



MISSISSIPPI STATE DEPARTMENT OF HEALTH

Mississippi Maternal Mortality Report 2017-2019

Mississippi State Department of Health

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The determination as to whether a maternal death was directly related to pregnancy and the recommendations contained in this report were provided by the Mississippi Maternal Mortality Committee Members. Statistical analysis and data visualization support was provided by the Mississippi State Department of Health.

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Executive Summary

Maternal mortality is an important indicator of the quality of health and healthcare experienced by pregnant women. Each maternal death is a loss affecting that mother's family, her community, and our state. The Mississippi Mortality Review Committee (MMRC) is tasked with reviewing maternal deaths to identify opportunities for improvement and make recommendations to prevent future deaths. Potential maternal deaths are identified through a surveillance process and referred to the MMRC for follow up. During the review, the MMRC determines whether the death was directly related to the pregnancy (pregnancy-related) or not (pregnancy-associated but not related).

Key Findings:

- For the period 2017-2019, 93 potential maternal deaths were reviewed by the MMRC.
- 40 (43.0%) of the maternal deaths were determined by the MMRC to be directly related to the pregnancy.
- The maternal mortality ratio was 36.0 maternal deaths per 100,000 live births.
- Black, non-Hispanic women had a maternal mortality rate 4 times higher than White, non-Hispanic women (65.1 vs. 16.2) for the period.
- The maternal mortality ratio was highest in the 30-34 and 35-44 age groups (61.1 and 79.3, respectively).
- 57.5% of the maternal deaths occurred during pregnancy or within the first 60 days after delivery while 42.5% occurred more than 60 days but less than one year after delivery.
- Of the maternal deaths, 55% of women began prenatal care in the first trimester and an additional 20% began care in the second trimester.
- The majority of maternal deaths among Black, non-Hispanic mothers were due to cardiovascular conditions and cardiomyopathy while deaths among White, non-Hispanic mothers were distributed evenly among cardiovascular conditions, embolism, and cerebrovascular accidents.

Key Recommendations:

For State Leaders:

- Policy makers should improve access to healthy environments, healthy food, and establish goals to improve overall health for neighborhoods with high prevalence of chronic disease and obesity, which contribute to cardiovascular conditions.
- Mississippi should make efforts to ensure insurance coverage before pregnancy and ensure patients receive options for ongoing insurance beyond the one-year postpartum period. The State of Mississippi should extend Medicaid coverage from 60 days postpartum to at least one year.
- Mental health services should be broad to tailor to various cultures, age groups, locations and conditions. If local in-person access is not available, access should be expanded by phone and telehealth.

For Hospitals:

- Standardized treatment systems for severe maternal hypertension and peripartum cardiovascular conditions should be standardized for all OB units and Emergency Departments.
- Hospital facilities should train all team members in maternal early warning signs with a clear chain of command for escalating concerns. Treatment algorithms for the management of symptoms such as shortness of breath in a high-risk postpartum patient should be included in hospital training and protocols.
- A coordinated response system is needed from the point of the 911 call about the fastest method of transport, the closest capable location, and needed expertise to support local providers.

For Providers:

- Perinatal social services should be seamlessly integrated in with clinical care in order to, facilitate complex medical and social care coordination, provide psychosocial support and minimize multiple referrals and additional visits for patients to obtain psychosocial support. A perinatal social worker could be embedded within clinical practices and hospitals and facilitate care coordination as well as provide at home support.
- Medical providers should be aware of how dismissal of patient concerns is more common in women and people of color leading to higher rates of misdiagnosis and undertreatment of conditions.
- All clinicians caring for pregnant and postpartum people or addressing cardiopulmonary concerns in a pregnant or postpartum person should have completed education on peripartum cardiomyopathy, its symptoms, diagnosis, and treatment within the last five years.

For Mothers:

- Expectant mothers should be educated on the warning signs for obstetric complications including postpartum depression and make a follow up plan with medical providers for where to go and what to do if a postpartum complication arises.

Introduction

The Mississippi Maternal Mortality Review Committee (MMRC) was established in 2017 following passage of House Bill 494, which required the formal review of maternal deaths in Mississippi and secured protections for the confidentiality of the process. The MMRC was developed with guidance from the Centers for Disease Control and Prevention (CDC) Division of Reproductive Health and modeled after well-established review committees in the United States. The committee includes representation from a broad range of physicians and nurses from multiple specialties (Obstetrics & Gynecology, Cardiology, Pulmonary Medicine, Anesthesiology, Maternal-Fetal Medicine, Public Health) along with other health professionals who extensively review maternal deaths to identify opportunities for prevention. This report provides a description of the MMRC review process, statistics and findings from the MMRC, and recommendations for state leaders, hospitals, medical providers, patients, families, and communities.

Mississippi defines “pregnancy-associated death” according to the CDC Pregnancy Mortality Surveillance System (PMSS), which includes deaths that occur during pregnancy and the first 365 days following the end of pregnancy. A “pregnancy-related death” refers to maternal deaths directly related to or aggravated by pregnancy or its management. ‘Maternal’ refers to women during pregnancy, childbirth, and the postpartum period. For this report, deaths up to one year after the end of pregnancy are included. This report summarizes pregnancy-associated deaths that occurred in Mississippi in the years 2017, 2018, and 2019.

To identify pregnancy-related and associated deaths, potential maternal deaths are first identified. Potential maternal deaths include any death certificate with an indication of pregnancy at or within one year of death, or matching a birth or fetal death certificate within one year of death, or with an underlying obstetric or pregnancy-related ICD-10 underlying cause of death code of A34, O00-O95, O98-O99.

Each identified death certificate is evaluated for possible errors including erroneous pregnancy check box selection. Maternal deaths that are determined to not be pregnancy-associated are excluded from review. After all pregnancy-associated deaths are identified, records pertinent to the pregnancy and maternal death are abstracted. Relevant records for review include prenatal records, hospital and emergency room records, coroner and autopsy reports, law enforcement reports, news reports and obituaries.

The Mississippi Maternal Mortality Review Committee uses the procedures from the CDC Maternal Mortality Review Committee Decision Form to guide its evaluation of all deaths at committee meetings. In the maternal mortality review process, the committee seeks to answer 5 specific questions during the review process:

1. What was the cause of death?
2. Was the death “pregnancy-related”?
3. Was there a chance for providers to alter the outcome or was the death not preventable?
4. What were the contributing factors to the death?
5. What are the recommendations for the contributing factors?

For the 2017-2019 maternal deaths for which medical records were available for review, the committee attempted to determine if the death was preventable and if there was some or a strong chance to alter the outcome. For the pregnancy-related deaths which are considered preventable, the committee reviewed the contributing factors of the death. Recommendations were then generated for dissemination to providers and the public with the objective of lessening maternal morbidity and mortality within our state.

Overview of Pregnancy-Related and Pregnancy-Associated Deaths

Total pregnancy-related and pregnancy-associated deaths determined by the MMRC

A total of 93 deaths occurring between 2017 and 2019 were reviewed by the MMRC (Table 1). Forty deaths (43.0%) were determined to be pregnancy-related, 44 deaths (43.7%) were pregnancy-associated but not related, and 9 deaths (9.7%) were determined to be pregnancy-associated but their relatedness could not be determined. The pregnancy-related mortality ratio for the 2017-2019 period was 36.0 deaths per 100,000 live births.

Table 1: Pregnancy-related and associated deaths determined by the MMRC by year of death, 2017-2019

Year of death	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total	Births
	Count	Ratio ¹	Count	Ratio ¹	Count	Ratio ¹		
2017	11	29.4	15	40.1	2	5.4	28	37,370
2018	14	37.8	22	59.4	2	5.4	38	37,009
2019	15	40.9	7	19.1	5	13.6	27	36,634
Total	40	36.0	44	39.6	9	8.1	93	111,013

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Maternal race and age

A total of 60 maternal deaths were reviewed for Black, non-Hispanic mothers (Table 2). Black, non-Hispanic deaths accounted for 31 of the 40 pregnancy-related deaths (77.5%). The pregnancy-related mortality ratio for Black, non-Hispanic women was 65.1 deaths per 100,000 live births. Black, non-Hispanic deaths accounted for 23 of the 44 pregnancy-associated but not related deaths (52.3%).

A total of 32 maternal deaths were reviewed for White, non-Hispanic mothers (Table 2). White, non-Hispanic deaths accounted for 9 of the 40 pregnancy-related deaths (22.5%). The pregnancy-related mortality ratio for White, non-Hispanic women was 16.2 deaths per 100,000 live births. White, non-Hispanic deaths accounted for 20 of the 44 pregnancy-associated but not related deaths (45.5%). Overall, the mortality ratio was four times higher among Black, non-Hispanic women than among White, non-Hispanic women. In comparison to national reported mortality ratios in 2016-2018 (Figure 1), the Black, non-Hispanic ratio was 41.4, and the White, non-Hispanic ratio was 13.7. The pregnancy-related mortality ratio for Black, non-Hispanic women in Mississippi increased by 25.4% between the periods 2013-2016 and 2017-2019 (Figure 1). The pregnancy-related mortality ratio for White, non-Hispanic women decreased by 14.3%, and the overall state maternal mortality ratio increased by 8.8% (33.1 to 36.0) for the same period.

Of the 40 pregnancy-related deaths, 14 deaths occurred among women between the ages of 30-34 (35.0%), 11 deaths occurred among women between the ages of 25-29 (27.5%), and 9 deaths occurred among women between the ages of 35-44 (22.5%) (Table 3).

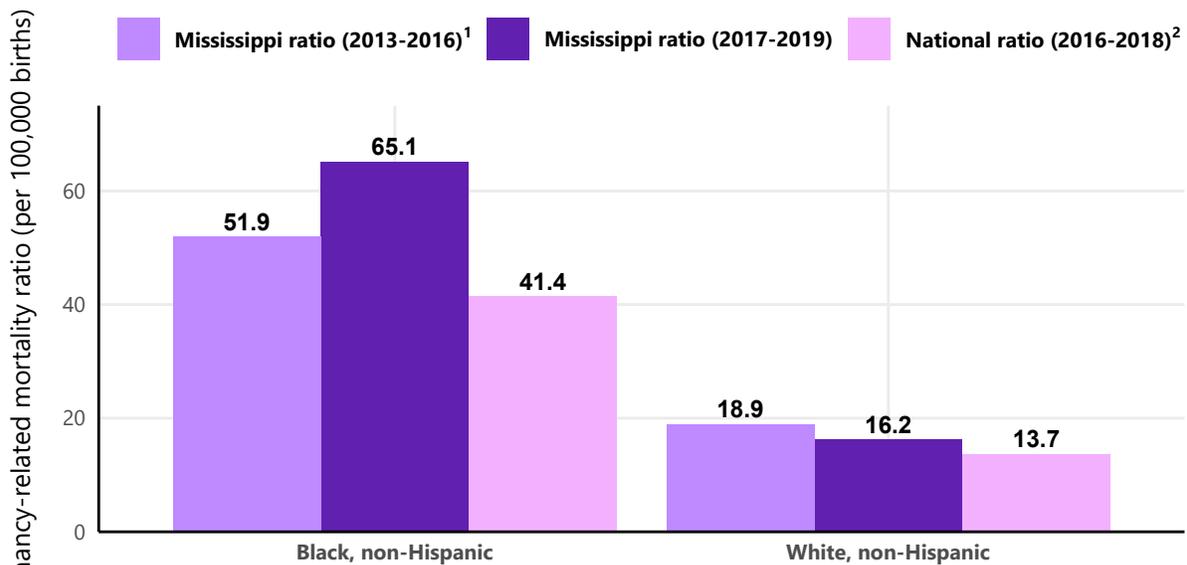
Table 2: Pregnancy-related and associated deaths by race/ethnicity, 2017-2019

Race/ethnicity	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total	Births
	Count	Ratio ¹	Count	Ratio ¹	Count	Ratio ¹		
Black, non-Hisp.	31	65.1	23	48.3	6	12.6	60	47,587
White, non-Hisp.	9	16.2	20	36.0	3	5.4	32	55,514
Other, non-Hisp.	0	0.0	0	0.0	0	0.0	0	2,890
Hispanic ²	0	0.0	1	19.9	0	0.0	1	5,022
Total	40	36.0	44	39.6	9	8.1	93	111,013

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

² Hispanic race/ethnicity includes Black, White, and other races

Figure 1: Pregnancy-related mortality ratio by race/ethnicity, comparison of Mississippi and national ratios



¹Mississippi State Department of Health, Mississippi Maternal Mortality Report 2013-2016. https://msdh.ms.gov/msdhsite/index.cfm/31,8127,299,pdf/MS_Maternal_Mortality_Report_2019_Final.pdf

²CDC Pregnancy Mortality Surveillance System (PMSS) Pregnancy-Related Mortality Ratio by Race/Ethnicity: 2016-2018 <https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.htm>

Table 3: Pregnancy-related and associated deaths by age, 2017-2019

Age (in years)	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Deaths	Births
	Count	Ratio ¹	Count	Ratio ¹	Count	Ratio ¹		
<20	1	11.2	5	55.9	0	0.0	6	8,944
20-24	5	15.5	12	37.2	3	9.3	20	32,275
25-29	11	31.0	9	25.4	4	11.3	24	35,453
30-34	14	61.1	11	48.0	0	0.0	25	22,906
35-44	9	79.3	6	52.9	2	17.6	17	11,348
45+	0	0.0	1	1,149.4	0	0.0	1	87
Total	40	36.0	44	39.6	9	8.1	93	111,013

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Timing of maternal death and pregnancy

The total number of maternal deaths are summarized below using pregnancy status time periods within 42 days and 60 days (Tables 4 and 5). Death certificates collect pregnancy information according to the 42 day time period. The 60 day time period was also included to show the potential influence of Medicaid status within 60 days postpartum. Of the 40 pregnancy-related deaths, 21 deaths (52.5%) occurred among women that were pregnant 43 days to 1 year before death (Table 4). Eleven deaths (27.5%) occurred among women that were pregnant within 42 days of deaths, and 8 deaths (20%) occurred among women that were pregnant at the time of death. Of the 44 pregnancy-associated not related deaths, 31 deaths (70.5%) occurred among women that were pregnant 43 days to 1 year before death. Two deaths (4.5%) occurred among women that were pregnant within 42 days of deaths, and 10 deaths (22.7%) occurred among women that were pregnant at the time of death.

For pregnancy-related deaths, 15 deaths (37.5%) occurred among women pregnant within 60 days of death, and 17 deaths (42.5%) occurred among women pregnant 61 days to 1 year before death (Table 5). Of pregnancy-associated not related deaths, 3 deaths (6.8%) occurred among women pregnant within 60 days of death, and 25 deaths (56.8%) occurred among women pregnant 61 days to 1 year of death.

Table 4: Pregnancy-related and associated deaths by pregnancy status within 42 days of death (death certificate time period), 2017-2019

Pregnancy status	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total
	Count	%	Count	%	Count	%	
Pregnant at the time of death	8	20.0	10	22.7	4	44.4	22
Pregnant within 42 days of death	11	27.5	2	4.5	1	11.1	14
Pregnant 43 days to 1 year before death	21	52.5	31	70.5	4	44.4	56
Unknown	0	0.0	1	2.3	0	0.0	1
Total	40	100.0	44	100.0	9	100.0	93

Table 5: Pregnancy-related and associated deaths by pregnancy status within 60 days of death (potential Medicaid coverage), 2017-2019

Pregnancy status (within 60 days)	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total
	Count	%	Count	%	Count	%	
Pregnant at the time of death	8	20.0	10	22.7	4	44.4	22
Pregnant within 60 days of death	15	37.5	3	6.8	2	22.2	20
Pregnant 61 days to 1 year before death	17	42.5	25	56.8	3	33.3	45
Unknown	0	0.0	6	13.6	0	0.0	6
Total	40	100.0	44	100.0	9	100.0	93

Type of delivery

Of pregnancy-related deaths, 8 deaths (20.0%) occurred among women with vaginal deliveries, 11 deaths (27.5%) occurred among women with primary cesarean deliveries, 8 deaths (20.0%) occurred among women with repeat cesarean deliveries, 8 deaths (20.0%) occurred among women with fetal deaths, and 5 deaths (12.5%) occurred among women with either no delivery or unavailable delivery information (Table 6).

Of pregnancy-associated not related deaths, 18 deaths (40.9%) occurred among women with vaginal deliveries, 5 deaths (11.4%) occurred among women with primary cesarean deliveries, 4 deaths (9.1%) occurred among women with repeat cesarean deliveries, 2 deaths (4.5%) occurred among women with fetal deaths, and 15 deaths (34.1%) occurred among women with either no delivery or unavailable delivery information.

Table 6: Pregnancy-related and associated deaths by delivery type, 2017-2019

Delivery type	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total
	Count	%	Count	%	Count	%	
Vaginal	8	20.0	18	40.9	2	22.2	28
Cesarean, primary	11	27.5	5	11.4	2	22.2	18
Cesarean, repeat	8	20.0	4	9.1	1	11.1	13
Fetal death	8	20.0	2	4.5	1	11.1	11
No delivery/unavailable	5	12.5	15	34.1	3	33.3	23
Total	40	100.0	44	100.0	9	100.0	93

Location of death

Among pregnancy-related deaths, 16 deaths (40%) occurred in an inpatient hospital setting, and 12 deaths (30%) occurred in an outpatient/ER hospital setting (Table 7). Five deaths (12.5%) occurred at the home/residence of the decedent, and 7 deaths (17.5%) occurred in a location other than a hospital or residence.

Among pregnancy-associated not related deaths, 5 deaths (11.4%) occurred in an inpatient hospital setting, and 7 deaths (15.9%) occurred in an outpatient/ER hospital setting. Ten deaths (22.7%) occurred at the home/residence of the decedent, and 22 deaths (50.0%) occurred in a location other than a hospital or residence.

Table 7: Pregnancy-related and associated deaths by type of place of death, 2017-2019

Type of place of death	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total
	Count	%	Count	%	Count	%	
Hospital inpatient	16	40.0	5	11.4	1	11.1	22
Hospital outpatient/ER	12	30.0	7	15.9	4	44.4	23
Home/residence	5	12.5	10	22.7	2	22.2	17
Other	7	17.5	22	50.0	2	22.2	31
Total	40	100.0	44	100.0	9	100.0	93

Timing of prenatal care

Of the pregnancy-related deaths, 22 deaths (55.0%) occurred among women who began prenatal care in the first trimester, 8 deaths (20%) occurred among women beginning prenatal care in the second trimester, and 2 deaths (5.0%) occurred among women beginning care in the third trimester (Table 8). One death (2.5%) occurred with no prenatal care, and 7 deaths (17.5%) have an unknown start of prenatal care.

Of the pregnancy-associated not related deaths, 16 deaths (36.4%) occurred among women beginning prenatal care in the first trimester, 5 deaths (11.4%) occurred among women beginning prenatal care in the

second trimester, and 5 deaths (11.4%) occurred among women beginning care in the third trimester. Three deaths (6.8%) occurred among women with no prenatal care, and 15 deaths (34.1%) have an unknown start of prenatal care.

Table 8: Pregnancy-related and associated deaths by when prenatal care began, 2017-2019

Trimester of prenatal care beginning	Pregnancy-related		Pregnancy-associated, not related		Pregnancy-associated, unable to determine relatedness		Total
	Count	%	Count	%	Count	%	
First trimester	22	55.0	16	36.4	2	22.2	40
Second trimester	8	20.0	5	11.4	2	22.2	15
Third trimester	2	5.0	5	11.4	0	0.0	7
No prenatal care	1	2.5	3	6.8	0	0.0	4
Unknown	7	17.5	15	34.1	5	55.6	27
Total	40	100.0	44	100.0	9	100.0	93

Medicaid status

To determine the number of mothers that were Medicaid recipients within the timing of their delivery, Medicaid recipient files were matched to vital records mortality data. Recipient files were also matched to live births to calculate Medicaid birth counts for maternal mortality ratios.

Of the 40 pregnancy-related deaths between 2017 and 2019, 33 deaths (82.5%) were Medicaid recipients (Table 9). Of the 44 pregnancy-associated not related deaths, 29 deaths (65.9%) were Medicaid recipients.

Table 9: Pregnancy-related and associated deaths by Medicaid status, 2017-2019

Payer	Pregnancy-related			Pregnancy-associated, not related			Pregnancy-associated, unable to determine relatedness			Total	Births ²
	Count	Ratio ¹	%	Count	Ratio ¹	%	Count	Ratio ¹	%		
Medicaid	33	43.7	82.5	29	38.4	65.9	8	10.6	88.9	70	75,530
Other	7	19.7	17.5	15	42.3	34.1	1	2.8	11.1	23	35,483
Total	40	63.4	100.0	44	80.7	100.0	9	13.4	100.0	93	111,013

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

² Birth counts by Medicaid status may be different than national sources due to the use of record matching

Of the 33 pregnancy-related deaths that were also Medicaid recipients, 15 women (45.5%) were pregnant 61 days to 1 year before their death, 13 women (39.4%) were pregnant within 60 days of death, and 5 women (15.2%) were pregnant at the time of their death (Table 10).

Among the 17 women with pregnancy-related deaths who were pregnant 61 days to 1 year before death (Table 11), 15 women (88.2%) were Medicaid recipients and 2 women (11.8%) used other payment sources. Of women with pregnancy-related deaths who were pregnant within 60 days of death, 13 women (86.7%) were Medicaid recipients and 2 women (13.3%) used other payment sources. Among women with

pregnancy-related deaths who were pregnant at the time of death, 5 women (62.5%) were Medicaid recipients and 3 women (37.5%) used other payment sources.

Table 10: Pregnancy-related deaths by Medicaid status within potential delivery time and pregnancy timing within 60 days, 2017-2019

Pregnancy status (within 60 days)	Medicaid		Other payer		Total
	Count	%	Count	%	
Pregnant at the time of death	5	15.2	3	42.9	8
Pregnant within 60 days of death	13	39.4	2	28.6	15
Pregnant 61 days to 1 year before death	15	45.5	2	28.6	17
Total	33	100.0	7	100.0	40

Table 11: Pregnancy-related deaths by pregnancy timing within 60 days and Medicaid status within potential delivery time, 2017-2019

Payer	Pregnant at the time of death		Pregnant within 60 days of death		Pregnant 61 days to 1 year before death		Total
	Count	%	Count	%	Count	%	
Medicaid	5	62.5	13	86.7	15	88.2	33
Other	3	37.5	2	13.3	2	11.8	7
Total	8	100.0	15	100.0	17	100.0	40

Causes of Death, Pregnancy-Related and Pregnancy-Associated

Pregnancy-related deaths were aggregated based on the assigned Pregnancy Mortality Surveillance System (PMSS) maternal mortality cause of death list, or PMSS-MM codes. The PMSS-MM codes were developed by CDC and the American College of Obstetricians and Gynecologists (ACOG) Maternal Mortality Study Group classifying pregnancy-related deaths.

Pregnancy-associated not related deaths were not assigned PMSS-MM codes, and these deaths were aggregated using the CDC National Center for Health Statistics (NCHS) list of 50 rankable causes of death derived from the NCHS list of 113 Selected Causes of Death.

Pregnancy-related causes of death determined by the MMRC

Of the 40 pregnancy-related deaths, cardiovascular conditions (excluding cardiomyopathy, HDP, and CVA) were the most common underlying cause, accounting for 9 deaths (22.5%) and a mortality ratio of 8.1 deaths per 100,000 births (Table 12). Cardiomyopathy accounted for 8 deaths (20.0%), embolisms accounted for 5 deaths (12.5%), cerebrovascular accidents accounted for 4 deaths (10.0%), and hemorrhage (excluding aneurysms and CVA) accounted for 3 deaths (7.5%). Three deaths (7.5%) had an unknown cause of death.

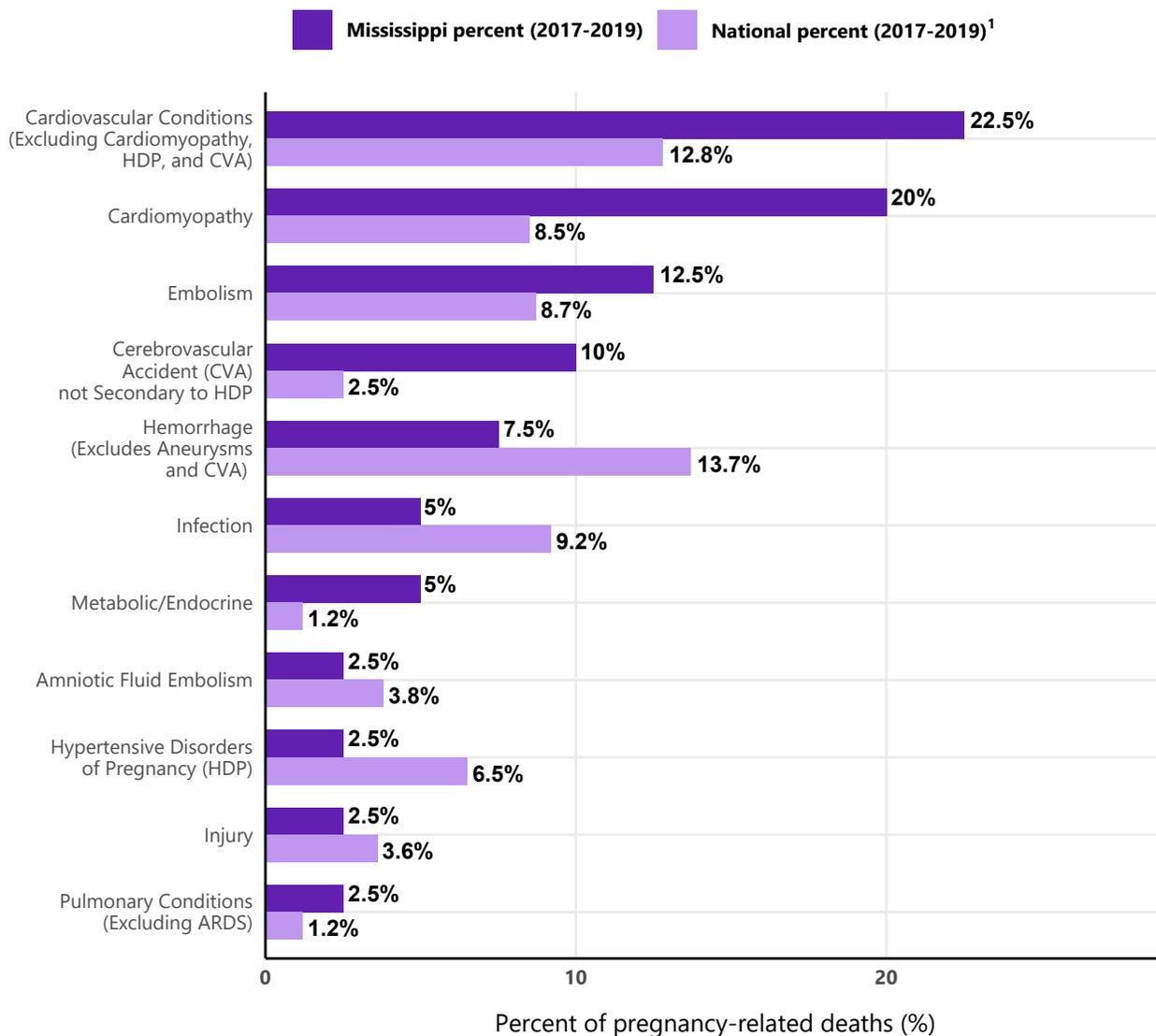
Table 12: Pregnancy-related deaths by cause of death (PMSS-MM) determined by the MMRC, 2017-2019

Cause (Pregnancy-related)	Pregnancy-related		
	Count	%	Ratio ¹
Cardiovascular Conditions (Excluding Cardiomyopathy, HDP, and CVA)	9	22.5	8.1
Cardiomyopathy	8	20.0	7.2
Embolism	5	12.5	4.5
Cerebrovascular Accident (CVA) not Secondary to HDP	4	10.0	3.6
Hemorrhage (Excludes Aneurysms and CVA)	3	7.5	2.7
Unknown Cause of Death	3	7.5	2.7
Infection	2	5.0	1.8
Metabolic/Endocrine	2	5.0	1.8
Amniotic Fluid Embolism	1	2.5	0.9
Hypertensive Disorders of Pregnancy (HDP)	1	2.5	0.9
Injury	1	2.5	0.9
Pulmonary Conditions (Excluding ARDS)	1	2.5	0.9
Total	40	100.0	36.0

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Comparing the percentages of causes of pregnancy-related deaths in Mississippi to reported percentages for the rest of the nation in 2017-2019 (Figure 2), cardiovascular conditions (excluding cardiomyopathy, HDP, and CVA) accounted for 12.8% of pregnancy-related deaths compared to 22.5% for Mississippi. Cardiomyopathy accounted for 8.5% of deaths (20% in Mississippi), embolism accounted for 8.7% of deaths (12.5% in Mississippi), cerebrovascular accidents accounted for 2.5% of deaths (2.5% in Mississippi), and hemorrhage accounted for 13.7% of deaths (7.5% in Mississippi).

Figure 2: Percent of pregnancy-related deaths by cause of death (PMSS-MM), comparison of Mississippi and national percentages



¹National percentages retrieved from CDC ERASE, Pregnancy-Related Deaths: Data from Maternal Mortality Review Committees in 36 US States, 2017-2019 <https://www.cdc.gov/reproductivehealth/maternal-mortality/erase-mm/data-mmrc.html>

Pregnancy-associated causes of death

Of the 53 pregnancy-associated not related deaths (including those unable to determine relatedness), 26 deaths (49.1%) were due to accidents (Table 13). As the leading cause of death for pregnancy associated deaths, accidents accounted for a mortality ratio of 23.4 maternal deaths per 100,000 births. Of the accidental deaths, 20 deaths were due to motor vehicle accidents (76.9% of accidents), 3 deaths were due to drug overdose (11.5% of accidents), and 2 deaths were due to accidental exposure to smoke, fire, and flames (7.7% of accidents) (Table 14).

Of the other pregnancy-associated not related deaths, homicide accounted for 11 deaths (20.8%). Ill-defined conditions accounted for 8 deaths (15.1%), 2 deaths (3.8%) were due to cancer/malignant neoplasms, and 2 deaths (3.8%) were due to suicide.

Table 13: Pregnancy-associated deaths by cause of death groups (NCHS 50 rankable causes), 2017-2019

Cause (pregnancy-associated, not related or unable to determine)	Pregnancy-associated		
	Count	%	Ratio ¹
Accidents	26	49.1	23.4
Homicide	11	20.8	9.9
Symptoms, Signs, Ill-Defined Conditions	8	15.1	7.2
All other	3	5.7	2.7
Malignant Neoplasms	2	3.8	1.8
Suicide	2	3.8	1.8
Heart Diseases	1	1.9	0.9
Total	53	100.0	47.7

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Table 14: Pregnancy-associated deaths by specific accident cause groups, 2017-2019

Specific accidental cause	Pregnancy-associated, accidental deaths		
	Count	%	Ratio ¹
Motor Vehicle Accidents	20	76.9	18.0
Drug Overdose	3	11.5	2.7
Accidental exposure to smoke, fire and flames	2	7.7	1.8
Other Accidents	1	3.8	0.9
Total	26	100.0	23.4

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Pregnancy-Related Maternal Mortality Causes and Characteristics

Pregnancy-related deaths are the primary focus of the MMRC. Additionally, the MMRC aims to better understand the characteristics of those deaths based on the information available from MMRC abstraction. The tables below include further tabulations of pregnancy-related deaths by race/ethnicity, age, and causes of death (PMSS-MM).

Pregnancy-related deaths by race/ethnicity and age

Of the 31 Black, non-Hispanic pregnancy-related deaths between 2017 and 2019, 10 deaths (32.3%) occurred among women ages 25-29 (Table 15). In comparison, White, non-Hispanic women had only 1 death (11.1%) occurring among this age group. Eight deaths (25.8%) occurred among Black, non-Hispanic women ages 30-34, and 8 deaths (25.8%) occurred among women ages 35-44. The mortality ratio among Black, non-Hispanic women was highest among age-groups 30-34 and 35-44, with 101.5 deaths and 188.0 deaths per 100,000 Black, non-Hispanic births, respectively. The highest mortality ratio among White, non-Hispanic women was in ages 30-34 with 45.9 deaths per 100,000 White, non-Hispanic births.

Table 15: Pregnancy-related deaths by age and race, 2017-2019

Age (in years)	Black, non-Hispanic				White, non-Hispanic				Total
	Count	%	Ratio ¹	Births	Count	%	Ratio ¹	Births	
<20	1	3.2	21.5	4,656	0	0.0	0.0	3,649	1
20-24	4	12.9	24.9	16,081	1	11.1	7.0	14,313	5
25-29	10	32.3	68.1	14,687	1	11.1	5.4	18,517	11
30-34	8	25.8	101.5	7,881	6	66.7	45.9	13,079	14
35-44	8	25.8	188.0	4,255	1	11.1	16.9	5,908	9
45+	0	0.0	0.0	27	0	0.0	0.0	48	0
Total	31	100.0	65.1	47,587	9	100.0	16.2	55,514	40

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Cause of death (PMSS-MM) by race/ethnicity

Of the 31 Black, non-Hispanic pregnancy-related deaths, 8 deaths (25.8%) were due to cardiomyopathy, 7 deaths (22.6%) were due to cardiovascular conditions (excluding cardiomyopathy, HDP and CVA), 3 deaths (9.7%) were due to embolism, and 3 deaths (9.7%) were due to hemorrhage (Table 16). In comparison to White, non-Hispanic deaths, 0 deaths (0.0%) were due to cardiomyopathy, 2 deaths (22.2%) were due to cardiovascular conditions (excluding cardiomyopathy, HDP and CVA), 2 deaths (22.2%) were due to embolism, and 0 deaths (0.0%) were due to hemorrhage.

Table 16: Pregnancy-related deaths by race and cause of death (PMSS-MM) determined by the MMRC, 2017-2019

Cause of death	Black, non-Hispanic			White, non-Hispanic			Deaths
	Count	%	Ratio ¹	Count	%	Ratio ¹	
Cardiovascular Conditions (Excluding Cardiomyopathy, HDP, and CVA)	7	22.6	14.7	2	22.2	3.6	9
Cardiomyopathy	8	25.8	16.8	0	0.0	0.0	8
Embolism	3	9.7	6.3	2	22.2	3.6	5
Cerebrovascular Accident (CVA) not Secondary to HDP	2	6.5	4.2	2	22.2	3.6	4
Hemorrhage (Excludes Aneurysms and CVA)	3	9.7	6.3	0	0.0	0.0	3
Unknown Cause of Death	2	6.5	4.2	1	11.1	1.8	3
Infection	1	3.2	2.1	1	11.1	1.8	2
Metabolic/Endocrine	1	3.2	2.1	1	11.1	1.8	2
Amniotic Fluid Embolism	1	3.2	2.1	0	0.0	0.0	1
Hypertensive Disorders of Pregnancy (HDP)	1	3.2	2.1	0	0.0	0.0	1
Injury	1	3.2	2.1	0	0.0	0.0	1
Pulmonary Conditions (Excluding ARDS)	1	3.2	2.1	0	0.0	0.0	1
Total	31	100.0	65.1	9	100.0	16.2	40

¹ Maternal mortality ratios calculated as deaths per 100,000 live births

Cause of death (PMSS-MM) by age

Of the 14 pregnancy-related deaths among women ages 30-34, 3 deaths (21.4%) were due to cardiovascular conditions (excluding cardiomyopathy, HDP, and CVA) and 3 deaths (21.4%) were due to embolism (Table 17). Two deaths (14.3%) were due to cerebrovascular accidents, 2 deaths (14.3%) were due to hemorrhage, 2 deaths (14.3%) were due to metabolic/endocrine causes, and 2 deaths (14.3%) had an unknown cause of death.

Of the 11 pregnancy-related deaths among women ages 25-29, 5 deaths (45.5%) were due to cardiomyopathy, 1 death (9.1%) was due to cardiovascular conditions (excluding cardiomyopathy, HDP, and CVA), and 2 deaths (21.4%) were due to cerebrovascular accidents.

Table 17: Pregnancy-related deaths by age and cause of death (PMSS-MM), 2017-2019

Cause of death	<20		20-24		25-29		30-34		35-44		Total
	Count	%	Count	%	Count	%	Count	%	Count	%	
Cardiovascular Conditions (Excluding Cardiomyopathy, HDP, and CVA)	0	0.0	0	0.0	1	9.1	3	21.4	5	55.6	9
Cardiomyopathy	0	0.0	2	40.0	5	45.5	0	0.0	1	11.1	8
Embolism	0	0.0	1	20.0	0	0.0	3	21.4	1	11.1	5
Cerebrovascular Accident (CVA) not Secondary to HDP	0	0.0	0	0.0	2	18.2	2	14.3	0	0.0	4
Hemorrhage (Excludes Aneurysms and CVA)	0	0.0	0	0.0	1	9.1	2	14.3	0	0.0	3
Unknown Cause of Death	0	0.0	0	0.0	0	0.0	2	14.3	1	11.1	3
Infection	1	100.0	1	20.0	0	0.0	0	0.0	0	0.0	2
Metabolic/Endocrine	0	0.0	0	0.0	0	0.0	2	14.3	0	0.0	2
Amniotic Fluid Embolism	0	0.0	0	0.0	0	0.0	0	0.0	1	11.1	1
Hypertensive Disorders of Pregnancy (HDP)	0	0.0	0	0.0	1	9.1	0	0.0	0	0.0	1
Injury	0	0.0	1	20.0	0	0.0	0	0.0	0	0.0	1
Pulmonary Conditions (Excluding ARDS)	0	0.0	0	0.0	1	9.1	0	0.0	0	0.0	1
Total	1	100.0	5	100.0	11	100.0	14	100.0	9	100.0	40

Preventability determination by the MMRC

Of the 40 pregnancy-related deaths reviewed by the MMRC, 35 deaths (87.5%) were determined by the committee to be preventable and 4 deaths (10.0%) were determined to not be preventable (Table 18). The preventability of one death (2.5%) was undetermined.

Of the 21 pregnancy-related deaths that occurred among women who were pregnant 43 days to 1 year before death, 18 deaths (85.7%) were determined to be preventable (Table 19). Of the 11 pregnancy-related deaths that occurred among women who were pregnant within 42 days of death, 10 deaths (90.9%) were determined to be preventable.

Table 18: Pregnancy-related deaths by preventability determination of the MMRC, 2017-2019

Preventability	Count	%
Preventable	35	87.5
Not preventable	4	10.0
Undetermined	1	2.5
Total	40	100.0

Table 19: Pregnancy-related deaths by pregnancy timing within 42 days and preventability determination of the MMRC

Preventability	Pregnant at the time of death		Pregnant within 42 days of death		Pregnant 43 days to 1 year before death		Total
	Count	%	Count	%	Count	%	
Preventable	7	87.5	10	90.9	18	85.7	35
Not preventable	1	12.5	1	9.1	2	9.5	4
Undetermined	0	0.0	0	0.0	1	4.8	1
Total	8	100.0	11	100.0	21	100.0	40

Table 20: Pregnancy-related deaths by pregnancy timing within 60 days and preventability determination of the MMRC

Preventability	Pregnant at the time of death		Pregnant within 60 days of death		Pregnant 61 days to 1 year before death		Total
	Count	%	Count	%	Count	%	
Preventable	7	87.5	14	93.3	14	82.4	35
Not preventable	1	12.5	1	6.7	2	11.8	4
Undetermined	0	0.0	0	0.0	1	5.9	1
Total	8	100.0	15	100.0	17	100.0	40

Of the 17 pregnancy-related deaths that occurred among women who were pregnant 61 days to 1 year before death, 14 deaths (82.4%) were determined to be preventable (Table 20). Of the 15 pregnancy-related deaths that occurred among women who were pregnant within 60 days of death, 14 deaths (93.3%) were determined to be preventable. The contributing factors of these deaths and discussions surrounding their preventability informed the following committee recommendations.

Maternal Mortality Review Committee Member Recommendations

Preventive treatment and care

- Mississippi should invest in health systems to correct for disproportionate burden of untreated chronic medical disease including obesity, heart disease and hypertension. Lack of access, insurance, healthy food, and emphasis on health throughout the life course leads to poor health and increased risk of death. This is a long-term preventive strategy that requires comprehensive health system change including Medicaid expansion, support of local health centers, increased primary care, and access to healthy food supply in poor and rural areas.
- Improvement in pre-pregnancy and postpartum health care and health maintenance is necessary. This requires addressing social factors that lead to poor health in the reproductive age population including food deserts, lack of education on health and access to healthy food and safe environments for physical activity, over-representation of fast food in poor and Black neighborhoods, and policies limiting medical care during pregnancy.
- Financial and personal stressors should be recognized medical risk factors for hypertension and poor birth outcomes. Patients should be screened for social stressors and provided resources during pregnancy.
- Patients with conditions where pregnancy would be life-threatening should be provided comprehensive contraceptive care counseling and follow-up opportunities. Medical providers outside of women's health that are caring for patients with such conditions should include a contraceptive care plan as part of their care for the patient.

Insurance

- State leaders can facilitate early initiation in prenatal care by implementing presumed eligibility for Medicaid or expanding Medicaid such that people enter pregnancy with necessary insurance and primary care.
- The State of Mississippi should extend Medicaid in the postpartum period to at least one year. Mississippi should also take efforts to ensure insurance coverage before pregnancy and ensure patients are transitioned to health exchange coverage or receive options for ongoing insurance beyond the one-year period.

Mental health

- Mental health should be assessed regularly including the capacity to cope with new and ongoing diagnoses and medical care. Patients with complex mental health conditions may face challenges adhering to treatment plans, keeping appointments or follow-up visits. Obstetric practices should integrate multi-level mental health assessments beyond depression and psychosis to include assessments of stress, coping and trauma.
- Health systems, Medicaid and medical providers should integrate mental health and substance use assessment and referrals to care in prenatal care.

- Mental health services should be broad to tailor to various cultures, age groups, locations and conditions. If local in-person access is not available, access should be expanded by phone and telehealth.

Substance use

- The Mississippi State Department of Mental Health and other agencies specializing in the care of substance use disorders should provide accessible resource lists for services needed by pregnant people with substance use disorders including mental health treatment, substance use treatment, inpatient and outpatient therapy, housing, food, domestic violence and sex trafficking resources, childcare and legal services.
- Ensure that all insurance programs cover substance use disorder treatment especially during and after pregnancy.

Patient care and education

- Patients with medical conditions that have very high mortality rates during pregnancy should receive preconception counseling and education about the risks of pregnancy at the time of diagnosis.
- The public should receive information about the location of health services, the closing of hospitals and how to access emergency care in local areas. State agencies and organizations should work together to assist the public in knowing when, how and where to access emergency medical services in rural areas.
- Home blood pressure monitoring systems should be integrated into clinical care so pregnant and postpartum patients may monitor blood pressures at home and have access to receptive response systems if blood pressures exceed normal ranges.
- Patients with life-threatening conditions should be educated and empowered when, where and how to seek medical attention quickly and have access to their specialists to assess early symptoms. Texting services, 24/7 hot lines, and other systems to facilitate rapid patient communication of concerns and symptoms should be considered.
- All patients with complex medical diagnoses during pregnancy and delivery should be assigned a care coordinator from the hospital or insurance payer that will remain a resource to the patient through 1 year postpartum or until the resolution of the medical condition and assist with coordinating appointments, identifying gaps in care, facilitating the transfer of records and that patient has adequate access to appointments. The care coordinator should work with the patient, medical providers and payers to ensure gaps are closed, follow-ups are completed and identify high-risk events like emergency visits, hospital readmissions resulting in missed appointments.
- The state should ensure adequate prenatal care while in prison and transition to access when outside of prison.

Intimate partner violence

- Mississippi should invest in strengthening resources at the community level to address intimate partner violence including expanding existing programs to support victims, providing short term housing or financial assistance to assist victims with achieving safe plans of action.
- Medical providers should employ evidence-based strategies to screen for intimate partner violence and have an internal plan for how patients disclosing intimate partner violence are cared for, who they are referred to, and how they are given resources.

Firearms

- All factors leading to increased gun violence must be addressed within local communities and resources made available to eliminate the root causes of gun violence.

Facility treatment and care

- Communication should be improved between providers during handoffs using standardized forms and communication.
- Medical facilities providing care to pregnant and postpartum patients should provide to patients in writing and verbally all critical conditions, events, procedures, and treatments administered to the patient during the admission or the medical encounter. Particularly, patients should be provided information verbally and in writing at the patient's reading level and language about diagnoses (example: preeclampsia, heart failure, cardiomyopathy) and the required treatment, follow-up, and severity. There should be documentation that this information was provided to the patient including the patient's written or verbal attestation of understanding.
- Facilities should adopt a standard policy to evaluate complaints of shortness of breath in pregnant and postpartum women.
- Providers should evaluate cardiopulmonary complaints at the bedside and make use of basic imaging to rule out pulmonary edema.
- Facilities should categorize patients as higher risk, perform risk assessment for obese patients, and establish algorithms for antepartum/postpartum to determine baseline cardiac function in chronic hypertension, morbidly obese patients.
- Health systems should integrate risk assessment for cardiac disease into obstetric practice including evaluation of obstructive sleep apnea.
- Health systems should ensure that all women with severe maternal hypertension have established follow up within 72 hours and 7 days postpartum.
- Patients with long-standing hypertension and severe forms of hypertension require a higher level of obstetric and postpartum care due to their risks of perinatal complications including severe pre-eclampsia, preterm birth and morbidity and death in the postpartum period.

- All obstetric facilities should implement clear guidelines to respond to elevated blood pressures and patient symptoms reflective of pre-eclampsia and utilize a standardized treatment guideline of appropriate medications and treatment within 1 hour of documented severe range blood pressures.
- Hospital facilities should implement a post birth program to educate all postpartum women on signs and symptoms of severe hypertension and cardiovascular disease.
- Women with severe maternal hypertension with additional cardiopulmonary comorbidities should be observed and evaluated for at least 72 hours following delivery and only after complete assessment of cardiopulmonary status is complete.
- All facilities should implement hemorrhage safety bundles and complete simulation training for maternal cardiovascular collapse.
- Facilities providing obstetric care must maintain an adequate blood supply and plans for obtaining blood and managing severe hemorrhage during emergencies. Transfer to outside institutions must be considered for patients needing or at risk of needing blood transfusion.
- Anemia identified during the prenatal period should be treated along an escalating algorithm of interventions from oral iron supplementation to IV iron supplementation to blood transfusion.
- Unrelenting headache requires a thorough workup. Medical providers caring for pregnant women should complete education on the workup of persistent, recurrent and refractory headache. Hospitals should establish guidelines for imaging.
- Reports of pain for incarcerated pregnant women should be monitored with appropriate diagnostic studies and physical exams. Prison medical staff should be educated on conditions related to obstetric emergencies, and the access to medical evaluations in prison should be improved.
- Workup for underlying heart disease in long-standing chronic hypertension should include a baseline EKG and Echo during pregnancy and within 6 months postpartum.
- Patients with cardiomyopathy must have the capacity to evaluate symptoms early and as needed. Lack of access to local specialists and the need to travel long distances can lead to delays in care. Telehealth services for outpatient assessments should be readily available statewide for specialists that are centralized in urban locations.
- Mental health assessment should be part of treatment of complex obstetric conditions like peripartum cardiomyopathy or where there is 'non-compliance' or 'non-adherence' documented.
- The committee recommends that providers use the word 'non-compliance' with caution and instead describe what is happening and why " the patient does not take medications regularly due to financial constraint" is more accurate, meaningful and actionable than " the patient is non-compliant with medications."
- The committee recommends that documentation of 'non-compliance' should trigger increased rather than decreased engagement with a patient considering- racial/cultural/linguistic concordance, patient education materials used, working with a care-manager or social worker, engaging family, addressing mental health concerns including trauma.
- Enhanced support for tobacco cessation should be provided for patients with pulmonary conditions. Tobacco cessation treatment should be better integrated in obstetric care and available in community settings.

Emergency services and 911

- Emergency departments should adopt severe maternal hypertension diagnosis and management algorithms for pregnant and postpartum women.
- Standardized treatment systems for severe maternal hypertension and peripartum cardiovascular conditions should be standardized for all OB units and Emergency Departments.
- Emergency responders and obstetric providers should recognize signs of hemorrhage and pending hemodynamic instability in the pregnant patient may include altered mental status, combativeness, panic and anxiety. Any pregnant person in severe pain, distress, and altered mental status of any form should be treated as a potential medical emergency and care should be expedited.
- A coordinated response system is needed from the point of the 911 call about the fastest method of transport (auto/helicopter), the closest capable location, and the needed expertise to support local providers.
- Emergency rooms that are staffed exclusively by NPs who cannot perform emergency cesareans should have an emergency plan to cover these needs. An ER Physician, General Surgeon or OB/gyn should be available /on-call (within 30 min) for these facilities in order to respond to pregnant patients.

Facility training and education

- Training programs and professional organizations should emphasize the training and education of medical providers and nurses in the diagnosis and management of pulmonary edema, particularly in morbidly obese patients where physical exam may be limited.
- Hospital facilities should train all team members in maternal early warning signs with a clear chain of command for escalating concerns. Treatment algorithms for the management of shortness of breath in a high-risk postpartum patient should be included in hospital training and protocols.
- All medical teams should be educated on the risks of patient safety events during handoffs and implement strategies such as the use of written handoffs and team sign outs for high-risk patients. Team huddles, briefs and debriefs can be implemented within labor and delivery units to prevent gaps in communication.
- Provider education should be improved for treatment of severe maternal hypertension, including workup of CHF/cardiomyopathy in patients with shortness of breath.
- Providers should receive education on the evaluation and management of pulmonary edema in the peripartum period, including the need for diuresis, dosing and duration of therapy. Cardiology should be consulted early for women with suspected heart failure.
- Medical providers of pregnant and postpartum women in outpatient and emergency care settings should receive education and recognize the signs and symptoms of peripartum cardiomyopathy and the appropriate workup and treatment.
- Implicit bias/anti-racism training should be incorporated for all staff to learn the common ways that patients experience discrimination including dismissed pain, diagnostic lapses, failure to complete evaluations and minimizing all symptoms despite high risk factors.

- Medical providers should take concerns presented by pregnant and postpartum women related to stroke seriously and understand the risks of stroke is elevated in the peripartum period. Providers in emergency care settings should be educated about the risks of stroke in pregnant and postpartum women and the appropriate workup.
- All clinicians caring for pregnant and postpartum people or addressing cardiopulmonary concerns in a pregnant or postpartum person should have completed education (CME, Training, Workshop) on peripartum cardiomyopathy, its symptoms, diagnosis, and treatment within the last five years.
- Patients experiencing a stillbirth, particularly related to abruption are at high risk of bleeding complications and experiencing coagulopathy. Health systems should educate providers, patients and nursing staff about these risks, monitor labs and treat anemia and abnormal coagulation studies promptly.

Resources

Data & Statistics

- **Centers for Disease Control & Prevention, Pregnancy Mortality Surveillance System**
<https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.htm>
- **Centers for Disease Control & Prevention, Enhancing Reviews and Surveillance to Eliminate Maternal Mortality (ERASE MM)**
<https://www.cdc.gov/reproductivehealth/maternal-mortality/erase-mm/index.html>

Maternal Mortality Review Committees

- **Centers for Disease Control and Prevention, Division of Reproductive Health's Building US Capacity to Review and Prevent Maternal Deaths**
www.Reviewtoaction.org

Patient Safety Bundles & Toolkits

- **Council for Patient Safety in Women's Healthcare-Alliance for Innovation in Maternal Health**
www.safehealthcareforeverywoman.org
- **California Maternity Quality Care Collaborative**
www.cmqcc.org
- **Association of Women's Health, Obstetric & Neonatal Nurses – Clinical and Practical Resources**
<https://www.awhonn.org/nurse-resources/>
- **Centers for Disease Control and Prevention, HEAR HER Campaign**
<https://www.cdc.gov/hearher/>

Patient Advocacy and Resources

- **ACOG After Pregnancy – Educational Material for Patients**
<https://www.acog.org/womens-health/pregnancy/after-pregnancy>
- **My Birth Matters**
<https://www.cmqcc.org/my-birth-matters>
- **Post-Birth Education Program**
<https://www.awhonn.org/page/POSTBIRTH>
- **National Birth Equity Collaborative**
www.birthequity.org
- **Preeclampsia Foundation**
www.preeclampsiafoundation.org
- **National Accreta Foundation**
<https://www.preventaccreta.org/>