# REPORT FROM MATERNAL MORTALITY REVIEW COMMITTEES: A VIEW INTO THEIR CRITICAL ROLE

## Acknowledgements

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# Preface: Proof of Concept

The data used in this report is made possible by a partnership with four states: Colorado, Delaware, Georgia, and Ohio, who have been supporting the development of the Maternal Mortality Review Data System (MMRDS), a precursor to the newly released Maternal Mortality Review Information Application (MMRIA). While this report reflects data from the four states, MMRIA is a reflection of lessons learned from implementing MMRDS in a total of 13 state Maternal Mortality Review Committees (MMRCs). The long-term engagement has benefited us all through rich mutual learning. The objective of this report is to celebrate how far we have come, understand the mechanics of using data from multiple reviews, identify opportunities for improvement, and consider what is possible as more review committees participate.

In 2016 project staff engaged with more than 30 states regarding their maternal mortality review processes. As a result of these conversations, the team provided focused onsite and distance-based technical assistance to specifically address challenges to reviews achieving their desired outcomes. States have unique needs ranging from too few cases for annual reporting, to so many cases they do not know where to start. For smaller states the project team encourages collaborative review at the regional level to add power to their analyses; and for larger states we are exploring opportunities to enable vital statistics teams to more efficiently identify maternal mortality cases and share them at the local level. The tools developed, the technical assistance provided, the ongoing efforts to make data consistent, and the responsive refining of the content of MMRIA support the implementation of MMRCs.

MMRIA provides a powerful resource in this endeavor, as states (or committees) can collaborate around a shared data framework and initiate discussions around how the data can inform improvement activities. The United States can best save lives and prevent harm by thoughtful and strategic practices that honor states' unique contexts and needs, and at the same time adopt a cohesive approach that leverages all of the data we collect on maternal deaths. MMRIA also provides support to reviews that take on challenging 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 reducing preventable maternal deaths and a reminder that we can only fulfill our commitment by working together.

January 20, 2017

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Dear Dr. Goodman:

We are proud to affirm our strong interest in a consistent approach to maternal mortality review. For nearly 100 years, many states and jurisdictions have funded maternal mortality review committees to assess available data on maternal deaths for use in identifying prevention opportunities. However, these groups have worked largely independently, without funding to create a comprehensive data repository, resulting in non-standard data collection and hindering information-sharing between committees. The Building U.S. Capacity to Review and Prevent Maternal Deaths project has addressed both of these challenges with the free Maternal Mortality Review Information Application (MMRIA), or "Maria," platform.

In 2015, Merck for Mothers awarded funds for a collaboration between the CDC Foundation, the Centers for Disease Control and Prevention (CDC), and the Association of Maternal and Child Health Programs (AMCHP) to improve data that are critical for identifying opportunities for preventing deaths among mothers. In its first year the Building U.S. Capacity to Review and Prevent Maternal Deaths project has reached out to 35 jurisdictions. The Maternal and Child Health programs that have worked most closely on the program respectfully submit this letter to highlight the importance of this work.

The three critical outcomes of this partnership are already apparent. First, partners are committing to a standard data-collection and analysis tool in MMRIA. It allows jurisdictions to collect data that is comparable, and therefore more meaningful, and come together to navigate the critical next step of using data to identify prevention opportunities. Second, a web-based resource is available to assist states and jurisdictions in establishing or improving a maternal mortality review. It contains tools from existing committees and national resources, including MMRIA, that all states can access to share best practices to improve data collection, analysis and the sustainability of review committees overall. Additionally, the ability to network with those doing similar work has not only population health improvement implications, but the power to consolidate resources. Third, a data report is expected in early-2018 with information from jurisdictions reporting data through MMRIA. The report will be the first to explore data across jurisdictions and analyze the data to identify opportunities to prevent mortality.

Throughout the last few decades the U.S. has been challenged by a persistently high maternal mortality rate that exceeds that of other countries of comparable income. There is a clear need for ongoing technical assistance as we continue to build the analytical capacity required to address the myriad of maternal and child health problems that plague our nation. Without strong, accurate data we cannot effectively measure the problem nor work toward effective policy change and program development that improves birth outcomes.

We are grateful for the opportunity to convey our sincere appreciation as we have benefited greatly from the training provided and look forward to ongoing participation in the Building U.S. Capacity to Review and Prevent Maternal Deaths project.

Sincerely,

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# Introduction to Maternal Mortality Review Committees

There are two national sources for trends and information on maternal deaths using vital statistics data (**Table 1**). One, the National Center for Health Statistics (NCHS), uses death certificate information to assign ICD-10 codes that are then used to identify maternal deaths and produce a maternal mortality rate (maternal deaths while pregnant or within 42 days postpartum per 100,000 live births). Two, the Pregnancy Mortality Surveillance System (PMSS) uses death certificates with 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 (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, as NCHS and PMSS do, 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 urban-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 (NCHS) | 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 | ICD-10 codes | Medical epidemiologists (PMSS codes) |
| Terms | Maternal death | Pregnancy-associated,<br>(Associated and) pregnancy-related,<br>(Associated but) not pregnancy-related |
| Measure | Maternal mortality rate - # of maternal deaths per 100,000 live births | Pregnancy-related mortality ratio - # of pregnancy-related deaths per 100,000 live births |

Most MMRCs identify cases by linking death certificate and birth certificate 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. We have learned that between 20% and 50% of maternal deaths in the United States are preventable through the work of MMRCs. [5,6,7] Beyond assessing preventability, MMRCs make recommendations, promote and increasingly, implement effective, jurisdiction-level 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. Potential cases of maternal death are identified through a partnership between the MMRC, the state Vital Records office, and epidemiologists. A routine review of deaths among women of reproductive age is conducted to determine if any are pregnancy-associated, that is, whether they occurred within one year of the end of a pregnancy. 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 for all death certificates of women of reproductive age for a given time period with infant birth or fetal death records during a related time period. 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 maternal deaths, such as through 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, and social services records. Abstractors distill information from these sources and develop committee review materials, including a case narrative, for each case. Committees then convene to discuss the cases.

There are six key decisions that maternal mortality review committees make for each death reviewed:

1. Was the death pregnancy-related?
2. What was the cause of death?
3. Was the death preventable?
4. What were the critical contributing factors 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?

A comprehensive database supports standardized case abstraction, case narrative development, documentation of committee decisions, and routine analyses.

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

# The Data

## Structure

Four state-based MMRCs –from Colorado, Delaware, Georgia, and Ohio – contributed data to this report. These states have been entering data into the Maternal Mortality Review Data System (MMRDS) since its inception, and have significantly informed its development. MMRDS is a relational 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 the data system. For each maternal death, there is one Death Certificate, Autopsy Report, Birth Certificate (parent section), Prenatal Care Record, Social and Psychological Profile, and Committee Review form. There may be more than one Birth Certificate (infant or fetal death section), Emergency Room Visits and Hospitalizations, Other Medical Office Visits, and Informant Interviews forms completed for a given maternal death. The Core Summary form is automatically populated or updated, via a button on the main menu page, with critical information from the other forms.

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 text fields for substance, concentration, unit of measure, and comments.

Because the data is housed in a relational database with multiple many-to-one forms and grids, the data cannot be exported as a single flat file with one entry per death. Instead, each form and grid is exported as its own flat file with unique identifiers linking them to one another.

Data were cleaned to ensure that only valid observations remained for analysis. Only observations that corresponded to valid records from the main menu were used. Four instances were identified where the dates of birth and death and state of residence were identical for two separate observations. It was not possible to determine which record of each pair was more accurate, so those observations were removed prior to analysis.

## Years

Years of deaths included in these analyses vary between the four reviews.

| | |
|---|---|
| Colorado: | 2008-2012 |
| Delaware: | 2009-2014 |
| Georgia: | 2012-2013 |
| Ohio: | 2008-2012 |

Our overarching focus is on demonstrating the use of standardized review committee data for understanding preventability, critical factors that contribute to deaths, and best opportunities for reducing pregnancy-related deaths, rather than trends in pregnancy-related mortality over time; thus, the variation in years between states is not a barrier to the collective use of this data.

Throughout the report, where possible, we present findings by race-ethnicity, age, and timing of death.

## Race and ethnicity

While race and ethnicity are captured in the data system just as it is recorded on the source document, and recoded consistent with Office of Management and Budget Race and Ethnic Standards for Federal Statistics and Administrative Reporting[8], available data did not support analysis beyond non-Hispanic white, non-Hispanic black, and Hispanic groupings. In the future, with more Reviews contributing data, we will 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.[9]

## Age at death

Using information from death certificates, age at death is captured as a continuous variable in the data system. 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 in the data system. 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 the data system.

For these analyses, we derived timing of death from the death certificate. When this information was missing or unknown from the death certificate, we used the number of days calculated from the dates in the death certicate and linked birth or fetal death cetificates. We grouped this continuous variable into categories consistent with the death certificate checkbox options. The decision to use the death certificate was justified by our examination of the Four Committee Data to determine the validity of the pregnancy checkbox information on the death certificate in comparison to the calculated number of days from linked certificates. There were 115 pregnancy-related deaths for which both calculated days (between the end of pregnancy and death) and pregnancy checkbox information were available. The project team used these 115 cases to assess sensitivity and positive predictive value of the checkbox to identify the timing of death, by days to death (**Table 2**).

**Table 2.** Validity of the Death Certificate Pregnancy Checkbox for Identifying Timing of Pregnancy-Related Deaths

| Timing of Death | Sensitivity | Positive predictive value |
|---|---|---|
| Pregnant at the time of death (n=34)* | 59% | 100% |
| Pregnant within 42 days of death (n=50) | 92% | 75% |
| Pregnant 43 days to 1 year before death (n=31) | 87% | 90% |

* This is limited to deaths that occurred during pregnancy that would have resulted in a fetal death or live birth being registered; and excludes pregnancy-related deaths that occurred during pregnancy and would not have resulted in a vital event registration, such as an ectopic pregnancy.

We present the following analyses of the Four Committee data in six sections, each corresponding to one 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 Four 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 critical decision a committee makes is whether a death was pregnancy-related.

The universe of pregnancy-associated deaths includes all deaths that have a temporal relationship to pregnancy, but not necessarily a causal relationship to pregnancy. Within that 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. Review committees start ascertaining pregnancy-related deaths by casting the widest net possible, identifying – through a diversity of strategies referred to earlier – all deaths among women with any evidence of pregnancy in the year before death. These are referred to as pregnancy-associated deaths—those deaths with only a temporal relationship with pregnancy. A subset of these may be determined to be pregnancy-related deaths — those deaths related to pregnancy or its management that occur during pregnancy or within a year of the end of a pregnancy (abortion, live birth, fetal or infant death).

Data is captured for the committee decision about pregnancy relatedness using the following four categories:

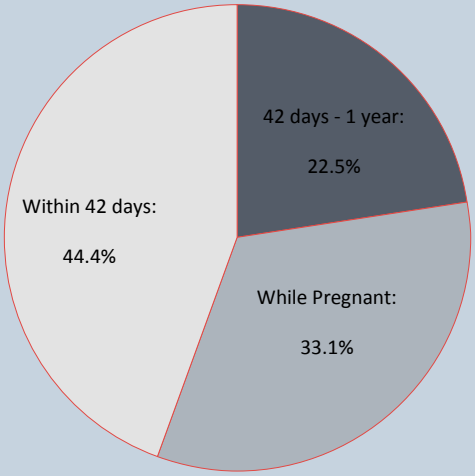
- Pregnancy-Related – The death of a woman during pregnancy or within one year of the end of pregnancy from a pregnancy complication, a chain of events initiated by pregnancy, or the aggravation of an unrelated condition by the physiologic effects of pregnancy.
- Pregnancy-Associated but NOT Related – The death of a woman during pregnancy or within one year of the end of pregnancy from a cause that is <u>not related to pregnancy</u>.
- Not Pregnancy-Related or Associated (i.e., woman was not pregnant at the time of, or within one year of her death)
- Unable to Determine if Pregnancy-Related or Associated

### Results

The Four Committee data includes a total of 650 potentially pregnancy-related deaths. Among these, 97 were determined to have no evidence of pregnancy within the year prior to the woman's death (neither pregnancy-related nor –associated; false positive pregnancy-associated deaths), and so were excluded from further analysis. The predominant reason for these 97 false positives were errors on the death certificate from the pregnancy checkbox. While the checkbox contributed to errors, the Four Committee data show that the checkbox also improved identification of pregnancy-related deaths. Without the pregnancy checkbox, approximately 50% of pregnancy-related deaths that occurred during pregnancy and 11% of pregnancy-related deaths that occurred within 42 days of the end of pregnancy, and 8% of pregnancy-related deaths that occurred within 43 days to 1 year of the end of pregnancy would have been missed.

Among the 553 valid pregnancy-associated deaths, 175 were determined by the Four Committees to be pregnancy-related (31.6%). Pregnancy-related deaths most commonly occurred within 42 days of the end of pregnancy (44.4%) (Figure 1).

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




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

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

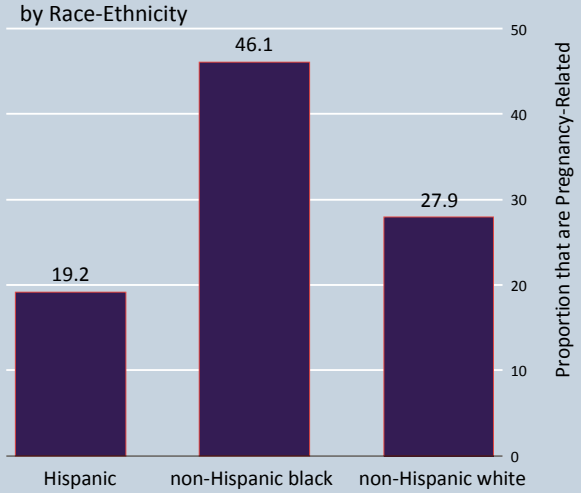
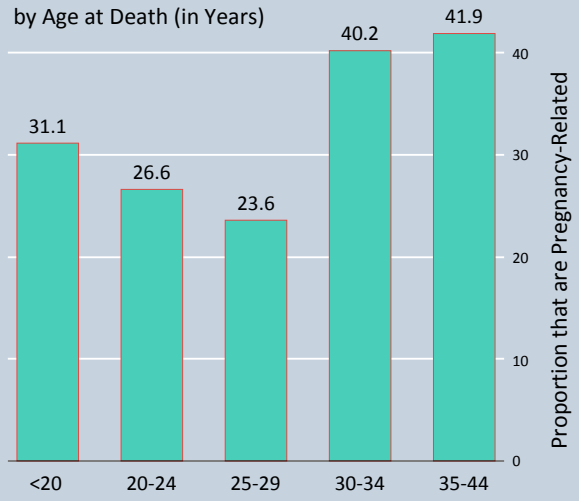


**Figure 3**. Proportion of Pregnancy-Associated Deaths Determined to be Pregnancy-Related




## Moving Forward

*The pregnancy checkbox.* MMRCs are in a unique position to evaluate strengths, weaknesses, and opportunities for improvement related to the pregnancy checkbox on the death certificate. As more reviews are able to use their data together, there will be expanded opportunities to document effects of the checkbox and evaluate the impacts of checkbox quality improvement efforts, as we did for the timing of death data point.

*Pregnancy-related deaths.* The Four Committee data 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, and age at death, as well as other categories.

## Question 2: What was the cause of death?

### Background and definitions

The causes of death can be captured in two ways within the data system. The first way is consistent with how the certifier of a death certificate documents causes of death – immediate, underlying, and contributing causes. This approach works well for capturing causes of death for all classifications of death; but does not for documenting causes of maternal death across MMRCs. To support standardization and consistency in documenting the cause of death, this information is captured in a second way, consistent with how the underlying cause of death is coded in the CDC Pregnancy Mortality Surveillance System (PMSS-MM).[a] The PMSS-MM was 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.[10,11] The consistency provided by the PMSS-MM overcomes a significant past hurdle that limited data-sharing by MMRCs. (Refer to **Appendix A** for PMSS-MM cause of death listing.)

### Results

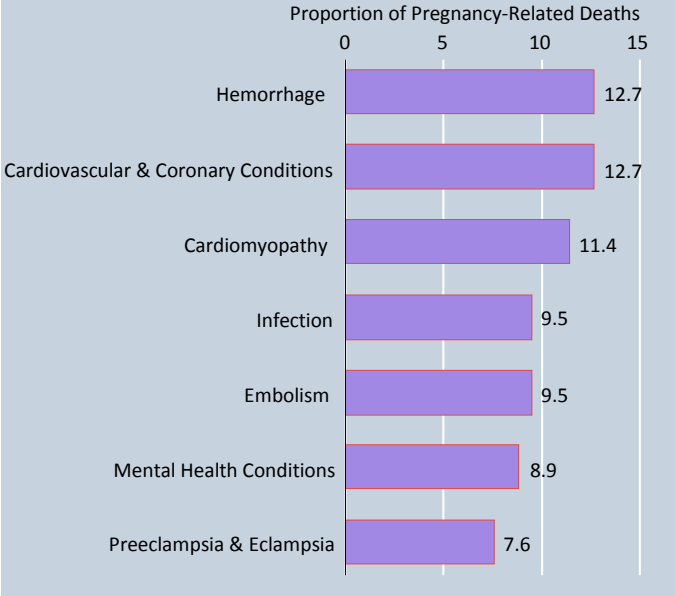
Of the 175 pregnancy-related deaths, 158 (90.3%) had a PMSS-MM underlying cause of death assigned by the committee. For three (1.9%) of the 158, the PMSS-MM code indicated the committee could not determine an underlying cause of death.

From the 74 potential underlying causes of death included in the PMSS-MM, 51 were used by the Four Committees. To support analyses using the underlying cause of death, a condensed set of 21 causes of death was created, as described in **Appendix B**.

[a] 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."

Overall, the leading causes of pregnancy-related death include seven causes accounting for 72.2% of all pregnancy-related deaths (**Figure 4**).

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




*State variations.* The leading underlying causes of death varied between states. Hemorrhage, mental health conditions, and cardiovascular and coronary conditions were in the five leading causes of pregnancy-related deaths for three of the four states. Infection, embolism, preeclampsia and eclampsia, and seizure disorders were among the five leading causes of pregnancy-related death for two of the four 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) Hemorrhage, mental health conditions (tied at 15.5%)
2) Cardiovascular and coronary conditions (at 14.3%), and
3) Cardiomyopathy, infection (tied at 11.9%).

These causes represent 76% of non-Hispanic white pregnancy-related deaths.

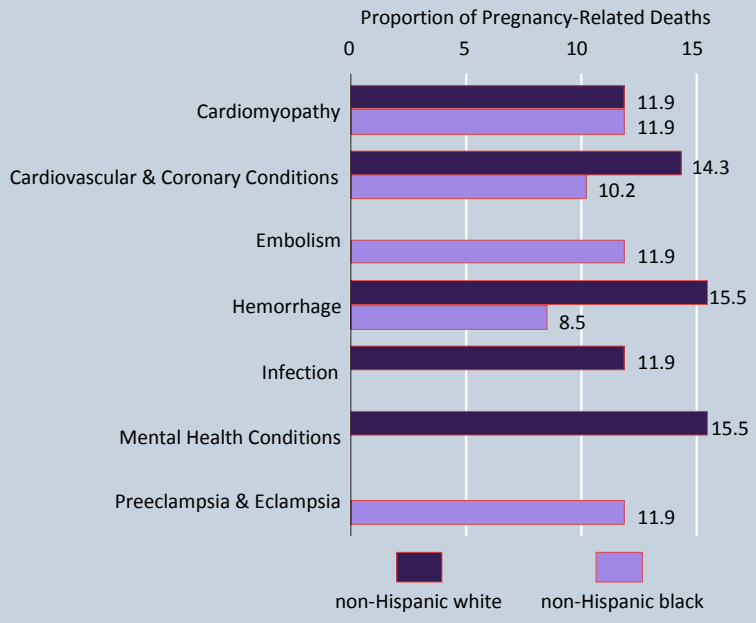
Among non-Hispanic black pregnancy-related deaths, the leading underlying causes were also spread among five causes:

1) Cardiomyopathy, embolism, preeclampsia and eclampsia (tied at 11.9%)
2) Cardiovascular and coronary conditions (at 10.2%), and
3) Hemorrhage (at 8.5%).

These causes represent just 54% 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.

There was not sufficient data to examine the leading underlying causes for Hispanic pregnancy-related deaths (**Figure 5**).

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




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

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

1) Cardiomyopathy (at 14.3%)
2) Hemorrhage (at 11.4%), and
3) Infection, mental health conditions, preeclampsia and eclampsia, and blood disorders (tied at 8.6%).

These causes represent 60% of pregnancy-related deaths in this age grouping.

Among women ages 25-29 years, the leading underlying causes of pregnancy-related death were also comprised of six causes:

1) Cardiovascular and coronary conditions (at 15.6%)
2) Hemorrhage, mental health conditions (tied at 12.5%), and
3) Cardiomyopathy, embolism, and seizure disorders (tied at 9.4%).

These causes represent 69% of pregnancy-related deaths in this age grouping.

Among women ages 30-34 years, the leading underlying causes of pregnancy-related death were comprised of four causes:

1) Cardiovascular and coronary conditions, infection (tied at 16.3%)
2) Embolism (at 14%), and
3) Hemorrhage (at 11.6%).

These causes represent 58% of pregnancy-related deaths in this age grouping.

Among women ages 35-44 years, though a wider age grouping (10-years, instead of 5-years), the leading underlying causes of pregnancy-related death were also comprised of four causes:

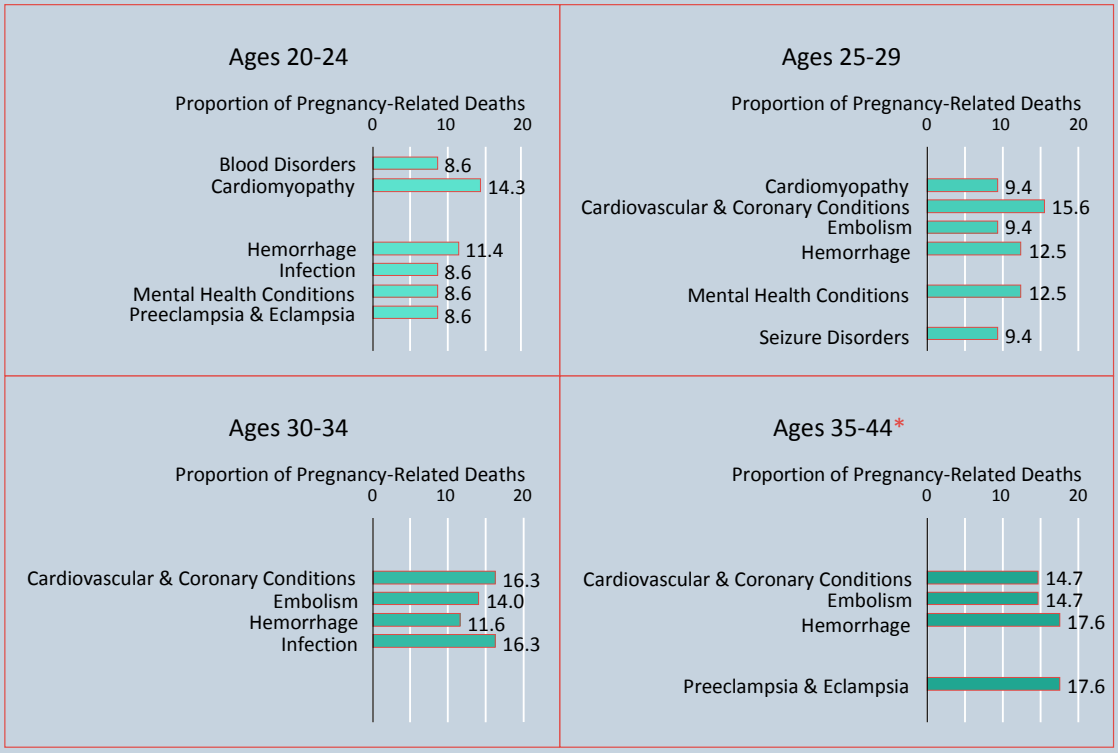
1) Hemorrhage, preeclampsia and eclampsia (tied at 17.6%) and
2) Cardiovascular and coronary conditions, embolism (tied at 14.7%).

These causes represent 65% of pregnancy-related deaths in this age grouping.

Hemorrhage was the one cause of pregnancy-related death that occurred among all age-specific leading causes (**Figure 6**).

**Figure 6**. Leading Underlying Causes of Pregnancy-Related Deaths

by Age at Death (in Years)

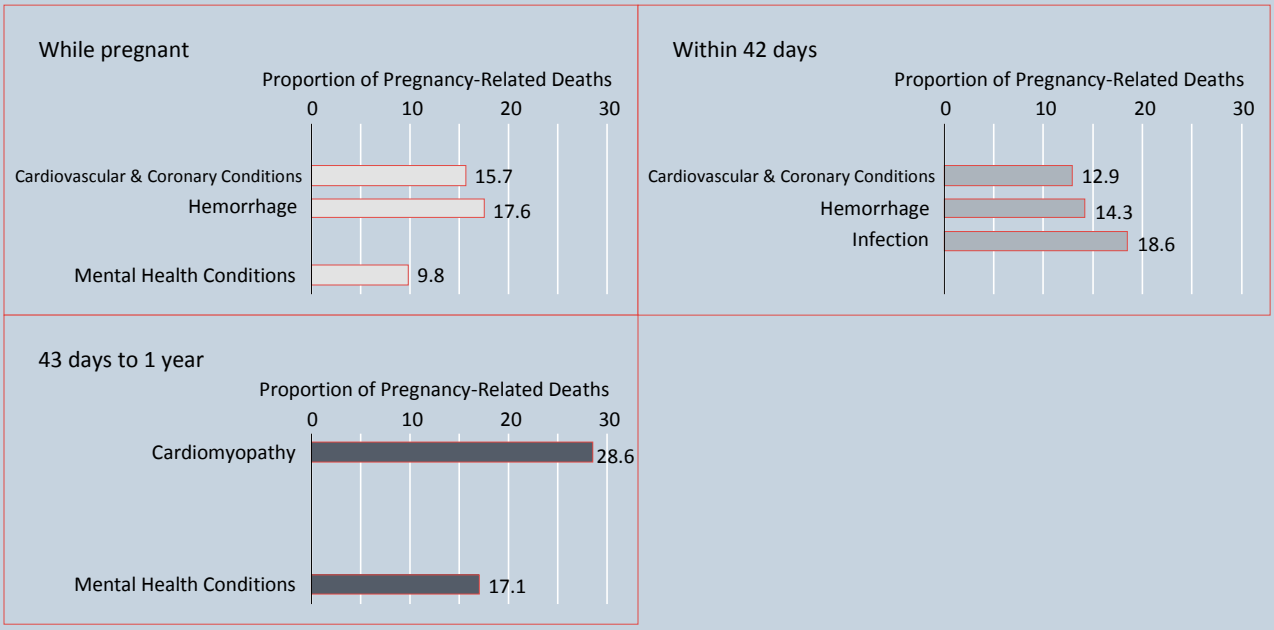



* All other age groupings are 5 years, but this is a 10 year grouping

*Timing of death variations.* The leading underlying causes of pregnancy-related death varied between the three categories of timing of death in relation to pregnancy (**Figure 7**). Among pregnancy-related deaths that occurred during pregnancy, hemorrhage was the leading cause of death , followed by cardiovascular and coronary conditions, and mental health conditions. Together, these three cause of death groupings represented 43% of pregnancy-related deaths that occurred during pregnancy. Among deaths that occurred within 42 days of the end of pregnancy, infection was the leading cause of death, followed by hemorrhage, and cardiovascular and coronary conditions. Together, these three cause of death groupings represented 46% of deaths that occurred during this time period. Among deaths that occurred 43 days to one year after the end of pregnancy, there were only two leading causes of pregnancy-related death - cardiomyopathy, followed by mental health conditions. Together, these two causes of death represented 46% of deaths in this time period. Five of the seven most frequent causes of pregnancy-related death, overall, are among the three leading causes for at least one time period. Although leading causes of pregnancy-related death overall, embolism and, preeclampsia and eclampsia, are not among the three leading causes for any one time period.

**Figure 7.** Leading Underlying Causes of Pregnancy-Related Deaths

by Timing of Death in Relation to Pregnancy




## Moving forward

*Cause of death groupings.* A limitation of the cause of death regroupings is that they may be masking sub-differences of importance. 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.

*Contributors and mechanisms.* The Project Team updated the PMSS-MM codes within the data system 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 listing, and to see how contributors and mechanisms are captured.

## Question 3: Was the death preventable?

### Background and definitions

There is a critical role for preventability information, when combined with the other committee decisions. The most frequent causes of pregnancy-related death can point to the greatest burdens, but say little about where the potential opportunities for impact lie. Joining these two pieces of information permits analysts to consider *both* the burden and potential opportunity for impact. This is one of the unique and critical roles that MMRCs can play in driving action to eliminate preventable maternal deaths.

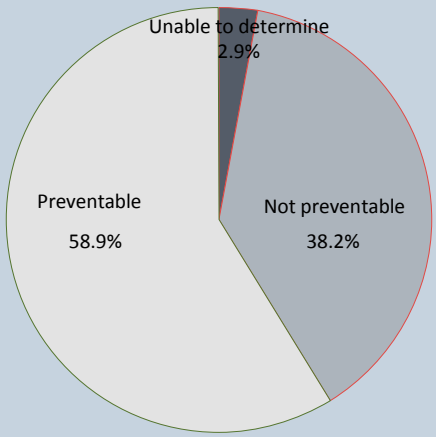
Determining preventability can be a challenging and intimidating process for a review committee due to the range of possible interpretations of the term. Using input from review committees and experts across the country, we developed the following definition of preventability: "A death is considered 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". The data system allows committees to document their decision using one of two approaches: determining preventability as a Yes or a No, or determining chance to alter outcome on a scale from none to some to good to strong (**Appendix A**).

There is value in documenting preventability in both ways, because a Yes/No says nothing about the degree of preventability, other than there was at least some chance to alter the outcome. With a Yes/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, a "Yes" response on the Yes/No question or a response of "some chance" or "good chance" were combined to create a composite Yes/No variable of the two questions.

### Results

For this preliminary analysis, we had usable preventability data (N=77) from three of the four MMRCs, limiting our ability to provide information beyond an overall description of the distribution of preventability among pregnancy-related deaths (**Figure 8**).

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




## Moving forward

*Documenting Preventability.* Not all MMRCs determine preventability, yet our work suggests that assessing preventability should be a priority as this determination is critical to informing improvement activities. Our analysis found the preventability of pregnancy-related deaths among the Four Committee data to be 59%. In comparison, the proportion of pregnancy-related deaths identified as preventable in the published literature ranges from 20% to 50%.[5,6,7] With more complete data, we can examine this finding and evaluate preventability by the leading causes of pregnancy-related deaths. Despite these issues, it is encouraging that preventability could not be determined by the committees for only 3% of pregnancy-related deaths, suggesting the potential for complete data when committees do address preventability.

## Question 4: What were the critical 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 critical factors that contributed to the death. These factors form the basis for a committee's specific and feasible recommendations.

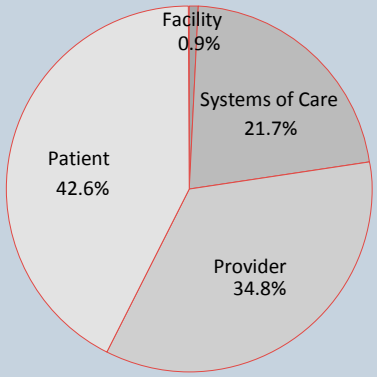
The data system includes three elements to identify critical factors. First, each factor is categorized into one of five levels: Patient, Community, Provider, Facility, or Systems of Care. Second, each factor is assigned a class among 23 specific factor class categories, along with "other." These classes include such barriers as delays, adherence issues, and lack of knowledge. Third, the factor is given a concise description. Refer to **Appendix A** for the complete list of critical factors 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. Though one state was unable to provide critical factor data, the other three states identified 538 critical factors among 159 pregnancy-related deaths (on average, 3-4 critical factors were identified for every one pregnancy-related death).

*Overall.* The overall distribution of critical factors among pregnancy-related deaths identifies patient factors most frequently, followed by provider, and systems of care factors (**Figure 9**). Facility factors are rarely identified, and community factors are absent from the Four Committee data. While patient factors are the most common, these often reflect patient factors that are dependent on providers and systems of care, which becomes evident when put together with class and descriptions, as we show below.

**Figure 9**. Distribution of Critical Factors among Pregnancy-Related Deaths



*Leading cause of death variations.* Critical factor classifications vary in their distribution within the leading causes of pregnancy-related death (**Table 3**). Of note is the low ratio of factors per death identified for deaths where embolism was identified as the underlying cause of death (1.3, which is less than one-half of what is observed for other causes). This may reflect that embolism deaths are considered some of the least preventable among pregnancy-related deaths.[5]

**Table 3**. Critical factor level by leading causes of pregnancy-related death

| | Critical Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Cause of Death** | ***Community*** | ***Facility*** | ***Provider*** | ***Patient*** | ***Systems of Care*** | ***Total Factors*** | ***Pregnancy-related deaths*** | ***Factors per death*** |
| ***Hemorrhage*** | | | | | | | | |
| *Count of Factors* | 0 | 3 | 21 | 19 | 26 | 69 | 17 | 4.1 |
| *% of cause-specific factors* | | 4.3 | 30.4 | 27.5 | 37.7 | | | |
| ***Cardiovascular & Coronary Conditions*** | | | | | | | | |
| *Count of Factors* | 0 | 0 | 16 | 32 | 13 | 61 | 18 | 3.4 |
| *% of cause-specific factors* | | | 26.2 | 52.5 | 21.3 | | | |
| ***Cardiomyopathy*** | | | | | | | | |
| *Count of Factors* | 0 | 2 | 26 | 30 | 12 | 70 | 18 | 3.9 |
| *% of cause-specific factors* | | 2.9 | 37.1 | 42.9 | 17.1 | | | |
| ***Infection*** | | | | | | | | |
| *Count of Factors* | 0 | 0 | 26 | 26 | 14 | 66 | 15 | 4.4 |
| *% of cause-specific factors* | | | 39.4 | 39.4 | 21.2 | | | |
| ***Embolism*** | | | | | | | | |
| *Count of Factors* | 0 | 0 | 5 | 13 | 1 | 19 | 15 | 1.3 |
| *% of cause-specific factors* | | | 26.3 | 68.4 | 5.3 | | | |
| ***Mental Health Conditions*** | | | | | | | | |
| *Count of Factors* | 0 | 0 | 21 | 30 | 16 | 67 | 10 | 6.7 |
| *% of cause-specific factors* | | | 31.3 | 44.8 | 23.9 | | | |
| ***Preeclampsia & Eclampsia*** | | | | | | | | |
| *Count of Factors* | 0 | 0 | 23 | 8 | 6 | 37 | 12 | 3.1 |
| *% of cause-specific factors* | | | 62.2 | 21.6 | 16.2 | | | |
| ***Total*** | | 5 | 138 | 158 | 88 | 389 | 105 | 3.7 |

When Critical Factor levels are examined along with the factor class and description, we are able to gain 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 descriptions of the most common factor levels, the most common factor classes within the most common factor levels; and the dominant themes associated with those most common level-class combinations from the description. An expandedpresentation of this information is included in **Appendix C**.

### *Hemorrhage*

*Provider factors* comprised 30.4% of the total critical factors identified as contributors to hemorrhage deaths. The most common class of provider factors was *assessment*, which represented 52% of all provider factors. The most common theme among provider assessment was *delays in diagnosis and effective treatment*.

*Patient factors* comprised 27.5% of the total critical factors identified as contributors to hemorrhage deaths. The most common class of patient factors was *knowledge*, which represented 38.5% of all patient factors. The most common theme among patient knowledge was patients' knowledge of *warning signs*.

*Systems of care factors* comprised 37.7% of the total critical factors identified as contributors to hemorrhage deaths. The most common class of systems of care factors was *personnel* at 38.5%, followed by *policies and procedures* at 19%, and *care coordination* at 15%. Common themes among systems of care personnel; policies and procedures; and care coordination were respectively, *inadequate training*, *absence of policies and procedures*, and a *lack of coordination* between providers in patient management.

### *Cardiovascular & Coronary Conditions*

*Provider factors* comprised 26.2% of the total critical factors identified as contributors to cardiovascular and coronary conditions deaths. The most common class of provider factors was *knowledge and assessment* at 44%. A common theme among provider knowledge and assessment was *misdiagnosis resulting in delayed diagnosis and appropriate treatment*.

*Patient factors* comprised 52.5% of the total critical factors identified as contributors to cardiovascular and coronary conditions deaths. The most common class of patient factors was *chronic conditions* and *knowledge*, which together accounted for 67% of patient factors. Patient chronic conditions most commonly specified *obesity* and patient knowledge most commonly referred to knowledge of *warning signs*.

*Systems of care factors* comprised 21.3% of the total critical factors identified as contributors to cardiovascular and coronary conditions deaths. The most common class of systems of care factors was *communication and coordination of care*, which together accounted for 58% of systems of care factors. The dominant theme among these two classes of systems of care factors was *breakdowns between providers* in coordinated care and management of patients.

### *Cardiomyopathy*

*Provider factors* comprised 37.1% of the total critical factors identified as contributing to cardiomyopathy deaths. The most common classes of provider factors were *assessment* at 42.3% and *referral* at 26.9% of provider factors. Dominant themes among provider assessment and referral included *misdiagnosis leading to delayed diagnosis and effective treatment*, and *failure to seek [cardiology] consultation*.

*Patient factors* comprised 42.9% of the total critical factors identified as contributors to cardiomyopathy deaths. The most common class of patient factors was *chronic conditions*, at 36.7% of patient factors. A common theme among patient chronic conditions was *obesity*.

### *Infection*

*Provider factors* comprised 39.4% of the total critical factors identified as contributing to infection deaths. The most common class of provider factors was *assessment*, at 57.7%. A common theme among provider assessment was *misdiagnosis leading to the use of ineffective treatment*.

*Patient factors* comprised 39.4% of the total critical factors identified as contributing to infection deaths. The most common class of patient factors was *chronic conditions* at 30.8% followed by *environment* at 23.1%. A common theme was not present among patient chronic conditions, but common themes among patient environment included *lack of housing and financial resources*.

### *Embolism*

*Provider factors* comprised 26.3% of the total critical factors identified as contributing to 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 68.4% of the total critical factors identified as contributing to embolism deaths. The most common class of patient factors was *chronic conditions* at 76.9%. The most commonly identified patient chronic condition was *obesity*.

### *Mental Health*

*Provider factors* comprised 31.3% of the total critical factors identified as contributing to mental health deaths. The most common class of provider factors was provider *assessment* at 33.3% and provider *communication* and *continuity of care* at 24% each. The dominant theme that emerged related to provider assessment was *failure to screen*. The most common themes for communication and continuity of care was a *lack of communication between patient providers* and a *lack of follow-up on the part of providers*.

*Patient factors* comprised 44.8% of the total critical factors identified as contributing to mental health deaths. There was not a predominant class of patient factor, with classes split evenly across *substance use, social support, knowledge, environment, and adherence*. Themes that emerged from these classes for patient factors included the *absence of social support systems*, *not recognizing the need to seek care*, *disruptive relationships and housing*, and *lack of adherence to medication(s)*.

*System of care factors* comprised 23.9% of the total critical factors identified as contributing to mental health deaths. The most common class of systems of care factors was *continuity of care* at 44%. The predominant theme for systems of care continuity were a *lack of coordination in patient management between providers*. Another related common theme was a *lack of communication between patient providers*.

### *Preeclampsia and Eclampsia*

*Provider factors* comprised 62.2% of the total critical factors identified as contributing to preeclampsia and eclampsia deaths. The two predominant classes, accounting for 70% of provider factors, were *assessment and knowledge*. Common themes included *misdiagnosis as the result of inadequate assessment* and *the use of ineffective treatments*.

While *patient factors* comprised 21.6% of the total critical factors identified as contributing to preeclampsia and eclampsia deaths, a common class and theme was not apparent.

While *system of care factors* comprised only 16.2% of the total critical factors identified as contributing to preeclampsia and eclampsia deaths, 67% were related to *communication*, and a dominant theme was *lack of communication as a barrier to coordination of care between providers*.

## Moving forward

*Critical factor descriptions.* The open-ended descriptions of the critical factors that contributed to a pregnancy-related death 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 reviews able to contribute data to support a report, the manual review of open-ended responses has the potential to become cumbersome, so we will explore alternative approaches to analyzing the open-ended description of critical factors.

*Community-level factors.* We will work with MMRCs to understand if the absence of community factors reflects a genuine absence, or if there are opportunities to improve MMRCs' abilities to identify community-level contributors. The identification of community-level contributors may also benefit from our work to integrate place-based information into case discussions [see Incorporating Equity].

## 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, which if implemented or altered, might have changed the course of events?*

Committees should attempt to develop a recommendation for each critical 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, and should not be short-changed.

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 "Prenatal care providers should screen all patients for substance use disorders at their first prenatal visit."

### Results

The Four Committee data did not support analyses of recommendations.

### Moving forward

*Complete and effective recommendations.* Through trainings, site visits, and technical assistance, we will continue to work with review committees 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 preventing pregnancy-related deaths. As more reviews are able to contribute data, there will be increased opportunity for identifying specific actions to prevent the leading causes of pregnancy-related death.

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

## Question 6: What is the anticipated impact of those actions if implemented?

### Background and definitions

There are two ways that MMRCs capture information related to the potential impacts of their recommendations in the system. 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 (referring to 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. Expected impact levels are adapted from CDC Director Tom Frieden's Health Impact Pyramid.[12] The base of the pyramid addresses social determinants of health. Actions aimed toward the base of the pyramid have greater impact population-wide and require less individual effort. Actions aimed toward the top of the pyramid help individuals rather than entire populations and depend on person-by-person behavioral change; yet, they require relatively less political commitment. Committees may find recommendations that are categorized at the base of the pyramid should be prioritized over recommendations that are categorized at the top of the pyramid.

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 to reduce preventable tragedies.

### Results

The Four Committee data did not support analyses of the expected impacts of recommendations.

### Moving forward

*Documentation of impact.* Of the six key decisions that a MMRC makes, determining impacts may be the least familiar. While it may have been a part of the conversation among stakeholders once analyses of a cohort of maternal death data were complete, documenting impact of recommendations has not historically been a part of the case review. We will continue to work with MMRCs, through trainings, site visits and technical assistance, to ensure that they are determining expected impact levels and documenting them in MMRIA.

*Putting it all together.* As more reviews contribute data to MMRIA, the additional cases' associated information will permit analyses of all six questions that MMRCs answer. A more complete data set will enhance our ability to identify the priority causes and contributors to maternal deaths, and within those priorities, to identify the prevention opportunities with the greatest potential to prevent maternal deaths.

## Data Summary

Analysis of the Four Committee data demonstrates MMRIA's ability to help MMRCs better understand the drivers of maternal deaths, and its ability to help MMRCs implement specific, feasible actions to prevent them. MMRIA is able to accommodate more reviews and their associated data; support multi-review analyses, and serves as a foundation for a unique data source on the country's maternal deaths that can inform prevention activities at state, regional and national levels.

We have used the Four Committee data to evaluate processes that underpin maternal mortality review, such as the use of the pregnancy checkbox on death certificates for case identification.

We have also used the data to describe the leading causes of pregnancy-related death. A standout finding was the identification of mental health as a leading underlying cause of pregnancy-related deaths, which may speak to one of the strengths of review committees, given their access to information beyond the death certificate [see Maternal Mental Health]. We must also acknowledge that these analyses benefited from all four review committees including maternal deaths due to mental health conditions in the scope of their review.

Analysis of the Four Committee data show that circumstances leading to maternal death are complex and multifactorial; no one contributing factor is likely sufficient to result in a death. Indeed, on average, three to four critical factors were identified for each pregnancy-related death. The contributing factor data adds multiple perspectives to inform the work to prevent maternal deaths, necessitating collaborative, multidisciplinary approaches. The Four Committee data shows common contributing factors across leading causes of death. Among providers these factors include 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. And among 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, such as hospitals and public health teams.

This report is a celebration and a demonstration of the potential forof MMRCs to reduce preventable maternal deaths; and the power of collegial, productive partnerships between stakeholders in maternal mortality prevention at state and national levels. To further empower stakeholders in this partnership, we next discuss emerging issues for review committees to consider as we all move forward: Maternal mental health, suicide, substance use disorder and equity.

# Next Steps: Emerging issues

## Maternal mental health

This report documents the contribution of mental health conditions to pregnancy-related mortality from the Four Committee data. 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 interdisciplinary approach.[13,14] While all four of the Committees who partnered to provide data to this report review maternal deaths related to or involving maternal mental health conditions, not all MMRCs do. Reasons for MMRCs not addressing this issue include difficulty recruiting relevant experts and lack of knowledge among existing committee members.

Three research associates synthesized the scientific and practice literature related to maternal mental health, suicide, and substance use disorder and created resources to help support MMRCs in addressing these topics. Their work, which is presented here, is intended to help reviews approach these topics in their discussions and decisions. In addition, the information was used to improve the content of the MMRIA, ensuring that information is captured in a way that supports the development of effective committee decisions and analyses related to these topics.

### Assessing mental health as a contributing factor in maternal deaths

*Background.* 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 first onset of mental illness and relapse.[15] Our understanding of maternal mental illness is negatively impacted by the frequency of under-diagnosis and misdiagnosis. This inaccuracy in diagnosis may result in inappropriate care, which could ultimately lead 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.[16,17] Mental illness relapse occurs more frequently when a woman's dosage of pharmacological treatment is decreased in pregnancy or maintained at pre-pregnancy levels, or completely discontinued.[18] Providers are challenged because both pharmacotherapy use and nonuse carry risks, necessitating a potentially complex risk-benefit analysis with each patient when considering the treatment of mental health conditions during pregnancy and the postpartum period. Adding to this challenge is variability in patient risk tolerance.

*Mental health conditions may contribute to pregnancy-related mortality in many ways*. The association between mental illness and mortality is complicated because mental illness does not directly kill women, but rather serves as an underlying factor resulting in injury in the form of suicide, accidental deaths, and deaths due to homicide.[19,20,21]

*Psychosocial and environmental risk factors associated with maternal mental health conditions*

- Chronic stressors, such as racism and poverty
- Unplanned pregnancy
- Lack of social support
- Childcare-associated stress
- Homelessness
- Exposure to violence and trauma
- Substance use disorder

*Potential health system-related recommendations for review committees to consider when it is determined that a mental health condition contributed to a pregnancy-related death.*

Promote universal screening prenatally and continued in the postpartum period for mental health conditions. Inadequate screening leads to delayed diagnosis and treatment. With increased screening more women may be appropriately treated and may also feel less isolated by their symptomology.

Develop the maternal mental health workforce. At present the maternal mental health workforce is underdeveloped. Primary care providers may feel uncomfortable treating women for mental illness and psychiatrists, lacking knowledge, may feel uncomfortable treating pregnant and postpartum women. Approaches might include building the maternal psychiatrist workforce, increasing collaborative care, promoting maternal mental health consultation services, and improving primary care provider and obstetrician/gynecologists' knowledge of maternal mental illness, treatment requirements, and trauma-informed care.

Increase women's ownership of their health in the perinatal period. Group prenatal care, education about mental health conditions, and childbirth education may help reduce stress triggers of maternal mental health conditions.

## Assessing maternal suicide

*Background*. For U.S. women ages 10-44 years, suicide is among the five leading causes of death.[22] The World Health Organization has identified suicide as a leading cause of death in high income countries both in pregnancy and within 42 days postpartum.[22] Suicidal ideation is a common complication of pregnancy and a recent review suggests that suicidal ideation occurs more often among pregnant women than among the general population.[23] Among postpartum women, suicide most commonly occurs in the late postpartum period (43 to 365 days).[24]

*Psychosocial and environmental risk factors associated with suicide*

- Prior suicide attempt(s)
- Depression during pregnancy or postpartum
- Suicidal ideation
- Postpartum psychosis
- Intimate partner violence
- Lack of connectedness to others
- Substance use disorder
- Post-traumatic stress disorder

*Potential health system-related recommendations for review committees to consider for maternal suicide deaths.*

Improve communication between prenatal care providers, mental health providers, and primary care providers. Because a previous suicide attempt is the strongest predictor of a suicide death, it is important that prenatal care providers are aware of their patients' histories related to risk factors associated with suicide (i.e., attempts, mental health diagnoses).[25] In addition, because suicide attempts and completions have been found to occur more frequently in the late postpartum period (43 to 365 days), it is important for the obstetric provider to communicate any related concerns to her primary care provider.

Increased and consistent screening and support for antenatal and postpartum depression, psychosis, and intimate partner violence. Postpartum depression has a prevalence of 13%, and childbirth can trigger onset or recurrent episodes of psychosis.[26] Because suicidal ideation is a predictor of depression and suicide, the Edinburgh Postnatal Depression Scale and the Patient Health Questionnaire can be used to screen for both depression and suicidal ideation. Providers may be hesitant to screen for intimate partner violence because they do not know what steps to take after a positive screen. It may be possible to overcome this challenge by increasing provider knowledge of applicable social services in the community and/or for hospitals or clinics to provide support, such as onsite counseling.

## Assessing substance use disorder as a contributing factor in maternal deaths

*Background*. From 1999 through 2010, opioid overdose deaths increased more than fivefold among women of reproductive age. Of all recorded overdose deaths in 2010, 85% involved one or more prescription drugs, with opioid pain relievers the most common prescription drug (71.3%).[27] The most commonly prescribed opioid analgesics in pregnancy are codeine, fentanyl, hydrocodone, morphine, oxycodone and tramadol. Women with opioid use disorder are frequently raised in family environments complicated by substance use, and often have been victims of physical and sexual violence. Self-medication with substances is associated with increased risk of both suicide and unintentional overdose.[28] Treatment for substance use disorder during pregnancy involves a complex assessment of risk 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*

- Late entry into prenatal care
- Poor adherence to health care appointments
- Poor weight gain during pregnancy
- Exhibited sedation, intoxication, withdrawal, or erratic behavior

*Potential health system related recommendations for review committees to consider for maternal deaths when substance use disorder contributed to a death*

Encourage comprehensive approaches to treatment. Treatment that includes both therapy and medically assisted treatment can reduce the risk of relapse and overdose.

Effective communication of hospital procedures for mothers with children testing positive for Neonatal Abstinence Syndrome. Pregnant women with substance use disorder may neglect to seek care because of fears about institutional procedures, like mandatory reporting to authorities. By increasing awareness among women that treatment and other preventative measures during pregnancy can support the maintenance of custody of children, it may be possible to reduce this strain between mothers and care systems.

Establish co-prescribing methods for opioid prescriptions. From work done by Rhode Island, it is estimated that by offering naloxone together with prescribed opioids, 58% of overdose deaths could have been prevented.[29]

Utilization of Prescription Drug Monitoring Programs (PDMPs). PDMPs can help providers to identify "doctor shopping" practices by some patients to gain access to multiple prescriptions. PDMPs maybe underutilized by emergency departments, which are a common target of these practices.[30]

## Moving forward

*Data system enhancements.*

MMRCs have expressed a need for better understanding the mental health and substance use issues that influence maternal deaths. In response to this need, MMRIA includes additional fields relevant to these concerns, including a dedicated Mental Health Profile Form. These fields are in part derived from MMRCs that regularly collect data on these issues when compiling maternal death case information.

The following characteristics are among those that may be associated with increased psychiatric morbidity:

- Positive Toxicology Result
- Trimester of First Prenatal Care Visit
- Pregnancy History, Prior Poor Outcomes
- Substance Use
- Mental Health Conditions
- Intimate Partner Violence
- Loss of Custody of Children
- Unplanned Pregnancy
- Homelessness
- Incarceration

If available, this information should be captured and included in case presentations. In addition, the following questions are incorporated in the MMRIA Committee Decisions Form to prompt reflection on these influences:

- Did mental health conditions contribute to the death?
- Did substance use disorder contribute to the death?
- Was the death a suicide?
- Was the death a homicide?
- If this death was a homicide, suicide, or accidental death, list the means of fatal injury.
- If this death was a homicide, what was the relationship of the perpetrator to the decedent?

In the future MMRIA will feature enhanced reporting functionality to provide users a quick view of any completed fields relevant to mental health and substance use.

*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.[31] Forty states, plus Washington DC, currently participate in NVDRS. Some MMRCs are already partnering with their state Violent Death Reporting System programs to exchange information. We are currently working with both the CDC NVDRS Program and MMRCs to describe and document the opportunities for these two programs to support improved identification and assessment of pregnancy-related violent deaths.

## Incorporating equity

### 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.[4,32] Studies have also suggested that socio-economic status and geography are related to a woman's chance of dying during pregnancy or within one year of the end of pregnancy.[2,33,34]

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: they consider social factors (e.g. socioeconomic status) as multidimensional; they situate individuals within multilevel contexts; and 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 place. When women live in areas without access to reliable transportation, fresh, affordable groceries, and safe public spaces for recreation and fitness, they are more likely to have worse maternal outcomes than women who do have access to these resources. Many of these social determinants of health are spatially patterned at each level, creating geographic variation in risk. For example rural/urban variation or spatial disparities within urban areas may reflect the different contexts of social and healthcare experience in each location. If the location of health outcomes are 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-level and systems-level issues, and to translate findings into specific recommendationsat those same levels.

*Data Sources*

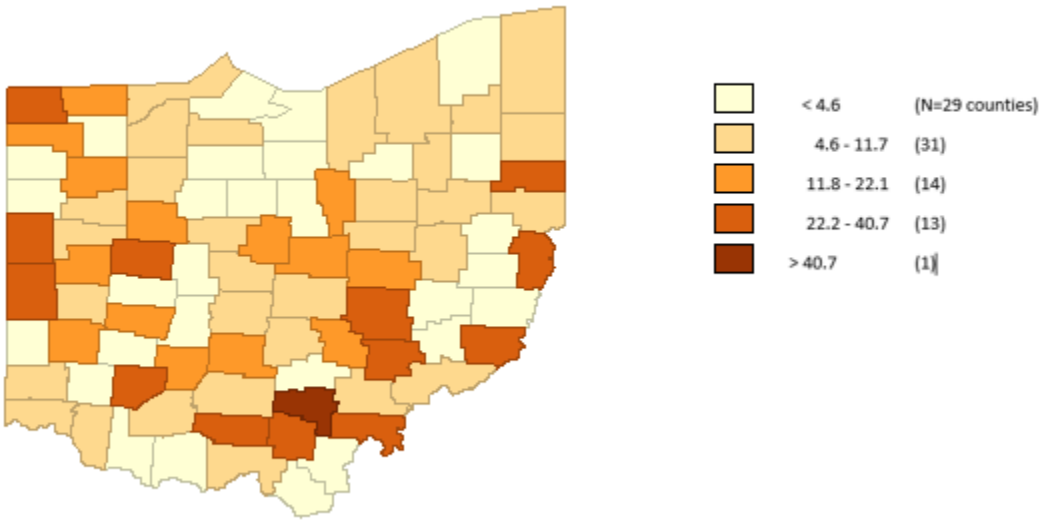
Geocoding. To be useful in examining maternal mortality or another outcome, community factors need to be linked to individual outcomes or events. Many of these contextual variables are publicly available, but individual events must have a spatial marker to link them with these variables. Having an address 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 to 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 are 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 utilization 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 neighborhood environment. Other variables are measured at a county level, which approximate a broader set of influences, including policies.

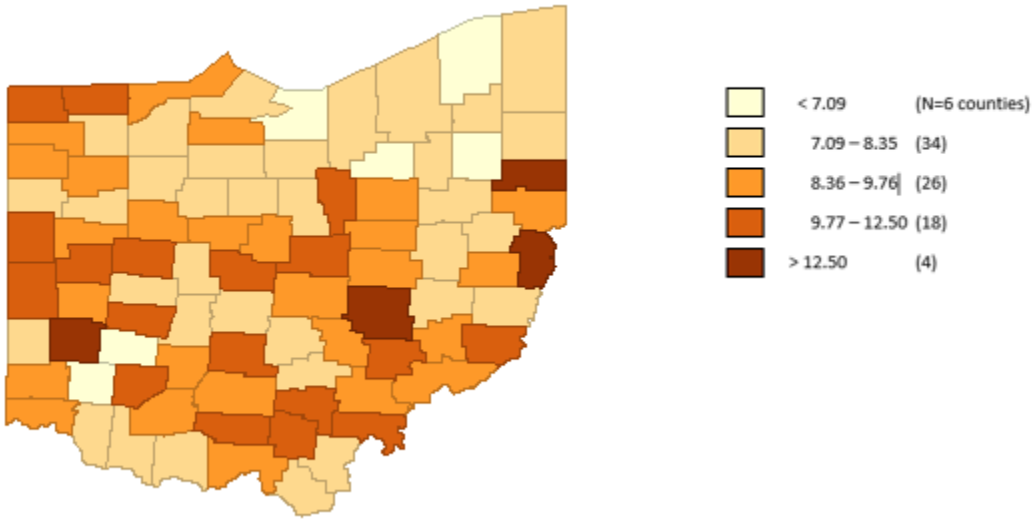
Examples of Data Mapped. We mapped the pregnancy-associated mortality rate (number of pregnancy-associated deaths per 100,000 women of reproductive age) by county in Ohio from 2008-2012 (**Figure 10**).

**Figure 10**. Ohio: Pregnancy-Associated Mortality Rate by County



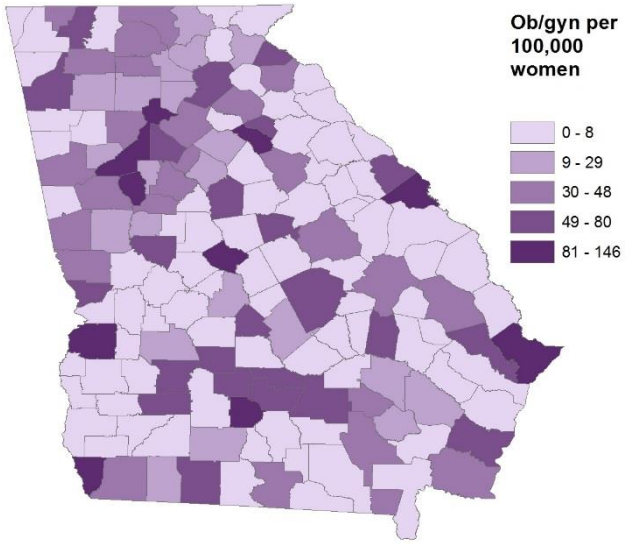

In addition to mapping the raw rates, we used Empirical Bayes Smoothing to smooth the rates since pregnancy-associated mortality rates were unstable due to small numbers (**Figure 11**). Empirical Bayes Smoothing is a way to adjust rates produced from rare events, to take into account that small differences in the number of cases can lead to large differences in the rate. It adjusts all estimates towards the mean rate, with rates from less populous counties being adjusted more than those from larger counties.

**Figure 11**. Ohio: Pregnancy-Associated Mortality Rate by County (Smoothed)



We can also map contextual-level variables potentially associated with maternal mortality. Below is a map of the ratio of obstetrician/gynecologists per 100,000 women of reproductive age for each county in Georgia (**Figure 12**).

**Figure 12**. Georgia: Ratio of Practicing Obstetrician/Gynecologists in Each County per 100,000 Women of Reproductive Age




## 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 an initial set of 21 potential contextual measures conceptually related to maternal mortality. We have applied the theoretical approach to review committee data captured in MMRDS, and used it to inform further development in MMRIA. Our future focus will shift to the implementation and evaluation of this approach.

Understanding the relationship between equity and maternal mortality. We will continue to refine the analytic approaches for examining the association of selected contextual level variables with maternal mortality. A priority is to explore and document the implications for using different potential measures used to represent maternal mortality, thinking about the rate (per women 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 review committees, supporting their incorporation of this information into case narrative development and committee discussions and decisions. We will hold trainings for review committee data analysts focusing on the use of this spatial data in 2017.

# Appendix A: Maternal Mortality Review Committee Decisions Form

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.
- ☐ **NOT PREGNANCY-RELATED OR -ASSOCIATED**
  (i.e. woman was not pregnant within one year of her death)
- ☐ **UNABLE TO DETERMINE IF PREGNANCY-RELATED OR -ASSOCIATED**

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 COMMITTEE AGREE WITH 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 attached page 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 ☐ NO

WAS THIS DEATH A **HOMICIDE**? ☐ YES ☐ NO

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

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

- ☐ NO RELATIONSHIP
- ☐ PARTNER
- ☐ EX-PARTNER
- ☐ OTHER RELATIVE
- ☐ OTHER ACQUAINTANCE
- ☐ OTHER, SPECIFY:
- ☐ N/A
- ☐ UNKNOWN

## 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, community, provider, facility, and/or systems 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 contributing factors that contributed to this death? Multiple class categories may be assigned to each contributing factor.

## 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?

| CRITICAL FACTOR | CLASS CATEGORY AND DESCRIPTION OF ISSUE | RECOMMENDATIONS OF THE COMMITTEE | LEVEL OF PREVENTION (SELECT FROM MENU BELOW) | LEVEL OF IMPACT (SELECT FROM MENU BELOW) |
|---|---|---|---|---|
| PATIENT/FAMILY | | | | |
| COMMUNITY | | | | |
| PROVIDER | | | | |
| FACILITY | | | | |
| SYSTEM | | | | |

**CLASS CATEGORY KEY** (DEFINITIONS 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

**PREVENTION**

- **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, nonacute 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

## CLASS 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 |
|---|---|
| ***Accidental Overdose*** | |
| ***Anesthesia Complications*** | |
| ***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*** | Post-partum/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 nonacute 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 |
| ***Embolisms*** | Thrombotic (non-cerebral), Amniotic fluid, Other embolism/Not otherwise specified |
| ***Hemorrhage*** | Rupture/Laceration/Intraabdominal bleeding; Placental abruption, Placenta previa, Ruptured ectopic pregnancy, uterine atony/ post-partum hemorrhage, Placenta accreta/increta/percreta, due to retained placenta, due to primary disseminated intravascular coagulation, Other hemorrhage/not otherwise specified |
| ***Homicide*** | Intentional injury |
| ***Infections*** | Post-partum 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, Smoke inhalation, Drowning |

# Appendix C: Critical Factors By Leading Causes of Death

### *Hemorrhage*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(27.5%)* | Knowledge *(38.5%)* | Knowledge of warning signs |
| Provider *(30.4%)* | Assessment *(52.0%)* | Delays in diagnosis and effective treatment |
| Facility *(4.3%)* | | |
| Systems of Care *(37.7%)* | Personnel *(38.5%)* | Inadequate training |
| | Policies and Procedures *(9.0%)* | Absence of policies and procedures |
| | Care Coordination *(15.0%)* | Lack of coordination between providers in patient management |
| Community *(0%)* | | |

### *Cardiovascular & Coronary Conditions*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(52.5%)* | Chronic Conditions *(37.5%)* | Obesity |
| | Knowledge *(25.0%)* | Lack of patient knowledge of warning signs |
| Provider *(26.2%)* | Assessment *(31.3%)* | Misdiagnosis and ineffective treatment |
| Facility *(0%)* | | |
| Systems of Care *(21.3%)* | Communication/Care Coordination *(58%)* | Lack of communication between providers that supports coordinated care |
| Community *(0%)* | | |

### *Cardiomyopathy*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(42.9%)* | Chronic Conditions *(36.7%)* | Obesity |
| Provider *(37.1%)* | Assessment *(42.3%)* | Misdiagnosis leading to delayed effective treatment |
| | Referral *(26.9%)* | Failure to seek [cardiology] consultation |
| Facility *(2.9%)* | | |
| Systems of Care *(17.1%)* | | |
| Community *(0%)* | | |

### *Infection*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(39.4%)* | Chronic Conditions *(30.8%)* | No common theme emerged |
| | Environment *(23.1%)* | Lack of housing and financial resources |
| Provider *(39.4%)* | Assessment *(57.7%)* | Misdiagnosis leading to ineffective treatment |
| Facility *(0%)* | | |
| Systems of Care *(21.2%)* | | |
| Community *(0%)* | | |

### *Embolism*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(68.4%)* | Chronic Conditions *(76.9%)* | Obesity |
| Provider *(26.3%)* | Knowledge *(60.0%)* | Lack of knowledge about the use of anticoagulants and thrombolytics |
| Facility *(0%)* | | |
| Systems of Care *(5.3%)* | | |
| Community *(0%)* | | |

### *Mental Health*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(44.8%)* | Split across multiple classes | Absence of social support systems<br>Not recognizing need to seek care<br>Disruptive relationships and housing<br>Lack of adherence to medication(s) |
| Provider *(31.3%)* | Assessment *(33.3%)* | Failure to screen |
| | Communication/Continuity of Care *(24%)* | Lack of communication between patient providers and lack of follow-up on the part of providers |
| Facility *(0%)* | | |
| Systems of Care *(23.9%)* | Continuity of Care *(44%)* | Lack of coordination in patient care between providers and lack of communication between patient providers |
| Community *(0%)* | | |

### *Preeclampsia and Eclampsia*

| **Factor Level** *(% of total factors)* | **Most Common Factor Class(es)** *(% of level-specific classes)* | **Common Themes** |
|---|---|---|
| Patient *(21.6%)* | | |
| Provider *(62.2%)* | Assessment *(39.1%)* | Inadequate assessment leading to misdiagnosis |
| | Knowledge *(30.4%)* | Misdiagnosis leading to ineffective treatment |
| Facility *(0%)* | | |
| Systems of Care *(16.2%)* | Communication *(67.0%)* | Lack of communication as a barrier to coordination of care between providers |
| Community *(0%)* | | |

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