals to hospital where clinicians need to be aware that early treatment with antibiotics can prevent progression to septic shock.

Take into account that women who are pregnant, have given birth or had a termination of pregnancy or miscarriage in the past six weeks are in a high-risk group for sepsis.

NICE NG51 Sepsis: recognition, diagnosis and early management (National Institute for Health and Care Excellence 2016)

Repeated presentation to the general practitioner or community midwife or alternatively repeated self-referral to the obstetric triage or day assessment unit should be considered a 'red flag' and warrant a thorough assessment of woman to investigate for signs of sepsis. (Knight, Kenyon et al. 2014)

Postnatal care

An obese woman presented to a maternity unit seven days after her third caesarean birth with concerns about her wound. No observations were taken. Her wound was described as being bruised but there was no comparison with what her wound looked like previously. A different midwife reviewed her wound at home the following day and again no comparisons were made with the wound's previous appearance. Two weeks after she gave birth, she became moribund and was taken to the emergency department where assessment and treatment was prompt. The source of the sepsis was thought to be her caesarean wound and necrotising fasciitis was identified. She died from multiorgan failure less than 36 hours after admission.

The woman above was in her fourth pregnancy and had other children with complex needs. When postnatal women attend before a planned review, leaving a baby or other children at home, it is likely that they have real concerns that should help inform any assessment. It is unlikely that a wound will become bruised a week after surgery without an underlying cause, thus comparison with previous observations should be made. Women often have pictures of their wounds if they have concerns or they can describe the course of the change if asked about it. Healthcare professionals should also document the appearances of a wound when assessing it to allow other staff to compare any reported changes.

At each postnatal contact by a midwife, assess the woman's physical health. For women who have had a caesarean section assess wound healing and symptoms of wound infection.

NICE NG194 Postnatal care (National Institute for Health and Care Excellence 2021b)

Vulnerable women

There were many women reviewed for this report who had one or several indicators of vulnerability, including women with a history of drug use, mental health problems, migrant women, women from minority groups and the socially vulnerable. There was evidence in the reviews that vulnerable women were not listened to leading to inappropriate care and general distrust and reluctance to seek further support. Safety netting needs to involve easily accessible and effective interventions and support systems with clear guidance for clinicians on what advice to give and how it should be delivered. Vulnerable women need and should be provided with more support during and after their pregnancy with the aim of modifying their risks and improving their outcomes.

An older woman died from influenza ten months after giving birth. She had a complex history including previous IV drug abuse, which had been stabilised with methadone, sexual abuse in childhood and sexual assault. There was no record of her being offered an influenza vaccine in pregnancy despite her being eligible.

This woman had a complex social, mental and physical history with several comorbidities. An influenza vaccination in pregnancy may have given her some protection from influenza; however, the reviewers recognised that she contracted influenza in a different flu season and vaccination may not have been as effective. Pregnancy is an opportunity for health promotion particularly for vulnerable women with socially complex lives. Smoking cessation, weight loss and vaccination are important health interventions that reduce the risk of premature death and protect both the woman and the child.

Comprehensive antenatal care should include integrated public health interventions as it is a time of concentrated contact with healthcare professionals. Women are often motivated to make changes during pregnancy especially if they perceive that there is a benefit to their child. A single conversation with a woman is rarely enough to effectively address the significant obstacles that vulnerable women have. Instead the conversation should be continuous at each point of contact with awareness of a woman's vulnerabilities.

Consider initiating a multi-agency needs assessment, including safeguarding issues, so that the woman has a coordinated care plan.

Respect the woman's right to confidentiality and sensitively discuss her fears in a non-judgmental manner.

In order to facilitate discussion of sensitive issues, provide each woman with a one-to-one consultation, without her partner, a family member, or legal guardian present, on at least one occasion.

NICE CG110 Pregnancy and complex social factors: a model for service provision for pregnant women with complex social factors (National Institute for Health and Care Excellence 2010)

6.6 Conclusions

The importance of comprehensive care with women's needs placed at the centre was a recurrent theme in the reviews; this entails the right specialities available at her point of care, timely senior involvement and senior "helicopter view". Another element was the importance of communication, within and between teams and between services, such as specialist and community care.

The following messages echo previous reports: act on 'red flag' signs of sepsis at presentation or during the course of the disease (UK Sepsis Trust 2016) and consider early initiation of antibiotic treatment, and then discontinue if bacterial infection is not confirmed. The reviewers emphasised the importance of recognising symptoms of infection after invasive procedures and also in planned or prolonged induction (National Institute for Health and Care Excellence 2016). Pregnant and recently pregnant women also need access to GP care and triage in the community, and the reviewers stressed that clinical examination is important in all settings (National Institute for Health and Care Excellence 2016). Information was sufficient to assess care for all 78 women. Assessors felt that different care might have made a difference for 51 women (65%) (Table 6.1).

Table 6.1: Classification of care received by women who died from infectious causes, UK and Ireland, 2019-21

Classification of care received	Women who died from COVID-19 Number (%) N=45	Women who died from other indirect infectious causes Number (%) N=17	Women who died from direct infectious causes Number (%) N=16
Good care	3 (7)	2 (12)	0 (0)
Improvements to care which would have made no difference to outcome	8 (18)	10 (59)	4 (25)
Improvements to care which may have made a difference to outcome	34 (76)	5 (29)	12 (75)

7. Messages for the care of women with general medical and surgical conditions

Cathy Nelson-Piercy, Roshni Patel, Rachel Mathers, Allison Felker and Marian Knight on behalf of the MBRRACE-UK general medical and surgical conditions chapter-writing group

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7.1 Key messages

New recommendations

Ensure that staff working within maternal medicine networks are equipped with the skills to care for the complex and multiple medical, surgical, mental health and social care needs of the current maternity population. **ACTION: Maternal Medicine Networks**

Ensure that guidance on care for pregnant women with complex social factors is updated to include a role for networked maternal medical care and postnatal follow-up to ensure that it is tailored to women's individual needs and that resources in particular target vulnerable women with medical and mental health comorbidities and social complexity. **ACTION: National Institute for Health and Care Excellence (NICE)**

Existing guidance and recommendations requiring improved implementation

Consider initiating a multi-agency needs assessment, including safeguarding issues so that women with complex social factors have coordinated care plans (National Institute for Health and Care Excellence 2010).

Women with multiple and complex problems require additional care following discharge from hospital after birth and there is a need for senior review prior to discharge, with a clear plan for the postnatal period. This review should include input from obstetricians and all relevant colleagues (Knight, Nair et al. 2017).

Women with complex physical and/or psychological comorbidities need care before, during, and after pregnancy; their health and medication should ideally be optimised before considering pregnancy; and they must be offered contraception and continuing care after and between pregnancies (Shakespeare, Duff et al. 2022).

Inpatient care [for nausea and vomiting in pregnancy and hyperemesis gravidarum] should be considered if there is at least one of the following: continued nausea and vomiting and inability to keep down oral antiemetics; continued nausea and vomiting associated with clinical dehydration or weight loss (greater than 5% of body weight), despite oral antiemetics; confirmed or suspected comorbidity (such as urinary tract infection and inability to tolerate oral antibiotics); or comorbidities such as epilepsy, diabetes, or HIV, where symptoms and inability to tolerate oral intake and medication could present further complications (Royal College of Obstetricians and Gynaecologists 2016b, Royal College of Obstetricians and Gynaecologists 2023).

For women with persistent or severe hyperemesis gravidarum, the parenteral, transdermal, or rectal route may be necessary and more effective than an oral regimen (Royal College of Obstetricians and Gynaecologists 2016b, Royal College of Obstetricians and Gynaecologists 2023).

In pregnant or postpartum women with complex medical problems involving multiple specialties, the responsible consultant obstetrician or physician must show clear leadership and be responsible for coordinating care and liaising with anaesthetists, midwives, other physicians, and obstetricians and all other professionals who need to be involved in the care of these women (Knight, Nair et al. 2017).

There should be policies defining how women are referred to and access specialist or tertiary services (e.g. neurosurgery, acute stroke services) (Royal College of Anaesthetists 2023).

Women who become acutely unwell during pregnancy, labour and the postnatal period should have immediate access to critical care, of the same standard as other sick patients, irrespective of location (Royal College of Anaesthetists 2018).

Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care (Knight, Bunch et al. 2022).

The emphasis should be on making a diagnosis, not simply excluding a diagnosis (Knight, Nair et al. 2016).

Monitor pregnant women with moderate/severe asthma closely to keep their asthma well controlled (Scottish Intercollegiate Guidelines Network 2019).

Acute severe asthma in pregnancy is an emergency and should be treated vigorously in hospital (Scottish Intercollegiate Guidelines Network 2019).

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

The development of maternal medicine specialist centres as a regional hub and spoke model must be an urgent national priority to allow early discussion of complex maternity cases with expert clinicians (Ockenden 2022).

High level actions are needed to ensure that it is seen as the responsibility of all health professionals to facilitate opportunistic counselling and appropriate framing of the advice when women attend any appointment, and that resources for pre- and post-pregnancy counselling are provided, together with open access to contraception services (Knight, Nair et al. 2017).

Services providing care to pregnant women should be able to offer all appropriate methods of contraception, including Long-Acting Reversible Contraception (LARC), to women before they are discharged from the service (The Faculty of Sexual and Reproductive Healthcare 2017).

Women of reproductive age presenting to the emergency department collapsed, in whom a pulmonary embolism is suspected, should have a Focused Assessment with Sonography in Trauma (FAST) scan to exclude intra-abdominal bleeding…especially in the presence of anaemia (Knight, Nair et al. 2016).

7.2 Background

This chapter examines in detail the care of women who died from general medical and surgical disorders with the exception of women who died from cardiac disease, malignancy, neurological disorders, mental health conditions and sepsis, which are considered either within separate chapters of this report or in other MBRRACE-UK reports during the triennial cycle (Knight, Bunch et al. 2021b, Knight, Bunch et al. 2022). General medical and surgical conditions are not infrequent among pregnant and recently pregnant women. Given the breadth of conditions described in this chapter it is important to disseminate learning from this report beyond the maternity community of practitioners to reach people caring for these women in general practice, surgery, emergency departments and other specialities. Pregnant and lactating women with co-morbidities should receive the same level of care as non-pregnant women unless there is a clear reason not to (Knight, Bunch et al. 2022).

7.3 The women who died

Twenty-one women died in the UK and Ireland between 2019-21 during pregnancy or up to 42 days after pregnancy from general medical and surgical conditions not considered elsewhere (“other indirect causes”) (Table 7.1). This represents an overall mortality rate of 0.94 (95% CI 0.58-1.43) 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.

Fourteen women died from endocrine causes: eight had diabetes, five of whom died from diabetic ketoacidosis, one from hypoglycaemia and two from long-term complications of diabetes; two died from Addison’s disease; other women died from a phaeochromocytoma, hyponatraemia, metabolic myopathy and severe hypertension. Six women died while pregnant or within six weeks after the end of pregnancy.

Seven women died due to haematological causes: three women died due to thrombotic thrombocytopenic purpura (TTP); two due to haemophagocytic lymphohistiocytosis (HLH); other women died from a thrombotic microangiopathy, and occlusive vasculopathy. Five women died while pregnant or within six weeks after the end of pregnancy.

Table 7.1: 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, 2019-21

Cause of Death	Number of women (%) (N=43)
Connective tissue	2 (5)
Endocrine	14 (33)
Gastrointestinal	6 (14)
Haematological	7 (16)
Respiratory	5 (12)
Intra-abdominal bleeding	6 (14)
Unascertained	3 (7)

Two women died from connective tissue disorders, both between six weeks and a year after the end of pregnancy. Five women died from respiratory disorders: four from asthma and one from interstitial lung disease; two women died while pregnant or within six weeks after the end of pregnancy. Six women died from gastrointestinal disorders: four from pancreatitis; other women died from bowel perforation and autoimmune hepatitis; all these women died between six weeks and a year after the end of pregnancy. Six women died from spontaneous intra-abdominal bleeding: four due to splenic artery aneurysmal rupture and two from other bleeding sources; all these women died while pregnant or within six weeks after the end of pregnancy. The causes of death of three women were unascertained, largely due to absent or low-quality post-mortem examination, but felt most likely to be due to indirect causes by assessors. Two of these women died while pregnant or within six weeks after the end of pregnancy.

7.4 Overview of care and new lessons to be learned

Complex care needs

A primiparous woman was known to have adrenal insufficiency prior to pregnancy. She had admissions with adrenal crises before pregnancy and several documented episodes in pregnancy. She saw her endocrinologist regularly who increased her medication and ensured a supply of emergency hydrocortisone. The endocrinologist documented repeatedly that she had severe nausea and vomiting from early in the first trimester. No plan was made for comprehensive antiemetic therapy despite the fact she was unable to keep her oral medication down on multiple occasions. There was minimal communication between the obstetric and endocrine teams. She had an uneventful labour and birth and was discharged the following day despite low sodium levels, a marker of poorly-controlled Addison's disease. She had various concerning symptoms postnatally, including further episodes of nausea and vomiting. She died from an adrenal crisis shortly after being discharged to community midwifery care.

The local hospital review identified that the lack of a local joint endocrinology-obstetric clinic adversely impacted this woman's care. Her endocrine care was provided remotely and communication between teams did not occur in a timely manner. A woman having repeated Addisonian crises in pregnancy should have had urgent endocrine review and potentially admission. Her death pre-dates development of MMNs; women with similar problems should now receive joint endocrine and obstetric care at a maternal medicine centre. Vomiting is a red flag in Addison's disease and needs to be urgently managed. Despite being very unstable, this woman was discharged postnatally with a plan for endocrinology review at 6-8 weeks, by which time she had died. The significance of her symptoms was not recognised either during pregnancy, or postnatally when she was discharged to community midwifery care.

Assessors noted that on many occasions midwives were expected to care for vulnerable women with complex and multiple conditions, including in recovery from theatre, when they had not been trained to do so. The severity of women's illnesses was therefore unrecognised. Midwifery training needs to match the complexity of the current maternity population.

Ensure that staff working within maternal medicine networks are equipped with the skills to care for the complex and multiple medical, surgical, mental health and social care needs of the current maternity population **N**

Vulnerable women and postnatal care

A vulnerable young woman with type 1 diabetes had an unplanned pregnancy. She had no financial and little emotional support. Prior to this pregnancy she had been on a paediatric insulin regimen as she had not attended diabetes clinic regularly. She booked early and was converted to the adult regimen in the late first trimester, however this led to multiple hypoglycaemic episodes. She was admitted with diabetic ketoacidosis on several occasions during the pregnancy. She had a caesarean birth in the early third trimester for poor glycaemic control. After discharge she had some midwifery visits but declined specialist health visiting for vulnerable mothers. She found social services involvement more threatening than helpful. She was admitted to hospital two months postnatally with another ketoacidotic episode but she did not have her baby with her, and self-discharged. She subsequently changed GP and never saw her new GP. She died from diabetic ketoacidosis at home a few months later.

The care of vulnerable women especially those who also have complex medical problems requires careful multidisciplinary care from all agencies. During pregnancy this woman had intensive midwifery, obstetric and diabetes care. After discharge, however, her care was more fragmented and she was unable to develop a trusting relationship with any of the multiple professionals with whom she had brief interactions. Compassionate care on occasions, for example facilitating keeping her baby with her when she was admitted to hospital, may have helped her to manage her condition better.

Many of the women who died from medical comorbidities, particularly diabetes, were extremely vulnerable. While, as with the first woman described in this section, there was evidence that the severity of their illness was not recognised during pregnancy, women predominantly deteriorated postnatally when they received less support and/or support was not tailored to their needs.

Ensure that guidance on care for pregnant women with complex social factors is updated to include a role for networked maternal medical care and postnatal follow-up to ensure that it is tailored to women's individual needs and that resources in particular target vulnerable women with medical and mental health comorbidities and social complexity **N**

Consider initiating a multi-agency needs assessment, including safeguarding issues so that women with complex social factors have coordinated care plans.

NICE CG110 Pregnancy and complex social factors: a model for service provision for pregnant women with complex social factors (National Institute for Health and Care Excellence 2010)

Women with multiple and complex problems require additional care following discharge from hospital after birth and there is a need for senior review prior to discharge, with a clear plan for the postnatal period. This review should include input from obstetricians and all relevant colleagues (Knight, Nair et al. 2017)

Women with complex physical and/or psychological comorbidities need care before, during, and after pregnancy; their health and medication should ideally be optimised before considering pregnancy; and they must be offered contraception and continuing care after and between pregnancies (Shakespeare, Duff et al. 2022)

7.5 Recurring lessons to be learned

Endocrine disorders

Recognition of new onset endocrine disorders

Several months after giving birth to a large for gestational age infant, a woman with known thyroid disorder presented with fatigue, dizziness, weight loss and acidosis. The diagnosis was felt to be new onset diabetes despite persistently normal glucose tolerance and HbA1c tests during and after pregnancy. She was also noted to be tanned. A diagnosis of Addison's disease was not considered and she died seven months postnatally of severe ketoacidosis of unknown cause.

A lack of knowledge about endocrine disorders among most maternity staff means that symptoms such as vomiting, weight loss, change in skin tone and acidosis, which are indicative of primary adrenal insufficiency (Addison's disease), are often ascribed to a simpler explanation. Women with one endocrine disorder are at an increased risk of other endocrine disorders, and this should be considered when making a diagnosis.

Maternity units should equip their staff with the skills necessary to recognise and manage acute deterioration and have pathways in place to readily obtain expert advice. Employing nurses alongside midwives for women with complexities or in high dependency areas can help facilitate recognition and treatment. Similarly, community midwives might work alongside GPs to provide a pathway for escalation of care after hospital discharge.

Hyperemesis gravidarum

For women with medical disorders who are dependent on regular oral medications, such as the woman with Addison's disease described in the section on complex care needs (and also women with HIV, epilepsy and mental health disorders), the management of hyperemesis gravidarum should prompt early treatment with antiemetics and include adequate doses of medications or parenteral administration to treat the nausea and vomiting.

Box 7.1: Causes and management of nausea and vomiting in pregnancy in women with medical conditions (Royal College of Obstetricians and Gynaecologists 2016b, Royal College of Obstetricians and Gynaecologists 2023)

Causes	Management
Hyperemesis gravidarum Endocrine disorders (e.g. Addison's disease, diabetes) Infection Gastrointestinal disorders (e.g. peptic ulcers, cholecystitis, gastroenteritis, pancreatitis, hepatitis) Neurological disorders (e.g. migraine, intracerebral haemorrhage, increased intracranial pressure Drug use	Oral antiemetics alone or in combination (e.g. antihistamines, phenothiazines, dopamine antagonists) Parenteral, transdermal or rectal antiemetics Ambulatory daycare Inpatient management

Inpatient care [for nausea and vomiting in pregnancy and hyperemesis gravidarum] should be considered if there is at least one of the following:

- **Continued nausea and vomiting and inability to keep down oral antiemetics**
- **Continued nausea and vomiting associated with clinical dehydration or weight loss (greater than 5% of body weight), despite oral antiemetics**
- **Confirmed or suspected comorbidity (such as urinary tract infection and inability to tolerate oral antibiotics)**
- **Co-morbidities such as epilepsy, diabetes, or HIV, where symptoms and inability to tolerate oral intake and medication could present further complications**

For women with persistent or severe hyperemesis gravidarum, the parenteral, transdermal, or rectal route may be necessary and more effective than an oral regimen.

RCOG Green-top guideline 69 (Royal College of Obstetricians and Gynaecologists 2016b, Royal College of Obstetricians and Gynaecologists 2023)

Communication and multidisciplinary care

As in the care of the woman described in section 7.4 complex care needs, proper communication between specialities/units, with the woman and her family and during the handover of care in the postnatal period is important for good, continuous care. When possible, there should be direct communication and verbal handover to ensure that messages about care are not lost due to the use of diverse electronic systems in different units. In instances when electronic records are used for handover, they should be streamlined to ensure information can be quickly and easily accessed in an emergency. Further, as mentioned elsewhere in this report, when a pregnant or recently pregnant woman arrives in the emergency department, maternity staff should be contacted so a full clinical assessment can be provided, and a proper diagnosis made.

As discussed in chapter 4, care for women with medical complexities should be multidisciplinary and include senior anaesthetists. Anaesthetic review of complex patients is particularly important as more than half of women receiving obstetric anaesthesia or analgesia are now considered to be at a high risk of complications (Royal College of Anaesthetists 2023). For high-risk patients, there should be pathways in place that encourage referral for evaluation early in pregnancy so anaesthetic management is considered in the woman's care plan. If a critically ill woman is requiring transfer to intensive care or a tertiary centre then the correct personnel, including senior anaesthetic staff, should be involved (Banerjee and Cantellow 2021). The benefits of mothers being cared for in local delivery suites or high dependency units where they are able to have their newborns with them should not be understated. Integrating level 2/3 critical care in these locations can help improve outcomes (Royal College of Anaesthetists 2018).

In pregnant or postpartum women with complex medical problems involving multiple specialties, the responsible consultant obstetrician or physician must show clear leadership and be responsible for coordinating care and liaising with anaesthetists, midwives, other physicians, and obstetricians and all other professionals who need to be involved in the care of these women (Knight, Nair et al. 2017)

There should be policies defining how women are referred to and access specialist or tertiary services (e.g. neurosurgery, acute stroke services) (Royal College of Anaesthetists 2023)

Women who become acutely unwell during pregnancy, labour and the postnatal period should have immediate access to critical care, of the same standard as other sick patients, irrespective of location (Royal College of Anaesthetists 2018)

Gastrointestinal disease

Pancreatitis

Four women died from pancreatitis; two had gallstones and two had had a cholecystectomy. Being female and hormonal changes due to pregnancy are both risk factors for gallstones and cholecystitis. Of the four women who died from pancreatitis, three were overweight or obese, which further increases the risk of gallstones and pancreatitis. Even with good care, pancreatitis is associated with high rates of mortality and should be considered in the differential diagnosis when women with multiple medical comorbidities, such as obesity, present with abdominal pain and vomiting.

Coordinated multidisciplinary care

A young woman with a history of ulcerative colitis died six months after giving birth from a necrotic stoma and small bowel. She had a subtotal colectomy and ileostomy three years prior to pregnancy. She presented to the emergency department on three occasions during pregnancy for abdominal pain and possible blockage of her ileostomy. She was admitted under the care of surgeons and managed conservatively. After she gave birth a new GP advised her to seek medical advice if she had sudden onset new pain and referred her to gastroenterology, though it is unclear if this appointment occurred. There was no postnatal surgical involvement.

In many instances, as in this woman, assessors noted the need for coordinated, multidisciplinary care that utilises expert advice, including through MMN where these have been established. This woman's care was appropriate and multidisciplinary during pregnancy, but this did not continue postnatally. Multiple blockages of an ileostomy can lead to strictures and necrotic tissue, which increase the risk of rupture. This woman had multiple morbidities and repeated bowel complications during pregnancy that would have benefited from attentive postnatal follow-up with a multidisciplinary team including a gastroenterologist, dietician, tissue viability nurse and possible surgical consultation.

Assessors also noted that in this woman's care, as in the care of several other women, a National Early Warning Score (NEWS) was used during her antenatal admissions. A national Maternity Early Warning Score (MEWS) should be used in all settings for monitoring of pregnant and recently pregnant women (up to four weeks after pregnancy), and scores should be acted on with appropriate escalation of care if required.

Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care (Knight, Bunch et al. 2022)

Making a diagnosis not simply excluding one

A multiparous women died ten months after the birth of her second child due to a fungal infection and underlying autoimmune hepatitis. At term she presented to her GP with generalised itching at which time bloods were taken and she was found to have elevated transaminases. There was no follow-up as she did not meet the diagnostic criteria for intrahepatic cholestasis of pregnancy. Four months postnatally she developed jaundice and itchiness attributed to shingles. Her liver function tests were abnormal prompting a hepatology referral, liver biopsy and diagnosis of autoimmune hepatitis. She did not respond to treatment and died.

This woman presented with generalised itching and abnormal liver function tests during pregnancy, but there was no follow-up or referral to hepatology until four months postnatally when she presented again with the same symptoms. She did not meet the diagnostic criteria for intrahepatic cholestasis of pregnancy as she had normal bile acids despite significantly raised transaminases, which were not tested again during pregnancy. The RCOG's guideline on intrahepatic cholestasis of pregnancy recommends offering repeat liver function tests and bile acid measurements until the end of pregnancy in women whose itching persists (Royal College of Obstetricians and Gynaecologists 2022). It is unclear if this woman's itching resolved during pregnancy, but assessors stressed the importance of follow-up when women have abnormal tests as exclusion of the most common diagnosis does not mean that there is no other cause. Clinicians should consider a broad array of diagnoses or refer to obstetric physicians or specialists outside of maternity staff when women have symptoms that are unexplained and do not resolve.

The emphasis should be on making a diagnosis, not simply excluding a diagnosis (Knight, Nair et al. 2016)

Haematology

The number of women who died in this triennium due to TTP or HLH is the same as in the previous triennium. Both women who died from HLH in this triennium were from white British/Scottish/Irish ethnic groups and not from ethnic minorities as in the previous two triennia (Knight, Nair et al. 2017, Knight, Bunch et al. 2020b). This condition has a 50% case fatality and survival is linked to prompt diagnosis and treatment, which is complicated by variable presentation (Fardet, Galicier et al. 2014). In adults, it is most often associated with malignancy, infection or autoimmune disorder (Schram, Comstock et al. 2016). An 'H Score' offers a validated assessment of the probability that a woman has HLH based on a number of features (Fardet, Galicier et al. 2014). The utility of MMN and specialist input in maternity care settings is emphasized in disorders such as HLH, where specialist input, such as from a haematologist in this instance, can help ensure timely diagnosis and treatment.

Respiratory disease

Asthma

A high-risk woman with asthma had repeated visits to the emergency department with threatened miscarriage and shortness of breath. She was using her reliever inhaler 8-9 times a day and was advised to see her GP. It is unclear if her respiratory team was aware of her pregnancy. Early in the second trimester she had an asthma attack and a cardiac arrest. She was resuscitated and admitted to ICU where she had a miscarriage and died a few days after admission.

Asthma is a common respiratory condition that has a wide range of severity. Many women who have well-controlled asthma have normal pregnancies with minimal risk of complications; however, studies suggest that 11-18% of pregnant women with asthma will have at least one emergency department visit, with 62% of these women requiring hospitalisation (Scottish Intercollegiate Guidelines Network 2019). As with this woman, severe asthma is more likely to worsen during pregnancy than mild asthma. This woman's asthma had been problematic in a previous pregnancy, but it does not appear she was referred to a respiratory team or seen in a multidisciplinary obstetric medical clinic. Either of these approaches may have helped to optimise her asthma treatment, especially as she was seen in the emergency department for shortness of breath on several occasions. Clinicians should be reminded of the guideline on the management of asthma produced jointly by the Scottish Intercollegiate Guidelines Network (SIGN) and the British Thoracic Society, which contains a chapter on the management of asthma in pregnancy (Scottish Intercollegiate Guidelines Network 2019).

Monitor pregnant women with moderate/severe asthma closely to keep their asthma well controlled.

Acute severe asthma in pregnancy is an emergency and should be treated vigorously in hospital.

SIGN 158 British Guideline on the management of asthma (Scottish Intercollegiate Guidelines Network 2019)

Contraception and pre-pregnancy counselling

A woman in her second pregnancy with a complex social history and multiple medical conditions was booked for antenatal care in a joint clinic with diabetes and asthma teams. Her glycaemic control was poor. She had multiple hospital admissions for asthma and in the late second trimester she was admitted to a high dependency unit with diabetic ketoacidosis. A caesarean birth was scheduled for 34+ weeks. Nine months after giving birth she had a cardiac arrest at home and died.

This woman received appropriate multidisciplinary care throughout her pregnancy, but remained unwell. She had a number of social and medical complexities including mental illness, hypothyroidism, respiratory disease, type 2 diabetes and a history of brittle asthma requiring multiple hospital admissions prior to pregnancy. Despite this, it appears she received no pre-pregnancy counselling regarding the risks to her health and life should she become pregnant.

As in previous reports (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017), assessors reviewing the care of women with medical disorders emphasised the need for effective pre-pregnancy planning and support, including discussions on effective contraception and counselling that realistically conveys the risk of severe outcomes. This woman was in her second pregnancy but it is unclear if she received advice after her first high-risk pregnancy regarding contraception or the risk of subsequent pregnancies. Pregnancy, and the period after, provides an ideal time to discuss contraception and family planning with women who are high-risk as they are in regular contact with reproductive healthcare services. Clinicians should refer to the current Faculty of Sexual and Reproductive Healthcare guidelines on contraception after pregnancy for guidance on contraceptive counselling and prescribing (The 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, Kenyon et al. 2014)

The development of maternal medicine specialist centres as a regional hub and spoke model must be an urgent national priority to allow early discussion of complex maternity cases with expert clinicians (Ockenden 2022)

High level actions are needed to ensure that it is seen as the responsibility of all health professionals to facilitate opportunistic counselling and appropriate framing of the advice when women attend any appointment, and that resources for pre- and post-pregnancy counselling are provided, together with open access to contraception services (Knight, Nair et al. 2017)

Services providing care to pregnant women should be able to offer all appropriate methods of contraception, including Long-Acting Reversible Contraception (LARC) to women before they are discharged from the service (The Faculty of Sexual and Reproductive Healthcare 2017)

Vascular disorders

Six women died from spontaneous intra-abdominal bleeding: four due to splenic artery aneurysmal rupture and two from other bleeding sources; all these women died while pregnant or within six weeks after the end of pregnancy. In most instances, the women were healthy prior to pregnancy and had no clear risk factors other than pregnancy.

A woman in her fourth pregnancy collapsed early in the third trimester with abdominal pain and was taken to the emergency department. She was hypotensive with an elevated respiratory rate and was found to be profoundly anaemic. Placental abruption and an aortic dissection were considered and plans were made for a diagnostic CT scan that did not occur. An ultrasound showed an intrauterine death and she was transferred for an emergency caesarean section. Upon opening her abdomen there was fresh blood in the peritoneal cavity the source of which could not be immediately identified. A vascular surgeon was called to identify the source of the bleeding but was unable to. A ruptured splenic aneurysm was identified post-mortem.

The team who initially evaluated this woman upon arrival in the emergency department suspected both placental abruption and non-obstetric haemorrhage including aortic dissection, but the woman never received a diagnostic CT scan as she was instead transferred for a category 1 caesarean section. The decision to operate in an obstetric theatre also meant that there was no CT scan on hand and limited available options for treatment. This woman was haemodynamically stable enough to be transferred to an obstetric theatre, which suggests that she was sufficiently stable to have a CT scan. Assessors felt that, in this woman, a rapid CT scan followed by immediate transfer to an appropriate operating theatre better able to cope with non-surgical bleeding and supporting interventional radiology may have made a difference to the outcome. This may not be the case for all women, and clinical stability should be considered prior to formal imaging.

Splenic artery aneurysm is rare but has a known association with pregnancy (van Rijn, Ten Raa et al. 2017). As noted in the 2017 MBRRACE-UK report (Knight, Nair et al. 2017), there should be heightened awareness of this potential event in pregnant women who present with non-obstetric intra-abdominal bleeding. The care of this woman re-emphasises another lesson raised in the 2017 report (Knight, Nair et al. 2017) concerning the value of a Focused Assessment with Sonography in Trauma (FAST) scan for assessment of pregnant women. This point of care ultrasound can help aid in rapid decision making through the identification of free fluid in the abdomen, which is likely to indicate bleeding. As noted in chapter 8 of this report regarding the care of women with neurological disorders, most imaging, including ultrasound and CT scans, is safe during pregnancy and should be used if indicated (American College of Obstetricians and Gynecologists 2017).

Women of reproductive age presenting to the emergency department collapsed…should have a Focused Assessment with Sonography in Trauma (FAST) scan to exclude intra-abdominal bleeding…especially in the presence of anaemia (Knight, Nair et al. 2016).

The messages for care of this woman, and the other women with intra-abdominal bleeding whose care was reviewed in this chapter, echoes that of the women with major obstetric haemorrhage who were reviewed in chapter 3 of this report. In particular, assessors noted dependence on use of vasopressors in hypovaelemic women and delays in recognition of concealed haemorrhage due to a reliance on assessment of physiological symptoms such as tachycardia and hypotension, which are late signs. Assessors also reiterated the importance of good situational awareness and senior input.

7.6 Conclusions

Many of the women in this chapter had multiple, underlying medical disorders, but at times the level of complexity or severity of their condition was not recognised. Many women were also vulnerable with additional social complexities including mental health conditions. While many of the messages for care noted in this chapter are repeated from previous reports, assessors noted a new need for appropriate midwifery training programmes and support to manage a growing obstetric population with multiple medical, surgical, mental health and social care needs. Supports should be tailored to women's individual needs and include both pre-pregnancy counselling and postnatal management to ensure care is continuous.

Information was sufficient to assess care for all 43 women. Assessors felt that different care might have made a difference for 20 women (47%) (Table 7.2). This is almost double the proportion of women in previous reports where assessors felt improvements to care may have made a difference (Knight, Nair et al. 2017, Knight, Bunch et al. 2020b). This serves to re-emphasise the need to disseminate the learning from this report widely to all members of multidisciplinary care teams who care for pregnant women, not just maternity staff.

Table 7.2: Classification of care received by women who died from general medical and surgical conditions, UK and Ireland, 2019-21

Classification of care received	(N=43) Number of women (%)
Good care	7 (16)
Improvements to care which would have made no difference to outcome	16 (37)
Improvements to care which may have made a difference to outcome	20 (47)

8. Learning from neurological complications

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8.1 Key messages

New recommendations

Develop training resources concerning shared decision making and counselling regarding medication use in pregnancy and breastfeeding, including specific information on the benefits and risks of different medications and non-adherence. **ACTION: Royal College of Obstetricians and Gynaecologists, Royal College of Midwives, Royal College of Physicians, Royal College of General Practitioners, Medicines and Healthcare Products Regulatory Agency**

Existing guidance and recommendations requiring improved implementation

Epilepsy

Refer women and girls with epilepsy who are planning pregnancy or are pregnant to an epilepsy specialist team for a review of their anti-seizure medication options (National Institute for Health and Care Excellence 2022a).

Ensure information about the care of women and girls during pregnancy is shared between the epilepsy specialist team, a specialist obstetric team and primary care (National Institute for Health and Care Excellence 2022a).

Pregnant women with epilepsy should have regular planned antenatal care with a designated epilepsy care team (Royal College of Obstetricians and Gynaecologists 2016c).

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 anti-seizure drugs; and seizure type and frequency (Royal College of Obstetricians and Gynaecologists 2016c).

Postpartum safety advice and strategies should be part of the antenatal and postnatal discussions with the mother alongside breastfeeding, seizure deterioration and anti-seizure medication intake (Royal College of Obstetricians and Gynaecologists 2016c).

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 (Knight, Bunch et al. 2020b).

Regard nocturnal seizures as a 'red flag' indicating women with epilepsy need urgent referral to an epilepsy service or obstetric physician (Knight, Bunch et al. 2020b).

Obstetric teams should take urgent action when pregnant women with a current or past diagnosis of epilepsy have discontinued anti-seizure medication without specialist advice. Urgent attempts should be made by all clinicians involved in care to offer the woman immediate access to an appropriately trained professional (e.g. neurologist/epilepsy specialist nurse or midwife) to review her medication and prescribe anti-seizure medication if appropriate. All women with epilepsy should be provided with the information they need prior to conception (Knight, Nair et al. 2017).

Explain to women and girls who are pregnant or are planning pregnancy the importance of adherence to their anti-seizure medications and that they should not stop their medication without medical supervision (National Institute for Health and Care Excellence 2022a).

Discuss the relative benefits and risks of adjusting medication with the woman or girl planning pregnancy to enable her to make decisions. This should include discussing the balance between the risks of poorly controlled seizures and the risks to the baby when anti-seizure medicines are taken in pregnancy or while breastfeeding (National Institute for Health and Care Excellence 2022a).

If monitoring of anti-seizure medications levels is carried out in pregnancy, discuss the results with the woman or girl with epilepsy to inform choices about any adjustments to doses (National Institute for Health and Care Excellence 2022a).

Women with epilepsy taking anti-seizure medication who become pregnant unexpectedly should be able to discuss therapy with an epilepsy specialist on an urgent basis. It is never recommended to stop or change anti-seizure medication abruptly without an informed discussion (Royal College of Obstetricians and Gynaecologists 2016c).

Healthcare professionals should acknowledge the concerns of women with epilepsy and be aware of the effect of such concerns on their adherence to anti-seizure medications (Royal College of Obstetricians and Gynaecologists 2016c).

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 (Royal College of Obstetricians and Gynaecologists 2016c).

All women with epilepsy should be advised to take 5mg/day of folic acid prior to conception and continue the intake until at least the end of the first trimester to reduce the incidence of major congenital malformation (Royal College of Obstetricians and Gynaecologists 2016c).

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 (Knight, Bunch et al. 2020b).

Pathology

In suspected epilepsy-related deaths, a full post-mortem examination, including neuropathology, organ histology and toxicology, is required (The Royal College of Pathologists 2019).

[Toxicology should be] carried out to evaluate blood levels of anti-seizure medications and compliance: to confirm prescribed anti-seizure medications were being taken at the correct dosage and to establish whether the patient had stopped taking the prescribed anti-seizure medications (The Royal College of Pathologists 2019).

Intracerebral disease

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 (National Institute for Health and Care Excellence 2023b).

When using medicines to treat hypertension in pregnancy, aim for a target blood pressure of 135/85 mmHg (National Institute for Health and Care Excellence 2023b).

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

(Royal College of Physicians 2019)

At the first postnatal midwife contact, inform the woman that persistent or severe headache, which could indicate hypertension, pre-eclampsia, post-dural puncture headache, migraine, intracranial pathology or infection, are symptoms or signs of potentially serious conditions, and she should seek medical advice without delay (National Institute for Health and Care Excellence 2021b).

With few exceptions, radiation exposure through radiography, 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 2017).

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) (National Institute for Health and Care Excellence 2022b).

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 (National Institute for Health and Care Excellence 2022b).

People with suspected acute stroke (including people already in hospital) should be admitted directly to a hyperacute stroke unit and be assessed for emergency stroke treatments by a specialist clinician without delay (Intercollegiate Stroke Working Party 2023).

MRI brain with stroke-specific sequences (DWI with SWI or T2*-weighted imaging) should be considered in patients with suspected acute stroke when there is diagnostic uncertainty (Intercollegiate Stroke Working Party 2023).

Pregnancy should not alter the standard of care for stroke (Knight, Kenyon et al. 2014).

8.2 The women who died

In total 42 women died during or up to a year after pregnancy from neurological causes.

Seventeen women died during or up to a year after the end of pregnancy in the UK and Ireland in 2019-21 from causes related to epilepsy, a mortality rate of 0.76 per 100,000 maternities (95% CI 0.44-1.22), of whom 14 died from Sudden Unexpected Death in Epilepsy (SUDEP) (mortality rate 0.63 per 100,000 maternities, 95% CI 0.34- 1.05). This is not statistically significantly lower than the rate for 2016-18 (0.74 per 100,000 maternities, 95% CI 0.44-1.18) and represents a near doubling of the rate of SUDEP between 2013-15 and 2019-21 (RR 1.96, 95% 0.77-5.39, p=0.131). This represents the period during which guidance on prescribing valproate for women and girls changed dramatically, necessitating a change in medication use amongst a large number of women of reproductive age with epilepsy (Medicines and Healthcare products Regulatory Agency 2018). It is important to note, in this context of ongoing concerns about valproate exposure in pregnancy, that none of the women who died were taking sodium valproate.

Twenty-five women died from other neurological causes during or up to a year after the end of pregnancy in the UK and Ireland in 2019-21. Thirteen women died from stroke during or up to six weeks after pregnancy: six from subarachnoid haemorrhage, five from intracerebral haemorrhage and two from ischaemic strokes. This represents an overall maternal mortality rate directly due to intracranial haemorrhage of 0.49 per 100,000 maternities (95% CI 0.25-0.88). Three women died from other neurological causes while pregnant or within six weeks of the end of pregnancy. A further nine women died between six weeks and one year after the end of pregnancy (four from subarachnoid haemorrhage, three from intracerebral haemorrhage and two from other causes).

8.3 Caring for women with epilepsy

Background

Epilepsy remains the most common neurological disease in pregnancy and SUDEP remains the leading cause of death for women with epilepsy during or up to a year after pregnancy. One of the common themes identified in this report, as in past reports (Knight, Bunch et al. 2020b), is proper adherence to anti-seizure medications, which continues to be a source of concern. Assessors also noted significant gaps in the pathways of care in a number of women; this was likely exacerbated by the COVID-19 pandemic. In many instances, women had no or negligible input from neurology/epilepsy services or access to those services was delayed. This was especially true for women with multiple adversities or complex comorbidities. It is hoped that this will improve with the establishment and development of MMN and joint pregnancy epilepsy clinics.

Overview of care and new lessons to be learned

Medication concordance

A multiparous woman known to have epilepsy with tonic-clonic seizures and intermittent focal seizures presented with increasing seizures at four weeks of gestation. Following discussion with a neurologist, levetiracetam was added to her lamotrigine. The woman was unable to tolerate this and reduced the dose. She was not referred to the obstetric medicine clinic after booking. The woman's medication was increased again late in the first trimester at a nurse-led clinic where the associate specialist also joined the consultation. When seen in antenatal clinic she reported ongoing seizures and was advised to contact her epilepsy specialist nurse. No direct contact was made between obstetric and neurology services. Her medication was gradually escalated by the epilepsy team throughout pregnancy, but serum levels were not measured. She continued to experience seizures and died from SUDEP in the third trimester. Serum levels of lamotrigine were low at post-mortem. Levetiracetam was not detected.

It is unclear whether this woman was taking her anti-seizure medication. Concordance does not appear to have been discussed antenatally despite her seizures being difficult to control, and lamotrigine levels were not measured despite high dosages of medication and ongoing seizures. Whilst it is impossible to ensure adherence to medication, the pattern of adherence behaviour should be explored, particularly when seizures appear to be resistant to treatment.

De-prescribing or lack of concordance with medication is not a new message to be raised in these confidential enquiry reports. It was very clear in many instances of women whose care was reviewed in every section of this report, including conversations concerning vaccination, steroid use in women with asthma, and epilepsy medication, that clinicians did not feel able to hold conversations, which may need to be repeated, about non-adherence medication safety.

Develop training resources concerning shared decision making and counselling regarding medication use in pregnancy and breastfeeding, including specific information on the benefits and risks of different medications and non-adherence **N**

Recurring lessons to be learned

Access to specialist services

Previous MBRRACE enquiries have recommended clear standards of care for joint maternity and neurology services. The purpose of this is to optimise anti-seizure medication regimens, allow for early neurology referral and review, particularly if the pregnancy is unplanned or women have worsening epilepsy symptoms, and to ensure pathways are in place for immediate specialist advice at all hours. Joint services should also include postnatal review to ensure anti-seizure medication doses are appropriately adjusted after pregnancy (Knight, Bunch et al. 2020b). Despite these recommendations, many of the women whose care was reviewed in this enquiry had limited or no support from a designated epilepsy care team and there was no expert assessment of seizure symptoms, risk factors or previous experience with medications.

A multiparous young woman with juvenile myoclonic epilepsy had an unplanned pregnancy. She had a history of nocturnal seizures for six years. She had not been taking any anti-seizure medication for three years prior to pregnancy. Her epilepsy and treatment history were not identified at booking. She had a nocturnal seizure at 18 weeks gestation, but no medications or safety measures were discussed until after a second seizure at 35-36 weeks. At this time, neurology advised her to start 500mg levetiracitam twice daily and SUDEP was discussed. Postnatal care did not include specialist services or review of medications. She died from SUDEP a few days postnatally. Levetiracetam serum levels were determined to be sub-therapeutic at post-mortem examination.

There were multiple missed opportunities to discuss and provide individualised, specialist care for this woman. At booking, this woman's epilepsy was not identified and her history was not explored. Her care followed a midwifery-led pathway without senior obstetric or neurology input. After her first seizure at 18 weeks, medication and safety were not discussed, which was a missed opportunity to engage her with specialist services. After her second nocturnal seizure at 35 weeks she was commenced on levetiracetam without an enquiry about her previous tolerance to this medication; she had previously ceased taking it due to a belief that it increased her seizures. There was also no postnatal medicine management plan indicating another missed opportunity to review her epilepsy and treatment.

Women at particular risk of accidents, injuries or epilepsy-related death should receive urgent epilepsy specialist/neurology team involvement prior to or as soon as pregnancy is confirmed or booked to ensure that adherence with medication can be assessed and medications adjusted as soon as possible in the event of increased seizure frequency (Knight, Bunch et al. 2020b). High-risk women include those with history of tonic-clonic seizures in the last 12 months, previous nocturnal or prolonged seizures and drug resistant epilepsy (Royal College of Obstetricians and Gynaecologists 2016c, National Institute for Health and Care Excellence 2022a). Documentation of risk conversations is imperative and there should be ongoing risk assessment at all stages, in particular during transition from paediatric to adult health services.

Refer women and girls with epilepsy who are planning pregnancy or are pregnant to an epilepsy specialist team for a review of their anti-seizure medication options.

Ensure information about the care of women and girls during pregnancy is shared between the epilepsy specialist team, a specialist obstetric team and primary care.

NICE NG217 Epilepsies in children, young people and adults (National Institute for Health and Care Excellence 2022a)

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

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 anti-seizure drugs; and seizure type and frequency.

Postpartum safety advice and strategies should be part of the antenatal and postnatal discussions with the mother alongside breastfeeding, seizure deterioration and anti-seizure medication intake.

RCOG Green-top Guideline 68 (Royal College of Obstetricians and Gynaecologists 2016c)

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 (Knight, Bunch et al. 2020b)

Regard nocturnal seizures as a 'red flag' indicating women with epilepsy need urgent referral to an epilepsy service or obstetric physician (Knight, Bunch et al. 2020b)

Obstetric teams should take urgent action when pregnant women with a current or past diagnosis of epilepsy have discontinued anti-seizure medication without specialist advice. Urgent attempts should be made by all clinicians involved in care to offer the woman immediate access to an appropriately trained professional (e.g. neurologist/epilepsy specialist nurse or midwife) to review her medication and prescribe anti-seizure medication if appropriate. All women with epilepsy should be provided with the information they need prior to conception (Knight, Nair et al. 2017)

Medication monitoring

An older primiparous woman had a history of juvenile myoclonic epilepsy. Her previous care by a neurologist had lapsed four years earlier. Prior to pregnancy, she was taking three anti-seizure medications. She expressed a desire to get pregnant to her GP who referred her for pre-pregnancy counselling. She was seen by an obstetrician but a neurologist was not available; her care was discussed with the neurologist by telephone after the visit. Four months later she was seen at an obstetric/neurology clinic and reported that she was pregnant. She was advised about the risks of polypharmacy and her serum levels were checked for all anti-seizure medications. While waiting for test results, the woman informed staff that she had stopped her phenobarbital. She was advised to restart. She died from SUDEP in the second trimester. Two of her three anti-seizure medications were in the therapeutic range; phenobarbital was not.

Many aspects of this woman's care were good. She was promptly referred for pre-pregnancy counselling after expressing her wish to get pregnant. This appointment also included appropriate contraception counselling and she was prescribed folic acid. At this time she was also offered contact with a specialist epilepsy nurse but she declined. When she presented to the next appointment at the joint obstetric/neurology clinic already pregnant, she was advised about the risks of polypharmacy, serum testing was ordered for all her anti-seizure medications to see if any could be reduced and she was advised to continue her medication until results were available. The discussion on medication adherence recurred several times in her pregnancy. Phenobarbital use in the UK has considerably reduced, particularly in younger women. If prescribed, sudden withdrawal should be avoided as this can lead to withdrawal seizures.

Whilst women with epilepsy should be encouraged to be their own advocates and make decisions about their health, they must also be provided with all the necessary information about the risks and benefits of medication and their concerns must be fully explored. This is especially true in high-risk women such as those treated with polytherapy anti-seizure medicines or co-prescribed other medicines that can lower seizure threshold (such as antidepressants) (Maguire, Marson et al. 2021). Serum analyses are useful when considering changes in anti-seizure medication and can help guide treatment dosage during pregnancy even if results may take up to four weeks in some instances. Baseline serum levels recorded early in pregnancy may also be useful to guide therapeutic management throughout pregnancy and into the postnatal period.

Explain to women and girls who are pregnant or are planning pregnancy the importance of adherence to their anti-seizure medications and that they should not stop their medication without medical supervision.

Discuss the relative benefits and risks of adjusting medication with the woman or girl planning pregnancy to enable her to make decisions. This should include discussing the balance between the risks of poorly controlled seizures and the risks to the baby when anti-seizure medicines are taken in pregnancy or while breastfeeding.

If monitoring of anti-seizure medications levels is carried out in pregnancy, discuss the results with the woman or girl with epilepsy to inform choices about any adjustments to doses.

NICE NG217 Epilepsies in children, young people and adults (National Institute for Health and Care Excellence 2022a)

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

Healthcare professionals should acknowledge the concerns of women with epilepsy and be aware of the effect of such concerns on their adherence to anti-seizure medications.

RCOG Green-top Guideline 68 (Royal College of Obstetricians and Gynaecologists 2016c)

The summary of care for the 17 women with epilepsy whose care was reviewed is shown in Table 8.1. Of these 17 women, 14 had an epilepsy diagnosis at the time of pregnancy and three women were diagnosed after pregnancy. Of the 14 women with an epilepsy diagnosis prior to/during pregnancy, 8 (57%) did not receive pre-pregnancy counselling, and in a further two women it was unclear if counselling discussions took place before they became pregnant. Of the women with an epilepsy diagnosis in pregnancy, all were prescribed anti-seizure medications, though it is unknown how many were adhering to the recommended schedule and/or dosage. Lamotrigine and levetiracetam were the most commonly prescribed anti-seizure medications. Two of the three women who were diagnosed with epilepsy after pregnancy were prescribed anti-seizure medications postnatally. Of the women who had epilepsy during pregnancy, 10 (71%) had at least one consultation with a specialist for review. One of the women who did not have a formal epilepsy diagnosis during pregnancy also underwent neurology review for her seizures during pregnancy.

Table 8.1: Summary of the care of the women with epilepsy who died UK and Ireland 2019-2021

Assessed cause of death	Timing of death	Pre-conception counselling	Was epilepsy controlled pre-pregnancy?	Specialist review during pregnancy?	Prescribed medication*	Improvements in care identified which would have changed outcome?
SUDEP	3rd trimester	No	No	Yes	Lamotrigine, Levetiracetam	Yes
Unascertained†	>6 weeks after pregnancy	No	N/A	No	None	Yes
SUDEP	>6 weeks after pregnancy	Unclear	Yes	Yes	Lamotrigine	No
SUDEP	>6 weeks after pregnancy	Yes	No	Yes	Lamotrigine, Levetiracetam	No
SUDEP	>6 weeks after pregnancy	Unclear	Yes	Yes	Levetiracetam	Yes
SUDEP	1st trimester	No	No	No	Lamotrigine	No
SUDEP†	>6 weeks after pregnancy	No	N/A	Yes	Lamotrigine‡	No
Epilepsy complications	>6 weeks after pregnancy	Yes	No	Yes	Levetiracetam	No
SUDEP	≤6 weeks after pregnancy	No	No	No	Levetiracetam	Yes
Epilepsy and substance use	1st trimester	No	Yes	No	Lamotrigine	No
SUDEP	3rd trimester	No	No	Yes	Levetiracetam	No
SUDEP†	>6 weeks after pregnancy	No	N/A	No	Levetiracetam‡	No
SUDEP	>6 weeks after pregnancy	No	No	Yes	Carbamazepine	No
SUDEP	2nd trimester	Yes	No	Yes	Topiramate, Phenobarbital, Levetiracetam	No
SUDEP	≤6 weeks after pregnancy	No	Yes	Unclear	Lamotrigine	No
SUDEP	2nd trimester	Yes	Unclear; medication change shortly before pregnancy	Yes	Lamotrigine	Yes
SUDEP	>6 weeks after pregnancy	No	No	Yes	Lamotrigine	No

*Note that this column shows women's prescribed medications; in several cases women were non-adherent to medication schedule and dosage
†Epilepsy was not diagnosed until after pregnancy
‡Prescribed after pregnancy; no prescribed anti-seizure medications during pregnancy

Pre-pregnancy counselling and contraception advice

The woman described in the section on medication monitoring waited a total of seven months for two separate pre-conception appointments. A need for prompt, pro-active contraception advice and pre-conception counselling in paediatric, transition and adult specialist services was a recurrent theme across chapters and many women's pregnancies were unplanned. Effective pre-conception counselling provides an opportunity to optimise medications with sufficient time to assess efficacy and make necessary changes. It also provides an opportunity to build trusting relationships, provide advice on contraception, lifestyle, safety and first aid, conduct risk assessments, commence folic acid and formulate a management plan for future pregnancy.

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.

All women with epilepsy should be advised to take 5mg/day of folic acid prior to conception and continue the intake until at least the end of the first trimester to reduce the incidence of major congenital malformation.

RCOG Green-top Guideline 68 (Royal College of Obstetricians and Gynaecologists 2016c)

SUDEP counselling

A recent analysis of data from the EpSMon (epilepsy safety monitor) app, found that women of childbearing age with epilepsy had a low baseline awareness of risks of SUDEP (Zhou, McLean et al. 2023). The need for risk assessments and counselling regarding SUDEP and additional risk factors, including recreational use of drugs and alcohol, was frequently identified in this enquiry. 'We need to talk about SUDEP' was also highlighted in a previous MBRRACE report (Knight, Bunch et al. 2020b). In some women where SUDEP was apparently discussed, it is unknown whether this included ongoing re-assessment of risk, especially if there were changes in risk factors.

SUDEP Action provides a SUDEP and Seizure Safety Checklist that can help guide risk assessment (***www.sudep.org/checklist***). It is important to consider assessment of multiple risk factors in addition to seizure frequency; pregnancy and the first year post-pregnancy should be included as risk factors for SUDEP. The NHS Rightcare Epilepsy Toolkit has been developed in England to support systems to understand the priorities in epilepsy care and key actions to take (***www.england.nhs.uk/rightcare/toolkits/epilepsy-toolkit/***) and includes further advice on identifying those most at risk of SUDEP.

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 (Knight, Bunch et al. 2020b)

Neuropathological investigation of deaths in epilepsy

Three (18%) of the women with epilepsy who died had no post-mortem examination. Thus, the cause of their death could not always be clearly ascribed. Two of the women who had a post-mortem examination had no histology taken from the brain but one did have histology taken of the other organs. Two women had a neuropathologist examine their whole brain while, in five other women, samples only were submitted for formal neuropathological assessment.

The diagnosis of SUDEP requires a full post-mortem examination including formal neuropathology and histology of the other main organs. As it is a diagnosis of exclusion, failure to undertake such a complete examination precludes the diagnosis. Three women's deaths were ascribed to SUDEP with incomplete examination, including one woman who had no brain histology and two without referral to neuropathology.

Toxicology was performed in all women with epilepsy who had post-mortem examinations. In one woman, the toxicology undertaken at her post-mortem showed her anti-seizure medication levels were present at lower than the therapeutic dose, but there was no further discussion of this in the pathologist's comment. In another woman's post-mortem toxicology report, there was no indication of the therapeutic range of medications to assess the significance of the result obtained.

The cause of death of two women was considered unascertained by the original pathologist, but on review the features were thought to be in keeping with an epilepsy-related death.

Key messages for pathologists

- A diagnosis of an epilepsy-related death usually requires a post-mortem. SUDEP in particular is a diagnosis of exclusion and requires a full post-mortem with histology and toxicology to exclude other possible causes of death in someone with epilepsy
- In epilepsy-related deaths, pathologists should follow the Royal College of Pathologists' autopsy guideline 'Deaths in patients with epilepsy including sudden deaths' (The Royal College of Pathologists 2019)
- Neuropathology examination is required for epilepsy-related deaths
- Interpretation of toxicology should take into account the significance of the levels of anti-seizure medications including an interpretation of therapeutic ranges

In suspected epilepsy-related deaths, a full post-mortem examination, including neuropathology, organ histology and toxicology, is required.

[Toxicology should be] carried out to evaluate blood levels of anti-seizure medications and compliance [to]:

- **Confirm prescribed anti-seizure medications were being taken at the correct dosage**
- **Establish whether the patient had stopped taking the prescribed anti-seizure medications**

The Royal College of Pathologists G175 Guidelines on autopsy practice: Deaths in patients with epilepsy including sudden deaths (The Royal College of Pathologists 2019)

8.4 Caring for women with signs and symptoms of intracerebral disease

Recurring lessons to be learned

The lessons identified from this review echo many of those in previous reports (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017, Knight, Bunch et al. 2020b). Assessors emphasised the importance of early specialist review, imaging and multidisciplinary involvement for women with signs and symptoms of intracerebral disease, such as headache and vomiting, or with persistent or new neurological signs or symptoms. Persisting, acute or severe headache and focal symptoms are red flags. For several women in this enquiry there was a lack of postpartum follow-up with BP measurement. This echoes a recurrent message across topics in this year's report about the importance of post-partum care for the mother.

> A woman with gestational diabetes had a sudden collapse at home in the third trimester. She had a rapid resuscitative hysterotomy but died the following day from a subarachnoid haemorrhage. During pregnancy, the woman was given a home BP monitor for high BP attributed to white coat syndrome. Serial readings were persistently high. She was told to take aspirin, but no antihypertensives were prescribed.

It is unknown if home BP monitoring was an effective method of managing this woman's hypertension as the assessors felt that her diabetes was the primary medical focus, not her BP. Evidence does suggest that, in most instances, the use of home BP monitoring in women with hypertensive disorders of pregnancy is effective without increasing adverse outcomes (Kalafat, Benlioglu et al. 2020). However, it is important to have safety netting in place to provide a clear pathway for follow-up including when and where to seek medical advice.

It has been noted in previous reports that pregnancy should not alter the standard treatment pathway for stroke (Knight, Kenyon et al. 2014), including haemorrhagic stroke. A resuscitative hysterotomy (RH) was performed in an attempt to save this woman's life. Assessors noted that this was appropriate management but also highlighted a need for better evidence regarding survival rates in out of hospital collapse and emergency caesarean section or RH. It is important to identify the survival/success by assessing rapid hospital transfer compared with RH performed out of hospital.

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 2023b)

An older woman had an elevated BP immediately postpartum. After discharge, she was seen by a community midwife but no concerns or BP recordings were documented during any home visits. For two weeks postnatally, she complained to her partner of severe headaches requiring regular paracetamol and ibuprofen. She collapsed with a severe headache and vomiting. A CT scan showed massive intracranial haemorrhage with features consistent with raised intracranial pressure. She died shortly afterwards.

This woman had several risk factors for haemorrhagic stroke during the puerperium including an abnormally high BP recording and advanced maternal age. The 2023 NICE guideline on hypertension in pregnancy emphasises the importance of the management of newly diagnosed and chronic hypertension in pregnancy but only chronic, not acute, hypertension management postnatally (National Institute for Health and Care Excellence 2023b). The 2021 NICE guideline on postnatal care recommends monitoring the woman's physical health for signs and symptoms of thromboembolism and pre-eclampsia, but does not recommend BP checks during postnatal assessments (National Institute for Health and Care Excellence 2021b). There was no indication of any ongoing assessment of BP at any of this woman's five home postnatal visits. A full assessment of this woman's condition would not be possible unless her BP was recorded, and hence her deteriorating health condition was not recognised. As part of standard postnatal care, community midwives and other health professionals caring for postnatal women, should evaluate women's physiological state through monitoring the vital parameters, which include BP. There also need to be clear pathways for when to seek medical advice and who to contact.

In many of the women whose care was assessed, headaches in the third trimester, during birth or postpartum were not recognised until they were catastrophic. The importance of recognising the concerning features associated with headaches has been noted in past enquiries (Knight, Nair et al. 2017, Knight, Bunch et al. 2020b). The development of sudden onset, persistent or severe headaches in pregnant and recently pregnant women should prompt immediate action and escalation (Royal College of Physicians 2019).

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**

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

At the first postnatal midwife contact, inform the woman that persistent or severe headache, which could indicate hypertension, pre-eclampsia, post-dural puncture headache, migraine, intracranial pathology or infection, are symptoms or signs of potentially serious conditions, and she should seek medical advice without delay.

NICE Guideline NG194 Postnatal Care (National Institute for Health and Care Excellence 2021b)

Premonitory symptoms

A nulliparous woman with Crohn's disease had complained of headaches, pain in the neck and shoulders and non-pulsatile tinnitus during the antenatal period. She had been reviewed in an ear, nose and throat clinic and an MRI had been planned for the early postnatal period. She experienced a sudden onset severe headache and collapsed at home in the third trimester. A CT scan taken on arrival at the hospital showed a large intracerebral haemorrhage. She had a live birth by emergency caesarean section. She was transferred to intensive care as she was too unstable for transfer to a neurosurgical unit and died within a few hours.

This woman presented with severe headache and sudden collapse followed by rapid deterioration. Several other women who were assessed had similar symptoms and outcomes. When this woman reported her neurological symptoms during the antenatal period, further investigations were delayed because of the pregnancy. This woman had a history and constellation of symptoms including headaches and tinnitus, as well as Crohn's disease, which is associated with a higher risk of stroke (Chen and Wang 2021). She should have been screened for stroke risk and had a neurological examination during the antenatal period.

In this woman, and others, earlier investigation with MRI brain imaging may have helped form an antenatal diagnosis and led to appropriate, timely intervention, which may have prevented the outcome. MRI is not contraindicated in pregnancy (American College of Obstetricians and Gynecologists 2017, Liew, Feghali et al. 2020); however, caution is advised with the use of gadolinium based contrast agents (American College of Obstetricians and Gynecologists 2017). Investigation with imaging should not be delayed for pregnant women presenting with new and/or concerning neurological symptoms and signs.

With few exceptions, radiation exposure through radiography, 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.

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

Further, none of this woman's consultations with other specialities were documented in her antenatal obstetric notes, indicating improvements that could be made in the communication between specialities.

Raised intracranial pressure in women with ventriculoperitoneal shunts

A nulliparous woman with a VP shunt was admitted for induction of labour at term. The team looking after her were informed that her VP the shunt was fractured and therefore redundant. She had been experiencing headaches from 28 weeks and developed hypertension at 36 weeks' gestation. During induction she complained of a right sided headache and vomited once. Shortly after giving birth, she was experiencing headaches with some high pressure features. A neurological examination was normal. One hour after examination she had a cardiac arrest. A CT scan showed hydrocephalus. She was transferred to the neuro-surgical intensive care unit for a new VP shunt but died from a secondary subarachnoid haemorrhage.

The care of this woman highlights the importance of careful management and close monitoring of pregnant and postnatal patients with ventriculoperitoneal (VP) shunts. This woman had repeated headaches and a known VP shunt; however, since the maternity team had a false reassurance that she was not reliant on the shunt, the associated risks and red flags were not recognised antenatally. Pregnancy can worsen symptoms of hydrocephalus and, in pregnant women with pre-existing shunts, raised intracranial pressure (ICP) is a common neurological complication (Wisoff, Kratzert et al. 1991). It has been reported that 59% of pregnant women with pre-existing shunts can develop symptoms of raised ICP due to malfunctioning of the shunt (Wisoff, Kratzert et al. 1991).

In view of this, women with a VP shunt need to be assessed early and regularly during pregnancy and the postpartum period for any changes in their neurological symptoms or signs of raised ICP such as headaches (often postural), vomiting, reduced consciousness level, gaze paresis (a sixth cranial nerve palsy), and seizures. New or persisting symptoms require radiological imaging, such as CT or MRI, and referral to a neurosurgeon. These women need care with a multidisciplinary team during pregnancy that should include an anaesthetist, obstetrician, and neurosurgeon. For women with complex neurology, this care should preferably come under the care of the MMN hub.

Recognition and management of stroke

A woman with a history of smoking and family history of VTE, was admitted ten days after giving birth with right sided weakness and reduced consciousness. She had a neurological assessment including a CT scan at admission that appeared normal. Further examination with a CT angiogram showed an evolving infarct and occlusion of the left internal carotid, left middle cerebral and both anterior cerebral arteries. By this time it was too late for intravenous thrombolysis, and thrombectomy could not be offered. She was transferred to intensive care but she deteriorated and died.

This woman highlights the importance of prompt recognition of neurological symptoms. In this instance, there was a delay in stroke diagnosis, and by the time her stroke was identified, she already had significant parenchymal damage. Presentations with focal neurological signs or symptoms should prompt immediate discussion with, or admission to, a hyperacute stroke unit for urgent assessment and treatment such as intravenous thrombolysis or thrombectomy.

The National Clinical Guideline for Stroke recommends that all patients with suspected acute stroke receive brain imaging as soon as possible (at most within an hour of arrival to a hospital)(Intercollegiate Stroke Working Party 2023). Stroke is a medical emergency and any person, including pregnant and postnatal women, with acute onset of focal neurological symptoms needs urgent diagnostic assessment to differentiate between acute stroke and other causes. Non-contrast CT scans are not sensitive for early detection (<3-6hr) of acute infarct and a negative scan does not exclude an acute ischaemic stroke. MRI with diffusion weighted imaging is more sensitive at identifying acute ischaemic stroke, even in the early stages, and should be the modality of choice if available.

The highest risk of maternal stroke occurs in the peripartum and immediate postpartum periods. The incidence of stroke in these periods is approximately triple that in non-pregnant women (Swartz, Cayley et al. 2017). Therefore, as emphasized in previous enquiries, it should be a priority for all staff in maternity settings to have training on how to recognise stroke (Knight, Bunch et al. 2020b).

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 Guideline NG128 Stroke and transient ischaemic attack in over 16s: diagnosis and initial management (National Institute for Health and Care Excellence 2022b)

People with suspected acute stroke (including people already in hospital) should be admitted directly to a hyperacute stroke unit and be assessed for emergency stroke treatments by a specialist clinician without delay.

MRI brain with stroke-specific sequences (DWI with SWI or T2*-weighted imaging) should be considered in patients with suspected acute stroke when there is diagnostic uncertainty.

National Clinical Guideline for Stroke for the United Kingdom and Ireland (Intercollegiate Stroke Working Party 2023)

Pregnancy should not alter the standard of care for stroke (Knight, Kenyon et al. 2014)

8.5 Conclusions

Medication management was once again the main theme identified in the care of women with epilepsy, alongside SUDEP awareness, risk assessment and risk management. Assessors emphasised that pregnancy should not alter the standard treatment pathway for stroke and highlighted the importance of management of hypertension and recognition of symptoms of intracerebral pathology. Information was sufficient to assess care for all 42 women (Table 8.2). Assessors felt that different care might have made a difference for 11 women (26%).

Table 8.2: Classification of care received by women who died from neurological causes, UK and Ireland, 2019-21

Classification of care received	Women who died from epilepsy Number (%) N=17	Women who died from stroke and other neurological causes Number (%) N=25
Good care	2 (12)	10 (40)
Improvements to care which would have made no difference to outcome	10 (59)	9 (36)
Improvements to care which may have made a difference to outcome	5 (29)	6 (24)

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