

**Maternal, Newborn and
Infant Clinical Outcome
Review Programme**



Saving Lives, Improving Mothers' Care

Rapid report: Learning from SARS-CoV-2-related
and associated maternal deaths in the UK



March - May 2020

Maternal, Newborn and Infant Clinical Outcome Review Programme



Saving Lives, Improving Mothers' Care

Rapid report: Learning from SARS-CoV-2-related
and associated maternal deaths in the UK

Marian Knight, Kathryn Bunch, Andrew Cairns, Roch Cantwell,
Philippa Cox, Sara Kenyon, Rohit Kotnis, Nuala Lucas,
Sebastian Lucas, Lisa Marshall, Cathy Nelson-Piercy, Louise Page,
Alison Rodger, Judy Shakespeare, Derek Tuffnell, Jenny Kurinczuk
on behalf of MBRRACE-UK

March - May 2020



Acknowledgement

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, MBRRACE-UK and other organisations who were involved in the notification of cases, the provision of data and the assessment of individual cases 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.

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, NHS Wales, 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, Cairns A, Cantwell R, Cox P, Kenyon S, Kotnis R, Lucas DN, Lucas S, Marshall L, Nelson-Piercy C, Page L, Rodger A, Shakespeare J, Tuffnell D, Kurinczuk JJ on behalf of MBRRACE-UK. 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 2020.

ISBN: 978-0-9931267-8-9

© 2020 Healthcare Quality Improvement Partnership and National Perinatal Epidemiology Unit, University of Oxford

Contents

1. Key messages	1
2. Background	3
3. Methods	3
4. The women who died	4
5. Overview of care and lessons to be learned	6
5.1 Messages for care of women with SARS-CoV-2 infection	6
5.1.1 Senior obstetric review	6
5.1.2 Location of care	7
5.1.3 Prevention and management of thromboembolism	8
5.1.4 Staffing and equipment	8
5.1.5 Treatment with antivirals or other therapies for COVID-19	9
5.1.6 Advice to stay at home/self-isolate	9
5.1.7 Communication, contact and care of families	10
5.1.8 Good care	10
5.2 Women with SARS-CoV-2 infection who died from other causes	10
5.3 Messages for mental health care	11
5.4 Messages for care of women who died as a result of domestic violence	12
6. Conclusions	14
7. References	15

Key to colour coding

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

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.

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

1. Key messages

New recommendations

1. Ensure all pregnant or post-partum women with COVID-19 receive multidisciplinary team care and obstetric leadership with daily review. This is essential in order to ensure timely recognition of deterioration, early assessment of the need for iatrogenic birth to help respiratory function and identification of postnatal complications. **[ACTION: Royal College of Obstetricians and Gynaecologists/Royal College of Midwives/Obstetric Anaesthetists Association/Royal Colleges of Physicians COVID-19 Guideline Development Groups]**
2. Ensure that pregnant and postpartum women are considered for antiviral or other specific therapies for COVID-19 as part of routine care, early access or compassionate use programmes. Pregnant and postpartum women should not be excluded from clinical trials unless there is a clear contraindication. **[ACTION: Royal College of Obstetricians and Gynaecologists/Royal College of Midwives/Obstetric Anaesthetists Association/Royal Colleges of Physicians COVID-19 Guideline Development Groups]**
3. Provide specific advice to pregnant and post-partum women with COVID-19 infection about the risk of deterioration and when to seek urgent medical attention or go to the hospital. This should be communicated via an interpreter if necessary. **[ACTION: Royal College of Obstetricians and Gynaecologists/Royal College of Midwives/Obstetric Anaesthetists Association COVID-19 Guideline Development Group]**
4. Ensure that communication with partners and families, including via an interpreting service if necessary, and facilitating visits between women and their partners is a priority when women are critically ill. **[ACTION: Royal College of Obstetricians and Gynaecologists/Royal College of Midwives/Obstetric Anaesthetists Association/Royal Colleges of Physicians COVID-19 Guideline Development Groups]**
5. 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. **[ACTION: Royal College of Obstetricians and Gynaecologists/Royal College of Midwives/Obstetric Anaesthetists Association/Royal College of Psychiatrists COVID-19 Guideline Development Groups; Local Maternity Systems; Mental Health Service Providers; Health Boards]**
6. Ensure that referral with mental health concerns on more than one occasion is considered a 'red flag' which should prompt clinical review, irrespective of usual access thresholds or practice. **[ACTION: Royal College of Obstetricians and Gynaecologists/Royal College of Midwives/Obstetric Anaesthetists Association/Royal College of Psychiatrists COVID-19 Guideline Development Groups; Local Maternity Systems; Mental Health Service Providers; Health Boards]**
7. Update guidance to reflect that safeguarding actions, including removal to a place of safety if necessary, should be followed in the context of public health measures such as lockdown. **[ACTION: Local Authorities, Adult Protection Committees, Northern Ireland Adult Safeguarding Partnership, Hospitals and Health Boards, Primary Care]**

Existing guidance and recommendations requiring improved implementation

Original source in brackets

1. Women of BAME background, [or with other risk factors such as hypertension, diabetes or raised BMI], should be advised that they may be at higher risk of complications of COVID-19; we advise they seek advice without delay if they are concerned about their health (RCOG Coronavirus and pregnancy guideline 2020). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**
2. Clinicians should be aware of this increased risk, and have a lower threshold to review, admit and consider multidisciplinary escalation of symptoms in women of BAME background (RCOG Coronavirus and pregnancy guideline 2020). **[ACTION: All Health Professionals]**
3. When reorganising services, maternity units should be particularly cognisant of evidence that BAME individuals are at particular risk of developing severe and life threatening COVID-19 disease (RCOG Coronavirus and pregnancy guideline 2020). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**
4. All pregnant women admitted with confirmed or suspected COVID-19 should receive prophylactic LMWH, unless birth is expected within 12 hours (RCOG Coronavirus and pregnancy guideline 2020). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**
5. For women with severe complications of COVID-19, the appropriate dosing regimen of LMWH should be discussed in a multidisciplinary team (MDT) that includes a senior obstetrician or clinicians with expertise in managing COVID-19 and VTE in pregnancy (RCOG Coronavirus and pregnancy guideline 2020). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**
6. Senior decision-making doctors need to assess the woman, and after multi-disciplinary team discussion with senior colleagues in other units, decide on the best place for her on-going care; decisions must include the means and timing of inter- or intra-hospital transfer to ensure that the transfer is carried out safely and to a high standard (Saving Lives, Improving Mothers' Care 2015). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**
7. Signs of decompensation include an increase in oxygen requirements or $\text{FiO}_2 > 40\%$, a respiratory rate $> 30/\text{min}$, reduction in urine output, or drowsiness, even if oxygen saturations are normal. Escalate urgently if any signs of decompensation develop (RCOG Coronavirus and pregnancy guideline). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**
8. Critical care support can be initiated in a variety of settings. Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care (Saving Lives, Improving Mothers' Care 2014). **[ACTION: Hospitals/Trusts/Health Boards, All Health Professionals]**

2. Background

The emergence of the SARS-CoV-2 virus led to immediate concerns about the impact of infection on pregnant women. Pregnant women were disproportionately infected with influenza A 2009/H1N1, with a high number of deaths due to respiratory complications of the disease noted in MBRRACE-UK reports (Knight, Kenyon et al. 2014, Knight, Nair et al. 2017). Initial reports on outcomes of SARS-CoV-2 for pregnant women were largely reassuring (Chen, Guo et al. 2020), but based on very small numbers from single centres. In response to the SARS-CoV-2 pandemic the MBRRACE-UK team instituted rapid notification of maternal deaths associated with SARS-CoV-2, following which notifications of SARS-CoV-2-associated maternal deaths were received in early April 2020. Expedited reviews were conducted into all deaths of women with confirmed or suspected SARS-CoV-2 infection during or up to one year after pregnancy, and any deaths of women who died from mental health-related causes or domestic violence, which might have been influenced by public health measures introduced to control the epidemic such as lockdown. During this period, the Healthcare Safety Investigation Branch (HSIB) also undertook investigations of maternal deaths associated with SARS-CoV-2 during or up to 42 days after the end of pregnancy in England (excluding suicides and homicides); HSIB writing group members contributed information and learning to this report based on their understanding of the systems in which the women received care.

In the context of the pandemic, health services were advised to plan for staffing levels of between 20-80% and to prepare for what services would look like in those circumstances. This led to dramatic changes in some services, such as perinatal mental health services, community midwifery and health visiting. These plans were led by local teams and hence varied throughout the country, with different judgements around which services were considered essential. This rapid report aimed to identify lessons learned to guide future care and pathway changes in the context of ongoing infection transmission and need for public health and NHS service measures to prevent infection. Changes to other services, as well as changes to advice and care-seeking behaviours, may have impacted on care for women with other medical co-morbidities such as cancer. Any maternal deaths caused by these co-morbidities will be the subject of future reports.

3. Methods

This enquiry used the standard MBRRACE-UK methodology, as described in previous reports (Knight, Nair et al. 2016). Women's deaths were identified through direct reports from staff at hospitals where women died, through media reports, through the Northern Ireland Maternal and Child Health (NIMACH) team and through death registrations in Scotland between 01/03/2020 and 31/05/2020. Deaths which met the remit for inclusion in both programmes were cross-checked with HSIB. Deaths were also cross-checked with the UK Obstetric Surveillance System (UKOSS) study of women hospitalised with SARS-CoV-2 infection in pregnancy (Knight, Bunch et al. 2020). Additional ascertainment of cases through linkage of birth and death records, which is part of the standard MBRRACE methodology, was not possible on this time scale, due to the fact that these linked data will not be available until mid-2021. However, independent ascertainment by MBRRACE-UK and HSIB identified the same women in England, thus providing reassurance that case ascertainment is high.

Each woman's care was reviewed independently by one or two MBRRACE-UK pathology, midwifery, obstetric and anaesthetic assessors. The care of selected women, according to their cause of death, was also reviewed by an obstetric physician assessor, infectious diseases physician assessor, psychiatry assessor or intensive care assessor.

HSIB investigations were carried out using the standard HSIB methodology (<https://www.hsib.org.uk/maternity/investigation-process/>) and findings described according to the SEIPS 2.0 human factors framework (Holden, Carayon et al. 2013)

All MBRRACE-UK assessments (5-7 per woman), together with the findings from HSIB assessments were then reviewed at a virtual multi-disciplinary chapter-writing meeting to identify lessons learned to improve future care.

4. The women who died

Ten women died with SARS-CoV-2 between 01/03/2020 and 31/05/2020 and their care was reviewed under the remit of MBRRACE-UK; seven of these women also had an HSIB investigation. Nine women with SARS-CoV-2 infection died during or up to six weeks after pregnancy and one died between six weeks and one year after the end of pregnancy. Seven women, including the woman who died in the late postpartum period, died from causes directly relating to COVID-19, six from cardio-respiratory complications of the disease, and one from cerebral thrombotic complications. One woman's precise cause of peripartum collapse could not be established by this enquiry as no post-mortem examination was carried out, however, it was considered to be related to COVID-19 on the basis of her clinical history. Two women had confirmed SARS-CoV-2 infection at the time of their death but died from unrelated causes.

The characteristics of the women whose care was reviewed is shown in table 1. Of note, all the eight women who died from COVID-19 were in the third trimester of pregnancy at the time of disease onset. Seven (88%) were from black and minority ethnic groups. Pre-existing diabetes, hypertension or cardiac disease were identified in very few of these women. All women who had confirmed SARS-CoV-2 infection died after giving birth; two of their babies were stillborn.

Four women died by suicide (three during or up to six weeks after pregnancy and one between six weeks and one year after the end of pregnancy), and two women died as a result of domestic violence (both between six weeks and one year after the end of pregnancy). Two women who died by suicide were still pregnant at the time of their deaths, the remaining women had all given birth or had pregnancy losses.

Overall, the women who died had 18 children from previous births, thus a total of 30 motherless children remain.

During the three months covered by this report an estimated 162,344 women gave birth in the UK. The estimated SARS-CoV-2-associated maternal mortality rate, including all deaths of women with SARS-CoV-2 infection, is therefore 6.2 per 100,000 (3.0-11.3), maternal mortality due to suicide during or up to one year after pregnancy was 2.5 per 100,000 (0.7-6.3), and mortality due to homicide during or up to one year after pregnancy was 1.2 per 100,000 (0.1-4.5). The usual MBRRACE-UK methodology would be to assess maternal mortality rates over a three year period to give a more robust estimate. These figures may thus appear to give an artificially high impression of excess maternal mortality due to SARS-CoV-2 infection. Annually there are approximately 70 maternal deaths in the UK, thus the seven deaths of women from COVID-19 complications should be seen in this context. Over a three-year period, assuming no more maternal deaths from COVID-19 occur, a statistically significant change in the overall maternal mortality rate may not be detectable.

Table 3.1: Characteristics of women included in this report

Characteristics	Women with SARS-CoV-2 infection (n=10) Frequency (%)	Women who died by suicide or from domestic violence (n=6) Frequency (%)	Total (n=16) Frequency (%)
Socio-demographic			
Age			
<25	0 (0)	3 (50)	3 (19)
25 – 29	3 (30)	0 (0)	3 (19)
30 – 34	3 (30)	3 (50)	6 (38)
≥ 35	4 (40)	0 (0)	4 (25)
Body mass index (kg/m²)			
<25	3 (30)	5 (83)	8 (50)
25-29	5 (50)	0 (0)	5 (31)
≥30	2 (20)	1 (17)	3 (19)
Parity			
0	4 (40)	1 (17)	5 (31)
≥1	6 (60)	5 (83)	11 (69)
UK citizen			
Yes	7 (70)	4 (67)	11 (69)
No	2 (20)	2 (33)	4 (25)
Missing	1 (10)	0 (0)	1 (6)
Ethnicity			
White European	1 (10)	5 (83)	6 (38)
Asian	5 (50)	0 (0)	5 (31)
Black	3 (30)	0 (0)	3 (19)
Chinese/Other	1 (10)	0 (0)	1 (6)
Mixed	0 (0)	1 (17)	1 (6)
Woman's region of birth			
United Kingdom	6 (60)	3 (50)	9 (56)
Europe	0 (0)	2 (33)	2 (13)
Asia	3 (30)	0 (0)	3 (19)
Africa	1 (10)	0 (0)	1 (6)
Other	0 (0)	1 (17)	1 (6)
Socioeconomic status (Occupational classification)			
Employed (Either woman or partner)	10 (100)	5 (83)	15 (94)
Unemployed (Both)	0 (0)	1 (17)	1 (6)
Able to speak/understand English			
Yes	10 (100)	6 (100)	16 (100)
Living arrangements			
With partner	8 (80)	6 (100)	14 (88)
Other	2 (20)	0 (0)	2 (13)
Known domestic abuse (prior to pregnancy/ during pregnancy)			
Yes	1 (10)	0 (0)	1 (6)
No	9 (90)	4 (67)	13 (81)
Missing	0 (0)	2 (33)	2 (13)
Known to social services			
Yes	3 (30)	2 (33)	5 (31)
No	7 (70)	4 (67)	11 (69)
Smoking			
Smoker	2 (20)	3 (50)	5 (31)
Non-smoker	7 (70)	3 (50)	10 (63)
Missing	1 (10)	0 (0)	1 (6)
Substance user			
Yes	3 (30)	2 (33)	5 (31)
No	7 (70)	4 (66)	11 (69)

5. Overview of care and lessons to be learned

5.1 Messages for care of women with SARS-CoV-2 infection

It is reassuring that, in contrast to the situation observed in the 2009 influenza A/H1N1 pandemic (Knight, Kenyon et al. 2014), most women's symptoms were recognised and the diagnosis of COVID-19 was made early once they reached hospital. However, the care women received was extremely variable according to the route through which they presented to hospital. Many women had minimal or delayed obstetric or midwifery input. Decisions around planning birth, in particular to facilitate maternal respiratory support, were therefore delayed, and frequently involved only junior obstetric staff. Once women had given birth, obstetric and midwifery review was rare and often entirely absent. It was also evident that some women had delayed seeking hospital care, either because of concerns about acquiring SARS-CoV-2 infection in hospital, or because of advice to self-isolate.

5.1.1 Senior obstetric review

A woman in her third trimester of pregnancy presented to the Emergency Department with a one week history of symptoms of COVID-19. Her observations were documented using a National Early Warning Score (NEWS) and not a modified early obstetric warning score (MEOWS). She had a respiratory rate of 36 but this was not recognised as significant. Her first review by a member of obstetric staff was eleven hours after she attended, when a junior obstetrician identified no obstetric concerns. She deteriorated a few days later and was documented to need high dependency or intensive care but no beds were available in either high dependency or intensive care areas. Her care was discussed with a consultant obstetrician at the time of her deterioration and a decision made for a caesarean birth. Following the birth, it was again noted that no beds were available and she was transferred back to a general ward where she deteriorated. She was intubated and transferred to the intensive care unit but her condition continued to worsen and she died a few days later.

This woman was cared for in five different areas and there was no consistency in who was caring for her. Obstetric input was limited and a senior obstetrician was only involved at the time of her caesarean. It was documented in her records after her caesarean that she 'should not need further obstetric review'. It has been a recurring message of these enquiries that ill pregnant women need senior obstetric review; this is even more pertinent in the context of a pregnant woman with COVID-19. It was noted in the 2015 report that 'having reached a hospital, some women needed transfer to another hospital or to another part of the same hospital for further investigation and treatment. The woman that is most impacted by this is the sick woman not quite ill enough for continuous level 3 care, but with multiple problems and for whom therefore no-one takes a leadership role for her overall [care]. These women have a tendency to become neglected and overlooked'. It is clear that multi-disciplinary team review is needed for any pregnant or post-partum woman with COVID-19; very few of the women whose care was reviewed here had such multidisciplinary team planning.

Senior decision-making doctors need to assess the woman, and after multi-disciplinary team discussion with senior colleagues in other units, decide on the best place for her on-going care; decisions must include the means and timing of inter- or intra-hospital transfer to ensure that the transfer is carried out safely and to a high standard.

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

Guidance from the RCOG 'Bacterial sepsis after pregnancy' guideline concerning obstetric review applies equally to the care of women with COVID-19.

The responsible consultant obstetrician must show clear leadership and be responsible for liaising with anaesthetists, midwives, infectious diseases physicians/microbiologists and all other professionals who need to be involved in the care of these women. When a woman is transferred to level 3 / intensive care, daily consultant obstetric involvement must remain, even if only in a supportive role, until such time that the woman is ready to be repatriated to the maternity unit.

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

It is of note that varying redeployment decisions had clearly been taken in different hospitals caring for the women who died. In some hospitals, junior obstetric staff were redeployed to non-maternity work leaving a senior-run service. However, as identified in HSIB investigations, in other hospitals consultant obstetric staff had been redeployed to front line COVID-19 general medical care, leaving unsupported junior staff to manage the labour suite, which exacerbated problems with lack of senior obstetric input for pregnant and postpartum women.

5.1.2 Location of care

In the vignette above, it was noted that a lack of high dependency or intensive care beds was repeatedly documented, the implication being that high dependency or intensive care could not be provided elsewhere. Although assessors recognised that there were very high pressures on critical care services at the time of this woman's death, as these enquiries have noted previously, critical care supportive treatment should always occur if beds are not immediately available. No consideration appears to have been made of the possibility of transfer to another facility to obtain an appropriate level of care when this care could not be provided in the location in which women were situated.

Critical care support can be initiated in a variety of settings.

Delay caused by bed pressures in a critical care unit is not a reason to postpone critical care.

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

A woman in the third trimester of pregnancy was admitted with a one week history of COVID-19 symptoms. She remained in the Emergency Department for several hours and was assessed as having mild-moderate COVID-19 by medical staff. It was recorded that she did not have evidence of respiratory failure but was hyperventilating. She deteriorated overnight and had a respiratory rate of 70 with an oxygen saturation of 94% on 4 litres of oxygen at the time a decision for caesarean birth was made. She improved initially but subsequently deteriorated and died.

It was apparent that the severity of women's condition was not recognised by staff who were not familiar with caring for pregnant or postpartum women. Several women had a metabolic acidosis, the significance of which was not recognised. Metabolic acidosis can be a marker of severe infection and in the context of diabetes and pregnancy may also be due to starvation or diabetic ketoacidosis. An accurate diagnosis (for example using blood ketone estimation) should ensure appropriate treatment. In particular, as described in the earlier vignette, decisions for iatrogenic birth, which may have improved women's respiratory function, were often delayed due to lack of obstetric and midwifery input. When decisions were taken, the decision was frequently made, and the caesarean performed, by a junior doctor. Induction of labour, as opposed to caesarean birth, did not appear to be considered even when it might have been appropriate for multiparous women who had previous uncomplicated vaginal births. This emphasises again the importance of multidisciplinary team care and obstetric leadership to ensure timely recognition of deterioration and early assessment of the need for iatrogenic birth to help respiratory function.

Signs of decompensation include an increase in oxygen requirements or $\text{FiO}_2 > 40\%$, a respiratory rate $> 30/\text{min}$, reduction in urine output, or drowsiness, even if oxygen saturations are normal.

• Escalate urgently if any signs of decompensation develop.

RCOG Coronavirus (COVID-19) and pregnancy guideline (Royal College of Obstetricians and Gynaecologists and The Royal College of Midwives 2020)

Ensure all pregnant or post-partum women with COVID-19 receive multidisciplinary team care and obstetric leadership with daily review. This is essential in order to ensure timely recognition of deterioration, early assessment of the need for iatrogenic birth to help respiratory function and identification of postnatal complications.

5.1.3 Prevention and management of thromboembolism

A postpartum woman who appeared to be recovering after intensive care suddenly deteriorated with a headache and blurred vision. A CT scan showed brain ischaemia and artery thrombosis from which she died. A second postpartum woman deteriorated very suddenly after a few days whilst in intensive care which may have been due to a thrombotic event.

The final acute deterioration in this second woman may have been due to a thrombotic complication. Emerging data and clinical experience point to a greatly increased prevalence of thrombotic disease in patients with COVID-19 (Klok, Kruip et al. 2020), particularly those admitted to intensive care where acute inflammatory state, hypoxaemia and immobility also predispose to thrombosis (Bikdeli, Madhavan et al. 2020). Pregnant women have further increased risk for thromboembolic events particularly in the 3rd trimester, which increase further with caesarean birth (Royal College of Obstetricians and Gynaecologists 2015).

Several studies demonstrated a high prevalence of PE and DVT with COVID-19 (in up to one third of patients in critical care) even when appropriate thromboprophylaxis was used (Klok, Kruip et al. 2020, Tang, Bai et al. 2020). General guidance is that venous thromboembolism and in particular pulmonary thrombotic or embolic events should be considered with a low threshold for investigating and treating in COVID-19 patients requiring continuous positive airways pressure (CPAP) or intubation especially with clinical deterioration even when prophylactic anticoagulation has been administered. It is noteworthy that both these women received appropriate thromboprophylaxis according to current RCOG guidance (Royal College of Obstetricians and Gynaecologists 2015). Given the high incidence of thrombotic complications in critically ill COVID-19 patients, many of whom have received prophylactic anticoagulation, many centres are now giving higher doses of LMWH in a proportion of patients using twice daily thromboprophylaxis. However evidence is currently awaited for the risks and benefits of full anticoagulation from the REMAP-CAP clinical trial which includes a randomisation to standard thromboprophylaxis versus therapeutic anticoagulation (<https://www.remapcap.org>).

Women should have a venous thromboembolism (VTE) risk assessment performed during their pregnancy as per the RCOG Green-top Guideline No 37a. Infection with SARS-CoV-2 should be considered as an additional risk factor and prompt reassessment.

All pregnant women admitted with confirmed or suspected COVID-19 should receive prophylactic LMWH, unless birth is expected within 12 hours.

For women with severe complications of COVID-19, the appropriate dosing regimen of LMWH should be discussed in a multidisciplinary team (MDT) that includes a senior obstetrician or clinicians with expertise in managing COVID-19 and VTE in pregnancy.

All pregnant women who have been hospitalised and have had confirmed COVID-19 should receive thromboprophylaxis for 10 days following hospital discharge. For women with persistent morbidity, consider a longer duration of thromboprophylaxis.

If women are admitted with confirmed or suspected COVID-19 within 6 weeks postpartum, they should receive thromboprophylaxis for the duration of their admission and for at least 10 days post discharge. Consider extending this until 6 weeks postpartum for women with significant ongoing morbidity.

RCOG Coronavirus (COVID-19) and pregnancy guideline (Royal College of Obstetricians and Gynaecologists and The Royal College of Midwives 2020)

5.1.4 Staffing and equipment

Although there was evidence of minor delays in urgent caesarean births due to donning of personal protective equipment (PPE), assessors did not feel this influenced women's care or the outcomes for them or their babies adversely. The impact of redeployment decisions on the availability of senior obstetric staff has been noted above.

The majority of these women received critical care in temporarily repurposed settings such as operating theatres or recovery areas. It was evident that some staff who had been redeployed from their very different usual roles were unfamiliar with the critical care equipment, including ventilatory support, they had to use and monitor, and had no experience of caring for pregnant or postpartum women. Some were operating in these roles after very minimal training and inevitably errors occurred. Attention to skills, knowledge and supervision is needed when acute settings are staffed with those unfamiliar with the area. Consideration should be given to establishing a minimum standard of orientation before working in a new clinical environment.

5.1.5 Treatment with antivirals or other therapies for COVID-19

None of the women who died from complications of COVID-19 were treated with antivirals or other medical therapies for COVID-19; their care was entirely supportive. Although assessors recognised that at the early stage of the pandemic, there was little evidence to guide medication use, no consideration had been made of using existing therapies or obtaining access to experimental therapies, for example under compassionate care programmes, or as part of clinical trials for any of the women who died. It has been a repeated message of these reports that pregnant or postpartum women with medical problems should be treated the same as non-pregnant women, unless there is a clear reason not to, and this applies equally in the management of COVID-19. The RECOVERY trial (<https://www.recoverytrial.net>) is actively promoting inclusion of pregnant women, and pregnant and postpartum women may also be considered for therapies such as remdesivir. Remdesivir is now being provided through the Medicines & Healthcare products Regulatory Agency (MHRA) Early Access to Medicines Scheme (EAMS) for hospitalised patients (including pregnant women) with severe disease (defined as oxygen saturation <95% on room air).

Ensure that pregnant and postpartum women are considered for antiviral or other specific therapies for COVID-19 as part of routine care, early access or compassionate use programmes.

Pregnant and postpartum women should not be excluded from clinical trials unless there is a clear contraindication.

New maternal medicine networks in England, and equivalent structures in the devolved nations, provide an ideal route to obtain advice on medical treatment of pregnant and postpartum women, and this should apply equally to women with COVID-19. Staff in non-maternity settings need to be aware of these networks as a route to obtain expert advice.

5.1.6 Advice to stay at home/self-isolate

Three women died at home or presented to hospital late, either because of reluctance to attend hospital for fear of infection, or due to following advice to stay at home.

Advice to stay at home appears to have been over-emphasised, and this was clearly coupled with anxiety about attending hospital, and the impact of visiting restrictions which meant women could have no partner visit until they were in established labour. In some instances women had been at home self-medicating with paracetamol or equivalent over the counter medications at relatively high doses for several days without seeking further advice. It is unclear whether the algorithms used by services such as NHS 111 were tailored differently for pregnant women, but it is clear that women needed to know when to go into hospital, or, as a minimum, when to telephone their midwife for advice. Current guidance for women who are self-isolating due to coronavirus symptoms simply states that they should consult NHS 111 or their maternity unit if their symptoms are more severe. Previous MBRRACE-UK reports have highlighted breathlessness 'red flags' for professionals (Box); similar guidance is needed for women about when to seek help.

Box: Breathlessness 'red flags' to be aware of:

Sudden onset breathlessness

Orthopnoea

Breathlessness with chest pain or syncope

Respiratory rate >20 breaths/min

Oxygen saturations < 94% or fall to < 94% on exertion [even with no sensation of breathlessness]

Breathlessness with associated tachycardia (heart rate can be elevated by 10-15% in a normal pregnancy-refer to pre-pregnancy observations/ECG)

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

Provide specific advice to pregnant and post-partum women with COVID-19 infection about the risk of deterioration and when to seek urgent medical attention or go to the hospital. This should be communicated via an interpreter if necessary.

As noted in section 4, the majority of women who died were from black or minority ethnic groups. Women are also at particular risk of complications of COVID-19 if they have other medical problems such as hypertension, diabetes or obesity (Knight, Bunch et al. 2020). It is particularly important that women in these groups are advised to seek help early.

Women of BAME background, [or with other risk factors such as hypertension, diabetes or raised BMI], should be advised that they may be at higher risk of complications of COVID-19; we advise they seek advice without delay if they are concerned about their health.

Clinicians should be aware of this increased risk, and have a lower threshold to review, admit and consider multidisciplinary escalation of symptoms in women of BAME background.

When reorganising services, maternity units should be particularly cognisant of evidence that BAME individuals are at particular risk of developing severe and life threatening COVID-19 disease.

RCOG Coronavirus (COVID-19) and pregnancy guideline (Royal College of Obstetricians and Gynaecologists and The Royal College of Midwives 2020)

5.1.7 Communication, contact and care of families

Some women did not see their babies before they died, and in several instances partners were unable to see women before they died. In at least two instances, partners were left at home completely unsupported and clearly unaware, in one instance due to language difficulties, how ill their partners had become. Communication with partners and families, including via an interpreting service if necessary, and facilitating visits between women and their partners must be a priority when women are critically ill. This is an essential part of end of life care.

Ensure that communication with partners and families, including via an interpreting service if necessary, and facilitating visits between women and their partners is a priority when women are critically ill.

5.1.8 Good care

A woman in the third trimester of pregnancy with breathlessness was seen in the Emergency Department. COVID-19 was suspected, a swab was taken, and she was advised to self-isolate. She was given advice to return if her symptoms worsened, which she did two days later. She was appropriately rapidly referred to the obstetric team and admitted to the labour ward for observation. She appeared to improve slightly, but an early decision was made for a caesarean birth to aid her respiratory condition. She had regional anaesthesia and was able to see her baby. Postnatally she began to deteriorate and her care was appropriately escalated with intensive care and respiratory medicine review before she was intubated and admitted to the intensive care unit. Unfortunately despite high quality intensive care she died.

This woman was provided with appropriate safety-netting advice at her initial presentation, and when her symptoms worsened, she was correctly admitted to the maternity unit. There was good communication between teams throughout and her care was escalated in a timely manner. An early decision for caesarean birth allowed her to give birth under regional anaesthesia and to see her baby before she died.

5.2 Women with SARS-CoV-2 infection who died from other causes

Two women in whom SARS-CoV-2 infection was diagnosed died from haemorrhagic conditions unrelated to their infection. Both women had exemplary resuscitation and potential causes for their collapse were identified and treated. Although resuscitation teams had to don personal protective equipment, this did not lead to delay which had an impact on the women's deaths, nor was there any evidence that the COVID-19 pandemic situation had delayed the women presenting for care.

5.3 Messages for mental health care

Four women died by suicide during this three month period. It was evident that changes to service provision as a direct consequence of the pandemic meant that women were not able to access appropriate mental health care. Receipt of the specialist care they needed may have prevented their deaths.

A postnatal woman with known mental health problems contacted her GP during the early days of lockdown requesting an increase in antidepressant. She had contacted the crisis team and was said to be “not suicidal”. She was rereferred to the perinatal mental health team. The next day she rang the crisis team. She had several further telephone consultations with perinatal mental health and crisis teams but was not seen face to face. She died by suicide the following day.

This woman had clear risk factors for postpartum psychosis. Her rapidly escalating severity of symptoms against a background of indicators of more pervasive depressive disorder (weight loss, persistent poor sleep) and possible family history were not recognised. Her undoubted agitated depression with symptoms which may have indicated psychosis appear to have been misattributed to anxiety and downgraded. Her husband’s distress does not appear to have triggered any questioning as to whether this presentation might have been a significant change for her. The lack of recognition of this pattern of presentation may have been affected by the absence of face to face assessment brought about by COVID-19-related changes to practice. She should have had a face-to-face assessment the same day yet both crisis and perinatal mental health teams seem to have viewed it as the other’s responsibility. Earlier face to face, or at the very least video consultation may have enabled the diagnosis of psychosis and prevented this woman’s death.

This woman’s care echoes previous messages identified in these reports concerning awareness of the pattern of rapid deterioration of perinatal mental illness, downgrading of symptoms, and recognition of red and amber flags. The 2015 MBRRACE report also points to the importance of professionals listening to the views of family members and including those views in the overall assessment and management (Knight, Nair et al. 2015).

Assessments should always include a review of previous history and always take into account the findings of recent presentations and escalating patterns of symptoms, their severity and any associated abnormal behaviour.

New and persistent expressions of incompetency as a mother or estrangement from the infant are ‘red flag’ symptoms and may be indicators of significant depressive disorder. In some instances, this may reflect psychotic thinking. In the presence of significant illness, such symptoms may be best addressed through inpatient mother and baby care.

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

Closely monitor women with a family history of bipolar disorder or postpartum psychosis and refer if any change in mental state. If they themselves have any mood disorder or history of postpartum mood destabilisation they should have an individualised assessment of risk.

Personal and familial patterns of occurrence and re-occurrence should inform risk minimisation strategies. Saving Lives, Improving Mothers’ Care 2017 (Knight, Nair et al. 2017)

This pattern of repeated referral and lack of face to face assessment was observed during pregnancy as well as postpartum.

A woman revealed a history of mental health problems and early life trauma during her pregnancy. Repeated referrals were either not accepted or cancelled due to COVID-19 restrictions. A letter to the woman from the perinatal mental health service arrived two months after the cancellation (one month after she gave birth) explaining that she would not be seen due to COVID-19 restrictions as they only saw people with acute mental illness, and providing leaflets on primary care psychological services, third sector and self-help resources. She died by suicide two weeks later.

Pregnancy and birth are extremely vulnerable times for those with mental health disorders or prior childhood adversity. While severe psychiatric illnesses peak in the postnatal period, the serious risks to the mother and baby go well beyond any purely “illness “ based model and assessment must consider the woman and her story, not just the illness. Biological, psychological and social issues combine in a particular way at this time. The bio-psycho-social consequences of mental illness and pregnancy are exacerbated further during times of generalised increased social stress as seen during a pandemic and social lockdown. It should be remembered that on-going domestic abuse can also be an underlying cause of mental illness and this should be considered when carrying out mental health assessments.

There was an opportunity for a specialist review of this woman, which could have been carried out by telephone or video, even in the context of COVID-19 restrictions, particularly following the second referral and indicators of deterioration in mental state. Specialist perinatal mental health services should remember the need to alter thresholds for assessment during pregnancy and the early postpartum. With the broadening of methods of assessment due to COVID-19, which is likely to be retained, there is an argument for lowering thresholds for triage assessments carried out by phone/video particularly in the perinatal period. During pregnancy, women continue to be seen face-to-face in maternity services for investigations such as ultrasound scans and routine antenatal appointments. Face to face mental health assessment will also be necessary in some circumstances, for example when women request face to face contact or when there is a clinical need following a perinatal mental health risk assessment. There is a clear role for involvement of the lead mental health obstetrician or midwife for triage and clinical review, particularly if there are repeated concerns, which may help ensure specialist services are not overwhelmed.

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.

Assessors were particularly concerned that referrals appeared to be ‘being bounced’ between different mental health services, with no one in either service recognising the pattern of repeated referral and the fact that women needed to be assessed by someone with mental health expertise. It has been noted before in these enquiries that thresholds based on proforma review restricting access to secondary care services are not appropriate. Repeated referral should be considered a ‘red flag’ which should prompt clinical review, irrespective of usual access thresholds or practice. Clinical review and assessment of symptoms will allow informed referral to the most appropriate service.

Ensure that referral with mental health concerns on more than one occasion is considered a ‘red flag’ which should prompt clinical review, irrespective of usual access thresholds or practice.

It was noted that women only received a single postnatal midwife visit due to COVID-19 guidelines, and that visits from Health Visitors appeared to have stopped. Women had clear mental health symptoms at the time of their postnatal midwife review, and assessors felt that there could have been a risk assessment about the need to further postnatal midwife review rather than an assumption that there would only be a single visit. This should be considered in future service planning.

5.4 Messages for care of women who died as a result of domestic violence

A woman with multiple disadvantages and past mental health difficulties was known to have a violent partner. No consideration appears to have been made around the protection of the woman herself. She died after a violent assault a few months postpartum during the lockdown period.

A second postpartum woman disclosed domestic violence to her Health Visitor on several occasions prior to lockdown and a referral was made to children’s services. Her partner made an attempt on her life during lockdown and she was advised to lock herself and her children into her home and seek family support. Neither she nor her children were removed to a place of protection. She was killed the following day.

Both these women needed safeguarding. Whilst the first woman had multiple problems and had disengaged with services, all conversations were around protection of the child rather than the woman herself. Professionals should never give up trying to develop therapeutic relationships that will enable those subject to abuse to seek support. These enquiries have observed before the need to protect women with multiple disadvantage, who are over-represented amongst women who die during pregnancy or postpartum. The second woman's care emphasises the need to ensure women can be removed to a place of safety even in the context of public health measures such as lockdown. Where a violent offender is released from custody, communication should include the wider multidisciplinary team working with the woman, including social services.

Update guidance to reflect that safeguarding actions, including removal to a place of safety if necessary, should be followed in the context of public health measures such as lockdown.

These reports have highlighted previously a number of key actions to improve future care of women who are subject to domestic violence or abuse, which are pertinent to learning from these women's deaths. It remains important that women are given the opportunity to disclose domestic abuse, and that they are appropriately referred for support if they disclose domestic abuse.

Healthcare professionals need to be alert to the symptoms or signs of domestic abuse and women should be given the opportunity to disclose domestic abuse in an environment in which they feel secure.

NICE Antenatal care guideline CG62 (National Institute for Health and Care Excellence 2008)

All health professionals caring for women should be aware of the pathway of care once domestic abuse is disclosed, and escalate to senior staff if necessary.

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

It is unclear whether other statutory reviews of these women's deaths have yet been undertaken. Domestic Homicide Reviews or equivalent are as important at the time of a pandemic as at any other time.

The care of any woman murdered during or up to one year after pregnancy should be subject to multi-agency Domestic Homicide Review or equivalent

Home Office Guidance for the Conduct of Domestic Homicide Reviews (Home Office 2016)

6. Conclusions

It is reassuring that pregnancy and postpartum women do not appear to be at higher risk of severe COVID-19 than non-pregnant women (Knight, Bunch et al. 2020). Nevertheless, review of the care of the women who died identified areas where change can be made in the future. Assessors felt that for the majority of women who died, improvements in care could have been made. For 33% of women, improvements in care may have made a difference to outcome (Table 2) and mitigating actions should be put in place to prevent deaths. While some of the improvements noted concerned the organisation of care in the context of a very pressed service dealing with a high level of need due to the SARS-CoV-2 pandemic, most represented what should be basic care for severely ill pregnant or postpartum women. Key mitigating actions to be put in place are: early senior obstetric review, multidisciplinary team decision-making and planning for iatrogenic birth, nuanced and early communication with families and compassionate end of life care. Of particular concern was the care for women with mental health problems as face to face services were withdrawn. Future planning must ensure that consideration is made in these circumstances to triage via video or telephone consultations to identify women who need further face-to-face mental healthcare and that repeated referral is not ignored. Perinatal mental health care is as essential as other aspects of maternity care.

This report did not examine the care of women who died from other morbidities such as cancer, epilepsy or heart disease, since impacts, in terms of maternal deaths, from the changes in services and behaviours during the pandemic are unlikely to be identified at this early stage. Ensuring that care of pregnant and postpartum women with both physical and mental health co-morbidities is not compromised by service changes must be a priority to ensure deaths do not occur in the future.

These findings emphasise the important considerations for the care of pregnant and postpartum women with COVID-19 going forward. However, in the absence of a vaccine, prevention must remain the goal of any public health intervention. All the women included in this report who died from COVID-19 were in the third trimester of pregnancy, and the majority were from black or other minority ethnic groups. Addressing the disparity in outcomes of COVID-19 amongst people from ethnic minority groups has already been established as a national and international priority. The recent UKOSS study of hospitalisation with confirmed SARS-CoV-2 also identified that more than half of pregnant women admitted were from black or other minority ethnic groups and that the majority of those admitted were in the late second or third trimester (Knight, Bunch et al. 2020). Other studies have also suggested that pregnant women are equally susceptible to infection whatever their gestation, but the majority of women who become severely ill are in the third trimester (Kayem, Lecarpentier et al. 2020). Attention to social distancing in the later stages of pregnancy to prevent infection must remain the key intervention to reduce infection. Ensuring that this occurs without a withdrawal of essential antenatal and mental health care and care of vulnerable women such as those subject to domestic violence must remain a priority.

Table 5.1: Classification of care received by women who died from SARS-CoV-2-associated causes, UK, 01/03/2020-31/05/2020

Classification of care received	Women with SARS-CoV-2 infection who died Number (%) N=10	Women who died by suicide or homicide Number N=6
Good care	2 (20)	1 (17)
Improvements to care which would have made no difference to outcome	5 (50)	2 (33)
Improvements to care which may have made a difference to outcome	3 (30)	3 (50)

7. References

- Bikdeli, B., M. V. Madhavan, D. Jimenez, et al. (2020). "COVID-19 and Thrombotic or Thromboembolic Disease: Implications for Prevention, Antithrombotic Therapy, and Follow-up." *J Am Coll Cardiol* [Epub ahead of print].
- Chen, H., J. Guo, C. Wang, et al. (2020). "Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records." *Lancet* 395(10226): 809-815.
- Holden, R. J., P. Carayon, A. P. Gurses, et al. (2013). "SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients." *Ergonomics* 56(11): 1669-1686.
- Home Office (2016). Multi-agency Statutory Guidance for the Conduct of Domestic Homicide Reviews. London, Home Office.
- Kayem, G., E. Lecarpentier, P. Deruelle, et al. (2020). "A snapshot of the Covid-19 pandemic among pregnant women in France." *J Gynecol Obstet Hum Reprod*: 101826.
- Klok, F. A., M. Kruip, N. J. M. van der Meer, et al. (2020). "Incidence of thrombotic complications in critically ill ICU patients with COVID-19." *Thromb Res* 191: 145-147.
- Knight, M., K. Bunch, N. Vousden, et al. (2020). "Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study." *BMJ* 369: m2107.
- Knight, M., S. Kenyon, P. Brocklehurst, 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., M. Nair, D. Tuffnell, 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., M. Nair, D. Tuffnell, et al. (2017). *Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2013-15*. Oxford, National Perinatal Epidemiology Unit, University of Oxford.
- Knight, M., M. Nair, D. Tuffnell, et al. (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.
- National Institute for Health and Care Excellence. (2008). "CG62: Antenatal care." Retrieved 15/04/2014, 2014, from <http://www.nice.org.uk/guidance/cg62>.
- National Institute for Health and Care Excellence. (2010). "CG110: Pregnancy and complex social factors: A model for service provision for pregnant women with complex social factors." Retrieved 23/07/2015, 2015, from <https://www.nice.org.uk/guidance/cg110>.
- Royal College of Obstetricians and Gynaecologists (2012). Green-top Guideline No. 64b. Bacterial Sepsis following Pregnancy. London, RCOG.
- 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 Obstetricians and Gynaecologists and The Royal College of Midwives (2020). *Coronavirus (COVID-19) Infection in Pregnancy: Information for healthcare professionals*. London, Royal College of Obstetricians and Gynaecologists.
- Royal College of Physicians (2019). *Acute Care Toolkit: Managing Acute Medical Problems in Pregnancy*. London, Royal College of Physicians.
- Tang, N., H. Bai, X. Chen, et al. (2020). "Anticoagulant treatment is associated with decreased mortality in severe coronavirus disease 2019 patients with coagulopathy." *J Thromb Haemost* 18(5): 1094-1099.





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: 978-0-9931267-8-9

