

Maternal, Newborn and Infant Clinical Outcome Review Programme



Saving Lives, Improving Mothers' Care

Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2018-20

Compiled report including supplementary material



November 2022

Maternal, Newborn and Infant Clinical Outcome Review Programme



Saving Lives, Improving Mothers' Care

Core report: Lessons learned to inform maternity
care from the UK and Ireland Confidential Enquiries
into Maternal Deaths and Morbidity 2018-20

Marian Knight, Kathryn Bunch, Roshni Patel, Judy Shakespeare,
Rohit Kotnis, Sara Kenyon, Jennifer J Kurinczuk (Eds.)

November 2022



Funding

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.

Design by: Sarah Chamberlain and Andy Kirk

Cover Artist: Tana West

This report should be cited as:

Knight M, Bunch K, Patel R, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2018-20. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2022.

ISBN: 978-0-9956854-2-0

Individual chapters from this report should be cited using the format of the following example for chapter 4:

Frise C, Russell S, Kelly T, Shakespeare J, Cranfield K, Mathers R, Bunch K and Knight M on behalf of the MBRRACE-UK diabetes and multimorbidity chapter-writing group. Messages on caring for women with multiple morbidities. In: Knight M, Bunch K, Patel R, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK. Saving Lives, Improving Mothers' Care Core Report - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2018-20. Oxford: National Perinatal Epidemiology Unit, University of Oxford 2022: p34-44

© 2022 Healthcare Quality Improvement Partnership and National Perinatal Epidemiology Unit, University of Oxford

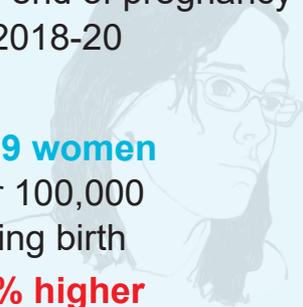
Missing Voices

Key messages from the report 2022



229 women died during or up to six weeks after the end of pregnancy in 2018-20

10.9 women per 100,000 giving birth
24% higher than 2017-19

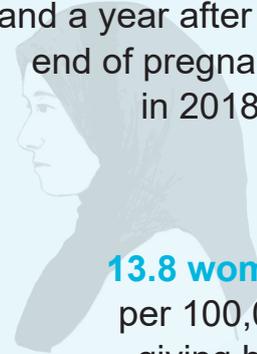


27 of their babies died
366 motherless children remain



A further **289 women** died between six weeks and a year after the end of pregnancy in 2018-20

13.8 women per 100,000 giving birth



9 women died from covid-19



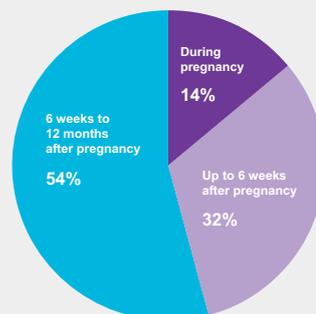
Excluding their deaths, **10.5 women** died per 100,000 giving birth

19% higher than 2017-19

1 in 9 women who died had **severe and multiple disadvantage**



Most women died in the postnatal period **86%**

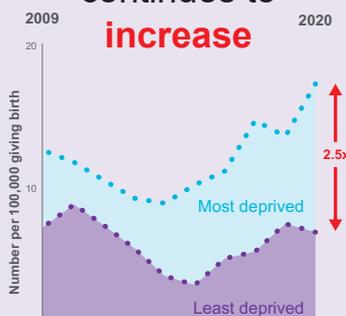


Black women were **3.7x** more likely to die than white women (**34 women** per 100,000 giving birth)

Asian women were **1.8x** more likely to die than white women (**16 women** per 100,000 giving birth)

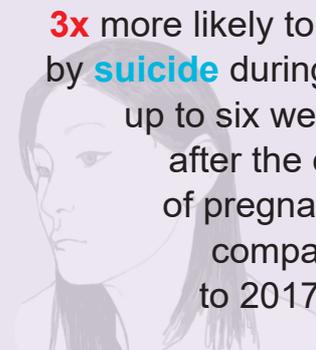


More women from **deprived areas** are dying and this continues to **increase**



In 2020, women were **3x** more likely to die by **suicide** during or up to six weeks after the end of pregnancy compared to 2017-19

1.5 women per 100,000 giving birth



Executive Summary

Introduction

This report, the ninth 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 2018 and 2020 in the UK. In addition, it also includes Confidential Enquiries into the care of women who died between 2018 and 2020 in the UK and Ireland from cardiovascular causes, hypertensive disorders, early pregnancy disorders and accidents and the care of women who died from mental-health related causes in 2020.

The report also includes a Morbidity Confidential Enquiry into the care of women with diabetic ketoacidosis in pregnancy.

Surveillance information is included for 536 women who died during or up to one year after the end of pregnancy between 2018 and 2020. The care of 61 women with diabetic ketoacidosis in pregnancy was reviewed in depth for the Confidential Enquiry chapter.

This report can be read as a single document; each chapter is also designed to be read as a standalone report as, although the whole report is relevant to maternity staff, service providers and policy-makers, there are specific clinicians and service providers for whom only single chapters are pertinent. There are seven different chapters which may be read independently, the topics covered are: 1. Surveillance of maternal deaths 2. Mental health and multiple adversity 3. Diabetic ketoacidosis (morbidity enquiry) 4. Cardiovascular disease 5. Hypertensive disorders of pregnancy 6. Early pregnancy disorders 7. Critical care.

Methods

Maternal deaths are reported to MBRRACE-UK, NIMACH or to MDE Ireland by the staff caring for the women concerned, or through other sources including coroners, procurators fiscal and media reports. In addition, identification of deaths is cross-checked with records from the Office for National Statistics, Information Services Division Scotland and National Records of Scotland. Each woman's care is examined by between ten and fifteen multidisciplinary expert reviewers and assessed against current guidelines and standards (such as that produced by NICE or relevant Royal Colleges and other professional organisations). Subsequently the expert reviews of each woman's care are examined by a multidisciplinary writing group to enable the main themes for learning to be drawn out for the MBRRACE-UK report. These recommendations for future care are presented here, alongside a surveillance chapter reporting three years of UK statistical surveillance data.

IMPORTANT NOTE: Relevant actions 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. *The phrasing 'All Health Professionals' is used for brevity but should be taken to mean the groups noted above.* Some actions may be more pertinent to specific professional groups than others but all should nonetheless be reviewed for relevance to practice by each group.

Causes and trends

There was a statistically non-significant increase in the overall maternal death rate in the UK between 2015-17 and 2018-20. An increase occurred even when deaths due to covid were excluded which suggests that an even greater focus on implementation of the recommendations of these reports is needed to achieve a reduction in maternal deaths. **ACTION: Policy makers, service planners/commissioners, service managers, all health professionals**

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

Psychiatric disorders and cardiovascular disorders are now responsible for the same number of maternal deaths in the UK; together these two causes represent 30% of maternal deaths. During 2020, maternal mortality directly attributable to covid-19 was at a rate comparable with that due to psychiatric and cardiovascular disorders.

There was a statistically significant increase in maternal death rates from direct causes between 2015-17 and 2018-20. 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 (suicide and substance abuse) account for nearly 40% of deaths occurring within a year after the end of pregnancy with maternal suicide remaining the leading cause of direct deaths in this period. Of concern is a further rise in suicides among young women, many of whom were care leavers.

Key messages to improve care

The majority of recommendations which MBRRACE-UK assessors have identified to improve care are drawn directly from existing guidance or reports and denote areas where implementation of existing guidance needs strengthening. Actions needed for which national guidelines are not available are presented here. All recommendations based on existing guidance are presented in online supplementary material available at www.npeu.ox.ac.uk/mbrrace-uk/reports

New recommendations to improve care

For professional organisations:

1. Develop guidance for the use of Brain Natriuretic Peptide measurement in pregnancy **[ACTION: Royal Colleges of Obstetricians and Gynaecologists, Physicians]**.
2. Develop guidance on ketone testing in pregnancy and the subsequent response to an abnormal test **[ACTION: Royal Colleges of Obstetricians and Gynaecologists, Midwives, Physicians, General Practitioners]**.
3. Ensure that guidance on the management of diabetic ketoacidosis in pregnancy is included in all guidelines used outside of the maternity setting **[ACTION: Joint British Diabetes Societies for Inpatient Care]**.

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

4. Commissioning bodies should ensure that providers of specialist Perinatal Mental Health Teams have sufficient resource to advise, and in complex or high-risk cases, be involved, in mental health assessments when in normal working hours. **[ACTION: Service planners/commissioners, Hospitals/Trusts/Health Boards]**.
5. Consider skills and drills training on the management of diabetic ketoacidosis in pregnancy to ensure that obstetricians and midwives are aware of the symptoms and signs of diabetic ketoacidosis. **[ACTION: Hospitals/Trusts/Health Boards]**.
6. Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
7. Ensure that the national Patient Group Direction allowing prescription of aspirin for pregnant women at risk of pre-eclampsia by midwives and pharmacists is widely implemented **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
8. Ensure that women's electronic records can be easily accessed and shared when they receive care in different settings **[ACTION: National Digital Policy Teams, Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
9. Be aware of how to contact the regional maternal medicine lead for urgent advice to ensure multidisciplinary senior review of women who are unwell. **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards, All Health Professionals]**.
10. Ensure maternal medicine networks and their equivalents in the devolved nations and Republic of Ireland can provide appropriate expertise and supervision for all women including those in rural/remote areas **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards, All Health Professionals]**.
11. Vulnerable and young women remain disproportionately represented amongst those who have died from ectopic pregnancy. Ensure care is personalised to provide appropriate additional safety measures **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.
12. Recognise the importance of a trauma history in the assessment of risk. Involve specialist Perinatal Mental Health Teams where there is a history of significant involvement with secondary mental health services or significant risk, particularly if it is a first pregnancy **[ACTION: Service planners/commissioners, service managers, health professionals]**.
13. Allow sufficient opportunity in electronic records systems for free text comment rather than relying solely on 'tick boxes'. Where a woman has a history of mental health difficulties, make a brief (as a minimum) comment on mental health **[ACTION: Service planners/commissioners, service managers, health professionals]**.

For health professionals and those designing professional education programmes:

14. Assess women with persistent and severe insomnia carefully for signs of underlying mental illness **[ACTION: All health professionals]**.
15. Access services such as Psychiatric Liaison, Crisis and Street Triage Teams should alert specialist Perinatal Mental Health Teams to any referrals of self-harm in pregnant or postpartum women that they have received to allow triage regarding the need for specialist follow-up **[ACTION: All health professionals]**.

16. Be alert to factors, such as cultural stigma or fear of child removal, which may influence the willingness of a woman or her family to disclose symptoms of mental illness, thoughts of self-harm or substance misuse **[ACTION: All Health Professionals, Professional education programmes]**.
17. Wheeze can be due to pulmonary oedema. Consider wheeze which does not respond to standard asthma management and exertional syncope as red flag symptoms of cardiovascular disease in addition to orthopnoea and chest pain **[ACTION: All Health Professionals, Professional education programmes]**.
18. Be aware of the common risk factors for heart disease and venous thromboembolism, such as extreme obesity, and consider on an individual basis whether women should be made aware of the symptoms and signs of heart disease as well as those of venous thromboembolism **[ACTION: All Health Professionals, Professional education programmes]**.
19. Be aware that women using oral anticoagulation with warfarin may be more safely managed without transition to low molecular weight heparin treatment when having an early termination of pregnancy **[ACTION: All Health Professionals, Professional education programmes]**.
20. Be aware of the added risk of fetal compromise when a woman's pregnancy is complicated by both hypertension and diabetes. It is not only babies predicted to be small for gestational age who may be at risk **[ACTION: All Health Professionals, Professional education programmes]**.
21. Involve the critical care team in antenatal multidisciplinary team planning for women with serious morbidity who are anticipated to require admission to intensive care after giving birth **[ACTION: All Health Professionals]**.

Conclusions

This report includes the surveillance information for women who died during and after pregnancy for 2018-20, which includes the first year of the Covid-19 pandemic, when there were many service-related changes. The clearest impact on maternal mortality rates has been an increase in mental health-related deaths, principally women who have died by suicide. The maternal mortality rate has risen even if women who died from Covid-19 are excluded. Across all the chapters in this report, assessors identified important messages concerning the care of women with multiple adversity and multiple morbidities, who are once again over-represented. The reviews of the care of women who died from Covid-19 are not included here, but impacts of pandemic-related service changes have been noted in several chapters reporting on the care of women who died from other conditions. The majority of women who died from Covid-19 in 2020 were from ethnic minority groups, but it is encouraging that despite this the disparity in maternal mortality rates between women from Black, Asian and Mixed ethnic groups and White women has continued to decrease slightly. Nevertheless, the maternal mortality rate amongst women who live in the most deprived areas is increasing and addressing these disparities 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.

Members of the MBRRACE-UK collaboration:

Jenny Kurinczuk, Professor of Perinatal Epidemiology, Director, National Perinatal Epidemiology Unit, National Programme Lead for MBRRACE-UK, University of Oxford
Marian Knight, Professor of Maternal and Child Population Health, Honorary Consultant in Public Health, Maternal Programme Lead for MBRRACE-UK, University of Oxford
Elizabeth Draper, Professor of Perinatal and Paediatric Epidemiology, Perinatal Programme Lead for MBRRACE-UK, University of Leicester
Charlotte Bevan, Senior Research and Prevention Officer, Sands
Alan Fenton, Consultant Neonatal Paediatrician, The Newcastle upon Tyne Hospitals NHS Foundation Trust
Sara Kenyon, Professor of Evidence Based Maternity Care, University of Birmingham
Rohit Kotnis, General Practitioner, Oxford
Bradley Manktelow, Professor of Medical Statistics, University of Leicester
Roshni Patel, Consultant in Maternal Medicine & Obstetrics, Chelsea and Westminster NHS Foundation Trust (from October 2021)
Janet Scott, Head of Research and Prevention, Sands
Lucy Smith, Professor in Perinatal Health, University of Leicester

Members of the Oxford-based MBRRACE-UK team:

Rachel Smith, Programme Manager
Kate De Blanger, Events Coordinator
Hatty Goddard, Programme Assistant
Miguel Neves, Software Developer
Scott Redpath, C# Developer and Data Manager
Peter Smith, Software Developer
Jemima Roberts, Data Coordinator
Shalimar Sahota, Data Assistant
Oliver Shaw, Administrative Assistant
Ella Sawtell, Administrative Assistant
Rosie Butler, Administrative Assistant

Events Coordination Support: Dagmar Hutt

NPEU Senior Epidemiologist: Kathryn Bunch

Other support staff who assisted on a temporary basis: Victor Diaconu, Roomana Bamboat

MDE Ireland

Edel Manning, MDE Ireland Coordinator, National Perinatal Epidemiology Centre, Cork, Ireland
Michael O'Hare, Chair, Joint Institute of Obstetricians and Gynaecologists/HSE Maternal Mortality Working Group, Ireland

MBRRACE-UK maternal mortality and morbidity confidential enquiry assessors who have undertaken reviews in the last year:

Rachel Addison, Consultant Anaesthetist, King's College Hospital NHS Foundation Trust
James Bamber, Consultant Anaesthetist, Cambridge University Hospitals NHS Foundation Trust
Stephen Brett, Consultant in Intensive Care Medicine, Imperial College Healthcare NHS Trust
Lynne Campbell, Consultant Anaesthetist, Brighton and Sussex University Hospitals NHS Foundation Trust

Steve Cantellow, Consultant Anaesthetist, Nottingham University Hospitals NHS Trust
Linda Dubiel, Consultant Anaesthetist, NHS Tayside
William Fawcett, Consultant Anaesthetist, Royal Surrey County Hospital NHS Foundation Trust
Deborah Horner, Consultant Anaesthetist, Bradford Teaching Hospitals NHS Foundation Trust
Vijay Jagannathan, Consultant in Anaesthetics/Critical Care, North Tees and Hartlepool NHS Foundation Trust
Nuala Lucas, Consultant Anaesthetist, Northwick Park Hospital, London
Rachel Mathers, Consultant Anaesthetist, Southern Health & Social Care Trust
Conan McCaul, Consultant Anaesthetist, The Rotunda Hospital, Dublin
Upma Misra, Consultant Anaesthetist, Sunderland Royal Hospital
Felicity Plaat, Consultant Anaesthetist, Queen Charlotte's and Hammersmith Hospitals, London
Seema Quasim, Consultant Anaesthetist, University Hospitals Coventry & Warwickshire NHSFT
Robin Russell, Consultant Anaesthetist, Oxford University Hospitals NHS Trust
Frank Schroeder, Consultant in Cardiothoracic Anaesthesia And Intensive Care, St George's Healthcare NHS Trust
Michelle Soskin, Consultant Anaesthetist, West Hertfordshire Hospitals NHS Trust
Gary Stocks, Consultant Anaesthetist, Imperial College Healthcare NHS Trust
Carl Waldmann, Consultant Anaesthetist & Intensive Care, Royal Berkshire NHS Foundation Trust
Sarah Wheatly, Consultant Anaesthetist, University Hospital of South Manchester NHSFT
Arlene Wise, Consultant Anaesthetist, NHS Lothian
Suresha Dealmeida, GP, London
Sarah Hillman, GP and NIHR clinical lecturer, Warwickshire
Rohit Kotnis, GP, Oxford
Anne Lashford, GP, Wiltshire
Becky MacGregor, Academic Clinical Fellow in General Practice, Warwickshire
Oliver Starr, GP, Hertfordshire
Chi Eziefula, Senior Lecturer in Infection, Brighton & Sussex Medical School
Claire Mackintosh, Consultant in Infectious Diseases, NHS Lothian
Oliver Koch, Consultant in Infectious Diseases, NHS Lothian
Alison Rodger, Professor of infectious diseases, Royal Free London NHS Foundation Trust
Margarita Bariou, Maternity Governance & Risk Lead, Birmingham Women's & Children's NHS Foundation Trust
Becky Bolton, Midwife, North West Anglia NHS Foundation Trust
Andrew Brown, Risk Management Midwife, Harrogate and District NHS Foundation Trust
Louise Clarke, Midwife, University Hospitals Coventry & Warwickshire NHST
Philippa Cox, Consultant Midwife, Homerton University Hospital NHS Foundation Trust
Fiona Cross-Sudworth, Midwife, Birmingham Women's and Children's NHS Foundation Trust
Becky Ferneyhough, Midwife, Betsi Cadwaladr University Health Board
Nicky Gammie, Senior Charge Midwife, NHS Borders
Fiona Hanrahan, Assistant Director of Midwifery & Nursing, The Rotunda Hospital, Dublin
Laura Menzies, Operational Unit Lead Midwife, NHS Highland
Kim Morley, Epilepsy specialist midwife, Hampshire Hospitals NHS Foundation Trust
Rebecca Percival, Project Midwife for Maternity Transformation Programme/Better Births
Catherine Pritchard, Clinical Supervisor for Midwives, Betsi Cadwaladr University Health Board
Lisa Relton, Midwife, Poole Hospital NHS Foundation Trust
Sophie Russell, Consultant Midwife, Lewisham and Greenwich NHS trust
Ceri Staples, Midwifery Sister, University Hospitals Plymouth NHS Trust
Meg Wilkinson, Consultant Midwife, University College London Hospitals NHSFT
Kaye Wilson, Head of Maternity Commissioning for North Central London
Philip Banfield, Consultant Obstetrician and Gynaecologist, Betsi Cadwaladr University Health Board
Chandrima Biswas, Consultant Obstetrician/Clinical Director, Whittington Health
Janet Brennand, Consultant in Maternal & Fetal Medicine, Southern General Hospital, Glasgow
David Churchill, Consultant Obstetrician (Maternal and Fetal Medicine), The Royal Wolverhampton Hospitals NHS Trust
Mandish Dhanjal, Consultant Obstetrician and Gynaecologist/Clinical Director, Imperial College Healthcare NHS Trust
Joanna Girling, Consultant Obstetrician and Gynaecologist, Chelsea and Westminster Hospital NHS Foundation Trust
Malcolm Griffiths, Consultant in Obstetrics and Gynaecology, Luton and Dunstable Hospital NHS Foundation Trust
Kate Harding, Consultant Obstetrician, St. Thomas' Hospital, London
Teresa Kelly, Consultant Obstetrician, Manchester University NHS Foundation Trust
Dawn Kernaghan, Consultant Obstetrician, NHS Greater Glasgow & Clyde
Alison Kirkpatrick, Consultant in Obstetrics and Gynaecology, Frimley Park Hospital NHS Trust
Rachel Liebling, Consultant Obstetrician, University Hospitals of Bristol NHSFT
Hilary MacPherson, Consultant Obstetrician and Gynaecologist, Forth Valley Royal Hospital
Imogen Montague, Consultant Obstetrician and Gynaecologist, Plymouth Hospitals NHS Trust

Avideah Nejad, Consultant Obstetrician, Hampshire Hospitals NHS Foundation Trust
Roshni Patel, Consultant in Maternal Medicine & Obstetrics, Chelsea and Westminster NHS Foundation Trust
Sarah Vause, Consultant in Fetal and Maternal Medicine, St. Mary's Hospital, Manchester
Stephen Wild, Clinical Lead and Consultant Obstetrician, North Tees & Hartlepool NHS Foundation Trust
Simi George, Consultant Pathologist, Guy's and St Thomas' NHS Foundation Trust
Samantha Holden, Consultant Paediatric Pathologist, Southampton University Hospitals NHS Foundation Trust
Sebastian Lucas, Professor of Pathology, Guy's and St Thomas' NHS Foundation Trust
Esther Youd, Consultant Histopathologist, Cwm Taf Health Board
Aisling Carroll, Consultant Cardiologist, University Hospitals Southampton NHS Foundation Trust
Bernard Clarke, Consultant Cardiologist and Lead for Maternal Cardiology, Central Manchester University Hospitals NHS Foundation Trust
Catherine Head, Consultant Cardiologist, Guy's and St Thomas' NHS Foundation Trust
Rachael James, Consultant Cardiologist, Brighton and Sussex University Hospitals NHS Trust
Sreeman Andole, Consultant in Stroke Medicine, Asst. Medical Director NHS England, Kings College Hospital NHS Foundation Trust
Pooja Dassan, Consultant Neurologist, London North West University Healthcare NHS Trust
Adrian Wills, Consultant Neurologist and Honorary Clinical Associate Professor, Nottingham University Hospitals NHS Trust
Anita Banerjee, Consultant Obstetric Physician, Guy's and St Thomas' NHS Foundation Trust and Imperial College Healthcare Trust
Paula Chattington, Consultant Diabetes, Endocrinology and General Medicine, Warrington & Halton Hospitals NHS Foundation Trust
Charlotte Frise, Consultant Obstetric Physician, Oxford University Hospitals NHS Trust
Lucy MacKillop, Consultant Obstetric Physician, Oxford University Hospitals NHS Trust (to Dec 2019)
Clare Mumby, Consultant Physician General Medicine, Diabetes and Endocrinology, Manchester University NHS Foundation Trust
Catherine Nelson-Piercy, Consultant Obstetric Physician, Guy's and St Thomas' NHS Foundation Trust and Imperial College Healthcare Trust
Francesca Neuberger, Consultant in Acute Medicine, North Bristol NHS Trust
Julie Anderson, Consultant Psychiatrist, Northern Health and Social Care Trust
Andrew Cairns, Consultant Perinatal Psychiatrist, Northumberland, Tyne and Wear NHS Trust
Sarah Cohen, Consultant Perinatal Psychiatrist, Hertfordshire Partnership University NHS Foundation Trust
Rowan Pearson, Associate Specialist in Perinatal Psychiatry, Leeds and York Partnerships NHS Foundation Trust
Anthony McCarthy, Consultant Psychiatrist, National Maternity Hospital, Dublin
Sue Smith, Consultant Perinatal Psychiatrist, Cardiff and Vale University Health Board
Shammi Ramlakhan, Consultant in Accident and Emergency, Royal Free London NHS Trust

Office for National Statistics

Karen J Williams, Joanne Copsey, Anne Baker, Alex Howland, Justine Pooley

NHS Digital

Oliver Smith, Denise Pine, Dave Cronin and the Data Applications Team

National Records of Scotland

Julie Ramsay, Maria Kay, Shirley White

Information Services Division Scotland, NHS National Services Scotland

Rachael Wood, Kirsten Monteath, Carole Morris

Northern Ireland Maternal and Child Health, NSC Public Health Agency

Heather Reid, Sinead Magill, Amy Watson, Melissa McAtamney

UK Obstetric Surveillance System

Melanie O'Connor, Hatty Goddard, Anna Balchan

The Maternal, Newborn and Infant Clinical Outcome Review Independent Advisory Group

Matthew Jolly, National Clinical Director for Maternity Review and Women's Health, NHS England (Chair)
Carol Beattie, Senior Medical Officer, Department of Health, Northern Ireland
Liz Brigante, Head of Quality and Standards, Royal College of Midwives
Kirstie Campbell, Unit Head, Maternal and Infant Health, Directorate of Children and Families, Scottish Government
Sarah Corcoran, Team leader, Maternal and Infant Health, Scottish Government
Jacqueline Dunkley-Bent, Chief Midwifery Officer, Nursing Directorate, NHS England
Becky Gunn, Chair of the Royal College of Obstetricians and Gynaecologists Women's Network
Karen Jewell, Nursing Officer for Maternity and Early Years, Welsh Government
Corinne Love, Senior Medical Officer (Obstetrics), Scottish Government
Eddie Morris, Consultant, Obstetrics and Gynaecology, Norfolk and Norwich University Hospital, President, Royal College of Obstetricians and Gynaecologists
Karen Todd, Maternity and Children's Health, Department of Health and Social Care
Zeenath Uddin, Head of Quality and Standards, Royal College of Midwives
Michele Upton, Head of Maternity and Neonatal Safety, NHS England and NHS Improvement
David Williams, Consultant Obstetric Physician, University College Hospital, London

Healthcare Quality Improvement Partnership

Tina Strack, Associate Director for Quality and Development, National Clinical Audit and Patient Outcomes Programme
Vivien Dunne, Project Manager

MBRRACE-UK Third Sector Stakeholder Group and Representatives

Clotilde Abe, Fivexmore
Atinuke Awe, Fivexmore
Beverly Beech, AIMS for Better Births
Charlotte Bevan, Sands
Jenny Chambers, ICP Support
Ann Chalmers, CBUK
Debbi Chippington Derrick, AIMS for Better Births
Jo Dagustun, AIMS for Better Births
Jane Denton, MBF
Elizabeth Duff, NCT
Ian Evans, CAPT
Jane Fisher, ARC
Jane Gorringer, Twins Trust
Marcus Green, APEC
Clea Harmer, Sands
Michelle Hemmington, Campaign for Safer Births
Jennifer Holly, NCT
Kirsty Kitchen, Birth Companions
Caroline Lee Davey, BLISS
Nicky Lyon, Campaign for Safer Births
Therese McAlorum, CBUK
Amy McCarthy, Twins Trust
Sarah McMullen, NCT
Ashley Martin, ROSPA
Mehali Patel, Sands
Nilushka Perera, Best Beginnings
Jane Plumb, GBS Support
Keith Reed, Twins Trust
Jessica Reeves, Sands
Janet Scott, Sands
Fiona Spargo-Mabbs, DSM Foundation
Claire Storey, ISA
Liz Thomas, AvMA
Cheryl Titherly, ARC
Maureen Tredwell, BTA

Natalie Turvile, Elizabeth Bryan Multiple Births Centre
Jenny Ward, Lullaby Trust
Pete Wallroth, Mummy's Star
Antonia Woodman, Maternal Mental Health Alliance

MBRRACE-UK Royal College and Professional Association Stakeholder Group and Representatives

Carmel Bagness, Royal College of Nursing
Sanjeev Deshpandi, British Association of Perinatal Medicine
Anita Dougall, Royal College of Obstetricians and Gynaecologist
Pamela Boyd, Royal College of Nursing
Denise Evans, Neonatal Nurses Association
Mervi Jokinen, Royal College of Midwives
Tamas Martan, British and Irish Paediatric Pathology Association
Surabhi Nanda, British Maternal Fetal Medicine Society
Marcia Philbin, Royal College of Paediatrics and Child Health
Felicity Plaat, Obstetric Anaesthetists Association and Royal College of Anaesthetists
Elena Pollina, British and Irish Paediatric Pathology Association
Shammi Ramlakhan, Royal College of Emergency Medicine
Rachel Scanlan, Royal College of Midwives
Trudi Seneviratne, Royal College of Psychiatrists
Melissa Whitworth, British Maternal Fetal Medicine Society
Rachel Winch, Royal College of Paediatrics and Child Health

Glossary of terms

| | | | |
|-----------------|---|-------------------|---|
| ACE | Angiotensin-converting enzyme | IMD | Index of Multiple Deprivation |
| AF | Atrial fibrillation | ITU | Intensive Therapy Unit |
| AFLP | Acute fatty liver disease of pregnancy | IV | Intravenous |
| BAP | British Association for Psychopharmacology | IVF | In vitro fertilisation |
| BAPM | British Association of Perinatal Medicine | JBPS-IP | Joint British Diabetes Societies for Inpatient care |
| BMI | Body Mass Index | LMWH | Low molecular weight heparin |
| BNP | Brain Natriuretic Peptide | MBRRACE-UK | Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK |
| BP | Blood pressure | MDE | Maternal Death Enquiry |
| CEMD | Confidential Enquiries into Maternal Deaths | MEWS | Maternity Early Warning Score |
| CI | Confidence interval | MEOWS | Maternity Early Obstetric Warning System |
| CKS | Clinical Knowledge Summaries | MRI | Magnetic Resonance Imaging |
| CMACE | Centre for Maternal and Child Enquiries | NCAPOP | National Clinical Audit and Patient Outcomes Programme |
| COVID-19 | Coronavirus disease 2019 | NHS | National Health Service |
| CT | Computerised Tomography | NICE | National Institute for Health and Care Excellence |
| CTPA | Computerised Tomography Pulmonary Angiogram | NICU | Neonatal Intensive Care Unit |
| EACTS | European Association for Cardio-Thoracic Surgery | NIMACH | Northern Ireland Maternal and Child Health |
| ECG | Electrocardiogram | ONS | Office for National Statistics |
| ECMO | Extracorporeal Membrane Oxygenation | PPCM | Peripartum cardiomyopathy |
| ESC | European Society for Cardiology | RCOG | Royal College of Obstetricians and Gynaecologists |
| ESPEN | European Society for Clinical Nutrition and Metabolism | RCP | Royal College of Physicians |
| EWS | Early warning systems | RCPPath | Royal College of Pathologists |
| FAST | Focussed Assessment with Sonography in Trauma | RR | Rate ratio |
| GP | General practitioner | RRR | Ratio of relative risks |
| GMC | General Medical Council | SADS/MNH | Sudden arrhythmic death syndrome with a morphologically normal heart |
| Hb | Haemoglobin | SARS-CoV-2 | Severe Acute Respiratory Syndrome Coronavirus 2 |
| HbA1c | Glycated Haemoglobin (A1c) | SCAD | Spontaneous coronary artery dissection |
| hCG | Human Chorionic Gonadotrophin | SIGN | Scottish Intercollegiate Guidelines Network |
| HELLP | Haemolysis, elevated Liver enzymes and Low Platelet count | SSRI | Selective serotonin reuptake inhibitors |
| HQIP | Healthcare Quality Improvement Partnership | STEMI | ST-elevation myocardial infarction |
| HSE | Health Service Executive | UKOSS | UK Obstetric Surveillance System |
| HSIB | Health Safety Investigation Branch | VTE | Venous thromboembolism |
| ICD-MM | International Classification of Diseases – Maternal Mortality | WHO | World Health Organisation |
| ICU | Intensive Care Unit | | |

Contents

| | |
|---|-----------|
| 1. Introduction and methods | 1 |
| 2. Maternal Mortality in the UK 2018-20: Surveillance and Epidemiology | 2 |
| 2.1 Key points | 2 |
| 2.2 Causes and trends | 2 |
| 2.3 The characteristics of women who died 2018-20 | 11 |
| 3. Improving mental health care and care for women with multiple adversity | 21 |
| 3.1 Key message | 21 |
| 3.2 Background | 22 |
| 3.3 The women who died | 23 |
| 3.4 Overview of care and new lessons to be learned | 27 |
| 3.5 Conclusions | 33 |
| 4. Messages on caring for women with multiple morbidities | 34 |
| 4.1 Key messages | 34 |
| 4.2 Background | 35 |
| 4.3 The women whose care was reviewed | 35 |
| 4.4 Overview of care and new lessons to be learned | 36 |
| 4.5 Conclusions | 44 |
| 5. Lessons on cardiovascular care | 45 |
| 5.1 Key messages | 45 |
| 5.2 Background | 46 |
| 5.3 The women who died | 46 |
| 5.4 Overview of care and new lessons to be learned | 50 |
| 5.5 Pathology in maternal cardiac deaths | 60 |
| 5.6 Conclusions | 62 |
| 6. Lessons on prevention and treatment of hypertensive disorders | 63 |
| 6.1 Key messages | 63 |
| 6.2 Background | 64 |
| 6.3 The women who died | 64 |
| 6.4 Overview of care and new lessons to be learned | 66 |
| 6.5 Conclusions | 73 |
| 7. Lessons on caring for women with early pregnancy disorders | 74 |
| 7.1 Key messages | 74 |
| 7.2 Background | 74 |
| 7.3 The women who died | 74 |
| 7.4 Overview of care and new lessons to be learned | 75 |
| 7.5 Conclusions | 77 |
| 8. Lessons for critical care | 78 |
| 8.1 Key messages | 78 |
| 8.2 Background | 78 |
| 8.3 The women who died | 79 |
| 8.4 Overview of care and new lessons to be learned | 79 |
| 8.5 Conclusions | 84 |
| 9. References | 85 |

1. Introduction and methods

In accordance with funder requirements, this report is has been considerably shortened and will no longer include an update on actions which have followed previous reports. Readers are referred to the 2016 report (Knight, Nair et al. 2016) for a full description of the methods of the confidential enquiry into maternal deaths, and to chapter 4 for a description of the methods for this year's confidential enquiry into maternal morbidity, which focussed on diabetes and multimorbidity.

Key to colour coding

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

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

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

Existing guidance requiring improved implementation is presented in green boxes

NICE 2345

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

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

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

2. Maternal Mortality in the UK 2018-20: Surveillance and Epidemiology

Kathryn Bunch and Marian Knight

2.1 Key points

There was a statistically non-significant increase in the overall maternal death rate in the UK between 2015-17 and 2018-20. An increase occurred even when deaths due to covid were excluded which suggests that an even greater focus on implementation of the recommendations of these reports is needed to achieve a reduction in maternal deaths. **ACTION: Policy makers, service planners/commissioners, service managers, all health professionals**

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

Eleven percent of the women who died during or up to a year after pregnancy in the UK in 2018-20 were at severe and multiple disadvantage. The main elements of multiple disadvantage were a mental health diagnosis, substance use and domestic abuse.

Psychiatric disorders and cardiovascular disorders are now responsible for the same number of maternal deaths in the UK; together these two causes represent 30% of maternal deaths. During 2020, maternal mortality directly attributable to covid-19 was at a rate comparable with that due to psychiatric and cardiovascular disorders.

There was a statistically significant increase in maternal death rates from direct causes between 2015-17 and 2018-20. 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 (suicide and substance abuse) account for nearly 40% of deaths occurring within 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, 247 women died in 2018-20 during or within 42 days of the end of pregnancy in the UK. The deaths of 18 women were classified as coincidental. Thus in this triennium 229 women died from direct and indirect causes, classified using ICD-MM (World Health Organisation 2012), among 2,101,829 maternities, a maternal death rate of 10.90 per 100,000 maternities (95% CI 9.53 – 12.40). This compares to the rate of 8.79 per 100,000 maternities (95% CI 7.58 – 10.12) in 2017-19 (rate ratio (RR) 1.24, 95% CI 1.02-1.51, $p=0.028$). Nine of the deaths which occurred between March and December 2020 were directly attributable to Covid-19 infection. If these nine deaths are excluded, the maternal mortality rate for 2018-20 would be 10.47 (95% CI 9.13 – 11.95) still higher than the rate for 2017-19 (RR 1.19 (95%CI 0.98 – 1.45), $p=0.077$) but no longer significantly so. 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 2018-20 (rate ratio (RR) 0.78, 95% CI 0.65-0.93, $p=0.005$ for trend in rolling rates over time). The direct maternal death rate has decreased by 23% since 2003-05 with a RR of 0.77 (95% CI 0.59-0.99 $p=.036$) while there was a 21% decrease in the rate of indirect maternal deaths (RR 0.79, 95% CI 0.62-1.02, $p=0.059$).

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 2010-12 and 2018-20 triennia. Over this time, maternal mortality has increased by 8%, (RR 1.08, 95% CI 0.90-1.30). Excluding 2020 maternal deaths from covid-19, maternal mortality over this period has increased by 3% (RR 1.03, 95% CI 0.86-1.27).

The rates of overall mortality and indirect maternal death in the 2018-20 triennium were not statistically significantly different from the rates in 2015-17, the immediately preceding triennium (RR for overall mortality = 1.19, 95% CI 0.98 to 1.44, $p=0.071$; RR for indirect deaths = 1.07, 95% CI 0.82 to 1.38, $p=0.613$)(excluding 9 deaths from covid-19 RR for overall mortality = 1.14, 95% CI 0.94 to 1.14, $p=0.169$; RR for indirect deaths = 0.99, 95% CI 0.76 to

1.29, p=0.922). The direct maternal death rate has however risen significantly between 2015-17 and 2018-20 (RR 1.36, 95% CI 1.02 to 1.82, p=0.033). It is concerning that maternal mortality rates, overall, direct and indirect have increased, albeit the increase is only statistically significant for direct deaths.

Triennial rates are shown in Table 2.2 and Figure 2.2, and suggest that the decrease in maternal mortality reported previously is no longer evident in the most recent triennium.

Table 2.1: Three-year rolling average direct and indirect maternal mortality rates per 100,000 maternities, deaths classified using ICD-MM; UK 2003-20

| 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 |

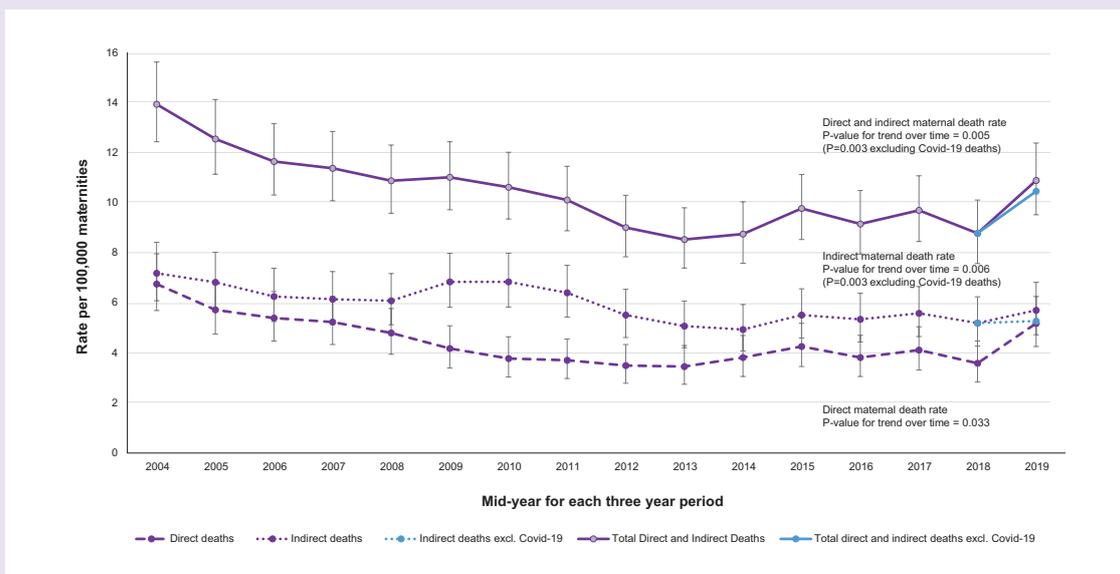
Sources: CMACE, MBRRACE-UK, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency

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

| 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 |

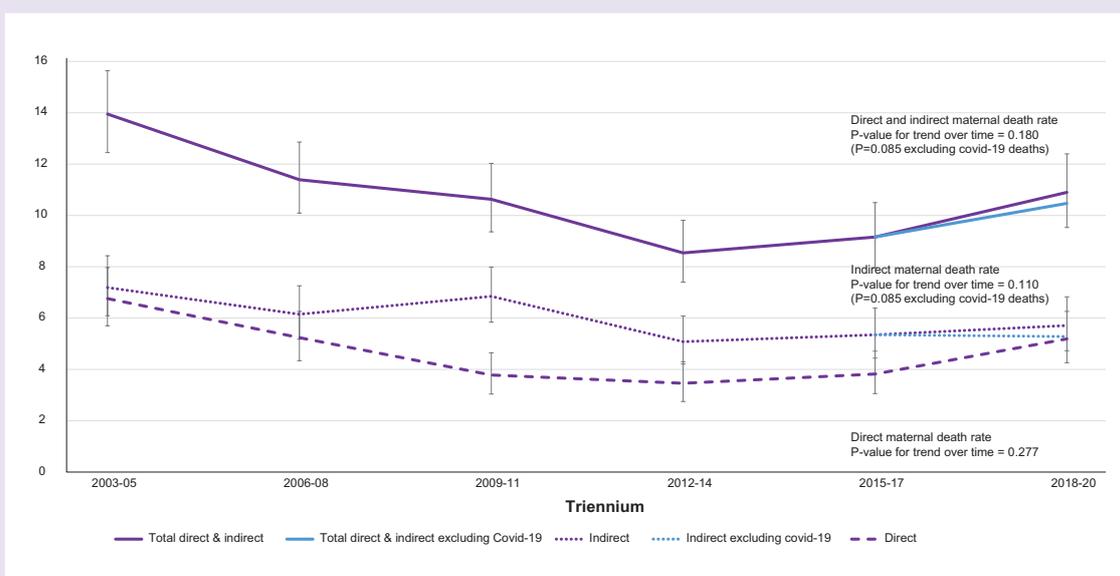
Sources: CMACE, MBRRACE-UK, Office for National Statistics, General Register Office for Scotland, Northern Ireland Statistics and Research Agency

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 2003-2020



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)

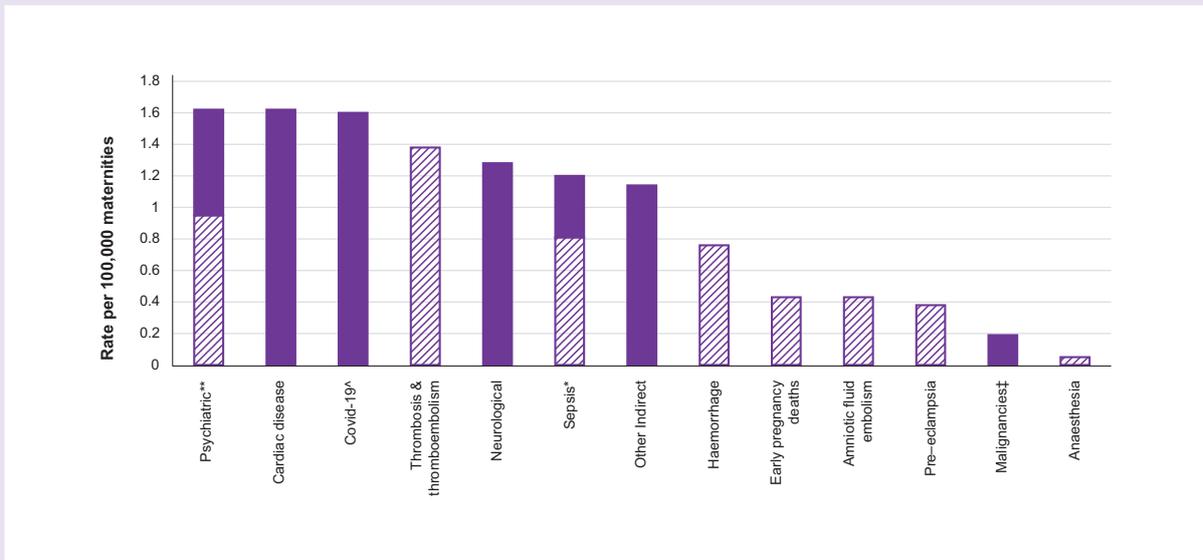


Sources: CMACE, MBRRACE-UK

Deaths due to individual causes

Maternal deaths by cause are shown in Tables 2.3 and 2.4, and Figure 2.3. Rolling three-year rates for individual causes are presented for five overlapping triennial reporting periods (2014-16, 2015-17, 2016-18, 2017-19 and 2018-20) (Table 2.3 and Figure 2.3) and for discrete, non-overlapping triennial periods between 1985-7 and 2018-20 (Table 2.4). This current report is the final report in a three-year cycle, therefore Table 2.4 has been newly updated with the latest triennial figures; 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 2018-20



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

*Rate for direct sepsis (genital tract sepsis and other pregnancy related infections) is shown in hatched and rate for indirect sepsis (influenza, pneumonia, others) in solid bar;

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

‡Rate for indirect malignancies (breast/ovary/cervix);

^Rate for Covid-19 deaths calculated using maternities March to December 2020 as denominator.

Source: MBRRACE-UK

Table 2.3: Maternal mortality rates per 100,000 maternities, by cause, by overlapping triennia, 2014 to 2020

| | 2014-16 | | | 2015-17 | | | 2016-18 | | | 2017-19 | | | 2018-20 | | |
|--|---------|-------|---------------|---------|-------|---------------|---------|-------|---------------|---------|-------|---------------|---------|-------|---------------|
| | n | Rate | 95% CI |
| All Direct and Indirect deaths | 225 | 9.78 | 8.54 - 11.14 | 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 |
| Direct deaths | | | | | | | | | | | | | | | |
| Pregnancy related infections - Sepsis* | 11 | 0.48 | 0.24 - 0.86 | 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 |
| Pre-eclampsia and eclampsia | 6 | 0.26 | 0.10 - 0.57 | 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 |
| Thrombosis and thromboembolism | 32 | 1.39 | 0.95 - 1.96 | 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 |
| Amniotic fluid embolism | 9 | 0.39 | 0.18 - 0.74 | 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 |
| Early pregnancy deaths | 3 | 0.13 | 0.03 - 0.38 | 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 |
| Haemorrhage | 18 | 0.78 | 0.46 - 1.24 | 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 |
| Anaesthesia | 1 | 0.04 | 0.001 - 0.24 | 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 |
| Psychiatric causes - Suicides | 16 | 0.70 | 0.40 - 1.13 | 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 |
| Malignancy - direct | 1 | 0.04 | 0.001 - 0.24 | 1 | 0.04 | 0.001 - 0.24 | - | - | - | - | - | - | - | - | - |
| Unascertained - direct | 1 | 0.04 | 0.001 - 0.24 | 2 | 0.09 | 0.01 - 0.32 | 1 | 0.05 | 0.001 - 0.25 | - | - | - | - | - | - |
| All Direct | 98 | 4.26 | 3.46 - 5.19 | 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 |
| Indirect | | | | | | | | | | | | | | | |
| Cardiac disease | 55 | 2.39 | 1.80 - 3.11 | 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 |
| Indirect Sepsis - Influenza | 2 | 0.09 | 0.01 - 0.31 | 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 |
| Indirect Sepsis - Pneumonia/ others | 6 | 0.26 | 0.10 - 0.57 | 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 |
| Indirect sepsis - Covid-19 | | | | | | | | | | | | | 9 | 1.60 | 0.73 - 3.04 |
| Other Indirect causes | 26 | 1.13 | 0.74 - 1.66 | 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 |
| Indirect neurological conditions | 24 | 1.04 | 0.67 - 1.55 | 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 |
| Psychiatric causes: Drugs/alcohol/others | 6 | 0.26 | 0.10 - 0.57 | 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 |
| Indirect malignancies | 8 | 0.35 | 0.15 - 0.69 | 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 |
| All Indirect | 127 | 5.52 | 4.60 - 6.57 | 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 |
| Coincidental | | | | | | | | | | | | | | | |
| Homicide | 10 | 0.43 | 0.21 - 0.80 | 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 |
| Other coincidental | 24 | 1.04 | 0.67 - 1.55 | 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 |
| All coincidental | 34 | 1.48 | 1.02 - 2.06 | 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 |
| Late deaths | 286 | 12.43 | 11.03 - 13.95 | 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 |

*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 | 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 | 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 | 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

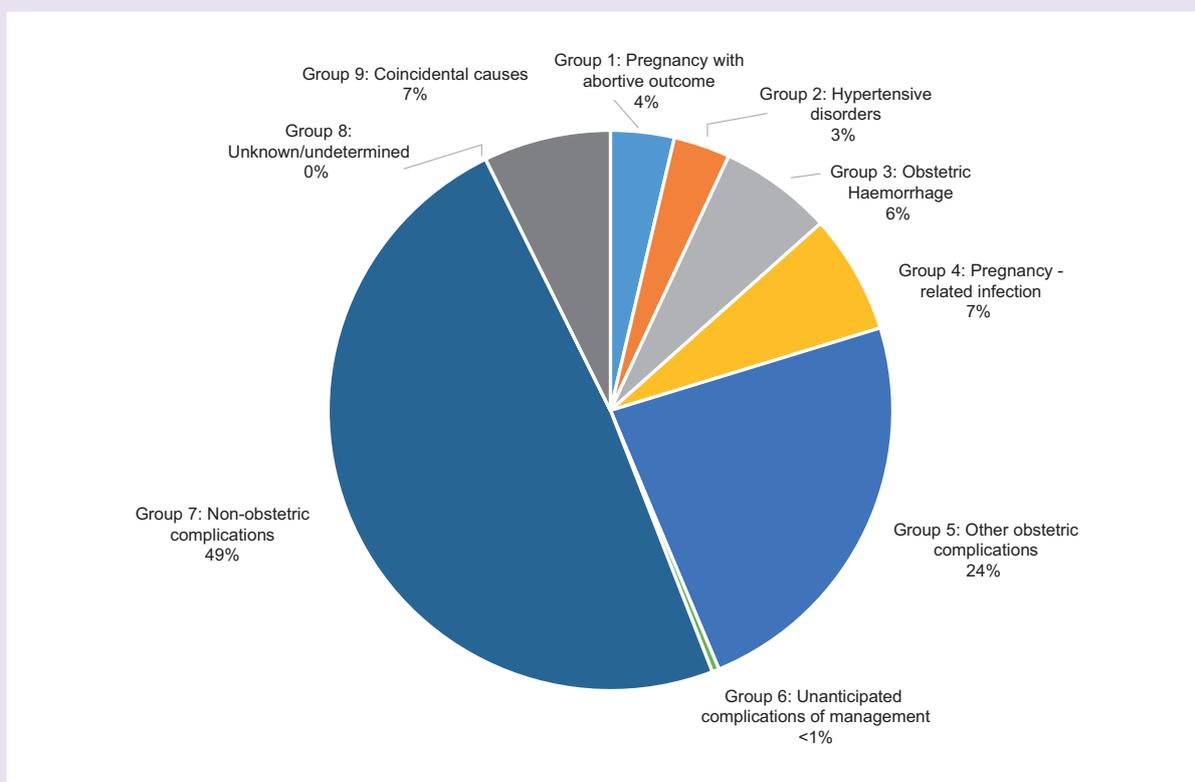
Sources: CMACE, MBRRACE-UK

Table 2.5: Maternal mortality rates per 100,000 maternities, by cause, by overlapping triennia, using ICD-MM classification, 2014 to 2020

| Cause of death | 2014-16 | | | 2015-17 | | | 2016-18 | | | 2017-19 | | | 2018-20 | | |
|--|---------|------|--------------|---------|------|--------------|---------|------|--------------|---------|------|--------------|---------|------|--------------|
| | n | Rate | 95% CI |
| Direct causes | | | | | | | | | | | | | | | |
| Group 1: Pregnancy with abortive outcome | 3 | 0.13 | 0.03 – 0.38 | 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 |
| Group 2: Hypertensive disorders | 6 | 0.26 | 0.10 – 0.57 | 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 |
| Group 3: Obstetric Haemorrhage | 18 | 0.78 | 0.46 – 1.24 | 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 |
| Group 4: Pregnancy-related infection | 11 | 0.48 | 0.24 – 0.86 | 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 |
| Group 5: Other obstetric complications | 59 | 2.56 | 1.95 – 3.31 | 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 |
| Group 6: Unanticipated complications of management | 1 | 0.04 | 0.001 – 0.24 | 1 | 0.04 | 0.001 – 0.24 | 1 | 0.05 | 0.001 – 0.25 | 1 | 0.05 | 0.001 – 0.30 | 1 | 0.05 | 0.001 – 0.27 |
| Indirect causes | | | | | | | | | | | | | | | |
| Group 7: Non-obstetric complications | 127 | 5.52 | 4.60 – 6.57 | 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 |
| Group 8: Unknown/undetermined | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - |
| Coincidental causes | | | | | | | | | | | | | | | |
| Group 9: Coincidental causes | 34 | 1.48 | 1.02 – 2.06 | 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 |

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 2018-20



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). The maternal mortality rate from VTE remains at a similar rate to 2015-17, suggesting that several of these deaths could be prevented with improvements to care.

Deaths due to suicide, sepsis and obstetric haemorrhage are the next most frequent direct causes of maternal death. There has been a statistically significant increase in the rate of suicide during pregnancy and up to six weeks after pregnancy in the UK, comparing 2017-19 with 2020. 10 women died out of 2,173,810 women giving birth in 2017-19 (0.46 per 100,000) compared with 10 out of 674,377 in 2020 (1.48 per 100,000) (RR 3.22, 95% CI 1.20-8.63, $p=0.012$), thus review of suicide deaths for 2020 has been expedited and messages for care are described in Chapter 3. Note, as described in Chapter 3, that the majority of maternal suicide deaths occur between six weeks and a year after pregnancy. The rate of maternal mortality from haemorrhage remains little changed from last year. The mortality rate for pregnancy related sepsis has continued to increase steadily, and is now statistically significantly higher than at its nadir in 2012-14, emphasising the messages from the 2021 rapid report which highlighted the importance of 'thinking sepsis, and not just COVID-19'. The maternal death rate from pre-eclampsia and eclampsia continues to be low but remains more than four times higher than the lowest observed rate, in 2012-14. Mortality rates from amniotic fluid embolism and anaesthesia remain essentially unchanged with continuing extremely low rates due to anaesthetic causes.

Indirect deaths

Deaths due to indirect causes comprise just over half (52%) of direct and indirect maternal deaths in the UK. As in previous reports, cardiac disease remains the largest single cause of indirect maternal deaths (Figure 2.3). There has been a decrease in the maternal mortality rate from cardiac disease since enhanced case ascertainment was introduced, but this is not statistically significant (RR 0.71, 95% CI 0.45-1.13 when comparing 2018-20 with 2003-05). Across the 2018-20 triennium as a whole, neurological causes are the second most common indirect cause of maternal death, with a statistically non-significant decrease in mortality rate. Mortality rates from other indirect causes have increased slightly although non significantly since 2015-17 (RR 1.13, 95% CI 0.61-2.10). Between March and December 2020, 9 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 1.60 per 100,000 maternities (95% CI 0.73-3.04). There is little doubt that changes to and pressures on maternity services as a result of the Covid-19 pandemic also contributed to some of the other maternal deaths during this same period; relevant messages for care are highlighted in specific chapters and in the previously-released rapid reports (Knight, Bunch et al. 2020, Knight, Bunch et al. 2021a).

International comparison

For international comparison, data are presented in Table 2.6 to highlight the maternal mortality ratios estimated for the UK using routinely reported data. The rate estimate from routine sources of data is much lower (just over half) than the actual rates as identified through the UK CEMD, which uses multiple sources of death identification. This emphasises the importance of the additional case identification and checking undertaken by the MBRRACE-UK team to give an accurate maternal mortality estimate.

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 Maternal Mortality Ratio and not the rate as elsewhere in the report.

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

In the triennium 2018-20, 289 women died between six weeks and one year after the end of pregnancy, representing a mortality rate of 13.7 per 100,000 maternities (95% CI 12.2 – 15.4). There has been no change in the rate of late pregnancy-related deaths since the first MBRRACE-UK confidential enquiry report. Rolling rates of late deaths are shown in Figure 2.5 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 38% 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, 2009-2020

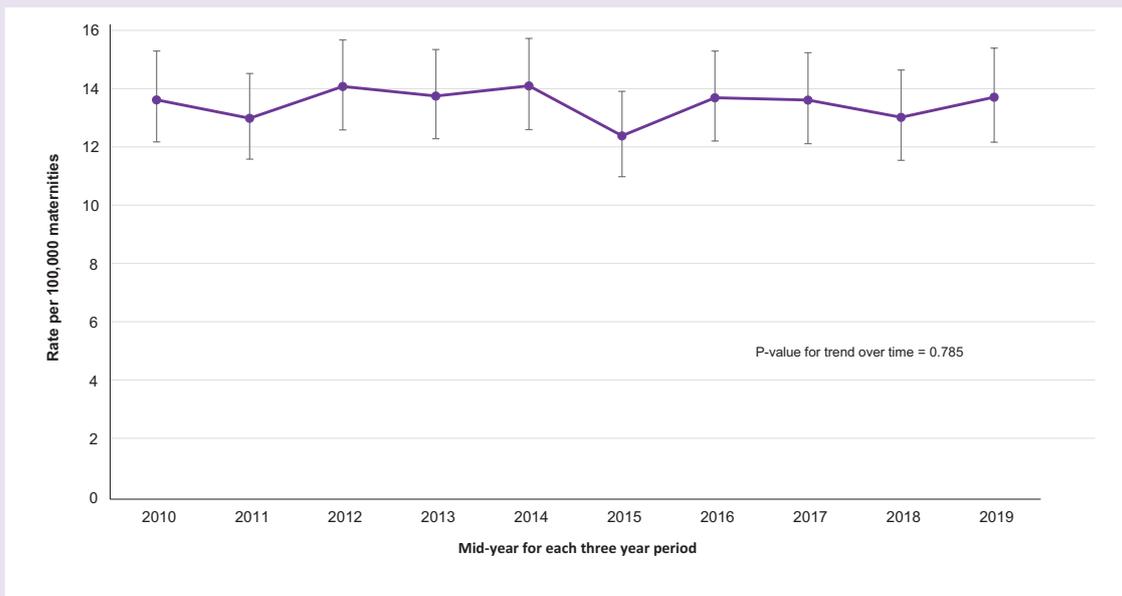
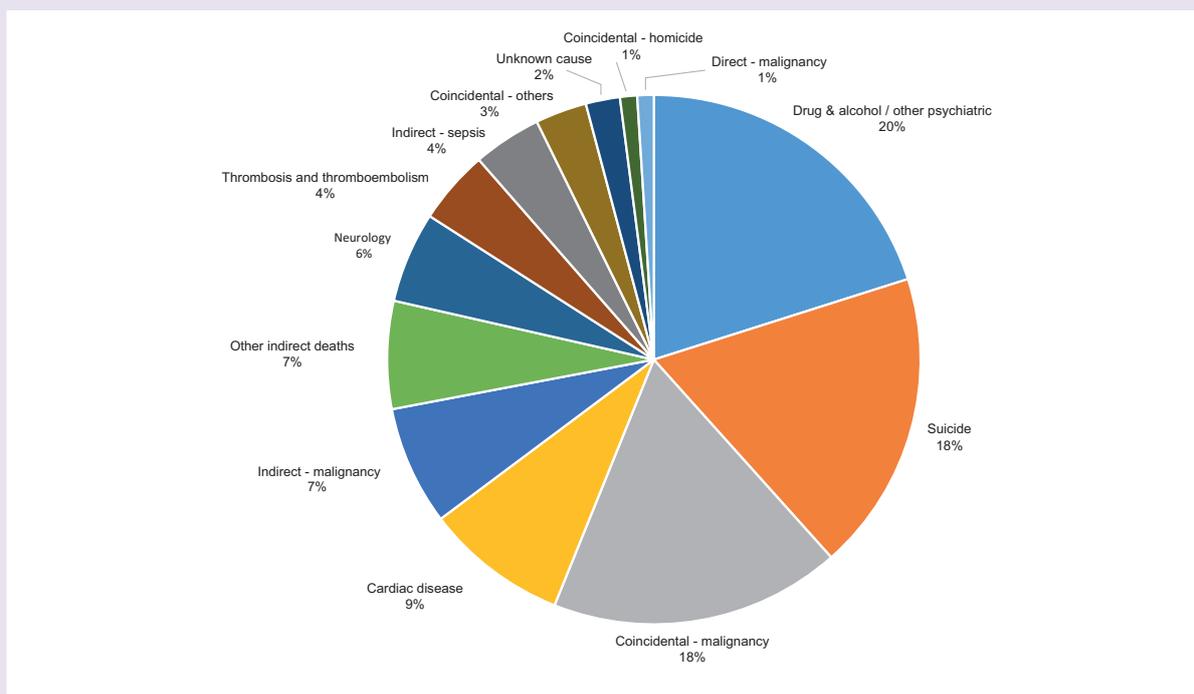


Figure 2.6: Causes of death amongst women who died between six weeks and one year after the end of pregnancy, UK 2018-20



2.3 The characteristics of women who died 2018-20

The women and babies

Of the 229 women who died from direct and indirect causes during or up to 42 days after the end of their pregnancy in 2018-20, 28% (64 women) were still pregnant at the time of their death and of these women 64% were ≤ 20 weeks' gestation (Table 2.7). Twenty three (10%) women had a pregnancy loss at ≤ 20 weeks' gestation. The remaining 142 women gave birth to a total of 142 infants, 115 (81%) survived, 27 died (24 babies were stillborn and 3 died in the neonatal period). The 229 women who died left behind a further 251 children, thus a total of 366 motherless children remain. The majority of the 142 women who gave birth did so in hospital (85%); 12% of women gave birth in an emergency department or an ambulance, and 4% at home (Table 2.8). In this triennium 91 (64%) of the women who died had a caesarean birth, 11% of these were perimortem as part of attempted resuscitation of the woman. A total of 10 babies were born by perimortem caesarean section of which 5 (50%) were born after 32 weeks of gestation. Two out of the 5 babies born after 32 weeks' gestation survived (2 were stillborn and 1 died in the neonatal period); all 5 babies delivered at 32 weeks or less were stillborn. Thus 2 (20%) of the total of 10 babies born by perimortem caesarean section survived, 7 (70%) were stillborn and 1 (10%) died in the neonatal period.

Table 2.7: Timing of maternal deaths in relation to pregnancy 2018-20

| Time period of deaths in the pregnancy care pathway | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Total (n=229) Frequency (%) |
|---|---------------------------------|-----------------------------------|--------------------------------|
| Antenatal period | | | |
| ≤ 20 weeks | 19 (17) | 22 (18) | 41 (18) |
| > 20 weeks | 7 (6) | 16 (13) | 23 (10) |
| Postnatal on day of delivery | 22 (20) | 20 (17) | 42 (18) |
| Postnatal 1-41 days after delivery | 61 (56) | 62 (52) | 123 (54) |

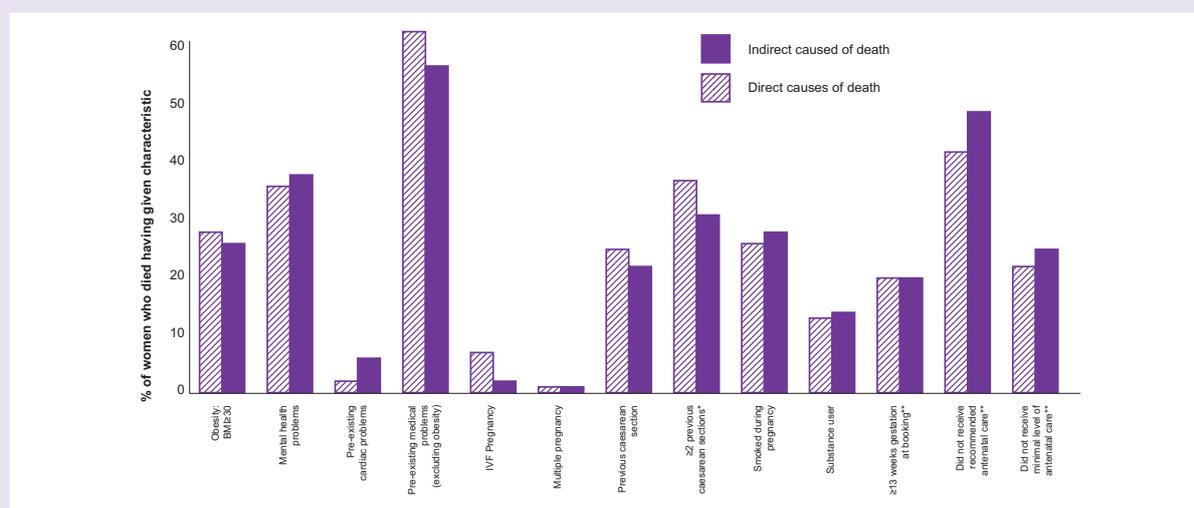
Table 2.8: Place of childbirth amongst women > 20 weeks' gestation who died after giving birth 2018-20

| | Direct (n=71) Frequency (%) | Indirect (n=71) Frequency (%) | Total (n=142) Frequency (%) |
|-----------------------------------|--------------------------------|----------------------------------|--------------------------------|
| Home | 1 (1) | 4 (6) | 5 (4) |
| Hospital (except A&E) | 65 (92) | 55 (77) | 120 (85) |
| Emergency Department or ambulance | 5 (7) | 12 (17) | 17 (12) |

Socio-demographic characteristics

The socio-demographic characteristics of women who died in 2018-20 are shown in Table 2.9 and Figure 2.7. Around a third of the women's records (28%) did not have information on whether they were subject to domestic abuse before or during pregnancy, this is similar to the proportion noted in last year's report but an improvement on the 53% reported in 2019. 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.

Figure 2.7: Selected characteristics of women who died from direct or indirect causes 2018-20



*Amongst women who had a previous caesarean birth

**NICE recommended antenatal care: booked at 10 weeks or less and no antenatal visits missed. Minimum level of care: booked at less than 13 weeks and 3 or fewer antenatal visits missed.

Table 2.9: The socio-demographic characteristics of women who died 2018-20

| Characteristics | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Total (n=229) Frequency (%) |
|--|---------------------------------|-----------------------------------|--------------------------------|
| Socio-demographic | | | |
| Age (years) | | | |
| <20 | 8 (7) | 1 (1) | 9 (4) |
| 20 – 24 | 11 (10) | 13 (11) | 24 (10) |
| 25 – 29 | 20 (18) | 30 (25) | 50 (22) |
| 30 – 34 | 32 (29) | 37 (31) | 69 (30) |
| 35 – 39 | 26 (24) | 27 (23) | 53 (23) |
| ≥ 40 | 12 (11) | 12 (10) | 24 (10) |
| Parity | | | |
| 0 | 43 (39) | 49 (41) | 92 (40) |
| 1 to 2 | 46 (42) | 52 (43) | 98 (43) |
| ≥3 | 19 (17) | 18 (15) | 37 (16) |
| Missing | 1 (1) | 1 (1) | 2 (1) |
| UK citizen | | | |
| Yes | 88 (81) | 101 (84) | 189 (83) |
| No | 9 (8) | 5 (4) | 14 (6) |
| Missing | 12 (11) | 14 (12) | 26 (11) |
| Ethnicity | | | |
| White European | 73 (67) | 79 (66) | 152 (66) |
| Indian | 7 (6) | 6 (5) | 13 (6) |
| Pakistani | 0 (0) | 7 (6) | 7 (3) |
| Bangladeshi | 3 (3) | 5 (4) | 8 (3) |
| Other Asian | 4 (4) | 2 (2) | 6 (3) |
| Black Caribbean | 3 (3) | 6 (5) | 9 (4) |
| Black African | 5 (5) | 8 (7) | 13 (6) |
| Others/ Mixed | 9 (8) | 6 (5) | 15 (7) |
| Missing | 5 (5) | 1 (1) | 6 (3) |
| Woman's region of birth | | | |
| United Kingdom | 68 (62) | 86 (72) | 154 (67) |
| Eastern Europe | 4 (4) | 3 (3) | 7 (3) |
| Western Europe | 3 (3) | 1 (1) | 4 (2) |
| Asia | 12 (11) | 13 (11) | 25 (11) |
| Africa | 6 (6) | 10 (8) | 16 (7) |
| Australia and North America | 1 (1) | 0 (0) | 1 (<1) |
| Central & South America & Caribbean | 2 (2) | 0 (0) | 2 (1) |
| Missing | 13 (12) | 7 (6) | 20 (9) |
| Socioeconomic status (Index of Multiple Deprivation (IMD) of postcode of residence) | | | |
| First quintile (Least deprived) | 9 (8) | 10 (8) | 19 (8) |
| Second quintile | 13 (12) | 11 (9) | 24 (10) |
| Third quintile | 16 (15) | 12 (10) | 28 (12) |
| Fourth quintile | 21 (19) | 24 (20) | 45 (20) |
| Fifth quintile (Most deprived) | 39 (36) | 51 (43) | 90 (39) |
| Missing | 11 (10) | 12 (10) | 23 (10) |
| Socioeconomic status (Occupational classification) | | | |
| Employed (Either woman or partner) | 75 (69) | 79 (66) | 154 (67) |
| Unemployed (Both) | 19 (17) | 17 (14) | 36 (16) |
| Missing | 15 (14) | 24 (20) | 39 (17) |
| Able to speak/understand English | | | |
| Yes | 97 (89) | 112 (93) | 209 (91) |
| No | 8 (7) | 6 (5) | 14 (6) |
| Missing | 4 (4) | 2 (2) | 6 (3) |
| Living arrangements | | | |
| With partner | 79 (72) | 81 (68) | 160 (70) |
| Living alone | 9 (8) | 14 (12) | 23 (10) |
| With parents/extended family | 10 (9) | 11 (9) | 21 (9) |
| Others | 5 (5) | 7 (6) | 12 (5) |
| Missing | 6 (6) | 7 (6) | 13 (6) |
| Domestic abuse (prior to pregnancy/ during pregnancy) | | | |
| Yes | 12 (11) | 15 (13) | 27 (12) |
| No | 66 (61) | 73 (61) | 139 (61) |
| Missing | 31 (28) | 32 (27) | 63 (28) |
| History of abuse as a child | | | |
| Yes | 10 (9) | 4 (3) | 14 (6) |
| No | 53 (49) | 64 (53) | 117 (51) |
| Missing | 46 (42) | 52 (43) | 98 (43) |
| Known to social services | | | |
| Yes | 21 (19) | 25 (21) | 46 (20) |
| No | 76 (70) | 81 (68) | 157 (69) |
| Missing | 12 (11) | 14 (12) | 26 (11) |

The rates of maternal mortality varied by age, socioeconomic status and ethnic background of the women, factors which are known to be independently associated with an increased risk of maternal death in the UK (Nair, Kurinczuk et al. 2015, Nair, Knight et al. 2016). Maternal mortality rates are higher amongst older women and those under 20, those living in the most deprived areas and amongst women from particular ethnic minority groups (Table 2.10). Women living in the most deprived areas continue to have the highest maternal mortality rates (Figure 2.8).

As noted in the 2016 report, we are no longer able to obtain denominator figures for specific ethnic groups, instead aggregate rates using larger ethnicity groupings are presented in Tables 2.10 and 2.11. The risk of maternal death in 2018-20 was statistically significantly over three and a half times higher among women from Black ethnic minority backgrounds compared with White women (RR 3.68; 95% CI 2.32 to 5.65); this is lower than the figure reported in the 2021 report and represents a non-significant reduction from the five-fold difference reported for 2015-17 (Figure 2.9). Women from Asian backgrounds also continued to be at higher risk than White women (RR 1.75, 95% CI 1.13 to 2.62), as were, to a lesser extent, women from mixed ethnic backgrounds (RR 1.32, 95% CI 0.35-3.47). Of note, of the 9 women who died from Covid-19, 5 were Asian and 3 were Black. In the comparison of relative risks between 2015-17 and 2018-20 the estimated ratios of relative risk (RRR) of maternal death in the different age, socioeconomic and ethnic groups did not show any statistically significant differences (Table 2.11).

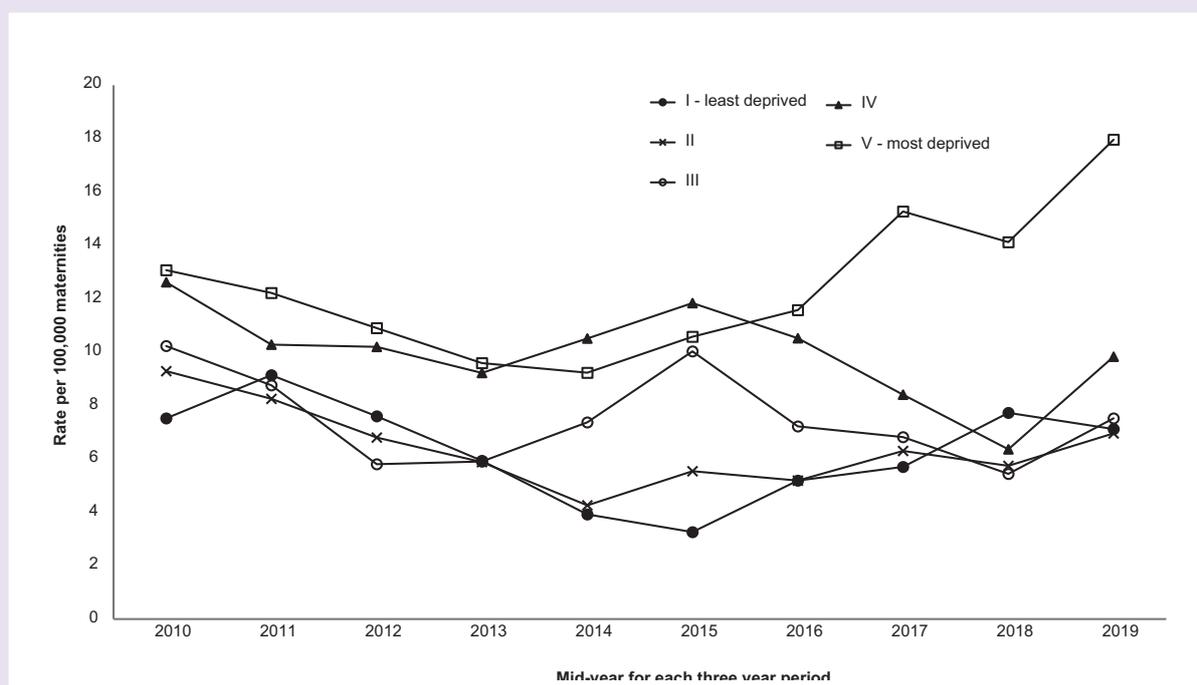
Table 2.10: Maternal mortality rates amongst different population groups 2018-20 (illustrated in figures 2.7 and 2.8)

| | Total maternities 2018-20 | Total deaths | Rate per 100,000 maternities | 95% CI | Relative risk (RR) | 95% CI |
|-------------------------------------|---------------------------|--------------|------------------------------|----------------|--------------------|--------------|
| Age (years) | | | | | | |
| <20 | 58,627 | 9 | 15.35 | 7.02 to 29.14 | 1.82 | 0.74 to 4.05 |
| 20-24 | 284,079 | 24 | 8.45 | 5.41 to 12.57 | 1 (Ref) | - |
| 25-29 | 571,632 | 50 | 8.75 | 6.49 to 11.53 | 1.04 | 0.62 to 1.76 |
| 30-34 | 692,078 | 69 | 9.97 | 7.76 to 12.62 | 1.18 | 0.73 to 1.96 |
| 35-39 | 400,386 | 53 | 13.24 | 9.92 to 17.31 | 1.57 | 0.95 to 2.65 |
| ≥ 40 | 94,860 | 24 | 25.30 | 16.21 to 37.64 | 2.99 | 1.63 to 5.51 |
| IMD Quintiles (England only) | | | | | | |
| I (Least deprived/ highest 20%) | 252,869 | 18 | 7.12 | 4.22 to 11.25 | 1 (Ref) | - |
| II | 287,258 | 20 | 6.96 | 4.25 to 10.75 | 0.98 | 0.49 to 1.96 |
| III | 319,035 | 24 | 7.52 | 4.82 to 11.19 | 1.06 | 0.55 to 2.07 |
| IV | 376,393 | 37 | 9.83 | 6.92 to 13.55 | 1.38 | 0.77 to 2.58 |
| V (Most deprived/ lowest 20%) | 445,465 | 80 | 17.96 | 14.24 to 22.35 | 2.52 | 1.50 to 4.47 |
| Ethnic group (England only) | | | | | | |
| White (inc. not known) | 1,386,873 | 128 | 9.23 | 7.70 to 10.97 | 1 (Ref) | - |
| Asian | 186,086 | 30 | 16.12 | 10.88 to 23.01 | 1.75 | 1.13 to 2.62 |
| Black | 76,487 | 26 | 33.99 | 22.21 to 49.80 | 3.68 | 2.32 to 5.65 |
| Chinese/ others | 73,025 | 6 | 8.22 | 3.02 to 17.88 | 0.89 | 0.32 to 1.99 |
| Mixed | 32,782 | 4 | 12.20 | 3.32 to 31.24 | 1.32 | 0.35 to 3.47 |

Table 2.11: Comparison of the relative risk of maternal death among different population groups between 2015-17 and 2018-20 (illustrated in figures 2.8 and 2.9)

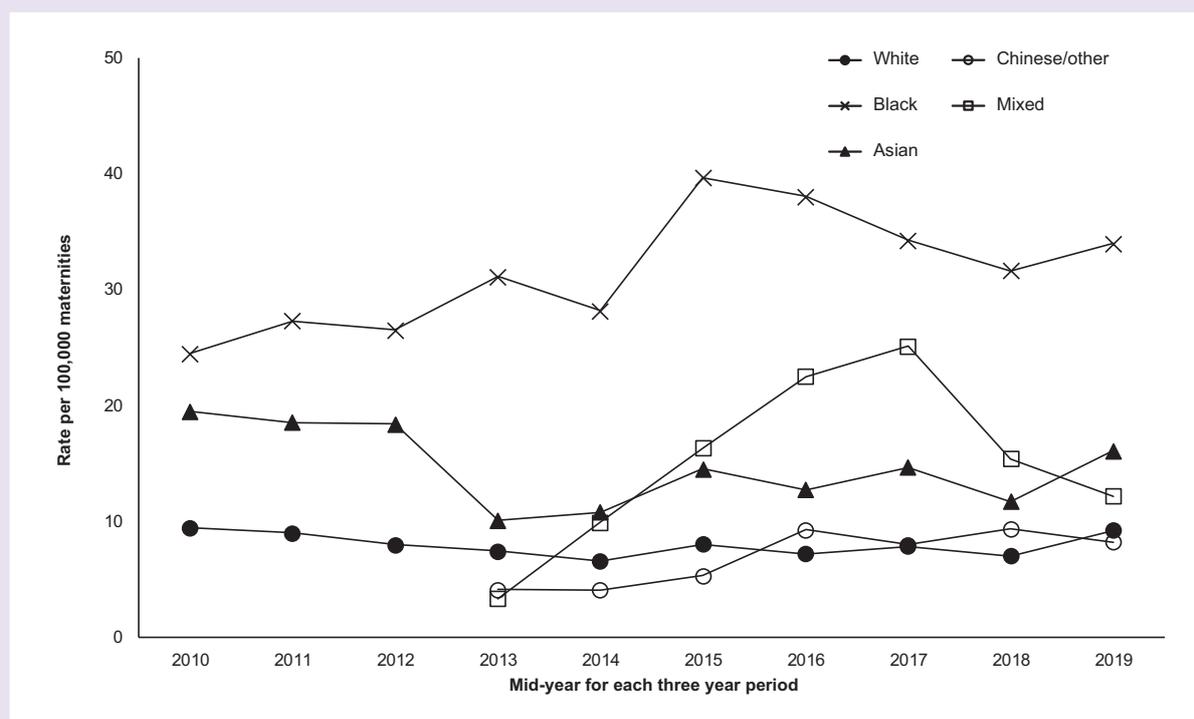
| | 2015-17 | | 2018-20 | | Ratio of the relative risks (RRR) (comparing 2018-20 with 2015-17) | 95% CI | P-value |
|-------------------------------------|--------------------|--------------|--------------------|--------------|--|--------------|---------|
| | Relative risk (RR) | 95% CI | Relative risk (RR) | 95% C | | | |
| Age (years) | | | | | | | |
| <20 | 2.16 | 0.86 to 5.00 | 1.82 | 0.74 to 4.05 | 0.84 | 0.25 to 2.86 | 0.784 |
| 20–24 | 1 (Ref) | - | 1 (Ref) | - | - | - | - |
| 25–29 | 1.53 | 0.90 to 2.74 | 1.04 | 0.62 to 1.76 | 0.70 | 0.32 to 1.46 | 0.322 |
| 30–34 | 1.27 | 0.74 to 2.27 | 1.18 | 0.73 to 1.96 | 0.93 | 0.44 to 1.96 | 0.848 |
| 35–39 | 2.30 | 1.33 to 4.11 | 1.57 | 0.95 to 2.65 | 0.68 | 0.32 to 1.46 | 0.327 |
| ≥ 40 | 4.34 | 2.26 to 8.43 | 2.99 | 1.63 to 5.51 | 0.69 | 0.28 to 1.69 | 0.416 |
| IMD Quintiles (England only) | | | | | | | |
| I (Least deprived/ highest 20%) | 1 (Ref) | - | 1 (Ref) | - | - | - | - |
| II | 1.00 | 0.46 to 2.22 | 0.98 | 0.49 to 1.96 | 0.98 | 0.34 to 2.80 | 0.970 |
| III | 1.39 | 0.70 to 2.90 | 1.06 | 0.55 to 2.07 | 0.76 | 0.29 to 2.02 | 0.585 |
| IV | 2.03 | 1.09 to 4.01 | 1.38 | 0.77 to 2.58 | 0.68 | 0.28 to 1.65 | 0.395 |
| V (Most deprived/ lowest 20%) | 2.23 | 1.23 to 4.33 | 2.52 | 1.50 to 4.47 | 1.13 | 0.49 to 2.60 | 0.774 |
| Ethnic group (England only) | | | | | | | |
| White (inc. not known) | 1 (Ref) | - | 1 (Ref) | - | - | - | - |
| Asian | 1.77 | 1.10 to 2.74 | 1.75 | 1.13 to 2.62 | 0.99 | 0.53 to 1.84 | 0.972 |
| Black | 5.27 | 3.44 to 7.87 | 3.68 | 2.32 to 5.65 | 0.70 | 0.38 to 1.28 | 0.247 |
| Chinese/ others | 1.29 | 0.50 to 2.74 | 0.89 | 0.32 to 1.99 | 0.69 | 0.20 to 2.40 | 0.561 |
| Mixed | 3.12 | 1.22 to 6.64 | 1.32 | 0.35 to 3.47 | 0.42 | 0.10 to 1.76 | 0.237 |

Figure 2.8: Maternal mortality rates 2009-20 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 2009-20 among women from different ethnic groups in England*



*Data for England only due to availability of denominator data

Just over a quarter of women who died in 2018-20 (26%) whose place of birth was known were born outside the UK; 24% of these women were known not to be UK citizens and citizenship was not recorded for a further 29%. Overall 6% of the women who died were not UK citizens although this may be an underestimate since citizenship was not recorded for 11%. Women who died who were born abroad and who were not UK citizens had arrived in the UK a median of 2 years before they died (range 6 months to 15 years). Women who died who were born abroad were from Asia (45%, mainly Bangladesh, India, and Pakistan) and Africa (29%, in particular Nigeria and Ghana), Eastern Europe (13%, mainly Romania) with the remainder (13%) from other parts of Europe, the Americas, Australasia and the Caribbean. Table 2.12 shows the rates of death amongst women born in selected countries with the highest number of deaths. Similar to the previous triennium, overall there was no statistically significant difference in maternal death rate between women born in the UK and those born outside the UK in 2018-20. However, women born in certain specific countries had a higher risk of death, statistically significantly higher in the case of women born in Bangladesh, compared to women born in the UK (Table 2.12). Of the 13 women who died who were not UK citizens and were born outside the UK, two were refugees/asylum seekers (15%), three were European Union citizens (23%) and eight (62%) had another or unknown status.

It is also of note that 20% of women who died were known to social services. This proportion is the same as reported for 2015-17 (20%) and 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) 2018-20

| Woman's country of birth | Maternities 2018-20 | Total Deaths | Rate per 100,000 maternities | 95% CI | Relative risk (RR) | 95% CI |
|--------------------------|---------------------|--------------|------------------------------|----------------|--------------------|---------------|
| UK | 1,523,667* | 154 | 10.11 | 8.57 to 11.84 | 1 (Ref) | - |
| Outside UK | 578,162* | 55 | 9.51 | 7.17 to 12.38 | 0.94 | 0.68 to 1.29 |
| Specific countries | | | | | | |
| <i>Bangladesh</i> | 20,693‡ | 7 | 33.83 | 13.60 to 69.69 | 3.35 | 1.32 to 7.06 |
| <i>India</i> | 41,396‡ | 5 | 12.08 | 3.92 to 28.18 | 1.20 | 0.38 to 2.85 |
| <i>Pakistan</i> | 50,402‡ | 4 | 7.94 | 2.16 to 20.32 | 0.79 | 0.21 to 2.05 |
| <i>Romania</i> | 48,175 | 4 | 8.30 | 2.26 to 21.26 | 0.82 | 0.22 to 2.15 |
| <i>Nigeria</i> | 17,765‡ | 3 | 16.89 | 3.48 to 49.34 | 1.67 | 0.34 to 4.97 |
| <i>Ghana</i> | 8,698‡ | 3 | 34.49 | 7.11 to 100.76 | 3.41 | 0.70 to 10.16 |

*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 20 women who died

It has been increasingly noted in these enquiries that women at severe disadvantage appear to be over-represented amongst the women who die. Severe and multiple disadvantage amongst pregnant women has been defined in other work (Birthrights and Birth Companions 2019). Not all elements of this definition were available in MBRRACE data, but of the 535 women who died in the UK in 2018-20 during or up to one year after pregnancy, 61 (11%) were of women considered to be at severe and multiple disadvantage on the basis of the data available (Table 2.13). This is a significant increase on the proportions reported for 2017-19 and 2015-17 (2018-20 versus 2017-19 RR 1.58, 95% CI 1.04-2.41, p=0.024; 2018-20 versus 2015-17 RR 1.89, 95% CI 1.23-2.95, p=0.002). 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 (53/61 women with multiple disadvantage) and domestic abuse (56/61 women with multiple disadvantage). This must continue to be regarded as a minimum estimate, since these three factors remain amongst the most poorly recorded, with, for women who died in pregnancy or within 42 days of delivery, information missing about mental health diagnoses for 8%, on substance use for 8% and on domestic abuse for 28%. Such information is even more likely to be missing for women dying between six weeks and one year after pregnancy.

Table 2.13: Severe and multiple disadvantage among women who died 2018-20

| | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Coincidental (n=18) Frequency (%) | Late Deaths (n=289) Frequency (%) | Total (n=536) Frequency (%) |
|---------------------|------------------------------------|--------------------------------------|---|---|-----------------------------------|
| Score* of <3 | 99 (91) | 110 (92) | 16 (89) | 250 (87) | 475 (89) |
| Score* of 3 or more | 10 (9) | 10 (8) | 2 (11) | 39 (13) | 61 (11) |

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

Medical and pregnancy-related characteristics

Studies have shown that 66% of the increased risk of maternal death in the UK could be attributed to medical comorbidities (Nair, Knight et al. 2016). Nearly two-thirds (60%) of the women who died in 2018-20 were known to have pre-existing medical problems (Table 2.14) and 37% were known to have pre-existing mental health problems. Of note for 8% of women who died in 2018-20 it was reported to be unknown whether they had previous or pre-existing mental health problems, this proportion is a small reduction on the 11% missing reported for the previous triennium. Over a quarter (27%) of the women who died in this triennium were obese (BMI \geq 30kg/m²) and a further 24% were overweight (Table 2.14). In this triennium, 10 women (4%) who died during or up to six weeks after pregnancy in the UK in 2018-20 had a pregnancy as a result of an assisted conception procedure (Table 2.15), this compares to 13 women (6%) in 2015-17.

The pregnancy-related characteristics of the women who died in 2018-20 are shown in Figure 2.7 and Table 2.15.

Table 2.14: Selected medical conditions and characteristics identified amongst women who died 2018-20 (illustrated in Figure 2.7)

| Medical condition/characteristic | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Total (n=229) Frequency (%) |
|--|---------------------------------|-----------------------------------|--------------------------------|
| Body mass index (BMI) (kg/m ²) | | | |
| <18 | 2 (2) | 2 (2) | 4 (2) |
| 18 – 24 | 40 (37) | 47 (39) | 87 (38) |
| 25 – 29 | 24 (22) | 31 (26) | 55 (24) |
| \geq 30 | 31 (28) | 31 (26) | 62 (27) |
| Missing | 12 (11) | 9 (8) | 21 (9) |
| Mental health problems or psychiatric disorders | | | |
| Yes | 39 (36) | 45 (38) | 84 (37) |
| No | 58 (53) | 68 (57) | 126 (55) |
| Missing | 12 (11) | 7 (6) | 19 (8) |
| Pre-existing cardiac problems | | | |
| Yes | 2 (2) | 7 (6) | 9 (4) |
| No | 103 (95) | 108 (90) | 211 (92) |
| Missing | 4 (4) | 5 (4) | 9 (4) |
| Any pre-existing medical problem (excluding obesity) | | | |
| Yes | 69 (63) | 68 (57) | 137 (60) |
| No | 36 (33) | 47 (39) | 83 (36) |
| Missing | 4 (4) | 5 (4) | 9 (4) |

Table 2.15: Pregnancy-related characteristics of the women who died 2018-20 (illustrated in Figure 2.7)

| Medical condition/characteristic | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Total (n=229) Frequency (%) |
|---|---------------------------------|-----------------------------------|--------------------------------|
| Pregnancy known to be as a result of assisted reproductive techniques | | | |
| Yes | 8 (7) | 2 (2) | 10 (4) |
| No | 101 (93) | 118 (98) | 219 (96) |
| Multiple pregnancy | | | |
| Yes | 1 (1) | 1 (1) | 2 (1) |
| No | 108 (99) | 119 (99) | 227 (99) |
| Previous caesarean section | | | |
| Yes | 27 (25) | 26 (22) | 53 (23) |
| No | 79 (72) | 90 (75) | 169 (74) |
| Missing | 3 (3) | 4 (3) | 7 (3) |
| Previous caesarean numbers (among women who had a previous caesarean section) | | | |
| 1 | 17 (63) | 18 (69) | 35 (66) |
| ≥2 | 10 (37) | 8 (31) | 18 (34) |

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. Fewer than half (44%) of women who received antenatal care, received the recommended level of care according to NICE antenatal care guidelines (booking at 10 weeks or less and no routine antenatal visits missed) (National Institute for Health and Care Excellence 2017).

Table 2.16: Other characteristics of women who died in 2018-20 (illustrated in Figure 2.7)

| Characteristics | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Total (n=229) Frequency (%) |
|---|---------------------------------|-----------------------------------|--------------------------------|
| Smoking | | | |
| Smoker | 28 (26) | 33 (28) | 61 (27) |
| Non-smoker | 67 (61) | 68 (57) | 135 (59) |
| Missing | 14 (13) | 19 (16) | 33 (14) |
| Substance user | | | |
| Yes | 14 (13) | 19 (16) | 33 (14) |
| No | 85 (78) | 92 (77) | 177 (77) |
| Missing | 10 (9) | 9 (8) | 19 (8) |
| Received any antenatal care* | | | |
| Yes | 88 (81) | 101 (84) | 189 (83) |
| No | 21 (19) | 19 (16) | 40 (17) |
| Gestational age at booking (among women who received any antenatal care) | | | |
| ≤10 | 50 (57) | 61 (60) | 111 (59) |
| 11 – 12 | 13 (15) | 17 (17) | 30 (16) |
| >13 | 18 (20) | 20 (20) | 38 (20) |
| Missing | 7 (8) | 3 (3) | 10 (5) |
| Received <i>recommended</i> antenatal care [†] (among women who received any antenatal care) | | | |
| Yes | 42 (48) | 42 (42) | 84 (44) |
| No | 37 (42) | 49 (49) | 86 (46) |

| Characteristics | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Total (n=229) Frequency (%) |
|---|---------------------------------|-----------------------------------|--------------------------------|
| Missing | 9 (10) | 10 (10) | 19 (10) |
| Received a minimum level of antenatal care [†] (among women who received any antenatal care) | | | |
| Yes | 59 (67) | 65 (64) | 124 (66) |
| No | 19 (22) | 25 (25) | 44 (23) |
| Missing | 10 (11) | 11 (11) | 21 (11) |

*Includes 9 women who died in early pregnancy. [†]NICE recommended antenatal care: booked at 10 weeks or less and no antenatal visits missed. Minimum level of care: booked at less than 13 weeks and 3 or fewer antenatal visits missed.

Classification of quality of care

This section includes information on women who died between 2018 and 2020 and are included in the confidential enquiry chapters of this report (including women who died between six weeks and a year after the end of pregnancy and women from the Republic of Ireland), along with the 61 women admitted for diabetic ketoacidosis management during pregnancy who are included in the morbidity enquiry. Table 2.17 and Figure 2.10 shows the classification of care as agreed by the assessors for the 144 women who died and whose case notes were available with sufficient information for an in-depth review. Among the women who died, 22% were assessed to have received good care, but detailed assessment showed that for another 38% improvements in care may have made a difference to their outcome. Opportunities to improve care were identified amongst the great majority (90%) of women admitted to hospital for diabetic ketoacidosis management; in 38% was it thought that improvements may have made a difference to outcome, but of note, improvements to care which would have made no difference to outcome were identified in 52% (Table 2.17, Figure 2.11).

Table 2.17: Classification of care received by women who died and are included in the confidential enquiry chapters and for whom case notes were available for an in-depth review or women who had a diabetic ketoacidosis episode included in the morbidity enquiry, UK and Ireland (2018-20) (illustrated in Figures 2.10 and 2.11)

| Classification of care received | Women who died (n=144)* Number (%) | Women who survived after DKA episode (n=61) Number (%) |
|---|--|---|
| Good care | 32 (22) | 6 (10) |
| Improvements to care which would have made no difference to outcome | 57 (40) | 32 (52) |
| Improvements to care which may have made a difference to outcome | 55 (38) | 23 (38) |

*includes only women whose case notes were available with sufficient information for an in-depth review considered in chapters 4-6

Figure 2.10: Classification of care received by women who died and are included in the confidential enquiry chapters and for whom case notes were available for an in-depth review, UK and Ireland (2018-20)

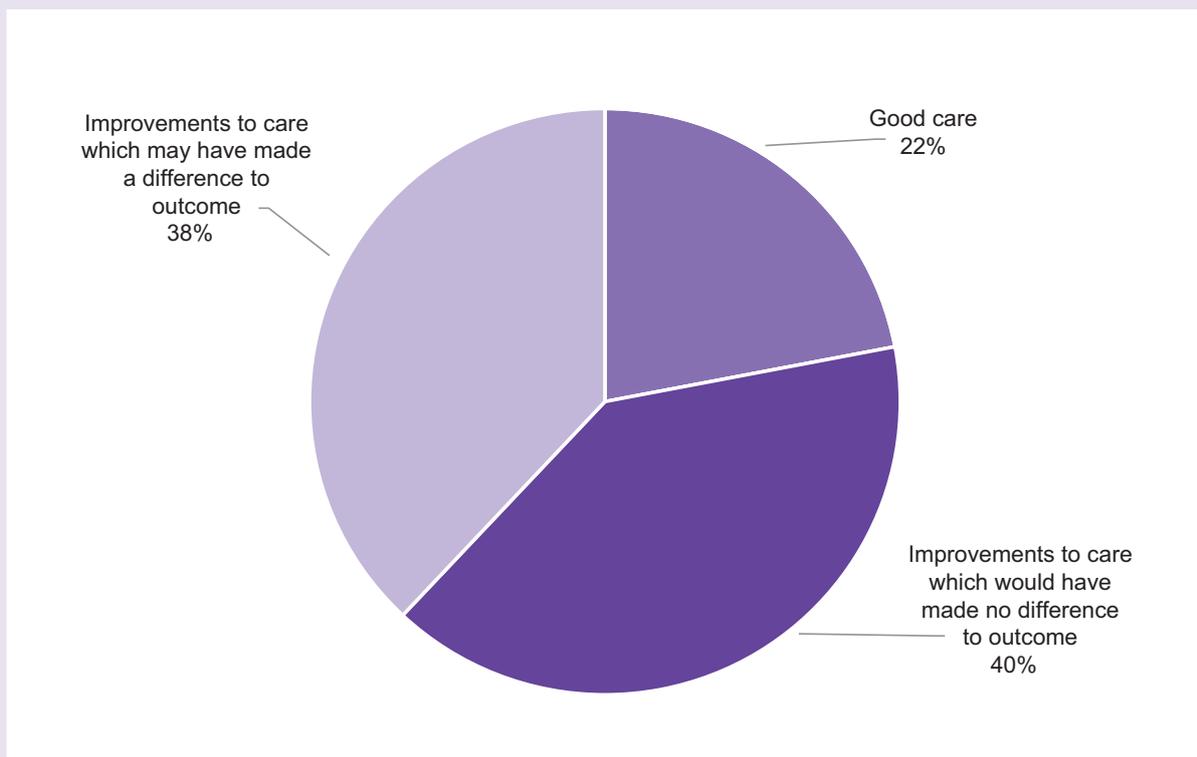
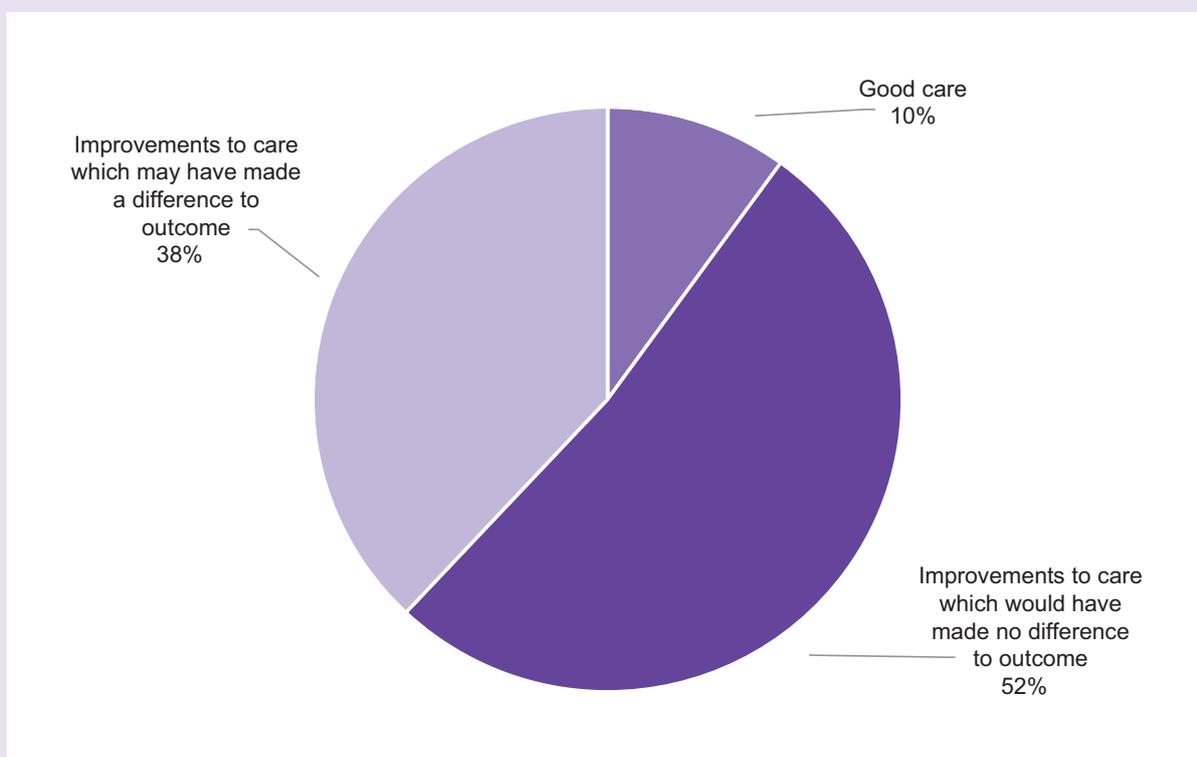


Figure 2.11: Classification of care received by women who had a diabetic ketoacidosis episode and are included in the morbidity enquiry, UK (2019-20)



Local clinicians' reports

The proportion of reports received from local clinicians of those requested for the confidential enquiry remains static at around 80% (Table 2.18). Local clinicians' reports are absolutely essential to allow MBRRACE-UK assessors to fully take account of any local 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 | 76 |
| Anaesthetists | 88 |
| Midwives | 85 |
| Critical Care Clinicians | 83 |
| Emergency Medicine Specialists | 81 |
| GPs | 85 |
| Physicians | 77 |
| Psychiatrists | 100 |
| <i>Total</i> | 83 |

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 less than three quarters (68%) (Table 2.19). However, the figure was 86% for women who died from direct causes, 75% amongst women who died from indirect causes, 56% amongst women who died from coincidental causes and 59% 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 death with a high quality autopsy is essential not only to improve future care, but to ensure any family counselling or testing is appropriate.

Table 2.19: Post-mortem information for maternal deaths in the UK 2018-20

| Specialty group | Direct (n=109) Frequency (%) | Indirect (n=120) Frequency (%) | Coincidental (n=18) Frequency (%) | Late Deaths (n=289) Frequency (%) | Total (n=536) Frequency (%) |
|--------------------------------------|------------------------------------|--------------------------------------|---|---|-----------------------------------|
| No Post Mortem | 13 (12) | 30 (25) | 7 (39) | 116 (40) | 166 (31) |
| Post Mortem Completed | 94 (86) | 90 (75) | 10 (56) | 170 (59) | 364 (68) |
| <i>Hospital</i> | 7 (7) | 10 (11) | 0 (0) | 16 (9) | 33 (9) |
| <i>Coroner/Procurator Fiscal</i> | 87 (93) | 80 (89) | 10 (100) | 154 (91) | 331 (91) |
| Records not available | 2 (2) | 0 (0) | 1 (6) | 3 (1) | 6 (1) |

3. Improving mental health care and care for women with multiple adversity

Andrew Cairns, Sara Kenyon, Roshni Patel, Kathryn Bunch and Marian Knight on behalf of the MBRRACE-UK mental health chapter-writing group

Chapter writing group members: Kathryn Bunch, Andrew Cairns, Fiona Cross-Sudworth, Hilde Engjom, Malcolm Griffiths, Fiona Hanrahan, Sara Kenyon, Marian Knight, Jenny Kurinczuk, Rachel Liebling, Becky MacGregor, Kim Morley, Roshni Patel, Felicity Platt, Judy Shakespeare

3.1 Key message

New recommendations

Assess women with persistent and severe insomnia carefully for signs of underlying mental illness. **ACTION: Health professionals.**

Recognise the importance of a trauma history in the assessment of risk. Involve specialist Perinatal Mental Health Teams where there is a history of significant involvement with secondary mental health services or significant risk, particularly if it is a first pregnancy. **ACTION: Service planners/commissioners, service managers, health professionals.**

Be alert to factors, such as cultural stigma or fear of child removal, which may influence the willingness of a woman or her family to disclose symptoms of mental illness, thoughts of self-harm or substance misuse. **ACTION: All health professionals, Professional education programmes.**

Access services such as Psychiatric Liaison, Crisis and Street Triage Teams should alert specialist Perinatal Mental Health Teams to any referrals of self-harm in pregnant or postpartum women that they have received to allow triage regarding the need for specialist follow-up. **ACTION: Service planners/commissioners, service managers, health professionals.**

Commissioning bodies should ensure that providers of specialist Perinatal Mental Health Teams have sufficient resource to advise, and in complex or high risk cases, be involved, in assessments when in normal working hours. **ACTION: Service planners/commissioners, service managers.**

Allow sufficient opportunity in electronic records systems for free text written comment rather than relying solely on 'tick boxes'. Where a woman has a history of mental health difficulties, make a brief (as a minimum) comment on mental health. **ACTION: Service planners/commissioners, service managers, health professionals.**

Existing recommendations requiring improved implementation

Women should receive continuity of mental health care. Where more than one mental health team is involved, there should be a clearly identified individual who co-ordinates care. (Saving Lives, Improving Mothers' Care 2018)

Consider previous history, pattern of symptom development and ongoing stressors when assessing immediate risk and management of women with mental health symptoms. Plans should address immediate, short-term and long-term risk (Saving Lives, Improving Mothers' Care 2021)

New expressions or acts of violent self-harm are 'red flag' symptoms and should always be taken seriously (Saving Lives, Improving Mothers' Care 2015).

There should be an expectation of early consultant psychiatrist involvement in the assessment and management of high-risk women and of women exhibiting sudden alterations in mental state in late pregnancy or the early puerperium (Saving Lives, Improving Mothers' Care 2015)

Establish triage processes to ensure that women with mental health concerns can be appropriately assessed, including face-to-face if necessary, and access specialist perinatal mental health services in the context of changes to the normal processes of care due to COVID-19. Perinatal mental health services are essential and face to face contact will be necessary in some circumstances. There is a clear role for involvement of the lead mental health obstetrician or midwife in triage and clinical review (Saving Lives, Improving Mothers' Care 2020)

Ensure specialist services have the capacity to assess and manage all women who require secondary care mental health services, and be able to adjust for the altered (generally lowered) thresholds for assessment in the perinatal period. This should not prevent shared management of women already engaged with another service, where that is in their best clinical interests (Saving Lives, Improving Mothers' Care 2021)

Ensure perinatal mental health services do not exclude patients on the basis of diagnosis, where they would ordinarily be seen by general adult mental health teams (Saving Lives, Improving Mothers' Care 2021)

Ask the woman about domestic abuse in a kind, sensitive manner at the first antenatal (booking) appointment, or at the earliest opportunity when she is alone. Ensure that there is an opportunity to have a private, one-to-one discussion (NICE Antenatal care guideline)

In women facing multiple adversity, changes in frequency or nature of presentations may reflect worsening mental state or the emergence of new complications (such as alcohol or substance misuse or interpersonal violence), and should prompt renewed attempts at engagement, diagnosis and care co-ordination. (Saving Lives, Improving Mothers' Care 2018)

Decisions on continuing, stopping or changing medication in pregnancy should be made only after careful review of the benefits and risks of doing so, to both mother and infant (Saving Lives, Improving Mothers' Care 2018)

If psychotropic medication has been discontinued in advance of, or during, pregnancy, ensure women have an early postnatal review to determine whether they should recommence medication, carried out either by the GP or mental health service depending on the level of pre-existing mental health care (Saving Lives, Improving Mothers' Care 2021)

When prescribing drugs for associated mental health conditions to people who self-harm, take into account the toxicity of the prescribed drugs in overdose. For example, when considering antidepressants, selective serotonin reuptake inhibitors (SSRIs) may be preferred because they are less toxic than other classes of antidepressants (NICE Clinical Guideline 133)

Loss of a child, either by miscarriage, stillbirth and neonatal death or by the child being taken into care increases vulnerability to mental illness for the mother and she should receive additional monitoring and support (Saving Lives, Improving Mothers' Care 2015)

Services should develop or adapt clear protocols and methods for sharing information, both within and between agencies, about people at risk of, experiencing, or perpetrating domestic violence and abuse. This is even more important with increasing use of electronic records to ensure all agencies involved in a woman's care are aware of her risk of domestic abuse. This would be further facilitated by support for the intra-operability of systems to support information sharing through electronic records (Saving Lives, Improving Mothers' Care 2020)

There is an urgent need to establish pathways for release of mental health records with the Chief Medical Officers and Departments of Health of Ireland and the four UK nations. Records for all women who die during or in the year after pregnancy who have had contact with mental health services should be released directly to MBRRACE-UK from risk/governance departments. ACTION: NHSE/I and equivalents in the devolved nations and Ireland (Saving Lives, Improving Mothers' Care 2018)

Ensure local incident review teams are multidisciplinary in composition and that investigations are carried out across organisational structures where indicated (Saving Lives, Improving Mothers' Care 2021)

Consider ways of ensuring that, for each woman who misuses substances:

- Progress is tracked through the relevant agencies involved in her care
- Notes from the different agencies involved in her care are combined into a single document
- There is a coordinated care plan (NICE Guideline CG110)

GPs should inform maternity services of any past psychiatric history and maternity services should ensure that the GP is made aware of a woman's pregnancy and enquire of the GP about past psychiatric history (Saving Lives, Improving Mothers' Care 2015)

Women with substance misuse are often more vulnerable and at greater risk of relapse in the postnatal period, even if they have shown improvement in pregnancy. Ensure they are reviewed for re-engagement in the early postpartum period where they have been involved with addictions services in the immediate preconception period or during pregnancy (Saving Lives, Improving Mothers' Care 2021)

3.2 Background

Mental ill health remains one of the leading causes of maternal death in pregnancy and the first postnatal year. Building on the rapid report published in 2020 looking at deaths in the early months of the COVID-19 pandemic, this chapter looks at those women who died during 2020 through suicide. These reviews have been expedited due to

the significantly increased maternal mortality rate due to mental health-related causes. As has been noted in other MBRRACE reports, multiple adversity remains a common theme amongst women dying through suicide, substance misuse, homicide and accidental death.

During the first year of the COVID-19 pandemic, very rapid changes were made to health services across the UK and Ireland. Mental health services were not immune from this and there was a broad spectrum of changes from teams where some staff were redeployed to other roles, through to teams that were able to operate relatively normally. Changes were seen across the pathway including both Perinatal Community Mental Health Teams, specialist inpatient Mother & Baby Units, referring universal services and emergency mental health teams such as Crisis Teams. Perhaps the most ubiquitous change was a reduction in face to face contact with patients and their families, and a sudden adoption of new (online) and not so new (telephone) means of assessment.

All of this occurred on a background of a recent huge expansion in specialist Perinatal Mental Health Services. Some of the specialist community teams had not existed two years prior to the outbreak of COVID-19. There was the potential for some newer members of staff being required to utilise novel means of contacting patients alongside changes in day to day contact with colleagues and senior team members due to other measures such as home working.

When reviewing the deaths, if specialist services were involved we were not able to know whether that service was new or well-established, due to the methodology behind this enquiry. Nor were we able to know how staffing had been affected by the pandemic or what processes had been introduced, such as use of telephone or online contact.

3.3 The women who died

This report includes 28 women who died by suicide during 2020 in the UK and Ireland during pregnancy or up to one year after the end of pregnancy, a rate of 3.84/100,000 maternities (95% CI 2.55-5.55). This compares with a rate of 2.64/100,000 maternities in 2017-19 (RR 1.46, 95% CI 0.90-2.23, $p=0.106$). The women who died by suicide had a median age of 30 (IQR 24-33), the majority (86%) were from white ethnic groups and were UK or Irish citizens (82%).

Noting that pregnancy is usually considered a protective factor for death by suicide, there has been a statistically significant increase in the rate of suicide during pregnancy and up to six weeks after pregnancy in the UK, comparing 2017-19 with 2020. 10 women died out of 2,173,810 women giving birth in 2017-19 (0.46 per 100,000) compared with 10 out of 674,377 in 2020 (1.48 per 100,000) (RR 3.22, 95% CI 1.20-8.63, $p=0.012$).

This increase contrasts with the general population data from the National Confidential Enquiry into Suicide and Safety in Mental Health which showed no significant increase in female suicides in 2020 compared with 2019 (Appleby, Richards et al. 2021). Office for National Statistics data for deaths by suicide in 2020 in England and Wales showed a rate of 4.9/100,000 in the general female population (a level which has been broadly static for 20 years) and females aged 10 to 24 years had the lowest age-specific suicide mortality rate (2.5 deaths per 100,000 females).

Of particular concern is the further increase in teenage suicides, with 5 deaths amongst 18,514 women giving birth in the UK and Ireland, giving a rate of 27/100,000. This is consistent with the increase in teenage suicides first reported in the 2017-19 report (11/100,000). Both findings are significantly higher than the previous 2014-16 report (2.5/100,000) which itself was in line with the rate in the general female population of that age group, thus the increase in rate pre-dates the COVID-19 pandemic. All the teenagers who died had Children's Social Services involved with their own children, their children were in care and the women had complex problems involving mental health, substance misuse and domestic abuse.

This report also includes the deaths of 27 women who died by as a result of substance misuse and other psychiatric causes during 2020. This gives a rate of 3.70/100,000 maternities (95% CI 2.44-5.38). This compares with a rate of 2.47/100,000 maternities in 2017-19.

In contrast to the 2017-19 report, there were higher rates of documented domestic abuse (33% vs 18%) among women who died by suicide (Table 3.1). This was despite their being no change in the proportion of women with this information missing. The same was true of women who died due to substance misuse, where the proportion for 2018 was 36%, 2019 was 43% and in 2020 was 70%.

Documentary evidence of social services involvement continued to climb with involvement in 43% vs 37% of suicides in 2017-19, and 85% vs 66% of substance misuse deaths in 2017-19. The reasons for this are unclear but it is possible that they may relate to greater flagging of concerns with social care following a number of high-profile national serious incidents of child neglect and death.

27% of women who died through suicide booked after 13 weeks gestation compared with 13% in 2017-19. From the records reviewed it is unclear why more women booked late but it is possible that the circumstances of the COVID pandemic, such as encouragement to stay at home or changes to how health professionals were working, might have affected this. There was an increase in the proportion of women dying through substance misuse who did not receive the recommended level of antenatal care, increasing from 60% in 2017-19 to 77% in 2020.

Table 3.1: Socio-demographic characteristics of women who died by suicide or from substance misuse, UK and Ireland 2020

| Characteristics | Suicide (n=28) Frequency (%) | Substance misuse (n=27) Frequency (%) |
|---|---------------------------------|--|
| Socio-demographic | | |
| Age at delivery (years) | | |
| <20 | 5 (18) | 1 (4) |
| 20 – 24 | 3 (11) | 6 (22) |
| 25 – 29 | 6 (21) | 5 (19) |
| 30 – 34 | 10 (36) | 7 (26) |
| 35 – 39 | 2 (7) | 7 (26) |
| ≥ 40 | 2 (7) | 1 (4) |
| Parity | | |
| 0 | 1 (4) | 1 (4) |
| 1 to 2 | 14 (50) | 20 (74) |
| ≥3 | 3 (11) | 2 (7) |
| Missing | 10 (36) | 4 (15) |
| UK or RoI citizen | | |
| Yes | 23 (82) | 25 (93) |
| No | 1 (4) | 1 (4) |
| Missing | 4 (14) | 1 (4) |
| Ethnicity | | |
| White incl. missing | 24 (86) | 26 (96) |
| Other ethnicity | 4 (14) | 1 (4) |
| Socioeconomic status (Index of Multiple Deprivation (IMD) of postcode of residence) | | |
| First quintile (Least deprived) | 3 (11) | 0 (0) |
| Second quintile | 4 (14) | 3 (11) |
| Third quintile | 6 (21) | 1 (4) |
| Fourth quintile | 4 (14) | 7 (26) |
| Fifth quintile (Most deprived) | 5 (18) | 13 (48) |
| Missing | 6 (21) | 3 (11) |
| Domestic abuse (prior to pregnancy/ during pregnancy) | | |
| Yes | 9 (32) | 19 (70) |
| No | 10 (36) | 5 (19) |
| Missing | 9 (32) | 3 (11) |
| History of abuse as a child | | |
| Yes | 5 (18) | 6 (22) |
| No | 8 (29) | 4 (15) |
| Missing | 15 (54) | 17 (63) |
| Known to social services | | |
| Yes | 12 (43) | 23 (85) |
| No | 11 (39) | 4 (15) |
| Missing | 5 (18) | 0 (0) |
| Received any antenatal care | | |
| Yes | 22 (79) | 26 (96) |
| No | 4 (14) | 1 (4) |
| Not known | 2 (7) | 0 (0) |
| Gestational age at booking (among women who received any antenatal care) | | |
| ≤10 | 12 (55) | 11 (42) |
| 11 – 12 | 2 (9) | 5 (19) |
| ≥13 | 6 (27) | 7 (27) |
| Missing | 2 (9) | 3 (12) |
| Received <i>recommended</i> antenatal care† (among women who received any antenatal care) | | |
| Yes | 11 (50) | 3 (12) |
| No | 10 (45) | 20 (77) |
| Missing | 1 (5) | 3 (12) |
| Received a minimum level of antenatal care† (among women who received any antenatal care) | | |
| Yes | 14 (64) | 11 (42) |
| No | 6 (27) | 12 (46) |
| Missing | 2 (9) | 3 (12) |

†NICE recommended antenatal care: booked at 10 weeks or less and no antenatal visits missed. Minimum level of care: booked at less than 13 weeks and 3 or fewer antenatal visits missed.

Pregnancy or postnatal loss

Previous reports have found high rates of loss events (termination, miscarriage, stillbirth, neonatal loss, child removal) in both those women dying by suicide and those dying in relation to substance misuse. In 2020 there were fewer associated loss events with 79% of women dying by suicide having had no loss vs 63% in 2017-19 (Table 3.2). The figures for deaths due to substance misuse showed an increase from 57% having a loss event in 2017-19 to 74% in 2020. This increase was primarily due to a relative increase in child removals.

Table 3.2: Pregnancy or postnatal loss or threatened loss amongst women who died by suicide or substance misuse, UK and Ireland 2020

| Type of loss | Suicide (n=28) Number of women (%) | Substance misuse (n=27) Number of women (%) |
|--|--|---|
| Pregnancy loss | 0 (0) | 2 (7) |
| Neonatal death | 1 (4) | 1 (4) |
| Post-termination of pregnancy | 2 (7) | 1 (4) |
| Infant removed into care or care of relatives and/or ongoing social services proceedings | 3 (11) | 16 (59) |
| No known loss events | 22 (79) | 7 (26) |

Mode of suicide

This review found no real change to the mode of suicide, with hanging remaining the most common mode of death, and overdose and falls from height the second most frequent methods. Other than an increase in the proportion of overdoses, these proportions have remained static for more than 20 years, with hanging the most common and over 80% of suicides being violent.

Over the same 20 years, the percentage of deaths by hanging in the general female population who die by suicide have almost doubled to 46% in 2019 and poisonings have fallen by around one third to 32% (Office for National Statistics 2020). As such the proportion of violent deaths in women of all age groups has been increasing towards the proportions seen in this Enquiry. However, a recent review of data from 2018-20 (Office for National Statistics 2021) also showed that violent suicides were much more common in women of reproductive age, with hangings representing 78% of deaths in females aged 10-14, falling to 59% in the 44-49 age group. That said, the same data showed higher proportions of poisonings and fewer deaths through jumping from heights or in front of moving objects such as trains. As such it still appears that violent deaths are more common in the perinatal period.

Table 3.3: Mode of death by suicide, UK and Ireland 2020

| Mode of death | Number of women (%) (n=25*) |
|------------------|--------------------------------|
| Hanging | 13 (52) |
| Overdose | 4 (16) |
| Fall from height | 4 (16) |
| Traffic/train | 3 (12) |
| Lacerations | 1 (4) |

*For 3 women the mode of suicide could not be ascertained

Timing of death

During 2020, the suicide deaths occurred both antenatally and postnatally, with the majority postnatally (Figure 3.1). Deaths from substance misuse and other psychiatric causes were predominantly post-pregnancy (Figure 3.2).

Figure 3.1: Timing of death by suicide during pregnancy or the post-pregnancy year, 2020

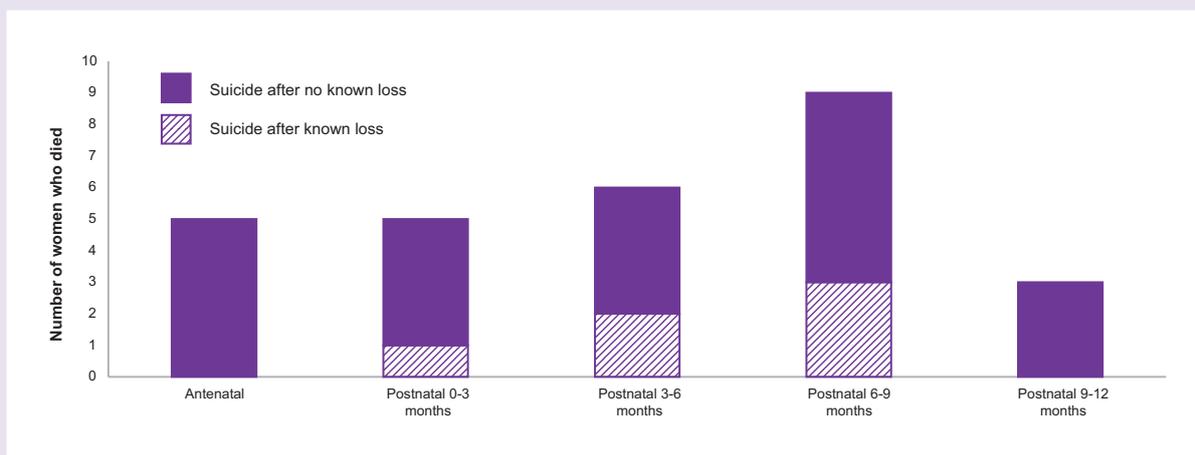
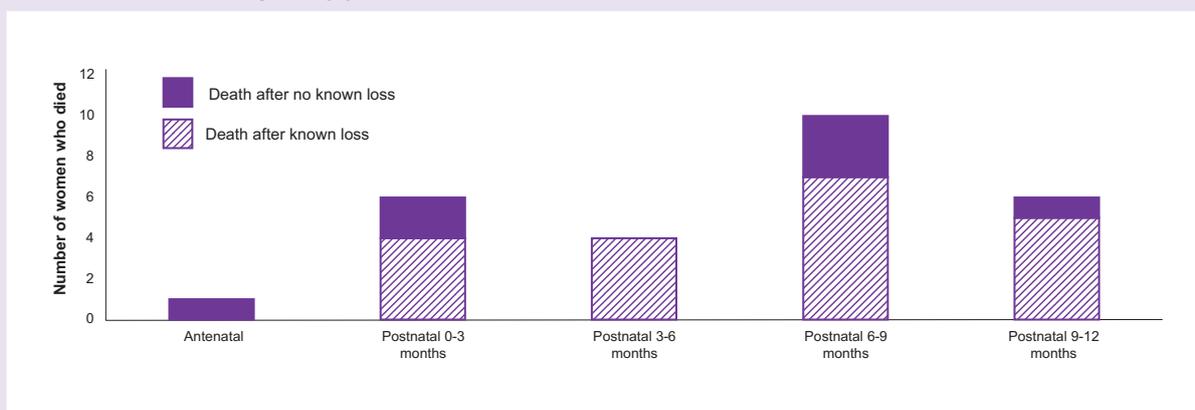


Figure 3.2: Timing of death from substance misuse or other psychiatric causes during pregnancy or the post-pregnancy year, 2020



Mental health diagnoses

In contrast to previous years, very few women who died by suicide had formal, clearly diagnosed mental health diagnoses. Four women had been given a diagnosis of emotionally unstable personality disorder. One had a diagnosis of anxiety and depression made during the index pregnancy by her GP. On review of the other women's records, it seems likely that two had undiagnosed severe depressive illnesses, one of whom had a red flag symptom of thoughts of maternal incompetence.

Involvement of services

It does not appear that any of the women who died through suicide had been admitted to a Mother and Baby Unit (Table 3.4). It is unclear whether this was related to pandemic-related changes to services. In one instance this was not felt appropriate, although the woman requested admission, in another the woman herself declined admission. In a further instance, Mother and Baby Unit admission was not pursued because of concerns about the management of a co-morbid physical health problem, as there were concerns about access to out-of-hours medical cover. Two women were admitted to adult inpatient units prior to their death in the community. Whereas in the previous report for 2017-19 women were cared for across a range of different mental health services, during 2020 almost one third had some form of contact with a specialist Perinatal Mental Health Team. One woman was referred to a generic Adult Mental Health Team and it was unclear why a specialist service had not been offered. One younger woman was under the care of a Child and Adolescent Mental Health Service. The proportion known only to universal services was broadly similar to previous reports.

Table 3.4: Highest level of care for women who died by suicide, UK and Ireland, 2020

| Level of care received | Number of women (%) (n=28) |
|--|-------------------------------|
| Mother and Baby Unit | 0 (0) |
| Adult inpatient | 2 (7) |
| Community perinatal mental health team / perinatal mental health day service | 8 (29) |
| Adult community mental health team | 1 (4) |
| Crisis / home treatment / liaison team | 1 (4) |
| Other psychiatry | 1 (4) |
| Addictions | 0 (0) |
| Specialist mental health midwife / obstetrician | 1 (4) |
| GP / maternity professional / health visitor | 7 (25) |
| Unascertained | 7 (25) |

Accidental deaths and homicides

Sixteen women died from accidental causes in the UK and Ireland between 2018 and 2020, and messages from their care are also included in this chapter. Messages for care identified from the deaths of women who were murdered were included in the 2020 MBRRACE-UK Rapid Report on covid-related deaths (Knight, Bunch et al. 2020).

3.4 Overview of care and new lessons to be learned

Multiple adversity

At least half of the women who died by suicide and the majority of women who died from substance misuse had multiple adversity. A history of childhood and/or adult trauma were very frequent. Many of the younger women who died were care leavers. Presentations could be complex with mental illness, substance misuse and physical health symptoms, such as chronic pain. There were several instances where services did not become involved soon enough during pregnancy. Earlier involvement may have given more time to develop a therapeutic professional relationship. There seemed to be a general lack of consideration of the potential interaction between mental and physical symptoms, such as the influence of mental state on chronic pain and seizure-like activity. In one instance, a woman had apparent poor control of epilepsy during pregnancy in association with low mood, and a question as to whether these represented non-epileptic attacks.

As has been noted in some previous reports, on occasion specialist Perinatal Mental Health Teams declined to become involved with women who had a complex history with previous secondary mental health involvement, despite evidence suggesting that the woman might struggle with the adjustment to parenthood, with potential for an associated deterioration in mental state and increase in risk of self-harm or other risky behaviour.

A multiparous teenager had a miscarriage before her death. She had a history of child abuse and previous involvement with Child and Adolescent Mental Health Services. She had a history of substance misuse and domestic violence. A diagnosis of Bipolar Affective Disorder had been raised although assessors considered this unlikely. The Perinatal Mental Health Team declined a referral prior to her death by suicide.

Women may struggle to engage for a variety of reasons including their attachment style and fear of child removal. Mental Health services are not a replacement for Social Care support and intervention but the women whose deaths were reviewed were typically of a complexity and risk that required secondary care intervention, be it mental health teams, addictions services or both. Even when women are unable to engage for whatever reason, Perinatal Mental Health Teams can have a role in providing advice and scaffolding to both universal services and social care in understanding potential patterns of deterioration, risk (such as risk of deterioration related to child removal) and how to access services in a crisis.

Recognise the importance of a trauma history in the assessment of risk. Involve specialist Perinatal Mental Health Teams where there is a history of significant involvement with secondary mental health services or significant risk, particularly if it is a first pregnancy. N

Ensure specialist services have the capacity to assess and manage all women who require secondary care mental health services, and be able to adjust for the altered (generally lowered) thresholds for assessment in the perinatal period. This should not prevent shared management of women already engaged with another service, where that is in their best clinical interests (Saving Lives, Improving Mothers' Care 2021) (Knight, Bunch et al. 2021b)

Ensure perinatal mental health services do not exclude patients on the basis of diagnosis, where they would ordinarily be seen by general adult mental health teams (Saving Lives, Improving Mothers' Care 2021) (Knight, Bunch et al. 2021b)

A woman with a complex history of abuse, self-harm and substance misuse had requested a termination but as she was in the second trimester she was required to travel outside her local area to access this. She missed her appointment and died two weeks later by hanging.

This woman reflects similar findings in Enquiry reports some years ago where there were concerns that some women, who were already at higher risk of unplanned pregnancy and fears for child removal, struggled to make the journeys required to attend for a planned termination. It also reinforces the importance of ensuring regular discussions about family planning and offering of long-acting contraception where this is supporting the woman's choice.

Prescribing issues - propranolol

A woman died following a propranolol overdose. This has been seen in previous reports (Knight, Bunch et al. 2018) and it is not clear that clinicians considered the risks in overdose. The woman had a complex history of childhood adversity, self-harm, domestic violence and substance misuse and was presumed to have been receiving the propranolol for anxiety. This is not consistent with NICE Guidelines for the management of anxiety, as the evidence for its use largely relates to social and performance anxiety (Baldwin, Anderson et al. 2014, National Institute for Health and Care Excellence 2020). Given the complexity of this woman's needs, its efficacy would have been uncertain and at the very least should have been reviewed, if used at all, given the risk of overdose. Where prescribing for anxiety is required, evidence based treatments such as SSRIs which are safer in overdose should be preferred.

When prescribing drugs for associated mental health conditions to people who self-harm, take into account the toxicity of the prescribed drugs in overdose. For example, when considering antidepressants, selective serotonin reuptake inhibitors (SSRIs) may be preferred because they are less toxic than other classes of antidepressants.

(NICE Clinical Guideline 113) (National Institute for Health and Care Excellence 2020b)

Violent Suicide

As has been well established across many years, the commonest means of suicide remain violent methods. Thoughts of violent suicide have been recognised as a 'red flag' by the Enquiry since 2015. During this one year 13 women died by hanging, three by jumping in front of a train and four by jumping from heights. This makes up over two thirds of all deaths. Violent suicide is an indicator of clear intent and underlying significant mental disorder. Any expression of violent suicidal thoughts in pregnancy or the postpartum period should be taken seriously, and mental health services should have a low threshold for initial and ongoing assessment.

New expressions or acts of violent self-harm are 'red flag' symptoms and should always be taken seriously (Saving Lives, Improving Mothers' Care 2015).

There was little documentary evidence that clinicians involved in these women's care were aware of this association. Indeed, one woman who died by hanging had presented to the Emergency Department the previous day with evidence of having used a ligature to attempt to harm herself. In another instance, a woman with a red flag of new and persistent expressions of incompetency as a mother, who also had a maternal family history of severe mental illness, jumped to her death.

Access services such as Psychiatric Liaison, Crisis and Street Triage Teams should alert specialist Perinatal Mental Health Teams to any referrals of self-harm in pregnant or postpartum women that they have received to allow triage regarding the need for specialist follow-up. N

Involvement of Multiple Teams

Given the nature of modern mental health services, it is not surprising that in a number of instances there were multiple mental health teams involved in a woman's care. Consistent with findings in previous reports, a lack of knowledge of perinatal mental health was identified in serious incident reviews. Assessment of complex or seriously unwell women was only undertaken by junior clinicians in all women for whom records were available for review, but note that the lack of availability of mental health records may mean that consultant psychiatrist review took place but was not documented in emergency department or maternity records.

Liaison, crisis and home treatment staff should have specific training, at induction and continuing professional development, in understanding the distinctive features and risks of perinatal mental illness if they are to provide emergency and out-of-hours care for pregnant and postnatal women. Formal links should be made with local specialist perinatal mental health services to facilitate training.

Women should receive continuity of mental health care. Where more than one mental health team is involved, there should be a clearly identified individual who co-ordinates care.

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

Reviewers considered that capacity of Perinatal Mental Health Teams to be involved with urgent assessment in working hours would have been beneficial. Accepting that referral numbers are increasing with service expansion in all four UK nations and the Republic of Ireland, such capacity would need to be developed with commissioners/health boards.

Commissioning bodies should ensure that providers of specialist Perinatal Mental Health Teams have sufficient resource to advise, and in complex or high risk cases, be involved, in assessments when in normal working hours. N

A new finding was difficulties for women transferring from Child and Adolescent Mental Health Teams to Adult Community Mental Health Teams. Difficulties during this transition have been recognised elsewhere (Goselink, Olsson et al. 2022), particularly the differing approaches to engagement. In some areas of paediatrics joint clinics are held to manage the transition from child to adult services. Some paediatric clinics (such as Epilepsy) also offer pre-pregnancy advice to women preparing for transition to adult services. Such approaches should be considered in mental health.

Changes to method of contact

In response to concerns about face-to-face contact, changes to communication occurred rapidly during the first year of the Covid pandemic. These changes were also reflected in the care of the women who died. Whilst some services did manage to maintain face-to-face contact, many were using telephone or video forms of communication. It was unclear to reviewers what the policy of the provider organisation was in regards to telephone or virtual contact in most instances. The initial assessment of one woman with severe depression took place at the fourth attempt by telephone. In another instance, a woman who died shortly afterwards by hanging had her assessment by the specialist Perinatal Mental Health Team also by telephone.

Establish triage processes to ensure that women with mental health concerns can be appropriately assessed, including face-to-face if necessary, and access specialist perinatal mental health services in the context of changes to the normal processes of care due to COVID-19. Perinatal mental health services are essential and face to face contact will be necessary in some circumstances. There is a clear role for involvement of the lead mental health obstetrician or midwife in triage and clinical review (Saving Lives, Improving Mothers' Care 2020 (Knight et al. 2020).

Sleep and Stigma

Several women had unusually severe insomnia, despite medical intervention to address this.

A non-English speaking woman contacted her health visitor at three months postpartum concerned about her baby. She herself had not slept for over a week. She was directed to the Emergency Department where the psychiatric liaison team did not identify any low mood using a telephone interpreter. She was not referred to a specialist Perinatal Mental Health Team. She was commenced on an antidepressant but did not continue it as she was breastfeeding. A week later her health visitor referred her to the Perinatal Mental Health Team. She was called by a member of the specialist team within the week after referral, who offered a talking therapy which she declined. She was also referred again to the specialist team who suggested she should be advised to attend the emergency department but did not attempt to coordinate an urgent assessment. She died by jumping from a height three days later.

Sleep disturbance is very common in relation to mental illness and a broader range of psychological difficulties. However, in these women the severity of insomnia was very marked and persisted despite the use of hypnotic medication. Severe sleep disturbance should lead clinicians to consider further assessment for underlying severe mental illness. Give consideration to a longitudinal assessment, particularly where a woman's insomnia is not responding to medication.

Assess women with persistent and severe insomnia carefully for signs of underlying mental illness N

The women described in the vignette above also illustrated some concerns that stigma around mental health, which may be relatively more prevalent in some cultures compared to others, may have influenced the willingness of women or their families to be open about mental health concerns. This has been recognised in previous reports. Likewise, it has also been evident that concern about the involvement of social services, or the potential removal of a child, has also been a factor influencing openness about mental health or ongoing substance misuse difficulties.

Be alert to factors, such as cultural stigma or fear of child removal, which may influence the willingness of a woman or her family to disclose symptoms of mental illness, thoughts of self-harm or substance misuse. N

Psychosis and mood disorders

In keeping with the general trend in recent Enquiry reports, there is a relative absence of women suffering from psychosis amongst those who died and fewer women with severe depressive illness which had been a feature in the reports in the first decade of this century. The methodology of this Enquiry does not allow us to understand the reasons for this apparent change. It is possible that there is greater awareness of the risks associated with these conditions, or the importance of continuing medication in pregnancy, which has led to fewer adverse outcomes. It is also possible that the greater awareness of the importance of trauma has led to improved enquiry and documentation of complex personal histories that has led us to take a differing view of some women presenting with low mood.

Concerns about medication

A number of women were worried about commencing or continuing medication. In the vignette above, the woman was worried about taking medication as her baby was breastfeeding. Evidence of good practice was seen, for example, a woman with an IVF pregnancy had a supportive GP who discussed in a balanced manner the use of antidepressants in pregnancy, in line with NICE guidance.

Decisions on continuing, stopping or changing medication in pregnancy should be made only after careful review of the benefits and risks of doing so, to both mother and infant.

If psychotropic medication has been discontinued in advance of, or during, pregnancy, ensure women have an early postnatal review to determine whether they should recommence medication, carried out either by the GP or mental health service depending on the level of pre-existing mental health care.

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

Use of electronic records

Over the past decade, records shared with the Enquiry reflect the general transition towards electronic notes. Whilst hand written records could be brief (or even illegible) at times, reviewers have been concerned that the format of some electronic records systems are both restrictive and prescriptive. The use of tick boxes, in particular, is quite widespread in assessments and leaves little opportunity for description or qualification. When attempting to understand the decision making process of clinicians, the brevity of typed notes and lack of reflection made it difficult to know whether clinicians had consciously weighed known risk factors, such as the red flags described in previous Enquiries. Mental health professionals should make greater reflection on their assessments rather than simply describing the presentation.

Allow sufficient opportunity in electronic records systems for free text written comment rather than relying solely on 'tick boxes'. Where a woman has a history of mental health difficulties, make a brief (as a minimum) comment on mental health N

Disclosure of psychiatric records

The Enquiry rests on the willingness of provider organisations to share records in a timely manner. A number of women whose care was reviewed had no mental health services records provided and the Enquiry continues to struggle to obtain records from some mental health providers. This can limit the potential both for understanding areas of improvement and also areas of good practice.

Decisions on continuing, stopping or changing medication in pregnancy should be made only after careful review of the benefits and risks of doing so, to both mother and infant.

If psychotropic medication has been discontinued in advance of, or during, pregnancy, ensure women have an early postnatal review to determine whether they should recommence medication, carried out either by the GP or mental health service depending on the level of pre-existing mental health care.

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

Accidental Deaths

Within the 16 women who died through accidental deaths during 2020, many also had a pattern of multiple adversity. At least two had diagnoses of Emotionally Unstable Personality Disorder. One of these two women had a marked increase in risk taking behaviours, associated with the use of alcohol and amphetamines. It appeared that this woman's baby had died but that this information was not shared with her mental health team. There was history of pregnancy loss also. She was not referred to addictions services despite ongoing use of substances and died in a road traffic accident. This woman reflected many of the themes found among women who died through suicide, particularly the association with multiple adversity, the importance of recognising changing patterns of behaviour and mental state, and of good communication and inter-agency working.

Substance misuse

A woman with a long history of anxiety and depression, significant domestic and sexual abuse, and longstanding substance abuse initially sought a termination of pregnancy. She continued with the pregnancy, intermittently engaging with antenatal care. Her substance abuse continued throughout pregnancy and social services, perinatal mental health services and maternity services made multiple attempts to engage with her. She gave birth at term and was discharged with her baby. Her baby was removed for safeguarding a few weeks later. She subsequently died from a multi-drug overdose.

This woman represented a significant challenge to care and support. Management of her history of sexual and physical trauma, domestic violence, compromised mental health, substance misuse, fragmented family relationships, chaotic living arrangements and a newborn removed from her care involved multiple different agencies. A hospital review concluded that gaps in social and mental health care were evident and many of the services were unaware of other interventions as their electronic records were all separate. Their recommendations included development and agreement of information sharing and a shared platform between different agencies.

Many of the women who died from substance misuse found it challenging to engage with services and there was evidence of professionals making significant attempts to engage. However, multiple services were frequently involved, and, as in this woman's care, there was little evidence of coordination or information sharing between them, which may have helped to provide the holistic care these women needed.

Consider ways of ensuring that, for each woman who misuses substances:

- **Progress is tracked through the relevant agencies involved in her care**
- **Notes from the different agencies involved in her care are combined into a single document**
- **There is a coordinated care plan**

NICE Guideline CG110 (National Institute for Health and Care Excellence 2010)

Communication

A woman with known prior opioid dependence and a past history of anxiety and depression booked late for antenatal care. She did not disclose her previous dependence and this information was not passed on to maternity services. She had regular telephone contacts with her GP requesting pain relief during her pregnancy. Face to face appointments were not offered due to the Covid-19 pandemic. She died from a mixed drug overdose in the third trimester.

This woman had been on a methadone programme in her first pregnancy but this was not known by maternity services, and therefore she did not receive specialist care. Her post-mortem notes that she was probably opioid naïve at the time of her death, but her frequent requests for pain relief may have been an indication of increasing distress and potential relapse of her dependence disorder. Specialist care may have allowed this to be identified and her relapse managed safely.

There is a clear duty on all health professionals to pass on relevant information that may affect the care a woman receives during pregnancy or alter her outcomes.

GPs should inform maternity services of any past psychiatric history and maternity services should ensure that the GP is made aware of a woman's pregnancy and enquire of the GP about past psychiatric history

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

Pregnancy or postnatal loss

A young care leaver was known to have learning difficulties, mental health problems and self-harm. During pregnancy she was assaulted on several occasions by her partner. Postnatally she received significant multi-agency involvement until the child was removed under a child protection order. Following the loss of her child her lifestyle became increasingly chaotic with substance abuse and reported low mood. She died from an accidental overdose a few months later.

Three quarters of the women who died from substance misuse had a child loss, mostly through child removal. In several instances, as in the woman described here, this led to an escalating pattern of domestic violence, mental health issues and substance misuse. Assessors noted that the pandemic exacerbated the lack of support for these women. The local midwife, reflecting on the care of one woman who died, reported that a programme designed to help vulnerable woman break the cycle of repeated pregnancies with subsequent removal of the child had lost its funding. Another woman with alcohol dependence had good support and engagement during pregnancy but died a few weeks after her child was removed into family care. Assessors felt that a lack of postnatal community support for those with chronic alcohol problems may have played a part in her death.

Loss of a child, either by miscarriage, stillbirth and neonatal death or by the child being taken into care increases vulnerability to mental illness for the mother and she should receive additional monitoring and support (Saving Lives, Improving Mothers' Care 2015 (Knight, Tuffnell et al. 2015))

Women with substance misuse are often more vulnerable and at greater risk of relapse in the postnatal period, even if they have shown improvement in pregnancy. Ensure they are reviewed for re-engagement in the early postpartum period where they have been involved with addictions services in the immediate preconception period or during pregnancy (Saving Lives, Improving Mothers' Care 2021)

Pandemic-related isolation

A highly vulnerable woman with a complex psychosocial history died following a drugs overdose two weeks after a first trimester miscarriage. Her history included emotionally unstable personality disorder, depression and post-traumatic stress disorder, following an abusive and violent relationship.

The local midwife's report described the challenges of this woman's life eloquently and with great insight and compassion. The woman tried throughout her life to overcome the challenges she faced. She was making good progress but was deeply affected by the social isolation caused by the restrictions during the pandemic, leading to a relapse in her recovery. Recovery is a process, and lapses are a normal part of the process. To minimise lapses, people need consistent, experienced clinical and social care, but the changes as a result of the pandemic meant that this was not possible for this woman.

3.5 Conclusions

A pattern of multiple adversity remains extremely common in women who die through suicide, substance misuse, homicide and accidental death. The importance of thorough, over-arching assessments which do not simply consider the woman's presentation 'in the moment' are as important in these women as they are in women with psychosis who may not have such a background history. Professional sensitive enquiry about underlying factors such as substance misuse and domestic abuse remains an important part of the risk assessment and clinicians need to remain mindful as to reasons why such information may not be disclosed.

It is important that specialist Perinatal Mental Health Teams are resourced to work with all of these women who have a secondary care mental health need, and not to exclude them on the basis of diagnosis or involvement with another team. Where there is a history of significant mental health concerns and risk related to past trauma, including previous childhood abuse, it should be recognised that although there may be a period of relative stability during pregnancy, becoming a parent (particularly for the first time) can be associated with a marked worsening of mental state and increase in risk.

The increased rate of teenage maternal suicides remains a significant concern. This was first identified in the 2017-19 report. Teenage women are most likely of any age group to die by violent means outside of pregnancy and this emphasises the additional specialist care these women need.

Many of the women who died through either suicide or substance misuse struggled to engage with services. Multiple services were frequently involved and given the underlying difficulties with engagement there is a need for agencies to work closely together when planning contacts to maximise the likelihood of attendance and engagement.

Several women with multiple and complex problems received good care with professionals working hard in a multi-agency fashion to engage and to try and reduce the risks that were recognised. Overall, assessors felt that improvements to care may have made a difference to the outcome in more than two thirds of women who died by suicide and more than a third of those who died from substance misuse (Table 3.5).

Table 3.5: Classification of care received by women who died by suicide or from substance misuse for whom there was sufficient information to assess their care, UK and Ireland 2020

| Classification of care received | Women who died by suicide (n=26*) Number of women (%) | Women who died by substance misuse (n=26*) Number of women (%) |
|---|--|---|
| Good care | 2 (8) | 2 (8) |
| Improvements to care which would have made no difference to outcome | 6 (23) | 15 (58) |
| Improvements to care which may have made a difference to outcome | 18 (69) | 9 (35) |

*Insufficient information to classify care for two women who died by suicide and one woman who died from substance misuse

4. Messages on caring for women with multiple morbidities

Charlotte Frise, Sophie Russell, Teresa Kelly, Judy Shakespeare, Katie Cranfield, Rachel Mathers, Kathryn Bunch and Marian Knight on behalf of the MBRRACE-UK diabetes and multimorbidity chapter-writing group

Chapter writing group members: Kathryn Bunch, Lynne Campbell, Paula Chattington, Bernard Clarke, Philippa Cox, Katie Cranfield, Hilde Engjom, Charlotte Frise, Teresa Kelly, Sara Kenyon, Dawn Kernaghan, Marian Knight, Jenny Kurinczuk, Nuala Lucas, Rachel Mathers, Roshni Patel, Sophie Russell, Frank Schroeder, Judy Shakespeare, Sarah Wheatly

4.1 Key messages

New recommendations

Consider skills and drills training on the management of diabetic ketoacidosis in pregnancy to ensure that all maternity staff are aware of the symptoms and signs of diabetic ketoacidosis. **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.

Develop guidance on ketone testing in pregnancy and the subsequent response to an abnormal test **[ACTION: Royal Colleges of Obstetricians and Gynaecologists, Midwives, Physicians and General Practitioners]**.

Ensure that guidance on the management of diabetic ketoacidosis in pregnancy is included in all guidelines used outside of the maternity setting **[ACTION: Joint British Diabetes Societies for Inpatient Care]**.

Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.

Existing guidance and recommendations requiring improved implementation

Consider an approach to care that takes account of multimorbidity if the person requests it or if any of the following apply:

- they find it difficult to manage their treatments or day-to-day activities
- they receive care and support from multiple services and need additional services
- they have both long-term physical and mental health conditions
- they frequently seek unplanned or emergency care
- they are prescribed multiple regular medicines (NICE NG56. Multimorbidity: clinical assessment and management)

[Ensure] adults with an individualised management plan for multimorbidity know who is responsible for coordinating their care (Multimorbidity. NICE Quality standard QS153)

Establish triage processes to ensure that women with mental health concerns can be appropriately assessed, including face-to-face if necessary, and access specialist perinatal mental health services in the context of changes to the normal processes of care due to COVID-19. Perinatal mental health services are essential and face to face contact will be necessary in some circumstances. There is a clear role for involvement of the lead mental health obstetrician or midwife in triage and clinical review (Saving Lives Improving Mothers' Care rapid report 2020)

Members of diabetes professional teams providing care or advice to adults with type 1 diabetes should be alert to possible clinical or subclinical depression and/or anxiety, particularly if someone reports or appears to be having difficulties with self-management (NICE Guideline NG17)

Diabetes professionals should:

- ensure they have appropriate skills to identify and provide basic management of non-severe mental health problems in people from different cultural backgrounds
- be familiar with appropriate counselling techniques and drug therapy, while arranging prompt referral to specialists for people whose mental health problems continue to interfere significantly with their wellbeing or diabetes self-management (NICE Guideline NG17)

Women with type 1 diabetes and nephropathy are at intermediate risk of venous thromboembolism and antenatal thromboprophylaxis with low molecular weight heparin should be considered (RCOG Green-top Guideline 37a)

Advise women with diabetes who are planning a pregnancy to aim to keep their HBA1c level below 48 mmol/mol (6.5%), if this is achievable without causing problematic hypoglycaemia (NICE Guideline NG3).

Information from practitioners, accompanied by an advice leaflet on reduced fetal movement, based on current evidence, best practice and clinical guidelines, to be provided to all pregnant women by 28+0 weeks of pregnancy and reduced fetal movement discussed at every subsequent contact (Saving Babies Lives Care Bundle version 2 2019)

HDU/level 2 facility and/or insertion of central line may be required [for pregnant women with DKA] (request urgent senior review) (JBDS-IP The management of DKA in adults 2021)

For women undergoing planned caesarean birth between 37+0 and 38+6 weeks an informed discussion should take place with the woman about the potential risks and benefits of a course of antenatal corticosteroids. Although antenatal corticosteroids may reduce admission to the neonatal unit for respiratory morbidity, it is uncertain if there is any reduction in respiratory distress syndrome, transient tachypnoea of the newborn or neonatal unit admission overall, and antenatal corticosteroids may result in harm to the neonate which includes hypoglycaemia and potential developmental delay (RCOG Green-top Guideline 74)

4.2 Background

As these reports have repeatedly showed, most women who die during or after pregnancy in the UK have multiple physical and mental health co-morbidities as well as social complexity. The presence of multiple long-term conditions has been recognised as an important focus of health research more widely (National Institute for Health and Care Research 2021), because of the differing needs for care and adverse impacts on the outcomes of each individual disease condition. The focus of this MBRRACE-UK morbidity enquiry was to investigate the health and care needs of pregnant women with multiple morbidities and was complemented by a confidential enquiry into diabetic ketoacidosis (DKA) in pregnancy funded as part of an NIHR project (reference PB_PG_0817_20004) (Diguisto, Strachan et al. 2022). Findings from both enquiries are presented here.

4.3 The women whose care was reviewed

The women whose care was reviewed were identified through a UK Obstetric Surveillance System (UKOSS) study of diabetic ketoacidosis in pregnancy conducted between April 2019 and September 2020. Over this period, 82 women were identified with DKA, 6.3 per 100,000 maternities. Records for all 82 women were sought for inclusion in the confidential enquiry. No records (n=8) were available from Northern Ireland due to the requirement for consent to be obtained before records could be released and lack of staff capacity in the context of the pandemic. Records were not forthcoming for a further 13 women, thus the care of 61 women was examined for the purposes of this chapter. The definition for women to be included in the MBRRACE-UK multimorbidity enquiry was women with DKA who also had either pre-existing hypertension or thyroid disease, however, 41% of women with DKA without either pre-existing hypertension or thyroid disease had other pre-existing physical or mental health co-morbidities and can be considered multi-morbid. This chapter therefore describes the messages for the care of the whole cohort, which includes lessons in relation to several intersecting co-morbidities as well as diabetes.

Table 4.1: The socio-demographic characteristics of women with diabetic ketoacidosis whose care was reviewed

| Characteristics | Women with hypertension/ thyroid (n=17) Frequency (%) | Women without hypertension/ thyroid disease (n=44) Frequency (%) | Total (n=61) Frequency (%) |
|---|--|---|-------------------------------|
| Age | | | |
| <20 | 1 (6) | 1 (2) | 2 (3) |
| 20 – 24 | 1 (6) | 14 (32) | 15 (25) |
| 25 – 29 | 3 (18) | 17 (39) | 20 (33) |
| 30 – 34 | 9 (53) | 5 (11) | 14 (23) |
| 35 – 39 | 3 (18) | 4 (9) | 7 (11) |
| ≥ 40 | 0 (0) | 3 (7) | 3 (5) |
| Parity | | | |
| 0 | 7 (41) | 16 (36) | 23 (38) |
| 1-2 | 9 (53) | 20 (45) | 29 (48) |
| ≥3 | 1 (6) | 8 (18) | 9 (15) |
| Multiple Pregnancy | | | |
| Yes | 0 (0) | 1 (2) | 1 (2) |
| No | 17 (100) | 43 (98) | 60 (98) |
| Ethnicity | | | |
| <i>White European</i> | 17 (100) | 35 (80) | 52 (85) |
| <i>Asian</i> | 0 (0) | 5 (11) | 5 (8) |
| <i>Black</i> | 0 (0) | 1 (2) | 1 (2) |
| <i>Chinese/Others</i> | 0 (0) | 2 (5) | 2 (3) |
| <i>Mixed</i> | 0 (0) | 1 (2) | 1 (2) |
| Socioeconomic status (Occupational classification) | | | |
| <i>Employed (Either woman or partner)</i> | 13 (76) | 26 (59) | 39 (64) |
| <i>Neither woman or partner employed</i> | 4 (24) | 12 (27) | 16 (26) |
| <i>Missing</i> | 0 (0) | 6 (14) | 6 (10) |
| Body mass index (BMI) (kg/m²) | | | |
| <25 | 7 (41) | 18 (41) | 25 (41) |
| 25-29 | | | |
| ≥30 | 6 (35) | 16 (36) | 22 (36) |
| <i>Missing</i> | 0 (0) | 1 (2) | 1 (2) |
| Smoking status | | | |
| Yes | 3 (18) | 16 (36) | 19 (31) |
| No | 14 (82) | 28 (64) | 42 (69) |
| Any pre-existing additional medical or mental health problem (excluding obesity) | | | |
| Yes | 8 (47) | 18 (41) | 26 (43) |
| No | 9 (53) | 26 (59) | 35 (57) |

4.4 Overview of care and new lessons to be learned

Care for women with multi-morbidities

Complexity and the need for a multidisciplinary approach

Many women whose care was reviewed for this chapter had multiple, complex and interacting medical and social conditions. Several women were so complex that their care teams clearly felt overwhelmed. There were examples of excellent multidisciplinary team care but similarly examples of where the multidisciplinary team members were not all in place. The challenges of women's individual circumstances meant that their care was often not well managed within existing structures, and there were many occasions when women fell through the gaps, impacting on aspects of diabetes care as well as care for their other morbidities. Women's care needs could not all be met by the diabetes pregnancy clinic or the diabetes specialist team or the obstetric medicine clinic and multidisciplinary specialist care was required from multiple teams often in multiple locations.

A multiparous ethnic minority woman with poorly controlled Type 1 diabetes mellitus had known peripheral neuropathy, chronic pain and hypertension. She was admitted with abdominal pain and vomiting and found to be 12 weeks pregnant. Her HbA1c was 92 mmol/mol on admission. Her medications (ACE inhibitor, statin and pregabalin) were stopped and she was started on methyldopa. She subsequently had multiple readmissions with poorly controlled hypertension and DKA; on one occasion she tested positive for cocaine. She had a caesarean section at 30 weeks and was readmitted two days after discharge with poorly controlled hypertension. Two months postpartum she was admitted again with DKA; at this point all her children were taken into care because of her poor self-management of diabetes and continued use of crack cocaine. She had a termination of pregnancy eight months later because of progressive complications of her diabetes. M

This woman had diabetes with end organ disease and chronic hypertension, but she was also using drugs and had social issues. Her care was managed by the obstetric team with intermittent advice from other specialities. Her hypertension care (with methyldopa as the drug of first choice) was outdated (National Institute for Health and Care Excellence 2019). Her treatment while in hospital was reactive, not proactive; there appeared to be no plan for the complexity of her care and no consideration of some important aspects of her care (drug and social issues).

She was a highly complex woman with multimorbidity. As pregnant women's health become more complex, they cannot get everything they need from just one service, such as a diabetes specialist nurse (DSN). This woman needed an approach that took into account her different problems, with an individualised management plan and a care coordinator. Women with similar and complex problems should be identified early in pregnancy and need a multidisciplinary team (MDT) approach that can respond to changes through pregnancy, birth, postpartum and plan for (or avoid with adequate contraception) the next pregnancy. Although guidelines exist to optimise care of adults with multimorbidity (National Institute for Health and Care Excellence 2016), it is not clear that this is often considered in the context of pregnancy.

Consider an approach to care that takes account of multimorbidity if the person requests it or if any of the following apply:

- they find it difficult to manage their treatments or day-to-day activities
- they receive care and support from multiple services and need additional services
- they have both long-term physical and mental health conditions
- they frequently seek unplanned or emergency care
- they are prescribed multiple regular medicines

NG56. Multimorbidity: clinical assessment and management (National Institute for Health and Care Excellence 2016)

[Ensure] adults with an individualised management plan for multimorbidity know who is responsible for coordinating their care.

Multimorbidity. Quality standard [QS153] 2017. www.nice.org.uk/guidance/qs153/chapter/Quality-statements

Mental Health

A young woman had a history of poorly controlled type 1 diabetes, drug misuse, self-harm and depression. As a child she had been known to safeguarding services and she was regarded as a vulnerable adult. Her midwife undertook her antenatal booking appointment by telephone because of Covid-19 and arranged for a diabetes specialist nurse to call her. The advice she was given was good, but then she became homeless and was housed in a hostel in a new area where she was not registered with a GP; she ran out of her diabetes equipment and medication. She collapsed and was admitted with DKA; as a result she had a miscarriage. While she was still in hospital, she took an overdose of insulin. A psychiatric assessment by a liaison team concluded she had no acute treatable mental illness. She was seen by a diabetes specialist nurse who had concerns about her ability to manage her own diabetes, but did not consider her mental health. She subsequently took her own discharge from hospital. M

This woman had a complex mixture of physical, mental health and social needs. In these circumstances, a face-to-face booking appointment would have been more appropriate (Knight, Bunch, et al 2020).

Establish triage processes to ensure that women with mental health concerns can be appropriately assessed, including face-to-face if necessary, and access specialist perinatal mental health services in the context of changes to the normal processes of care due to COVID-19. Perinatal mental health services are essential and face to face contact will be necessary in some circumstances. There is a clear role for involvement of the lead mental health obstetrician or midwife in triage and clinical review.

MBRRACE-UK Rapid report: Learning from SARS-CoV-2-related and associated maternal deaths in the UK March – May 2020 (Knight, Bunch, et al 2020)

The liaison psychiatric services did not consider she reached the usual threshold for mental health services. The diabetes specialist nurse only dealt with her diabetes. She may have benefited from a referral to a perinatal mental health team for a fuller recognition of her needs and an offer of support.

Mental health problems in women with diabetes (depression, anxiety and eating disorders) are common (Ducat, Philipson et al. 2014). Depression is especially common in perinatal women with type 1 diabetes (Ross, Falhammar et al. 2016). NICE guidelines for management of diabetes in pregnancy do not consider mental health (National Institute for Health and Care Excellence 2020), but the adult guideline for Type 1 diabetes emphasises poor glycaemic control as a flag for mental health problems (National Institute for Health and Care Excellence 2022). They recommend diabetes professionals (which would include diabetes specialist nurses working with pregnant women), have a knowledge of mental health disorders.

Members of diabetes professional teams providing care or advice to adults with type 1 diabetes should be alert to possible clinical or subclinical depression and/or anxiety, particularly if someone reports or appears to be having difficulties with self-management.

Diabetes professionals should:

- ensure they have appropriate skills to identify and provide basic management of non-severe mental health problems in people from different cultural backgrounds
- be familiar with appropriate counselling techniques and drug therapy, while arranging prompt referral to specialists for people whose mental health problems continue to interfere significantly with their wellbeing or diabetes self-management.

NICE Guideline NG17 (National Institute for Health and Care Excellence 2022a)

Engagement

An older woman with type 2 diabetes, hypertension, anxiety, and a BMI over 40kg/m² was looked after in her pregnancy only by a community midwife and a diabetes specialist midwife, as she declined any other input. She frequently declined to give urine specimens or to have her blood pressure checked. In addition, she declined to check her blood sugars despite a raised HbA1c or to take aspirin and low molecular weight heparin. When a scan at 30 weeks showed reduced fetal growth and significant polyhydramnios, further assessment was declined. At 31 weeks' gestation she consulted her GP because of backache and vomiting for 3 days. Hospital admission was advised and declined. She laboured that night and gave birth quickly at home. Shortly after admission to hospital she was diagnosed with DKA. M

A significant number of women proved challenging for teams to engage with. This led to women receiving care outside national guidance which may have contributed to preventable complications. As emphasised above, diabetes is known to be psychologically demanding and outside pregnancy, psychosocial therapies have been shown to be valuable in improving compliance (Delamater, Jacobson et al. 2001, Delamater 2006). Some diabetes teams have access to a psychologist who could be used to help engagement with the obstetric diabetes team who are likely to be new professionals to her. The intensity of monitoring and blood sugar control required in pregnancy for optimum management is likely to be challenging for many people, particularly those who do not usually check their blood sugars frequently or who don't normally use insulin. Some women may feel overwhelmed, resulting in their disengagement. Individualised care, psychological support, continuity and flexibility in engagement are all important

in forming a trusting relationship, empowering patients with the aim of improving outcomes (Delamater, Jacobson et al. 2001). This approach is resource and thus funding intensive, however the benefits may go beyond the index pregnancy if self-care behaviours are improved.

Fluid balance and co-morbidity with hypertensive disorders of pregnancy

A woman with type 1 diabetes was admitted in the early third trimester with a urinary tract infection, DKA and raised blood pressure. She was managed with a variable rate insulin infusion and concurrent intravenous fluid, labetalol and nifedipine for her blood pressure and antibiotics. The following day she developed limb swelling, severe pain, respiratory symptoms with low oxygen saturations and was noted to be anaemic (Hb 85g/l). She was treated with furosemide for fluid overload. Her pre-eclampsia worsened and she had an elective caesarean birth a few days later. M

This woman's care highlights that women who may not have multiple morbidities at the start of pregnancy become multi-morbid with the onset of a pregnancy-related condition such as pre-eclampsia. Her care illustrates the complexity in fluid management of pregnant women with diabetes. The development of DKA alongside emerging pre-eclampsia led to over-zealous fluid infusion and subsequent pulmonary oedema which needed treatment with furosemide.

The peripartum management of diabetes is challenging and needs a multi-disciplinary approach. Input from obstetricians, endocrinologists, anaesthetists and diabetes nurse specialists is advised. When diabetes is further complicated by pre-eclampsia and DKA the addition of critical care input may be necessary (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2022). The management of both pre-eclampsia and DKA have clear and well-defined goals but conflict in their strategies. In the simplest terms, treatment of DKA will focus on fluid resuscitation of an extremely dehydrated patient, whereas in pre-eclampsia fluid restriction is the norm.

Pre-eclampsia management in women with diabetes is complicated by the need for many IV infusions e.g. variable rate insulin infusion (VRII), substrate fluid, oxytocin, anti-hypertensives and magnesium (National Institute for Health and Care Excellence 2020). Fluid balance must be closely monitored in these patients. They are at risk of fluid overload and development of pulmonary oedema. NICE recommends fluid restriction to 80ml/hr unless there are ongoing fluid losses (National Institute for Health and Care Excellence 2019). It may be possible to give drug infusions in a smaller volume after discussion with a local pharmacy team (Yap, Modi et al. 2020).

The increased fluid regime as part of DKA guidelines can also raise the possibility of fluid overload. A low threshold for input from the critical care team is advised, as women may need an arterial line placed (for ease of blood sampling and detection of hypertension) and CVP monitoring for signs of fluid overload (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2022).

Prevention of co-morbidity with venous thromboembolism

A woman with a 10 year history of type 1 diabetes was pregnant for the second time. No VTE risk assessment was conducted in early pregnancy and there was no documentation about nephropathy or proteinuria. At 28 weeks she developed a pulmonary embolism which was appropriately treated. At this stage staff became aware of her diabetic nephropathy. In the third trimester she was admitted hyperglycaemic and mildly ketotic with a short history of diarrhoea and vomiting. A CTG was pathological so she underwent emergency caesarean birth. M

Diabetic nephropathy can result in significant protein leak, which can be exacerbated in pregnancy. This can cause complications such as hypoalbuminaemia and peripheral oedema. There can also be difficulty distinguishing a pathological increase in proteinuria (for example if super-imposed pre-eclampsia develops) from a worsening of the underlying kidney disease. Significant protein loss is a risk for venous thromboembolism and prophylactic LMWH should be prescribed.

It is therefore important to:

- Enquire about diabetic nephropathy on the first clinical review
- Assess baseline proteinuria
- Prescribe VTE prophylaxis if protein leak is significant (nephrotic range proteinuria)

Women with type 1 diabetes and nephropathy are at intermediate risk of venous thromboembolism and antenatal thromboprophylaxis with low molecular weight heparin should be considered

Green-top Guidance 37a (Royal College of Obstetricians and Gynaecologists 2015)

Diabetes-related comorbidities: gastroparesis

A young woman with a long history of type 1 diabetes was admitted on several occasions during her pregnancy with vomiting and repeated concerns about the development of diabetic ketoacidosis. Whilst gastroparesis was felt likely by the doctors that reviewed her, there was no involvement of the gastroenterology team, no consideration of other treatments, such as use of erythromycin as a pro-kinetic and no emphasis on the importance of metoclopramide. There was also repeated confusion / uncertainty about whether she had diabetic ketoacidosis, and the diagnosis was suggested at times even when she was not hyperglycaemic, ketotic or acidotic. M

The neuropathy that is seen in individuals with pre-existing diabetes is well known to affect the peripheries, but less well known is the effect on the innervation of the stomach, which can result in gastroparesis. Gastroparesis is a slowing of gastric emptying, which is almost invariably exacerbated in pregnancy. Women may be diagnosed with hyperemesis gravidarum if their symptoms increase in pregnancy, but it is helpful to be clear about the diagnosis as the treatment for gastroparesis focuses on speeding up gastric motility, and other treatments commonly used for hyperemesis, which target central receptors, may not make a difference.

A number of women with pre-existing diabetes also appeared to have a current or past history of substance misuse. It is therefore important to enquire about current cannabis use, as this can be emetogenic.

Messages for care of women with diabetes

Culturally sensitive care

An older multiparous Muslim woman was diagnosed with gestational diabetes. She was referred to a specialist dietician and discussed her desire to fast for Ramadan. She was counselled that she could have both medical and pregnancy exemption, but she decided to fast despite this. Her diabetes was difficult to control, and she had an episode of euglycaemic ketoacidosis later in pregnancy. She received intensive senior multidisciplinary involvement throughout her pregnancy and had an induced birth at term without complications. M

Assessors felt this woman received good care. She received specialist dietary advice, tailored to her needs, and senior multidisciplinary care throughout her pregnancy. It is important to be aware of times when women, as in this instance, may need advice from a religious adviser to assist with their diabetes control. Culturally sensitive recipe advice can also be helpful (<https://selondonccg.nhs.uk/news/culturally-sensitive-cookbook-for-women-and-birthing-people-with-gestational-diabetes-free/>).

Recognition of DKA

A multiparous woman with poorly controlled diabetes and episodes of DKA pre-pregnancy booked with an HbA1c of 80mmol/mol. She had multiple admissions with hyperglycaemia and impending DKA needing IV insulin infusions. On her last admission at 29 weeks she presented with abdominal pain and reduced fetal movements. She had high capillary ketones of 3.3mmol/l and a blood glucose of 8.9mmol/L. It was not recognised that she had DKA until her condition worsened with acute abdominal pain and vomiting. Her blood glucose rose to 22mmol and even higher capillary ketones of 6.3mmols and an arterial pH of 7.1 She underwent an emergency caesarean section but her baby required extensive resuscitation and died 24 hours later. M

There were several women in this enquiry who were admitted with DKA that was not promptly recognised or treated appropriately which contributed to poor fetal and neonatal outcomes. DKA in pregnancy is associated with a high maternal and perinatal death rate and should be treated as an obstetric emergency and requires a multidisciplinary approach. DKA can occur with lower glucose levels in the presence of raised ketones. Pregnant women with diabetes who present with signs and symptoms associated with DKA (Mohan, Baagar et al. 2017) should have DKA excluded, noting that occasionally DKA may be the first presentation of diabetes in pregnancy.

Box 4.1: Symptoms and signs which may occur in DKA in pregnancy (Mohan, Baagar et al. 2017)

| | |
|-------------------------|-----------------------------------|
| Nausea and vomiting | Hyperventilation |
| Abdominal pain | Tachypnoea |
| Polyuria or polydipsia | Hypotension |
| Blurred visions | Tachycardia |
| Muscle weakness | Coma |
| Drowsiness | Shock |
| Lethargy | Abnormal fetal heart rate tracing |
| Change in mental status | Reduced fetal movement |

Consider skills and drills training on the management of diabetic ketoacidosis in pregnancy to ensure that all maternity staff are aware of the symptoms and signs of diabetic ketoacidosis. N

Euglycaemic ketoacidosis

A young woman was pregnant for the second time. Her first pregnancy was complicated by gestational diabetes, macrosomia and shoulder dystocia. In this pregnancy she was diagnosed with gestational diabetes at 30 weeks, but developed nausea and vomiting with metformin so was changed to insulin therapy. A few days later she was feeling unwell and on admission she was found to be acidotic and ketotic, with only a slightly raised glucose level. She was treated appropriately with intravenous glucose and insulin. Her liver function was also abnormal. Investigations were undertaken but no clear underlying cause was identified.

She had a caesarean birth at 32 weeks' gestation. All tests for diabetes after she gave birth were normal. M

Ketone testing when blood glucose is raised is a reflex response for clinicians. The changes that occur in pregnancy, however, mean that ketosis can occur much more quickly, particularly in the third trimester. This means that any woman can become ketotic, including those with gestational diabetes like the woman described above, and those without diabetes or hyperglycaemia. 'Euglycaemic' ketoacidosis is a term used in the non-pregnant setting to refer to DKA when blood glucose is less than 13.8 mmol/L (250 mg/dl). This is a potentially confusing term, however, as this glucose level is still abnormal (above the upper limit of normal in both non-pregnant and pregnant individuals) and is often associated with the diagnosis of diabetes. Importantly, ketoacidosis with a normal or low glucose level is seen in non-diabetic pregnant women after a short period of vomiting, and is more commonly referred to as 'starvation' ketoacidosis. Ketoacidosis was also reported in non-pregnant and pregnant individuals with COVID-19, which appears to be more complex than simply a result of reduced oral intake.

Importantly:

- The absence of a known diagnosis of diabetes does not mean ketosis cannot occur
- The absence of pre-existing diabetes does not mean ketosis is not possible
- A low threshold for capillary ketone testing should be used, in all unwell pregnant women
- Ketosis should be promptly treated in all women irrespective of underlying diagnosis to prevent acidosis

Ketonaemia

A 30 year old woman with no history of diabetes presented to the Emergency department at 24 weeks of gestation with vomiting and a headache. Urine dipstick showed 3+ ketones. There was concern about a venous sinus thrombosis so she underwent CT head, in addition to receiving intravenous rehydration. She was discharged home without repeat ketone testing, fetal assessment or glucose measurement. Two days later she was readmitted with severe DKA and an intrauterine death was confirmed. M

There is an absence of guidelines about ketone testing in pregnancy. Urinary ketones can be an indicator of pathology but are most commonly identified when multi-test urine dipsticks are being used solely for the detection of proteinuria and therefore often overlooked. Abnormal urinary ketones should prompt capillary glucose and ketone measurement. A venous blood gas is advised if either of these is abnormal or if capillary ketone testing is not easily available to check for acidosis. Capillary ketone testing is preferred as this is more accurate and can provide closer information about hour-by-hour changes in ketone level. Assessors felt that if the significance of this woman's urinary ketones had been recognised and acted on, the stillbirth of her baby might have been prevented.

Develop guidance on ketone testing in pregnancy and the subsequent response to an abnormal test N

Serial scanning and fetal wellbeing

A young woman with type 1 diabetes became pregnant with a booking HbA1c of 54mmol/ mol. There was no evidence that she received contraceptive advice pre-pregnancy. During pregnancy she found glucose control difficult. Serial growth scans showed a normal growth trajectory which was considered reassuring. At 37 weeks a planned ultrasound scan diagnosed an intrauterine death. She was admitted the same day for induction of labour and found to have DKA. M

Several women with pre-existing diabetes became pregnant with a raised HbA1c at booking and later went on to have sudden intrauterine deaths in the third trimester. All medical staff should be aware that both a raised HbA1c at booking and poor glucose control in pregnancy increase the risk of sudden intrauterine death in pregnancy, especially after 36 weeks, and women should therefore be advised about highly effective contraception pre-pregnancy until their control is as good as possible. It is not possible to predict sudden intrauterine death from serial growth scans or cardiotocography. Other tests of fetal wellbeing are not recommended by NICE (National Institute for Health and Care Excellence 2020) until 38 weeks of pregnancy, but women with diabetes should receive the same advice about awareness of fetal movements as all other women, and this should be discussed at every visit.

Advise women with diabetes who are planning a pregnancy to aim to keep their HbA1c level below 48 mmol/ mol (6.5%), if this is achievable without causing problematic hypoglycaemia (NICE Guideline NG3).

Information from practitioners, accompanied by an advice leaflet on reduced fetal movement, based on current evidence, best practice and clinical guidelines, to be provided to all pregnant women by 28+0 weeks of pregnancy and reduced fetal movement discussed at every subsequent contact.

Saving Babies Lives Care Bundle version 2 2019

DKA is an obstetric emergency

DKA is an obstetric emergency as it carries a risk of mortality and morbidity for the pregnant woman and the fetus (Diguisto, Strachan et al. 2022). In three women admitted with DKA there were delays in recognition and treatment of the DKA which assessors felt had contributed to their babies being stillborn. While there are clear Joint British Diabetes Societies for Inpatient Care (JBDS-IP) guidelines for management of DKA in adults (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2021), they do not contain any specific guidance concerning management of DKA in pregnancy, which include specifics such as the occurrence of euglycaemic ketoacidosis, as well as considerations around fetal monitoring and decisions concerning delivery. Some considerations concerning DKA

in pregnancy are included in the JBDS-IP guideline on managing diabetes and hyperglycaemia during labour and birth (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2022) but this is clearly not widely available in acute medical settings.

Correcting the maternal condition is imperative as it will improve both her clinical condition and that of the baby, but, as is frequently seen in these reports, delays due to uncertainty around the care of pregnant women were evident particularly in non-maternity settings. While the fetal heart should be auscultated early, at an appropriate gestation CTG monitoring should be considered until there is improvement in the maternal condition (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2022). The decision for delivery is complex and is based on multiple factors including the gestational age and the response to treatment of the mother. These additional aspects of care need to be incorporated into the JBDS-IP general adult guidance to ensure pregnant women receive the same standard of care as other adults with DKA.

Ensure that guidance on the management of diabetic ketoacidosis in pregnancy is included in guidelines used outside of the maternity setting **N**

Critical care

JBDS-IP guidance acknowledges the fact that pregnant/peripartum patients with DKA represent a particularly high risk group (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2021) who “need specialist input as soon as possible and special attention needs to be paid to their fluid balance.” The treatment and monitoring required for adequate, timely management of DKA is not only labour intensive, but requires significant expertise both on the part of medical and nursing staff. Whatever the underlying cause or precipitant for DKA, national guidelines recognise that this particularly vulnerable patient group are likely to require a High Dependency/ Level 2 critical care environment (rather than an Enhanced Maternal Care setting) (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2021, Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2022). Several women’s care was not escalated to an appropriate level and/or the potential severity of their DKA was not recognised. All critically unwell obstetric patients must not only have a clear route of escalation to critical care, but also access to the expertise of critical care outreach or equivalent services.

HDU/level 2 facility and/or insertion of central line may be required [for pregnant women with DKA] (request urgent senior review)

JBDS-IP The management of DKA in adults 2021 (Joint British Diabetes Societies for Inpatient Care (JBDS-IP) 2021)

Pregnancy-specific protocols

A woman with diabetes was admitted to the surgical ward at 26 weeks gestation. Her blood pressure was raised at 140/102 but as a NEWS chart was used, it did not score so was not escalated. At 29 weeks she was admitted with diarrhoea and vomiting and went on to develop DKA. An urgent obstetric review was requested but an intrauterine death was diagnosed. She was admitted to a high dependency unit for the management of the DKA and again a NEWS chart was used. A different IT system was also in place which the maternity team did not have access to. It was only when she was moved to delivery suite that her raised blood pressure was noted and treatment for pre-eclampsia with intravenous labetalol and magnesium sulphate was started. **M**

When pregnant women are admitted to other areas of a hospital the care they receive should be of the same standard as that in the maternity unit. Recording observations on a NEWS chart gives false assurance, delaying treatment of pregnancy related complications such as pre-eclampsia. UK nations and Ireland have provided guidance and standard obstetric early warning scores (Healthcare Improvement Scotland 2018, Department of Health 2019, NHS England 2022) (for England rollout is expected in early 2023), but it is important to note that observations should be interpreted by reviewing the whole clinical picture and not focusing on one aspect of it. A robust multidisciplinary team review can aid the assessment and management.

Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care. **N**

Steroids

A woman with well controlled Type 1 diabetes was admitted at 38 weeks for antenatal steroids prior to a planned caesarean section. She rapidly developed signs of DKA which was treated promptly by the multidisciplinary team. M

Several women had DKA secondary to maternal steroid administration. Antenatal corticosteroids reduce admission to the neonatal unit for babies born before 36+6 weeks' gestation. From 37+0- 38+6 weeks, they may not reduce admission and they may cause harm including hypoglycaemia and potential developmental delay to a neonate (Stock, Thomson et al. 2022). Given that pregnant women with diabetes will require extra insulin when receiving antenatal steroids (National Institute for Health and Care Excellence 2020), the risk of neonatal hypoglycaemia and DKA in the mother, antenatal steroids should only be given after 36+6 weeks after a full discussion of the risks and benefits (Stock, Thomson et al. 2022).

For women undergoing planned caesarean birth between 37+0 and 38+6 weeks an informed discussion should take place with the woman about the potential risks and benefits of a course of antenatal corticosteroids. Although antenatal corticosteroids may reduce admission to the neonatal unit for respiratory morbidity, it is uncertain if there is any reduction in respiratory distress syndrome, transient tachypnoea of the newborn or neonatal unit admission overall, and antenatal corticosteroids may result in harm to the neonate which includes hypoglycaemia and potential developmental delay.

Green Top Guideline 74 Antenatal corticosteroids to reduce neonatal morbidity and mortality (Stock, Thomson et al. 2022)

4.5 Conclusions

Assessors felt that for 38% of women, different care might have made a difference to the outcome for them or their baby (Table 4.2). This morbidity enquiry clearly shows the additional challenges faced by women with multiple morbidities in pregnancy, which is exacerbated when they receive care by teams who are inexperienced in pregnancy medicine. While all of the women whose care was reviewed for the purposes of this chapter recovered from their DKA episode, many of their babies did not; improved care may have prevented several babies from being stillborn. Diabetes care has been highlighted as an area of improvement in previous perinatal confidential enquiry reports examining the care of stillborn babies (Draper, Kurinczuk et al. 2015). It is also clear that while guidelines exist which aim to optimise care of adults with multimorbidity, this is not yet regularly considered in the context of pregnancy. This must be an important focus for new maternal medicine networks in England and equivalent structures in the devolved nations and Ireland.

Table 4.2: Classification of care received by women with diabetic ketoacidosis

| Classification of care received | N=61 Number of women (%) |
|---|-----------------------------|
| Good care | 6 (10) |
| Improvements to care which would have made no difference to outcome | 32 (52) |
| Improvements to care which may have made a difference to outcome | 23 (38) |

5. Lessons on cardiovascular care

Hilde Engjom, Bernard Clarke, Joanna Girling, Sarah Hillman, Samantha Holden, Sebastian Lucas, Lucy MacKillop, Roshni Patel, Esther Youd, Kathryn Bunch and Marian Knight on behalf of the MBRRACE-UK cardiac chapter-writing group

Chapter writing group members: Janet Brennand, Kathryn Bunch, Lorraine Cardill, Bernard Clarke, Louise Clarke, Hilde Engjom, Becky Ferneyhough, Joanna Girling, Cathy Head, Sarah Hillman, Samantha Holden, Rachael James, Marian Knight, Jenny Kurinczuk, Sebastian Lucas, Lucy MacKillop, Roshni Patel, Seema Quasim, Frank Schroeder, Arlene Wise, Esther Youd

5.1 Key messages

New recommendations

Wheeze can be due to pulmonary oedema. Consider wheeze which does not respond to standard asthma management and exertional syncope as red flag symptoms of cardiovascular disease in addition to orthopnoea and chest pain **[ACTION: All health professionals, Professional education programmes]**.

Be aware of the common risk factors for heart disease and venous thromboembolism, such as extreme obesity, and consider on an individual basis whether women should be made aware of the symptoms and signs of heart disease as well as those of venous thromboembolism **[ACTION: All health professionals, Professional education programmes]**.

Ensure maternal medicine networks and their equivalents in the devolved nations and Republic of Ireland can provide appropriate expertise and supervision for all women, including those in rural/remote areas. **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.

Develop guidance for the use of Brain Natriuretic Peptide measurement in pregnancy **[ACTION: Royal Colleges of Obstetricians and Gynaecologists and Physicians]**.

Be aware that women using oral anticoagulation with warfarin may be more safely managed without transition to low molecular weight heparin treatment when having an early termination of pregnancy **[ACTION: All health professionals, Professional education programmes]**.

Existing guidance and recommendations requiring improved implementation

A raised respiratory rate, chest pain, persistent tachycardia and orthopnoea are important signs and symptoms of cardiac disease which should always be fully investigated. The emphasis should be on making a diagnosis, not simply excluding a diagnosis. (Knight, Nair et al. 2016)

Heart failure in cardiomyopathy can develop rapidly and guidelines for the management of acute heart failure and cardiogenic shock apply. For rapid diagnosis and decision-making, a pre-specified management algorithm and expert interdisciplinary team are crucial (ESC guidelines on the diagnosis and management of acute and chronic heart failure).

Women [who have had confirmed pre-eclampsia] should be given an individual [postpartum] care plan on hospital discharge that includes:

- Who will provide follow-up care, including medical review if needed.
- Frequency of blood pressure monitoring.
- Thresholds for reducing or stopping treatment. (NICE CKS Hypertension in pregnancy)

A persistent sinus tachycardia is a 'red flag' and should always be investigated, particularly when there is associated breathlessness. (Saving Lives, Improving Mothers' Care 2019)

Take a cardiac-specific history and suspect heart failure if there is not another likely cause of any of the following symptoms:

- Breathlessness when lying down (ruling out aortocaval compression) or at rest
- Unexplained cough, particularly when lying down or which produces frothy pink sputum

- Paroxysmal nocturnal dyspnoea – being woken from sleep by severe breathlessness and coughing, which may produce pink frothy sputum and is improved by moving to an upright position
- Palpitation (awareness of persistent fast heart rate at rest). (National Institute for Health and Care Excellence 2019a)

Think Aorta (Aortic Dissection Awareness UK)

When aortic dissection occurs in a young woman, the underlying diagnosis should be assumed to be an inherited aortopathy until proven otherwise (Saving Lives, Improving Mothers' Care 2016)

A family history of sudden death of a young relative (aged less than 40) is important and may be an indication of inherited cardiac conditions (Saving Lives, Improving Mothers' Care 2019)

Anyone with a family history or genetic confirmation of aortopathy or channelopathy should be referred for cardiac assessment before pregnancy (Saving Lives, Improving Mothers' Care 2019)

Investigate and treat pregnant and postpartum women the same as non-pregnant women unless there is a clear reason not to (Saving Lives, Improving Mothers' Care Reports 2014-21)

Ensure that all clinical staff caring for pregnant or postpartum women, whatever the location of care, are aware of the concerning 'red flag' symptoms described in the RCP Acute care toolkit 15: Managing acute medical problems in pregnancy (Saving Lives Improving Mothers' Care 2021)

Pregnancy in women with a mechanical valve, especially in the mitral position, is associated with a high risk of maternal and fetal complications, which should be carefully discussed with the patient and family (2021 ESC/EACTS Guidelines for the management of valvular heart disease)

All women with pre-existing cardiac disease (congenital or ischemic) should be offered pre-pregnancy counselling (Saving Lives Improving Mothers' Care 2016) including contraceptive advice (Saving Lives Improving Mothers' Care 2019)

Recommendations for the management of atrial fibrillation during pregnancy:

- Immediate electrical cardioversion is recommended in case of haemodynamic instability or pre-excited atrial fibrillation
- Therapeutic anticoagulation with heparin or [warfarin] according to the stage of pregnancy is recommended for patients with atrial fibrillation (2020 ESC Guidelines for the diagnosis and management of atrial fibrillation)

5.2 Background

This report sees a welcome decrease in the overall rate of maternal cardiovascular death, which follows the 2016 MBRRACE-UK report when the importance of awareness of maternal heart disease was first raised (Knight, Nair et al. 2016). Psychiatric disorders and cardiovascular disorders are now responsible for the same number of maternal deaths in the UK; together these two causes represent 30% of maternal deaths occurring in the UK. Cardiovascular disease had been the leading cause of maternal death in the UK for more than 20 years and remains the leading cause of maternal death in other high resource settings (Creanga, Syverson et al. 2017). Women are dying largely from acquired heart disease, likely to be a result of a combination of the changing maternity population, with women entering pregnancy at older ages, with more co-morbid conditions such as obesity and hypertension, alongside specialist multidisciplinary care before and during pregnancy providing better quality care for women with known heart conditions. We now need to ensure that this similar quality of care is provided for women whose cardiac disease becomes evident for the first time during or after pregnancy.

5.3 The women who died

Between 2018-20 the deaths of 61 women from heart disease associated with, or aggravated by, pregnancy were reported to the Enquiry (Table 5.1). Of these, 34 occurred in the UK during pregnancy or within 42 days of the end of pregnancy. This represents a maternal mortality rate from cardiac disease in the UK of 1.62 per 100,000 maternities which is lower, but not significantly so, than the rate for 2015-17 (2.10 per 100,000 maternities) (RR 0.77, 95%CI 0.50-1.19) (Figure 5.1).

Figure 5.1: Maternal mortality from cardiac causes, UK: 1985-2020

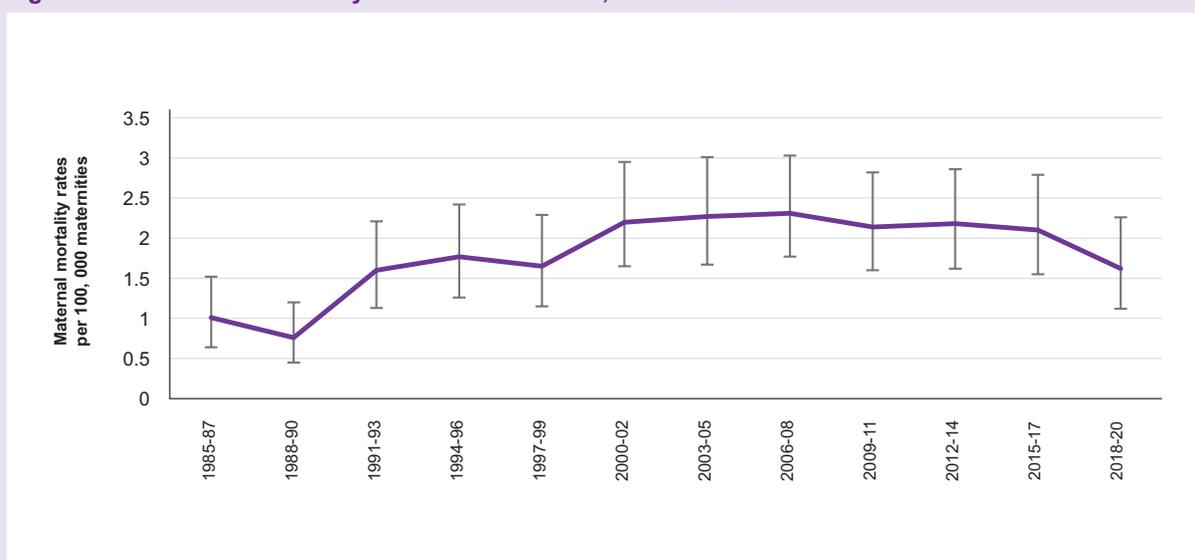


Table 5.1: Timing of maternal deaths due to cardiac causes in relation to pregnancy, UK and Ireland, 2018-20

| Time period of deaths in the pregnancy care pathway | Total (N=61) Frequency (%) |
|---|-------------------------------|
| Antenatal period/ still pregnant | 9 (15) |
| Postnatal on day of delivery | 11 (18) |
| Postnatal 1 to 42 days after delivery | 15 (25) |
| Postnatal 43-91 days | 5 (8) |
| Postnatal 92-182 days | 9 (15) |
| Postnatal 183-273 days | 10 (16) |
| Postnatal 274-364 days | 2 (3) |

Only 10% of women who died from cardiovascular causes were recognised to have a pre-existing cardiac problem (Table 5.2). Maternal mortality rates from cardiovascular disease generally increased with age, with women aged 40 or over at six times higher risk of death compared with women aged 25-29 (Table 5.3). Of particular note, almost half of women who died from cardiovascular causes were resident in the most deprived quintile of areas (Table 5.2), which is reflected in a two-fold higher mortality rate from cardiovascular disease compared to women living in the least deprived quintile of areas (Table 5.3).

Table 5.2: Medical, demographic and pregnancy related characteristics of women who died from a cardiac cause, UK and Ireland, 2018-20

| Characteristics | Total (N=61) Frequency (%) |
|--|-------------------------------|
| Age | |
| <20 | 0 (0) |
| 20 – 24 | 10 (16) |
| 25 – 29 | 10 (16) |
| 30 – 34 | 16 (26) |
| 35 – 39 | 14 (23) |
| ≥ 40 | 11 (18) |
| Pre-existing cardiac problems | |
| Yes | 6 (10) |
| No | 54 (89) |
| Missing | 1 (2) |
| Pre-existing health problems (excluding obesity) | |
| Yes | 35 (57) |
| No | 25 (41) |
| Missing | 1 (0) |
| Ethnicity | |
| White European | 42 (69) |
| Asian | 10 (16) |
| Black | 7 (11) |
| Other ethnicity | 2 (3) |
| Woman's region of birth | |
| United Kingdom/Ireland | 41 (67) |
| Outside UK/Ireland | 15 (25) |
| Missing | 5 (8) |
| Socioeconomic status (Index of Multiple Deprivation) | |
| First quintile (Least deprived / highest 20%) | 8 (13) |
| Second quintile | 5 (8) |
| Third quintile | 6 (10) |
| Fourth quintile | 8 (13) |
| Fifth quintile (Most deprived / lowest 20%) | 29 (48) |
| Missing | 5 (8) |
| Body mass index (BMI) | |
| <18 | 1 (2) |
| 18-24 | 18 (30) |
| 25-29 | 16 (26) |
| ≥30 | 22 (36) |
| Missing | 4 (7) |
| IVF pregnancy | |
| Yes | 2 (3) |
| No | 59 (97) |
| Multiple pregnancy | |
| Yes | 2 (3) |
| No | 59 (97) |
| Previous caesarean section | |
| Yes | 16 (26) |
| No | 44 (72) |
| Missing | 1 (2) |
| Previous caesarean numbers (among women who had a previous caesarean section) | |
| 1 | 14 (88) |
| ≥2 | 2 (13) |

Table 5.3: Medical, demographic and pregnancy related characteristics of women who died from a cardiac cause, UK and Ireland, 2018-20

| | Total maternities 2018-20 | Total deaths* | Rate per 100,000 maternities | 95% CI | Relative risk (RR) | 95% CI |
|---|---------------------------|---------------|------------------------------|---------------|--------------------|---------------|
| Age | | | | | | |
| <20 | 61,285 | 0 | 0 | | | |
| 20 – 24 | 297,996 | 10 | 3.36 | 1.61 to 6.17 | 2.02 | 0.75 to 5.40 |
| 25 – 29 | 601,217 | 10 | 1.66 | 0.80 to 3.06 | 1 (Ref) | |
| 30 – 34 | 751,442 | 16 | 2.13 | 1.22 to 3.46 | 1.28 | 0.55 to 3.16 |
| 35 – 39 | 454,269 | 14 | 3.08 | 1.68 to 5.17 | 1.85 | 0.77 to 4.66 |
| ≥ 40 | 108,327 | 11 | 10.15 | 5.07 to 18.17 | 6.11 | 2.35 to 16.03 |
| IMD Quintiles (England only) | | | | | | |
| <i>I (Least deprived / highest 20%)</i> | 252,869 | 7 | 2.77 | 1.11 to 5.70 | 1 (Ref) | - |
| <i>II</i> | 287,258 | 4 | 1.39 | 0.38 to 3.57 | 0.50 | 0.11 to 1.98 |
| <i>III</i> | 319,035 | 5 | 1.57 | 0.51 to 3.66 | 0.57 | 0.14 to 2.07 |
| <i>IV</i> | 376,393 | 8 | 2.13 | 0.92 to 4.19 | 0.77 | 0.24 to 2.49 |
| <i>V (Most deprived / lowest 20%)</i> | 445,465 | 27 | 6.06 | 3.99 to 8.82 | 2.19 | 0.93 to 5.96 |

*52 deaths occurred in England but IMD information was not available for one woman

Overall, a fifth of women (20%) died from ischaemic causes, and a quarter from myocardial disease/cardiomyopathy (25%) (Table 5.4 and Figure 5.2).

Figure 5.2: Causes of cardiovascular deaths, UK and Ireland 2018-20

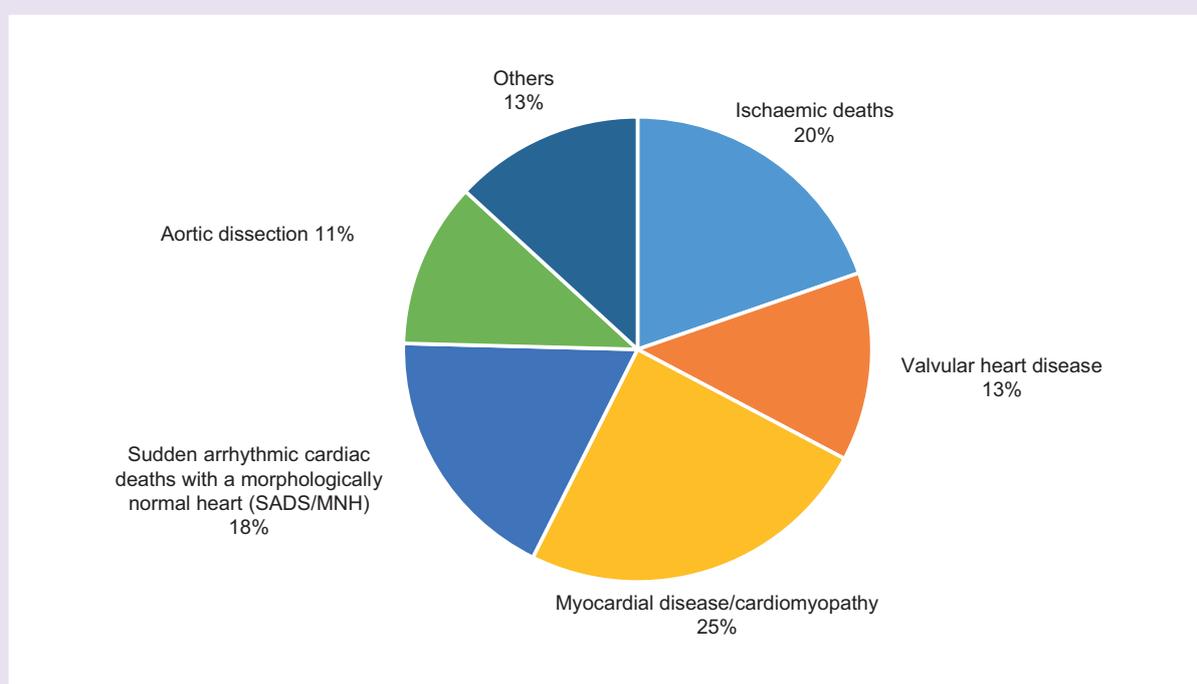


Table 5.4: Sub-classification of cardiac deaths for whom information was available for an in-depth review, UK and Ireland, 2018-20

| Sub-classification | Number of deaths | Percentage of total (n=61) |
|---|------------------|----------------------------|
| Ischaemic deaths | 12 | 20 |
| <i>Atherosclerosis</i> | 11 | |
| <i>Coronary artery dissection</i> | 1 | |
| Valvular heart disease | 8 | 13 |
| <i>Valve disease</i> | 5 | |
| <i>Endocarditis</i> | 3 | |
| Essential hypertension | 0 | 0 |
| Myocardial disease/ cardiomyopathy | 15 | 25 |
| <i>Dilated cardiomyopathy (DCM)</i> | 1 | |
| <i>Left ventricular hypertrophy (LVH) idiopathic and in morbid obesity</i> | 5 | |
| <i>Myocarditis</i> | 3 | |
| <i>Peripartum cardiomyopathy (PPCM)</i> | 3 | |
| <i>Defined cardiomyopathy</i> | | |
| <i>Hypertrophic cardiomyopathy (HCM)</i> | 1 | |
| <i>Arrhythmogenic cardiomyopathy (ACM)</i> | 0 | |
| <i>Ventricular disease (not otherwise specified)</i> | 2 | |
| Sudden arrhythmic cardiac deaths with a morphologically normal heart (SADS/MNH) | 11 | 18 |
| Aortic dissection | 7 | 11 |
| Others | 8 | 13 |
| <i>Pulmonary arterial hypertension</i> | 4 | |
| <i>Undetermined cardiac disease</i> | 3 | |
| <i>Congenital heart disease not included elsewhere</i> | 1 | |
| TOTAL | 61 | |

5.4 Overview of care and new lessons to be learned

Overall messages

Symptoms and signs

An older white British woman was experiencing cough and wheeze when visited at home during the week after she gave birth. Her community midwife attributed this to the inhalational analgesia used during labour. The following week she presented to hospital with increasing symptoms, severe cardiomyopathy was diagnosed and she was admitted. Her condition deteriorated but her care was not escalated. She died a few days later. There was no post-mortem and the final definitive cardiac diagnosis was not clear. Cardiac genetic tests were not performed.

It is likely that this woman's initial cough and wheeze were due to heart failure and pulmonary oedema (cardiac asthma), and it is possible that referral to the hospital at that point might have resulted in a different outcome. Wheeze can be a manifestation of pulmonary oedema. When wheeze is new or when thought to be related to asthma but does not settle with asthma management, pulmonary oedema should be considered. Six of the women who eventually died from myocardial causes had complained about cough, wheeze and/or shortness of breath. Two further women were treated for suspected lower respiratory tract infection.

A multiparous white British woman collapsed in the first trimester whilst running for the bus. Following review in the emergency department her ECG was said to be abnormal, but the collapse was considered to be vasovagal and there was no follow up. She had several further presentations to primary care, midwifery and the emergency department with increasing shortness of breath and dizziness which she had not experienced with her previous gestations, and

these were also attributed to pregnancy. In the third trimester she also experienced haemoptysis. Investigations including CTPA and echocardiogram led to the diagnosis of pulmonary arterial hypertension; she was quickly transferred to the regional specialist centre where she received high standard multidisciplinary management. A few minutes after a planned caesarean birth she had a cardiac arrest and could not be resuscitated.

Syncope during exertion is not physiological and should not be attributed to pregnancy. Exertional syncope should always be investigated further as it suggests an inability to increase cardiac output. All healthcare professionals who provide care for pregnant women should be familiar with Royal College of Physicians recommendations for managing women with acute medical presentations (Royal College of Physicians 2019). Acute medicine and obstetrics should each have a lead to liaise across the two specialties to optimise care and care pathways (Royal College of Physicians 2019, Mackillop 2021).

A raised respiratory rate, chest pain, persistent tachycardia and orthopnoea are important signs and symptoms of cardiac disease which should always be fully investigated. The emphasis should be on making a diagnosis, not simply excluding a diagnosis. (Knight, Nair et al. 2016)

Heart failure in cardiomyopathy can develop rapidly and guidelines for the management of acute heart failure and cardiogenic shock apply. For rapid diagnosis and decision-making, a pre-specified management algorithm and expert interdisciplinary team are crucial (2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy) (Regitz-Zagrosek, Roos-Hesselink et al. 2018)

Wheeze can be due to pulmonary oedema. Consider wheeze which does not respond to standard asthma management and exertional syncope as red flag symptoms of cardiovascular disease in addition to orthopnoea and chest pain

N

Postpartum blood pressure control

A young, obese, white British woman with a history of antiphospholipid syndrome and previous thrombosis was commenced on dalteparin and aspirin in pregnancy. She developed early onset pre-eclampsia and had a caesarean birth in the early third trimester. She declined to recommence warfarin whilst breast feeding and remained on dalteparin for several months. On various occasions postnatally both in outpatient and GP appointments the woman's blood pressure was documented to be high but it was not treated. She developed chest pain and was reviewed by the GP. She was reassured that the pain was likely musculoskeletal after a normal ECG. A few months postnatally the woman collapsed in the street from a cardiac arrest. Cardiac catheterisation identified an occluded coronary artery. Life support was withdrawn and she died from a hypoxic brain injury.

The anticoagulation advice for this woman postpartum was fragmented with confusion in primary care and a lack of a structured plan on discharge from hospital regarding anticoagulation and hypertension management. Warfarin is safe to take while breast feeding, and the woman should have been reassured.

Good control of blood pressure postpartum is paramount, for both short and long term health outcomes. The NICE Clinical Knowledge Summary for hypertension in pregnancy gives guidance on how to manage women with hypertensive disorders of pregnancy (National Institute for Health and Care Excellence 2022). In this instance, for a woman with gestational hypertension, medication should have been restarted when her blood pressure was above 150/100 with a target of reducing it to under 140/90.

Women [who have had confirmed pre-eclampsia] should be given an individual [postpartum] care plan on hospital discharge that includes:

- **Who will provide follow-up care, including medical review if needed.**
- **Frequency of blood pressure monitoring.**
- **Thresholds for reducing or stopping treatment.**

NICE Clinical Knowledge Summary Hypertension in pregnancy (National Institute for Health and Care Excellence 2022b)

Acute coronary syndrome can occur in young women. This woman had many predisposing factors for acute coronary syndrome but it is likely that her age and sex caused confirmation bias when the clinician considered the cause of her chest pain.

Investigation of tachycardia and palpitations

A multiparous Asian woman who did not speak English was diagnosed with anaemia at booking and given parenteral iron and B12 supplements with effect. She reported intermittent tachycardia during pregnancy, this was attributed to anaemia and not investigated further. She was found dead in bed at term due to a sudden arrhythmic cardiac death with a morphologically normal heart (SADS/MNH).

As noted in previous MBRRACE-UK reports (Knight, Nair et al. 2016, Knight, Bunch et al. 2019), there were several women with a persistent tachycardia which was not investigated. Palpitations are common in pregnancy; while they are frequently benign, some will represent a significant arrhythmia. Pregnant women presenting with palpitations require a careful assessment to determine whether their symptoms can be attributed to normal physiology or require further investigation for pathology. Women with a very clear history of an awareness of a physiological rise in heart rate (in the absence of a significant tachycardia on examination) or the occasional ectopic beat may not require further investigation. If this is not clear from the history, or if symptoms are severe or persistent, systematic investigations should be carried out to establish a cause.

A persistent sinus tachycardia is a 'red flag' and should always be investigated, particularly when there is associated breathlessness. (Saving Lives, Improving Mothers' Care 2019) (Knight, Bunch et al. 2019)

Take a cardiac-specific history and suspect heart failure if there is not another likely cause of any of the following symptoms:

- **Breathlessness when lying down (ruling out aortocaval compression) or at rest**
- **Unexplained cough, particularly when lying down or which produces frothy pink sputum**
- **Paroxysmal nocturnal dyspnoea – being woken from sleep by severe breathlessness and coughing, which may produce pink frothy sputum and is improved by moving to an upright position**
- **Palpitation (awareness of persistent fast heart rate at rest).**

NG121 Intrapartum care for women with existing medical conditions or obstetric complications and their babies (National Institute for Health and Care Excellence 2019a)

Aortic dissection

Think Aorta

A young woman with a previously uncomplicated pregnancy presented to the emergency department at term complaining of sudden onset, central chest pain radiating to her back and up to her jaw whilst out shopping. The pain in her back was at the level of her bra. She felt worse pain if she tried to lie down and could barely do this. She had normal examination, observations, ECG, bloods (including troponin and blood gases) and was reviewed by an emergency department consultant who felt the pain was not cardiac related. She did not have a chest x-ray. The emergency department consultant attributed the pain to early labour and recommended discharge. A second consultant agreed. A midwife did not feel she was in labour. Intravenous paracetamol and Gaviscon did not help her pain but it was partly relieved by morphine. A fetal tachycardia occurred and her pain was then thought to be related to an abruption. She had an induced birth and the pain settled and she was discharged the next day. The following day she collapsed and could not be resuscitated despite thrombolysis. Her aortic dissection was diagnosed at post-mortem.

Professionals did not listen to this woman, her husband or midwife. The pain was not at all typical of labour but professionals wanted to find an obstetric cause. The woman herself knew this was not early labour or else she would have presented to the midwifery led unit. No obstetric opinion was sought by either emergency department consultant

because this was not in keeping with their policy that women needing review are transferred to the maternity unit. This should not have stopped the emergency department consultant picking up the telephone and discussing the woman with an obstetrician. A chest x-ray may have helped with the diagnosis.

At the consultant led unit she had an artificial rupture of membranes for induction following possible abruption, yet she had clear liquor, so had not had a notable abruption. Again, there was not joined up thinking. This is a rare diagnosis and event and those involved did not think of aortic dissection. The symptoms were in keeping with that diagnosis and not labour. It is likely that the original presentation was the initial dissection and at the point of cardiac rupture she arrested.

Without intervention, survival falls every hour after dissection occurs (Mehta, Suzuki et al. 2002), and considering the diagnosis to enable appropriate investigations remains the most important message. Of the seven women who died from aortic dissection, two were presumed to have renal colic, and two, including this woman, were presumed to have an abruption. Considering a cardiac differential diagnosis is imperative in these situations.

Think aorta (Aortic dissection awareness UK)

Family history

A woman collapsed and died from an aortic dissection at term. A thorough review identified that at booking she had described that her sister had had a heart condition but that she herself had been tested and cleared. Her sister had had an aortic dissection but the woman had only had a single echocardiogram for screening.

A single echocardiogram does not exclude a familial aortopathy or tendency to aortic dissection. There does not appear to have been a genetics opinion or gene panel performed. The woman was appropriately asked about her family history but reported that she had been cleared of risk (as was her understanding). The echo in 2014 was actually mildly abnormal. We do not know whether her aorta was dilated before it dissected, but had she had further routine screening prior to pregnancy, a cardiac obstetric opinion and imaging in pregnancy, important aortic dilatation if present would have been identified and could have been treated and the risk managed. Having given a history that she had been tested and cleared, the pregnancy management was appropriate.

When aortic dissection occurs in a young woman, the underlying diagnosis should be assumed to be an inherited aortopathy until proven otherwise.

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

A family history of sudden death of a young relative (aged less than 40) is important and may be an indication of inherited cardiac conditions.

Anyone with a family history or genetic confirmation of aortopathy or channelopathy should be referred for cardiac assessment before pregnancy.

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

Myocardial ischaemia

Twelve women died from myocardial ischaemia, 11 from atherosclerosis and 1 from spontaneous coronary artery dissection (SCAD). This compares to 20 deaths in 2015-17 (6 from SCAD). Although not a statistically significant reduction, this may represent raised awareness of the symptoms and signs of cardiac disease in pregnant and post-partum women since it was first highlighted in the 2016 report.

Risk factors

A grand-multiparous obese hypertensive woman in her late forties with several medical and mental health co-morbidities who smoked conceived spontaneously and was booked for consultant care. She received aspirin, appropriate thromboprophylaxis and had multidisciplinary team follow-up. She developed pre-eclampsia and had an induced late preterm birth. She collapsed at home and died three months postpartum from left ventricular failure following an acute myocardial infarction thought to have occurred a few weeks earlier.

This woman had multiple risk factors for ischaemic heart disease, including both lifestyle and medical factors. While assessors felt she received good care during pregnancy, there is no evidence anyone discussed her cardiovascular risk or considered providing advice on symptoms and signs of heart disease. Pregnancy and the postpartum period is an opportunity for lifestyle advice and preventive intervention and being aware of the risk factors for cardiovascular disease is important (Box 5.1). Ischaemic heart disease is often overlooked as a diagnosis in the maternity population and there needs to be a high index of suspicion in order to promptly detect and effectively institute treatments.

Box 5.1: Risk factors for ischaemic heart disease

- Older age
- Smoking
- Obesity
- Diabetes
- Hypertension and/or pregnancy hypertensive disorders
- Family history of premature coronary disease
- Hypercholesterolaemia

Symptom awareness

A woman with normal BMI who did not smoke had an uneventful pregnancy. Her father had died from myocardial infarction at 50 years old. At eight months postnatally she presented on three separate occasions within one week with chest pain radiating to her left arm. She was diagnosed with acute coronary syndrome and non-STEMI and transferred to the catheter lab. She was found to have spontaneous coronary artery dissection and arrested during the procedure. She was transferred to theatre for surgery but died the same day.

This woman had presented on three occasions before the diagnosis was made. This emphasises again the messages made in previous reports concerning 'red flags' and the symptoms and signs of heart disease. The common symptoms associated with ischemic heart disease can develop over a short time frame and necessitate immediate attention. Women with young babies and other children do not have time to present repeatedly to the emergency department unless there is something wrong. A repeat presentation should prompt senior, multidisciplinary review.

Box 5.2: Chest pain 'red flags' to be aware of

- Pain requiring opioids
- Pain radiating to arm, shoulder, back or jaw
- Sudden onset, tearing or exertional chest pain
- Associated with haemoptysis, breathlessness, syncope or abnormal neurology
- Abnormal observations

RCP Toolkit: Care for the acutely ill pregnant woman 2019 (Royal College of Physicians 2019)

Investigate and treat pregnant and postpartum women the same as non-pregnant women unless there is a clear reason not to.

Saving Lives, Improving Mothers' Care Reports 2014-21

Thromboprophylaxis

Two extremely obese women who had significant bleeding should have received postpartum thromboprophylaxis according to RCOG guidelines, but their risk was not correctly assessed and no low molecular weight heparin was prescribed. Both collapsed and died from coronary thrombosis a few days after hospital discharge. Similar to the woman described above, these women had clear risk factors for ischaemic heart disease. Risk factors for ischaemic heart disease have significant overlap with those associated with venous thromboembolism. While correct thromboprophylaxis is unlikely to have prevented these women's myocardial infarctions, it is important to be aware of the common risk factors and raise awareness of the symptoms and signs of cardiac disease amongst women who require thromboprophylaxis due to obesity.

Be aware of the common risk factors for heart disease and venous thromboembolism, such as extreme obesity, and consider on an individual basis whether women should be made aware of the symptoms and signs of heart disease as well as those of venous thromboembolism **N**

Spontaneous Coronary Artery Dissection (SCAD)

Only one woman died from SCAD in this triennium. A recent analysis, including 13 women who died from SCAD and whose deaths were considered in previous reports, suggested that the highest risk period for pregnancy-associated SCAD was in the six months immediately postpartum, with the highest number of women affected in the first month postnatally (Chan, Premawardhana et al. 2022). Rapid recognition and early intervention remain the most important responses.

Myocardial disease

Fifteen women died from myocardial disease, with left ventricular hypertrophy either alone or in association with obesity and hypertension, the most commonly seen myocardial condition (5 women). Three other women died from cardiac causes where the quality of the postmortem was insufficient to delineate the exact cardiac cause; myocardial disease was among the differential diagnoses for these three women.

Awareness

A woman of Asian origin had an uncomplicated birth. A few weeks later she collapsed after several days of nonspecific symptoms including increasing back pain, breathlessness, palpitations and worsening exhaustion. Emergency services attended quickly. Following transfer to the emergency department urgent investigations were carried out including echocardiography and a CT scan and viral myocarditis was considered the most likely cause of her heart failure. Her condition deteriorated rapidly, and despite inotropic support she died.

This woman had excellent care during the short acute presentation that led to her death. She had a number of 'red flag' symptoms in the few days before her collapse. Whilst earlier presentation may not have prevented her death, this emphasises again the importance of making women aware of the significance of symptoms such as orthopnoea.

Recognition and response

An Asian woman had an uncomplicated term birth. She had no significant medical history other than occasional anxiety attacks. In the postnatal period she made several contacts with her GP surgery. She reported a recurrence of anxiety attacks and was prescribed propranolol which did not help. She had a face to face consultation on the third occasion, tachycardia, hypoxia and basal crepitations were noted and oral antibiotics prescribed for a chest infection. A few days later she presented to the emergency department with vomiting, dehydration and three week history of shortness of breath. Cardiac ultrasound identified severe heart failure with pulmonary oedema due to peripartum cardiomyopathy and she was transferred to a regional cardiac centre. Subsequent escalation of treatment was unsuccessful, and she died a few weeks later.

A feeling of anxiety may be a manifestation of hypoxia and of heart disease, and should not be automatically be assumed to be related to mental health, especially if a previously successful intervention is unhelpful. In the postnatal period, new or deteriorating symptoms may have a pregnancy-related aetiology. It is unclear if a full history was taken to delineate her symptoms before her final presentation, or if the potential importance of hypoxia in a young woman was appreciated. It is worth noting that this woman's care may have been impacted by pandemic-related changes to services. Her remote prescription for propranolol, slow access to her GP, the lack of escalation to maternity or acute settings, and her later presentation to the emergency department may all have been as a consequence of the pandemic and delayed her diagnosis. Assessors felt her options for transfer for more advanced care may also have been impacted.

All healthcare practitioners caring for pregnant and recently delivered women should be familiar with the range of medical disorders including peripartum cardiomyopathy that can occur.

Ensure that all clinical staff caring for pregnant or postpartum women, whatever the location of care, are aware of the concerning 'red flag' symptoms described in the RCP Acute care toolkit 15: Managing acute medical problems in pregnancy.

Saving Lives Improving Mothers' Care 2021 (Knight, Bunch et al. 2021b)

Brain Natriuretic Peptide (BNP)

BNP (Brain Natriuretic Peptide) and NT-pro BNP (N-terminal BNP) are biomarkers (neurohormones) that are widely used in the diagnosis, management and assessment of progress of treatment of heart failure of all types, both in the elective and emergency settings. Normal levels of these biomarkers throughout pregnancy have been established over the last decade (Hameed, Chan et al. 2009, Furenas, Eriksson et al. 2020) and pregnancy specific reference intervals have also now been defined (Dockree, Brook et al. 2021). A systematic review and meta-analysis of the diagnostic accuracy of BNP and N-terminal BNP in 13 studies was undertaken by Sheikh et al (Sheikh, Ostadrahimi et al. 2021). Taken together, these studies suggest that measurement of serum levels of BNP or NT-pro BNP can be used as a diagnostic aid to assist in the investigation of women with suspected cardiac disease in pregnancy, as is standard practice in the non-pregnant population (McDonagh, Metra et al. 2021). Assessors felt that there was the potential for use of BNP or NT-pro BNP measurement to aid diagnosis for several women, including the woman whose care is described above.

Develop guidance for the use of Brain Natriuretic Peptide measurement in pregnancy

N

Benefits of treatment

An older ethnic minority woman with several medical co-morbidities, including epilepsy, declined to take her usual medication while pregnant. At booking she had hypertension, but did not wish to receive treatment and upheld this decision also when hypertension became more severe. Multiple assessments of capacity were carried out throughout her pregnancy. By term she had severe untreated hypertension and the fetal weight was estimated to be on the 10 percentile for gestational age. She was advised hospital admission and induction, but declined and wished to wait for spontaneous labour. She collapsed at home a few days later as a result of hypertensive heart disease and could not be resuscitated.

This woman's care illustrates the challenges staff may encounter providing counselling about treatment and consequence of non-compliance with treatment recommendations in pregnancy. Multiple individuals were involved in caring for this woman, and she also moved care if she was unhappy and felt she was not met with respect. This provides further evidence for the need to engage with third sector organisations to address advocacy and support for ethnic minority women to increase understanding of their individual beliefs about illness, disease and pharmaceutical medications.

While the risks of medications were discussed, the risks of untreated disease (in this case epilepsy and hypertension) were not adequately addressed. Concerns over medication effects on the unborn child need to be balanced with the dangers of not or under-treating a condition which can also lead to perinatal or maternal morbidity or mortality. Training of doctors, nurses, midwives and AHPs, especially for those working outside maternity services is required to ensure this balance is understood and clearly communicated to pregnant women to allow them to make an informed decision regarding their medication.

Distance and tertiary care

An older White British woman with a complex medical and mental health history including known cardiac disease presented with an unplanned pregnancy. There was no documentation of pre-pregnancy or contraception counselling following her cardiac diagnosis. She was short of breath at rest throughout most of the pregnancy. In the early third trimester she was admitted with breathlessness and palpitations to her local hospital, echocardiography identified cardiac failure which was treated. Her cardiac function declined further and she was transferred to the regional cardiac centre. There was good multidisciplinary team involvement and she had an uneventful induced birth at term. Contraception was provided. Although she requested an early discharge to be near her family, appropriate investigations were undertaken prior to discharge and she had a plan for follow-up. She died from her cardiomyopathy a few weeks postpartum.

This woman had a significant cardiac condition and multiple co-morbidities. It is not clear that she had received pre-pregnancy advice concerning the potential impact of pregnancy on her cardiac condition, nor had she received contraceptive advice. On initial presentation to the emergency department the severity of her condition was not recognised and there were delays in calling the maternity medical team. However, once the significance of her condition was recognised, she was cared for appropriately at her local hospital and her care was transferred in a timely manner to a specialist centre when she deteriorated. The tertiary centre team made a plan of care for the antenatal, intrapartum and postnatal period. This undoubtedly improved the chances of a good pregnancy outcome, however the location of the specialist centre far away from her home meant she was discharged early wishing to be closer to her family. The reviewers felt that this woman's care was an excellent example of multidisciplinary involvement with appropriate planning and management, but noted the importance of ensuring that new networked maternal medicine services can deliver individualised care for women irrespective of their distance from the tertiary centre.

Ensure maternal medicine networks and their equivalents in the devolved nations and Republic of Ireland can provide appropriate expertise and supervision for all women, including those in rural/remote areas. N

Sudden arrhythmic cardiac death with a morphologically normal heart (SADS/MNH)

Eleven women (18%) died from SADS/MNH during 2018-20 in the UK and Ireland, a proportion unchanged from 2015-17. As SADS/MNH is thought to be a sudden death as a result of an arrhythmia, prodromal symptoms and family history can be important. One of the women who died reported palpitations in pregnancy and another had a relevant family history of sudden cardiac death. Some genetic syndromes are known to underlie SADS/MNH, emphasising the importance of retaining tissue for potential family screening, but this was infrequent, as described in the pathology section.

Valve disease

Pre-pregnancy counselling and pregnancy termination

An older woman with a past history of metallic mitral valve replacement and warfarin anticoagulation had a confirmed pregnancy at 6 weeks. She was unsure if she should continue the pregnancy. She was seen for specialist haematology assessment and the warfarin was changed to tinzaparin. Termination of pregnancy was discussed (via an interpreter), but before this could take place she had a thromboembolic stroke. Thrombus was identified on the mitral valve. She deteriorated and died a few months later.

This woman had been in regular contact with her GP prior to pregnancy (monitoring her anticoagulation) but there was no documentation about contraception or pre-conception care. The woman's daughter had been acting as a translator and there may have been a reluctance to discuss aspects of care "through" her. All women on warfarin should be offered effective contraception and a preconception appointment with a specialist should be offered.

Therapeutic anticoagulation during pregnancy is of utmost importance to avoid complications in these patients, bearing in mind that no anticoagulation regimen is ideal and management will require a careful balance between maternal and fetal risks (Vahanian, Beyersdorf et al. 2021).

For this woman who had presented at 6 weeks gestation while on warfarin and opting for a termination, continuation of the warfarin would have limited her risk of adverse outcome.

Be aware that women using oral anticoagulation with warfarin may be more safely managed without transition to low molecular weight heparin treatment when having an early termination of pregnancy. N

All women with pre-existing cardiac disease (congenital or ischemic) should be offered pre-pregnancy counselling (Saving Lives Improving Mothers' Care 2016) including contraceptive advice (Saving Lives Improving Mothers' Care 2019)

Anticoagulation

A woman with a mechanical mitral valve replacement had a planned pregnancy. She had received pre-pregnancy advice. Management of her anticoagulation was complex with bleeding episodes and subsequently a valve thrombosis in the third trimester when warfarin was stopped and she had a period of subtherapeutic anticoagulation with low molecular weight heparin. She was stabilised and had a caesarean birth but died following an emergency valve replacement.

The management of anticoagulation for mechanical heart valves in pregnancy is complex and needs to be individualised. From a previous MBRRACE report (Knight, Bunch et al. 2018) and UKOSS publication (Vause, Clarke et al. 2017), women with mechanical heart valves have an approximately 50% chance of severe morbidity, most commonly serious and significant bleeding.

This woman's care illustrates the particular challenges around swapping from one type of anticoagulation to another. At 34 weeks her warfarin was stopped and LWMH commenced, however there was a period of 48 hrs when she had subtherapeutic LWMH and it was soon after this that an echocardiogram demonstrated an increased gradient across her mitral valve in keeping with valve thrombus. Unless at very high clot risk, the use of LWMH throughout pregnancy could minimise risks associated with transition between warfarin and LWMH. It is also important to note that thrombolysis can be considered for the management of valve thrombosis in women who are critically ill and in whom valve replacement surgery is considered high-risk or is not immediately available (Vahanian, Beyersdorf et al. 2021).

Pregnancy in women with a mechanical valve, especially in the mitral position, is associated with a high risk of maternal and fetal complications, which should be carefully discussed with the patient and family. 2021 ESC/EACTS Guidelines for the management of valvular heart disease (Vahanian, Beyersdorf et al. 2021)

Endocarditis

Assessors noted that, in common with many of the women whose care is described in other chapters of this report, the women who died from endocarditis had multiple vulnerabilities, and may have benefitted from a single point of contact in both antepartum and postpartum care.

Atrial fibrillation

An Asian woman with known moderate/severe mitral regurgitation in whom valve replacement was being considered developed fast atrial fibrillation with haemodynamic compromise later in pregnancy. Her heart rate and rhythm was hard to control. Her cardiologists decided that anticoagulation was not indicated. She underwent induction of labour and immediately post delivery experienced another episode of fast atrial fibrillation which was treated on the coronary care unit. She was discharged a few days later to enable her to be at home with her baby, but returned to the emergency department in extremis in pulmonary oedema and atrial fibrillation after two weeks. She had chest pain, cough and breathlessness since discharge but had declined admission after a previous emergency department visit. An assumption was made that she had a pulmonary embolism but her left ventricular failure was diagnosed after she collapsed. She died shortly afterwards.

Assessors felt that this woman's care was compromised at many points by the fact that she was pregnant or postpartum, and a non-English speaker. It is unclear why neither electrical cardioversion nor anticoagulation were considered when she first presented in pregnancy; European Society for Cardiology guidelines are clear that both are recommended. Issues with poor understanding and miscommunication (medicines, appointments, date of induction) were clear throughout her notes; translation was undertaken by her husband or a series of staff but rarely an interpreter. It was commented that her baby could not be accommodated on the medical ward which was a possible reason for her declining admission. No consideration seems to have been made to providing her with the care she needed in another location.

Recommendations for the management of AF during pregnancy:

- **Immediate electrical cardioversion is recommended in cases of haemodynamic instability or pre-excited AF**
- **Therapeutic anticoagulation with heparin or [warfarin] according to the stage of pregnancy is recommended for patients with AF**

2020 ESC Guidelines for the diagnosis and management of atrial fibrillation (Hindricks, Potpara et al. 2020)

Pulmonary arterial hypertension

A multiparous woman with a history of postpartum haemorrhage but no cardiac history attended the emergency department in the second trimester with haemoptysis on three successive days. A Chest X Ray was reported as normal, and a CTPA reported focal lung infection. Although ECG features of right heart strain were recorded, an echocardiogram was not performed. She gave birth at term but a week later she was readmitted with severe breathlessness and vaginal bleeding; echocardiography confirmed impaired right ventricular function and pulmonary hypertension. She died shortly afterwards. Post mortem demonstrated features of primary pulmonary hypertension.

Independent review of her initial radiology imaging confirmed that features of pulmonary arterial hypertension were present at that stage.

Four women died as a result of pulmonary hypertension. Pulmonary hypertension defines a heterogeneous group of disorders with differing causes and therefore treatment is directed to the underlying cause, if known (Humbert, Kovacs et al. 2022). However, no single clinical feature or investigation taken in isolation can predict the outcome and prognosis of pulmonary hypertension (Yaghi, Novikov et al. 2020). Acutely decompensated pulmonary hypertension, as in this woman, can be triggered by a wide number of factors (Savale, Weatherald et al. 2017). In the

setting of pregnancy (Thomas, Yang et al. 2017, Afify, Kong et al. 2022), changes in haemodynamics during and after delivery (fluid shifts or blood loss), or thrombosis, for example, can precipitate acute pulmonary hypertensive crises with a high mortality.

If earlier diagnosis had been made when the woman first presented, appropriate referral for tertiary investigation and intervention may potentially have made a difference to her outcome.

5.5 Pathology in maternal cardiac deaths

Aortic dissection

Esther Youd

Seven women died from aortic dissection in this period. Five were of white European ethnicity. Their ages ranged from 21-43 years and BMIs 19-28kg/m². The stage of pregnancy ranged from the first trimester to more than six months postpartum. Two women had a prior medical history of hypertension, and one of those had features of hypertensive heart disease at autopsy.

The massive cardiovascular changes associated with pregnancy may be a factor in the pathogenesis of aortic dissections, particularly in late stage pregnancy or early post partum, however, inheritable conditions including connective tissue disorders such as Marfan syndrome, Loeys Dietz and Ehlers Danlos syndrome and other inheritable syndromes such as familial thoracic aortic aneurysm and dissection are important causes in this patient group, and dissections associated with connective tissue disorders can occur at any stage of pregnancy.

An autopsy was carried out in five women. In the remaining two instances the women presented to hospital, and were diagnosed with aortic dissection and had surgical treatment, but subsequently died. Whilst an autopsy was not required to establish the cause of death, it may have been useful to allow histological examination of the aorta and retention of genetic material for potential future family screening.

Of the five women who had an autopsy, histological assessment of the aorta was carried out in all (good practice), however, the histology description was very limited in four of five women, with little consideration of medial degeneration features which might suggest an inheritable condition (mucoid extracellular matrix accumulation, elastic fibre fragmentation/thinning/loss, smooth muscle cell nuclei loss, laminar medial collapse, medial fibrosis) (Stone, Bruneval et al. 2015, Halushka, Angelini et al. 2016). Whilst these features are not specific for any one disease, their description and evaluation of severity can help distinguish the more likely aetiology.

A morphological description of the aortic valve is important, as bicuspid aortic valve may be associated with aortic dissection, and is the most common inherited cardiac condition in the UK. In this series, in four of the five women the valve was described as “normal” but without specific comment on the number of valve leaflets. There was no comment on the aortic valve morphology in one woman.

When encountering aortic dissection at autopsy, particularly in the young, retention of spleen (or similar suitable material) for genetic testing is important. In this series in only one woman was the spleen retained, with subsequent genetic testing confirming Ehlers Danlos syndrome as the underlying genetic cause. In one woman the autopsy description includes some morphological features that might have pointed towards Marfan syndrome, however, there was no comment on the palate and only limited histological description, with no retention of genetic material, potentially a missed opportunity to identify an important inheritable condition.

Take home message for pathologists:

- **Histology evaluation of the aorta is important to try to distinguish features of connective tissue disorders from features of hypertension and other acquired aetiologies (see consensus statements from the Society for Cardiovascular Pathology and the Association for European Cardiovascular Pathology) (Stone, Bruneval et al. 2015, Halushka, Angelini et al. 2016)**
- **Standard special stains include EVG to evaluate elastin fragmentation, and alcian blue to evaluate mucoid extracellular matrix accumulation**
- **In all cases of aortic dissection a sample of spleen should be retained (or other appropriate sample for the local genetics laboratory) for potential genetic testing, and unless a non-heritable cause is identified, the family should be referred to the local cardiologist or geneticist for consideration of screening**
- **The morphology of the aortic valve should be specifically described (bicuspid or tricuspid)**

Peripartum cardiomyopathy

Samantha Holden

A diagnosis of peripartum cardiomyopathy was given by the referring pathologist / clinical team for seven women. Following review by the panel, this was only considered the true diagnosis in three women. The three women with peripartum cardiomyopathy (PPCM) were aged between 22 and 31 years of age, two of Caucasian origin, all with a BMI at booking below 30kg/m². All three had a clinical diagnosis of PPCM made and they died between three weeks and four months after giving birth. A post mortem examination was performed for two women, although the description of the heart histology was not extensive in either.

One of the other women had a clinical diagnosis of PPCM but there was a differential diagnosis of myocarditis. No post mortem examination was undertaken so the final diagnosis was considered unclear by the panel.

The three women who were not considered to have PPCM highlight important learning points. One woman died suddenly five months post partum with no previous history. She had right ventricular dilation which was referred to by the reporting pathologist as 'right ventricular cardiomyopathy (peripartum)'; this is not an entity which is recognised. There were no clinical features to suggest peripartum cardiomyopathy and the panel's view was this was a sudden arrhythmic cardiac death.

Two further women diagnosed as having peripartum cardiomyopathy were felt by the panel to have hypertensive heart disease – in both patients their booking BMI was over 45kg/m² and there were no clinical features to suggest peripartum cardiomyopathy. It should be noted one of these cases was referred for specialist opinion but the diagnosis of peripartum cardiomyopathy was still given.

Peripartum cardiomyopathy is rare and relies on clinical diagnosis rather than the pathology. More common causes of a large heart, including genetic cardiomyopathy, hypertension or obesity-associated cardiomegaly, should be considered, rather than assuming all large hearts in pregnancy are due to peripartum cardiomyopathy. Histology of the myocardium in several of the autopsies was not extensive; appropriate sampling of the myocardium is necessary in all instances. This over-diagnosis of PPCM seems to reflect the assumption we see in other areas of this report to attribute conditions to pregnancy and a lack of appreciation of case definitions by pathologists.

SADS/MNH

Sebastian Lucas

There are ongoing national initiatives to identify people with inherited cardiac disease in order to prevent future deaths, particularly among the young (Sheppard 2022). In maternity, this includes the standard cardiomyopathies (hypertrophic, arrhythmogenic right ventricular), unexplained left ventricular hypertrophy, dissection of the aorta, and sudden arrhythmic cardiac death with morphologically normal heart (SADS/MNH). All these syndromes are known to have specific gene associations in a proportion of patients that increases with ever-advancing genetic analytical progress.

SADS/MNH was first mentioned in the UK maternal confidential enquiries in the triennial report for deaths in 2003-5, and has increased in number and proportion of total deaths since (Table 5.5). This is due to increasing recognition of the condition by pathologists. No other country acknowledges SADS/MNH deaths to this extent, presumably most are listed as 'unascertained cause of death'.

Table 5.5: Maternal deaths from SADS/MNH, UK and Ireland 2003-2020

| | Number of women who died during or up to 6 weeks after pregnancy | MMR per 100,000 maternities | Number of women who died more than 6 weeks up to a year after pregnancy | Late MMR per 100,000 maternities |
|--------------------------|--|-----------------------------|---|----------------------------------|
| 2003-5* | 3 | 0.1 | n/a | n/a |
| 2006-8* | 10 | 0.4 | n/a | n/a |
| 2009-14 | 36 | 0.8 | 17 | 0.4 |
| 2015-17 | 10 | 0.41 | 5 | 0.21 |
| 2018-20 (current report) | 5 | 0.22 | 6 | 0.26 |

*UK only

All the 11 mothers who died between 2018-20 died suddenly and unexpectedly in the community; their median age was 33 years (range 20-42). Around half died more than six weeks after pregnancy; those dying before or shortly after giving birth had reached 28 weeks to term; all but one were White women; none were morbidly obese. One had a suggestive family history of premature cardiac death, and another had reported palpitations during pregnancy.

At autopsy, all their heart/body weight ratios were within the normal range; all had toxicology screens which were negative for cardio-stimulatory drugs, but only one had formal exclusion of acute anaphylaxis through mast cell tryptase blood analysis. Four of the 11 autopsies had the heart reviewed by a cardiac pathology specialist.

Regarding cardiac disease genetic association, four of the 11 mothers had DNA analysis performed on tissue; none are known to have resulted in a positive link, although one mother had an abnormal gene associated with seizures.

The critical question is whether pregnancy, delivery and post-delivery care of the baby are risk factors for death from SADS/MNH. As yet, it is unclear epidemiologically whether the maternal mortality rate of SADS/MNH is any different from the expected death rate from SADS/MNH among non-pregnant women in the same age range, who have not had a pregnancy within the previous year. A higher rate would indicate that these deaths represent a syndrome that demands closer attention within maternal services.

Pathologists need to maintain vigilance in the assessment of deaths where there is no obvious macroscopic causation, and follow the recommended UK protocols for the optimal examination of the heart at autopsy (Royal College of Pathologists 2022). Only then will we be able to assess the true contribution of inherited cardiac disorders such as SADS/MNH to maternal mortality.

5.6 Conclusions

Assessors considered that in almost one third of instances, different care may have prevented women's deaths (Table 5.6). As has been a repeated focus of these reports, raising awareness of the importance of 'red flag' cardiac symptoms, and considering cardiac causes as part of the differential diagnosis for women presenting with pain, wheeze and breathlessness remain the most important actions. Only one in ten women were known to have cardiac disease prior to pregnancy. While the decreased mortality rate from cardiac causes noted in this report gives cautious reasons for optimism, women continue to enter pregnancy with a greater range and number of risk factors for cardiac disease. This emphasises not only the importance of recognition of cardiac disease when it occurs for the first time during and immediately after pregnancy, but also of actions pre-pregnancy to identify and address risk factors.

Table 5.6: Classification of care received by women who died from cardiovascular causes, UK and Ireland, 2018-20

| Classification of care received | Women who died (N=61) Number of women (%) |
|---|--|
| Good care | 16 (26) |
| Improvements to care which would have made no difference to outcome | 25 (41) |
| Improvements to care which may have made a difference to outcome | 19 (31) |
| Records unavailable | 1 (2) |

6. Lessons on prevention and treatment of hypertensive disorders

Marian Knight, Kate Harding, Louise Page, Nicki Pusey and Samantha Holden on behalf of the MBRRACE-UK hypertensive disorders chapter-writing group

Chapter writing group members: Jim Bamber, Anita Banerjee, Margarita Bariou, Kathryn Bunch, David Churchill, Bernard Clarke, Hilde Engjom, Nicky Gammie, Kate Harding, Samantha Holden, Sara Kenyon, Alison Kirkpatrick, Marian Knight, Cassie Lawn, Upma Misra, Louise Page, Roshni Patel, Beccy Percival, Nicki Pusey, Robin Russell

6.1 Key messages

New recommendations

Ensure that the national Patient Group Direction allowing prescription of aspirin for pregnant women at risk of pre-eclampsia by midwives and pharmacists is widely implemented **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.

Ensure that women's electronic records can be easily accessed and shared when they receive care in different settings **[ACTION: National Digital Policy Teams, Service Planners/Commissioners, Hospitals/Trusts/Health Boards]**.

Be aware of how to contact the regional maternal medicine lead for urgent advice to ensure multidisciplinary senior review of women who are unwell. **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards, All Health Professionals]**.

Be aware of the added risk of fetal compromise when a woman's pregnancy is complicated by both hypertension and diabetes. It is not only babies predicted to be small for gestational age who may be at risk **[ACTION: All health professionals, Professional education programmes]**.

Existing guidance requiring improved implementation

At the first antenatal (booking) appointment (and later if appropriate), discuss and give information on what antenatal care involves and why it is important (NICE Guideline NG201 Antenatal care)

When giving women (and their partners) information about antenatal care, use clear language, and tailor the timing, content and delivery of information to the needs and preferences of the woman and her stage of pregnancy. Information should support shared decision making between the woman and her healthcare team, and be:

- offered on a one-to-one or couple basis
- supplemented by group discussions (women only or women and partners)
- supplemented by written information in a suitable format, for example, digital, printed, braille or Easy Read
- offered throughout the woman's care
- individualised and sensitive
- supportive and respectful
- evidence-based and consistent
- translated into other languages if needed (NICE Guideline NG201 Antenatal care)

Explore the knowledge and understanding that the woman (and her partner) has about each topic to individualise the discussion (NICE Guideline NG201 Antenatal care)

During labour measure blood pressure hourly in women with hypertension (NICE Guideline NG133 Hypertension in pregnancy)

Transfer the woman to obstetric-led care if any of the following are observed at any point, unless the risks of transfer outweigh the benefits:

- a single reading of either raised diastolic blood pressure of 110 mmHg or more or raised systolic blood pressure of 160 mmHg or more
- either raised diastolic blood pressure of 90 mmHg or more or raised systolic blood pressure of 140 mmHg or more on 2 consecutive readings taken 30 minutes apart (NICE Intrapartum care guideline CG190)

If induction is unsuccessful, discuss this with the woman and provide support. Fully reassess the woman's condition and the pregnancy in general, and assess fetal wellbeing using antenatal cardiotocography interpretation (NICE Guideline NG207 Inducing labour)

If induction is unsuccessful, discuss and agree a plan for further management with the woman, including whether she would like further attempts at induction, taking into account the clinical circumstances and her preferences (NICE Guideline NG207 Inducing labour)

In women with severe pre-eclampsia, limit maintenance fluids to 80 ml/hour unless there are other ongoing fluid losses (for example, haemorrhage) (NICE Guideline NG133 Hypertension in pregnancy)

For women with gestational hypertension whose blood pressure is lower than 160/110 mmHg after 37 weeks, timing of birth, and maternal and fetal indications for birth should be agreed between the woman and the senior obstetrician (NICE Guideline NG133 Hypertension in pregnancy)

For women with pre-eclampsia who are 37 weeks onwards initiate birth within 24-48 hours (NICE Guideline NG133 Hypertension in pregnancy)

6.2 Background

The number of women who die from hypertensive disorders of pregnancy has been in single figures in the UK and Ireland for the last three triennia. Nevertheless, it is of concern that the mortality rate in this triennium in the UK is now more than four times higher than it was in 2012-14, when only two women died. Hypertensive disorders of pregnancy remain one of the leading causes of maternal death worldwide, and the UK will only maintain its low maternal death rate with continued emphasis on prevention, early detection and optimal management of hypertensive disorders. This will become even more important with increasing numbers of women entering pregnancy with risk factors for hypertensive pregnancy disorders, and multiple morbidities which add complexity to the treatment of co-existing pre-eclampsia, as highlighted in chapter 4. To enhance the messages for improving care of women with hypertensive disorders, for the purposes of this chapter, MBRRACE-UK assessors worked together with members of the HSIB maternity team and considered messages for care arising from HSIB reviews of babies who died or had severe brain injury in association with a maternal hypertensive disorder of pregnancy.

6.3 The women who died

In 2018-2020 eight women died from hypertensive disorders of pregnancy, all either during pregnancy or up to six weeks after the end of pregnancy. The mortality rate in the UK remains low (0.38/100,000, 95% CI 0.16-0.75) but is four times higher than in the 2012-14 triennium when the rate was at its lowest (0.09/100,000 maternities, 95% CI 0.01-0.31) (RR 4.46, 95% CI 0.89-43.1).

Two women died following intracranial haemorrhage in association with HELLP syndrome, two women died from Acute Fatty Liver of Pregnancy (AFLP), and two died following eclamptic seizures (Table 6.1). Two women died from pulmonary oedema; both died at home and neither woman's death was associated with intravenous fluid administra-

tion. However, issues around fluid management in the context of women with pre-eclampsia and pre-existing diabetes are described in chapter 4. The care of three women who died was potentially impacted by pandemic-related factors, including remote consultation and concern around hospital attendance.

Table 6.1: Causes of death among women who died from hypertensive disorders of pregnancy (1997-2020)

| | 1997-2002§ | 2003-8§ | 2009-14¶ | 2015-17¶ | 2018-20¶ |
|----------------------------|------------|---------|----------|----------|----------|
| Intracranial Haemorrhage | 16 | 18 | 7* | 3* | 2** |
| Eclampsia/ cerebral oedema | 0 | 6 | 3 | 1 | 2 |
| Pulmonary oedema | 3 | 0 | 0 | 0 | 2 |
| Hepatic rupture | 2 | 1 | 0 | 0 | 0 |
| Hepatic Necrosis/HELLP | 9 | 5 | 4* | 2* | 2** |
| AFLP | 7 | 7 | 1 | 1 | 2 |
| Total | 37 | 37 | 14 | 6 | 8 |

*One woman died due to both intracranial bleed and HELLP syndrome.

**Two women died due to both intracranial bleed and HELLP syndrome.

§ Figures for UK only

¶ Figures for UK and Ireland but note no deaths occurred in Ireland in 2018-20

Five of the women who died were aged 30 or over and two women were obese (Table 6.2). Half of women who died were Black or Asian. One woman died from a hypertensive disorder of pregnancy following IVF. The majority of women died in the immediate postnatal period (Table 6.3).

Table 6.2: The socio-demographic characteristics of women who died from hypertensive disorders of pregnancy, UK and Ireland, 2018-20

| Characteristics | Number of women (%) N=8 |
|--|----------------------------|
| Socio-demographic | |
| Age (years) | Median=31, range 23 to 47 |
| <30 | 3 (38) |
| ≥ 30 | 5 (63) |
| BMI at booking (kg/m ²) | |
| 18-24 | 4 (50) |
| 25-29 | 2 (25) |
| ≥30 | 2 (25) |
| Parity | |
| Nulliparous | 5 (63) |
| Multiparous | 3 (38) |
| Multiple pregnancy | |
| Singleton | 8 (100) |
| Twin | 0 (0) |
| Ethnicity | |
| White | 4 (50) |
| Asian | 2 (25) |
| Black | 2 (25) |
| Woman's region of birth | |
| United Kingdom/ Ireland | 5 (63) |
| Outside UK/Ireland | 3 (38) |
| Socioeconomic status (Index of Multiple Deprivation) | |

| Characteristics | Number of women (%) N=8 |
|---|----------------------------|
| First - third quintile (Least deprived) | 4 (50) |
| Fourth/ fifth quintile | 4 (50) |

Table 6.3: Timing of maternal deaths from hypertensive disorders of pregnancy, UK and Ireland, 2018-20

| Time period of deaths in the pregnancy care pathway | Number (%) N=8 |
|---|-------------------|
| Antenatal period or on day of childbirth | 2 (25) |
| Postnatal 1 to 42 days after childbirth | 6 (75) |

HSIB reviews where maternal hypertensive pregnancy disorders were considered an associated cause were examined. All available reviews of the care of babies who died were assessed (4 babies who were stillborn and 8 who died in the neonatal period), together with all reviews of the care of babies with severe brain injury from Black, Asian, Mixed and other ethnic minority groups (13 babies), and a sample, stratified by English region, of reviews of the care of babies with severe brain injury from White ethnic groups (15 babies). The reviews of the care of 40 babies were assessed in total.

6.4 Overview of care and new lessons to be learned

Messages for care of women with hypertensive disorders identified from reviews of maternal deaths

Pre-pregnancy care

A young woman with a BMI over 50kg/m², previous pregnancy loss, asthma, sleep apnoea and hypertension conceived with no evidence of pre-pregnancy planning, contraceptive advice or health optimisation. She had poorly controlled hypertension throughout her pregnancy. She collapsed at home at term and could not be resuscitated.

As in previous years obesity was a factor among some of the women who died. Two women had a BMI over 40kg/m². Interventions to modify obesity risk in pregnancy are best addressed pre-conception as significant weight reduction in pregnancy is not recommended. One woman with significant risk factors for hypertensive disorders of pregnancy underwent IVF treatment without any evidence of a discussion of the potential risks of pregnancy. For women who seek IVF treatment abroad outwith the UK or Republic of Ireland regulatory framework, their GP may be best placed to provide counselling of the risks of IVF pregnancy particularly those related to age and comorbidity.

When young women with co-morbidities present to reproductive or maternity health services (such as for contraceptive advice, with a pregnancy loss, postnatally or after termination of pregnancy), the opportunity should be taken to discuss health optimisation, as these women are all at high risk during a future pregnancy. The time for this counselling needs to be made available in the scheduling of appointments.

Aspirin

A woman with a history of pre-eclampsia booked for consultant care and was recommended by her midwife to commence aspirin. She attended a consultant appointment in the second trimester and was given a proforma letter advising that aspirin should be prescribed. Her GP did not receive this for a further three weeks and therefore aspirin prescription was delayed. She developed severe pre-eclampsia in the third trimester with pulmonary oedema from which she died.

Despite the knowledge that low dose aspirin (75-150mg) reduces the risk of pre-eclampsia having been widespread for many years (and included in the NICE 2013 quality standard), a number of women described in this report were not receiving low dose aspirin, or received it later in pregnancy than advised. This may be due to a lack of knowledge amongst those health professionals who see these women in early pregnancy (Midwife, GPs, obstetricians and non-maternity clinicians), or a difficulty in accessing aspirin or a reluctance among women to take medication. It is noted that although aspirin can be purchased as an over the counter medication it is not "licensed" in pregnancy,

thus pharmacists in the UK are unable to dispense it for pre-eclampsia prophylaxis. As a result the only options for at risk women are to buy it on the pretence it is for someone else, or to have it prescribed by their GP. This causes delay in starting this medication or raises concerns among women that there may be risk from taking aspirin. This problem was also noted in HSIB reports into babies who died or had severe brain injury.

The 2019 MBRRACE-UK report recommended that a national Patient Group Direction, including advice relating to safe, timely and cost-effective local implementation, should be developed to ensure consistent high quality care by allowing midwives to supply aspirin to eligible women in line with NICE Guidance (Knight, Bunch et al. 2019). A national Patient Group Direction was released in February 2022 (NHS Specialist Pharmacy Service 2022) and it is now essential that this is widely implemented. This will enable both midwives and pharmacists to prescribe aspirin for pregnant women with recognised risk factors and hence ensure all women can access aspirin as early as possible to benefit from its preventive effect.

Ensure that the national Patient Group Direction allowing prescription of aspirin for pregnant women at risk of pre-eclampsia by midwives and pharmacists is widely implemented. N

Continuity of records

The woman described in the previous vignette had separate admissions to different hospitals in different parts of the country in the third trimester before she died. In these instances she was admitted with a severe headache and raised blood pressure which settled, and on one occasion she was treated with labetalol. Assessors felt that the fact that she was unable to share her medical records from the first admission at a unit remote from her home, meant that the severity of her pre-eclampsia was not recognised in subsequent admissions. This is likely to become an increasing problem as electronic records replace hand held paper records unless it can be ensured that electronic records can be shared and are accessible when required. Sharing of records with her GP may also have ensured she received an earlier aspirin prescription.

Ensure that women's electronic records can be easily accessed and shared when they receive care in different settings. N

Access to antenatal care

A Black African woman had much of her antenatal care overseas. On return to the UK in the third trimester she was seen by her GP who recommended immediate review in the hospital because of her raised blood pressure. She declined an ambulance and said she would make her own way to the hospital. She was found later that day, unresponsive. She died from an intracranial haemorrhage.

Whilst as health professionals we may understand the benefits of good (appropriate, compassionate and supportive) antenatal care, some women may not be aware of its value, or may have anxieties about attending antenatal clinic appointments (e.g. risk of Covid-19 infection or being brought to the attention of the "authorities"). This could lead to some women, particularly vulnerable and migrant women, either not accessing the care to which they are entitled (and need) or not following medical advice. In this triennium four out of eight women who died were from Black and Asian backgrounds, two of whom were born abroad.

At the first antenatal (booking) appointment (and later if appropriate), discuss and give information on what antenatal care involves and why it is important

When giving women (and their partners) information about antenatal care, use clear language, and tailor the timing, content and delivery of information to the needs and preferences of the woman and her stage of pregnancy. Information should support shared decision making between the woman and her healthcare team, and be:

- offered on a one-to-one or couple basis
- supplemented by group discussions (women only or women and partners)
- supplemented by written information in a suitable format, for example, digital, printed, braille or Easy Read

- offered throughout the woman's care
- individualised and sensitive
- supportive and respectful
- evidence-based and consistent
- translated into other languages if needed.

Explore the knowledge and understanding that the woman (and her partner) has about each topic to individualise the discussion.

NICE Guideline NG201 Antenatal care (National Institute for Health and Care Excellence 2021a)

Vulnerability

A woman had multiple problems including mental health problems, ADHD and autism, previous domestic violence and additional financial and housing stressors during pregnancy. She had multiple and overlapping appointments during pregnancy; she was unable to attend a mental health appointment because she had a social services visit at the same time. She could not afford the bus fare to hospital and missed several appointments. In the third trimester her blood pressure was noted to be significantly elevated with proteinuria and she was admitted to labour ward. Her blood pressure was controlled initially with one off doses of labetalol and nifedipine. Steroids for lung maturation were commenced but she discharged herself against medical advice later that same day, with plans to see her GP for a blood pressure check the next day (Saturday). She was found dead a week later.

While this woman had excellent social support put in place in pregnancy, it was clear there were no robust plans for her follow-up when she discharged herself against medical advice. As noted in the 2019 report, it is important, particularly in high risk or vulnerable women, to ensure that there are robust care pathways in place to ensure appropriate follow up, which may require additional home visits.

Communication and location of care

A woman presented in spontaneous labour following an uneventful pregnancy. As she was in labour staff considered her raised blood pressure on admission was caused by pain. She was admitted to the low risk birth unit for labour care; no further observations were performed before the baby was born. The woman was transferred to the labour ward due to delay in second stage and had an assisted vaginal birth. Syntometrine was given for the third stage of labour. Around an hour after giving birth she complained of a headache and was found to have a markedly elevated blood pressure. Shortly afterwards she became unresponsive and began having seizures. A CT scan confirmed an intracranial haemorrhage. She died the day after giving birth.

This woman's care highlights the difference in low and high risk care pathways. Her admission blood pressure was not repeated and she was admitted to a low risk birth unit. Here, the assumption was that everything was normal and her raised blood pressure was due to pain; guidelines for low risk care, requiring blood pressure observations every four hours in the first stage of labour, meant that a routine check did not happen before the woman was transferred to the labour ward. A repeat blood pressure following her admission to the low risk birth unit is likely to have altered her care pathway with transfer directly to the labour ward for closer monitoring, including blood tests and urinalysis. This would have supported an earlier diagnosis of hypertension (and possibly pre-eclampsia) with earlier treatment and a different care plan for the third stage of labour.

The woman's raised blood pressure was not plotted on the electronic MEWS chart which would have automatically flagged her as high risk, and mandated communication between the birth centre and labour ward to escalate her care. Review and completion of contemporaneous electronic documentation is often more challenging for staff looking after women in labour, and this may contribute to key information being missed.

During labour measure blood pressure hourly in women with hypertension

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

Transfer the woman to obstetric-led care if any of the following are observed at any point, unless the risks of transfer outweigh the benefits:

- a single reading of either raised diastolic blood pressure of 110 mmHg or more or raised systolic blood pressure of 160 mmHg or more
- either raised diastolic blood pressure of 90 mmHg or more or raised systolic blood pressure of 140 mmHg or more on 2 consecutive readings taken 30 minutes apart

NICE Intrapartum care guideline CG190 (National Institute for Health and Care Excellence 2017)

Senior Support and a holistic review

A woman gave birth preterm. In the subsequent 24 hours she was severely oliguric despite 6 litres of intravenous fluid. She became extremely oedematous and developed mild hypertension, with abnormal liver and renal function. She was referred to critical care three days later. She died from AFLP before the regional liver team were able to advise on suitability for transfer and specialist hepatic care.

While an acute deterioration (such as massive postpartum haemorrhage or an eclamptic seizure) may be more obvious to recognise and respond to, a slow deterioration, especially postnatally in a mother who may appear initially reasonably well, is more difficult to recognise and diagnose. In women who are not responding to standard care it is vital that the multidisciplinary team (obstetric, anaesthetic and where relevant obstetric medicine consultants) review the patient together and take a holistic view, taking into account the whole history, the clinical findings and the results of investigations. It is important not to be misled by incidental findings (such as a Covid positive swab). Early referral to the critical care team and escalation for regional expert advice and management may increase the chance of considering more unusual diagnoses that require specialist management.

Be aware of how to contact the regional maternal medicine lead for urgent advice to ensure multidisciplinary senior review of women who are unwell. **N**

Pre-eclampsia and pathology

Pathological diagnosis of pre-eclampsia relies on histological examination, predominantly of the kidney and placental decidua. In a proportion of deaths with a clinical history of pre-eclampsia, histological sampling of the kidney was not performed or significant negative comments were not included in the report (whether the death was directly related to pre-eclampsia or not). This is a standard investigation recommended by Royal College of Pathologists guidelines (Royal College of Pathologists 2010); without this examination it is impossible to fully confirm the presence of pre-eclampsia. The RCPPath guidelines also state electron microscopy should be taken in cases where pre-eclampsia is known or suspected; this did not appear to have been undertaken.

Additional messages for care of women with hypertensive disorders identified from HSIB reviews of the care of babies who died or had severe brain injury

Prolonged induction processes

A woman having her second baby experienced an uneventful pregnancy until 38 weeks when she was noted to have raised blood pressure and proteinuria. An induction of labour was commenced with a prostaglandin pessary, and this was followed by multiple cycles of prostaglandin gel. Four days after IOL was started the woman's membranes ruptured and her labour was augmented with oxytocin. After several hours a caesarean section was performed in the first stage of labour for a pathological CTG. Her baby was born requiring resuscitation, experienced seizures and underwent 72 hours of therapeutic cooling. An MRI was performed which showed the baby had hypoxic encephalopathy and subdural bleeding. M

An older woman had a second pregnancy complicated by both insulin dependent gestational diabetes and pre-eclampsia. She was offered induction of labour at 37 weeks. Following four cycles of prostaglandin an artificial rupture of membranes was performed. The woman progressed rapidly to a vaginal birth complicated by shoulder dystocia. Her baby was born with no discernible heart beat and required extensive resuscitation and therapeutic cooling. M

Both of these babies were born after prolonged induction of labour, and this was a theme identified in the care of several babies. Staff did not recognise the prolonged induction of labour as a change in either mother's risk status; bedside reviews by the obstetric teams did not occur until multiple cycles of prostaglandin had been given over several days. Both women expressed a preference for caesarean birth at various points in the induction process. NICE guidance is clear that women's preferences should be taken into account if, as in these women, induction is unsuccessful (National Institute for Health and Care Excellence 2021). Earlier input from the multidisciplinary team to facilitate communication with the mothers about their preferences with broader insight into their cumulative risk factors may have led to different care pathways.

If induction is unsuccessful, discuss this with the woman and provide support. Fully reassess the woman's condition and the pregnancy in general, and assess fetal wellbeing using antenatal cardiotocography interpretation.

If induction is unsuccessful, discuss and agree a plan for further management with the woman, including whether she would like further attempts at induction, taking into account the clinical circumstances and her preferences.

NICE Guideline NG207 Inducing labour (National Institute for Health and Care Excellence 2021b)

In both instances, the prolonged induction of labour added further stress to an already compromised baby; the subsequent NICU admissions led to families being exposed to additional stresses and separation from their babies in the immediate days after birth. There is extensive evidence that such interventions can be detrimental to families, with depression and anxiety more common in both parents and the developing children (Lean, Rogers et al. 2018).

Pre-eclampsia and gestational diabetes

A multiparous woman met the criteria for testing for gestational diabetes in pregnancy. This was not completed. During the pregnancy a rise in the symphysis-fundal height (SFH) trajectory was noted, to above the 90th centile. The estimated fetal weight on ultrasound was around the 80th centile. The SFH trajectory continued over the 90th centile.

The woman was admitted to a midwifery led unit in labour at term. Her blood pressure on admission was 150/110mmHg but she did not have proteinuria. An assessment was made that she was in the latent phase of labour and monitoring of the fetal heart rate was commenced using intermittent auscultation every 30 minutes. Her blood pressure remained high and was attributed to her being in pain.

When her waters broke meconium was seen. Shortly afterwards there was a fetal bradycardia and she had an emergency caesarean birth after transfer to the obstetric unit. The baby's birthweight was on the 20th centile. The baby required resuscitation following birth and was transferred to the neonatal unit. Cerebral function monitoring was abnormal and therapeutic cooling commenced. A neonatal MRI showed changes consistent with hypoxic ischaemic encephalopathy. M

Hypertensive disorders of pregnancy and diabetes share links to the metabolic syndrome. Women with risk factors for the metabolic syndrome have an increased chance of developing pre-eclampsia or pregnancy induced hypertension and gestational diabetes during pregnancy. As highlighted in chapter 4, co-existence of diabetes and pre-eclampsia adds complexity to women's management as requirements for management of the two conditions may be conflicting. The placental dysfunction of pre-eclampsia leads to compromised oxygen delivery at a time when the accelerated metabolism of the fetus of a woman with diabetes means oxygen demands are greater. Similarly, the tendency of diabetes to lead to larger babies and that of hypertensive disorders of pregnancy to lead to smaller babies, in combination, may lead to a baby being born on a birth centile within the expected range who has unrecognised fetal growth restriction. This may impact on the baby's ability to cope with the demands of labour, as in this instance, and on the accuracy of the clinical team's intrapartum risk assessment.

Recognition that it is not only babies predicted to be small for gestational age (below the 10th centile) who may be a risk of compromise during labour is important to be aware of when a woman's pregnancy is complicated by both hypertension and diabetes.

Be aware of the added risk of fetal compromise when a woman's pregnancy is complicated by both hypertension and diabetes. It is not only babies predicted to be small for gestational age who may be at risk of compromise during labour.

Normalisation of blood pressure

Normalisation bias is a way of thinking that leads people to believe that the information they are receiving is incorrect or unimportant. Expectation bias is a way of decision making based on multiple experiences. When combined these biases can lead to poor recognition and inconsistent management of risk. In many of the reviews, including those described above, women were found to have a first episode of raised blood pressure when they were admitted in labour. Staff displayed a tendency to normalise this increase as being related to the pain of the mother's contractions. This would sometimes lead to repeated attempts to measure the woman's blood pressure in order to obtain a value in the expected range; in some instances, this led to delays in obtaining obstetric advice. In others, no advice was sought, as once a 'normal' blood pressure value was obtained the normalisation bias became superimposed on the expectation that all would be well.

Similarly, on several occasions the cuff size used to measure a woman's blood pressure was factored into a clinician's decision-making processes. Where a high blood pressure measurement was lower when repeated using a larger cuff size, the lower value was used as a baseline upon which to base care pathway decisions.

For many of the babies whose care was reviewed for this chapter, there were multiple cumulative risk factors. When taken alone, each of these risk factors may have been considered minor and not related to the baby's wellbeing; when considered together, cumulative risk factors become more likely to affect the baby. The process of normalising a mother's raised blood pressure, by changing the cuff size, or relating it to a mother's pain, meant an additional risk factor was often not recognised.

Hyponatraemia

A woman in her first pregnancy laboured spontaneously post-term. During the pregnancy she had experienced intermittent hypertension. No treatment had been needed and no diagnosis of pre-eclampsia had been made. During labour her blood pressure was elevated, and she had proteinuria. Her labour was augmented with an oxytocin

infusion, and she received intravenous fluids and an epidural. The baby was born by forceps birth and required resuscitation. Following therapeutic cooling an MRI of the baby's brain showed appearances suggestive of hypoxic ischaemic encephalopathy. M

During the labour the woman had a positive fluid balance of almost 3L. Her urine output during labour was less than 250ml over 11 hours. The confidential enquiry into maternal deaths has previously identified the importance of accurate fluid balance during labour for women with hypertensive disorders of pregnancy, and, as previously noted, careful attention to fluid balance in women with pre-eclampsia had previously eliminated pulmonary oedema as a cause of maternal death in women with hypertensive disorders in the UK and Ireland (Knight, Bunch et al. 2018).

Fluid overload in pre-eclampsia can lead to pulmonary oedema, which can have a direct impact on both the woman's and her baby's wellbeing. Excessive fluid intake, both oral and intravenous, is also associated with hyponatraemia which is associated with both maternal and neonatal seizures. Neonatal seizure secondary to hyponatraemia is an important differential diagnosis for the neonatal team to consider.

Hyponatraemia is not uncommon following labour; approximately 1 in 4 women who take in more than 2.5L of fluid in labour will become hyponatraemic (Moen, Brudin et al. 2009). NHS Resolution has also identified risks associated with maternal and neonatal hyponatraemia during their review of cases referred to their Early Notification scheme (NHS Resolution 2019). Fluid overload was noted in some of the women with diabetes and pre-eclampsia whose care was examined in chapter 4 and emphasises that fluid management in pre-eclampsia must be a continued focus.

In women with severe pre-eclampsia, limit maintenance fluids to 80 ml/hour unless there are other ongoing fluid losses (for example, haemorrhage).

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

Pre-eclampsia at term

A woman in her second pregnancy had a history of pre-existing hypertension. Her blood pressure was measured weekly and at 20 weeks she was prescribed labetalol. This was stopped three weeks later when her blood pressure returned to normal range. Her blood pressure became raised again at 40 weeks; no obstetric review was arranged and an induction of labour was booked for a week later. During the induction process the baby became bradycardic and a category 1 caesarean section was undertaken. The baby required extensive resuscitation and went on to receive 72 hours of cooling. An MRI showed changes suggestive of hypoxic ischaemic encephalopathy. M

This vignette highlights a downgrading of a woman's risk status leading to a missed opportunity for an obstetric review. The woman was discharged from obstetric care at 37 weeks when her blood pressure had stabilised, and her risk-assessment was downgraded to a low-risk pathway. This downgrading of her risk status influenced future decisions regarding her care and normalised her subsequent hypertension. NICE guidance suggests that where a mother has an increased risk factor, in this case raised blood pressure, after 37 weeks, an induction of labour should be discussed and offered (National Institute for Health and Care Excellence 2019). An earlier induction of labour may have changed the outcome for the baby.

For women with gestational hypertension whose blood pressure is lower than 160/110 mmHg after 37 weeks, timing of birth, and maternal and fetal indications for birth should be agreed between the woman and the senior obstetrician.

For women with pre-eclampsia who are 37 weeks onwards initiate birth within 24-48 hours.

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

Aspirin

Missed opportunities to prescribe aspirin in a timely fashion were also identified from the HSIB reviews of babies' care.

A woman was identified as having two moderate risk factors for pre-eclampsia at her first trimester booking visit. She was primiparous and had a family history of pre-eclampsia. Although the antenatal risk factors were correctly identified aspirin was not prescribed. She developed pre-eclampsia at 35 weeks. Her baby underwent therapeutic cooling after an emergency birth.

M

Placental pathology

In several of the investigations included in this review there are examples of, when requested, how useful placental pathology can be in understanding the contributory factors to the clinical outcome for babies (Box 5.1). The Royal College of Pathologists (Royal College of Pathologists 2019) recommend that ‘as a minimum, all placentas from stillbirths, fetal growth restriction (FGR – below 10th centile with abnormal fetal growth curve during pregnancy), immaturity (less than 32+0 completed weeks gestation), and cases of severe fetal distress requiring admission to a neonatal intensive care unit (NICU), maternal pyrexia (>38°C) and late miscarriages (20+0 to 23+6 39 completed weeks gestation) should be referred’ for full pathological examination including histology. It is important to ensure that processes exist to ensure that this takes place.

Box 6.1: HSIB reviews showing the added value of placental pathology

“The placental histology (an examination with a microscope) showed two features. Firstly, there was evidence of maternal arterial malperfusion in the placenta. This means there were changes to the blood vessels in the placenta that might affect oxygen getting to the baby. Maternal arterial malperfusion is associated with pre-eclampsia. The Mother had two moderate risk factors for pre-eclampsia at booking for which aspirin was indicated. She did not receive any aspirin during her pregnancy. The administration of aspirin may have reduced the chance of the maternal arterial malperfusion.”

“The placenta was sent for histopathology. The report concluded that there was ‘maternal vascular malperfusion, consistent with pre-eclampsia’.”

“A post-mortem (PM) examination was carried out and showed no external or internal abnormalities. It showed ‘early hypoxic-ischaemic damage in the brain and the placental histology showed features consistent with maternal vascular malperfusion’.”

“The placenta histopathology showed delayed villous maturation’ and stated that ‘delayed villous maturation for gestation causes impairment of gas exchange in the terminal villi and puts a baby at risk for sudden hypoxia/asphyxia’.”

6.5 Conclusions

For three quarters of the women whose care was reviewed for the purposes of this chapter (6/8), different care might have made a difference to their outcome. It is clear that continued attention to enabling women with risk factors to receive aspirin is needed, and to ensure that abnormal blood pressure measurements are not normalised. The reviews of the care of babies who died or had severe brain injury in association with maternal hypertensive pregnancy disorders has emphasised the need to avoid prolonged induction processes. The reviews of morbidity, both in this and previous chapters, have identified the need for renewed focus on fluid management; fluid overload was seen in both women who died reviewed here, amongst the mothers of babies reviewed by HSIB, and amongst the mothers reviewed in chapter 4 who had co-existing diabetes and pre-eclampsia. Details of these areas of guidance requiring improved implementation are available in the online supplementary material. There will be significant numbers of women affected by pre-eclampsia and other hypertensive disorders of pregnancy for the foreseeable future, and we cannot afford to become complacent about their care.

Table 6.4: Classification of care received by women who died from hypertensive disorders, UK and Ireland, 2018-20

| Classification of care received | Women who died (N=8) Number of women (%) |
|---|---|
| Good care | 0 |
| Improvements to care which would have made no difference to outcome | 2 (25) |
| Improvements to care which may have made a difference to outcome | 6 (75) |

7. Lessons on caring for women with early pregnancy disorders

Roshni Patel and Marian Knight on behalf of the MBRRACE-UK early pregnancy chapter-writing group

Chapter writing group members: Jim Bamber, Anita Banerjee, Margarita Bariou, Kathryn Bunch, David Churchill, Bernard Clarke, Hilde Engjom, Nicky Gammie, Kate Harding, Samantha Holden, Sara Kenyon, Alison Kirkpatrick, Marian Knight, Upma Misra, Roshni Patel, Beccy Percival, Robin Russell

7.1 Key messages

New recommendations for care

Vulnerable and young women remain disproportionately represented amongst those who have died from ectopic pregnancy. Ensure care is personalised to provide appropriate additional safety measures [**ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards**].

Existing guidance and recommendations requiring improved implementation

When diagnosing complete miscarriage on an ultrasound scan, in the absence of a previous scan confirming an intrauterine pregnancy, always be aware of the possibility of a pregnancy of unknown location. Advise these women to return for follow-up (for example, hCG levels, ultrasound scans) until a definitive diagnosis is obtained [NICE NG126].

Throughout a woman's care, provide the woman and (with her consent) her partner specific evidence-based information in a variety of formats. This should include (as appropriate):

- when and how to seek help if existing symptoms worsen or new symptoms develop, including a 24-hour contact telephone number
- what to expect during the time she is waiting for an ultrasound scan
- what to expect during the course of her care (including expectant management), such as the potential length and extent of pain and/or bleeding, and possible side effects; this information should be tailored to the care she receives

Ensure that sufficient time is available to discuss these issues with women during the course of her care and arrange an additional appointment if more time is needed [NICE NG126].

Women of reproductive age who present with shock or collapse of unknown cause should have a Focussed Assessment with Sonography in Trauma (FAST) scan before they receive thrombolysis. Only surgical care can save these women [Saving Lives, Improving Mothers' Care 2016].

7.2 Background

Women are still dying from early pregnancy problems. In this report almost all women died from ectopic pregnancy, which remains as frequent a cause of maternal death as other pregnancy problems such as hypertensive disorders. Maternal deaths from early pregnancy-related causes may also be secondary to complications of termination of pregnancy, trophoblastic disease and miscarriage.

7.3 The women who died

In 2018-2020, 109 women died whilst less than 24 weeks gestation or after a pregnancy that ended at less than 24 weeks in the United Kingdom and Ireland. Their causes of death are shown in Table 7.1, and reviews of the care of the majority are considered in different chapters of this and other reports. Nine of these women died from early

pregnancy problems and their care is considered here. No women died from trophoblastic disease. One woman died from complications of an incomplete miscarriage. The remaining eight women who died had ectopic pregnancies. All women who were diagnosed before death died within 48 hours of presentation. (Table 7.2).

Table 7.1: Causes of death amongst women who died at less than 24 weeks' gestation whilst still pregnant or after their pregnancy ended at less than 24 weeks (2018-20), UK and Ireland

| Cause of Death | Number of women | Percentage |
|--------------------------------|-----------------|------------|
| Sepsis | 6 | 6 |
| Thrombosis and thromboembolism | 11 | 10 |
| Cardiac disease | 6 | 6 |
| Mental Health problems | 31 | 28 |
| Early pregnancy-related causes | 9 | 8 |
| Haemorrhage | 1 | 1 |
| Neurology | 16 | 15 |
| Other indirect causes | 12 | 11 |
| Unascertained | 2 | 2 |
| Coincidental deaths | 15 | 14 |
| Total | 109 | 100 |

Table 7.2: The socio-demographic characteristics of women who died from early pregnancy complications, UK and Ireland, 2018-20

| Characteristics | Number of women (%) N=9 |
|-------------------------|----------------------------|
| Age (years) | Median=31, Range 17 to 39 |
| <30 | 4 (44) |
| ≥ 30 | 5 (56) |
| Parity | |
| Nulliparous | 5 (56) |
| Multiparous | 4 (44) |
| UK/Irish citizen | |
| Yes | 4 (44) |
| No | 1 (11) |
| Missing | 4 (44) |
| Ethnicity | |
| White European | 6 (67) |
| Other ethnic group | 3 (33) |
| Woman's region of birth | |
| United Kingdom/ Ireland | 4 (44) |
| Outside UK/Ireland | 3 (33) |
| Missing | 2 (22) |

7.4 Overview of care and new lessons to be learned

Managing pregnancy of unknown location

A vulnerable woman presented to the emergency department with a suspected miscarriage. She had taken photographs of the expelled products. She had an ultrasound scan, which showed an empty uterus, and no adnexal masses. Speculum examination confirmed a closed cervical os. Based on these findings and the photographs she was told she had a complete miscarriage and discharged home with the advice to repeat a pregnancy test in two weeks. She was not given any written information and did not have a current GP. She was found dead three weeks later. Post-mortem confirmed intra-abdominal haemorrhage secondary to ruptured ectopic pregnancy.

Women with pregnancy of unknown location warrant particularly close attention and it is essential to adhere to national guidance (National Institute for Health and Care Excellence 2019). Products of conception cannot be diagnosed from photographs. Women should be managed as a pregnancy of unknown location if a pregnancy has not been previously identified on ultrasound scan. Vulnerable women need additional safety netting in place. Where a follow up pregnancy test is required, systems need to be in place to ensure this occurs. If a woman cannot afford a pregnancy test, she should be given a follow-up appointment in the early pregnancy service or provided with a pregnancy test at the time of discharge.

When diagnosing complete miscarriage on an ultrasound scan, in the absence of a previous scan confirming an intrauterine pregnancy, always be aware of the possibility of a pregnancy of unknown location. Advise these women to return for follow-up (for example, hCG levels, ultrasound scans) until a definitive diagnosis is obtained.

Throughout a woman's care, provide the woman and (with her consent) her partner specific evidence-based information in a variety of formats. This should include (as appropriate):

- **when and how to seek help if existing symptoms worsen or new symptoms develop, including a 24-hour contact telephone number**
- **what to expect during the time she is waiting for an ultrasound scan**
- **what to expect during the course of her care (including expectant management), such as the potential length and extent of pain and/or bleeding, and possible side effects; this information should be tailored to the care she receives**

Ensure that sufficient time is available to discuss these issues with women during the course of her care and arrange an additional appointment if more time is needed.

NG126 Ectopic pregnancy and miscarriage: diagnosis and initial management (National Institute for Health and Care Excellence 2019b)

Vulnerable and young women remain disproportionately represented amongst those who have died from ectopic pregnancy. They need additional safety measures incorporated into their care, for example, enhanced follow-up pathways. Each contact with girls or women of childbearing age following miscarriage, prescribing contraception, at sexually-transmitted infection screening and at smear tests is an opportunity to educate regarding red flag symptoms associated with ectopic pregnancy. The awareness of symptoms may reduce deaths amongst vulnerable women and teenage girls.

Vulnerable and young women remain disproportionately represented amongst those who have died from ectopic pregnancy. Ensure care is personalised to provide appropriate additional safety measures. N

FAST scanning

An ethnic minority woman who was known to be pregnant collapsed in the community with abdominal pain. She was brought to the emergency department where she had a cardiac arrest. She was noted to have a very low haemoglobin but was thrombolysed for presumed pulmonary embolism. A FAST scan was not carried out. Her ectopic pregnancy was diagnosed at a subsequent laparotomy undertaken when signs of bleeding became more evident, but she continued to deteriorate and died.

Three women died from ruptured ectopic pregnancies after receiving thrombolysis. A Focused Assessment with Sonography in Trauma (FAST scan) was not performed prior to thrombolysis in any of these women, despite symptoms indicative of ectopic pregnancy as in this woman, who had abdominal pain and was severely anaemic on admission. As previously recommended a pregnancy test and a FAST scan should be undertaken before thrombolysis in all women of reproductive age. All collapsed or shocked pregnant women do not have a pulmonary embolism. The diagnosis of pulmonary embolism has improved significantly in recent years but treatment should not be given until a FAST scan has excluded intra-abdominal pathology or bleeding.

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 from a ruptured ectopic pregnancy especially in the presence of anaemia.

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

Good care

A young woman collapsed in the community and received bystander cardiopulmonary resuscitation. She was attended by paramedics who performed further advanced cardiac life support and transferred her rapidly to hospital with ongoing resuscitation. Vascular access was difficult and intra-osseous access was used. Advanced resuscitation resulted in a spontaneous cardiac output. She had a positive pregnancy test and a FAST scan showed fluid in the abdomen. She was transferred to theatre for a laparotomy at which two litres of blood was found in her abdomen and a salpingectomy was performed. She was transferred to intensive care but became progressively unstable and died.

This woman received appropriate care but died in spite of this. Cardiopulmonary resuscitation was carried out in the community, paramedics arrived swiftly and she was immediately transferred to hospital. A pregnancy test and FAST scan were undertaken on admission enabling rapid diagnosis and treatment of her ectopic pregnancy. She received maximal supportive treatment on the intensive care unit but sadly continued to deteriorate and died. This emphasises the importance of public and health professional awareness of the presenting symptoms and signs of an ectopic pregnancy as a rupture may put a woman into extremis which may not be survivable despite good care.

7.5 Conclusions

Assessors concluded that almost all the women who died from an ectopic pregnancy could have had better care, which might have altered the outcome for a third (3/9). Whilst the numbers in this report are small, ectopic pregnancy remains common with a prevalence of approximately 1%. With improved patient and clinician awareness regarding the symptoms of ectopic pregnancy more extra uterine pregnancies could be identified earlier and before collapse occurs. Where women of reproductive age, who may or may not be known to be pregnant, present with collapse, an ectopic pregnancy must be excluded as venous thromboembolism and cardiac disease must not be considered as the only causes. Every opportunity should be taken to ensure women of reproductive age who seek gynaecological or early pregnancy care are aware of the symptoms associated with ectopic pregnancy. It is important that all women know where to seek advice if they are concerned, that early pregnancy services are visible and accessible and welcoming to young and vulnerable women.

Table 7.3: Classification of care received by women who died from early pregnancy disorders, UK and Ireland, 2018-20

| Classification of care received | Women who died (N=9) Number of women (%) |
|---|---|
| Good care | 1 (11) |
| Improvements to care which would have made no difference to outcome | 5 (56) |
| Improvements to care which may have made a difference to outcome | 3 (33) |

8. Lessons for critical care

Katie Cranfield, Nuala Lucas, Marian Knight and Frank Schroeder on behalf of the MBRRACE-UK critical care chapter-writing group

Chapter writing group members: Kathryn Bunch, Lynne Campbell, Paula Chattington, Bernard Clarke, Philippa Cox, Katie Cranfield, Hilde Engjom, Charlotte Frise, Teresa Kelly, Sara Kenyon, Dawn Kernaghan, Marian Knight, Jenny Kurinczuk, Nuala Lucas, Rachel Mathers, Roshni Patel, Sophie Russell, Frank Schroeder, Judy Shakespeare, Sarah Wheatly

8.1 Key messages

New recommendations for care

Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care **[ACTION: Service Planners/Commissioners, Hospitals/Trusts/Health Boards, All Health Professionals]**.

Involve the critical care team in antenatal multidisciplinary team planning for women with serious morbidity who may require admission to intensive care after giving birth **[ACTION: All Health Professionals]**

Existing guidance and recommendations requiring improved implementation

The recognition and management of severe acute illness requires good multidisciplinary teamwork. An anaesthetist or critical care specialist should be involved early (CMACE 2006-8)

The route of escalation to critical care services should be clearly defined and include multidisciplinary discussion. Critical care outreach or an equivalent service should be available to ill women and provide support and education to healthcare professionals delivering enhanced maternal care (EMC guidelines 2018)

Women with pre-existing medical conditions should have pre-pregnancy counselling by doctors with experience of managing their disorder in pregnancy (Saving Lives, Improving Mothers' Care 2014)

A general clinical assessment should be performed to assess malnutrition in the ITU, until a specific tool has been validated. The general clinical assessment should include a nutritional [history], such as unintentional weight loss or a decrease in physical performance before ICU admission. It should also include a physical examination, general assessment of body composition, and muscle mass and strength, if possible. Every critically ill patient staying for more than 48 h in the ICU should be considered at risk for malnutrition (ESPEN guideline-on-clinical-nutrition-in-the-intensive-care-unit)

Referral to the NHS ECMO service should be made for pregnant women or women post-pregnancy using the same criteria as for other adult patients. Where doubt exists about a woman's suitability for ECMO, clinicians should seek advice from their regional ECMO centre early (Saving Lives, Improving Mothers' Care Rapid Report 2021)

8.2 Background

The first chapter dedicated to intensive care issues in maternal deaths appeared in the 1991–93 triennial report. Since then, there has been an evolution in the understanding and delivery of care to critically ill obstetric patients. Looking after critically ill pregnant and postpartum women requires a multidisciplinary team of experts in critical care, obstetrics, midwifery and other medical and surgical disciplines as well as allied hospital services. Women admitted to ICU are often young and previously well, and the deterioration leading to ICU admission is often unexpected. Despite the demographic changes in the obstetric population, admission to the intensive care unit (ICU) during and after pregnancy is uncommon. The National Maternity and Perinatal Audit (NMPA) analysis of maternity admissions to intensive care in England, Wales and Scotland identified a rate of 2.75 admissions per 1000 women who were pregnant or recently pregnant (Jardine and NMPA Project Team 2019). Admission to ICU was more likely among women of advanced maternal age, Black ethnicity, BMI over 35kg/m² and parity of 3 or more. Outcomes for obstet-

ric patients admitted to ICU are generally good, with relatively short length of stay, and only a very small proportion requiring an admission lasting longer than seven days. However, the care of women who were reviewed in this chapter nevertheless identified some important messages for learning.

8.3 The women who died

For the purposes of this chapter, the care of 35 women was reviewed. Cardiac disease was the most frequent cause of women's death (Table 8.1), reflecting the fact that it remains the leading cause of maternal death alongside psychiatric disorders. Women who die from mental health-related causes are under-represented amongst those cared for in ICU due to the high proportion who die by violent suicide. Note that this does not represent all women cared for in ITU who died between 2018-20, solely those whose care was reviewed for the purposes of the chapters in this report.

Table 8.1: Causes of death of women whose critical care was assessed, UK and Ireland, 2018-20

| Cause of Death | Total (n=35) Frequency (%) |
|--------------------------------|-------------------------------|
| Early pregnancy death | 1 (3) |
| Pre-eclampsia and eclampsia | 4 (11) |
| Neurological | 1 (3) |
| Thrombosis and thromboembolism | 2 (6) |
| Sepsis | 5 (14) |
| Deaths from psychiatric cause | 4 (11) |
| Cardiac disease | 11 (31) |
| Malignancy | 3 (9) |
| Other indirect deaths | 1 (3) |
| Accidental | 1 (3) |
| Unascertained | 2 (6) |

8.4 Overview of care and new lessons to be learned

Identification of critical illness and the role of critical care outreach

As with previous MBRRACE-UK reports, for most women whose care was reviewed in this chapter, death was not an abrupt event but occurred in the context of critical illness. The role of early identification and the response to serious maternal morbidity highlighted in other chapters is also a recurring theme in this chapter.

Early warning systems (EWS) are now embedded in the routine care of most hospitalised patients in the NHS. Surveys have shown that while they are now almost universally used in maternity units, there is widespread inter-hospital variation in the type of EWS and thresholds for escalating care vary significantly (Isaacs, Wee et al. 2014). Several factors have contributed to this variation, including a lack of evidence and validation of EWS in the obstetric population. Poor correlation with obstetric physiology can be seen when there is an 'overlap' of early clinical features typical for critical illness and normal physiology in the peri-partum period (e.g. tachycardia). The 4P observational study tracked physiological measurements (blood pressure, heart rate, oxygen saturation, temperature, and respiratory rate) of pregnant women from the first trimester to term (Green, Mackillop et al. 2020). Data from more than 1000 women were used to produce evidence-based, gestation-specific centiles and normal ranges for vital signs during pregnancy. This work has led to the development of an English national obstetric EWS that will support the standardisation of practice (NHS England 2022). Other MEWS have been developed in the devolved nations and Ireland (Healthcare Improvement Scotland 2018, Department of Health 2019).

A woman presented to primary and secondary care several times in the third trimester with tiredness and respiratory symptoms. She was eventually diagnosed with metastatic cancer during an emergency department attendance. She deteriorated rapidly, and a decision was made to expedite birth. Despite being short of breath, she did not have a chest X-ray or blood gas analysis before her caesarean section. Postoperatively she received routine postoperative care in the labour ward. Her continued deterioration was not detected until several hours after she gave birth, when investigations confirmed she had developed an acute kidney injury and liver failure. She was transferred to ITU but died three days later.

A maternity early warning score chart which may have expedited the recognition of this woman's deterioration was not in use. A critical care outreach team could have provided valuable and earlier input into the care of this woman, if her deterioration had been identified. The role of critical care outreach teams is now well established within general hospital care, but their contribution to the care of obstetric patients is less clear. The model for providing critical care outreach services within individual hospitals may vary, but such outreach teams should provide these four elements: a reliable method of alerting the team when early signs of deterioration are recorded; a team with the appropriate skill mix and that is familiar with obstetric patients (or can involve clinicians who are); an administrative structure to provide the required resources; and a process of audit and education to help prevent future events.

A woman was admitted to hospital with decompensated liver failure and pneumonia a few months after giving birth. She had good clinical care, including daily reviews by the critical care outreach team. When she developed respiratory failure, she was promptly admitted to ITU. Despite advanced intensive care support, she continued to deteriorate and died.

This woman's care illustrates good multidisciplinary involvement and early critical care outreach. As previous MBRRACE-UK reports and national enquiries have highlighted, all members of teams involved in caring for unwell obstetric patients should attend regular multidisciplinary joint training including simulation. This should include emergency drills, use of handover tools such as SBAR and human factors training (Ockenden 2022). It is vital that other relevant teams who may be involved in caring for obstetric patients are included in this training, to not only improve knowledge, but teamworking and EWS response. Depending on different local services this is likely to include critical care, critical care outreach teams, emergency departments, acute medicine/medical emergency teams and obstetric anaesthesia teams.

Ensure the appropriate national Maternity Early Warning Score is used to monitor a pregnant woman wherever in the hospital she receives care.

N

The recognition and management of severe acute illness requires good multidisciplinary teamwork. An anaesthetist or critical care specialist should be involved early (Lewis, Cantwell et al. 2011)

The route of escalation to critical care services should be clearly defined and include multidisciplinary discussion.

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

Enhanced Maternal Care guidelines 2018 (Maternal Critical Care/Enhanced Maternity Care Standards Development Working Group 2018)

High risk conditions – planning and peripartum management

Despite improvements in therapeutic strategies and management, pulmonary hypertension remains a condition associated with high maternal mortality (Martin and Edwards 2019, Low, Guron et al. 2021). Patients can experience rapid deterioration during pregnancy and particularly at the time of giving birth. Early multidisciplinary management and planning are essential. This should include identification and referral to a maternal medicine centre at the earliest opportunity where critical care specialists should form part of the multi-disciplinary team planning the woman's maternity care. Caesarean section is the preferred mode of birth with combined spinal-epidural anaesthesia being the preferred anaesthetic technique (Hemnes, Kiely et al. 2015). Delivery and the first postpartum week have been recognised as particularly vulnerable periods for women with pulmonary hypertension due to fluid shifts and the use of oxytocic drugs to manage the third stage. Given the risk of significant decompensation in the period surrounding delivery and the first week postpartum, it is vital that critical care specialists are involved in planning care around this period. Particular thought should be given to the location of birth, taking into account plans for ongoing care and management should the patient decompensate during this period.

A woman developed significant dyspnoea in the third trimester of pregnancy and was diagnosed with pulmonary hypertension. She was immediately transferred to a tertiary centre with experts in the management of pulmonary hypertension. After extensive investigation and multidisciplinary discussion, an elective caesarean section was planned. She was admitted to ITU preoperatively to optimise care. Caesarean section under regional anaesthesia was uneventful until shortly after she gave birth, when she had a cardiac arrest from which she could not be resuscitated.

As in this woman's care, it may be appropriate to consider antenatal admission to a critical care unit to optimise care prior to birth, as well as to extend the period of intensive care postpartum. Making women with pulmonary hypertension and similar high-risk conditions aware of the possible need for ICU care as part of pre-pregnancy discussions may be appropriate.

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

Involve the critical care team in antenatal multidisciplinary team planning for women with serious morbidity who may require admission to intensive care after giving birth. N

General critical care management and specific therapies

The Covid-19 pandemic has highlighted the inequity of medical care experienced by pregnant women compared to the non-pregnant population that was already identified in previous MBRRACE reports (Knight, Morris et al. 2020). When pregnant women are admitted to ICU, they must have the same access to potentially life-saving therapies and medications as non-pregnant patients.

Nutritional state, body composition and metabolism

A woman was admitted to ITU after an emergency caesarean birth because of worsening preeclampsia. She had a prolonged stay in ITU and suffered multiple complications, including severe sepsis, cardiac failure, and pneumonia. She not only had severe hyperemesis in the antenatal period but also significant nutritional problems throughout her ITU stay. At the time of her death, she had lost more than 20% of her booking weight. She had a cardiac arrest attributed to hypokalaemia and poor cardiac function.

It is recognised that many controversies still exist in the subject on the provision of nutritional support in critically ill patients. The optimal approach to nutrition in the population of critically unwell (non-pregnant) adults remains unknown despite numerous RCTs published over the past decade. Controversies remain in the timing of initiation (early versus late) as well as the approach (trophic or full feeding) in the non-pregnant population, and there is limited data or guidance available for the management of nutrition in the critically unwell obstetric population.

Critically unwell obstetric patients are likely to have a significantly higher basal metabolic rate compared to their non-pregnant baseline, due to the effects of both the pregnancy itself and critical illness. Not only can suboptimal nutritional support increase the risk of maternal morbidity and mortality, but it can also negatively impact fetal growth and increase the risk of a poor neonatal outcome. The catabolic effects of critical illness and risks of overfeeding are well recognised. In the very acute phase of critical illness, the main focus of nutritional support is likely to mainly consist of optimisation of fluid balance and electrolytes. Blood volume increases in pregnancy from 65ml/kg pre-pregnancy to approximately 100ml/kg (Vricella 2017). Particular care should be taken when assessing obstetric patients' fluid status. Women with a low weight and/or body mass index may have a circulating blood volume of less than 4 litres even whilst pregnant, meaning that the significance of a post-partum haemorrhage may be underestimated. Similarly, reduced colloid osmotic pressure may make the risk of iatrogenic fluid overload particularly high in this patient group. Care should be given to careful assessment of fluid balance and volume state, with consideration of using dynamic measures such as point of care echocardiography or cardiac output monitoring.

Even in the presence of a potentially normal (or even raised) body mass index at the time of their admission to critical care, assessors felt an unrecognised poor nutritional state contributed to the deaths of a number of women. Many nutritional assessment tools e.g., MUST or NUTRIC have not been validated in either critical care or obstetric populations. In line with UK and European guidelines, all critically unwell pregnant patients should be assessed and managed by a multidisciplinary team including experts in dietetics and nutrition (Singer, Blaser et al. 2019).

A general clinical assessment should be performed to assess malnutrition in the ITU, until a specific tool has been validated. The general clinical assessment should include a nutritional [history], such as unintentional weight loss or a decrease in physical performance before ICU admission. It should also include a physical examination, general assessment of body composition, and muscle mass and strength, if possible.

Every critically ill patient staying for more than 48 h in the ICU should be considered at risk for malnutrition. ESPEN guideline on clinical nutrition in the intensive care unit (Singer, Blaser et al. 2019)

Whilst calorific requirements are unlikely to be substantially increased during the first two trimesters for a woman with a healthy body mass index, an increased intake of approximately 200 Kcal per day is recommended for women in their third trimester. The need for vitamin D, folic acid and iron supplementation should be reviewed for every critically ill pregnant woman and prescribed in line with antenatal guidelines. Women found to have poor nutritional reserves, or a more restrictive diet may require additional vitamin/micronutrient supplementation. It is important to seek early expert support from critical care and dieticians in assessing and managing the nutritional requirements of critically unwell obstetric patients.

Care should be taken to avoid and minimise the risk of refeeding syndrome in at risk patients. Adequate monitoring of the consequence of nutritional support should be undertaken to identify the potential complications associated with both under- and over-feeding including electrolyte monitoring (including phosphate and magnesium) and liver function tests (Berger, Reintam-Blaser et al. 2019).

As in non-pregnant patients, oral diet when safe, or enteral nutrition (via nasogastric (NG) tubes) should remain the route of choice for critically unwell obstetric patients (Singer, Blaser et al. 2019). The physiological changes to the gastrointestinal tract mean pregnant patients are at a greater risk of delayed gastric emptying/aspiration of gastric contents as well as constipation. Risks of adverse complications can be minimised in line with ESPEN guidelines by considering the following:

- early use of anti-aspiration prophylaxis (in the form of proton pump inhibitors or H2 receptor antagonists)
- monitoring of gastric aspirate quantities with early use of prokinetics when required
- positioning in semi-recumbent position
- continuous rather than bolus enteral feed
- post-pyloric feeding in patients with gastric feeding intolerance not solved with prokinetic agents

As already mentioned in chapter 4, obstetric patients are particularly vulnerable to (relatively short) periods of starvation and glucose dysregulation. Short periods of starvation may precipitate significant episodes of ketoacidosis but blood glucose in this setting may be normal or low. There should be a low threshold for assessing for ketoacidosis and managing this appropriately with intravenous glucose, rehydration and insulin as required. Whatever the cause of ketoacidosis in a pregnant patient these women require intensive monitoring and there should be a low threshold for admitting these women to critical care to facilitate their optimal management.

Extracorporeal Membrane Oxygenation (ECMO)

The role of ECMO in treating critically ill obstetric patients has been highlighted by the Covid-19 pandemic. Maternal and fetal survival rates are higher than in other populations with maternal survival rates of up to 80-90% and fetal survival rates 70-80% (Saad, Rahman et al. 2016, Ong, Zhang et al. 2020). However, timely referral to specialist ECMO services is vital. Patients who have undergone a prolonged period (> 7 days) of mechanical (invasive or non-invasive positive pressure) ventilation are likely to have significantly less reversible lung disease (Camporota, Meadows et al. 2021). The MBRRACE-UK 2021 rapid report of SARS-CoV-2-related maternal deaths described widespread variation in whether critically ill pregnant women were referred for ECMO. While standard referral criteria exist, that must apply equitably to pregnant and non-pregnant patients, decision-making around referral in an obstetric patient can be complex and nuanced. Joint discussion and decision making between the referring hospital and ECMO centre can ensure timely and appropriate referral.

Referral to the NHS ECMO service should be made for pregnant women or women post-pregnancy using the same criteria as for other adult patients.

Where doubt exists about a woman's suitability for ECMO, clinicians should seek advice from their regional ECMO centre early.

MBRRACE-UK Rapid Report 2021 (Knight, Bunch et al. 2021a)

Discharge from ITU

Discharge from ICU back to the maternity unit or another ward can be a vulnerable period in the patient's journey through the hospital and can expose women to preventable errors and adverse events. In addition to the change from continuous monitoring and management by a broad multidisciplinary team, there will be a change in health-care providers, from intensive care staff to obstetricians and midwives. Optimal transfers of care require effective communication between discharging and admitting care areas that include direct communication (in person or via telephone); concise, accurate, up-to-date discharge summaries and a clear plan for ongoing care.

Compassionate care

A woman was admitted to ITU with unsurvivable injuries following a road traffic accident. Her family, including her children, were supported to be with her when she died.

There were several examples of compassionate care of women who were admitted to ICUs and their families. Families, and where possible, a woman's involvement is central to improved shared decision-making and improved delivery of end-of-life care. National guidance exists to support practice in this area (Cosgrove, Baruah et al. 2019).

The death of an obstetric patient may be particularly distressing for staff, and support is essential to help them provide compassionate and skilful care. Lack of support for staff at these times can have a physical and psychological impact, and can contribute to burnout, compassion fatigue, moral injury, distress and dissonance with end-of-life care. This in turn may lead to reduced quality of care and an increased risk of adverse safety incidents (van Mol, Kompanje et al. 2015, Rathert, Williams et al. 2018). Strategies that can mitigate these risks include debriefing sessions and initiatives that foster positive team culture and team communication. Organisational, individual, and structural mechanisms are required to ensure that all staff feel supported to deliver end-of-life care.

Optimising care and multi-disciplinary team working

As with previous reports, reviewers were left with the impression that smooth team working had not always been achieved when caring for obstetric patients. The role of 'authentic multidisciplinary team' working has been described as a pre-requisite of high quality maternal critical care. Labour ward teams engage in regular multidisciplinary skills drills, and specialists in obstetrics and gynaecology may be very experienced in multidisciplinary team communication for cancer patients. However, multidisciplinary team communication for clinical decision making in the acute situation is less established and not well studied. In addition, women present with such a range of conditions that the particular speciality teams who need to cooperate, may have no previous experience of working together. The Covid-19 pandemic has necessitated and increased our ability to work collaboratively in novel ways. Video-conferencing technology is now routinely used to facilitate case conferences across units, specialties and centres. Such systems could be used in both acute and chronic settings to enable critical care specialist input into the multidisciplinary team. This, along with increased collaborative working through networked maternal medicine, will hopefully improve the quality of care that this group of women receive.

Hospitals differ in their configuration of care for women who are critically ill during pregnancy, birth or the postnatal period. In different hospitals women with the same clinical condition may be cared for in various settings: labour ward, a medical ward or the ICU. It is important to acknowledge that no single specialist or care location has all the skill and knowledge to care for the critically ill obstetric patient. Acknowledgement of the compromises in care that these women face may help clinicians to address and manage some of the associated shortfalls of the individual care locations. For example, admission to critical care may mean being cared for by staff who only infrequently look after pregnant women; they may be less confident prescribing medications in pregnancy and may be less able to facilitate routine care for partners and new babies. An awareness of these potential shortfalls will enable staff to be proactive about seeking support with prescribing and drive units to find innovative ways to facilitate some co-located routine newborn care for families as a whole (Box 8.1).

Box 8.1: Advantages and disadvantages of different locations for providing critical care for pregnant and postpartum woman

|  Delivery Suite |  Critical Care |  Medical Ward |
|---|---|--|
| <p>Pros</p> <ul style="list-style-type: none"> ▲ Used to pregnant patients ▲ Confident prescribing in pregnancy ▲ Staff nearby if go into labour ▲ Parents + baby co-located ▲ Confident management of pregnancy related-syndromes e.g. PET ▲ High consultant presence <p>Cons</p> <ul style="list-style-type: none"> ▼ May not be confident with unwell patients ▼ Possibly no nursing staff ▼ May not be co-located with ICU ▼ Lack of access to physicians | <p>Pros</p> <ul style="list-style-type: none"> ▲ Confident management of unwell patients ▲ Invasive monitoring ▲ Additional organ support ▲ 1:1 nursing support ▲ High consultant presence <p>Cons</p> <ul style="list-style-type: none"> ▼ Not all staff comfortable with pregnant patients ▼ Lack confidence prescribing pregnancy ▼ Lack awareness MEOWs parameters ▼ Partner/baby often not co-located ▼ Support if in labour | <p>Pros</p> <ul style="list-style-type: none"> ▲ Confident management of multiple medical conditions ▲ Partner/baby may be welcome/co-located ▲ Nursing/medical staff familiar with wide range medical conditions <p>Cons</p> <ul style="list-style-type: none"> ▼ Not all staff comfortable with pregnant patients ▼ Lack confidence prescribing pregnancy ▼ Lack awareness MEOWs parameters ▼ Partner/baby often not co-located ▼ Support if in labour |

Reproduced with permission from Cranfield et al. (Cranfield, Horner et al. 2022)

It is also important to acknowledge the potentially dynamic nature of these factors and that they may influence the ability of the different teams to identify and manage the critically unwell obstetric patient. Different mixes of skill sets within teams at different times, staff fatigue, workload, bed and staffing pressures may all be relevant factors to consider when working as a team and finding the ideal care location for an unwell woman. When working in highly pressured, dynamic environments such as delivery suite and critical care, effective team working requires an ability to take into account these environmental, system, staffing and patient factors. Without considering these factors, women whose experiences of pregnancy and childbirth may have already been incredibly traumatic, could face further risks, including increased mortality, physical and psychological morbidity.

8.5 Conclusions

As these reports have frequently highlighted, critical care is a treatment, not a place. Early involvement of the critical care outreach team when women deteriorate can facilitate earlier escalation of care, and allows for nuanced discussion of the preferred location of care, taking into account each woman’s individual needs. For women with underlying medical co-morbidities who are likely to require critical care, planning ahead and antenatal critical care admission to optimise treatment could be considered. For the women whose care was assessed for the purposes of this chapter, assessors felt that improvements in care might have made a difference to outcome for 49% (17/35). While this assessment relates to improvements across the whole care pathway, it was clear that for some women, better integration of critical care within the multidisciplinary team might have led to the earlier, intensive, care that they needed.

Table 8.2: Classification of care received by women whose care was reviewed for the purposes of this chapter, UK and Ireland, 2018-20

| Classification of care received | Women who died (N=35) Number of women (%) |
|---|--|
| Good care | 6 (17) |
| Improvements to care which would have made no difference to outcome | 12 (34) |
| Improvements to care which may have made a difference to outcome | 17 (49) |

9. References

- Afify, H., et al. (2022). "Pulmonary Hypertension in Pregnancy: Challenges and Solutions." *Integr Blood Press Control* 15: 33-41.
- Appleby, L., et al. (2021). "Suicide in England in the COVID-19 pandemic: Early observational data from real time surveillance." *Lancet Reg Health Eur* 4: 100110.
- Baldwin, D. S., et al. (2014). "Evidence-based pharmacological treatment of anxiety disorders, post-traumatic stress disorder and obsessive-compulsive disorder: a revision of the 2005 guidelines from the British Association for Psychopharmacology." *J Psychopharmacol* 28(5): 403-439.
- Berger, M. M., et al. (2019). "Monitoring nutrition in the ICU." *Clin Nutr* 38(2): 584-593.
- Birthrights and Birth Companions (2019). *Holding it all together: Understanding how far the human rights of woman facing disadvantage are respected during pregnancy, birth and postnatal care.* London, Birthrights and Birth Companions.
- Camporota, L., et al. (2021). "Consensus on the referral and admission of patients with severe respiratory failure to the NHS ECMO service." *Lancet Respir Med* 9(2): e16-e17.
- Chan, N., et al. (2022). "Pregnancy and Spontaneous Coronary Artery Dissection: Lessons From Survivors and Nonsurvivors." *Circulation* 146(1): 69-72.
- Cook, J. L., et al. (2017). "Measuring Maternal Mortality and Morbidity in Canada." *J Obstet Gynaecol Can* 39(11): 1028-1037.
- Cosgrove, J., et al. (2019). *Care at the end of life: a guide to best practice, discussion and decision-making in and around critical care.* London, Faculty of Intensive Care Medicine.
- Cranfield, K., et al. (2022). "Current perspectives on maternity critical care." *Anaesthesia* In press.
- Delamater, A. M. (2006). "Improving Patient Adherence." *Clinical Diabetes* 24(2): 71-77.
- Delamater, A. M., et al. (2001). "Psychosocial Therapies in Diabetes: Report of the Psychosocial Therapies Working Group." *Diabetes Care* 24(7): 1286-1292.
- Department of Health (2017). *Safer Maternity Care - progress and next steps.* London, Department of Health.
- Department of Health (2019). *IMEWS (NCEC National Clinical Guideline No. 4 Version 2).* Dublin, Department of Health.
- Diguisto, C., et al. (2022). "A study of diabetic ketoacidosis in the pregnant population in the United Kingdom: Investigating the incidence, aetiology, management and outcomes." *Diabet Med* 39(4): e14743.
- Dockree, S., et al. (2021). "Pregnancy-specific Reference Intervals for BNP and NT-pro BNP-Changes in Natriuretic Peptides Related to Pregnancy." *J Endocr Soc* 5(7): bvab091.
- Draper, E., et al. (2015). *MBRRACE-UK 2015 Perinatal Confidential Enquiry: Term, singleton, normally-formed, antepartum stillbirth.* Leicester, The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of Leicester.
- Ducat, L., et al. (2014). "The mental health comorbidities of diabetes." *JAMA* 312(7): 691-692.
- Furenas, E., et al. (2020). "Pregnancy in a healthy population: dynamics of NTproBNP and hs-cTroponin T." *Open Heart* 7(2).
- Goselink, R. J. M., et al. (2022). "Transition to adult care in epilepsy: A systematic review." *Seizure* 101: 52-59.
- Green, L. J., et al. (2020). "Gestation-Specific Vital Sign Reference Ranges in Pregnancy." *Obstet Gynecol* 135(3): 653-664.

Halushka, M. K., et al. (2016). "Consensus statement on surgical pathology of the aorta from the Society for Cardiovascular Pathology and the Association For European Cardiovascular Pathology: II. Noninflammatory degenerative diseases - nomenclature and diagnostic criteria." *Cardiovasc Pathol* 25(3): 247-257.

Hameed, A. B., et al. (2009). "Longitudinal changes in the B-type natriuretic peptide levels in normal pregnancy and postpartum." *Clin Cardiol* 32(8): E60-62.

Healthcare Improvement Scotland. (2018). "The Scottish Maternity Early Warning System (MEWS)." Retrieved 31/07/2022, from ihub.scot/improvement-programmes/scottish-patient-safety-programme-spsp/spsp-programmes-of-work/maternity-and-children-quality-improvement-collaborative-mcqic/maternity-care/national-mews/.

Hemnes, A. R., et al. (2015). "Statement on pregnancy in pulmonary hypertension from the Pulmonary Vascular Research Institute." *Pulm Circ* 5(3): 435-465.

Hindricks, G., et al. (2020). "2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): The Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC." *European Heart Journal* 42(5): 373-498.

Humbert, M., et al. (2022). "2022 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension." *Eur Heart J*.

Isaacs, R. A., et al. (2014). "A national survey of obstetric early warning systems in the United Kingdom: five years on." *Anaesthesia* 69(7): 687-692.

Jardine, J., et al. (2019). *Maternity Admissions to Intensive Care in England, Wales and Scotland in 2015/16: A Report from the National Maternity and Perinatal Audit*. London, Royal College of Obstetricians and Gynaecologists.

Joint British Diabetes Societies for Inpatient Care (JBDS-IP) (2021). *The Management of Diabetic Ketoacidosis in Adults (JBDS 02)*. London, Joint British Diabetes Societies for Inpatient Care (JBDS-IP).

Joint British Diabetes Societies for Inpatient Care (JBDS-IP) (2022). *Managing diabetes and hyperglycaemia during labour and birth (JBDS 12)*. London, Joint British Diabetes Societies for Inpatient Care (JBDS-IP).

Knight, M. Bunch, K., et al. (2020). *Saving Lives, Improving Mothers' Care Rapid Report: Learning from SARS-CoV-2-related and associated maternal deaths in the UK March – May 2020* Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M. Bunch, K., et al. (2021a). *Saving Lives, Improving Mothers' Care Rapid Report 2021: Learning from SARS-CoV-2-related and associated maternal deaths in the UK June 2021 – March 2021*. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M. Bunch, K., et al., Eds. (2018). *Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2014-16*. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M. Bunch, K., et al., Eds. (2021b). *Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2017-19*. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M. Bunch, K., et al., Eds. (2019). *Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2015-17*. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M. Nair, M., et al. (2014). *Saving Lives, Improving Mothers' Care - Lessons learned to inform future maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009-12*. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M., et al. (2020). "Include pregnant women in research-particularly covid-19 research." *BMJ* 370: m3305.

Knight, M. Nair, M., et al. (2016). Saving Lives, Improving Mothers' Care - Surveillance of maternal deaths in the UK 2012-14 and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009-14. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Knight, M. Nair, M., et al., Eds. (2015). Saving Lives, Improving Mothers' Care - Surveillance of maternal deaths in the UK 2011-13 and lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009-13. Oxford, National Perinatal Epidemiology Unit, University of Oxford.

Lean, R. E., et al. (2018). "NICU Hospitalization: Long-Term Implications on Parenting and Child Behaviors." *Curr Treat Options Pediatr* 4(1): 49-69.

Lewis, G., et al. (2011). "Saving Mothers' Lives: Reviewing maternal deaths to make motherhood safer: 2006-2008. The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom." *BJOG* 118 Suppl 1: 1-203.

Low, T. T., et al. (2021). "Pulmonary arterial hypertension in pregnancy-a systematic review of outcomes in the modern era." *Pulm Circ* 11(2): 20458940211013671.

Mackillop, L. (2021). "Networked maternal medicine services in England and the role of the obstetric physician." *The Obstetrician & Gynaecologist* 23: 86-88.

Martin, S. R., et al. (2019). "Pulmonary Hypertension and Pregnancy." *Obstet Gynecol* 134(5): 974-987.

Maternal Critical Care/Enhanced Maternity Care Standards Development Working Group (2018). Care of the critically ill woman in childbirth; enhanced maternal care. London, Royal College of Anaesthetists (RCOA), Royal College of Obstetricians and Gynaecologists (RCOG), Royal College of Midwives (RCM), Intensive Care Society (ICS), Faculty of Intensive Care Medicine (FICM) and Obstetric Anaesthetists' Association (OAA).

McDonagh, T. A., et al. (2021). "2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: Developed by the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) With the special contribution of the Heart Failure Association (HFA) of the ESC." *European Heart Journal* 42(36): 3599-3726.

Mehta, R. H., et al. (2002). "Predicting death in patients with acute type a aortic dissection." *Circulation* 105(2): 200-206.

Moen, V., et al. (2009). "Hyponatremia complicating labour--rare or unrecognised? A prospective observational study." *BJOG* 116(4): 552-561.

Mohan, M., et al. (2017). "Management of diabetic ketoacidosis in pregnancy." *The Obstetrician & Gynaecologist* 19(1): 55-62.

Nair, M., et al. (2016). "Risk factors and newborn outcomes associated with maternal deaths in the UK from 2009 to 2013: a national case-control study." *BJOG* 123(10): 1654-1662.

Nair, M., et al. (2015). "Factors associated with maternal death from direct pregnancy complications: a UK national case-control study." *BJOG* 122(5): 653-662.

National Institute for Health and Care Excellence. (2010). "CG110: Pregnancy and complex social factors." Retrieved 31/07/2022, from www.nice.org.uk/guidance/cg110.

National Institute for Health and Care Excellence. (2016). "NG56: Multimorbidity: clinical assessment and management." Retrieved 31/07/2022, from www.nice.org.uk/guidance/ng56.

National Institute for Health and Care Excellence. (2017). "CG190: Intrapartum care for healthy women and babies." Retrieved 15/04/2022, from www.nice.org.uk/guidance/cg190.

National Institute for Health and Care Excellence. (2019a). "NG121: Intrapartum care for women with existing medical conditions or obstetric complications and their babies." Retrieved 27/06/2019, from www.nice.org.uk/guidance/ng121.

National Institute for Health and Care Excellence. (2019b). "NG126: Ectopic pregnancy and miscarriage: diagnosis and initial management." Retrieved 27/06/2022, 2022, from www.nice.org.uk/guidance/ng126.

National Institute for Health and Care Excellence. (2019c). "NG133: Hypertension in pregnancy: diagnosis and management." Retrieved 27/06/2019, from www.nice.org.uk/guidance/ng133.

National Institute for Health and Care Excellence. (2020a). "NG3: Diabetes in pregnancy: management from preconception to the postnatal period." Retrieved 02/08/2021, from www.nice.org.uk/guidance/ng51.

National Institute for Health and Care Excellence. (2020b). "NG113: Generalised anxiety disorder and panic disorder in adults: management." Retrieved 30/07/2022, from www.nice.org.uk/guidance/ng113.

National Institute for Health and Care Excellence. (2021a). "NG201: Antenatal care." Retrieved 31/07/2022, from www.nice.org.uk/guidance/ng201.

National Institute for Health and Care Excellence. (2021b). "NG207: Inducing labour." Retrieved 31/07/2022, from www.nice.org.uk/guidance/ng207.

National Institute for Health and Care Excellence. (2022a). "NG17: Type 1 diabetes in adults: diagnosis and management." Retrieved 31/07/2022, from www.nice.org.uk/guidance/ng17.

National Institute for Health and Care Excellence. (2022b). "NICE Clinical Knowledge Summary: Hypertension in pregnancy." Retrieved 13/07/2022, from cks.nice.org.uk/topics/hypertension-in-pregnancy/.

National Institute for Health and Care Research (2021). Best Research for Best Health: The Next Chapter. London, National Institute for Health and Care Research.

NHS England (2019). Saving Babies' Lives Care Bundle Version 2. London, NHS England.

NHS England (2022). NHS England - Maternity early warning score podcasts. London, NHS England.

NHS Resolution (2019). The Early Notification scheme progress report: collaboration and improved experience for families. London, NHS Resolution.

NHS Specialist Pharmacy Service. (2022). "Supply of aspirin tablets to individuals at risk of pre-eclampsia during pregnancy: PGD template." Retrieved 31/07/2022, from www.sps.nhs.uk/articles/supply-of-aspirin-75mg-tablets-to-at-risk-individuals-during-pregnancy/.

Ockenden, D. (2022). Findings, conclusions and essential actions from the independent review of maternity services and the Shrewsbury and Telford Hospital NHS Trust. London, Her Majesty's Stationery Office.

Office for National Statistics. (2020). "Suicides in England and Wales: 2019 registrations." Retrieved 31/07/2022, from www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2019registrations#suicide-methods.

Office for National Statistics. (2021). "Suicides in England and Wales: 2020 registrations." Retrieved 31/07/2022, from www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2020registrations.

Ong, J., et al. (2020). "Extracorporeal membrane oxygenation in pregnancy and the postpartum period: a systematic review of case reports." *Int J Obstet Anesth* 43: 106-113.

Petersen, E. E., et al. (2019). "Vital Signs: Pregnancy-Related Deaths, United States, 2011-2015, and Strategies for Prevention, 13 States, 2013-2017." *MMWR Morb Mortal Wkly Rep* 68(18): 423-429.

Rathert, C., et al. (2018). "Evidence for the Quadruple Aim: A Systematic Review of the Literature on Physician Burnout and Patient Outcomes." *Med Care* 56(12): 976-984.

Regitz-Zagrosek, V., et al. (2018). "2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy." *Eur Heart J* 39(34): 3165-3241

Ross, G. P., et al. (2016). "Relationship between depression and diabetes in pregnancy: A systematic review." *World J Diabetes* 7(19): 554-571.

Royal College of Obstetricians and Gynaecologists (2015). Green-top Guideline 37a: Reducing the Risk of Venous Thromboembolism During Pregnancy and the Puerperium. London, RCOG.

Royal College of Pathologists (2010). Guidelines on Autopsy Practice Scenario 5: Maternal death. London, Royal College of Pathologists.

Royal College of Pathologists (2019). G108: Tissue pathway for histopathological examination of the placenta. London, Royal College of Pathologists.

- Royal College of Pathologists (2022). Autopsy Guideline G145. Sudden death with likely cardiac pathology. London, Royal College of Pathologists.
- Royal College of Physicians (2019). Acute Care Toolkit: Managing Acute Medical Problems in Pregnancy. London, Royal College of Physicians.
- Saad, A. F., et al. (2016). "Extracorporeal Membrane Oxygenation in Pregnant and Postpartum Women With H1N1-Related Acute Respiratory Distress Syndrome: A Systematic Review and Meta-analysis." *Obstet Gynecol* 127(2): 241-247.
- Savale, L., et al. (2017). "Acute decompensated pulmonary hypertension." *Eur Respir Rev* 26(146).
- Sheikh, M., et al. (2021). "Cardiac Complications in Pregnancy: A Systematic Review and Meta-Analysis of Diagnostic Accuracy of BNP and N-Terminal Pro-BNP." *Cardiol Ther* 10(2): 501-514.
- Sheppard, M. (2022). "National and Coronial Sudden Unexpected Death (NHS-C-SUD). A pilot programme." *Bulletin of Royal College of Pathologists*. In press.
- Singer, P., et al. (2019). "ESPEN guideline on clinical nutrition in the intensive care unit." *Clin Nutr* 38(1): 48-79.
- Stock, S., et al. (2022). "Antenatal corticosteroids to reduce neonatal morbidity and mortality." *BJOG: An International Journal of Obstetrics & Gynaecology* 129(8): e35-e60.
- Stone, J. R., et al. (2015). "Consensus statement on surgical pathology of the aorta from the Society for Cardiovascular Pathology and the Association for European Cardiovascular Pathology: I. Inflammatory diseases." *Cardiovasc Pathol* 24(5): 267-278.
- Thomas, E., et al. (2017). "Pulmonary Hypertension and Pregnancy Outcomes: Insights From the National Inpatient Sample." *J Am Heart Assoc* 6(10).
- Vahanian, A., et al. (2021). "2021 ESC/EACTS Guidelines for the management of valvular heart disease: Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)." *European Heart Journal* 43(7): 561-632.
- van Mol, M. M., et al. (2015). "The Prevalence of Compassion Fatigue and Burnout among Healthcare Professionals in Intensive Care Units: A Systematic Review." *PLoS One* 10(8): e0136955.
- Vause, S., et al. (2017). "Pregnancy outcomes in women with prosthetic heart valves: a prospective descriptive population based study using the United Kingdom Obstetric Surveillance System (UKOSS) data collection system." *BJOG* 124(9): 1411-1419.
- Vricella, L. K. (2017). "Emerging understanding and measurement of plasma volume expansion in pregnancy." *Am J Clin Nutr* 106(Suppl 6): 1620S-1625S.
- World Health Organisation. (2012). "The WHO Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM." Retrieved 07/10/2015, from http://apps.who.int/iris/bitstream/handle/10665/70929/1/9789241548458_eng.pdf?ua=1.
- Yaghi, S., et al. (2020). "Clinical update on pulmonary hypertension." *J Investig Med* 68(4): 821-827.
- Yap, Y., et al. (2020). "The peripartum management of diabetes." *BJA Educ* 20(1): 5-9.

MBRRACE-UK

National Perinatal Epidemiology Unit
Nuffield Department of Population Health
University of Oxford
Old Road Campus
Oxford OX3 7LF

Tel: +44-1865-289715

Email: mbrrace-uk@npeu.ox.ac.uk

Web: www.npeu.ox.ac.uk/mbrrace-uk

ISBN: 978-0-9956854-2-0

