# REPORT FROM NINE MATERNAL MORTALITY REVIEW COMMITTEES

MMRIA
MATERNAL MORTALITY REVIEW INFORMATION APP

BUILDING U.S. CAPACITY TO REVIEW AND PREVENT MATERNAL DEATHS

REVIEW to ACTION
MERGING TOGETHER TO PREVENT MATERNAL MORTALITY

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# Executive Summary

Approximately 700 women across the United States (U.S.) die each year as a result of pregnancy or pregnancy-related complications. Non-Hispanic black women experience maternal deaths at a rate three to four times that of non-Hispanic white women, a racial disparity that is mirrored across many maternal and infant outcomes. While surveillance using vital statistics can tell us about trends and disparities, state and local maternal mortality review committees (MMRC) are best positioned to comprehensively assess maternal deaths and identify opportunities for prevention. The Maternal Mortality Review Information Application (MMRIA) and its precursor, the Maternal Mortality Review Data System (MMRDS), assist MMRCs in abstracting relevant data from a diversity of sources, documenting committee decisions for each reviewed maternal death, and analyzing data for action. Using data from nine MMRCs (hereafter, the Nine Committees), this updated and expanded report includes—for the first time—recommendations for prevention, discussion of severe maternal morbidity review, and novel work on a MMRIA socio-spatial dashboard to incorporate health equity into MMRC discussions.

Nearly 50% of all pregnancy-related deaths were caused by hemorrhage, cardiovascular and coronary conditions, cardiomyopathy, or infection. The leading underlying causes of death varied by race. Preeclampsia and eclampsia, and embolism were leading underlying causes of death among non-Hispanic black women. Over a three-year period, the United Kingdom had only two deaths from preeclampsia and eclampsia, suggesting deaths from these hypertensive disorders of pregnancy are highly preventable. Mental health conditions were a leading underlying cause of death among non-Hispanic white women, reinforcing the value of MMRCs including mental health-related maternal deaths in the scope of their review, and having access to information beyond death certificates.

The Nine Committees estimated that over 60% of pregnancy-related deaths were preventable. The most common factors identified as contributing to the death were patient/family factors (e.g., lack of knowledge on warning signs and need to seek care) followed by provider (e.g., misdiagnosis and ineffective treatments) and systems of care factors (e.g., lack of coordination between providers). While the Nine Committees most commonly identified patient factors, the patient factors identified are often dependent on providers and systems of care. For the first time, the Nine Committees provided analyzable recommendations to prevent future maternal deaths and the estimated level of potential impact if those recommendations were implemented. The following were the most common recommendation themes that the Nine Committees also estimated to have the largest potential for population-level impact if implemented: adopting levels of maternal care, improving policies regarding prevention initiatives, enforcing policies and procedures related to obstetric hemorrhage, and improving policies related to patient management. Social and environmental factors may also contribute to a woman's risk of dying during or within one year of pregnancy. MMRCs can incorporate contextual social determinants of health into case discussions, and translate findings into specific recommendations. This report is a demonstration of MMRCs' potential to address health equity as a strategy to reduce maternal mortality and severe maternal morbidity.

To turn the tide on maternal mortality in the U.S. we must build on current momentum and support the critical work of MMRCs. State- and local-level MMRCs can be the gold standard for understanding why preventable maternal deaths continue to occur and to prioritize ways to effectively reduce maternal deaths. As more MMRCs are able to share data, there will be greater understanding and specificity of potential high impact recommendations. These recommendations for action will be beneficial for public health and clinical care decision-makers as they design strategies to eliminate preventable maternal deaths at the local, state, regional and national levels. Describing recommendations for each of the leading causes of death is an important step forward; determining the potential of a recommendation to prevent maternal deaths remains an important opportunity for the future.

# Preface

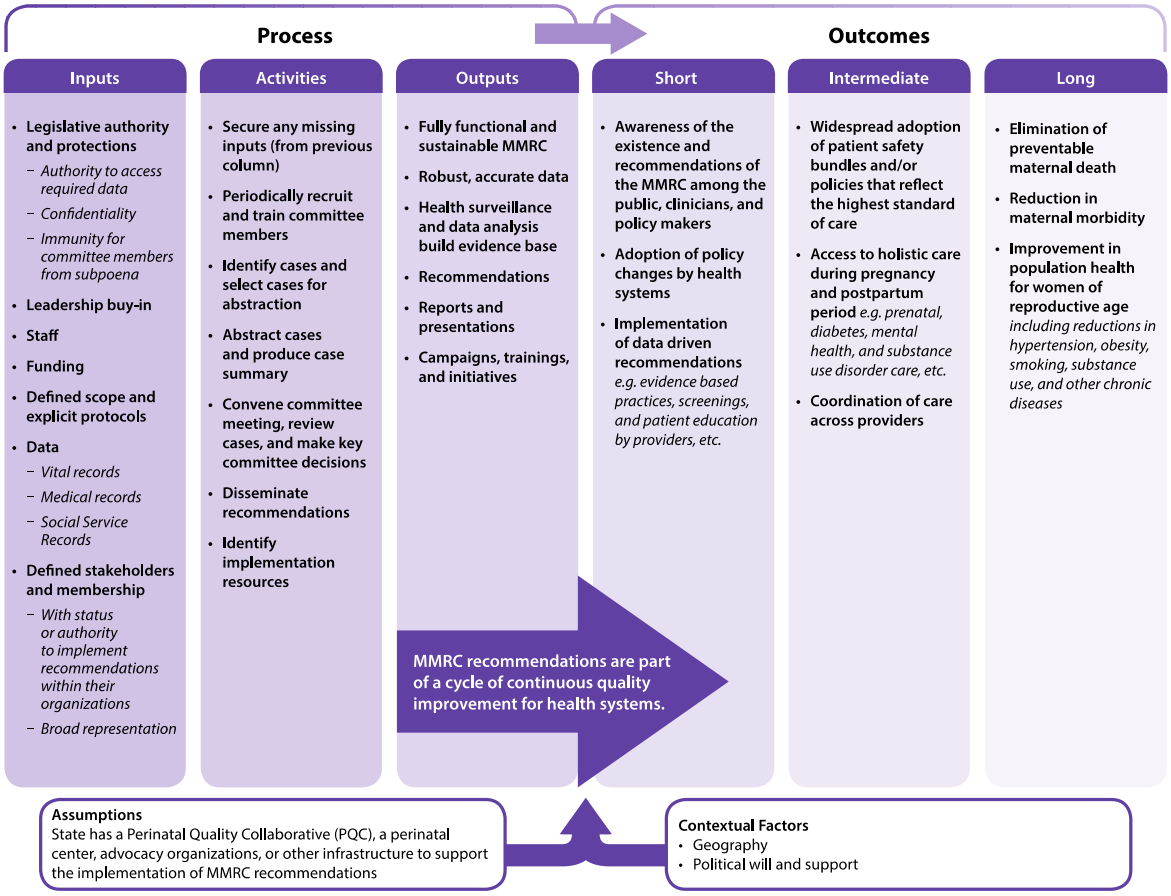
The data used in this report are made possible by a partnership with nine states that have been supporting the development of the Maternal Mortality Review Data System (MMRDS) and/or the Maternal Mortality Review Information Application (MMRIA): Colorado, Delaware, Georgia, Hawaii, Illinois, North Carolina, Ohio, South Carolina, and Utah. While this report reflects data from the nine states, MMRIA is a reflection of lessons learned from implementing MMRDS or MMRIA in a total of 20 state and local MMRCs. The long-term engagement with these MMRCs has benefited us all through rich mutual learning. Through the development of this report, we have come to understand the mechanics of combining and using data from multiple MMRCs. We have also identified opportunities for improvement and future possibilities as more MMRCs collaborate.

As of January 1, 2018, the Building U.S. Capacity to Review and Prevent Maternal Deaths team (hereafter, project team) has responded to 48 jurisdictions (42 states, five cities and one U.S. territory) requesting MMRIA and other MMRC support tools. These jurisdictions, representing approximately 92% of U.S. maternal deaths, are listed below.

1. Alabama Dept. of Public Health
2. Alaska Maternal & Child Death Review
3. Arizona Dept. of Health Services
4. Arkansas Dept. of Health
5. Colorado Dept. of Public Health & Environment
6. Connecticut Dept. of Public Health
7. Delaware Child Death Review Commission
8. District of Columbia Dept. of Health
9. Florida Dept. of Health
10. Georgia Maternal Mortality Review
11. Hawaii Dept. of Health
12. Illinois Dept. of Public Health
13. Indiana State Dept. of Health
14. Iowa Dept. of Public Health
15. Kansas Dept. of Health & Environment
16. Kentucky Dept. for Public Health
17. Los Angeles County Public Health
18. Louisiana Bureau of Family Health
19. Maryland Dept. of Health & Mental Hygiene
20. Massachusetts Dept. of Public Health
21. Michigan Dept. of Health & Human Services
22. Minnesota Dept. of Health
23. Mississippi State Dept. of Health
24. Missouri Dept. of Health & Senior Services
25. Montana Dept. of Public Health & Human Services
26. Nebraska Dept. of Health & Human Services
27. Nevada Dept. of Health & Human Services
28. New Hampshire Dept. of Health & Human Services
29. New Jersey Central Jersey Family Health Coalition
30. New Mexico Dept.of Health
31. New York City Dept. of Health & Mental Hygiene
32. North Carolina Dept. of Health & Human Services
33. Ohio Dept. of Health
34. Oklahoma State Dept. of Health
35. Oregon Health Authority
36. Pennsylvania Dept. of Health
37. Philadelphia Dept. of Public Health
38. Puerto Rico Dept.of Health
39. San Antonio (TX) Metropolitan Health District
40. South Carolina Dept. of Health and Environmental Control
41. Tennessee Dept. of Health
42. Texas Dept. of State Health Services
43. Utah Dept. of Health
44. Virginia Dept. of Health
45. Washington Dept. of Health
46. West Virginia Bureau for Public Health
47. Wisconsin Dept. of Health Services
48. Wyoming Dept. of Health

The project team partnered with eight MMRCs to develop a logic model that outlines the requirements for creating a fully functional MMRC (**Figure A**). MMRIA provides an opportunity for MMRCs to achieve process requirements such as collecting data, producing case summaries, and providing reports using robust data; the content of MMRIA was developed with these requirements in mind.

**Figure A.** Logic Model for Creating a Fully-Functional Maternal Mortality Review Committee




Beyond MMRIA, the project team developed resources and provided focused onsite and distance-based technical assistance to address specific challenges MMRCs experience. States have unique needs ranging from too few cases for annual reporting, to so many cases that it is difficult to find sufficient resources to initiate a review. For smaller states, the project team encourages interstate collaborative use of MMRC data at the regional level to add power to their analyses and prevention actions; for larger states, the team is exploring opportunities for intrastate collaboration by local reviews.

The tools developed and the technical assistance provided, coupled with refined MMRIA content and ongoing efforts to make data consistent, all support the effective and efficient implementation of MMRCs. MMRIA provides a shared data framework that empowers MMRC prevention activities. The U.S. can best save lives and prevent harm with thoughtful and strategic practices that honor unique contexts and needs at the state and local levels, while simultaneously adopting a cohesive approach that leverages all the data we collect on maternal deaths. MMRIA also provides support to reviews that take on emerging issues—such as maternal suicide, drug overdose, and intimate partner violence—in the form of scientific- and practice-based resources and tools. This report is a recognition of our common commitment to eliminating preventable maternal deaths and reducing disparities. We can only fulfill our commitment by working together.

# Introduction To Maternal Mortality Review Committees

There are two national sources for trends and information on maternal deaths using vital statistics data (**Table 1**). The first, the National Center for Health Statistics (NCHS), uses death certificate information to assign ICD-10 codes that are used to identify maternal deaths and produce a maternal mortality rate (i.e., maternal deaths while pregnant or within 42 days postpartum per 100,000 live births). The second, the Pregnancy Mortality Surveillance System (PMSS), uses death certificates that show a relationship to pregnancy identified by either a checkbox on the death certificate or by a linked birth or fetal death certificate registered in the year preceding death. Medical epidemiologists review this information to identify pregnancy-related deaths and produce a pregnancy-related mortality ratio (i.e., pregnancy-related deaths while pregnant or within a year postpartum per 100,000 live births).

A reliance on vital statistics alone to measure maternal mortality makes it challenging to determine whether changes observed are the result of improved identification of maternal deaths or changes in the risk.[1, 2] While surveillance using vital statistics can tell us about trends and disparities, state- and local-based MMRCs are best positioned to comprehensively assess maternal deaths and identify opportunities for prevention.[3, 4]

**Table 1.** National Sources of Maternal Mortality Information*

| | *CDC – National Center for Health Statistics* | *CDC – Pregnancy Mortality Surveillance System (PMSS)†* |
|---|---|---|
| **DATA SOURCE** | **DEATH CERTIFICATES** | **DEATH CERTIFICATES LINKED TO FETAL DEATH AND BIRTH CERTIFICATES** |
| **Time Frame** | During pregnancy – 42 days postpartum | During pregnancy – 365 days postpartum |
| **Source of classification** | International Classification of Diseases, 10th revision (ICD-10) codes | Medical epidemiologists assign PMSS codes |
| **Terms** | Maternal death | • Pregnancy-associated death,<br>• (Associated and) Pregnancy-related death,<br>• Associated but not pregnancy-related death |
| **Measure** | Maternal mortality rate:<br># of maternal deaths<br>per 100,000 live births | Pregnancy-related mortality ratio:<br># of pregnancy-related deaths<br>per 100,000 live births |
| **Purpose** | Show national trends and provide a basis for international comparison | Analyze clinical factors associated with deaths, publish information that may lead to prevention strategies |
| **Strengths** | • Best source of historical data (back to 1900)<br>• Reliable basis for international comparison<br>• Based on readily available data (death certificates) | Most clinically relevant national measure of the burden of maternal deaths |
| **Challenges** | • Constrained by ICD-10 codes<br>• Lacks sufficient detail to inform prevention strategies | • Constrained by information available on death and birth certificates<br>• Lacks detailed information on contributors to deaths |

* Adapted from St. Pierre et al, 2017. [5]

† https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pmss.html

The foundation for case identification by most MMRCs is linking death certificates to birth certificates or fetal death records, an approach that is consistent with PMSS. However, MMRCs have access to additional information on maternal deaths, such as medical and social records, that allow a deeper examination of the processes and factors leading to the death than what is possible from vital registration information alone. Beyond assessing preventability, MMRCs make recommendations, promote, and increasingly implement, effective population-based prevention activities.

Members of MMRCs typically represent public health, obstetrics and gynecology, maternal-fetal medicine, nursing, midwifery, forensic pathology, mental health, and behavioral health. Members might also include social workers, patient advocates, and other relevant, multidisciplinary stakeholders. Through a partnership between the MMRC, the state vital records office, and epidemiologists, deaths among women of reproductive age are examined to determine if they occurred during pregnancy or within a year of the end of pregnancy (pregnancy-associated deaths). Through this process, potential cases of pregnancy-related deaths are then identified.

Death certificates may indicate a pregnancy-associated death through a pregnancy checkbox or a cause of death code related to pregnancy. By themselves, however, death certificates are not sufficient to comprehensively identify all pregnancy-associated deaths. To further identify pregnancy-associated deaths, a routine linkage should be conducted between all death certificates of reproductive-aged women with infant birth or fetal death records for the year preceding death. When pregnancy-associated deaths are identified from death certificates alone, a representative of vital records or the MMRC may need to confirm that the death occurred during pregnancy or within one year of the end of pregnancy.

Some MMRCs have additional protocols for identifying pregnancy-associated deaths, such as linkages to hospital discharge data, direct hospital reporting, media reports, or obituary searches. All identified cases are sent to a MMRC representative to be entered into a database. Sources of case information may include birth and death certificate data, prenatal care records, hospital records, autopsy reports, informant interview, and social services records. Abstractors distill relevant information from these sources and develop committee review materials, including a case narrative, for each case. MMRCs then convene to discuss the cases.

There are six key decisions MMRCs make for each death reviewed:

1. Was the death pregnancy-related?
2. What was the underlying cause of death?
3. Was the death preventable?
4. What were the factors that contributed to the death?
5. What are the recommendations and actions that address those contributing factors?
6. What is the anticipated impact of those actions if implemented?

While all six questions are essential, the last four questions highlight the unique and critical role of MMRCs: preventability, contributing factors, recommendations for improvement, and measurement of potential for impact. The analyses included in this 2018 report cover all six questions, two of which overlap with PMSS, and four of which are unique to MMRCs.

# The Data

## Structure

Nine state-based MMRCs—Colorado, Delaware, Georgia, Hawaii, Illinois, North Carolina, Ohio, South Carolina, and Utah—contributed data to this report. These states have been entering data into either MMRIA (released in 2017) or its precursor, MMRDS. MMRIA is a custom application and MMRDS is a database built on the Centers for Disease Control and Prevention's (CDC's) publicly available Epi Info™ software version 7.1.5.2. There are 11 forms in MMRDS and 12 forms in MMRIA. For each maternal death, there is one form for abstracting information from the death certificate, autopsy report, birth certificate (parent section), prenatal care record, social and environmental profile, mental health profile (MMRIA only), case narrative (MMRIA only), and ultimately the committee decisions. There may be more than one of the following forms completed for a given maternal death: birth certificate (infant or fetal death section), emergency room visits and hospitalizations, other medical office visits, medical transports (MMRIA only), and informant interviews. We anticipate all states that used MMRDS in 2017 will transition to MMRIA in 2018.

Within many of the forms, there are one or more grids for data entry that may be used to store a list of relevant information, such as vital signs or laboratory tests. For example, within the autopsy report form, there are four grids: gross findings, microscopic findings, causes of death, and toxicology. Grids contain multiple data fields that relate to a common event or finding. For example, the toxicology grid from the autopsy report contains fields for substance, concentration, unit of measure and comments.

## Years

Years of deaths included in these analyses vary between the Nine Committees.

| | |
|---|---|
| Colorado | 2008—2012 |
| Delaware | 2009—2015 |
| Georgia | 2012—2014 |
| Hawaii | 2015 |
| Illinois | 2015 |
| North Carolina | 2014—2015 |
| Ohio | 2008—2015 |
| South Carolina | 2014—2017 |
| Utah | 2014 |

Rather than report trends in pregnancy-related mortality over time, our overarching focus in this report is to demonstrate the use of standardized MMRC data for understanding preventability, factors that contribute to deaths, and best opportunities for reducing pregnancy-related deaths; thus, the variation in years between states is not a barrier to the collective use of these data. As more MMRCs use MMRIA and are able to share data, it may be possible to look at both the most current and the overall data.

## Race and ethnicity

Where possible throughout the report, we present findings by race-ethnicity, age, and timing of death. While race and ethnicity are captured in the data set just as they are recorded on the source documents, and

recoded consistent with Office of Management and Budget Race and Ethnic Standards for Federal Statistics and Administrative Reporting[6], available data did not support analysis beyond non-Hispanic white, non-Hispanic black and Hispanic groupings. In the future, with more MMRCs contributing data, we may be able to describe deaths by additional race and ethnicity categories. We used race and ethnicity data from the birth certificate when available and from death certificates when a birth certificate was unavailable, based on evidence that the birth certificate is a more reliable source of data on race and ethnicity.[7]

## Age at death

Using information from death certificates, age at death is captured as a continuous variable in the data set. For the purposes of analysis, we grouped age at death into six categories:

- Younger than 20 years
- 20-24 years
- 25-29 years
- 30-34 years
- 35-44 years
- 45 years and older

## Timing of death in relation to pregnancy

The timing of a woman's death in relation to pregnancy is captured in two ways. Death certificates capture the relationship of death to pregnancy through a pregnancy checkbox. Standard checkbox options, as specified by the National Center for Health Statistics, are:

If female:

- Not pregnant within past year
- Pregnant at time of death
- Not pregnant, but pregnant within 42 days of death
- Not pregnant, but pregnant 43 days to 1 year before death
- Unknown if pregnant within the past year

In addition, when a death certificate links to a birth or fetal death record, then the number of days between death and the end of pregnancy is calculated within MMRDS/MMRIA. We grouped this continuous variable into categories consistent with the death certificate checkbox options. When this information was missing or unknown, we used timing information on the death certificate checkbox.

## Data cleaning

Data from the Nine Committees were cleaned to ensure that only valid observations remained for analysis. In addition, four duplicate entries were identified and removed.

We present the following analyses of the Nine Committee data in six sections, corresponding to each of the six key decisions that MMRCs make. Within each section, the project team provides background and definitions, a description of the results of the Nine Committee analyses specific to that question, and a discussion of how we are moving forward to better understand opportunities for preventing pregnancy-related deaths.

# Question 1: Was the Death Pregnancy-Related?

## Background and definitions

The first decision a committee makes is whether a death was pregnancy-related.

Pregnancy-associated deaths include all deaths that have a temporal relationship to pregnancy but not necessarily a causal relationship to pregnancy. Within the universe of pregnancy-associated deaths are pregnancy-related deaths. Pregnancy-related deaths refer to the death of a pregnant or postpartum woman as a result of her pregnancy. MMRCs start ascertaining pregnancy-related deaths by casting the widest net possible, identifying all deaths among women with any evidence of pregnancy in the year before death (i.e. pregnancy-associated deaths). A subset of these may be determined to be pregnancy-related deaths — deaths causally related to pregnancy or its management that occur during pregnancy or within a year of the end of a pregnancy (i.e., abortion, live birth, fetal or infant death).

MMRCs document their decision on pregnancy-relatedness using the following four categories:

- Pregnancy-related: The death of a woman during pregnancy or within one year of the end of pregnancy from a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy.
- Pregnancy-associated, but NOT related: The death of a woman during pregnancy or within one year of the end of pregnancy from a cause that is not related to pregnancy.
- Unable to determine if pregnancy-related or pregnancy-associated, but NOT related
- Not pregnancy-related or associated (i.e., false positive, woman was not pregnant within one year of her death)

## Results

Data from the Nine Committees include a total of 855 potential pregnancy-related deaths. Among these, 119 were determined to have no evidence of pregnancy within the year prior to the woman's death (not pregnancy-related or -associated; false positive pregnancy-associated deaths); therefore, they were excluded from further analyses. Information on pregnancy-relatedness was missing for 23 deaths and the Nine Committees determined an additional 33 deaths were pregnancy-associated but were unable to determine the pregnancy-relatedness; these 56 deaths were excluded from further analyses.

Among the 680 valid pregnancy-associated deaths for which relatedness could be determined, the Nine Committees determined 237 were pregnancy-related (34.9%). Pregnancy-related deaths occurred more commonly within 42 days of the end of pregnancy (45.0%) than during pregnancy (37.6%) or 43 days to one year after the end of pregnancy (17.5%) (**Figure 1**).

Variations in race-ethnicity (**Figure 2**) and age (**Figure 3**) were observed in the proportion of pregnancy-associated deaths determined to be pregnancy-related.

**Figure 1.** Distribution of Pregnancy-Related Deaths by Timing of Death in Relation to Pregnancy

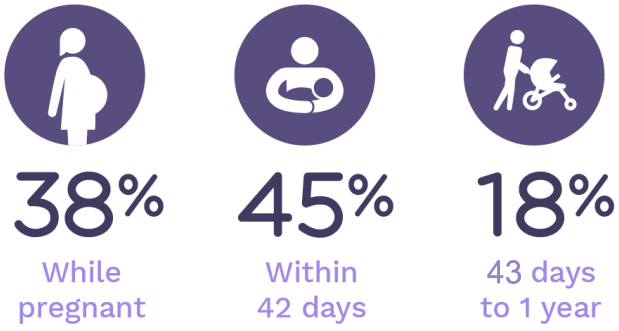


**Figure 2.** Proportion of Pregnancy-Associated Deaths Determined to be Pregnancy-Related, by Race-Ethnicity

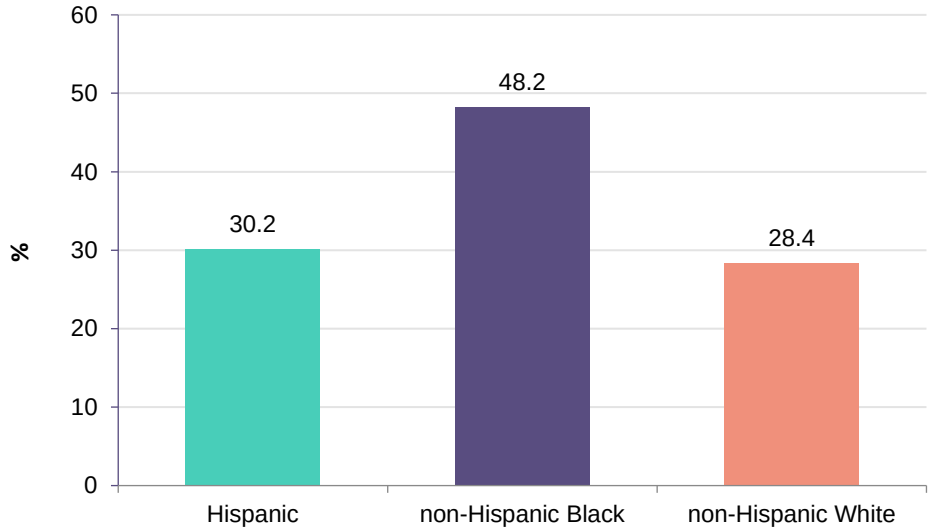
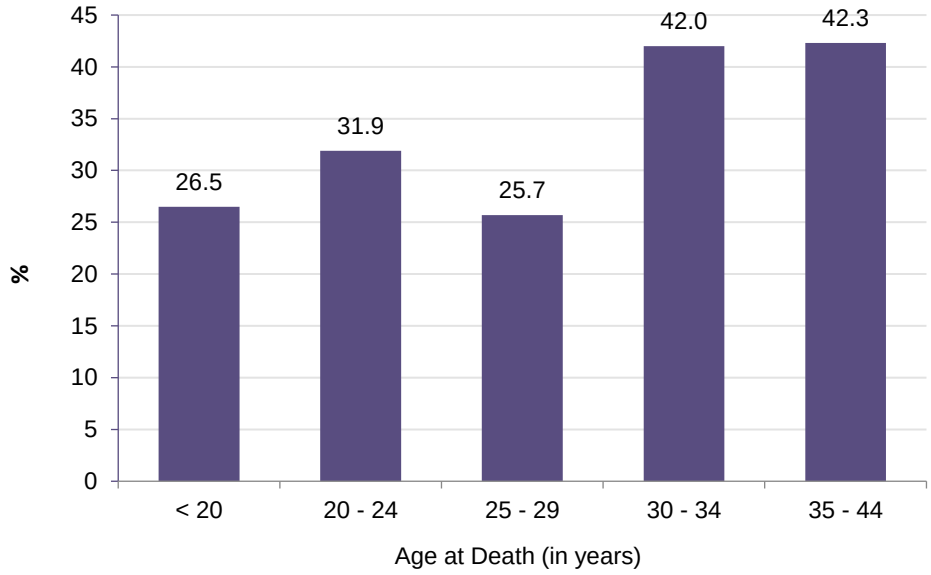



**Figure 3.** Proportion of Pregnancy-Associated Deaths Determined to be Pregnancy-Related, by Age at Death




## Moving forward

*Information about pregnancy-related deaths.* Data from the Nine Committees show variation in the proportion of pregnancy-associated deaths that are pregnancy-related by race-ethnicity and age at death. As more MMRCs are able to incorporate their data, we can illustrate and compare this variation within and across various categories, including race-ethnicity, age at death, and geography.

*Consistency of pregnancy-related death decisions.* The project team continues to provide technical assistance—in-person and distance-based—to support consistent decision making within and across MMRCs. As more MMRCs are able to share their data, we will be able to look for inconsistencies in decisions about pregnancy-relatedness to improve or develop support tools.

# Question 2: What Was the Cause of Death?

## Background and definitions

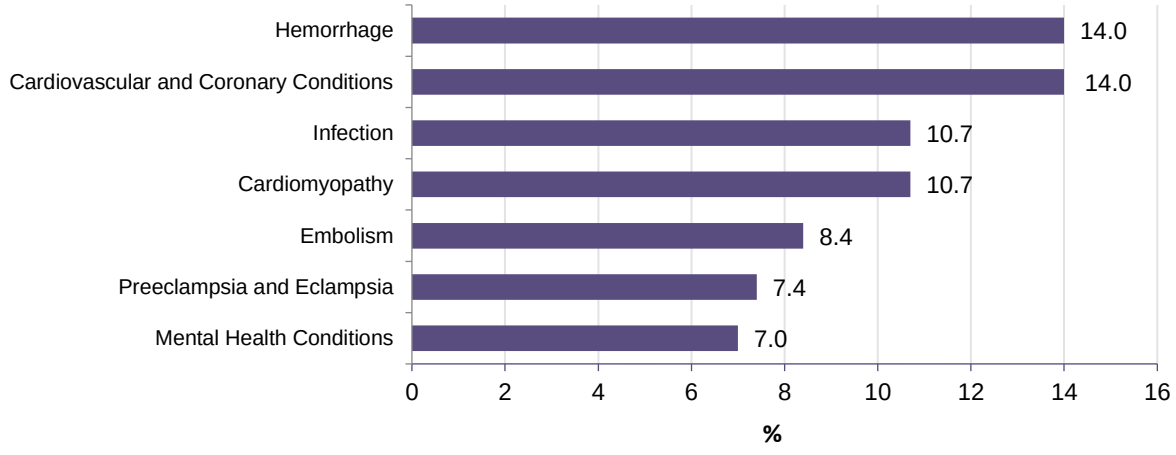
The causes of death can be captured two ways in the data set. The first way allows MMRCs to document causes of death, using free text fields, consistent with how the certifier of a death certificate documents causes of death: immediate, underlying, and contributing causes. This approach works well for capturing all causes of death, but free text fields do not work well for documenting causes of maternal death in a standard way across MMRCs. To encourage standardization and consistency in documenting the cause of death, the second approach for documenting MMRC decisions on causes of death is consistent with how the underlying cause of death is coded by the CDC Pregnancy Mortality Surveillance System (PMSS).† The PMSS codes were developed by CDC and the American College of Obstetricians and Gynecologists (ACOG) Maternal Mortality Study Group as a standard approach for classifying pregnancy-related deaths in clinically meaningful ways.[8, 9] The consistency provided by the PMSS maternal mortality cause of death list, or PMSS-MM codes, overcomes a significant hurdle that limited data sharing by MMRCs in the past (refer to **Appendix A** for PMSS-MM codes).

## Results

Of the 237 pregnancy-related deaths, 215 (90.7%) had a PMSS-MM underlying cause of death code assigned by the committee. For three (1.4%) of the 215, the PMSS-MM code indicated the committee could not determine an underlying cause of death. From the 74 potential underlying causes of death included in the PMSS-MM codes, the Nine Committees used a total of 52 codes for the 215 deaths. To support analyses using the underlying cause of death, a condensed set of 21 causes of death was created, as described in **Appendix B**.

Overall, there were seven leading underlying causes of pregnancy-related death, accounting for 72.1% of all pregnancy-related deaths (**Figure 4**). In addition, there were at least 5 pregnancy-related deaths due to each of the following: amniotic fluid embolism (4.2%), homicide (3.3%), cerebrovascular accidents (2.8%), unintentional injury (2.8%), anesthesia complications (2.3%), and autoimmune diseases (2.3%).

**Figure 4.** Leading Underlying Causes of Pregnancy-Related Deaths*




* Amniotic fluid embolism is not included in the embolism grouping due to differences in etiology and opportunities for prevention.

† The underlying cause of death, as defined by the World Health Organization (WHO), is "disease or injury that initiated the train of events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury."

*State variations.* The leading underlying causes of death varied among states. Only two states had the same three leading causes of pregnancy-related deaths (cardiovascular and coronary conditions, hemorrhage, and infection); however, states with small numbers of pregnancy-related deaths made it difficult to draw comparisons across all states.

*Race-ethnicity variations.* The leading underlying causes of death varied between non-Hispanic white and non-Hispanic black pregnancy-related deaths (**Figure 5**). Among non-Hispanic white pregnancy-related deaths, the leading underlying causes of death were comprised of five causes:

1. Cardiovascular and coronary conditions (at 15.5%),
2. Hemorrhage (at 14.4%),
3. Infection (at 13.4%),
4. Mental health conditions (at 11.3%), and
5. Cardiomyopathy (at 10.3%).

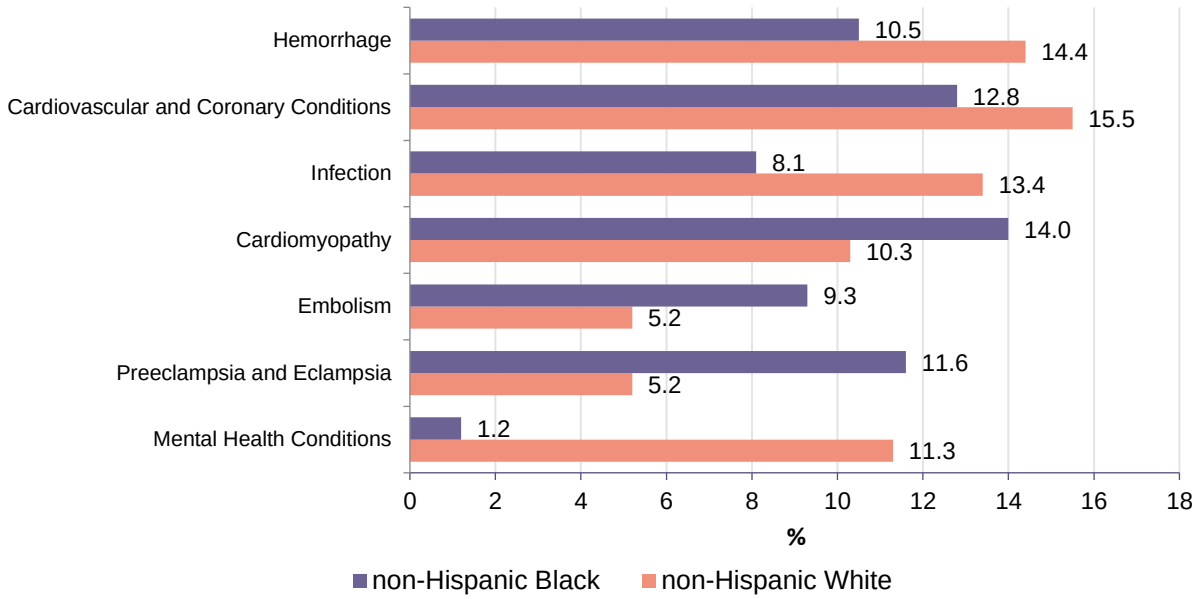
These top five causes represent 64.9% of non-Hispanic white pregnancy-related deaths.

Among non-Hispanic black pregnancy-related deaths, the following were the five leading underlying causes:

1. Cardiomyopathy (at 14.0%),
2. Cardiovascular and coronary conditions (at 12.8%),
3. Preeclampsia and eclampsia (at 11.6%),
4. Hemorrhage (at 10.5%), and
5. Embolism (at 9.3%).

These causes represent just 58.1% of non-Hispanic black pregnancy-related deaths, suggesting a broader diversity of pregnancy-related causes of death among non-Hispanic black women than among non-Hispanic white women.

**Figure 5.** Leading Underlying Causes of Pregnancy-Related Deaths, by Race-Ethnicity



There were not sufficient data to examine the leading underlying causes of pregnancy-related deaths among Hispanic women.

*Age variations.* The leading underlying causes of pregnancy-related death varied by age at death (**Figure 6**).

Among women ages 20-24 years, there were six leading underlying causes of pregnancy-related death:

- Cardiomyopathy and infection (both at 12.8%),
- Cardiovascular and coronary conditions, preeclampsia and eclampsia (both at 10.6%), and
- Hemorrhage and mental health conditions (both at 8.6%).

These causes represent 63.8% of pregnancy-related deaths in this age group.

Among women ages 25-29 years, there were five leading underlying causes of pregnancy-related death:

- Cardiovascular and coronary conditions, hemorrhage, and embolism (both at 12.5%), and
- Cardiomyopathy and mental health conditions (both at 10.0%).

These causes represent 57.5% of pregnancy-related deaths in this age group.

Among women ages 30-34 years, there were five leading underlying causes of pregnancy-related death:

- Infection (15.3%),
- Hemorrhage and cardiovascular and coronary conditions (both at 13.6%), and
- Cardiomyopathy and embolism (both at 10%).

These causes represent 62.7% of pregnancy-related deaths in this age group.

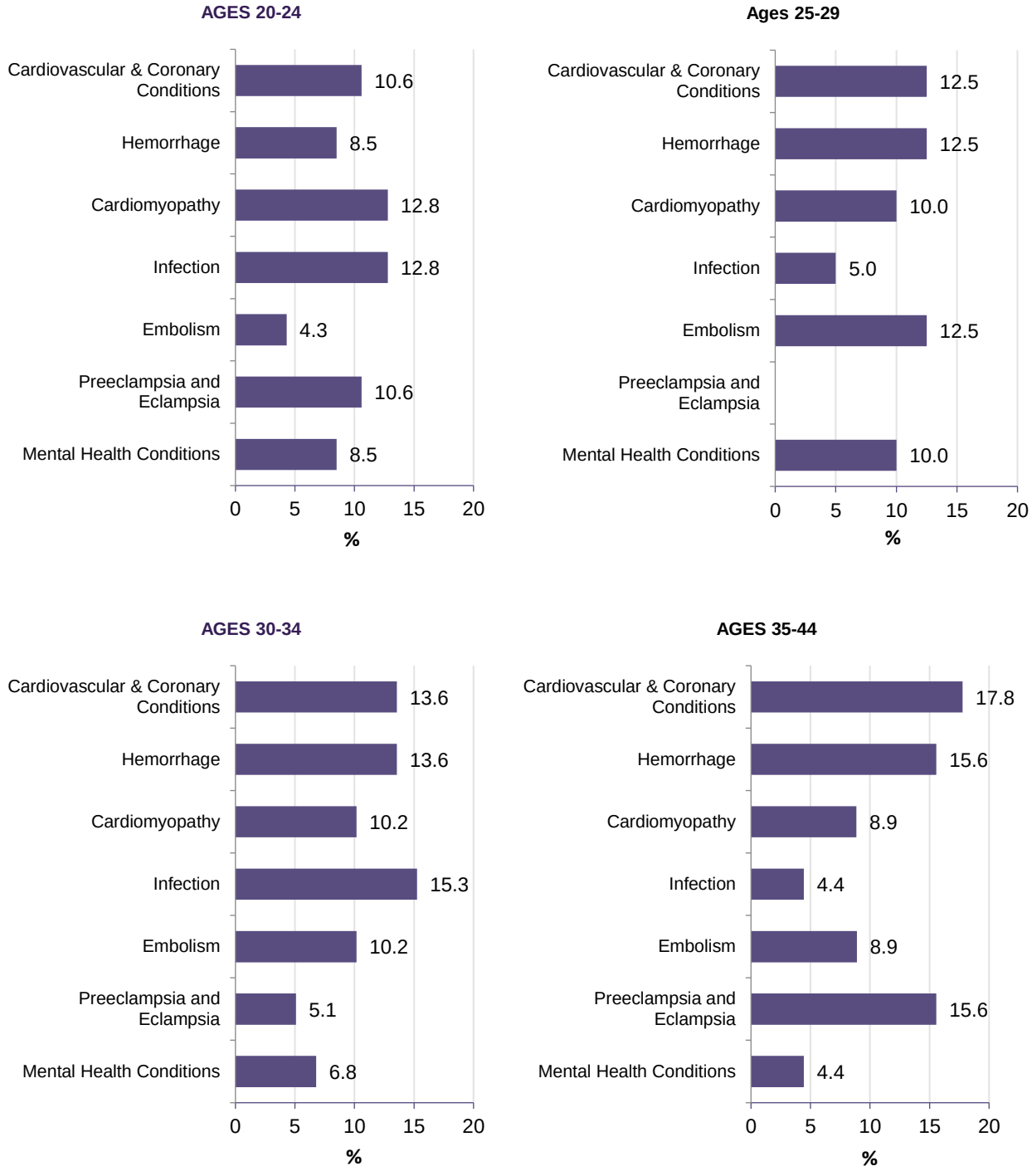
Among women ages 35-44 years, there were five leading underlying causes of pregnancy-related death:

- Cardiovascular and coronary conditions (17.8%),
- Hemorrhage, preeclampsia and eclampsia (both at 15.6%), and
- Cardiomyopathy and embolism (both at 8.9%).

These causes represent 66.7% of pregnancy-related deaths in this age group.

Cardiomyopathy, cardiovascular and coronary conditions, and hemorrhage are leading causes of pregnancy-related death that occurred among all age groups (**Figure 6**).

**Figure 6**. Leading Underlying Causes of Pregnancy-Related Deaths, by Age at Death (in Years)



*Timing of death variations.* The leading underlying causes of pregnancy-related death varied in timing of death (**Figure 7**).

Among pregnancy-related deaths that occurred during pregnancy, hemorrhage and cardiovascular and coronary conditions (both at 19.7%) were the leading causes of death, followed by embolism (9.2%). Among hemorrhage deaths, three (12.5%) were due to ectopic pregnancy and 6 (25%) were due to abnormal placental implantation. Together, these three causes represented 48.7% of pregnancy-related deaths that occurred during pregnancy.

Among deaths that occurred within 42 days of the end of pregnancy, infection (21.7%) was the leading cause of death, followed by hemorrhage (12.4%), cardiovascular and coronary conditions (12.4%), and preeclampsia and eclampsia (9.3%). Together, these four causes represented 55.7% of deaths that occurred during this time period.

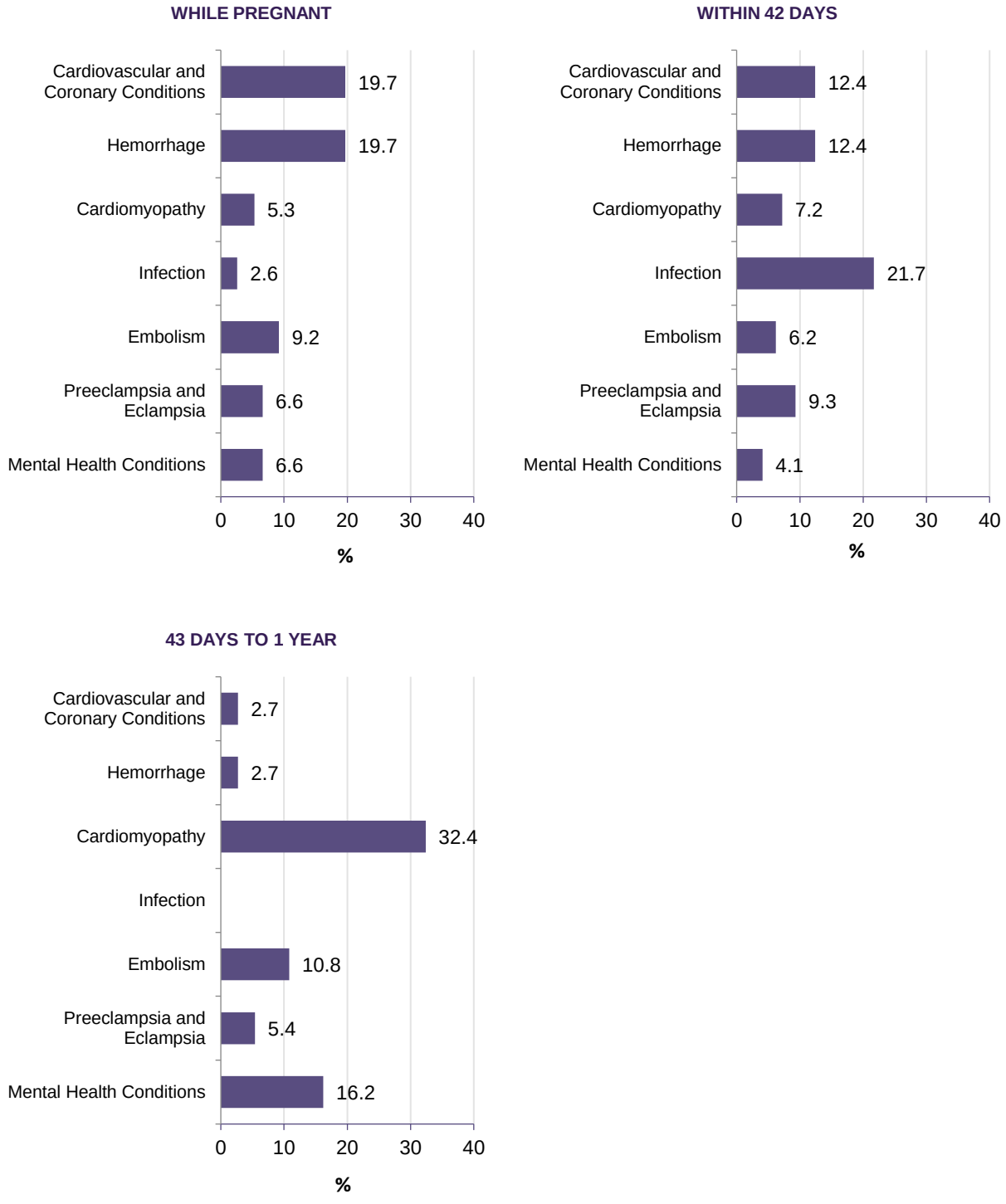
Among deaths that occurred 43 days to one year after the end of pregnancy, there were three leading causes of pregnancy-related death: cardiomyopathy (32.4%), mental health conditions (16.2%), and embolism (10.8%). Together, these three causes represented 59.5% of deaths in this time period.

## Moving forward

*Cause of death groupings.* A limitation of the cause of death groupings is that they may be masking important differences between causes of death within a grouping. As more reviews are able to contribute their data to aggregated analyses, we will be increasingly able to disaggregate cause of death groupings to identify these differences. Based on feedback from subject matter experts, amniotic fluid embolism has been added as a separate cause of death grouping due to differences in etiology and opportunities for prevention, and is no longer included with other embolisms.

*Contributors and mechanisms.* The project team updated the PMSS-MM codes within MMRIA to help clarify cause of death categories. The committee review and decisions form has been modified to document important contributors, such as obesity, and mechanisms of death that are not always underlying causes of death, such as suicide. Refer to **Appendix A** for a complete PMSS-MM code listing available to MMRCs in MMRIA and to see how contributors and mechanisms are captured.

**Figure 7**. Leading Underlying Causes of Pregnancy-Related Deaths, by Timing of Death in Relation to Pregnancy



# Question 3: Was the Death Preventable?

## Background and definitions

When combined with other committee decisions, there is a critical role for information on preventability. The most frequent causes of pregnancy-related death can point to the greatest burdens, but they say little about where the potential opportunities for prevention lie. Assessing preventability among the leading causes of death permits analysts to consider both the burden and potential opportunity for prevention. Determining preventability is one of the unique and critical roles that MMRCs can play in driving actions that will eliminate preventable maternal deaths.

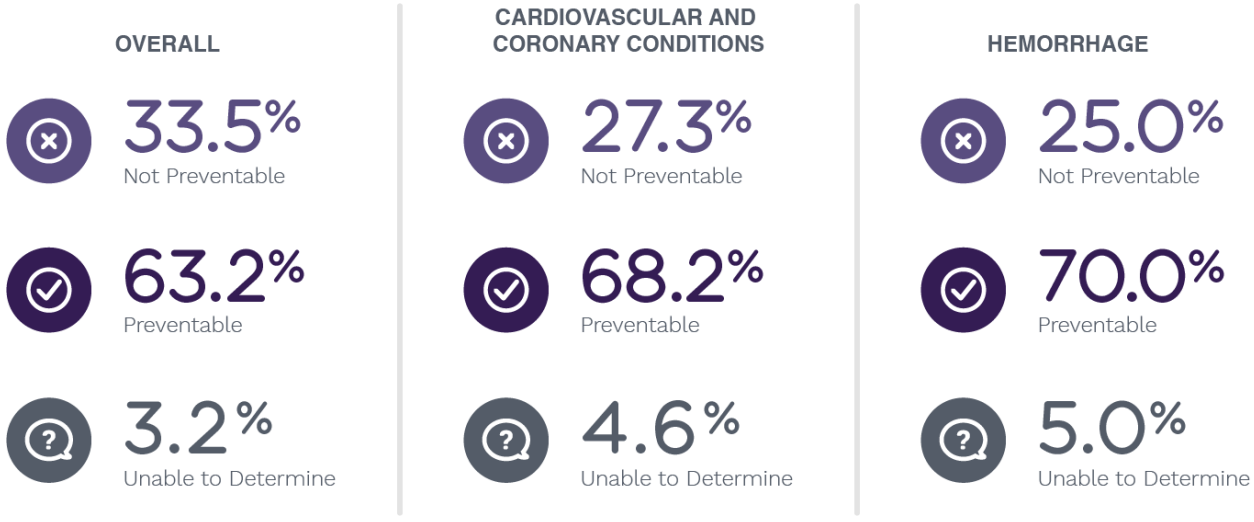
Determining preventability can be challenging and intimidating for MMRCs due to the range of possible interpretations of the term. Using input from MMRCs and experts across the country, we developed the following definition of preventability: a death is considered preventable if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes to patient, community, provider, facility, and/or systems factors.[10] MMRIA allows MMRCs to document their decision using two approaches: 1) determining preventability as a “yes” or ”no”, and/or 2) determining the chance to alter outcomes using a scale that indicates “no chance”, “some chance”, or “good chance” (**Appendix A**).

There is value in both ways of documenting preventability, because a ”yes” or “no” does not provide detail on the degree of preventability, other than there was at least some chance to alter the outcome. With a ”yes” or “no”, “some chance” and “good chance” are treated the same. The scale response provides additional specificity to the degree of preventability. For the purposes of this analysis, responses to the “yes” or “no” and the scale response questions were combined to create one composite preventability variable. A “yes” response or a response of “some chance” or “good chance” were coded as “preventable”; a “no” response or “no chance” were coded as “not preventable”.

## Results

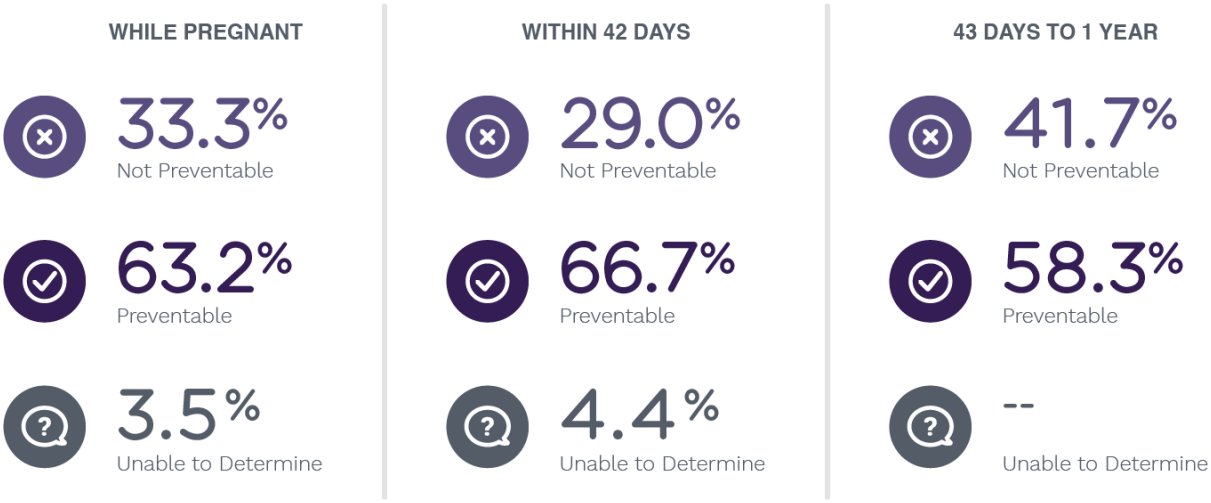
The Nine Committees estimated that 63.2% of pregnancy-related deaths were preventable (Figure 8). Preventability varied by cause of death, with 68.2% of cardiovascular and coronary deaths and 70.0% of hemorrhage deaths estimated to be preventable.

**Figure 8**. Distribution of Preventability Among Pregnancy-Related Deaths



Similarly, variations in the percentage of deaths estimated to be preventable varied by timing of death in relation to pregnancy. An estimated 63.2% of deaths that occurred during pregnancy, 66.7% of deaths that occurred within 42 days of the end of pregnancy, and 58.3% of deaths that occurred between 43 days and one year after the end of pregnancy were determined to be preventable (**Figure 9**).

**Figure 9**. Distribution of Preventability Among Pregnancy-Related Deaths, by Timing in Relation to Pregnancy




## Moving forward

*Documenting preventability.* It is encouraging that MMRCs could not determine preventability for only 3% of pregnancy-related deaths, suggesting a high potential for complete data when MMRCs include preventability in their determinations. Assessing preventability should be a priority because it is critical to informing and prioritizing potential actions. Using data from the Nine Committees, our analyses found that 63% of pregnancy-related deaths were preventable, and the preventability for deaths due to hemorrhage was a high of 70%. In comparison, the proportion of pregnancy-related deaths identified as preventable in published literature ranges from 20% to 50%.[10-12] In last year's MMRC report, 59% of pregnancy-related deaths were determined preventable based on data from four MMRCs. It is encouraging that the data from the Nine Committees found a similar, though slightly higher percentage to be preventable, suggesting a possible shift over the last decade toward increased opportunities for prevention. With more complete data, we can continue to evaluate preventability by additional leading causes of pregnancy-related deaths.

# Question 4: What Were the Factors that Contributed to this Death?

## Background and definitions

After a committee determines that a death is pregnancy-related, identifies the underlying cause of death, and determines potential preventability, they proceed to identify the factors that contributed to the death. These factors form the basis for a committee's specific and feasible recommendations.

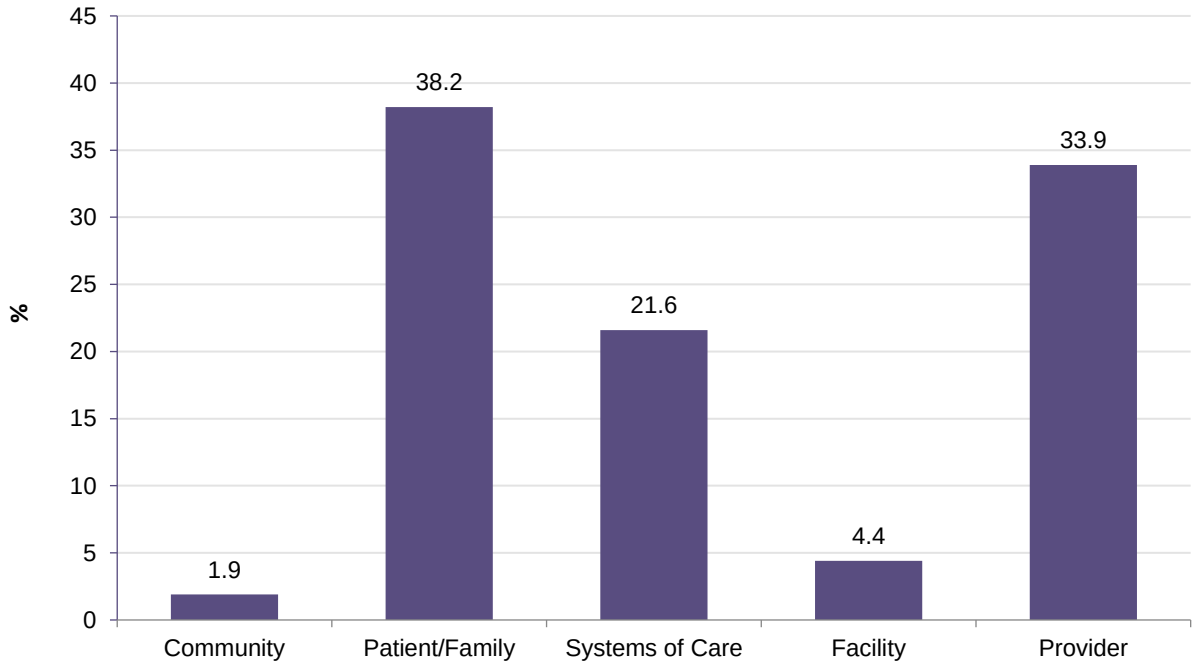
MMRIA uses a three-step process to capture information on factors that contribute to a death. First, each factor is categorized into one of five levels: patient/family, provider, facility, systems of care, or community. Second, each factor is assigned at least one of 23 specific contributing factor classes (along with "other"). Contributing factor classes include unstable housing, social support or isolation, violence, and barriers such as delays, adherence, and knowledge. Third, the factor is given a concise description by the committee. Refer to **Appendix A** for the complete list of contributing factor classes and definitions.

## Results

Through the process of case review, MMRCs can identify service delivery and access gaps, as well as quality improvement opportunities from each woman's death. The Nine Committees identified 780 contributing factors among 195 pregnancy-related deaths (on average, four contributing factors were identified for every one pregnancy-related death).

The largest proportion of factors identified by MMRCs as contributing to pregnancy-related deaths were patient/family factors, followed by provider and systems of care factors (**Figure 10**). Facility and community factors were rarely identified. While patient factors were the most common, they were often dependent on providers and systems of care, which becomes evident when combined with contributing factor classes and descriptions, as shown on pages 26-28.

**Figure 10.** Distribution of Contributing Factors among Pregnancy-Related Deaths



*Leading cause of death variations.* Contributing factor classifications vary in their distribution within the leading causes of pregnancy-related death (**Table 2**). Of note is the low ratio of factors per death identified for deaths where embolism was the underlying cause (1.6, which is less than one-half of what is observed for other causes). This supports earlier findings that embolism deaths are considered one of the least preventable among pregnancy-related deaths.[5]

**Table 2**. Contributing Factor Level by Leading Causes of Pregnancy-related Death

| | CONTRIBUTING FACTORS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **CAUSE OF DEATH** | **COMMUNITY** | **FACILITY** | **PROVIDER** | **PATIENT / FAMILY** | **SYSTEMS OF CARE** | **TOTAL FACTORS** | **PREGNANCY – RELATED DEATHS**** | **FACTORS PER DEATH** |
| **CARDIOVASCULAR & CORONARY CONDITIONS** | | | | | | | | |
| **Count of Factors** | 6 | 12 | 26 | 51 | 25 | 120 | 28 | 4.3 |
| **% of cause-specific factors** | 5.0 | 10.0 | 21.7 | 42.5 | 20.8 | -- | -- | -- |
| **HEMORRHAGE** | | | | | | | | |
| **Count of Factors** | 0 | 7 | 31 | 26 | 36 | 100 | 27 | 3.7 |
| **% of cause-specific factors** | -- | 7.0 | 31.0 | 26.0 | 36.0 | -- | -- | -- |
| **INFECTION** | | | | | | | | |
| **Count of Factors** | 1 | 1 | 36 | 30 | 20 | 88 | 21 | 4.2 |
| **% of cause-specific factors** | 1.1 | 1.1 | 40.9 | 34.1 | 22.7 | -- | -- | -- |
| **CARDIOMYOPATHY** | | | | | | | | |
| **Count of Factors** | 0 | 1 | 24 | 31 | 11 | 67 | 16 | 4.2 |
| **% of cause-specific factors** | -- | 1.7 | 41.4 | 43.1 | 13.8 | -- | -- | -- |
| **EMBOLISM** | | | | | | | | |
| **Count of Factors** | 0 | 0 | 5 | 15 | 3 | 23 | 14 | 1.6 |
| **% of cause-specific factors** | -- | -- | 21.7 | 65.2 | 13.0 | -- | -- | -- |
| **MENTAL HEALTH CONDITIONS** | | | | | | | | |
| **Count of Factors** | 5 | 3 | 24 | 37 | 19 | 88 | 14 | 6.3 |
| **% of cause-specific factors** | 5.7 | 3.4 | 27.3 | 42.1 | 21.6 | -- | -- | -- |
| **PREECLAMPSIA & ECLAMPSIA** | | | | | | | | |
| **Count of Factors** | 2 | 2 | 29 | 13 | 10 | 56 | 11 | 5.1 |
| **% of cause-specific factors** | 3.6 | 3.6 | 51.8 | 23.2 | 17.9 | -- | -- | -- |
| **Total** | 14 | 26 | 175 | 203 | 124 | 542 | 131 | 4.1 |

**Pregnancy-related deaths that had at least one contributing factor identified. Contributing factors from at least 7 pregnancy-related deaths included in the 2017 report are not represented here due to changes in data formatting.

When contributing factor levels are examined together with the factor class and description, we are able to gain a greater understanding of specific contributors among the leading causes of pregnancy-related deaths. For each of the leading causes of pregnancy-related death, we provide a summary of the most common factor levels, the most common factor classes within the most common factor levels, and the dominant themes that emerged from the descriptions.

Themes from the contributing factor descriptions were coded and reconciled by two coders for the top three causes of death. The remaining contributing factors were coded by one coder and reviewed by a second coder for consistency. A codebook was developed in tandem with the application of the codes, and changes to code names and definitions were discussed and finalized by both coders. Contributing factor themes were created by examining the level (e.g., patient/family, provider) and the corresponding class (e.g., referral, policies/procedures, continuity of care/care coordination) to develop codes appropriate for each level and class combination. In some cases, similar themes were aggregated under a common code even if the level/class combinations differed (e.g., "finances" code included both patient and system of care contributing factors). Once the contributing factor themes were coded, the data were sorted by theme for inclusion in this report. An expanded presentation of this information is included in **Appendix C**.

*Hemorrhage*

*Provider factors* comprised 31.0% of the total contributing factors for hemorrhage deaths. The most common class of provider factors was *assessment*, which represented 33.3% of all provider factors. The most common themes among provider assessment for both ectopic and non-ectopic hemorrhage were *delays in diagnosis and effective treatment, missed diagnosis,* and *ineffective treatments*.

*Patient factors* comprised 26.0% of the total contributing factors for hemorrhage deaths. The most common class of patient factors was *knowledge*, which represented 30.8% of all patient factors. The most common theme among patient knowledge for both ectopic and non-ectopic hemorrhage was patients' knowledge of *warning signs and need to seek care*.

*Systems of care factors* comprised 36.0% of the total contributing factors for hemorrhage deaths. The most common class of systems of care factors was *personnel* at 27.8%, followed by *policies and procedures* at 19.4%, and *care coordination* at 16.7%. Common themes among systems of care personnel, policies and procedures, and care coordination were, *inadequate training and inadequate or unavailable personnel*, *absence of policies and procedures*, and a *lack of coordination* between providers in patient management.

*Cardiovascular & Coronary Conditions*

Provider factors comprised 21.7% of the total contributing factors for cardiovascular and coronary conditions deaths. The most common class of provider factors was *knowledge* at 16.7%. Common themes among provider knowledge were *delayed diagnosis and appropriate treatment* and *ineffective treatments.*

Patient factors comprised 42.5% of the total contributing factors for cardiovascular and coronary conditions deaths. The most common class of patient factors was *chronic disease* and *knowledge*, which together accounted for 41.2% of patient factors. Patient chronic conditions most commonly specified *obesity* and patient knowledge *of warning signs and need to seek care.*

Systems of care factors comprised 20.8% of the total contributing factors for cardiovascular and coronary conditions deaths. The most common class of systems of care factors was *communication*. The dominant themes identified were *lack of communication between providers* that supports coordinated care, and *inadequate or unavailable personnel*.

*Cardiomyopathy*

Provider factors comprised 41.4% of the total contributing factors for cardiomyopathy deaths. The most common classes of provider factors were *assessment* at 33.3% and *knowledge* and *referral* both at 16.7%. Dominant themes among provider assessment and knowledge included *failure to screen, misdiagnosis, ineffective treatments*, and *delayed or missed diagnosis*. *Failure to seek [cardiology] consultation* was a common theme among the referral class.

Patient factors comprised 43.1% of the total contributing factors for cardiomyopathy deaths. The most common class of patient factors was *chronic disease* at 25.8% of patient factors. Common themes among patient chronic conditions were *obesity* and being *unaware of warning signs and the need to seek care.*

Systems of care factors comprised 27.3% of the total contributing factors for cardiomyopathy deaths. The most common class of system factors was *personnel* at 27.3%. The most dominant themes among personnel were *inadequate training* and *inadequate or unavailable personnel*.

*Infection*

Provider factors comprised 40.9% of the total contributing factors for infection deaths. The most common class of provider factors was *assessment*, at 41.7%. A common theme among provider assessment was *delayed or missed diagnosis*, leading to the *use of ineffective treatment*.

Patient factors comprised 34.1% of the total contributing factors for infection deaths. The most common class of patient factors was *chronic disease* at 30.0% followed *by environmental* at 16.7%. Common themes among patient chronic conditions were *obesity* and *other contributing diagnoses*. A common theme among patient environment included *housing*.

Systems of care factors comprised 22.7% of the total contributing factors for infection deaths. The most common classes of systems of care factors were *communication* at 20.0% and *personnel* at 15.0%. The dominant themes identified were *lack of communication between providers* that supports coordinated care, and *inadequate training*, respectively.

*Embolism*

Provider factors comprised 21.7% of the total contributing factors for embolism deaths. The most common class of provider factors was *provider knowledge* at 60.0%. A common theme that emerged was a *lack of provider knowledge about the use of anticoagulants and thrombolytics.*

Patient factors comprised 65.2% of the total contributing factors for embolism deaths. The most common class of patient factors was *chronic conditions* at 53.3%. The most commonly identified patient chronic condition was *obesity.*

*Mental Health*

Provider factors comprised 27.3% of the total contributing factors for mental health deaths. The most common classes of provider factors were *provider assessment* at 25.0% and *provider communication* at 20.1%. The dominant themes that emerged related to provider assessment were *failure to screen* and the *use of ineffective treatments*. The most common themes for communication were a *lack of communication between providers* to support coordinated care and a *lack of communication between providers and patients/families.*

Patient factors comprised 42.1% of the total contributing factors for mental health deaths. There was not a predominant class of patient factors, with classes split across *substance use, social support, knowledge, environment,* and *adherence*. Themes that emerged from these classes included *lack of adherence to medications or treatment plans, abusive relationships and unstable housing, substance use, absence of*

*social support systems*, and *not recognizing warning signs and the need to seek care.* While these factors were labeled as patient factors, they are often dependent on providers and systems of care.

System of care factors comprised 21.6% of the total contributing factors for mental health deaths. The most common classes of systems of care factors were *communication* and *continuity of care*, both at 22.2%. The predominant themes for systems of care communication was a *lack of communication between providers* that supports patient management. Common themes for continuity were *inadequate outreach support system* and *inadequate or unavailable personnel.*

### *Preeclampsia and Eclampsia*

Provider factors comprised 51.8% of the total contributing factors for preeclampsia and eclampsia deaths. The two predominant classes were *knowledge* at 20.7% and *referral* at 13.8%. Common themes included *delayed diagnosis or treatment, misdiagnosis, use of ineffective treatments*, and *failure to seek consultation.*

Patient factors comprised 23.2% of the total contributing factors for preeclampsia and eclampsia deaths. The most common class of patient factors was *chronic conditions* at 30.1%. The most commonly identified patient chronic conditions were *substance use* and *obesity*.

While system of care factors comprised only 17.9% of the total contributing factors for preeclampsia and eclampsia deaths, 40% were related to *communication*, and a dominant theme was *lack of communication as a barrier to coordination of care between providers*.

## Moving forward

*Contributing factor descriptions.* While at least one contributing factor was identified for more than 80% of pregnancy-related deaths, there remains an opportunity for improving the specificity of the open-ended descriptions of the contributing factors. Contributing factor descriptions add a richness to the quantitative level and class responses. Typical of analytic approaches for open-ended responses, we qualitatively assessed the descriptions to identify themes. As we increase the number of MMRCs able to contribute data to support a report, we will explore alternative approaches to analyze the open-ended descriptions of contributing factors.

*Community-level factors.* We will work with MMRCs to understand if the limited amount of community factors reflects a genuine absence, or if there are opportunities to improve MMRCs' abilities to identify community-level contributors, such as expanding committee membership. Identifying community-level contributors may also benefit from our work to integrate socio-spatial information into case discussions [see Incorporating Equity – an Update].

# Question 5: What Are the Recommendations and Actions That Address Those Contributing Factors?

## Background and definitions

There is one key question that a review committee can use to help them move to case-specific recommendations: *If there was at least some chance that the death could have been averted, what were the specific and feasible actions, if implemented or altered, that might have changed the course of events?*

Committees should attempt to develop a recommendation for each contributing factor level-class combination identified. An effective recommendation addresses who is responsible to act, what the action is, and when the action should take place. Concise, feasible, and specific recommendations are the culmination of the committee's discussions and decisions. The importance of this portion of committee discussion should not be underestimated.

For example, if the MMRC determines that a mental health condition was the underlying cause of death, that substance use disorder contributed to the death, and that a lack of provider assessment—specifically, not screening for substance use disorder during prenatal care—was a contributing factor, then an actionable recommendation could be that prenatal care providers should screen all patients for substance use disorders at their first prenatal visit.

Recommendation themes (e.g., improve training, enforce policies and procedures, ensure appropriate level of care determination, etc.) were coded and reconciled by two coders as previously described for the coding of contributing factor themes.

## Results

The Nine Committees identified 193 recommendations among 58 pregnancy-related deaths that were coded into themes (on average, three to four recommendations were identified for every one pregnancy-related death). The most common themes among pregnancy-related deaths included the following:

- Improve training
- Enforce policies and procedures
- Adopt levels of maternal care/ensure appropriate level of care determination[***]
- Improve access to care
- Improve patient/provider communication
- Improve patient management for mental health conditions
- Improve procedures related to communication and coordination between providers
- Improve standards regarding assessment, diagnosis and treatment decisions
- Improve policies related to patient management, communication and coordination between providers, and language translation
- Improve policies regarding prevention initiatives, including screening procedures and substance use prevention or treatment programs

An expanded presentation of this information, including specific examples from each recommendation theme, is included in **Appendix D**.

[***] For more information on levels of maternal care, refer to the ACOG and SMFM Obstetric Care Consensus Statement: https://www.acog.org/Clinical-Guidance-and-Publications/Obstetric-Care-Consensus-Series/Levels-of-Maternal-Care

*Leading cause of death variations.* While there is overlap in recommendations by the leading causes of death, there is also some variation. Recommendations for the two leading causes of death (cardiovascular and coronary conditions and hemorrhage) both include improving training, adopting levels of maternal care, improving procedures related to communication and coordination between providers, and improving standards and policies (**Table 3**). However, improving access to care and improving policies specific to prevention initiatives were additional recommendation themes for cardiovascular and coronary conditions. In contrast, recommendation themes for hemorrhage also included enforcing policies/procedures and improving patient/provider communication. Additionally, a recommendation for mandating autopsies was noted, which would provide MMRCs with a more thorough account of the clinical causes of death.

**Table 3.** Recommendation Themes for Action, by Cause of Death

| CARDIOVASCULAR AND CORONARY CONDITIONS | HEMORRHAGE |
|---|---|
| Improve training | Improve training |
| Adopt maternal levels of care/Ensure appropriate level of care determination | Adopt maternal levels of care/Ensure appropriate level of care determination |
| Improve procedures related to communication and coordination between providers | Improve procedures related to communication and coordination between providers |
| Improve standards regarding assessment, diagnosis, and treatment decisions | Improve standards regarding assessment, diagnosis, and treatment decisions |
| Improve policies related to patient management, communication and coordination between providers, and language translation | Improve policies related to patient management, communication and coordination between providers, and language translation |
| Improve access to care | Improve patient/provider communication |
| Improve policies regarding prevention initiatives | Enforce policies/procedures |
| | Mandate autopsies |

## Moving forward

*Complete and effective recommendations.* Through trainings, site visits, and technical assistance, we will continue to work with MMRCs to ensure that they develop effective recommendations and that these are documented in MMRIA. The recommendations are critical to understanding what specific actions committees identify as the best opportunities for preventing pregnancy-related deaths. This report represents an advancement in the ability to present cause of death-specific recommendations. However, a specific recommendation was identified for only 24% of pregnancy-related deaths, highlighting the opportunities for improving the completeness of recommendations. As more MMRCs are able to share data, there will be increased opportunity for identifying specific actions for prevention among all of the leading causes of pregnancy-related death.

*Recommendation descriptions.* Similar to contributing factors, recommendations are open-ended descriptions that require a tailored analytic approach. We will evaluate approaches for analyzing the recommendations to identify what is the most appropriate analytic approach.

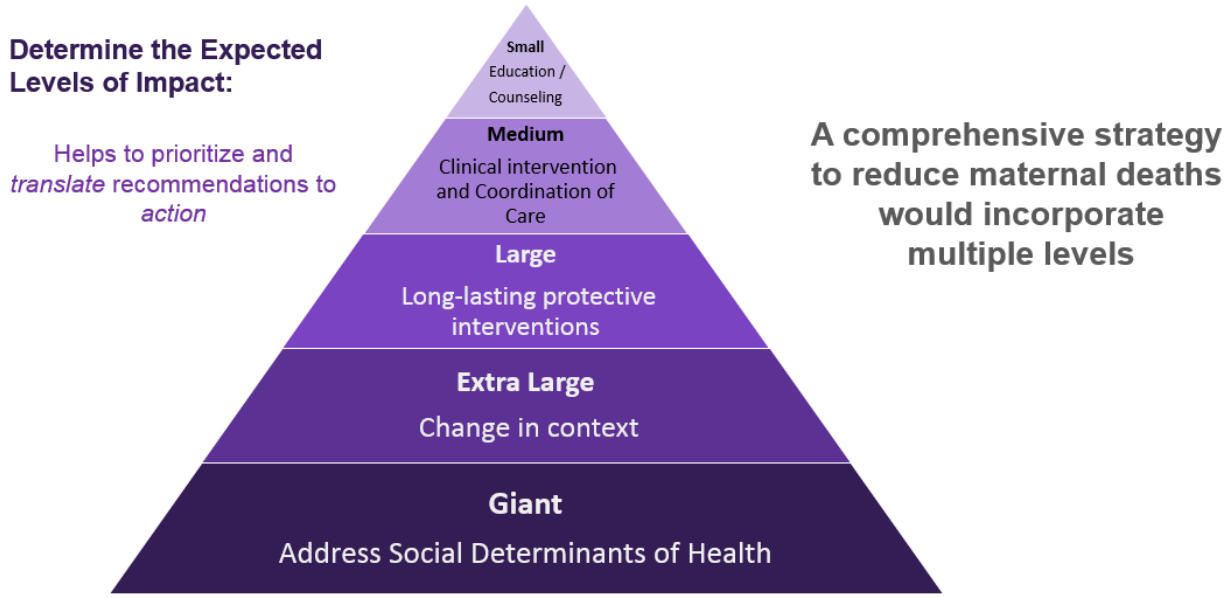
# Question 6: What Is the Anticipated Impact of Those Actions If Implemented?

## Background and definitions

There are two ways that MMRCs capture information in MMRIA related to the potential level of impact their recommendations would have if implemented. First, the MMRC assigns a specific level of prevention to each recommendation. They determine whether, if implemented, the action would result in what is known in public health literature as primary prevention (actions that prevent the contributing factor before it occurs), secondary prevention (actions that reduce the impact of a contributing factor once it has occurred), or tertiary prevention (actions that reduce the impact or progression of what has become an ongoing contributing factor). Recommendations that support primary prevention may be prioritized over those that support secondary or tertiary prevention.

Second, each specific committee recommendation is assigned an expected level of impact if the recommendation was implemented, ranging from small to giant. Expected impact levels are adapted from the Health Impact Pyramid (**Figure 11**).[13] The base of the pyramid addresses social determinants of health. Actions aimed toward the base of the pyramid have greater potential for population-level impact and require less individual effort (referred to as giant). Actions aimed toward the top of the pyramid (referred to as small) focus on the individual level (rather than entire populations) and depend on person-by-person behavioral change; yet, they require relatively less political will in comparison to the base of the pyramid. Ideally MMRCs would identify opportunities across the spectrum of impact levels.

**Figure 11.** Expected Level of Impact if Recommendation is Implemented



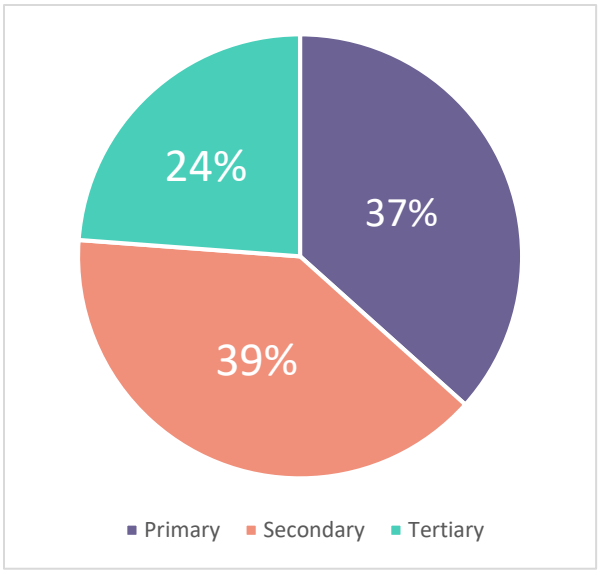

When MMRCs review deaths, consider preventability, develop recommendations, and assess their likely impacts, this information can inform policymakers and other stakeholders in their efforts to prioritize recommendations and provide resources to translate them into action for eliminating preventable tragedies.

## Results

There were 172 responses from the Nine Committees regarding the level of prevention for a recommendation, and 169 responses on the level of impact if the recommendation was implemented. Most

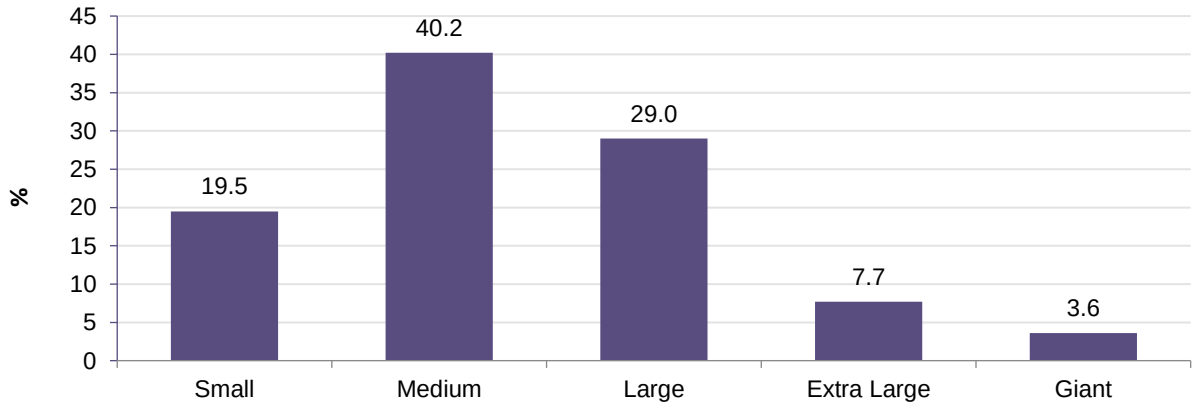
recommendations were identified as resulting in either primary (36.6%) or secondary (39.5%) prevention, and 23.8% of recommendations were identified as resulting in tertiary prevention (**Figure 12**).

**Figure 12.** Level of Prevention for Recommendations




The level of impact if the recommendation was implemented was estimated to be either small or medium for 59.7% of recommendations. The level of impact was considered large, extra large or giant for 40.3% of recommendations (**Figure 13**).

**Figure 13.** Anticipated Impact of Actions if Implemented



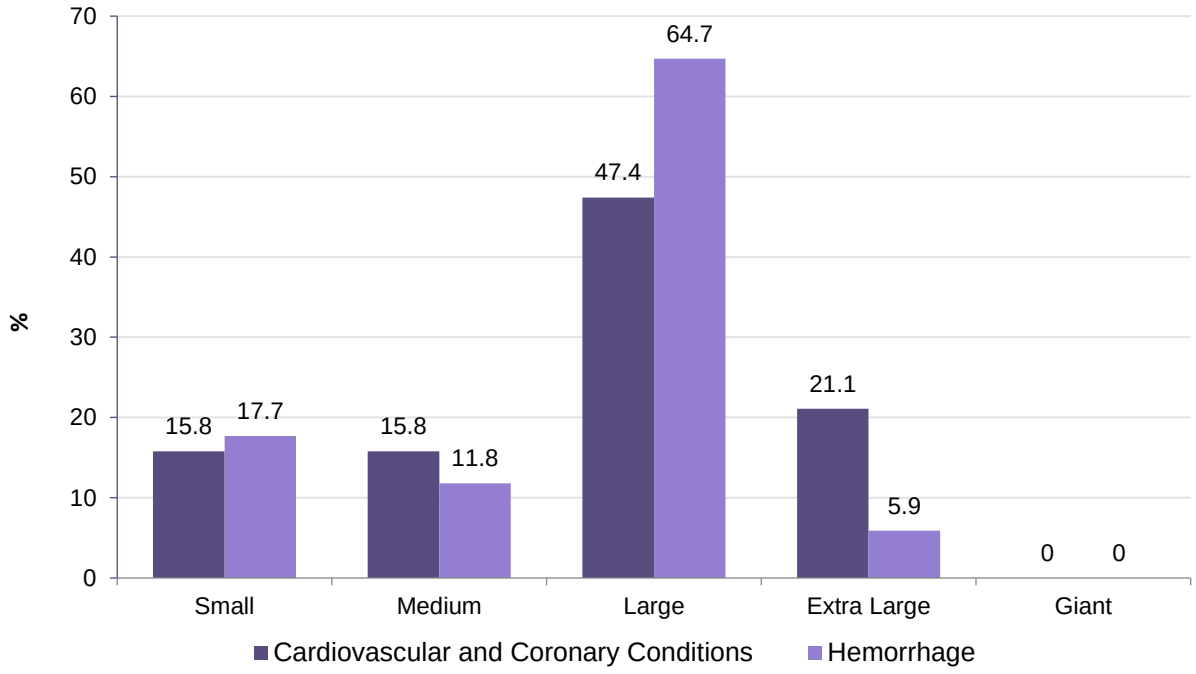

In the data from the Nine Committees, we were able to describe how impact levels vary across recommendation themes. For example, recommendations for improving training was estimated to have a smaller impact, whereas recommendations for improving policies regarding prevention initiatives and screening procedures would likely have a larger impact for prevention (**Table 4**).

**Table 4.** Recommendation Themes for Action and Estimated Potential for Impact if Implemented

| | IMPACT LEVEL (%) | |
|---|---|---|
| **RECOMMENDATION** | **SMALL TO MEDIUM** | **LARGE TO GIANT** |
| **Improve training** | 72.7 | 27.3 |
| **Enforce policies and procedures** | 40.0 | 60.0 |
| **Adopt maternal levels of care/Ensure appropriate level of care determination** | 0.0 | 100.0 |
| **Improve access to care** | 50.0 | 50.0 |
| **Improve patient/provider communication** | -- | -- |
| **Improve patient management for mental health conditions** | 80.0 | 20.0 |
| **Improve procedures related to communication and coordination between providers** | 55.0 | 45.0 |
| **Improve standards regarding assessment, diagnosis, and treatment decisions** | 69.2 | 30.8 |
| **Improve policies related to patient management, communication and coordination between providers, and language translation** | 42.9 | 57.1 |
| **Improve policies regarding prevention initiatives, including screening procedures and substance use prevention or treatment programs** | 0.0 | 100.0 |

The estimated level of impact for recommendations also varies by cause of death (**Figure 14**). Recommendations with large and extra large potential impacts represent more than two-thirds of recommendations for the two leading causes of pregnancy-related death. Assessing both the recommendations and their level of impact, improving policies regarding prevention initiatives (e.g., reimbursement for smoking cessation aids) is the theme that may have the biggest level of impact for preventing future deaths due to cardiovascular and coronary conditions. In contrast, enforcing policies/procedures and adopting levels of maternal care are themes that may have the biggest impact on preventing future deaths due to hemorrhage.

**Figure 14.** Estimated Potential Impact of Recommendations if Implemented, by Cause of Death




## Moving forward

*Documentation of impact.* Of the six key decisions that a MMRC makes, determining potential impacts may be the least familiar. While discussing the impact of recommendations may have been part of stakeholder discussions once analyses of maternal death data were complete, documenting the impact of recommendations has not historically been a part of each individual case review. Data from the Nine Committees demonstrates that over a short period of time, documenting recommendations and their impacts for each maternal death has increasingly become a part of committee discussions and decisions. In the 2017 report, there were not sufficient data to include analyses related to impact. We will continue to work with MMRCs—through trainings, site visits and technical assistance—to document the impact of recommendations.

Recommendations and corresponding impact levels by the leading causes of death were not able to be fully presented because recommendations had to be grouped, thus reducing their granularity. As more data are collected, reviewing the impact of specific recommendations for each of the leading causes of death will provide valuable information for public health decision makers.

# Data Summary

Analysis of the data from the Nine Committees demonstrates MMRIA's ability to help MMRCs better understand the drivers of maternal deaths and implement specific, feasible actions to prevent them. MMRIA serves as a foundation for bringing maternal death data together and using those data to inform prevention activities at local, state, regional, and national levels.

We used data from the Nine Committees to describe the leading causes of pregnancy-related death. A key finding was identifying mental health as a leading underlying cause of pregnancy-related death. This supports the value of MMRCs access to information beyond death certificates [see Maternal Mental Health – an Update]. We must also acknowledge that these analyses benefited from MMRCs including mental health-related maternal deaths in the scope of their review.

Additionally, analyses of the data from the Nine Committees show that circumstances leading to maternal death are complex and multifactorial; no one contributing factor is likely sufficient to result in a death. On average, four contributing factors were identified for each pregnancy-related death, suggesting that collaborative and multidisciplinary approaches are required to eliminate preventable maternal deaths. Data from the Nine Committees identified common contributing factors across leading causes of death. Among providers, these factors included lack of assessment—resulting in misdiagnosis—and delayed or ineffective treatment. Among patients, factors pointed to complications of obesity and lack of knowledge of warning signs, or lack of knowledge of symptoms requiring health care assessment. For systems of care, the key factors related to lack of patient care coordination and poor communication between providers. These findings highlight potential opportunities for action from multiple stakeholders, including hospitals and public health programs.

Unlike in our previous report, the Nine Committees provided analyzable recommendations to prevent future deaths and the estimated level of impact if those recommendations were implemented. Collecting and analyzing data on recommendations and their impact level can provide valuable information to public health and clinical care decision makers as they design and prioritize strategies to eliminate preventable deaths at the local, state, regional and national levels.

This report is a demonstration of MMRCs' potential to eliminate preventable maternal deaths and of the power of collegial, productive partnerships between stakeholders in maternal mortality prevention at local, state, regional and national levels. To further empower stakeholders in this partnership, we next discuss emerging issues for MMRCs to consider moving forward: maternal mental health, suicide, substance use disorder, severe maternal morbidity, and health equity.

# Emerging Issues

## Maternal Mental Health Conditions – an Update

Mental health conditions are one of the leading causes of pregnancy-related death. In addition, while a mental health condition (including substance use disorder) may not have caused the death, it may have contributed to the death. The association between mental illness and mortality is complicated, because mental illness does not directly kill women: it serves as an underlying factor that may result in suicide, accidental death, and death due to accidental drug intoxication or homicide.[14-16]

### Background

*Assessing mental health conditions as a contributing factor in maternal death.* Perinatal mood and anxiety disorders are conditions that impact women's mental health during pregnancy and up to one year after delivery. They include depression, anxiety, and affective disorders with psychotic episodes and psychosis. Pregnancy and the postpartum period are associated with both the onset of mental illness and relapse.[17] Our understanding of maternal mental illness is negatively impacted by the frequency of under-diagnosis and misdiagnosis. The result can be inappropriate care, potentially leading to missed opportunities for treatment and increased risk of morbidity and mortality. In addition, the metabolic changes of pregnancy may require adjustments to adequate pharmacological treatment dosage—especially beginning in the second trimester—but many providers are hesitant to treat depression and anxiety with antidepressants in pregnancy.[18, 19] Mental illness relapse occurs more frequently when a woman's dosage of pharmacological treatment is decreased in pregnancy, maintained at pre-pregnancy levels, or completely discontinued.[20] Providers are challenged because both pharmacotherapy use and non-use carry risks, necessitating a potentially complex risk-benefit analysis when considering the treatment of mental health conditions during pregnancy and the postpartum period. Adding to this challenge is variability in patient risk tolerance.

Psychosocial and environmental risk factors associated with maternal mental health conditions

- Chronic stressors, such as racism and poverty
- Lack of access to insurance, transportation, and providers
- Substance use disorder
- Chronic Disease
- Obesity
- Unplanned pregnancy
- Delay or failure to seek prenatal care
- Social isolation and lack of social support
- Childcare-associated stress
- Homelessness
- Exposure to violence and trauma

*Assessing substance use disorder as a contributing factor in maternal deaths*. In the U.S., drug overdose deaths nearly tripled during 1999-2014. Of all recorded drug overdose deaths in 2014, 60.9% involved an opioid. Over time, the majority has been from commonly prescribed opioids, but a recent surge in deaths is largely due to heroin and other synthetic opioids.[21] From 2014 to 2015 alone, the death rate from synthetic opioids other than methadone increased by 72.2%, and heroin death rates increased by 20.6%. From 2005 to 2014, the rate of opioid-related inpatient stays increased faster for females than for males: females had a higher rate of opioid-related inpatient stays in the majority of U.S. states in 2014.[22] Self-medication with substances is associated with increased risk of both suicide and unintentional overdose.[23] Opioid abuse and dependence is associated with a 4.6 fold-increased risk of maternal death during hospitalization.[24] Treatment for substance use disorder during pregnancy involves a complex assessment of risks related not only to pregnancy, but also to interactions with other treatments of comorbid conditions, such as antidepressants.

Psychosocial and environmental factors associated with substance use disorder

- Mental health conditions
- Lack of financial resources and insurance
- Late entry into prenatal care
- Poor adherence to health care appointments and medical recommendations
- Poor weight gain during pregnancy
- Exhibited sedation, intoxication, withdrawal, or erratic behavior

*Assessing maternal suicide*. For U.S. women ages 10-44 years, suicide is among the five leading causes of death.[25] A recent review suggests that suicidal ideation occurs more often among pregnant women than the general population.[26] Among postpartum women, suicide most commonly occurs in the late postpartum period (43 to 365 days).[27]

Psychosocial and environmental risk factors associated with suicide

- Prior suicide attempt(s)
- Suicidal ideation
- Depression during pregnancy or postpartum
- Substance use disorder
- Non-adherence with medical recommendations
- No continuity of care
- Patient and family lack of knowledge regarding mental health conditions and treatments
- Postpartum psychosis
- Previous diagnosis of bipolar disorder
- Post-traumatic stress disorder
- Lack of access to insurance, transportation, and providers
- Intimate partner violence
- Isolation and lack of social support

## Using MMRIA

### Data system enhancements

Mental health conditions are a complicated contributor to maternal mortality that cannot always be detected by just the death certificate or the autopsy report. Because of their comprehensive and interdisciplinary approach, MMRCs are in a unique position to identify and document the contribution of mental health conditions to pregnancy-related mortality.[28, 29] MMRCs have expressed a need for better understanding of mental health and substance use issues that influence maternal deaths. In response, MMRIA provides definitions of mental health conditions and substance use disorder (**Box**) and a mental health profile form. In addition, MMRIA includes checkboxes in the MMRIA committee decisions form to prompt reflection on the influences of mental health conditions and substance use disorder (**Figure 15**).

**Box.** Select Definitions Provided in MMRIA.

**MENTAL HEALTH CONDITIONS**

The woman carried a diagnosis of a psychiatric disorder. This includes postpartum depression.

**SUBSTANCE USE DISORDER – ALCOHOL, ILLICIT/PRESCRIPTION DRUGS**

Substance use disorder is characterized by recurrent use of alcohol and/or drugs causing clinically and functionally significant impairment, such as health problems or disability. The committee may determine that substance use disorder contributed to the death when the disorder directly compromised a woman's health status (e.g. acute methamphetamine intoxication exacerbated pregnancy-induced hypertension, or woman was more vulnerable to infections or medical conditions).

**Figure 15.** Committee Decisions Form, Select Questions and Checkboxes Related to Mental Health Conditions, Substance Use Disorder, Suicide, and Homicide.

### *Estimating the contribution of mental health conditions and substance use disorder*

Only MMRCs who entered data into MMRIA (versus its predecessor, MMRDS) were able to use the mental health conditions and substance use disorder checkboxes. Thus, we used data from the following forms to assess whether mental health conditions or substance use disorder contributed to each pregnancy-related death:

- Death certificate
- Autopsy report
- Mental health profile (available in MMRIA only)
- Social and environmental profile
- Committee decisions form:
    - Mental health conditions and substance use disorder checkboxes (**Figure 15**) (available in MMRIA only)
    - Determination of contributing factors related to the death
    - PMSS-MM codes
    - Notes about key circumstances surrounding the death

Specifically, we looked for mentions of mental health conditions, depression, anxiety, bipolar disorder, psychosis, or substance use disorder contributing to the death in any way. We then categorized each death according to whether a mental health condition or a substance use disorder contributed to the death, and whether the death was a suicide.

By searching for these keywords in the data from the Nine Committees, we found that mental health conditions and substance use disorder contributed to 12.9% and 8.2% of pregnancy-related deaths, respectively; 6.5% of pregnancy-related deaths were suicides. In comparison, when looking at PMSS-MM codes only, the percentage of pregnancy-related deaths with an underlying cause of death of mental health conditions was 7.0%, as shown in **Figure 4**. This shows that mental health conditions and substance use can contribute to deaths even when they are not the underlying cause. As more MMRCs use checkboxes, more complete analyses of deaths where mental health conditions or substance use disorder contributed to the death, but did not cause the death, will be possible.

Data from states with the checkboxes available indicated that mental health conditions or substance use disorder contributed to just three of the 28 deaths we identified as having mental health conditions or substance use disorder. Of the remaining 25 deaths we identified as having mental health conditions or substance use disorder, eight had PMSS-MM codes indicating that the underlying cause of death was mental health conditions (100.0) or depression (100.1), and two were suicides incorrectly coded as intentional injury - homicide (88.1).

These discrepancies highlight that the use of only one data component currently underestimates the contribution of mental health conditions and substance use disorders to pregnancy-related mortality. If utilized, the checkboxes in MMRIA can serve as a consistent measure that helps committees better understand the contribution of mental health conditions and substance use disorder to maternal mortality. Further training to MMRCs on the committee decision form checkboxes and PMSS-MM codes may be needed.

## Moving forward

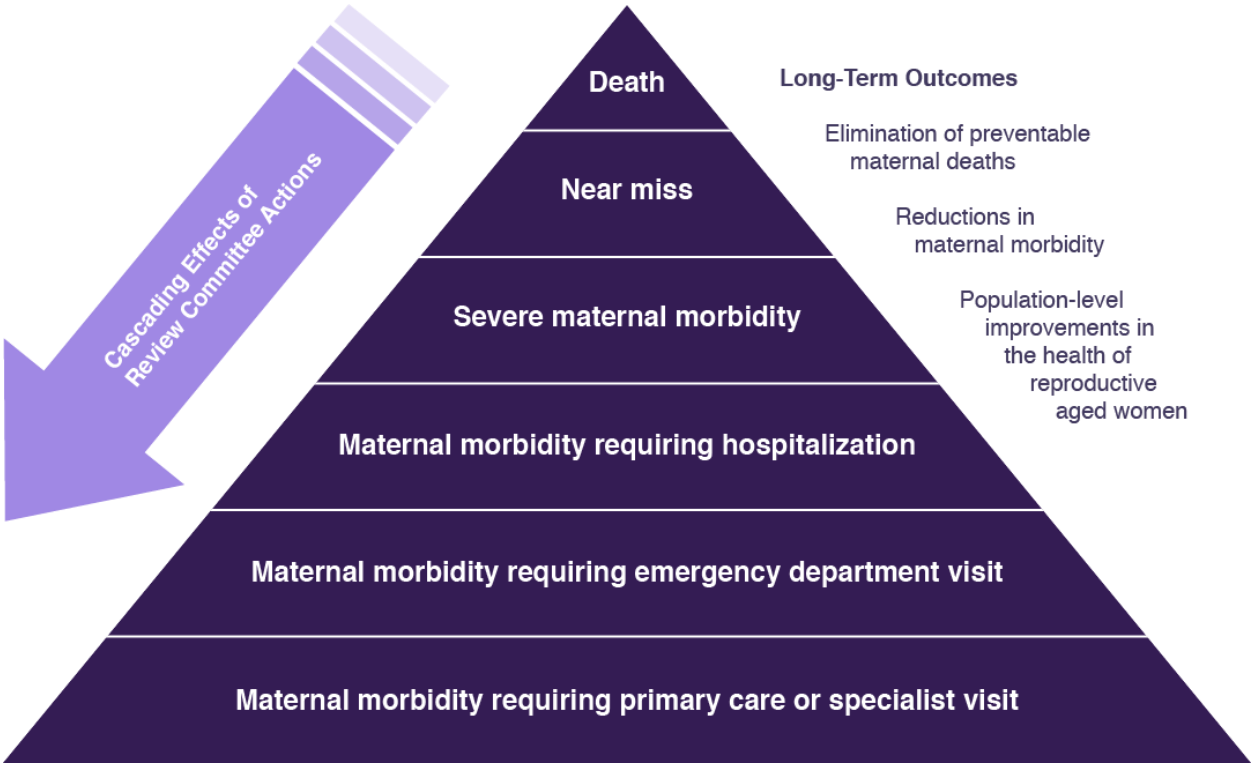
*Documentation of the contribution.* Our analyses of the data from the Nine Committees suggest that there remains an underascertainment of the contribution of mental health conditions, substance use disorder, and suicide to pregnancy-related deaths. We will continue to work with MMRCs to help identify opportunities for expanding their scope to include these deaths and to increase use of the checkboxes on the MMRIA committee decisions form.

*The National Violent Death Reporting System (NVDRS).* The National Violent Death Reporting System is a state-based surveillance system covering all types of violent deaths.[30] Forty states, plus Washington, D.C. and Puerto Rico, currently participate in the NVDRS. Some MMRCs are already partnering with their state violent death reporting system programs to exchange information. We continue to encourage MMRCs to work with their NVDRS programs to understand opportunities for improving the identification and assessment of pregnancy-related violent deaths.

## Severe Maternal Morbidity Review

A maternal death is the most extreme and rarest negative maternal outcome. The small numbers of maternal deaths make comprehensive and multidisciplinary review of these deaths feasible, providing an efficient way for identifying prevention opportunities that lead to cascading prevention effects on other maternal health outcomes (**Figure 16**). We see this efficiency in the data from the Nine Committees where, on average, four contributing factors and three to four recommendations were identified for every one pregnancy-related death. Actions taken in response to review committee recommendations can reduce negative maternal health outcomes such as severe maternal morbidity (SMM), which are too numerous to comprehensively review at a state or even local level.

**Figure 16.** Cascading Prevention Impacts and Long-Term Outcomes of Maternal Mortality Review



## Severe Maternal Morbidity Surveillance and Facility-Based Review

SMM refers to unexpected outcomes of labor and delivery that result in significant short- or long-term consequences to a woman's health.[31] Nationally, SMM occurs approximately 100 times more commonly than a pregnancy-related death.[32] This estimate is based on hospital discharge data and the CDC SMM index, currently comprised of 18 SMM indicators (e.g., sepsis, hysterectomy, or shock).[33] The CDC SMM index was developed for population-level surveillance purposes but can be confused with SMM review processes, which needs to occur within facilities.[34]

While the CDC SMM index works well for population-level surveillance at the national and state levels,[35-38] it does not work as well at the facility level.[39] However, it should be acknowledged that even if the index worked well at the facility level, the number of SMMs flagged for review would be far too numerous to effectively review in the comprehensive way that MMRCs review deaths. For these reasons, two screening criteria have been recommended by the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal Fetal Medicine (SMFM) to trigger review at the facility level for a more limited number of cases: transfusion of four or more units of blood and admission of a pregnant or postpartum woman to an intensive care unit (ICU).[31] Still, there remains the need for a more specific approach to support the efficient identification of SMMs for facility review within those that screen positive from the two criteria. These facility reviews can have an important role in identifying facility and health care system-specific quality improvement opportunities, which can complement the population- and systems-level actions generated by MMRCs and Perinatal Quality Collaboratives.

## SMM Review by MMRCs at the State or Local Level

Many MMRCs have expressed interest in applying their comprehensive case review process to review SMMs, but population-level review of all SMM cases would overwhelm any committee. It may be possible to triage particular cases for review using the aforementioned guidelines coupled with the following two criteria: 1) there is a strong relationship to mortality and 2) the morbidity occurs relatively rarely.

To understand if any of the SMM index indicators meet these criteria, we examined the 2009-2014 National Inpatient Sample. The International Classification of Diseases (ICD-9-CM) diagnosis and procedures codes were used to identify pregnancy hospitalizations and hospitalizations with a SMM indicator. We classified all pregnancy hospitalizations hierarchically into three periods: prenatal, delivery, and postpartum hospitalizations. From the 18 current SMM index indicators, we identified three SMM indicators that are present in 95% of in-hospital deaths during pregnancy. These same three SMM indicators were present in 92% of the deaths that occurred during a prenatal hospitalization, 95% of deaths that occurred during delivery hospitalization, and 98% of postpartum in-hospital deaths. While strongly tied to in-hospital deaths, the three SMM indicators are a small percentage of the overall SMM index (~8%) and total pregnancy hospitalizations (0.1% or approximately 5,500 nationally per year). The three SMM indicators are:

1. Cardiac arrest/ventricular fibrillation (ICD-9, DX: 427.41, 427.42, 427.5)
2. Conversion of cardiac rhythm (ICD-9, PR: 99.6x), and
3. Mechanical ventilation (ICD-9, PR: 93.90, 96.01-96.05 minus 96.04 and 96.7x)

While these three SMM indicators could potentially be utilized as triggers for state- or local-level SMM review by MMRCs, they have not yet been tested for this purpose.

## Incorporating SMM Information into MMRC Processes

Rather than reviewing individual SMMs in the comprehensive way that they review deaths, MMRCs may be able to increase their ability to identify prevention opportunities more efficiently by incorporating SMM information into their processes. Three commonly discussed ways that MMRCs can incorporate SMM information include:

*1) Incorporating SMM surveillance information.* MMRCs can bring descriptive surveillance information to their meetings, providing population-level context for deaths the MMRC reviews. For example, an MMRC might review trends, geographic variations, and populations disproportionately affected by the SMM indicator Amniotic Fluid Embolism if the MMRC will be reviewing a death caused by Amniotic Fluid Embolism. An advantage of SMM surveillance indicators and the SMM index is that they are measured using administrative data that are often readily available to MMRC members, and epidemiologists are increasingly familiar with using the SMM indicators. Ohio's Pregnancy-Associated Mortality Review is one example of an MMRC that has incorporated SMM surveillance information into development of its recommendations.[±]

*2) Incorporating aggregate facility-level review information.* As the number of facility-based SMM reviews increase within a jurisdiction, this creates opportunities for aggregating SMM information across hospitals for use by MMRCs at their meetings. Similar to SMM surveillance information, what is presented to the MMRC could be specific to the deaths they will discuss in that meeting, or to the leading causes of pregnancy-related death in their jurisdiction. An advantage that facility-based SMM review information has over the SMM surveillance data is that the facility review information is potentially richer in details, and is from the clinical provider perspective on care received related to SMM. The incorporation of aggregated facility-level SMM review information could help with understanding what SMM prevention opportunities MMRCs are not able to identify from a review of deaths. There is not currently a MMRC in the United States, that we are aware of, which is integrating facility SMM reviews into their processes; however, the New York City Maternal Mortality and Morbidity Review Committee (M3RC) is planning to pilot this approach in 2018.

*3) Incorporating SMM survivors' voices.* The voices of women who have survived an SMM can provide unique and important information to MMRC discussions which can then broaden recommendations. Two approaches for bringing survivors' voices into reviews are interviewing SMM survivors and including survivors as MMRC members.

*4) Interviewing SMM survivors.* Interviews with SMM survivors have been conducted across a diversity of settings, with recent publications from the United Kingdom[40] to Malaysia.[41] Interviews have taken place from one to 10 months after delivery.[40, 42, 43] Evidence suggests that it takes about one month before a SMM survivor begins to reflect back on their experience, and so it has been suggested that interviews not take place before one month after delivery.[43, 44] There were common findings across these diverse settings. Women commonly report fear for their ability to recover and implications for daily activity, frustration at not realizing the idealized pregnancy and birth, powerlessness that comes with experiencing the unexpected, and trauma from the experience of their emergency and in some cases the loss of a child. In terms of implications for care, common themes across these studies include a lack of communication between providers and patients (i.e., keeping the woman and her partner informed of what may happen or is happening), and a lack of information at discharge on how to manage their health once home. Survivors also commonly report lack of communication between emergency care and primary care providers. These interviews have typically taken place as part of research studies, rather than as part of ongoing surveillance and monitoring processes.

[±]For more information visit:
https://www.odh.ohio.gov/-/media/ODH/ASSETS/Files/cfhs/pamr/2017/SMM-Factsheet.pdf

There is not currently a MMRC in the United States that we are aware of, which has integrated SMM interviews into their processes; however, the aforementioned New York City M3RC is planning to pilot this approach in 2018. An example of what might come from this approach is provided in **Table 5**, which highlights good quality care practices identified by SMM survivors in the United Kingdom[45].

**Table 5.** Beneficial care practices identified by SMM survivors in the United Kingdom*

| | |
|---|---|
| **In the emergency** | Small personal touches of reassurance by doctors and midwives |
| | Information and small acts of kindness to reassure partners during anxious waiting |
| **Transfer in the hospital** | Sensitivity to women's emotional and physical needs to ease transfer |
| **Access to the baby** | Having access to their baby, even when very ill |
| **Follow-up** | Meeting with doctors to understand more about what had happened |
| | The opportunity to see and go through their notes |
| | Sensitivity about where follow-up meetings took place |
| **Communication & Understanding** | Good communication with health professionals during pregnancy |
| | Good communication afterwards to help women make sense of the experience |
| **Postnatal support** | Support from their primary care team after discharge, as women recover and try to get back to normal life |
| | Counseling to help with long-lasting mental impacts |

*Adapted from Knight M, et al. 2016.[45]

*5) Including SMM survivors as MMRC members.* The inclusion of patient and/or family advisors in clinical quality improvement processes is not new, but is new for MMRCs. For a decade, the Joint Commission has engaged patients and families through a Patient and Family Advisory Council, recognizing their role in helping to address patient safety and health care quality improvement.* The Agency for Healthcare Research and Quality has also recognized the value of patient and family engagement in safety and quality improvement initiatives in hospitals.[46] State-level safety initiatives have also engaged patient and family representatives.[47]

The Perinatal Quality Collaborative of North Carolina (PQCNC) took a thoughtful approach early in their formation to identify what role families should have and how they should be engaged in the perinatal quality improvement processes of the PQCNC.[47] The patient and family engagement has evolved over time in the PQCNC, from a separate patient and family initiative into integrated representation in their hospitals' Perinatal Quality Improvement Teams.** The success in North Carolina has encouraged and informed the engagement of patient and family representatives in other state perinatal quality collaboratives. The Florida Perinatal Quality Collaborative (FPQC) has a family representative on their Steering Committee who helps to ensure that priority perinatal quality improvement initiatives are informed by the family voice.*** Most recently the Illinois Perinatal Quality Collaborative (ILPQC), working in partnership with the Preeclampsia Foundation, the March of Dimes, and Hand to Hold, is engaging Patient Advisors to participate on hospital teams implementing quality improvement initiatives.**** Currently, we are not aware of any MMRCs that include a patient/SMM survivor member. This may reflect the challenge of identifying representatives who can provide a holistic voice across the diversity of deaths MMRCs review; nonetheless, including SMM survivors as MMRC members may be the most effective ongoing approach for incorporating SMM information into MMRC processes.

* https://www.jointcommission.org/facts_about_the_patient_and_family_advisory_council/

** https://www.pqcnc.org/

*** http://health.usf.edu/publichealth/chiles/fpqc

**** http://ilpqc.org/

# Incorporating Equity – an Update

## Analytic Framework: Theoretical Background

Maternal mortality rates in the United States are higher than many other developed countries, and social factors may contribute to this difference.[4] Non-Hispanic black women experience maternal deaths at a rate three to four times that of non-Hispanic white women, a racial disparity that is mirrored across many maternal and infant outcomes.[4, 48] Studies have suggested that socioeconomic status and geography or location are related to maternal death.[2, 49, 50]

These upstream factors that affect a person's well-being are sometimes called social determinants of health. When conceptualizing the possible relationships between social determinants of health and maternal mortality, it is useful to consider the potential pathways. Theoretical models can be used to describe and organize social determinants of health and their mechanisms, typically characterized by at least three domains: 1) they consider social factors (e.g., socioeconomic status) as multidimensional, 2) they situate individuals within multi-level contexts, and 3) they incorporate time in a life course and historical framework with respect to the timing and duration of exposures across the life course. Organizing determinants into multiple dimensions and levels allows us to consider the context in which a woman lived and to understand the potential effects of social factors on her death.

There is a connection between social determinants of health and location. When women live in areas without access to reliable transportation, fresh and affordable groceries, and safe public spaces for recreation and fitness, they are more likely to have worse maternal outcomes than women who have access to these resources. Many of these social determinants of health are spatially patterned at each level, creating geographic variation in risks. For example, rural/urban variation or spatial disparities within urban areas may reflect the different contexts of social and health care experiences in each location. If the location of health outcomes is known, they can be linked to individual and contextual level variables to describe multi-dimensional and multi-level determinants. Considering contextual levels enables us to think directly about regional- and systems-level issues and translate findings into specific recommendations at those same levels.

## Data Sources

*Geocoding.* To be useful in examining maternal mortality or another outcome, community factors need to be linked to individual outcomes or events. Many of these contextual variables are publicly available, but individual events must have a spatial marker to link them with these variables. Having an address for an event allows it to be geocoded, which can then be used to associate it with contextual factors. MMRIA collects this information and geocodes each death, allowing MMRCs to incorporate contextual social determinants of health into case discussions and examine the relationship between contextual social determinants of health and maternal mortality.

*Contextual level variables.* Information on the social determinants of health for contextual level variables is available from a number of publicly available sources, including the American Community Survey (ACS) and the Area Health Resource File (AHRF). The ACS collects demographic and socioeconomic information and is sampled on a continuous basis. The AHRF compiles variables on health care access and use from multiple sources.

It is important to consider the spatial level at which variables are measured, because different spatial levels correlate with different levels of social determinants. Some variables are measured at the level of census tract—a geographic area with 1,200-8,000 residents—which may estimate the influences of a woman's local environment. Other variables are measured at a county level, which approximate a broader set of influences, including policies.

*Limitations.* The socio-spatial indicators available can help MMRCs describe contributors to inequity, of which geographic, income, and racial-ethnic disparities in pregnancy-related mortality are a symptom. However, potentially important indicators are not available. We can describe a community's access to care but not the quality of care provided. We can describe a community's level of segregation but not its level of racism, structural inequity and discrimination, or the chronic stress it causes. We also lack standard measures for less tangible but positive influences on maternal health outcomes, such as the presence of supportive motherhood groups and other faith- and community-based outreach organizations. We prioritized broad domains and illustrative community-based indicators that have previously been associated with maternal health and perinatal outcomes such as fetal growth restriction, inadequate or excessive maternal perinatal weight gain, pregnancy-related hypertension, or infant mortality. Correlates of these perinatal outcomes may also influence risk for maternal death. We can learn from infant mortality and there is a lot of momentum to identify better indicators of structural inequity and how they impact maternal outcomes.[51-54] As indicators become available, they can be incorporated into the framework. Despite these limitations, we present a framework that advances the incorporation of health equity into MMRC discussions.

## The MMRIA Equity Framework

The process of maternal mortality review centers on a comprehensive assessment of the underlying causes of each maternal death in order to characterize which deaths are potentially preventable and what interventions could be instituted to affect different outcomes in the future. The power in this approach comes from the holistic review by multidisciplinary teams that consider the cascade of events leading towards that final tragic event.

The MMRIA tool encourages MMRCs to consider the contributions of patient/family, provider, facility, health system and community-level factors as part of the broader context of each death. The presence of large and persistent population-level disparities in maternal mortality—by race, class and geography—suggest that this"broader context' for examination should include not only individual-level factors that distinguish "high risk" from "low risk" women, but also social contextual factors which systematically expose populations of women to higher or lower risk environments. Despite the theoretical importance of looking at socio-spatial context and environment as contributors to population disparities in maternal mortality, in our first year Report from Maternal Mortality Review Committees: A View into their Critical Role, no committees identified "community-level" factors as contributors to pregnancy-related deaths. This could have occurred for one of at least three reasons:

1. There were no deaths for which community factors had a contributing role.
2. Review committees did not have community-based data on which to base the attribution of community-level factors to any cases.
3. Review committees may not perceive that community-based social determinants of health are modifiable, and therefore the death was not preventable at the community level.

While it is possible that community-based factors had no impact on any deaths, this would counter current evidence. While there is very little research testing the role of any specific social determinants of maternal mortality, there is substantial evidence supporting the causal role of social determinants for disparities in other related morbidity and mortality (e.g., pre-term birth, infant mortality). Therefore, we do not assume that the absence of "community-level" factors in our last report is evidence that community-level factors do not contribute to pregnancy-related death.

The social and environmental experiences (e.g., exposures, resources, and opportunities) shared by population groups defined by race, class or geography affect individual health behaviors, exposures and opportunities. These group-level factors may explain group-level differences in individual risk factor prevalence, or, alternatively, the social environment may contribute to the background "usual" rate of

disease observed for a given population. To enrich the maternal mortality case narrative with plausible community-based contextual data, we developed a framework which builds on four underlying assumptions and objectives:

1. First, we assumed that the geographic communities in which women live, work and seek health care contain important opportunities and exposures that pattern women's health before conception, during pregnancy, and postpartum. Thus, geographically-referenced indicators mark potential risks related to social determinants of health for mothers.
2. Second, we identified five broad domains that capture aspects of the health service infrastructure, variation in access to quality care, indicators of local population health and the broader socioeconomic environment. We identified three health-specific domains (general health environment, reproductive health environment, and behavioral health environment), as well as the transportation environment, as important community-based determinants of women's health. We further posit that the broader socioeconomic environment influences the density and quality of health-specific resources (e.g., the previous four domains), and can also directly affect individual health and population health equity.
3. Third, we sought to identify specific community-based or systems-level indicators or measures that rely on existing data and can be readily incorporated into maternal mortality review activities. The indicators are selected to capture aspects of the health service environment, the social environment, and the state of population health in each woman's local geographic region.
4. Finally, we identified evidence-informed policy and programmatic interventions that serve as models for the translation of community-level contributors to mortality into future prevention activities. We identified the evidence-informed policies using a systematic web-based narrative review of the academic literature and publicly available information on existing policy interventions addressing the identified community risk factors.

While the specific indicators continue to evolve, **Table 6** lists several illustrative indicators for each domain, as well as a brief summary of identified evidence-informed community-based interventions that map onto the domains. The summaries are drawn from an inventory of potential policy interventions. Many policies are repeated across multiple domains, particularly those addressing disparities in access to specialized care in the perinatal period. For example, telemedicine policy interventions—both for direct service provision, as well as to increase provider collaboration and training—would be appropriate to address risk factors in the general health, reproductive health and behavioral health services environment domains. State-administered Medicaid programs have enormous potential to use innovative strategies for improving maternal health, reflected here in policy options addressing multiple issues including maternal depression, access to interconception care, as well as language and transportation services.

To integrate these socio-spatial indicators and the table of evidence-informed policies, we propose a visual "dashboard" representing the community-based factors for each case with her "community" defined by her residential geocoded address. A mock-up of one sample dashboard is represented in **Figure 17**, with interpretation guides in **Figure 18**. Note that this preliminary dashboard contains only a subset of the indicators in Table 6, but a more complete dashboard is in development. In the future, this dashboard will be available via the MMRIA system to facilitate the committee's case narrative development and discussion. The "policy menu" will also be provided for facilitating committee recommendations based on their case discussions.

**Table 6.** Health Equity Domains, Indicators, and Potential Policy and Programmatic Interventions

| PROPOSED SOCIO-SPATIAL INDICATORS | DATA SOURCE | EXAMPLES OF POSSIBLE INTERVENTIONS FOR THIS DOMAIN |
|---|---|---|
| **GENERAL HEALTH SERVICES ENVIRONMENT** | | |
| Primary Care provider availability | Area Resource File | • Telemedicine (direct service provision and provider continuing education)<br>• State Medicaid reimbursement policies that incentivize telemedicine<br>• Training and loan repayment programs to incentivize clinician location<br>• Mobile health units<br>• State administrative and reimbursement policies that incentivize providers to accept Medicaid |
| Medicaid eligible | Area Resource File | |
| Uninsured | SAHIE | |
| Obesity | County Rankings/BRFSS | |
| Poor/Fair self-rated health | County Rankings/BRFSS | |
| **REPRODUCTIVE HEALTH SERVICES ENVIRONMENT** | | |
| Obstetrician availability | Area Resource File | • Telemedicine (direct service provision and provider collaboration/continuing education)<br>• State Medicaid reimbursement policies that incentivize telemedicine<br>• Collaboration around integration of care and safe transfers during birth<br>• Mobile health units<br>• Family Medicine rotations and residency with a focus on obstetric services |
| Certified Nurse Midwife availability | Area Resource File | Reduce barriers to independent practice for advanced practice Registered Nurses |
| Family planning needs | Guttmacher Institute | • State Medicaid patient reimbursement for contraception and education in clinical settings<br>• Training of primary care physicians on contraceptive methods |
| Newborn care resources | Area Resource File | Integration of care and safe transfer of care |
| Infant mortality | County Rankings/NCHS | |
| Low birthweight | County Rankings/NCHS | |
| Chlamydia | County Rankings/CDC | |
| Teen pregnancy | County Rankings/NCHS | |
| **BEHAVIORAL HEALTH ENVIRONMENT** | | |
| Mental Health provider availability | Area Resource File | • Telemedicine (direct service provision and provider collaboration/continuing education)<br>• Medicaid reimbursement for maternal depression screening during well-child screening |

| PROPOSED SOCIO-SPATIAL INDICATORS | DATA SOURCE | EXAMPLES OF POSSIBLE INTERVENTIONS FOR THIS DOMAIN |
|---|---|---|
| | | • Provider training on integrating maternal mental health services into the clinical setting<br>• Increased collaboration between medical and behavioral health providers |
| Poor mental health days | County rankings/BRFSS | |
| Frequent mental distress | County rankings/BRFSS | |
| Drug overdose deaths | County rankings/ CDC Wonder | |
| Non-medical opioid use | SAMHSA/NSDUH | • Provision of priority access for maternal drug treatment programs<br>• Access to Medication Assisted Treatment for pregnant women |
| Any mental illness | SAMHSA/NSDUH | |
| Unmet substance abuse need | SAMHSA/NSDUH | Public education to reduce stigma among medical professionals |
| Prevalence serious thoughts of suicide | SAMHSA/NSDUH | |
| **TRANSPORTATION ENVIRONMENT** | | |
| Rural/Urban composition | ACS | |
| Car ownership | ACS | • State Medicaid reimbursement for non-emergency transportation<br>• Public transportation grants and initiatives<br>• Ride hailing partnerships |
| Long commute driving alone | County rankings/ ACS | Ride hailing partnerships |
| Public transit availability | EPA Smart Location Database | • Public transportation grants and initiatives<br>• State Medicaid reimbursement for non-emergency transportation<br>• Ride hailing partnerships |
| **SOCIAL AND ECONOMIC ENVIRONMENT** | | |
| Current poverty and persistent poverty | ACS | • Increased screening and counseling for intimate partner violence<br>• Integrated referrals to social service supports in clinical models<br>• Group prenatal care |
| Violent Crime | FBI Uniform Crime Reporting | Integrated referrals to social service supports in clinical models |
| Income Inequality | ACS | • Increased screening and counseling for intimate partner violence<br>• Integrated referrals to social service supports in clinical models |
| Educational attainment | ACS | • Integrated referrals to social service supports in clinical models<br>• Group prenatal care |
| Severe Housing Problems | County rankings | |
| Ability to speak English | ACS | • State certification for medical interpreters<br>• Medicaid reimbursement for language services<br>• Video medical interpretation |
| Racial & Economic Segregation | ACS | |

**Figure 17.** Interpreting the (Proposed) MMRIA Socio-Spatial Dashboard

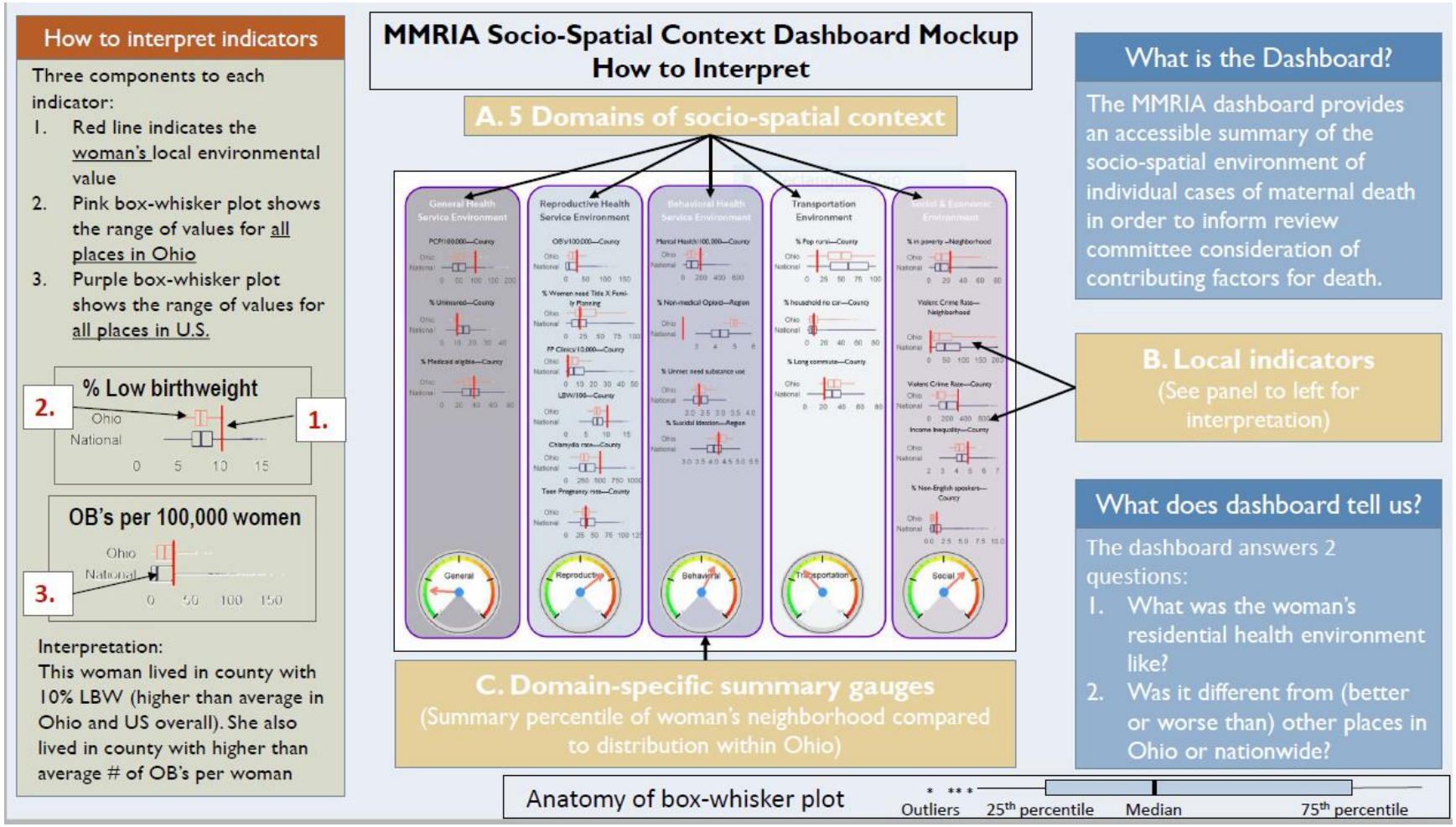
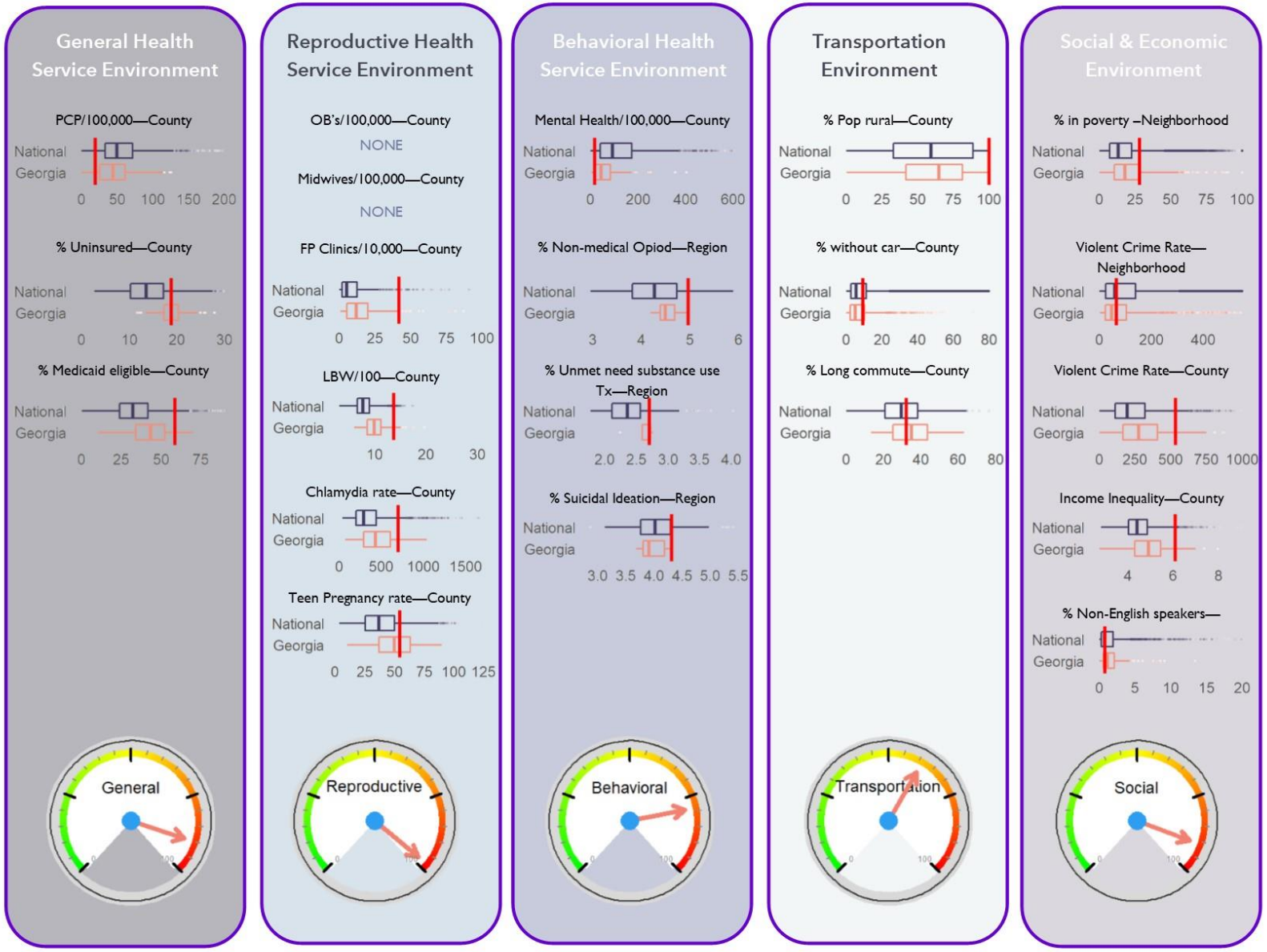


**Figure 18.** Example of MMRIA Socio-Spatial Dashboard



## Moving forward

*Contextual level measures.* We have developed a theoretical basis for examining social determinants at a contextual level for maternal mortality and have identified a preliminary set of contextual measures related to maternal mortality.

*Understanding the relationship between equity and maternal mortality.* We will continue to refine the analytic approaches for examining the association of selected socio-spatial variables with maternal mortality. A priority is to explore and document the implications for using different potential measures to represent maternal mortality, considering the rate (per woman of reproductive age) and the ratio (per live births). Effective analyses of the association between the exposure of contextual-level social determinants and the outcome of pregnancy-associated mortality can then be conducted.

*Incorporating equity into review discussions.* We will work closely with MMRCs, supporting their incorporation of this information into case narrative development and committee discussions and decisions.

# Summary

The process of maternal mortality review centers on a comprehensive assessment of the underlying causes of each maternal death in order to characterize which deaths are potentially preventable and what interventions could be instituted to affect different outcomes in the future. MMRCs have made significant progress towards using a common set of data elements to comprehensively assess and address maternal deaths. We are gaining insight into not only the underlying causes of death, but to the cascade of events ultimately leading to the tragic event. With this powerful insight, MMRCs are targeting recommendations for action. As more data are available, further analyses within and across race-ethnicity, age at death, cause of death, and geography will be possible. Improved richness of recommendation descriptions will also deepen our understanding of the best opportunities for preventing pregnancy-related deaths.

Mental health conditions continue to be a leading underlying cause of pregnancy-related maternal deaths, and they serve as contributors to even more maternal deaths. MMRCs are in a unique position to identify and document the contribution of mental health conditions to pregnancy-related mortality because of their comprehensive and multidisciplinary approach. We will continue to work with MMRCs to identify opportunities and tools to assist in the review and documentation of deaths related to mental health conditions and substance use disorder.

A maternal death is the most extreme and the most rare negative maternal outcome. Actions taken in response to review committee recommendations can lead to reductions in negative maternal health outcomes that may be too common to individually review at a state or local level (e.g., severe maternal morbidity). Lastly, social and environmental factors may contribute to a woman's risk of dying during or within one year of pregnancy. MMRCs can incorporate contextual social determinants of health into case discussions, and translate findings into specific recommendations at the regional- and systems-level.

Each maternal death is one too many. While we encourage existing MMRCs to comprehensively review cases, we will continue technical assistance on establishing MMRCs and MMRIA system development to address emerging issues. The Building U.S. Capacity to Review and Prevent Maternal Deaths team will also work on an updated 2019 Report from Maternal Mortality Review Committees to release early next year.

State- and local-level MMRCs are poised to be the gold standard for understanding why maternal deaths continue to occur and make recommendations for action. However, there is still more work to do to connect MMRC data to action. Commitment at multiple levels is necessary to achieve this goal. Women and families deserve no less.

# Appendix A:

## Maternal Mortality Review Committee Decisions Form

Form begins on the next page.

REVIEW DATE

RECORD ID #

PREGNANCY-RELATEDNESS: SELECT ONE

- ☐ **PREGNANCY-RELATED**
  The death of a woman during pregnancy or within one year of the end of pregnancy from a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy
- ☐ **PREGNANCY-ASSOCIATED, BUT NOT -RELATED**
  The death of a woman during pregnancy or within one year of the end of pregnancy from a cause that is not related to pregnancy
- ☐ **UNABLE TO DETERMINE IF PREGNANCY-RELATED OR PREGNANCY-ASSOCIATED, BUT NOT -RELATED**
- ☐ **NOT PREGNANCY-RELATED OR -ASSOCIATED**
  (i.e. false positive, woman was not pregnant within one year of her death)

ESTIMATE THE DEGREE OF RELEVANT INFORMATION (RECORDS) AVAILABLE FOR THIS CASE:

- ☐ **COMPLETE**
  All records necessary for adequate review of the case were available
- ☐ **MOSTLY COMPLETE**
  Minor gaps (i.e. information that would have been beneficial but was not essential to the review of the case)
- ☐ **SOMEWHAT COMPLETE**
  Major gaps (i.e. information that would have been crucial to the review of the case)
- ☐ **NOT COMPLETE**
  Minimal records available for review (i.e. death certificate and no additional records)
- ☐ **N/A**

DOES THE COMMITTEE AGREE WITH THE UNDERLYING CAUSE OF DEATH LISTED ON DEATH CERTIFICATE? ☐ **YES** ☐ **NO**

## COMMITTEE DETERMINATION OF CAUSE(S) OF DEATH

| TYPE | CAUSE (DESCRIPTIVE) |
|---|---|
| IMMEDIATE | |
| CONTRIBUTING | |
| UNDERLYING | |
| OTHER SIGNIFICANT | |

**IF PREGNANCY-RELATED, COMMITTEE DETERMINATION OF UNDERLYING CAUSE OF DEATH**
Refer to page 3 for PMSS-MM cause of death list. If more than one is selected, list in order of importance beginning with the most compelling (1-2; no more than 2 may be selected in the system).

| | | | | |
|---|---|---|---|---|
| DID **OBESITY** CONTRIBUTE TO THE DEATH? | ☐ YES | ☐ PROBABLY | ☐ NO | ☐ UNKNOWN |
| DID **MENTAL HEALTH CONDITIONS** CONTRIBUTE TO THE DEATH? | ☐ YES | ☐ PROBABLY | ☐ NO | ☐ UNKNOWN |
| DID **SUBSTANCE USE DISORDER** CONTRIBUTE TO THE DEATH? | ☐ YES | ☐ PROBABLY | ☐ NO | ☐ UNKNOWN |
| WAS THIS DEATH A **SUICIDE**? | ☐ YES | ☐ PROBABLY | ☐ NO | ☐ UNKNOWN |
| WAS THIS DEATH A **HOMICIDE**? | ☐ YES | ☐ PROBABLY | ☐ NO | ☐ UNKNOWN |

IF HOMICIDE, SUICIDE, OR ACCIDENTAL DEATH, LIST THE **MEANS OF FATAL INJURY**

- ☐ FIREARM
- ☐ SHARP INSTRUMENT
- ☐ BLUNT INSTRUMENT
- ☐ POISONING/ OVERDOSE
- ☐ HANGING/ STRANGULATION/ SUFFOCATION
- ☐ FALL
- ☐ PUNCHING/ KICKING/BEATING
- ☐ EXPLOSIVE
- ☐ DROWNING
- ☐ FIRE OR BURNS
- ☐ MOTOR VEHICLE
- ☐ INTENTIONAL NEGLECT
- ☐ OTHER, SPECIFY:
- ☐ UNKNOWN
- ☐ NOT APPLICABLE

IF HOMICIDE, WHAT WAS THE **RELATIONSHIP OF THE PERPETRATOR TO THE DECEDENT**?

- ☐ NO RELATIONSHIP
- ☐ PARTNER
- ☐ EX-PARTNER
- ☐ OTHER RELATIVE
- ☐ OTHER ACQUAINTANCE
- ☐ OTHER, SPECIFY:
- ☐ UNKNOWN
- ☐ NOT APPLICABLE

## COMMITTEE DETERMINATION OF PREVENTABILITY

A death is considered preventable if the committee determines that there was at least some chance of the death being averted by one or more reasonable changes to patient, family, provider, facility, system and/or community factors.

| | | |
|---|---|---|
| WAS THIS DEATH **PREVENTABLE**? | ☐ YES | ☐ NO |
| CHANCE TO ALTER OUTCOME? | ☐ GOOD CHANCE | ☐ SOME CHANCE |
| | ☐ NO CHANCE | ☐ UNABLE TO DETERMINE |

## CONTRIBUTING FACTORS WORKSHEET

What were the factors that contributed to this death? Multiple contributing factors may be present at each level.

| CONTRIBUTING FACTOR LEVEL | CONTRIBUTING FACTOR AND DESCRIPTION OF ISSUE |
|---|---|
| PATIENT/FAMILY | |
| PROVIDER | |
| FACILITY | |
| SYSTEM | |
| COMMUNITY | |

### CONTRIBUTING FACTOR KEY (DESCRIPTIONS ON PAGE 4)

- Delay
- Adherence
- Knowledge
- Cultural/religious
- Environmental
- Violence
- Mental health conditions
- Substance use disorder - alcohol, illicit/prescription drugs
- Tobacco use
- Chronic disease
- Childhood abuse/ trauma
- Access/financial
- Unstable housing
- Social support/ isolation
- Equipment/ technology
- Policies/procedures
- Communication
- Continuity of care/ care coordination
- Clinical skill/ quality of care
- Outreach
- Enforcement
- Referral
- Assessment
- Legal
- Other

## RECOMMENDATIONS OF THE COMMITTEE

If there was at least some chance that the death could have been averted, what were the specific and feasible actions that, if implemented or altered, might have changed the course of events?

| RECOMMENDATIONS OF THE COMMITTEE | LEVEL OF PREVENTION (SEE BELOW) | LEVEL OF IMPACT (SEE BELOW) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

### PREVENTION LEVEL

- **PRIMARY:** Prevents the contributing factor before it ever occurs
- **SECONDARY:** Reduces the impact of the contributing factor once it has occurred (i.e. treatment)
- **TERTIARY:** Reduces the impact or progression of an ongoing contributing factor once it has occurred (i.e. management of complications)

### EXPECTED IMPACT LEVEL

- **SMALL:** Education/counseling (community- and/or provider-based health promotion and education activities)
- **MEDIUM:** Clinical intervention and coordination of care across continuum of well-woman visits through obstetrics (protocols, prescriptions)
- **LARGE:** Long-lasting protective intervention (improve readiness, recognition and response to obstetric emergencies/LARC)
- **EXTRA LARGE:** Change in context (promote environments that support healthy living/ensure available and accessible services)
- **GIANT:** Address social determinants of health (poverty, inequality, etc.)

## IF PREGNANCY-RELATED, COMMITTEE DETERMINATION OF UNDERLYING CAUSE OF DEATH* PMSS-MM

If more than one is selected, please list them in order of importance beginning with the most compelling (1-2; no more than 2 may be selected in the system).

*PREGNANCY-RELATED DEATH: THE DEATH OF A WOMAN DURING PREGNANCY OR WITHIN ONE YEAR OF THE END OF PREGNANCY FROM A PREGNANCY COMPLICATION, A CHAIN OF EVENTS INITIATED BY PREGNANCY, OR THE AGGRAVATION OF AN UNRELATED CONDITION BY THE PHYSIOLOGIC EFFECTS OF PREGNANCY.

- ☐ **10** Hemorrhage (excludes aneurysms or CVA)
- ☐ **10.1** Hemorrhage – rupture/laceration/ intra-abdominal bleeding
- ☐ **10.2** Placental abruption
- ☐ **10.3** Placenta previa
- ☐ **10.4** Ruptured ectopic pregnancy
- ☐ **10.5** Hemorrhage - uterine atony/postpartum hemorrhage
- ☐ **10.6** Placenta accreta/increta/percreta
- ☐ **10.7** Hemorrhage due to retained placenta
- ☐ **10.8** Hemorrhage due to primary DIC
- ☐ **10.9** Other hemorrhage/NOS
- ☐ **20** Infection
- ☐ **20.1** Postpartum genital tract (e.g. of the uterus/ pelvis/perineum/necrotizing fasciitis)
- ☐ **20.2** Sepsis/septic shock
- ☐ **20.4** Chorioamnionitis/antepartum infection
- ☐ **20.5** Non-pelvic infections (e.g. pneumonia, TB, meningitis, HIV)
- ☐ **20.6** Urinary tract infection
- ☐ **20.9** Other infections/NOS
- ☐ **30** Embolism - thrombotic (non-cerebral)
- ☐ **30.9** Other embolism/NOS
- ☐ **31** Embolism - amniotic fluid
- ☐ **40** Preeclampsia
- ☐ **50** Eclampsia
- ☐ **60** Chronic hypertension with superimposed preeclampsia
- ☐ **70** Anesthesia complications
- ☐ **80** Cardiomyopathy
- ☐ **80.1** Postpartum/peripartum cardiomyopathy
- ☐ **80.2** Hypertrophic cardiomyopathy
- ☐ **80.9** Other cardiomyopathy/NOS
- ☐ **82** Hematologic
- ☐ **82.1** Sickle cell anemia
- ☐ **82.9** Other hematologic conditions including thrombophilias/TTP/HUS/NOS
- ☐ **83** Collagen vascular/autoimmune diseases
- ☐ **83.1** Systemic lupus erythematosis (SLE)
- ☐ **83.9** Other collagen vascular diseases/NOS
- ☐ **85** Conditions unique to pregnancy (e.g. gestational diabetes, hyperemesis, liver disease of pregnancy)
- ☐ **88** Injury
- ☐ **88.1** Intentional (homicide)
- ☐ **88.2** Unintentional
- ☐ **88.9** Unknown/NOS
- ☐ **89** Cancer
- ☐ **89.1** Gestational trophoblastic disease (GTD)
- ☐ **89.3** Malignant melanoma
- ☐ **89.9** Other malignancies/NOS
- ☐ **90** Cardiovascular conditions
- ☐ **90.1** Coronary artery disease/myocardial infarction (MI)/atherosclerotic cardiovascular disease
- ☐ **90.2** Pulmonary hypertension
- ☐ **90.3** Valvular heart disease congenital and acquired
- ☐ **90.4** Vascular aneurysm/dissection (non-cerebral)
- ☐ **90.5** Hypertensive cardiovascular disease
- ☐ **90.6** Marfan Syndrome
- ☐ **90.7** Conduction defects/arrhythmias
- ☐ **90.8** Vascular malformations outside head and coronary arteries
- ☐ **90.9** Other cardiovascular disease, including CHF, cardiomegaly, cardiac hypertrophy, cardiac fibrosis, non-acute myocarditis/NOS
- ☐ **91** Pulmonary conditions (excludes ARDS-Adult respiratory distress syndrome)
- ☐ **91.1** Chronic lung disease
- ☐ **91.2** Cystic fibrosis
- ☐ **91.3** Asthma
- ☐ **91.9** Other pulmonary disease/NOS
- ☐ **92** Neurologic/neurovascular conditions (excluding CVAs)
- ☐ **92.1** Epilepsy/seizure disorder
- ☐ **92.9** Other neurologic diseases/NOS
- ☐ **93** Renal disease
- ☐ **93.1** Chronic renal failure/End-stage renal disease (ESRD)
- ☐ **93.9** Other renal disease/NOS
- ☐ **95** Cerebrovascular accident (hemorrhage/ thrombosis/aneurysm/ malformation) not secondary to hypertensive disease
- ☐ **96** Metabolic/endocrine
- ☐ **96.1** Obesity
- ☐ **96.2** Diabetes mellitus
- ☐ **96.9** Other metabolic/endocrine disorders
- ☐ **97** Gastrointestinal disorders
- ☐ **97.1** Crohn's disease/ulcerative colitis
- ☐ **97.2** Liver disease/failure/transplant
- ☐ **97.9** Other gastrointestinal diseases/NOS
- ☐ **100** Mental health conditions
- ☐ **100.1** Depression
- ☐ **100.9** Other psychiatric conditions/NOS
- ☐ **999** Unknown COD

## CONTRIBUTING FACTOR DESCRIPTIONS

**DELAY** OR FAILURE TO SEEK CARE

The woman was delayed in seeking or did not access care, treatment, or follow-up care/actions (e.g. missed appointment and did not reschedule).

**ADHERENCE** TO MEDICAL RECOMMENDATIONS

The woman did not accept medical advice (e.g. refused treatment for religious or other reasons or left the hospital against medical advice).

**KNOWLEDGE** - LACK OF KNOWLEDGE REGARDING IMPORTANCE OF EVENT OR OF TREATMENT OR FOLLOW-UP

The woman did not receive adequate education or lacked knowledge or understanding regarding the significance of a health event (e.g. shortness of breath as a trigger to seek immediate care) or lacked understanding about the need for treatment/follow-up after evaluation for a health event (e.g. needed to keep appointment for psychiatric referral after an ED visit for exacerbation of depression).

**CULTURAL/RELIGIOUS**, OR LANGUAGE FACTORS

Demonstration that any of these factors was either a barrier to care due to lack of understanding or led to refusal of therapy due to beliefs (or belief systems).

**ENVIRONMENTAL** FACTORS

Factors related to weather or terrain (e.g. the advent of a sudden storm leads to a motor vehicle accident).

**VIOLENCE** AND INTIMATE PARTNER VIOLENCE (IPV)

Physical or emotional abuse other than that perpetrated by intimate partner (e.g. family member or stranger); IPV: Physical or emotional abuse perpetrated by the woman's current or former intimate partner.

**MENTAL HEALTH CONDITIONS**

The woman carried a diagnosis of a psychiatric disorder. This includes postpartum depression.

**SUBSTANCE USE DISORDER – ALCOHOL, ILLICIT/ PRESCRIPTION DRUGS**

Substance use disorder is characterized by recurrent use of alcohol and/or drugs causing clinically and functionally significant impairment, such as health problems or disability. The committee may determine that substance use disorder contributed to the death when the disorder directly compromised a woman's health status (e.g. acute methamphetamine intoxication exacerbated pregnancy-induced hypertension, or woman was more vulnerable to infections or medical conditions).

**TOBACCO USE**

Woman's use of tobacco directly compromised the woman's health status (e.g. long-term smoking led to underlying chronic lung disease).

**CHRONIC DISEASE**

Occurrence of one or more significant pre-existing medical conditions (e.g. obesity, cardiovascular disease, or diabetes).

**CHILDHOOD SEXUAL ABUSE/TRAUMA**

Woman experienced rape, molestation, or other sexual exploitation during childhood plus persuasion, inducement, or coercion of a child to engage in sexually explicit conduct; or woman experienced physical or emotional abuse or violence other than that related to sexual abuse during childhood.

LACK OF **ACCESS/FINANCIAL** RESOURCES

System issues, e.g. lack or loss of healthcare insurance or other financial duress, as opposed to woman's noncompliance impacted woman's ability to care for herself (e.g. did not seek services because unable to miss work or afford postpartum visits after insurance expired). Other barriers to accessing care: insurance non-eligibility, provider shortage in woman's geographical area, and lack of public transportation.

**UNSTABLE HOUSING**

Woman lived "on the street" or in a homeless shelter or lived in transitional or temporary circumstances with family or friends.

**SOCIAL SUPPORT/ISOLATION** - LACK OF FAMILY/ FRIEND SUPPORT SYSTEM

Social support from family, partner, or friends was lacking, inadequate, and/or dysfunctional (e.g. domestic violence, no one to rely on to ensure appointments were kept).

INADEQUATE OR UNAVAILABLE **EQUIPMENT/ TECHNOLOGY**

Equipment was missing, unavailable, or not functional, (e.g. absence of blood tubing connector).

LACK OF STANDARDIZED **POLICIES/PROCEDURES**

The facility lacked basic policies or infrastructure germane to the woman's needs (e.g. response to high blood pressure or a lack of or outdated policy or protocol).

POOR **COMMUNICATION**/LACK OF CASE COORDINATION OR MANAGEMENT/ LACK OF CONTINUITY OF CARE (SYSTEM PERSPECTIVE)

Care was fragmented (i.e. uncoordinated or not comprehensive) among or between healthcare facilities or units, (e.g. records not available between inpatient and outpatient or among units within the hospital, such as Emergency Department and Labor and Delivery).

LACK OF **CONTINUITY OF CARE**

Care providers did not have access to woman's complete records or did not communicate woman's status sufficiently. Lack of continuity can be between prenatal, labor and delivery, and postpartum providers.

**CLINICAL SKILL/QUALITY OF CARE**

Personnel were not appropriately skilled for the situation or did not exercise clinical judgment consistent with current standards of care (e.g. error in the preparation or administration of medication or unavailability of translation services).

INADEQUATE COMMUNITY **OUTREACH**/RESOURCES

Lack of coordination between healthcare system and other outside agencies/organizations in the geographic/cultural area that work with maternal child health issues.

INADEQUATE LAW **ENFORCEMENT** RESPONSE

Law enforcement response was not in a timely manner or was not appropriate or thorough in scope.

LACK OF **REFERRAL** OR CONSULTATION

Specialists were not consulted or did not provide care; referrals to specialists were not made.

FAILURE TO SCREEN/INADEQUATE **ASSESSMENT** OF RISK

Factors placing the woman at risk for a poor clinical outcome recognized, and the woman was not transferred/transported to a provider able to give a higher level of care.

**LEGAL**

Legal considerations that impacted outcome.

# Appendix B:

## Underlying Cause of Death Regroupings

| REGROUPING | SPECIFIED CAUSES INCLUDED IN REGROUPING |
|---|---|
| Anesthesia Complications | |
| Amniotic Fluid Embolism | |
| Autoimmune Diseases | Systemic lupus erythematosus, Other collagen vascular diseases/Not otherwise specified |
| Blood Disorders | Sickle cell anemia, Other hematologic conditions including thrombophilias/Thrombotic thrombocytopenic purpura/Hemolytic uremic syndrome/Not otherwise specified |
| Cardiomyopathy | Postpartum/peripartum cardiomyopathy, Hypertrophic cardiomyopathy, Other cardiomyopathy/Not otherwise specified |
| Cardiovascular and Coronary Conditions | Coronary artery disease/Myocardial infarction/Atherosclerotic cardiovascular disease, Pulmonary hypertension, Valvular heart disease, Vascular aneurysm/Dissection, Hypertensive cardiovascular disease, Marfan's syndrome, Conduction defects/Arrhythmias, Vascular malformations outside the head and coronary arteries, Other cardiovascular disease, including congestive heart failure, cardiomegaly, cardiac hypertrophy, cardiac fibrosis, and non-acute myocarditis/Not otherwise specified |
| Cerebrovascular Accidents | Hemorrhage/thrombosis/aneurysm/ malformation, but not secondary to hypertensive disease |
| Conditions Unique to Pregnancy | e.g., Gestational diabetes, Hyperemesis, Liver disease of pregnancy |
| Embolism | Thrombotic (non-cerebral), Other embolism/Not otherwise specified |
| Hemorrhage | Rupture/Laceration/Intra-abdominal bleeding; Placental abruption, Placenta previa, Ruptured ectopic pregnancy, uterine atony/ postpartum hemorrhage, Placenta accreta/increta/percreta, due to retained placenta, due to primary disseminated intravascular coagulation, Other hemorrhage/not otherwise specified |
| Homicide | Intentional injury |
| Infection | Postpartum genital tract (e.g., of the uterus/pelvis/perineum/necrotizing fasciitis), Sepsis/septic shock, Chorioamnionitis/antepartum infection, Non-pelvic infections (e.g., pneumonia, H1N1, meningitis, HIV), Urinary tract infection, Other infections/Not otherwise specified |
| Liver and Gastrointestinal Conditions | Crohn's disease/Ulcerative colitis, Liver disease/failure/transplant, Other gastrointestinal diseases/Not otherwise specified |
| Malignancies | Gestational trophoblastic disease, Malignant melanoma, Other malignancies/Not otherwise specified |
| Mental Health Conditions | Depression, Other psychiatric conditions, Suicide |
| Metabolic / Endocrine Conditions | Obesity, Diabetes mellitus, Other metabolic/Endocrine disorders/Not otherwise specified |
| Preeclampsia and Eclampsia | |
| Pulmonary Conditions (Excluding Adult Respiratory Distress Syndrome) | Chronic lung disease, Cystic fibrosis, Asthma, Other pulmonary disease/Not otherwise specified |
| Renal Diseases | |
| Seizure Disorders | Epilepsy/seizure disorder, Other neurologic diseases/Not otherwise specified |
| Unintentional Injury | e.g., Motor vehicle accidents, Accidental overdose, Smoke inhalation, Drowning |
| | |

# Appendix C:

## Contributing Factors by Leading Causes of Death

### *Cardiovascular and Coronary Conditions*

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility** (10.0%) | **Access/Financial** (20.0%) | |
| | **Continuity of Care/Care Coordination** (20.0%) | Lack of coordination between providers that supports coordinated care |
| **Patient/Family** (42.5%) | **Chronic Disease** (25.5%) | Obesity |
| | **Knowledge** (15.7%) | Lack of knowledge on warning signs and need to seek care |
| | **Substance Use Disorder** (13.7%) | Substance Use |
| | **Adherence** (11.8%) | Lack of adherence to medications or treatment plan |
| **Provider** (21.7%) | **Knowledge** (16.7%) | Delayed diagnosis or treatment<br>Ineffective treatments |
| | **Communication** (12.5%) | Failure to seek consultation<br>Lack of communication with patient and/or other providers |
| | **Continuity of Care/Care Coordination** (12.5%) | Lack of coordination between providers that supports continuity of care |
| **Systems of Care** (20.8%) | **Communication** (21.7%) | Lack of communication between providers that supports coordinated care<br>Inadequate or unavailable personnel |
| **Community** (5.0%) | | |

### *Hemorrhage*

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility** (7.0%) | **Clinical Skill/Quality of Care** (33.3%) | |
| | **Policies/Procedures** (33.3%) | |
| **Patient/Family** (26.0%) | **Knowledge** (30.8%) | Lack of knowledge on warning signs and need to seek care |
| | **Cultural/Religious** (15.4%) | |
| **Provider** (31.0%) | **Assessment** (33.3%) | Delayed or missed diagnosis or treatment<br>Ineffective treatments |
| | **Knowledge** (13.3%) | Failure to seek consultation |
| **Systems of Care** (36.0%) | **Personnel** (27.8%) | Inadequate training<br>Inadequate or unavailable personnel |
| | **Policies/Procedures** (19.4%) | Lack of applicable policies and procedures |
| | **Continuity of Care/Care Coordination** (16.7%) | Lack of coordination and communication between providers that supports patient management |
| **Community** (0%) | | |

### *Cardiomyopathy*

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility** (1.7%) | | |
| **Patient/Family** (43.1%) | **Chronic Disease** (25.8%) | Obesity<br>Unaware of warning signs and need to seek care |
| | **Adherence** (12.9%) | Lack of adherence to medications or treatment plans |
| | **Substance Use Disorder** (12.9%) | Substance use |
| **Provider** (41.4%) | **Assessment** (33.3%) | Failure to screen<br>Delayed or missed diagnosis or treatment |
| | **Knowledge** (16.7%) | Misdiagnosis or ineffective treatments |
| | **Referral** (16.7%) | Failure to seek consultation |
| **Systems of Care** (13.8%) | **Personnel** (27.3%) | Inadequate training<br>Inadequate or unavailable personnel |
| **Community** (0%) | | |

### *Infection*

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility** (1.1%) | | |
| **Patient/Family** (34.1%) | **Chronic Disease** (30.0%) | Obesity and other contributing diagnoses |
| | **Environmental** (16.7%) | Housing and other contributing factors |
| | **Knowledge** (13.3%) | Lack of knowledge on warning signs and need to seek care |
| | **Substance Use Disorder** (13.3%) | Substance use |
| **Provider** (40.9%) | **Assessment** (41.7%) | Delayed or missed diagnosis or treatment<br>Ineffective treatments |
| | **Knowledge** (11.1%) | Misdiagnosis |
| **Systems of Care** (22.7%) | **Communication** (20.0%) | Lack of communication between providers that supports coordinated care |
| | **Personnel** (15.0%) | Inadequate training |
| **Community** (1.1%) | | |

### *Embolism*

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility** (0%) | | |
| **Patient/Family** (65.2%) | **Chronic Disease** (53.3%) | Obesity and other contributing diagnoses |
| | **Knowledge** (20.0%) | Lack of knowledge on warning signs and need to seek care |
| | **Substance Use Disorder** (13.3%) | Substance use |
| **Provider** (21.7%) | **Knowledge** (60.0%) | Lack of knowledge about the use of anticoagulants and thrombolytics |
| **Systems of Care** (13.0 %) | | |
| **Community** (0%) | | |

### *Mental Health**

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility**<br>(3.4%) | **Split across multiple classes** | Inadequate assessment of risk |
| **Patient/Family**<br>(42.1%) | **Split across multiple classes** | Lack of adherence to medications or treatment plans<br>Abusive relationships and unstable housing<br>Substance use<br>Lack of social support systems<br>Lack of knowledge on warning signs and need to seek care |
| **Provider**<br>(27.3%) | **Assessment**<br>(25.0%) | Failure to screen<br>Ineffective treatment<br>Inadequate assessment of risk leading to delayed diagnosis, treatment, or follow-up |
| | **Communication**<br>(20.1%) | Lack of communication between providers to support coordinated care<br>Lack of communication or ineffective communication between providers and patients/families |
| | **Continuity of Care/Care Coordination**<br>(12.5%) | Lack of follow-up by provider<br>Failure to seek consultation |
| **Systems of Care**<br>(21.6%) | **Communication**<br>(22.2%) | Lack of communication between providers that supports patient management |
| | **Continuity of Care/Care Coordination**<br>(22.2%) | Inadequate outreach support system<br>Inadequate or unavailable personnel |
| **Community**<br>(5.7%) | | |

*Themes identified among deaths where mental health was determined to be a contributing factor (n=38) were also included.

### *Preeclampsia and Eclampsia*

| **FACTOR LEVEL** (% OF TOTAL FACTORS) | **MOST COMMON FACTOR CLASS(ES)** (% OF LEVEL-SPECIFIC CLASSES) | **COMMON THEMES** |
|---|---|---|
| **Facility** (3.6%) | | Inappropriate level of care |
| **Patient/Family** (23.2%) | **Chronic Disease** (30.1%) | Substance use<br>Obesity |
| | **Knowledge** (15.4%) | Lack of knowledge on warning signs and need to seek care |
| **Provider** (51.8%) | **Knowledge** (20.7%) | Delayed diagnosis or treatment<br>Misdiagnosis or ineffective treatment |
| | **Referral** (13.8%) | Failure to seek consultation |
| | **Assessment** (10.3%) | Failure to screen |
| | **Clinical Skill/Quality of Care** (10.3%) | |
| **Systems of Care** (17.9%) | **Communication** (40.0%) | Lack of communication between providers that supports patient management |
| **Community** (3.6%) | | |

# Appendix D:

## Recommendations for Action with Select Examples

| |
|---|
| **IMPROVE TRAINING** |
| Training on safe methods and medication during labor induction, including appropriate use of vacuum and forceps during delivery |
| Provider education on how to perform cardiac exams |
| Training on caring for patients with drug addiction |
| Death certificate training for clinicians |
| Training for emergency room staff on the care of pregnant women |
| Provider education on patient follow-up |
| Training on how to administer mental health and suicide assessments and steps to take following positive results |
| **ENFORCE POLICIES AND PROCEDURES** |
| Enforce policies related to obstetric hemorrhage |
| **ADOPT MATERNAL LEVELS OF CARE/ENSURE APPROPRIATE LEVEL OF CARE DETERMINATION** |
| Establish levels of care to properly triage patients |
| Address resource requirements in level three and four hospitals |
| Establish a regional system for perinatal emergent care |
| Adopt maternal levels of care |
| **IMPROVE ACCESS TO CARE** |
| Improve access to prenatal care services |
| Improve access to care for Medicaid patients with chronic conditions |
| Improve access to medical translator services |
| **IMPROVE PATIENT/PROVIDER COMMUNICATION** |
| Improve provider counseling on delivery options and potential risks |
| **IMPROVE PATIENT MANAGEMENT FOR MENTAL HEALTH CONDITIONS** |
| Improve documentation in medical records on mental health |
| Provide immediate referrals for counseling and mental health treatment |
| Provide referrals to suicide prevention programs and domestic violence programs if needed |
| **IMPROVE PROCEDURES RELATED TO COMMUNICATION AND COORDINATION BETWEEN PROVIDERS** |
| Determine who will care for specific high-risk obstetric patients and the expertise required for each procedure |
| Identify quality improvement procedures and implement periodic drills, including obstetric emergency drills for birthing hospitals |
| Improve hand-off communication |
| Improve communication with emergency room staff |

| IMPROVE PROCEDURES RELATED TO COMMUNICATION AND COORDINATION BETWEEN PROVIDERS |
|---|
| Improve documentation of abnormal test results and management plan |
| Improve assessment and documentation of risk factors during prenatal visits |
| **IMPROVE STANDARDS REGARDING ASSESSMENT, DIAGNOSIS AND TREATMENT DECISIONS** |
| Improve standards regarding admission to critical care ICU |
| Obtain cardiovascular consults for morbidly obese patients |
| **IMPROVE POLICIES RELATED TO PATIENT MANAGEMENT, COMMUNICATION AND COORDINATION BETWEEN PROVIDERS, AND LANGUAGE TRANSLATION** |
| Use home health agencies |
| Improve policies on follow-up and care coordination of high-risk patients, or patients with mental health conditions or substance use disorder |
| **IMPROVE POLICIES REGARDING PREVENTION INITIATIVES, INCLUDING SCREENING PROCEDURES AND SUBSTANCE USE PREVENTION OR TREATMENT PROGRAMS** |
| Improve policies on risk factor assessment and counseling prior to hospital discharge |
| Enroll smokers in smoking cessation programs |

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