

Tennessee Maternal Mortality

Review of 2017 Maternal Deaths



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Dedication

The Tennessee Department of Health expresses its gratitude to the committee members who have contributed to the data gathered for this report. Thank you to the state Maternal Mortality Review Committee who have reviewed all of the deaths and developed recommendations to put in this report that can save lives. It is with deepest sympathy and respect that we dedicate this report to the memory of those 78 women, and to their loved ones, who died while pregnant or within one year of pregnancy in 2017. We hope our efforts to further understand the causes and contributing factors of maternal mortality in Tennessee will prevent future deaths.

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EXECUTIVE SUMMARY

This report describes the state of maternal mortality in Tennessee in 2017. It includes the demographic characteristics of women who died while pregnant or within one year of pregnancy as well as summarizes the causes of death and contributing factors. Through a comprehensive review of these deaths by the Tennessee Maternal Mortality Review (MMR) Committee, this report identifies specific opportunities for prevention of maternal mortality and promotion of women's health. Below are the MMR Committee's key findings and recommendations:

Key Findings:

- In 2017, **78 women in Tennessee died** while pregnant or within one year of pregnancy. This translates to a pregnancy-associated mortality ratio (PAMR) of 96.3 per 100,000 live births.
- A majority of deaths (56%) occurred 43 days to one year after pregnancy; 22% occurred up to 42 days after pregnancy, and 22% occurred during pregnancy.
- More than one-quarter (28%) of deaths were pregnancy-related. A death is considered pregnancy-related if it would not have occurred had the women not been pregnant. This translates to a pregnancy-related mortality ratio (PRMR) of 27.2 per 100,000 live births. The top three causes of pregnancy-related deaths were embolism, cardiovascular and hemorrhage.
- Sixty-three percent (63%) of deaths were determined to be pregnancy-associated, but not related. A death is considered pregnancy-associated, but not related if the pregnancy did not make contribute to the outcome. The top

three causes of pregnancy-associated, but not related deaths were overdose, motor vehicle accidents and violence.

- Substance Use Disorder (SUD) and mental health conditions were contributing factors in maternal deaths. SUD contributed to 33% of all maternal deaths in 2017 and mental health conditions contributed to 18% of deaths. Ninety-six percent of deaths in which SUD was a contributing factor were determined to be preventable. Deaths to women with SUD did not occur in isolation; almost half of all deaths with SUD as a contributing factor also had a co-occurring mental health diagnosis as a contributing factor (46%).
- Women with only a high school degree or GED (136.3 per 100,000 live births) or less (139.9 per 100,000) were more than two times as likely to die compared to women with more than a high school degree (61.7 per 100,000).
- Eight-five percent of all maternal deaths were determined to be preventable. 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.
- Preventable pregnancy-associated deaths were multi-factorial: on average, 4.1 factors were identified as contributing to each death.

Summary of 2019 Key Recommendations:

1. The State should expand resources and patient access to treatment options for substance and mental health disorders both during pregnancy and for the year following pregnancy.

2. The State should increase public awareness about motor vehicle and driver safety, particularly regarding the importance of safety restraints and the danger of driver under the influence or driving while distracted.
3. The State should address critical issues of maternal mortality including intimate partner violence, the increased risk of violence and lethality during pregnancy and post pregnancy, and how to access support services/resources that are available.
4. Clinics and hospitals should improve protocols, education and screening on several maternal health topics. Improved protocols are needed to address high risk medical conditions during pregnancy to include: pre-eclampsia, eclampsia, hemorrhage, cardiomyopathy, thrombosis, infection prevention and follow-up of patients. Education for clinic and hospital staff is needed on clotting as a risk factor during pregnancy. Improved use of screenings should be utilized for substance use disorder, mental health disorders and domestic violence.
5. Healthcare providers should be proficient in current standards of care and best practices during prenatal, intrapartum and postpartum periods. Best practices should be promoted for preconception planning services and recognition of signs and symptoms of complications such as hemorrhage and other high risk conditions. Care coordination should be improved for chronic conditions, mental health and substance abuse disorders.

6. Health care systems should develop multi-disciplinary care teams and assure ongoing care coordination before and after delivery and when interfacing with social services.
7. Women and their friends and families should receive education to identify new or emerging symptoms that require early attention before, during and after pregnancy and should be encouraged to seek care early should symptoms arise. This includes discussions with their healthcare providers on chronic conditions in advance of becoming pregnant.

MATERNAL MORTALITY OVERVIEW

Objective

The objective of this report is to describe the state of maternal mortality in Tennessee in 2017. This report describes the demographic characteristics of maternal deaths as well as summarizes the causes and contributing factors of these deaths. Through a comprehensive review of these deaths by the Tennessee Maternal Mortality Review (MMR) Committee, this report identifies opportunities for prevention of maternal mortality and promotion of women's health with specific recommendations at the individual/family, community, provider, facility, and systems levels. This report is a requirement of the Tennessee Maternal Mortality Review and Prevention Act of 2016.

Background

The death of a woman during pregnancy, childbirth, or within the first year postpartum is a tragic, sentinel event that has immediate impacts on a woman's family and community. These deaths reflect comprehensive determinants of health, such as individual, family and provider factors along with facility, system, and community factors.

Nationally, it is estimated that approximately 700 women in the United States die as a result of pregnancy or pregnancy-related complications each year.¹ Racial disparities persist in these statistics as non-Hispanic Black women are three to four times more likely to die from a pregnancy-related complication than non-Hispanic

¹ Building U.S. Capacity to Review and Prevent Maternal Deaths. (2018). Report from nine maternal mortality review committees. Retrieved from http://reviewtoaction.org/Report_from_Nine_MMRCs

White women.² Reducing maternal mortality and improving maternal health are national priorities.^{3 4}

Maternal Mortality in Tennessee Prior to 2017

Prior to the implementation of the MMR Program in Tennessee, the state relied on vital statistics alone to identify all deaths to women while pregnant or within one year of pregnancy. In 2012, Tennessee introduced a pregnancy checkbox on the death certificate to aid in identifying maternal deaths; therefore, data prior to 2012 are not comparable due to different case identification methodologies. Based solely on data from vital statistics, on average, 74 Tennessean women died during or within one year of pregnancy each year during 2012-2016. The pregnancy-associated mortality ratio, or the number of pregnancy-associated deaths per 100,000 live births, was 91.6 in 2016, using vital statistics data alone.

There are some limitations in only using vital statistics data to measure and understand maternal mortality. With the noted changes in case identification on the death certificate through the pregnancy checkbox, it is difficult to determine whether changes seen in maternal mortality statistics reflect better ascertainment or actual changes in risk of death.⁵ There have been errors in reported pregnancy status documented in the literature, which have potentially led to an overestimation of pregnancy-related deaths.⁶ Prior to the MMR Program in Tennessee, there was no procedure to confirm these identified cases. In addition, vital statistics data are unable to capture information on whether these deaths

² Pregnancy Mortality Surveillance System. Centers for Disease Control and Prevention. Available at: <https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pmss.html>

³ Healthy People 2020 [Internet]. Washington, DC: U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion [cited 03 January 2019]. Available from: https://www.healthypeople.gov/node/4897/data_details.

⁴ Kogan MD, Dykton C, Hirai AH, et al. A new performance measurement system for maternal and child health in the United States. *Matern Child Health J.* 2015;19(5):945-57.

⁵ Creanga AA, Callaghan WM. Recent increases in the U.S. maternal mortality rate: disentangling trends from measurement issues [letter]. *Obstet Gynecol* 2017;129:206–7

⁶ Baeva S, Saxton DL, Ruggiero K, Kormondy ML, Hollier LM, Hellerstedt J, Hall M, Archer NP. Identifying maternal deaths in Texas using an enhanced method, 2012. *Obstet Gynecol.* 2018;131(5),762-769.

were preventable or what recommendations could help eliminate preventable maternal deaths.

The MMR Program provides an opportunity to address limitations in measurement of maternal deaths. With its establishment in 2017, each maternal death identified through vital statistics data was verified with a comprehensive, standardized process. Additionally, the review of each death by the Maternal Mortality Review Committee enabled further data collection on cause of death, contributing factors, preventability, and recommendations.

The Maternal Mortality Review and Prevention Act

Tennessee established the Maternal Mortality Review (MMR) Program on January 1, 2017 upon the effective date of the Maternal Mortality Review and Prevention Act of 2016 (T.C.A. § 63-3-2). The legislation further created the MMR Committee to review maternal deaths and make determinations regarding the preventability of maternal deaths.

MMR Program

Set forth in legislation, the purpose of the MMR Program is to:

- 1) Identify and address the factors contributing to poor pregnancy outcomes for women; and
- 2) Facilitate state systems changes to improve the health of women before, during and after pregnancy.

MMR Committee

The MMR Committee is a multidisciplinary expert panel, with representation from public health, obstetrics-gynecology, maternal and fetal medicine, anesthesiology, neonatology, pediatrics, nurse-midwifery, nursing, chief medical examiner, mental and behavioral health, domestic violence, as well as representation from Hospital Patient Safety and the Tennessee Senate and House of Representatives. The MMR Committee is tasked to review maternal deaths and report recommendations for

changes to any law, rule, and policy that would promote the safety and well-being of women and prevention of maternal deaths.

Definitions

Categorizations of maternal mortality further specify timing and cause of death. While some organizations define maternal mortality as only occurring within 42 days of pregnancy, the Tennessee Maternal Mortality Review and Prevention Act of 2016 uses the following definitions, which are aligned with the Centers for Disease Control and Prevention (CDC):

- **Pregnancy-associated deaths:** The death of a woman during pregnancy or within one year of the end of pregnancy from any cause. Pregnancy-associated deaths can be classified into **pregnancy-related deaths** or **pregnancy-associated but not related deaths**.
 - **Pregnancy-related deaths:** 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 deaths:** 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.

MATERNAL MORTALITY REVIEW PROGRAM PROCESS

The Maternal Mortality Review (MMR) Program process involves four processes: case identification, case verification, case abstraction, and case review. This section will review each process in more detail. A visual illustration of this process is found at the end of this section in **Figure 4**.

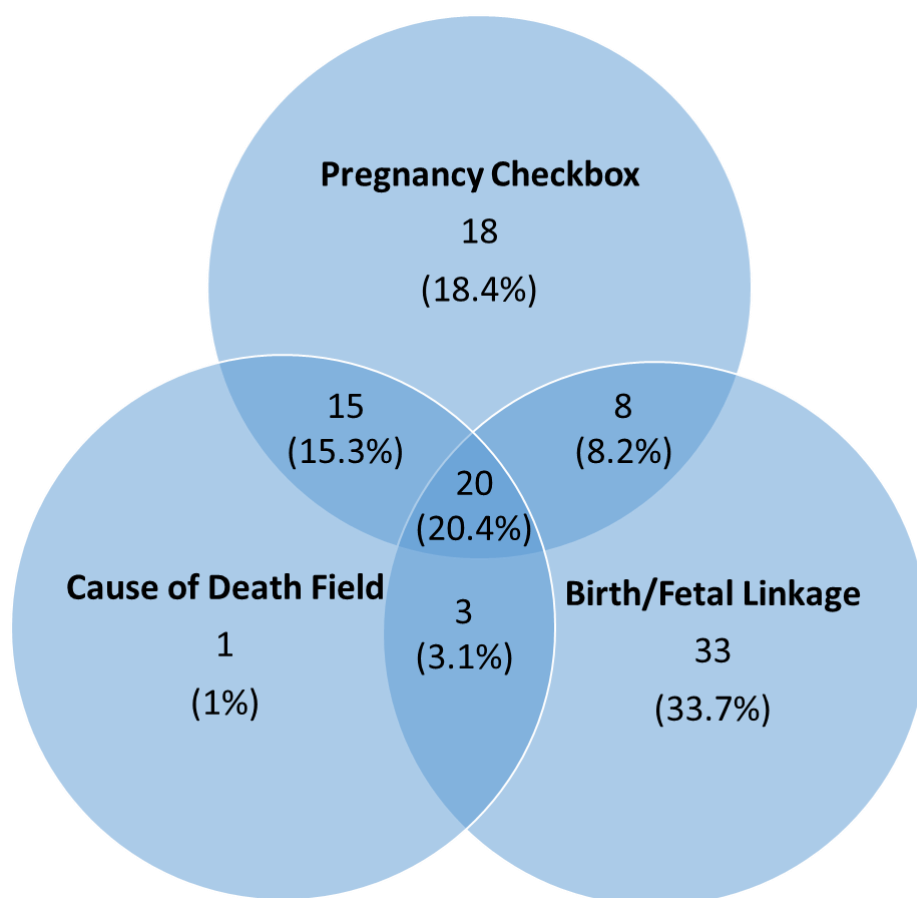
Case Identification

The MMR Program coordinates with the TDH Office of Vital Records and Statistics to identify all eligible pregnancy-associated deaths for review. All death certificates of women aged 10-55 years in calendar year 2017 were screened and considered potential cases if they met any of the following criteria:

1. Presence of specific underlying death codes on the death certificate: Tenth Revision of the International Classification of Diseases (ICD-10) codes A34, O00-O99
2. Linkage of a birth certificate or a fetal death record to a death certificate within one year of death
3. Presence of a checkbox on the death certificate to indicate the decedent was either: 1) pregnant at death, 2) not pregnant, but pregnant within 42 days of death, or 3) not pregnant, but pregnant within 43 days to 1 year before death

In 2017, 98 potential pregnancy-associated deaths were flagged through this case identification methodology. See **Figure 1** for case identification sources for all pregnancy-associated deaths. More than half of identified cases (53%) had only one source for case identification. The most common source of the identification was the pregnancy checkbox on the death certificate (62% of all identified deaths).

Figure 1: Pregnancy-Associated Death Case Identification, Vital Statistics, Tennessee 2017



Case Verification

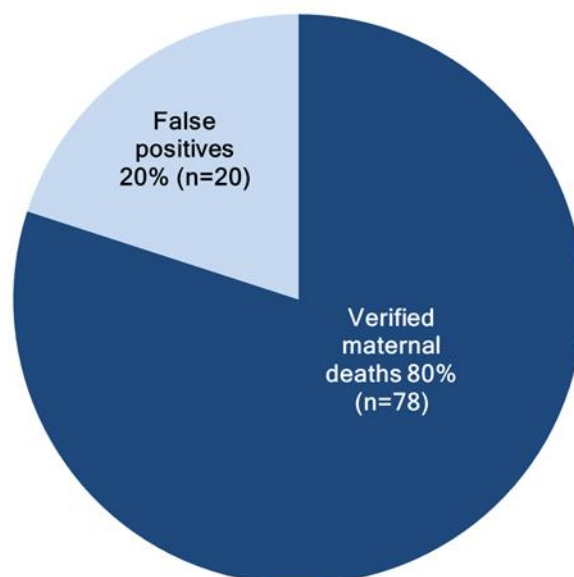
For a case to be considered eligible for review by the Maternal Mortality Review Committee, the death needed to be verified through a standardized, comprehensive process. Upon receipt of the initial list of identified cases, the Maternal Mortality Nurse Consultant and Program Coordinator requested medical

records for all identified decedents. In addition, social media, obituaries, or other news sources were investigated. For example, if a case were a homicide, the nurse abstractor would request not only the hospital records at death, but also any police reports, social services records, the autopsy report, as well as the prenatal care and delivery records if applicable. Deaths were verified as pregnancy-associated deaths, and therefore, eligible for review, if the records received were complete and there was at least one indication of pregnancy or recent pregnancy within one year of death.

If records were complete but there was either 1) a clear contraindication with pregnancy or recent pregnancy (for example, a stated hysterectomy more than one year prior to death in a medical record) or 2) no indication of pregnancy or recent pregnancy in any record, the Maternal Mortality Nurse Consultant and Program Coordinator determined that the death was **not verified** as a pregnancy-associated death and classified as a false positive. Those false positive cases did not move forward to the case abstraction or review process.

Out of the 98 cases identified as potential pregnancy-associated deaths, 78 (80%) were verified deaths of women while pregnant or within one year of pregnancy; the remaining 20 (20%) were false positives (**See Figure 2**). These 78 confirmed cases were elevated for case abstraction and subsequent review by the Maternal Mortality Review Committee.

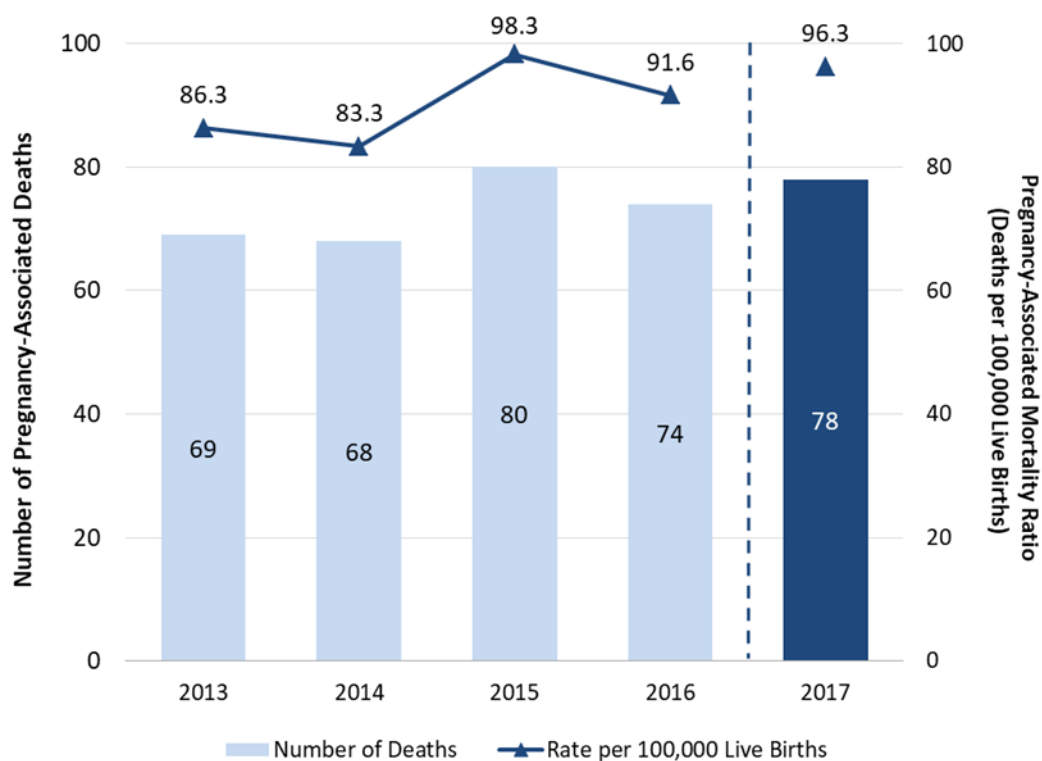
**Figure 2: Pregnancy-Associated Death Case Verification,
MMR Program Data, Tennessee 2017**



Data sources: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program; Tennessee Department of Health, Office of Vital Records and Health Statistics, Death Statistical File, 2017.

Through verifying each pregnancy-associated death in Tennessee in 2017, the MMR Program data was used to calculate the pregnancy-associated mortality ratio (PAMR). In 2017, the Tennessee PAMR was 96.3 per 100,000 live births; it is important to note that this is not directly comparable to previous estimates, as those deaths were not able to be verified (See **Figure 3**). The effect this verification process had on the overall estimate of the burden of pregnancy-associated mortality is substantial. If the MMR Program did not verify the deaths identified through vital statistics in 2017, the PAMR would have been 26% higher (96.3 vs. 121.0 per 100,000 live births). Efforts to improve data collection and case identification processes have been initiated based on the case verification findings.

Figure 3: Pregnancy-Associated Mortality, Tennessee 2013-2016, 2017



Note: The 2017 number of pregnancy-associated deaths and the 2017 pregnancy-associated ratio are not comparable to estimates from 2013-2016; the 2017 data source is the MMR Program while the 2013-2016 data source is vital statistics.

Data sources: Tennessee Department of Health, Office of Vital Records and Health Statistics, Death Statistical File, 2013-2017.

Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program. Population estimates based on interpolated data from the U.S. Census's Annual Estimates of the Resident Population.

Case Abstraction

One key aspect of the Tennessee MMR Program is the record collection and abstraction process. Once a death is verified, the Maternal Mortality Nurse Consultant and Program Coordinator identifies the multiple disciplinary aspects of the decedent's care, which enables a thorough case review. To align with national recommendations, Tennessee utilizes the Maternal Mortality Review Information Application (MMRIA) database from the CDC to capture critical aspects of each case in a standardized format prior to review by the MMR Committee. Documentation in

MMRIA represents a wide variety of data sources, and contains multiple forms, including: the death certificate, autopsy report, birth certificate, prenatal care record, social and environmental profile, mental health, case narrative, and committee decisions.

Case Review

After each death is fully abstracted, the Maternal Mortality Nurse Consultant and Program Coordinator assigns each case to either the Internal Team or the Full Review Team. This decision is based on individual case cause of death and record completeness.

Tennessee utilizes the CDC's decision form to ensure case review standardization for every verified pregnancy-associated death. This decision form provides guidance on key decisions required for each case, including:

- **Was the death pregnancy-related?**
- **What was the underlying cause of death?**
- **Was the death preventable?**
- **What factors contributed to the death?**
- **What recommendations may help prevent future deaths?**

The form is finalized during the MMR Committee Meeting.

Internal Team Review Process

Cases that appear to not be related to the pregnancy such as motor vehicle accidents, gunshot wounds, and overdose cases are assigned to the Internal Team. Additionally, cases that have limited records are also assigned to the Internal Team. The internal team is composed of TDH staff with expertise in obstetrics and gynecology, gynecologic oncology, pediatrics, chronic diseases, mental health, death review, and injury prevention. These cases are reviewed intensively by the Internal Team prior to the Full Team Review. Each team member completes a decision form. The nurse abstractor combines the forms into one per case. Each internal case is presented in summary at the Full Team Review, with the Full Team providing consensus for each element of the decision form. If there are substantial questions raised on internal cases, they are held over for a more comprehensive Full Team Review.

Full Team Review Process

Deaths that are thought to have occurred in relation to a woman's pregnancy with adequate record collection are assigned a primary and secondary reviewer on the MMR Committee by the Maternal Mortality Nurse Consultant and Program Coordinator based on subject matter expertise. The case decision form is preliminarily drafted by the assigned primary and secondary reviewer prior to the MMR Committee meeting. The primary and secondary reviewers are members who present the case to the committee. Initially, once the case was presented, the decision form was filled by the entire committee. With guidance from the CDC on effective time management, a process of having the assigned reviewers complete a draft of their case's decision form prior to the meeting was initiated. The filled decision form is presented for the committee to review. The committee discusses the form and comes to a consensus about each element on the form.

Figure 4: Flow Chart MMR Program Process



DEMOGRAPHICS OF ALL PREGNANCY-ASSOCIATED DEATHS

During 2017, 78 Tennessean women died within one year of pregnancy. **Table 1** provides a description of these women by age, race/ethnicity, educational level, insurance type, and residence, in comparison to maternal characteristics of all Tennessee births in 2017. The table describes frequencies and percentages of all women who died as well as ratios that compare these deaths to maternal characteristics of the total birth population.

The pregnancy-associated mortality ratio (PAMR), which is the number of pregnancy-associated deaths per 100,000 live births, is also shown in **Table 1** for each subgroup; ratios are not presented for all subgroups if there were small numbers. The overall PAMR for all deaths was 96.3 per 100,000 live births. Social determinants of health such as education level, housing status, and poverty often are a factor in these deaths. Women with only a high school degree/GED (136.3 per 100,000) or less (139.9 per 100,000) were more than two times as likely to die compared to women with more than a high school degree (61.7 per 100,000). Disparities were also seen by insurance status, which is reflective of poverty and other risk factors. The PAMR was higher for older women aged 30-39 years compared to women aged less than 30 years (102.2 per 100,000 vs. 84.4 per 100,000). Contrary to our previous state data, there was not a significant difference in the PAMR between non-Hispanic White and non-Hispanic Black women in 2017 Tennessee. Additional years of data will enable us to study racial and ethnic disparities in subsets of pregnancy-associated deaths. There was also no difference in rural versus metropolitan data.

Table 1. Demographic Characteristics of All Pregnancy-Associated Deaths Compared to Characteristics of all Tennessee Births, 2017

Characteristics	Pregnancy-Associated Deaths (N=78)		Total Tennessee Births (N=81,024)		Pregnancy-Associated Mortality Ratio (PAMR)
	Frequency	Percent	Frequency	Percent	
Maternal Age					
Less than 30 years	43	55	50,958	63	84.4
30-39 years	29	37	28,388	35	102.2
40+ years	6	8	1,678	2	-
Maternal Race/Ethnicity					
Non-Hispanic White	55	71	53,496	66	102.8
Non-Hispanic Black	18	23	16,415	21	109.7
Other	5	6	10,096	12	-
Maternal Education (highest level attained)					
Less than high school	15	19	10,724	13	139.9
High school or GED	31	40	22,737	28	136.3
More than high school	29	37	47,001	58	61.7
Unknown	3	4	562	1	-
Insurance Type					
TennCare	52	67	39,043	48	97.3
Private	19	24	33,030	41	48.4
Other	3	4	4,666	6	-
Unknown	4	5	4,285	5	-
Place of Residence					
Metropolitan county	34	44	35,452	44	96.0
Rural county	44	56	45,572	56	97.0

Note: Metropolitan county includes: Davidson, Hamilton, Knox, Madison, Shelby, and Sullivan Counties.

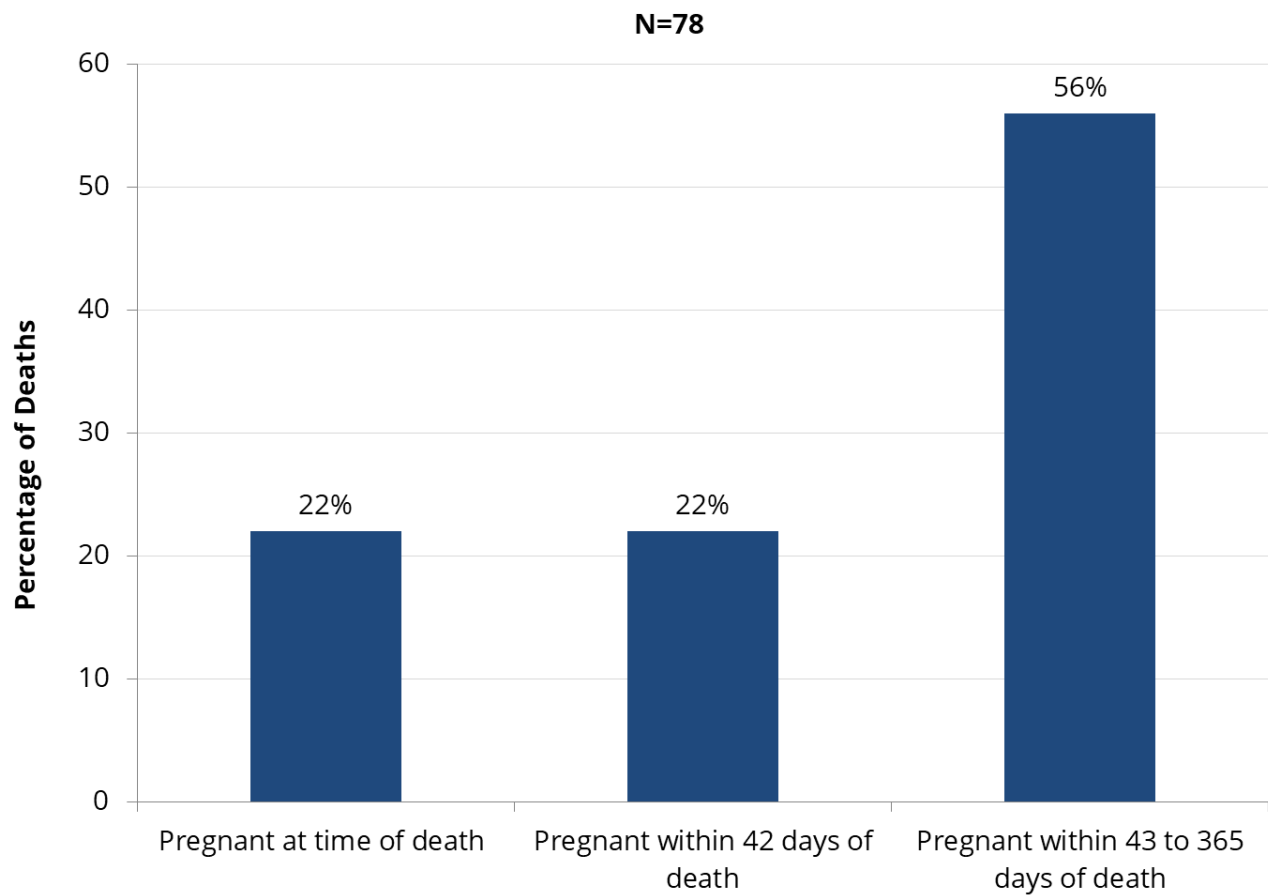
Data sources: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

Tennessee Department of Health, Office of Vital Records and Health Statistics, Birth Statistical File, 2017. Population estimates based on interpolated data from the U.S. Census's Annual Estimates of the Resident Population.

Timing of Death in Relation to Pregnancy

The majority of pregnancy-associated deaths occurred 43 days to one year after pregnancy (56%). The remaining deaths occurred either during pregnancy (22%) or within 42 days of pregnancy (22%) (**Figure 5**).

Figure 5. Timing of All Pregnancy Associated Deaths in Relation to Pregnancy, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

COMMITTEE DECISIONS FOR ALL PREGNANCY-ASSOCIATED DEATHS

Contributing Factors

The MMR Committee was asked to determine whether substance use disorder (SUD), mental health conditions and obesity contributed to all pregnancy-associated deaths occurring during pregnancy or within one year of the end of pregnancy. **Figure 6** provides the percentage of deaths in which these factors contributed.

Substance Use Disorder (SUD)

Of the three factors, the Committee determined that SUD contributed to the largest percentage of deaths. One-third (33%) of all pregnancy-associated deaths in 2017 had SUD as a contributing factor (**Figure 6**). The large majority (81%) of these deaths occurred in the late post-partum period, between 43 and 365 days postpartum. Among these deaths, the majority were to non-Hispanic White women (81%), women with TennCare coverage (62%), and women who lived in metropolitan areas (69%).

Deaths to women with SUD did not occur in isolation; almost half of all deaths with SUD as a contributing factor also had a co-occurring mental health diagnosis as a contributing factor (46%).

Mental Health Conditions

The Committee determined that mental health conditions were a contributing factor in 18% of all pregnancy-associated deaths (**Figure 6**). Similar to SUD, these deaths mostly occurred in the late post-partum period (79%), between 43 and 365 days of pregnancy. These deaths mostly occurred among non-Hispanic White

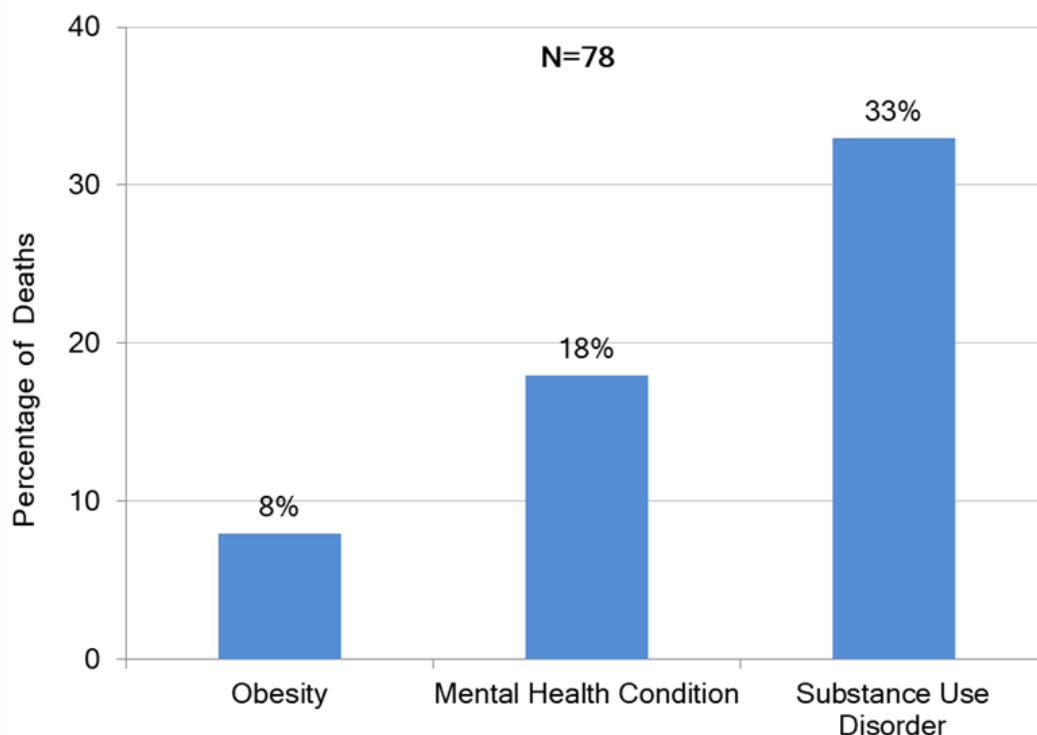
women (86%), women with TennCare coverage (57%), and women living in metropolitan areas (64%).

Obesity

Eight percent of all pregnancy-associated deaths reviewed were determined to have obesity as a contributing factor (**Figure 6**). There were no differences in the percentage of deaths occurring by timing of death (33% of deaths occurred during pregnancy, within 42 days of pregnancy and within 43-365 days of pregnancy). Half of these deaths were to non-Hispanic Black women (50%) and women with TennCare coverage (50%). The majority of these deaths occurred to women who resided in metropolitan areas (83%).

Almost all pregnancy-associated deaths with SUD, mental health condition, and obesity as contributing factors were determined to be preventable by the Committee (96%). Only one death was considered non-preventable.

Figure 6: Contributing Factors for All Pregnancy-Associated Deaths, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

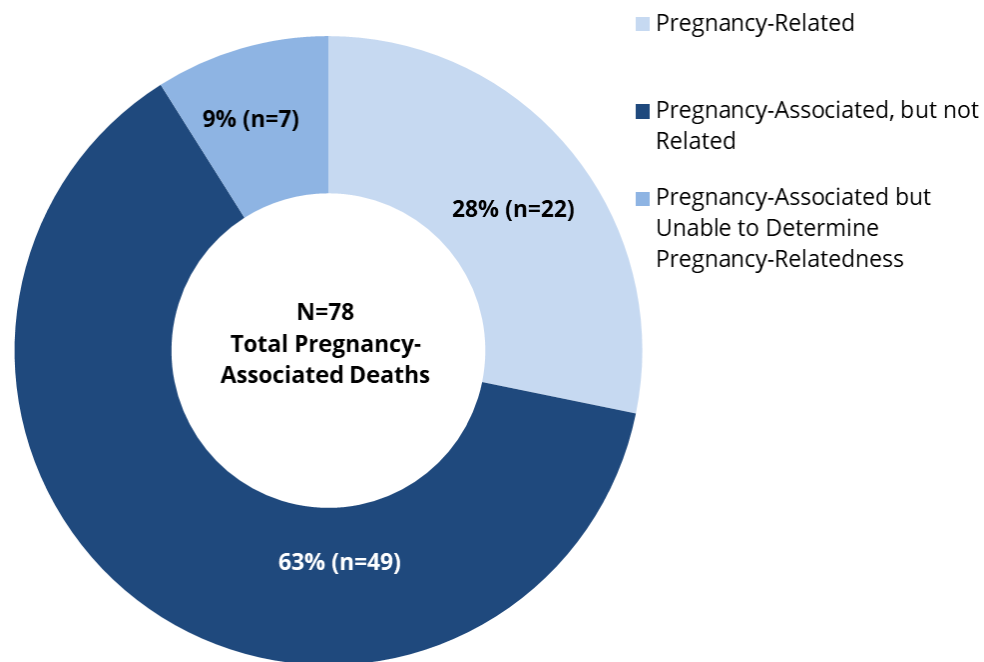
Violent Deaths

Of the 78 pregnancy-associated deaths reviewed, there were 13 violent deaths: 11 cases of homicide (14% of all deaths) and two cases of suicide (3% of all deaths). Most violent deaths (62%) occurred among non-Hispanic white women. Also, the majority of violent deaths (62%) occurred between 43 days and one year of pregnancy. All violent deaths were determined to be preventable by the Committee.

Pregnancy-Relatedness

Of the 78 pregnancy-associated deaths in 2017, 28% of deaths (N=22) were determined to be pregnancy-related and 63% (N=49) were classified as not pregnancy-related by the Committee, meaning these deaths were not a result of the woman's pregnancy (**Figure 7**). The Committee was unable to determine pregnancy-relatedness in 9% of all cases.

Figure 7. Committee Determination of Pregnancy-Relatedness, Pregnancy-Associated Deaths, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

As there were significant differences in pregnancy-related vs. pregnancy-associated, but not related deaths, the next sections will further describe the committee decisions regarding these two types of deaths in more detail.

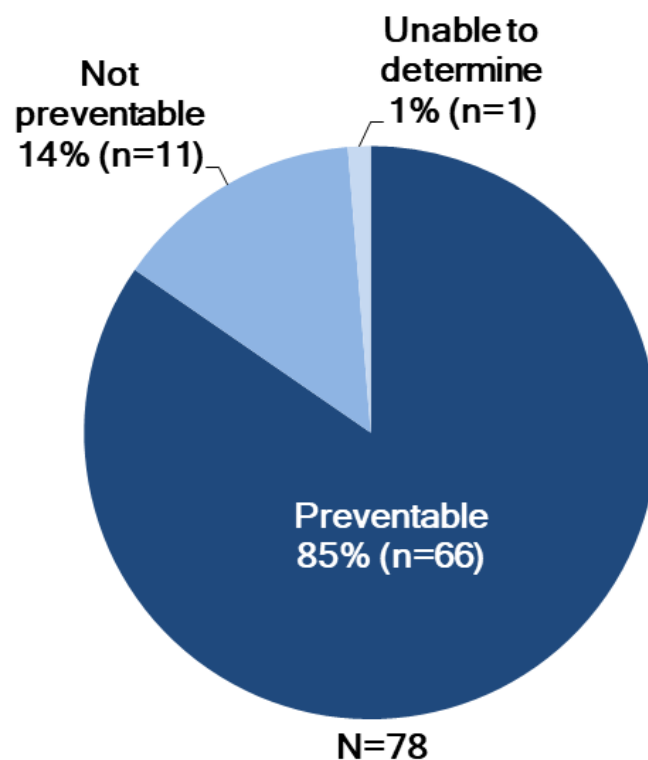
Preventability

Deaths were considered preventable if 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.⁷

⁷ Building U.S. Capacity to Review and Prevent Maternal Deaths. (2018). Report from Nine Maternal Mortality Review Committees. http://reviewtoaction.org/Report_from_Nine_MMRCs

The committee found that 85% of all pregnancy-associated deaths were preventable and 14% were not preventable (**Figure 8**). The committee was unable to determine preventability for one death (1%).

Figure 8. Preventability of All Pregnancy-Associated Deaths, Tennessee, 2017

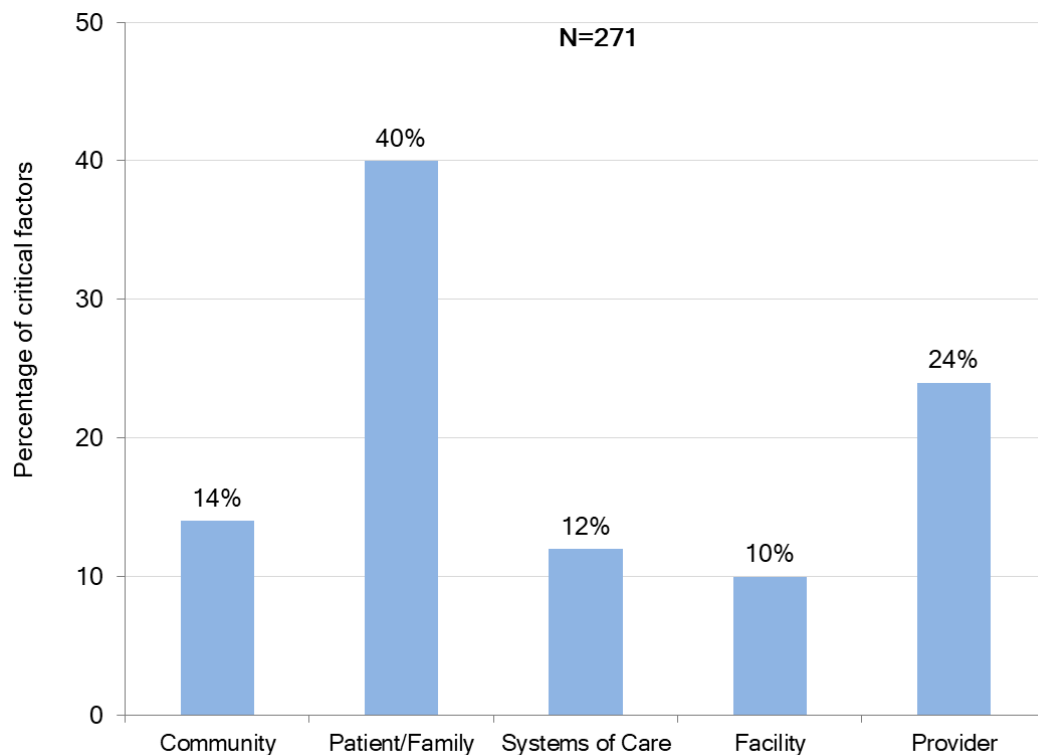


Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

For each of the 66 preventable deaths, the Committee identified critical factors that contributed to each death and categorized them into one of five factor levels in which change in the outcome could have occurred. There were a total of 271 critical factors identified. The five factor levels are patient/family, provider, facility, systems of care, and community. The critical factors helped guide discussion for the Committee's recommendations to eliminate preventable maternal death.

On average, the Committee determined there were 4.1 factor levels for each preventable pregnancy-associated death in Tennessee in 2017. In addition, these critical factors spanned an average of 2.7 of the 5 designated levels (patient/family, provider, facility, systems of care, and community). **Figure 9** provides the percentage of critical factors affecting preventable deaths.

Figure 9. Critical Factors Contributing to Preventable Pregnancy-Associated Deaths, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

PREGNANCY-RELATED DEATHS

Demographics of Pregnancy-Related Deaths

Pregnancy-related deaths are deaths to women 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.

A total of 22 deaths were classified as pregnancy-related by the committee (28% of all pregnancy-associated deaths). The pregnancy-related mortality ratio (PRMR), or number of pregnancy-related deaths per 100,000 live births, was 27.2 per 100,000 live births in 2017. Table 2 describes these decedents by demographic characteristics, including age, race/ethnicity, educational level, insurance type, and place of residence.

The majority of deaths occurred among women under 30 years old (45%) and between 30 and 39 years of age (41%). More than half of the women were non-Hispanic White (55%) and half received more than a high school education (college graduates and non-graduates) (50%). A large percentage of deaths occurred among women with TennCare insurance (55%) and who resided in metropolitan areas of the state (50%). In regards to TennCare coverage, pregnancy is a primary eligibility category for TennCare. Women who become pregnant may become eligible for TennCare and often apply for coverage at different points in their pregnancy. Some pregnant women do not apply for TennCare coverage until their delivery. As such, TennCare Coverage is not reflective of the length of time that the pregnant women may have had health insurance coverage by TennCare.

**Table 2. Demographic Characteristics of Pregnancy-Related Deaths,
Tennessee, 2017**

Characteristics	Pregnancy-Related Deaths (N=22)		Total Tennessee Births (N=81,024)	
	Frequency	Percent	Frequency	Percent
Maternal Age (at time of death)				
Less than 30 years	10	45	50,958	63
30-39 years	9	41	28,388	35
40+ years	3	14	1,678	2
Maternal Race/Ethnicity				
Non-Hispanic White	12	55	53,496	66
Non-Hispanic Black	8	36	16,415	21
Other	2	9	10,096	12
Maternal Education (highest level attained)				
Less than high school	5	23	10,724	13
High school or GED	6	27	22,737	28
More than high school	11	50	47,001	58
Unknown	0	0	562	1
Insurance Type				
TennCare	12	55	39,043	48
Private	8	36	33,030	41
Other	0	0	4,666	6
Unknown	2	9	4,285	5
Place of Residence				
Metropolitan county	11	50	35,452	44
Rural/Micropolitan county	11	50	45,572	56

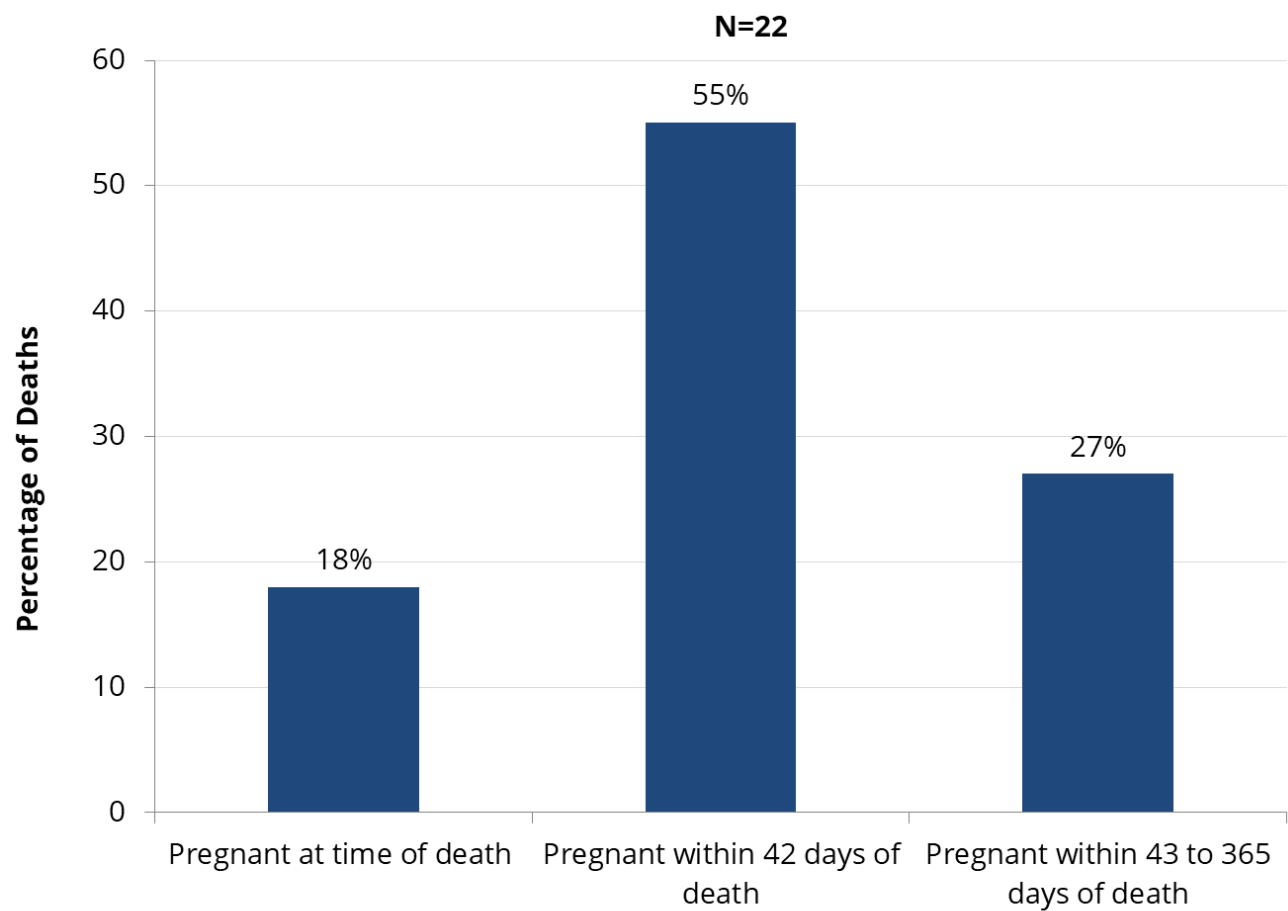
Note: Metropolitan county includes: Davidson, Hamilton, Knox, Madison, Shelby, and Sullivan Counties.

Data sources: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program; Tennessee Department of Health, Office of Vital Records and Health Statistics, Birth Statistical File, 2017.

Timing of Death of Pregnancy-Related Deaths

Pregnancy-related deaths were most common within 42 days of pregnancy (55%) when compared to deaths within 43 to 365 days of pregnancy (27%) and deaths during pregnancy (18%) (**Figure 10**).

Figure 10: Timing of Pregnancy-Related Deaths, Tennessee, 2017



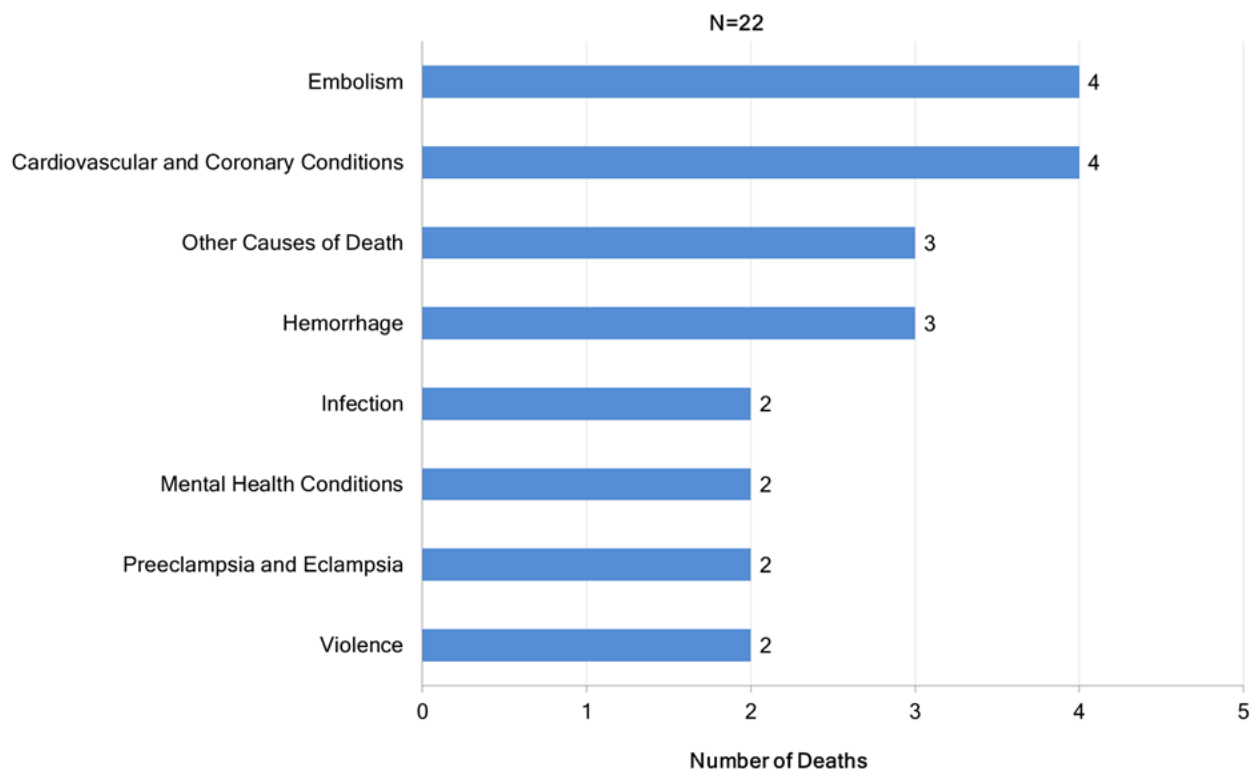
Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

Underlying Causes of Pregnancy-Related Deaths

Underlying causes of pregnancy-related deaths were grouped into eight different categories, based on classification from Building U.S. Capacity to Review and Prevent Maternal Deaths.⁸ **Figure 11** provides the number of pregnancy-related deaths by each of the underlying cause of death categories. The leading causes of pregnancy-related deaths were embolism (4 deaths) and cardiovascular and coronary conditions (4 deaths). Leading causes of death by race and ethnicity are not provided due to very small numbers.

For the categorizing of the underlying causes of death please see **Appendix 3**.

Figure 11: Leading Underlying Causes of Pregnancy-Related Deaths, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

⁸ Building U.S. Capacity to Review and Prevent Maternal Deaths. (2018). Report from nine maternal mortality review committees. Retrieved from http://reviewtoaction.org/Report_from_Nine_MMRCs

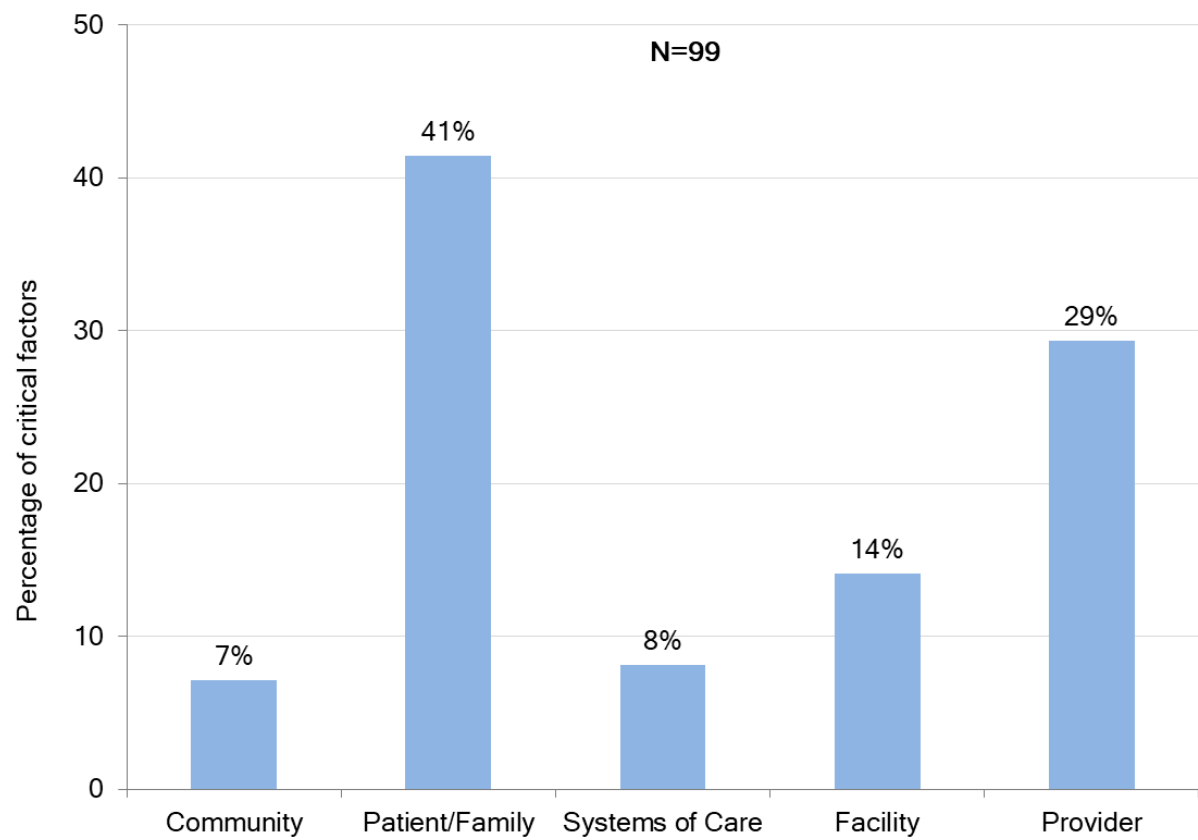
Preventability of Pregnancy-Related Deaths

Of the 22 pregnancy-related deaths, 20 (91%) were determined to be preventable.

Critical Factors of Pregnancy-Related Deaths

If a pregnancy-related death was deemed preventable, the Committee then assessed critical factors that contributed to the death. Preventable pregnancy-related deaths were multi-factorial events, with contributing factors on multiple levels. The Committee identified 99 contributing factors among 20 preventable pregnancy-related deaths. On average, the Committee found 5.0 factors contributed to each preventable pregnancy-related death in Tennessee and each death touched, on average, 2.9 of the 5 factor levels (individual/family, provider, facility, community, systems of care). The distribution of contributing factors by level among preventable pregnancy-related deaths is shown in **Figure 12**. The largest proportion of contributing factors were at the patient/family level (41%), followed by the provider level (29%); whereas, the community and systems of care levels had the smallest proportions of factors identified.

Figure 12: Critical Factors Contributing to Preventable Pregnancy-Related Deaths, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

Although the numbers are small, examining contributing factors among the top causes of death from embolism and cardiovascular and coronary conditions highlighted opportunities for Committee discussion on prevention recommendations. For deaths due to embolism, examples of contributing factors identified included: lack of coordination of care with primary care provider at the systems level, lack of accurate assessment of signs and symptoms of deep vein thrombosis at the provider level and a delay in seeking medical care and treatment at the patient/family level. For

cardiovascular and coronary conditions, examples of contributing factors included: a lack of continuity of care around blood pressure monitoring and reporting as well as discharge education protocols at the systems level, and inadequate risk assessment and knowledge of the severity of the condition at the provider level. A full list of contributing factors for pregnancy-related preventable deaths is found in **Appendix 1**.

PREGNANCY-ASSOCIATED, BUT NOT RELATED DEATHS

Demographics of Pregnancy-Associated but Not Related Deaths

Pregnancy-associated, but not related deaths are deaths to women during pregnancy or within one year of pregnancy from a cause that is not related to pregnancy.

A total of 49 pregnancy-associated deaths (63%) were classified as not pregnancy-related by the committee. This means the death was unrelated to pregnancy. **Table 3** provides a description of the women who died by age, race/ethnicity, educational level, insurance type, and place of residence.

The majority of pregnancy-associated, but not related deaths occurred among women under 30 years old (59%) and of non-Hispanic White race (73%). The percentage of deaths among women who graduated from high school or completed a GED (39%) was similar to the percentage of women with more than a high school education (college graduates and non-graduates) (37%). A large percentage of deaths occurred among women with TennCare insurance (69%) and who resided in metropolitan areas of the state (45%).

Table 3: Demographic Characteristics of Pregnancy-Associated, but Not Related Death, Tennessee, 2017

Characteristics	Pregnancy-Associated, but not Related (N=49)		Total Tennessee Births (N=81,024)	
	Frequency	Percent	Frequency	Percent
Maternal Age				
Less than 30	29	59	50,958	63
30-39	17	35	28,388	35
40+	3	6	1,678	2
Maternal Race/Ethnicity				
Non-Hispanic White	36	73	53,496	66
Non-Hispanic Black	10	20	16,415	21
Other	3	6	10,096	12
Maternal Education (highest level attained)				
Less than high school	10	20	10,724	13
High school or GED	19	39	22,737	28
More than high school	18	37	47,001	58
Unknown	2	4	562	1
Insurance Type				
TennCare	34	69	39,043	48
Private	11	22	33,030	41
Other	2	4	4,666	6
Unknown	2	4	4,285	5
Place of Residence				
Metropolitan county	22	45	35,452	44
Rural county	27	55	45,572	56

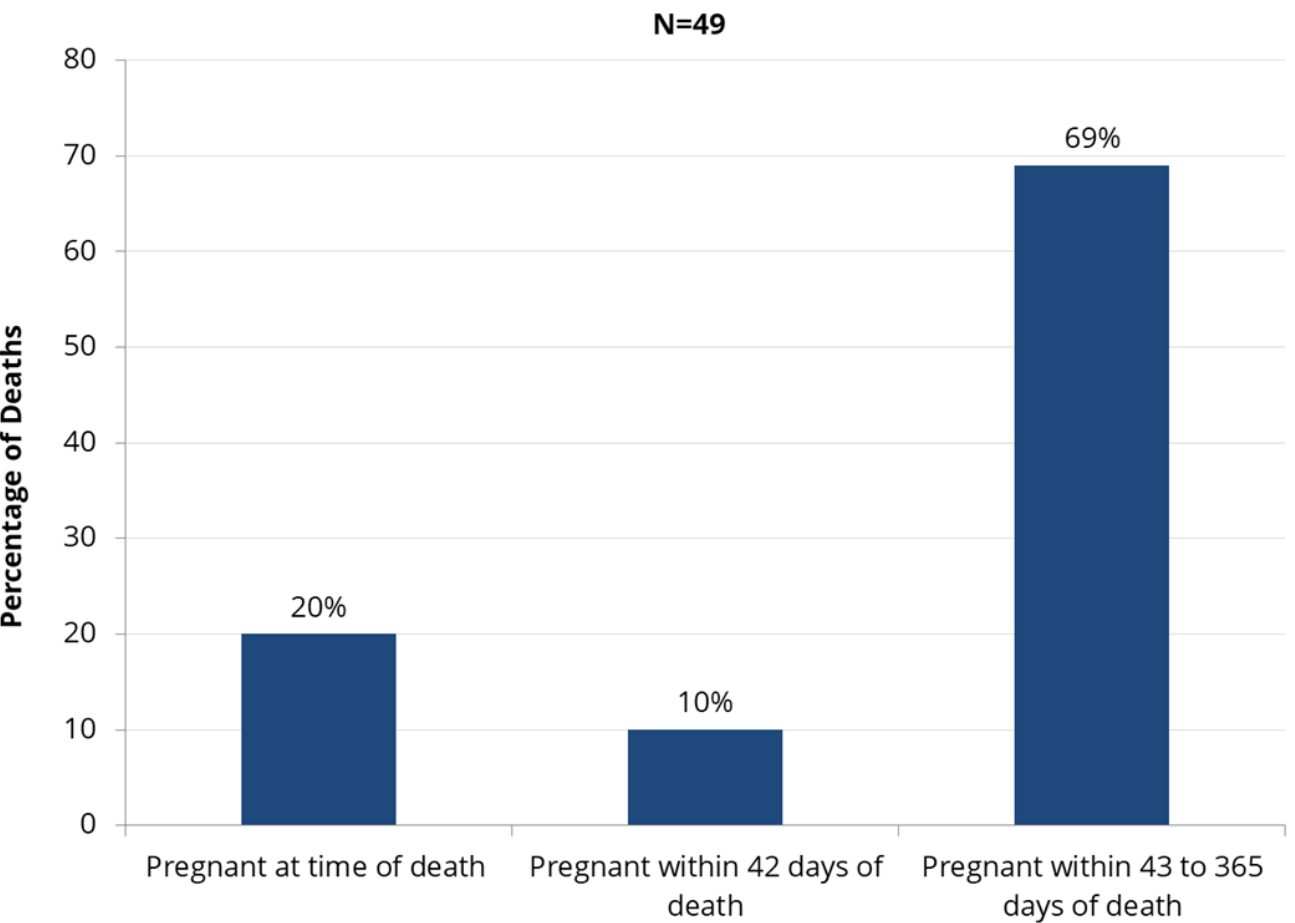
Note: Metropolitan county includes: Davidson, Hamilton, Knox, Madison, Shelby, and Sullivan Counties.

Data sources: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program; Tennessee Department of Health, Office of Vital Records and Health Statistics, Birth Statistical File, 2017.

Timing of Death of Pregnancy-Associated, but Not Related Deaths

Pregnancy-associated, but not related deaths were more common within 43 days to one year after pregnancy (69%) when compared to deaths occurring during pregnancy (20%) and deaths within 42 days of pregnancy (10%) **(Figure 13)**.

Figure 13. Timing of Pregnancy-Associated, but Not Related Deaths, Tennessee, 2017



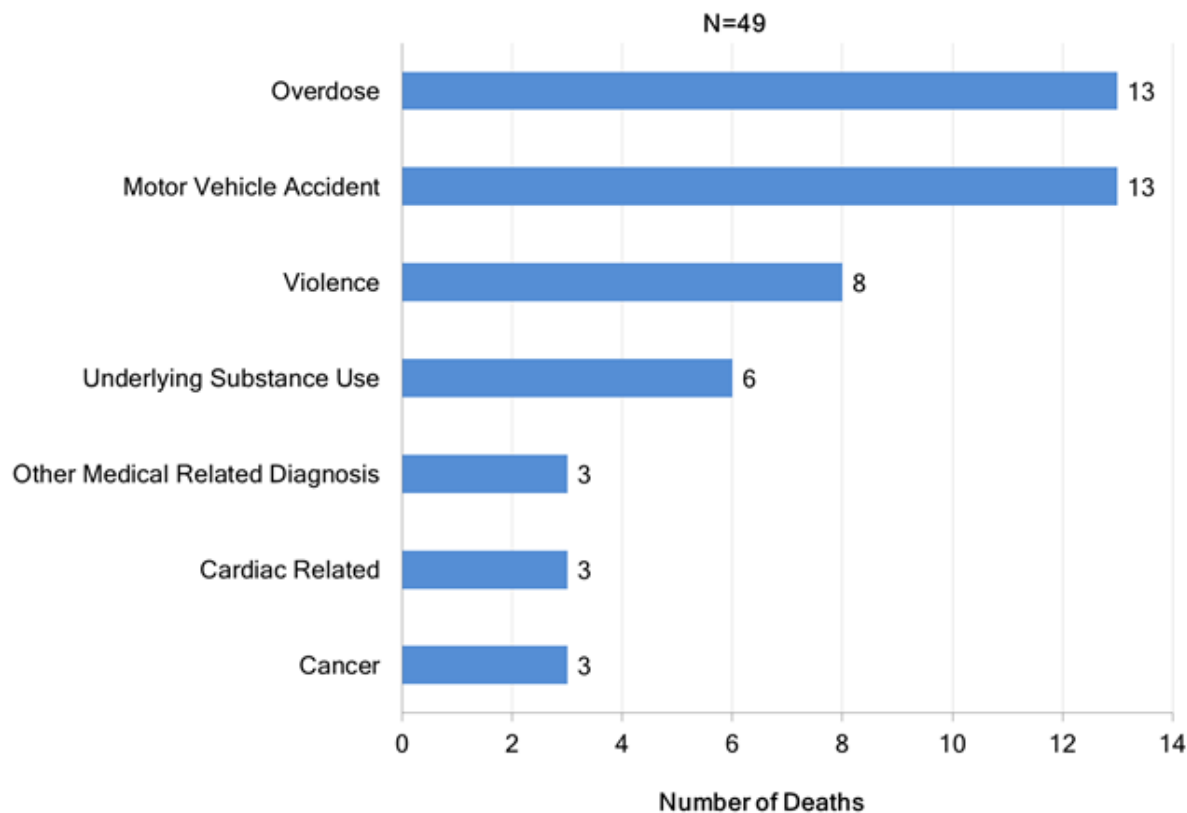
Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

Immediate Causes of Pregnancy-Associated, but Not Related Deaths

Immediate causes of pregnancy-associated, but not related deaths were grouped into seven different categories, which are defined in **Appendix 4**. **Figure 14** provides the number of deaths by each of the categories. The leading causes of pregnancy-associated, but not related deaths were overdose (13 deaths) and motor vehicle accidents (13 deaths).

Deaths from all causes were highest among non-Hispanic white women than non-Hispanic black or women of other race/ethnicities. Immediate causes by race and ethnicity are not provided due to small numbers.

Figure 14. Leading Immediate Causes of Pregnancy-Associated, but Not Related Deaths, Tennessee, 2017



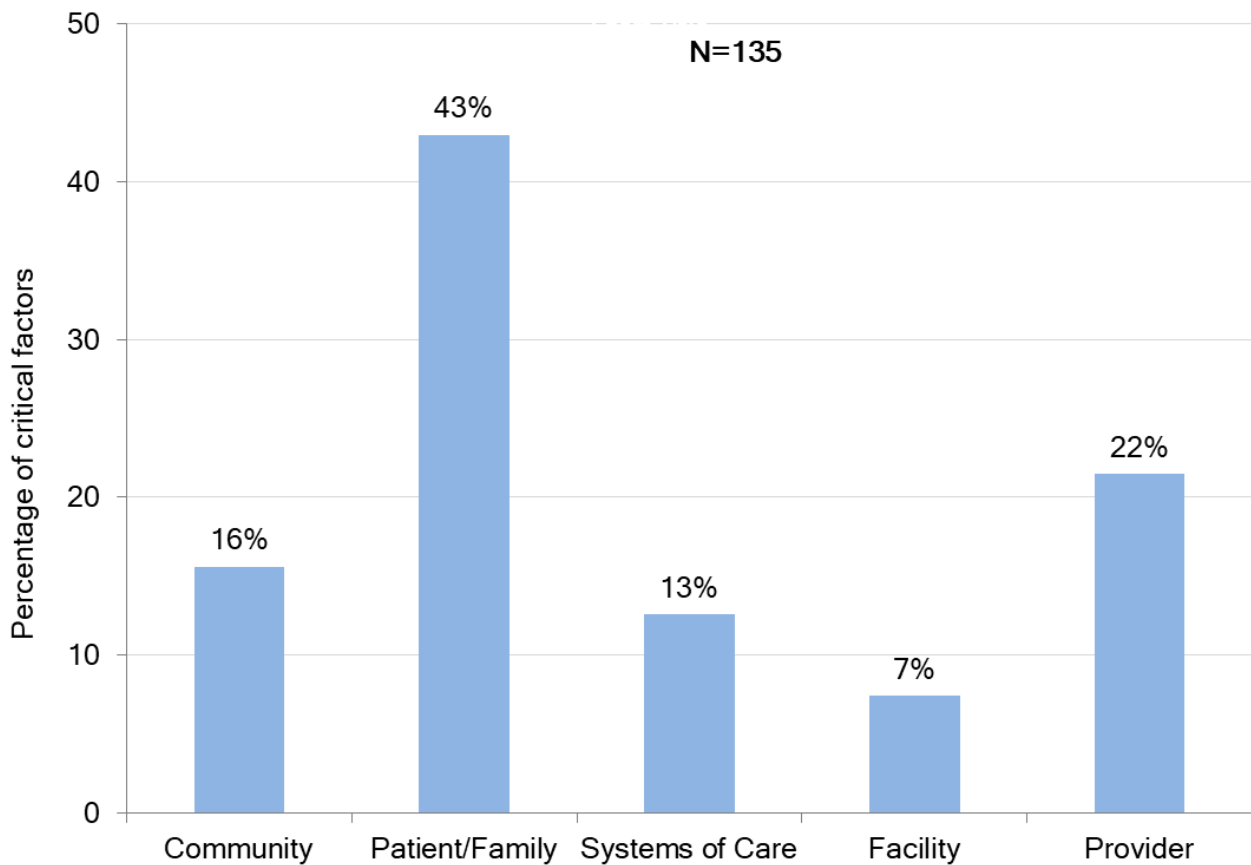
Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

Critical Factors of Pregnancy-Associated but Not Related Deaths

The Committee then identified contributing factors among those preventable pregnancy-associated, but not related deaths. Similar to pregnancy-related deaths, these deaths were also multi-factorial events, with contributing factors occurring on multiple levels. The Committee identified 135 contributing factors among 41 preventable pregnancy-associated but not related deaths. On average, the Committee found 3.3 factors that contributed to each preventable pregnancy-associated, but not related death in Tennessee and each death touched, on average, 2.6 of the 5 levels of impact (individual/family, provider, facility, community, systems of care). The distribution of contributing factors by level among preventable pregnancy-associated, but not related deaths is shown in **Figure 15**. The largest proportion of contributing factors among preventable pregnancy-associated, but not related deaths were at the patient/family level (41%), followed by the provider level (29%); whereas, the community and systems of care levels had the smallest proportions of factors identified.

Compared to pregnancy-related preventable deaths, associated but not related deaths had fewer factors on average identified (5.0 vs. 3.3), but higher proportions of contributing factors at the systems of care (8% vs. 13%) and community (7 vs. 16%) levels.

Figure 15. Critical Factors Contributing to Preventable Pregnancy-Associated, but Not Related Deaths, Tennessee, 2017



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

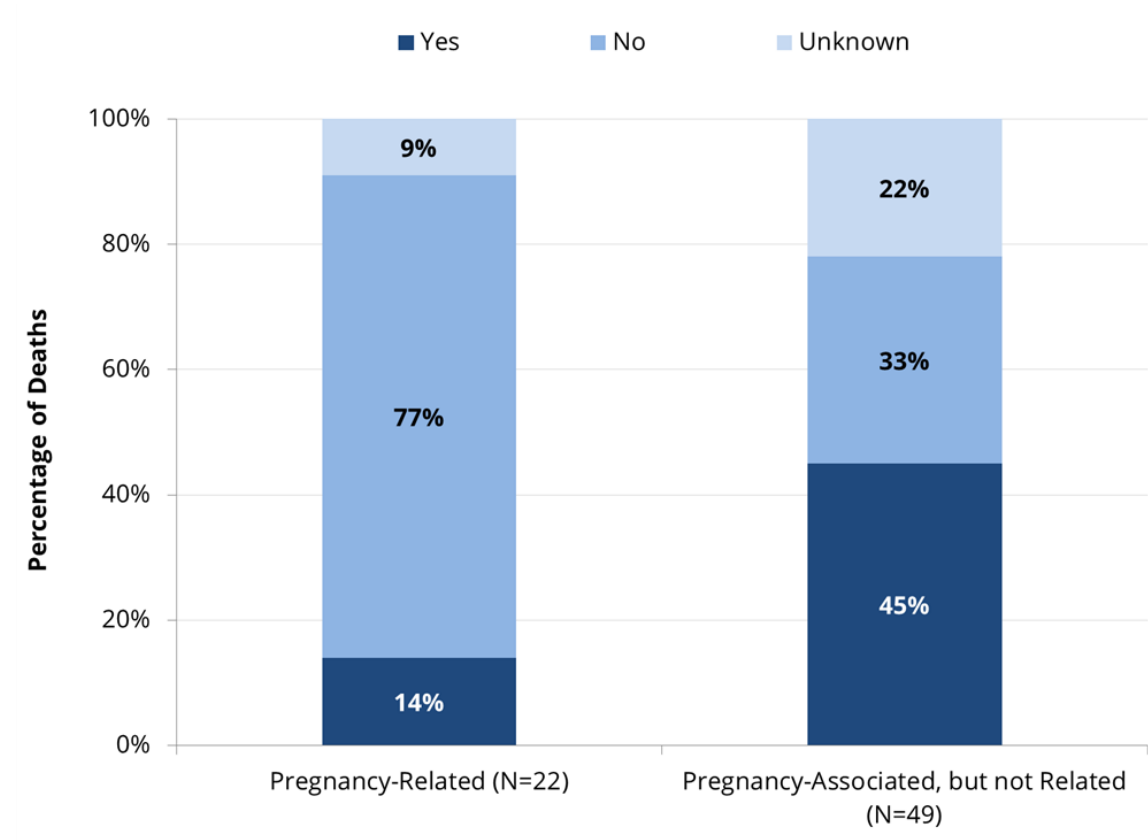
Describing critical factors that contributed to the top causes of preventable pregnancy-associated, but not related deaths of overdose and motor vehicle accidents illustrate opportunities for prevention. For overdose deaths, examples of contributing factors identified included: lack of available resources for treatment for pregnant and postpartum women with SUD at the community level, lack of appropriate referrals to specialists for pregnant and postpartum women with SUD at the facility and provider level, lack of physician skill in prescribing controlled substances and implicit bias towards pregnant and postpartum women with SUD at the provider level, and limited

prenatal care utilization at the patient/family level. For motor vehicle deaths, indicators identified included: awareness of dangers of driving while under the influence of substances at the community level and seatbelt usage at the patient/family level. A full list of contributing factors for pregnancy-associated, but not related preventable deaths is found in **Appendix 2**.

Contributing Factors: Substance Use Disorder

The Committee determined that SUD was a contributing factor in 45% of pregnancy-associated, but not related deaths (**Figure 16**). This is more than double the percentage of pregnancy-related deaths in which SUD was a contributing factor.

Figure 16. Substance Use Disorder and Pregnancy-Relatedness, Tennessee 2017

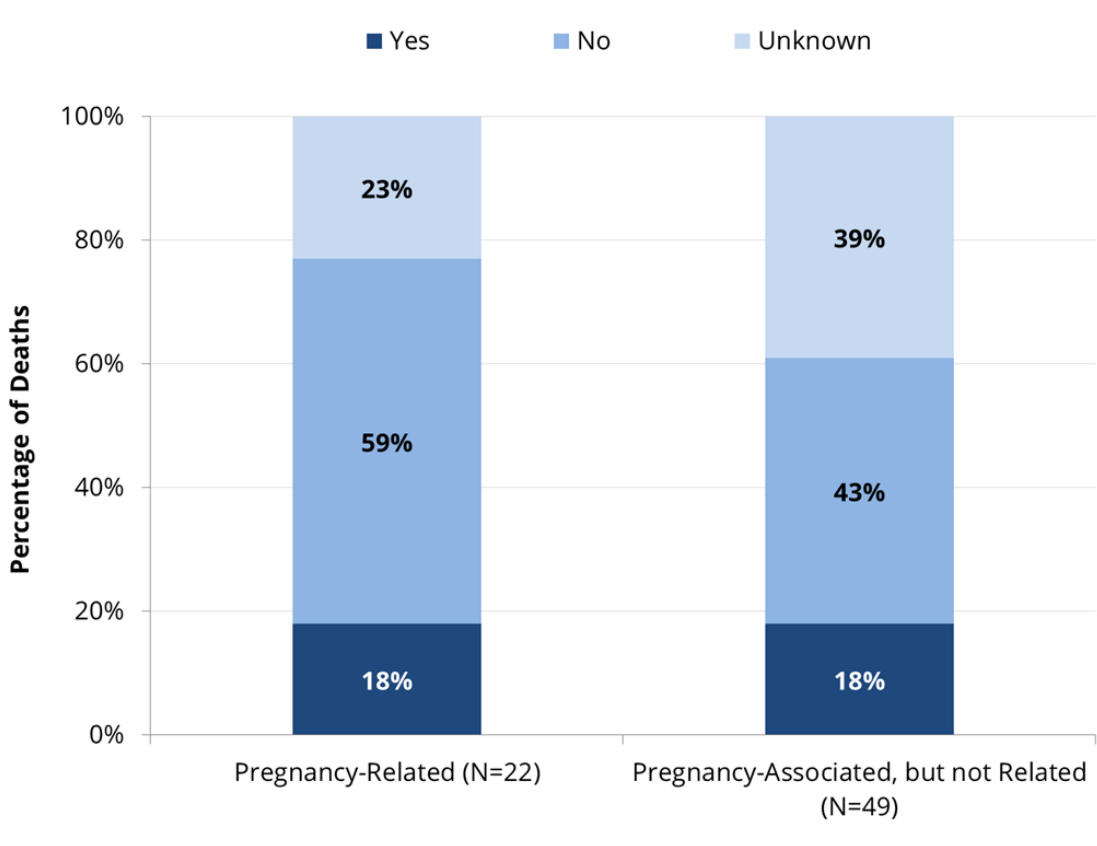


Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

Contributing Factors: Mental Health Conditions

The Committee determined that mental health conditions were a contributing factor in 18% of pregnancy-related deaths and 18% of pregnancy-associated, but not related deaths (Figure 17).

Figure 17. Mental Health Conditions: Pregnancy-Related vs. Pregnancy-Associated, but Not Related, Tennessee 2017

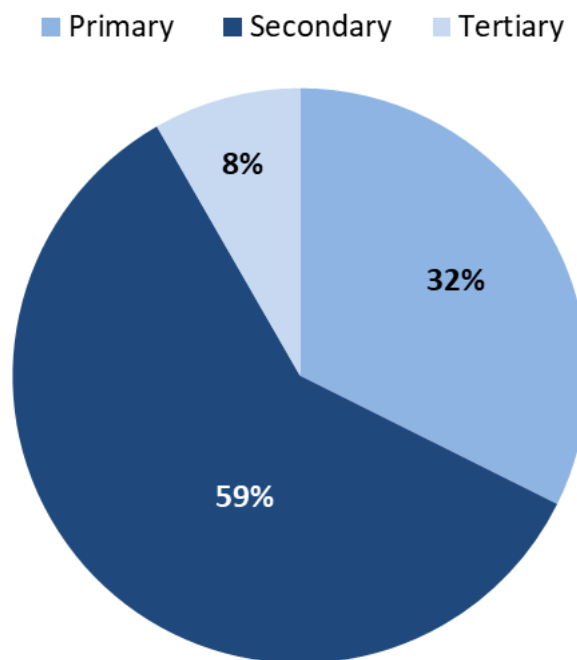


Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

RECOMMENDATIONS FOR PREVENTION

The TN MMR Committee identified key recommendations for every 2017 death that was determined to be preventable. Each recommendation was prioritized based on impact and feasibility. Based on the themes that emerged from the 2017 maternal mortality cases, the committee made recommendations that are specifically tailored towards clinics and hospital systems, healthcare providers, women and their families and the state of Tennessee. Among all preventable deaths, the MMR Committee made a total of 246 recommendations. The recommendations encompassed all three levels of prevention, with a majority (59%) being secondary prevention recommendations, followed by primary prevention recommendations (32%) (**Figure 18**).

Figure 18: Level of Prevention of Recommendation



Data Source: Tennessee Department of Health, Division of Family Health and Wellness, Maternal Mortality Review Program.

After thorough review of recommendations and considerations of feasibility and impact, the MMR Committee makes the following key recommendations:

State of Tennessee

1. The State should raise public awareness about intimate partner violence in general, the increased risk of violence and lethality during pregnancy and post pregnancy, and how to access support services/resources that are available.
2. The State should expand education, resources and patient access to treatment options for substance and mental health disorders both during pregnancy and for a year following pregnancy. This should include knowledge and access to naloxone.
3. The State should raise public awareness about motor vehicle and driver safety, particularly around the importance of safety restraints and the dangers of driving distracted and driving under the influence.
4. The State should strengthen disciplinary action for prescribers of inappropriate quantities of opioid containing medication.

Clinics and Hospital Systems

1. Clinics and hospitals should implement protocols consistent with current best practice for addressing pre-eclampsia and eclampsia, hemorrhage, cardiovascular disease, thrombosis, infection prevention, and contacting patients who are lost to follow-up.
2. Clinics and hospital systems should offer obstetric providers ongoing training on addressing implicit bias, recognizing the signs/symptoms of domestic violence, utilizing the lethality assessment during pregnancy and postpartum period and accessing community resources.
3. Clinics and hospital systems should offer system-wide education on clotting disorders and thrombotic diseases as a risk factor of pregnancy.
4. Clinics and hospital systems should develop and implement universal referral of women with history of or active substance use disorder or mental health disorder. Policies, procedures and protocols should be in place to assure

substance use and mental health screenings, treatments and referrals are provided throughout prenatal and postpartum care.

5. Clinics and hospital systems should provide ongoing system-wide education on the importance of utilizing a universal intimate partner violence screening tool during all visits, and implement a referral process to assist victims with accessing support services.
6. Health systems should integrate multidisciplinary teams (i.e. inclusion of case management, social work, care coordinators, other subspecialists, etc.) in the care of women with underlying chronic conditions, mental health and/or substance abuse disorders and ensure coordinated care throughout the pregnancy, intrapartum and postpartum periods.

Healthcare Providers

1. Providers who treat pregnant and postpartum women, including obstetrics, maternal fetal medicine, primary care, and subspecialty providers, should ensure they are aware of best practices. This should include awareness of recommended screenings and assessments, preconception planning services, and the recognition of the signs and symptoms of potential complications.
2. Obstetric providers should increase their knowledge and awareness of hemorrhage and consider expanding the differential diagnosis to include uterine atony (tone), lacerations or rupture (trauma), retained products or invasive placenta (previa, accrete, percreta), coagulopathy (Disseminated Intravascular Coagulopathy) and utilize rapid team based care. Standardized transfusion protocols should be used to minimize morbidity and mortality.
3. Obstetric providers should adopt the recent recommendation from the American College of Obstetricians and Gynecologists (ACOG), which supports the implementation of differentiating follow-up care directives tailored to individual needs pending delivery, postpartum and postoperative outcomes.⁹
4. Providers should utilize the controlled substance monitoring database (CSMD) as required by law and provide alternate pain management options for women during pregnancy.

⁹ Optimizing postpartum care. ACOG Committee Opinion No. 736. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2018;131:e140–50.

5. Providers should emphasize the value of early entry into prenatal care and compliance with recommended standards of care in each trimester and during the intrapartum and postpartum periods.

Women and their Friends and Families

1. Pregnant and postpartum women should identify new or emerging symptoms and seek early attention if they are significant and persistent.
2. Women with chronic condition(s) should have regular visits with their healthcare providers and discuss the impact of pregnancy on their condition(s) in advance of becoming pregnant.
3. Pregnant women should seek early access to prenatal care and ongoing adherence to appointments.
4. Families and friends should have access to naloxone and be prepared to administer it if a family member has a history risk for substance abuse.
5. Families and friends should consider learning bystander CPR.

APPENDICES

Appendix 1: Full List of Contributing Factors for Pregnancy-Related Deaths, Tennessee 2017

Factor Level	Contributing Factors
Community	• Lack of education/counseling for victims of abuse and intimate partner violence • Domestic violence • Inadequate community outreach/resources • Lack of education on cancer in pregnancy • Potential lack of resources for social support • Knowledge of seriousness of her condition • Lack of bystander CPR and naloxone administration
Patient/Family	• Gap on importance of preconception counseling • Poor quality of care • Patient treated as though she was not high risk • Knowledge gap about the impact of chronic disease such as hypertension, diabetes and obesity on pregnancy • Partner violence • Late term elective termination • Patient awareness of risk due to medical history • Domestic violence • Patient choices • Patient's inability to comply with care • Multiple medical co-morbidities • Likely childhood abuse/trauma • Possible intimate partner violence • Awareness of and action upon signs of major depression/postpartum depression • Mental health conditions (available records show no evidence of treatment) • Obesity in pregnancy • Smoking in the home and understanding of detriment of second-hand smoke for pregnant women and children • Stress of multiple care giving roles and chronic disease • Unintended pregnancy • Adherence concerns due to social factors such as child care, transportation and access • Limited prenatal care • Signed out and left against medical advice • Delay of care; reporting prolonged history of symptoms before

	- seeking care • Noncompliance with standard follow up protocols • Possible limited knowledge • Knowledge of seriousness of her condition • Obesity • Knowledge and understanding of risk • Delay of care • Adherence of medical devices, to medications, to recommendations and to appointments • Adherence to treatment • Asthma as chronic disease • Tobacco use in asthma • Lack of use of effective birth control
Systems of Care	• Lack of continuity of care- high risk patient with multiple specialty providers • Lack of case coordination- no communication with primary care provider • Lack of access medical facilities for pregnancy interruption • Care coordination between different services may have contributed to the delay • Patient in intensive care • Lack of documentation of coordination of care for specialty care • Communication among providers • Barriers to medication access
Facility	• Lack of continuity of care- no documentation for a protocol to monitor and report blood pressures or symptoms after discharged home during the postpartum period • Lack of continuity of care- no communication with primary care provider • Lack of standardization • Lack of training on following American Academy of Obstetrics and Gynecology (ACOG) recommendations¹⁰ • Adequate screenings and follow up pertaining to domestic violence • Lack of appropriate supervision assistance with ambulatory activities given high fall risk • Failure to coordinate with provider for outreach to the patient when lost to follow up • Delay of care no documentation of effort made to schedule dilation and curettage • Care coordination between hospitalization & out-patient care -

¹⁰ Optimizing postpartum care. ACOG Committee Opinion No. 736. American College of Obstetricians and Gynecologists. Obstet Gynecol 2018;131:e140–50.

	transitional care • Care coordination lacking
Provider	• Inadequate assessment of risk • Lack of screening for violence • Was the provider aware of her history • Failure to screen/inadequate assessment of risk for thrombosis in elective termination • Evaluation of symptoms of deep vein thrombosis (DVT) and pulmonary emboli (PE) • Noted that the provider screened and provided education about domestic violence • Education • Leaving against medical advice • Lack of referral or consultation to mental health • Inadequate assessment of risk • Lack of knowledge-respiratory care in pregnancy • Delay in care from postpartum to intensive care • Delay in diagnosis and treatment • Failure to involve gynecologic oncologist early in sentinel pregnancy • Reliable contraception not provided postpartum for potential future high risk pregnancies • Possible provider unconscious bias contributed to lack of outreach to patient after loss to follow up • Possible lack of education to patient about the need for strict follow up • Follow up with outpatient provider to ensure continued care • Insufficient/incomplete assessment and treatment Patient needed much more aggressive care and treatment • Care coordination between medical and mental health providers • Lack of communication between emergency department and primary prenatal/obstetric provider • Delay of treatment due to pregnancy • Referral to specialists • Inadequate assessment of risk

Appendix 2: Contributing Factors to Pregnancy-Associated but Not Related Deaths, Tennessee, 2017

Factor Level	Contributing Factors
Community	• Limited availability of resources on SUD to pregnant women • Community education/awareness about SUD • Lack of community education of individuals with SUD • Limited available resources to address needs of pregnant and post • Awareness of postpartum women with SUD • Level of access/financial revenues • Lack of resources/education on mental health and SUD • Access and utilization of community mental health and substance abuse resources • Homicide • No record of patient's community support • Limited knowledge and resources to address needs of pregnant women • Knowledge-SUD and effects on individuals and families • Availability and awareness of resources • Lack of social support/isolation and community outreach measures • Lack of community resources
Patient/Family	• Depression • Substance use disorder—prescription drugs • Intimate partner violence • History of SUD, not documented if patient was connected to primary care or substance use providers after delivery • Knowledge of highway safety • No prenatal care • Auto accident • History of substance abuse, enrolled in rehab and on methadone • Substance use disorder- alcohol and prescription drugs • History of chronic alcoholism and mental health • Marital conflict/family breakdown • Domestic and intimate partner violence • Environment: road conditions • Disrupting prenatal care; patient having multiple prenatal care providers • Patient did not adhere to prenatal plan of care or medication

	assisted therapy (MAT) plan • Substance use disorder—illicit drug dependency; needed to alter meds due to pregnancy • Failure to seek care • Undesired pregnancy • Intimate partner violence • Partner provided illicit substances • Bipolar disorder, prior history suicidality • Heroin • Limited prenatal care • Patient had worsening symptoms with associated cause of death several days prior to visiting her primary care provider • Intimate partner violence • Innocent bystander • Discontinuity of care • Alcohol abuse; mental Health, substance use—tobacco • Lack of seat belt use Inadequate or unavailable technology—auto airbags failed to deploy upon impact • Delay of seeking care • Poor outpatient rehab • Exposure to tobacco with chronic disease • She and family may not have been aware of her vulnerability to death given her high risk status • Intimate partner violence-homicide • High score on post-partum depression screen • Illicit substance use-combined fentanyl /cocaine
Systems of Care	• No system of care to assure patient has access and availability of all services needed to assure comprehensive SUD care • No documentation that patient accessed care for SUD through the health system after sentinel pregnancy • Lack of services available to victims of abuse and lack of education on intimate partner violence • Access to firearms • No access to health care system • Multiple providers • Continuity of care and care coordination in correctional facilities for substance use disorder • Patient reported outstanding bill—possible reason for noncompliance with prenatal visits • Poor communication and lack of care coordination with MAT provider. Did not have contact with obstetric provider • No consistent or unitary system of care to assure patients receive requisite services for comprehensive SUD care

	• Disjointed system • Follow up treatment to inpatient • Connection to care • No postpartum care after cesarean delivery • Lack of policies and procedures in place to allow for flexibility for accepting critically ill patients
Facility	• Care coordination-there was no facility coordination of care between prenatal provider, MFM and SUD providers • No facility encounters • Limited coordination of care by facility • Lack of services for low income individuals with SUD • Lack of care coordination between facility and outpatient providers, physicians and therapists • Incorrect reading of diagnostic imaging • Weather delay causing delay of transfer to higher acuity • Failure to screen
Provider	• Knowledge and care coordination -Patient had adequate prenatal care, but no record of referrals for SUD or treatment facilities • Adequate referral to higher level of care. Example: maternal fetal medicine (MFM) • Inadequate assessment • Inadequate referral • Large quantities of opioid medications prescribed • No visits with provider • Failure to screen • Patient was not seen by provider, no prenatal care • Over prescribing of controlled medications, lack of controlled substance monitoring database (CSMD) use • Lack of standardization • Provider gave known addict on MAT a prescription for opioid medications • Limited prenatal visits and care due to patient noncompliance with visit schedule • Lack of screening for SUD and domestic violence • Lack of referral for SUD • Patient stated she became addicted to opioids given post cesarean. • No standardized policies, procedures or protocols to outreach to high risk patients with limited or no prenatal care • Provider bias (patient with history of drug use) • Provider awareness and care coordination of hypertension • Lack of thorough evaluation to rule out preeclampsia

	• Receiving hospitals accepting the patient for higher acuity care; delay in referral; delay in care coordination • Failure to refer; failure to seek consult • Care coordination for substance abuse • Lack of community resources
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Appendix 3: Pregnancy -related causes of death categories

Category	Specified Cause of Death Indicated on Committee Decision Form
Cardiovascular and Coronary Conditions	Vascular aneurysm/dissection (non-cerebral), other cardiovascular disease, including CHF Cardiac Hypertrophy, cardiac fibrosis, non-acute myocarditis/NOS, Other Cardiovascular Disease, including CHF, cardiomegaly, cardiac hypertrophy, cardiac fibrosis, non-acute myocarditis/NOS, postpartum/peripartum cardiomyopathy
Embolism	Embolism thrombotic, embolism non-cerebral
Hemorrhage	Hemorrhage - uterine atony/postpartum hemorrhage, placenta accreta/increta/percreta, cerebrovascular accident (CVA)
Infection	Non-pelvic infections (e.g. Pneumonia, TB, Meningitis, HIV), sepsis/septic shock
Pre-eclampsia and Eclampsia	Chronic hypertension with superimposed preeclampsia, eclampsia
Violence	Intentional (homicide)
Mental health	Mental health conditions
Other	Cancer, asthma, neurologic/neurovascular conditions (excluding CVA's)

Appendix 4: Pregnancy- Associated, but not related causes of death categories

Category	Specified Cause of Death Indicated on Decision Form
Overdose	Probable acute fentanyl intoxication, acute fentanyl and sertraline intoxication and acute bronchopneumonia, multiple drug toxicities, fentanyl overdose, combined toxicities, acute methamphetamine toxicity, heroin overdose, combined drug toxicity, acute combined drug intoxication, combined fentanyl and cocaine intoxication.
Causes Related to Underlying Substance Use (with underlying causes)	Dilated cardiomyopathy/polysubstance abuse, acute respiratory failure/septic shock/endocarditis/IV drug use, multi-organ failure/septic shock due to MRSA bacterium/suspect IV drug use, Methicillin-resistant Staphylococcus aureus sepsis due to endocarditis, due to intravenous narcotism/methamphetamine toxicity endocarditis, fungal endocarditis/substance use disorder, acute bronchopneumonia/seizure disorder/substance use disorder.
Violence	Gunshot wound to the head, multiple stab wounds, penetrating gunshot wound to the abdomen
Motor Vehicle Accident (MVA)	Motor vehicle collision, multiple blunt force injuries due to MVA, blunt trauma to the head, asphyxia due to drowning, craniocerebral injuries.
Cardiac Related Deaths	Cardiac tamponade, ischemic cardiovascular disease, viral myocarditis
Other Medical Related Diagnosis	Fulminant adrenal hemorrhage, central venous thrombosis, acute asthma exacerbation
Cancer	Leukocytosis (AML), breast cancer, sarcoma

Appendix 5: Tables

1. Demographic Characteristics of All Pregnancy-Associated Deaths Compared to Characteristics of all Tennessee Births, 2017
2. Demographic Characteristics of Pregnancy-Related Deaths, Tennessee, 2017
3. Demographic Characteristics of Pregnancy-Associated, but Not Related Death Tennessee, 2017

Appendix 6: Figures

1. Pregnancy-Associated Death Case Identification, Vital Statistics, Tennessee 2017
2. Pregnancy-Associated Death Case Verification, MMR Program Data, Tennessee 2017
3. Pregnancy-Associated Mortality, Tennessee 2013-2016, 2017
4. Flow Chart MMR Program Process
5. Timing of All Pregnancy Associated Deaths in Relation to Pregnancy, Tennessee, 2017
6. Contributing Factors for all Pregnancy-Associated Deaths, Tennessee 2017
7. Committee Determination of Pregnancy-Relatedness, Pregnancy-Associated Deaths, Tennessee, 2017
8. Preventability of All Pregnancy-Associated Deaths, Tennessee, 2017
9. Critical Factors Contributing to All Preventable Pregnancy-Associated Deaths, Tennessee, 2017
10. Timing of Pregnancy-Related Deaths, Tennessee, 2017
11. Leading Underlying Causes of Pregnancy-Related Deaths, Tennessee, 2017
12. Critical Factors Contributing to All Preventable Pregnancy-Related Deaths, Tennessee, 2017
13. Timing of Pregnancy-Associated, but Not Related Deaths, Tennessee, 2017
14. Leading Immediate Causes of Pregnancy-Associated, but Not Related Deaths, Tennessee, 2017
15. Critical Factors Contributing to All Preventable Pregnancy-Associated, but Not Related Deaths, Tennessee, 2017

16. Substance Use Disorder: Pregnancy-Related vs. Pregnancy-Associated, but Not Related, Tennessee 2017
17. Mental Health Conditions: Pregnancy-Related vs. Pregnancy-Associated, but Not Related, Tennessee 2017
18. Level of Prevention of Recommendations