

Maternal Mortality and Morbidity Review in Massachusetts

A Bulletin for Health Care Professionals

**Pregnancy-Associated Mortality
2000-2007**



Massachusetts Department of Public Health
Bureau of Family Health and Nutrition

July 2014

Pregnancy-Associated Mortality 2000-2007

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Massachusetts Department of Public Health

July 2014

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Acknowledgments

This report was prepared by Hafsadou Diop , Karin Downs, Ruth Karacek, Xiaohui Cui and Angela Nannini of the Bureau of Family Health and Nutrition, Massachusetts Department of Public Health (MDPH).

We wish to thank the Massachusetts Maternal Mortality and Morbidity Review Committee for reviewing cases and making recommendations to improve the health of mothers in Massachusetts.

A special thanks to Staff from the Office of the State Medical Examiner, the MDPH Division of Health Care Quality, and MDPH Privacy and Data Access Office.

In addition thanks to the MDPH technical reviewers and Commissioner's Office for their comprehensive review of this publication.

Suggested Citation:

Maternal Mortality and Morbidity Review in Massachusetts: A Bulletin for Health Care Professionals, Pregnancy-Associated Mortality. 2000-2007. Boston, MA: Bureau of Family Health and Nutrition. Massachusetts Department of Public Health. February 2014.

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*See Appendix A for an alphabetical list of Maternal Mortality and Morbidity Review Committee Members and MDPH and Office of Chief Medical Examiner Staff.

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Summary of Findings

Although pregnancy-associated death remains an infrequent event in Massachusetts, disparities by race/ethnicity, age, insurance type, and cause of death remain. The following highlights some key findings contained in this report:

- The overall pregnancy-associated mortality ratio (PAMR) was 26.1 per 100,000 live births and did not change significantly over the eight-year period.
- The pregnancy-related mortality ratio (PRMR) was 7.9 per 100,000 live births and did not change significantly over the eight-year period.
- Black non-Hispanic women had a higher PAMR than women in other racial ethnic groups and their risk of dying was 1.9 times higher compared to white non-Hispanic women.
- Younger (<30) and older (≥ 35) women were more likely to die compared to women aged 30-34 years.
- Compared to women who had private insurance, those who had public insurance were 2.7 times as likely to die during pregnancy or within one year postpartum.
- Women with a high school education or less were more likely to die from any pregnancy-associated cause.
- The mortality ratios for medical and injury deaths were 17.4/100,000 and 7.9/100,000 live births, respectively.
- Complications of pregnancy, labor or delivery were the leading causes of pregnancy-related deaths.
- Cardiovascular diseases and cancer were the leading cause of pregnancy-associated but not pregnancy-related deaths.

I. Purpose

The purpose of this report is to present data on maternal deaths and pregnancy-associated mortality from 2000 through 2007 in Massachusetts. This report also suggests strategies for improving maternal health outcomes. This report covers both medical and injury-related deaths of women who died while pregnant or within one year postpartum.

II. Background

Maternal death, a sentinel event, has dramatically decreased in Massachusetts over the last century. There is a long history of reviewing maternal deaths in Massachusetts which began as a systematic effort in 1941 when the Committee on Maternal Welfare of the Massachusetts Medical Society initiated case reviews of maternal deaths with the goal of improving maternal health. Since 1997, the Massachusetts Department of Public Health (MDPH) has convened the Maternal Mortality and Morbidity Review Committee (MMMRC) to review maternal deaths, study the incidence of pregnancy complications, and make recommendations to improve maternal outcomes and eliminate preventable maternal death. Understanding the causes of these deaths provides insight into the factors that contributed to both maternal morbidity and mortality, which can inform strategies to reduce the incidence of these tragic events.

The work of the MMMRC, protected under M.G.L. c. 111, section 24A and 24B, assures the confidentiality of all records and proceedings. The committee consists of obstetricians, certified nurse midwives, maternal fetal medicine specialists, neonatologists, pathologists, critical care specialist and the state medical examiner or his designee (See Appendix A). Since 1997, the MMMRC has reviewed and summarized maternal deaths from 1990 to the most current available data. Two previous reports were published in 2000 and 2002, respectively; one of which presented the ratios, causes, and timing of medical causes of death from 1995 through 1998 and the other summarized the injury deaths from 1990 to 1999. This report will present findings from reviews of deaths occurring from 2000-2007. Over time, definitions of maternal death have evolved and case ascertainment methods have improved, but the goal of promoting maternal health has remained unchanged.

Definition of Maternal Death Used in this Study

For the purpose of this report, the MMMRC used the definition of maternal mortality recommended by the Maternal Mortality Study Group, a national group jointly chaired by the Division of Reproductive Health at the Centers for Diseases Control and Prevention (CDC) and the American College of Obstetricians and Gynecologists (ACOG). The Maternal Mortality Study Group uses the term “pregnancy-associated” instead of “maternal” to reflect the inclusion of deaths occurring during pregnancy. As such, the definition of a pregnancy-associated death is the death of a woman while pregnant or within one year of termination of pregnancy, irrespective of the cause.

Pregnancy-associated deaths are divided into three categories:

- 1. Pregnancy-related.* The death of a woman while pregnant or within one year of termination of pregnancy, from any cause related to or aggravated by her pregnancy or its management, but not from accidental or incidental causes. For example, included under this definition is the death of a woman from postpartum hemorrhage or amniotic fluid embolism.
- 2. Pregnancy-associated-but-not-pregnancy-related.* The death of a woman while pregnant or within one year of termination of pregnancy due to a cause unrelated to pregnancy. For example, the death of a woman from a motor vehicle collision.
- 3. Pregnancy-associated but undetermined if pregnancy-related.* The death of a woman while pregnant or within one year of termination of pregnancy from a cause that cannot be determined or conclusively categorized as either pregnancy-related or not pregnancy related. For example, a woman dies at six months postpartum from a self-inflicted cause with an unknown mental health history.

The MMMRC further categorizes these deaths into deaths caused by a medical condition and deaths caused by injury.

III. Methods

Case Finding

The MDPH used multiple methods for identifying pregnancy-associated deaths in Massachusetts from 2000 through 2007. Massachusetts hospitals are mandated by state law to report to the MDPH's Division of Health Care Quality the death of any woman during pregnancy or within 90 days of delivery or termination, regardless of the cause of her death, if this death occurs in a hospital setting. First, all mandatory reports of maternal death provided by hospitals to the MDPH Division of Health Care Quality are also provided to the MMMRC. Second, MDPH conducted a manual and automated review of death certificates to determine whether there is an indication on the death certificate that a woman was pregnant at the time of her death. Third, MDPH employed an enhanced surveillance method linking birth certificates and fetal death certificates to death certificates of reproductive-age women. This generated a list of all women in Massachusetts who died within one year of being pregnant or giving birth. This method captured most pregnancy-associated deaths but may have missed a pregnant woman who died before 20 weeks gestation or carried a fetus weighing less than 350 grams. Fourth, the MDPH also linked maternal death data with the Pregnancy to Early Life Longitudinal (PELL) data system. The PELL data system linked the birth certificates and the fetal death records to their corresponding hospital discharge data yielding even more information on women who died while pregnant or within a year of experiencing a live birth or fetal death. Finally, a small number of maternal deaths are identified through newspaper articles, an annual report of women who died as a result of domestic violence, or informal reports from MMMRC members or members of the obstetric health care community.

Case review

For each identified pregnancy-associated death, MDPH staff requested and obtained copies of all available hospital medical records related to both the pregnancy and death. A primary and secondary reviewer from the MMMRC analyzed all available documents and summarized each case for the entire Committee without identifying patients, clinicians, or institutions. In addition, Committee members with expertise in oncology, neurology, internal medicine, anesthesiology, pathology, substance use disorders, infectious disease, and injury prevention were often asked to review specific cases in their field of expertise. After a case was presented by a primary and secondary MMMRC reviewer, the entire committee discussed the appropriateness of care and deliberated until consensus on the following questions was reached:

- Was the death pregnancy-related?
- Was the death preventable?
- What public health and/or clinical strategies might prevent future deaths?

A 'preventable medical-related death' is broadly defined as a death that may have been averted by one or more changes in the health care system related to clinical care, facility infrastructure, public health infrastructure and/or patient factors. Similarly a 'preventable injury-related death' can be broadly defined as a death that may have been averted by one or more changes in either the health care system or the public services system (transportation as well as social services).

Limitations

Records that may have provided additional information but were not available to the reviewers included ambulatory care records not part of the hospital medical records; hospital records for births or fetal deaths occurring outside of Massachusetts; and information about deaths or births occurring in non-hospital settings. Other limitations included lack of records from a transferring community hospital.

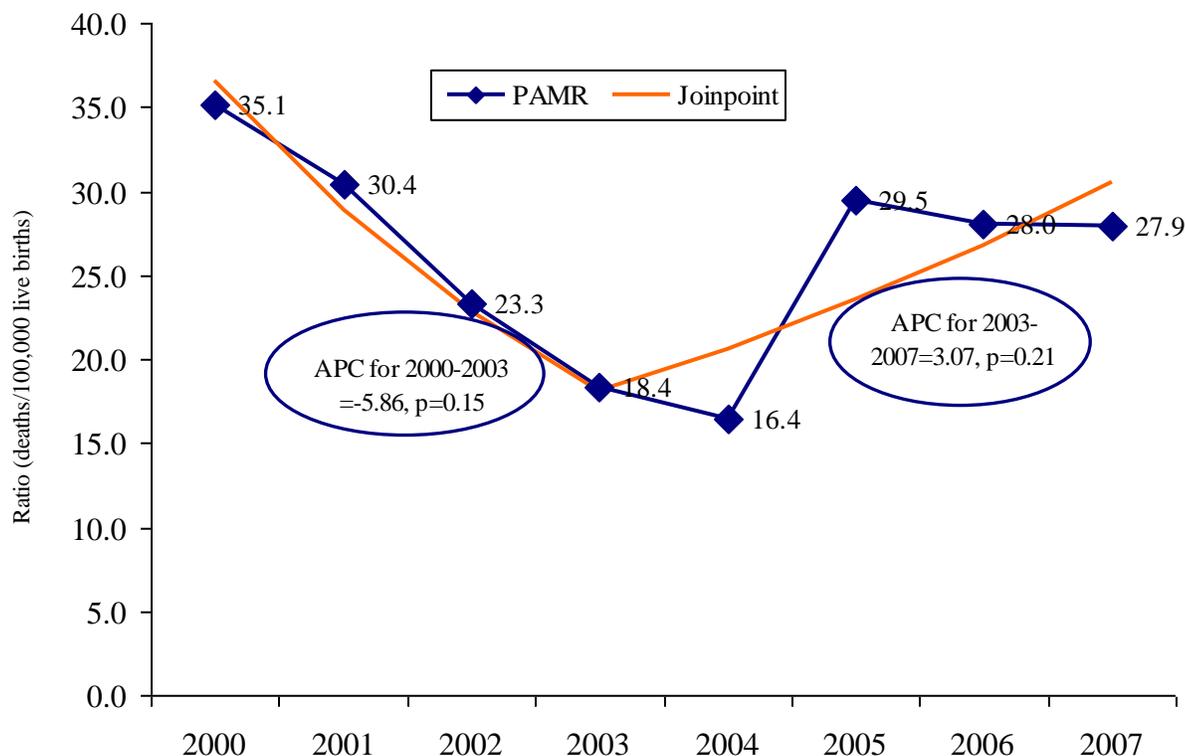
IV. Results - Mortality Ratios, Causes, and Timing of Deaths

Pregnancy-Associated Mortality Ratio and Pregnancy-Related Mortality Ratio

From 2000 through 2007, MDPH identified 168 maternal deaths that met the definition of a pregnancy-associated death. Of the 168 deaths, 112 (67%) were caused by medical conditions. Of the remaining deaths, 51 (30%), were caused by intentional or unintentional injuries and five were due to unknown or undetermined causes.

PAMR was defined as the total number of pregnancy-associated deaths over the total number of live births. The PAMR over the eight-year period was 26.1 per 100,000 live births. Trend test using Joinpoint¹ showed the PAMR decreased during 2000 to 2003, while it increased from 2003 to 2007. The Annual Percent Change (APC) for PAMR was -5.86 in 2000-2003 and 3.07 in 2003-2007, respectively, but neither of them was significant (Figure 1).

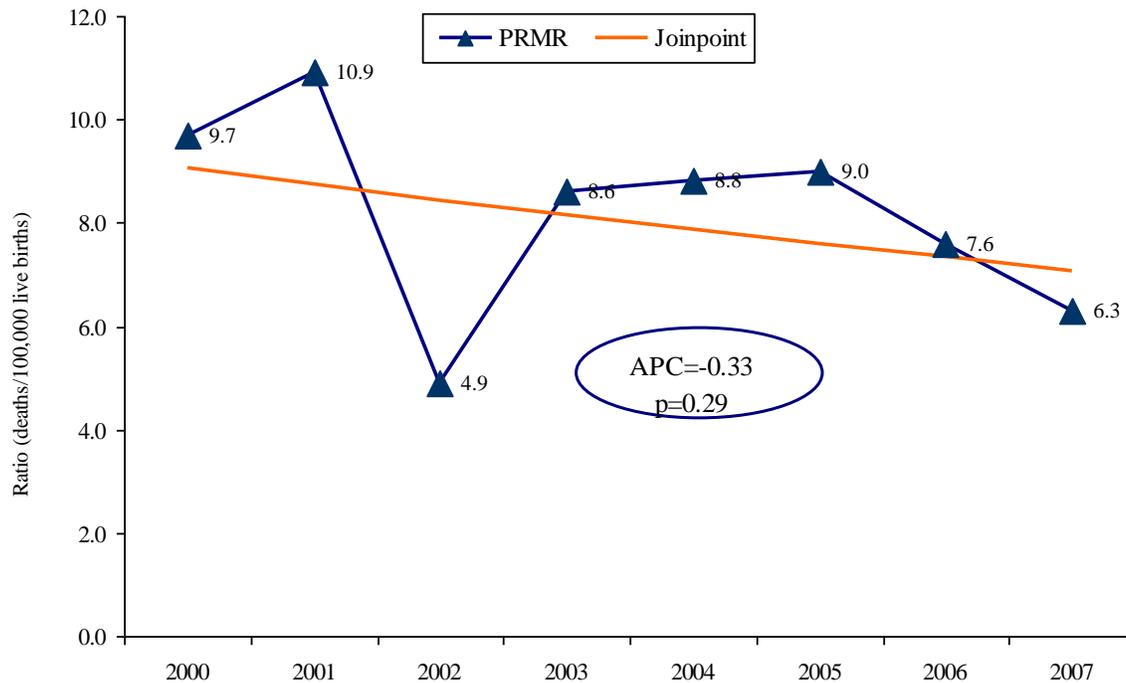
Figure 1. Pregnancy-Associated Mortality Ratio, Massachusetts, 2000-2007



¹ Joinpoint is a trend analysis tool developed by the National Cancer Institute. It creates a “model” (graph) that best describes the trend in events. Points where the trend turns around are called “joinpoints”. It shows the Annual Percentage Change (APC) for each line segment in the model.

PRMR was defined as the total number of pregnancy-related deaths over the total number of live births. The overall PRMR over the eight-year period was 7.9 per 100,000 live births. The PRMR decreased during 2000 through 2007 with an insignificant APC of -0.33 (Figure 2).

Figure 2. Pregnancy-Related Mortality Ratio, Massachusetts, 2000-2007



From 2000 to 2007, the mortality ratios for medical and injury deaths were 17.4/100,000 and 7.9/100,000 live births, respectively. These ratios cannot be compared to other publications due to differences in definitions and case finding methodologies.

Pregnancy-Associated Mortality Ratios by Select Maternal Characteristics

- **Race/Ethnicity:** Overall, black non-Hispanic women were 1.9 times as likely to die during pregnancy or within one year postpartum compared to white non-Hispanic women.
- **Age:** Younger (<30) and older (≥ 35) women were more likely to die compared to women aged 30-34 years.
 - Women older than 35 were 2.5 times as likely to die of medical causes than women aged 30-34.
 - Women younger than 30 years were 3 times as likely to die of injury than women aged 30-34.
- **Health Insurance at Delivery:** Compared to women who had private insurance, those who had public insurance were 2.7 times as likely to die during pregnancy or within one year postpartum.
- **Education of Mother:** Women with a high school education or less were more likely to die from any pregnancy-associated cause. Compared to women who attained more than 12 years of education, the relative risk for those who completed only 12 years of education was 2.3. Those who completed fewer than 12 years of education were 1.7 times as likely to die as women who attained more than 12 years of education.

Additional characteristics are presented in Table 1 below.

Table 1. Pregnancy-Associated Mortality Ratios by Race, Age, Payer at Delivery, and Education Level of Mothers, Massachusetts, 2000-2007

	Frequency	Percent (%)	PAMR*	Risk Ratio (95% Confidence Interval)
Race/Ethnicity				
Non-Hispanic white	112	64.3	24.5	1.0
Non-Hispanic black	23	13.1	47.3	1.9 (1.2-3.0)
Hispanic	19	10.7	23.8	1.0 (0.6-1.6)
Asian Pacific	9	5.4	21.2	0.9 (0.4-1.7)
Non-Hispanic American Indians and others	5	3.0	36.1	1.5 (0.6-3.6)
Age, years				
<30	81	48.2	28.1	1.8 (1.2-2.7)
30-34	34	20.2	16.4	1.0
≥35	53	31.6	36.1	2.2 (1.4-3.4)
Age medical cause only				
<30	45	40.2	15.6	1.4 (0.9-2.2)
30-34	24	21.4	11.6	1.0
≥35	43	38.4	29.3	2.5 (1.5-4.1)
Age, injury cause only				
<30	35	68.6	12.1	3.0 (1.4-6.1)
30-34	8	15.7	3.9	1.0
≥35	8	15.7	5.4	1.6 (0.6-3.9)
Payer at delivery†				
Private	57	33.9	13.6	1.0
Public	78	46.4	36.2	2.7 (1.9-3.7)
Education of mother‡				
<12 years	19	13.9	26.0	1.7 (1.0-2.8)
12 years	55	40.2	35.4	2.3 (1.6-3.3)
>12 years	63	46.0	15.3	1.0

* Per 100,000 live births.

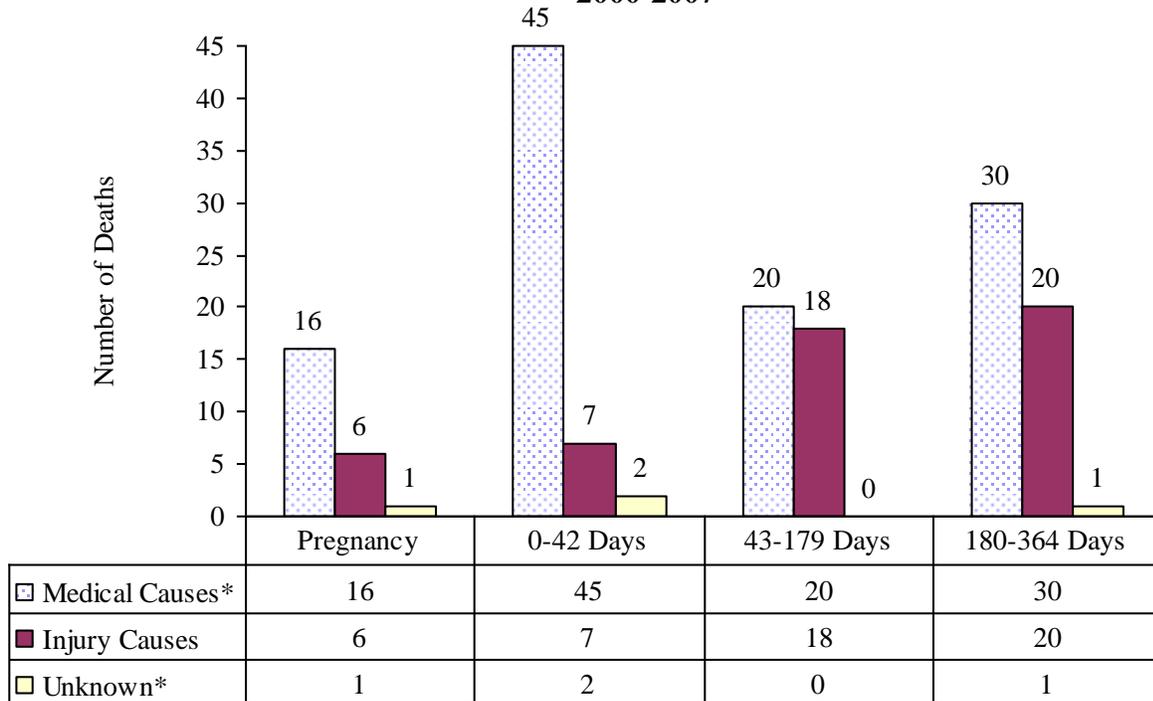
† Includes 135 deaths of women who had live births and either private or public payers at delivery. Excludes 1 self-pay, 1 free care, and 33 cases who did not have live births. Private: commercial indemnity plan, commercial managed care plan, or other private insurance. Public: Medicaid, Healthy Start (state program for low-income women who do not qualify for Medicaid), Medicare, or other government sources.

‡ Includes 137 deaths of women who had live births.

Timing of Pregnancy-Associated Deaths

Although risk for pregnancy-associated death exists throughout pregnancy and the first year postpartum, the level of risk varies by period and cause. Among the pregnancy-associated deaths, almost half (46%, n=77) occurred either during pregnancy or within 42 days post-partum, and slightly more than half (53%, n=89) occurred after 42 days post-partum.

Figure 3. Timing of Pregnancy-Associated Deaths, Massachusetts, 2000-2007



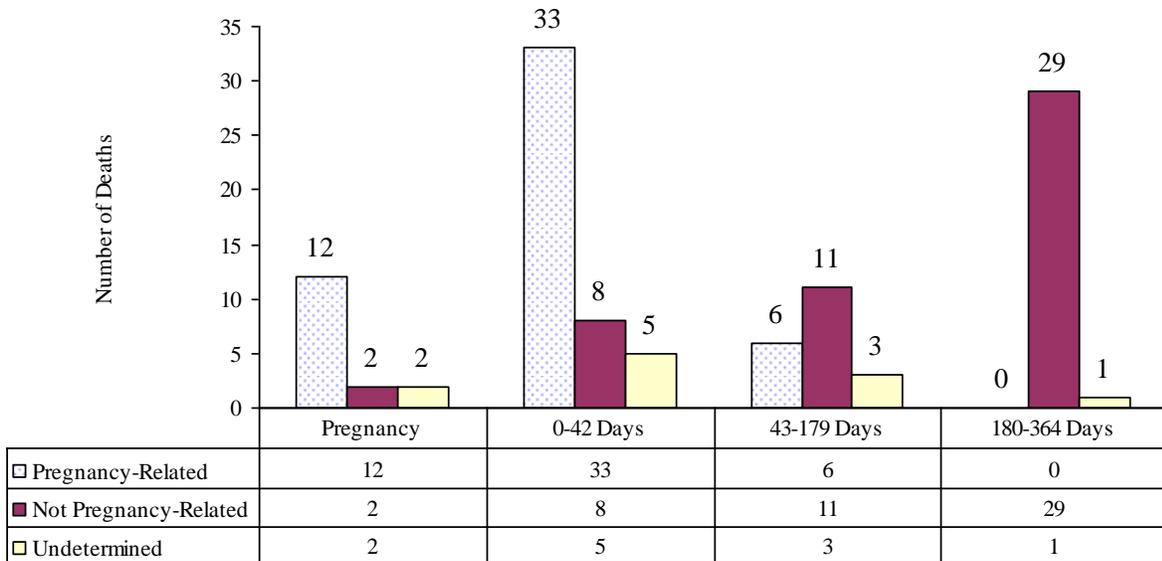
* Timing of death was missing for 1 medical-caused case and 1 unknown cause case

Timing of Medical Causes of Death

Of the 112 deaths due to medical causes, 62 occurred either during pregnancy or within 42 days postpartum.

- Most (45 out of 62) of the pregnancy-related deaths occurred within 42 days postpartum, a time coinciding with close contact with obstetrical providers.
- Among deaths that were not pregnancy-related, most (40 out of 50) occurred after 42 days postpartum.

Figure 4. Timing of Pregnancy-Associated Deaths, Medical Causes, Massachusetts, 2000-2007

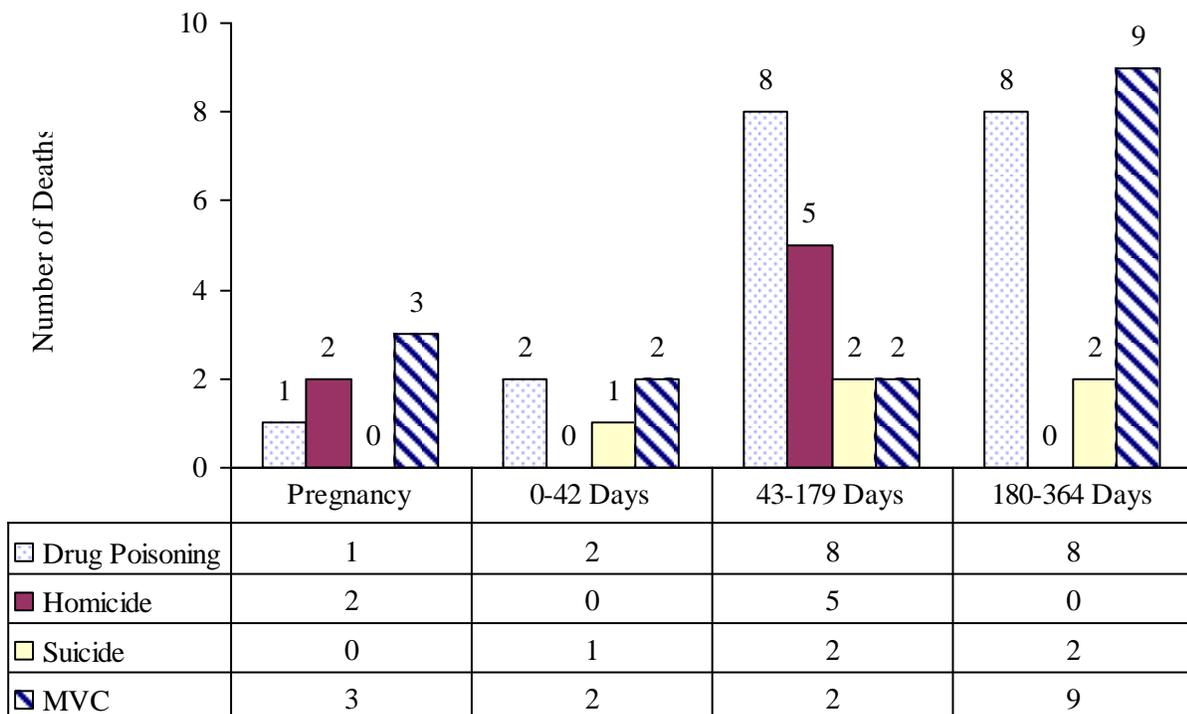


Timing of Injury Causes of Death

The majority of deaths (38 out of 51) caused by injuries occurred after the 6-week postpartum period (43-364 days).

- The majority of injury deaths were unintentional (35 out of 51).
- The majority of homicide deaths (5 out of 7) and suicide deaths (4 out of 5) occurred in the 43-364 days postpartum period.
- Deaths due to motor vehicle collisions (MVC) occurred across all periods with over half occurring within six months postpartum.
- Most of the deaths due to drug poisoning including overdose (16 out of 19) occurred after the 6-week postpartum period.

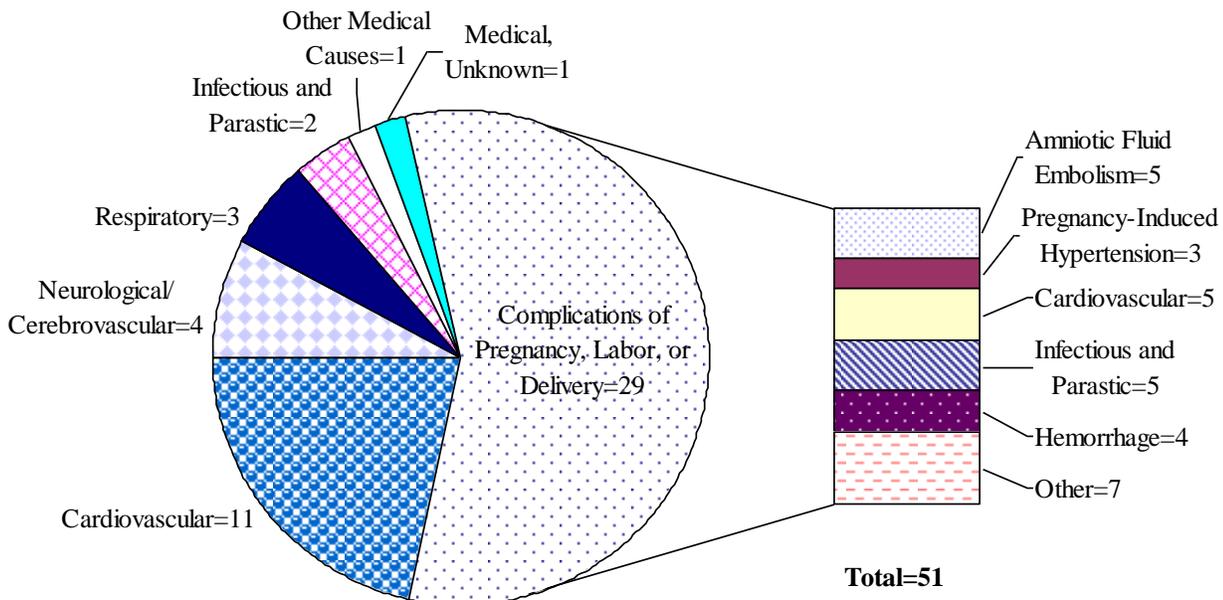
Figure 5. Timing of Pregnancy-Associated Deaths, Injury Causes, Massachusetts, 2000-2007



Distribution of Causes of Death

Medical Causes: The distribution of medical causes is presented in Figures 6 and 7. Among the 112 deaths caused by medical conditions, 51 (45%) were pregnancy-related, 50 (45%) were not related to pregnancy, and 11 (10%) were undetermined.

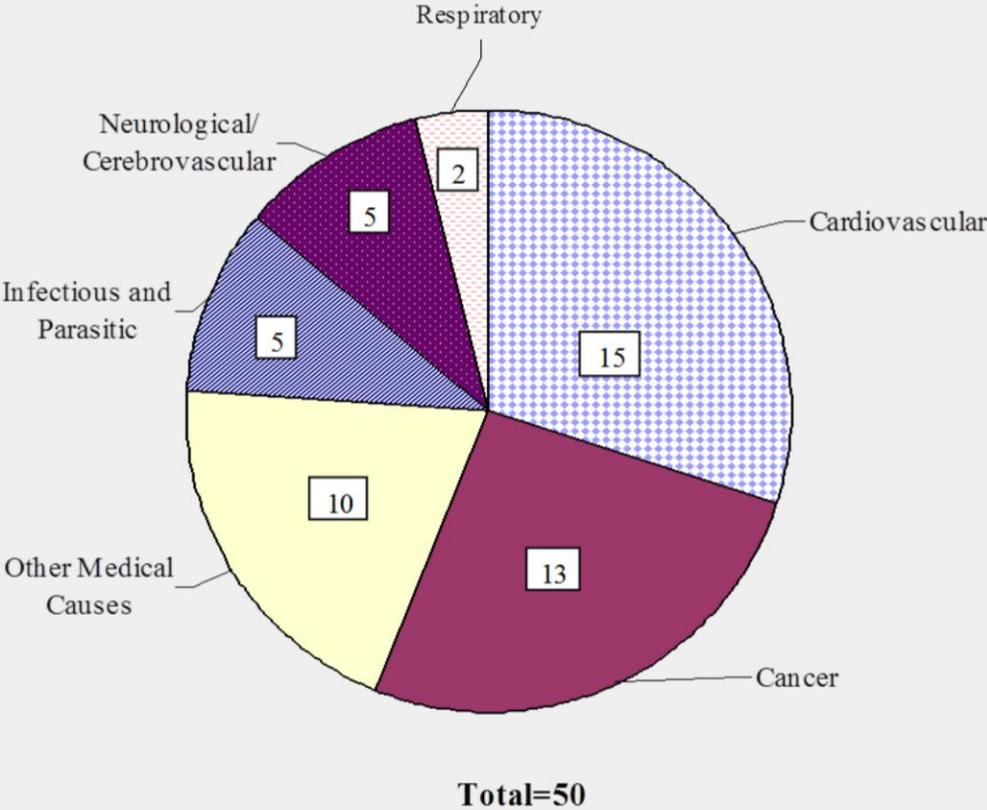
Figure 6. Distribution of Pregnancy-Related Deaths Caused by Medical Conditions, Massachusetts, 2000-2007



The leading causes of pregnancy-related deaths were complications of pregnancy, labor or delivery (n=29, 57%), which included amniotic fluid embolism (n=5), infectious/parasitic disease (n=5), cardiovascular disease (n=5), hemorrhage (n=4), pregnancy-induced hypertension (n=3) including preeclampsia, eclampsia, and HELLP (**H**emolysis, **E**levated **L**iver enzymes, **L**ow **P**latelet count) syndrome, and other complications (n=7) including anesthesia complications, ruptured ectopic pregnancy, placental abruption, acute fatty liver, and postpartum angiopathy. The second leading cause was cardiovascular diseases (n=11, 22%). Next, were deaths caused by neurology/cerebrovascular diseases (n=4; 8%) and respiratory diseases (n=3, 6%).

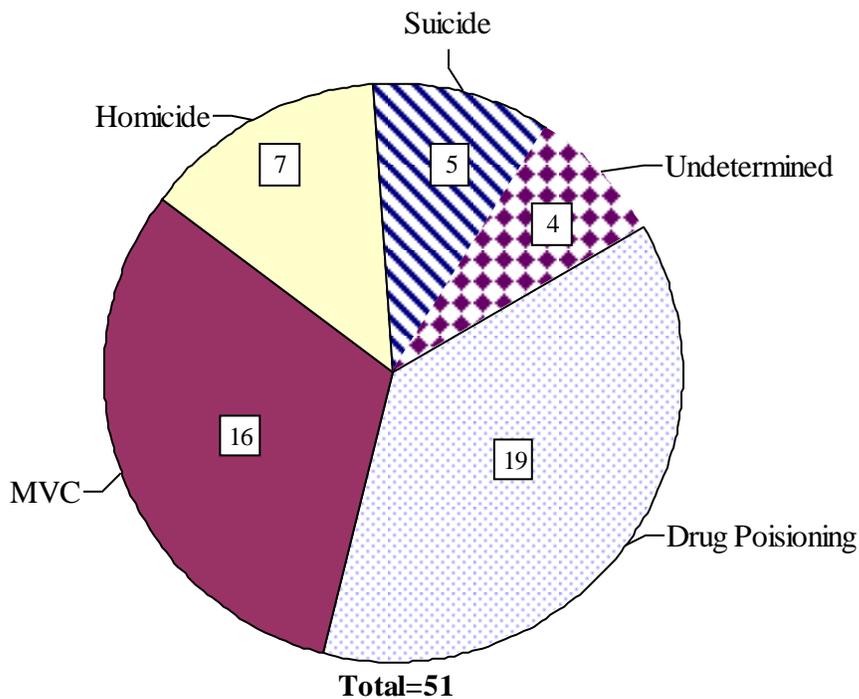
The leading causes of pregnancy-associated but not pregnancy-related deaths from medical causes were cardiovascular diseases (n=15, 30%) followed by cancer (n=13, 26%), infectious and parasitic diseases (n=5, 10%) and neurological/cerebrovascular diseases (n=5, 10%). Cancers included breast, lung, gastric, esophageal melanoma, and other rare cancers. Infections included HIV, meningitis, pneumonia, hepatitis, myocarditis, panencephalitis, and pyelonephritis. Other causes included seizure disorders, metabolic, cerebrovascular diseases, and other rare conditions.

Figure 7. Pregnancy-Associated Deaths, Medical Causes but not Pregnancy-Related, Massachusetts, 2000-2007



Distribution of Injury Deaths: Drug poisoning including drug overdose was the primary cause of death among the 51 injury-related deaths and accounted for 37% of the deaths (n=19). The second leading cause was motor vehicle collisions (MVC) with 31% (n=16). Among the remaining deaths, 14% (n=7) were the result of homicides and 10% (n=5) were suicides. In 8% (n=4) of injury deaths the intentionality was undetermined.

**Figure 8. Distribution of Injury Deaths,
Massachusetts, 2000-2007**



Preventable Deaths

The following preventable death determinations were made with the benefit of retrospective review and current clinical practice guidelines at the time of the review rather than at the time of the death.

Table 2. Preventable Pregnancy-Associated Deaths, Medical Causes, Massachusetts, 2000-2007

Preventability	Pregnancy-Related			Total N (%)
	Yes N (%)	No N (%)	Undetermined N (%)	
Preventable	12 (24)	9 (18)	0	21 (19)
Not preventable	22 (43)	35 (70)	3 (27)	60 (54)
Undetermined	17 (33)	6 (12)	8 (73)	31 (28)
Total	51 (100)	50 (100)	11 (100)	112 (100)

Overall, 19% (n=21) of the medical deaths may have been “preventable”. The preventability could not be determined in 28% of cases (n=31), from the information available at the time of review, and the remaining 54% (n=60) were determined by the committee to be not preventable. Among the pregnancy-related deaths, 24% (n=12) may have been preventable, and among the deaths not related to pregnancy 18% (n=9) may have been preventable.

V. Recommendations

The recommendations included in this report are based on the reviews of all pregnancy-associated deaths occurring in Massachusetts during 2000-2007 by the MMMRC. These recommendations were developed using the framework for public health action developed Dr. Thomas Frieden, current Director of the Centers of Disease Control and Prevention (CDC)². Dr. Frieden used a five-tiered pyramid to describe different types of public health and clinical interventions. While interventions targeted at the base of the pyramid have a greater population impact, a comprehensive public health system needs to develop interventions for each tier. In addition, interventions aimed at the top of the pyramid require increased individual effort. Using this five-tier pyramid, the recommendations of the MMMRC are as follows:

A. Maternal Counseling and Education: Maternal counseling is at the individual or group level to provide specific information to pregnant and postpartum women. This tier represents health education (education provided during clinical encounters as well as education in other settings), which is perceived by some as the essence of public health action but is generally the least effective type of intervention. The MMMRC had two recommendations:

1. *Offer universal screening, including HIV, to all pregnant women.*
2. *Offer universal screening for smoking and referrals as needed to all pregnant women.*
3. *Offer counseling regarding motor vehicle safety education including seat belt safety.*

B. Perinatal Clinical Interventions: This level of the pyramid represents ongoing clinical interventions and direct clinical care. This level, although similar to the fifth tier, has the interventions designed to help individuals rather than entire populations, but it could theoretically have a large population impact if universally and effectively applied. The MMMRC had fourteen recommendations, four of these match the *Recommendations to improve maternity care in Massachusetts, Report of the Expert Panel in Obstetrics* convened by the Betsy Lehman Center for Patient Safety and Medical Error Reduction Massachusetts Department of Public Health, November 18, 2009. *

1. *Offer Universal screening, including a rapid HIV test, to all pregnant women.*
2. *Develop standard practice guidelines for managing pregnant patients for behavioral health and mental health.*
3. *Develop Minimum standards and policies to ensure that all obstetrical providers have access to coverage arrangements that allow adequate rest; as needed, adjustments in work load and work hours that are consistent with current research should be made.**

² Frieden, TR. A framework for public health action: the health impact pyramid. [Am J Public Health](#). 2010 Apr;100(4):590-5. Epub 2010 Feb 18.

4. *Establish protocols for handing off patients in a structured & consistent manner to ensure maximum continuity of information and patient care plans. The prenatal record should be available when the patient arrives in L&D.**
 - *Enhance screening & documentation of screening and response to a positive screen during prenatal, intrapartum and postpartum care.*
 - *The content of the communication should include relevant history such as behavioral health issues, pertinent social history, physical and laboratory data as well as progress, plans and concerns regarding deterioration.*
 - *Improve DPH protocols to assure improved data including social work notes.*
5. *Improve and expand case management to better link social services with medical providers including increased case management and/or outreach for women with mental health or substance abuse; model could be similar to that of chronic disease.*
6. *Require that each maternity hospital have clinical guidelines and protocols for recognizing and managing maternal hemorrhage including standardized timing and criteria for implementing a massive transfusion protocol. The guidelines and protocols should include procedures that effectively address the clinical risk and management of peripartum maternal hemorrhage. **
7. *Establish clear communications of treatment plan to staff, patient, and family which include: **
 - *Methods for resolving conflicts on patient care management*
 - *Optimal staffing level, and clear accountability of all relevant staff at all times*
 - *Prompt disclosure of medical errors and adverse outcomes/events to patient and family*
 - *Linguistic competence, cultural competence and sensitivity in patient care*
 - *Structured communication (including handoffs and nonverbal communication) for all labor and delivery staff*
 - *Regular assessment of communication skills*
 - *Work hours and fatigue*
 - *Hand-offs*
 - *Availability of prenatal records in Labor & Delivery*
8. *Develop a checks and balance process to prevent multiple systems error within a facility.**
9. *Increase training around psychotropic medications.*
10. *Reduce blood work error by assuring clinical charting & lab work/results are timely and noted by clinicians.*
11. *Establish Quality Assurance (QA) protocols to assure charts are complete with current diagnosis and medications and comprehensive behavioral health care including Medication Assisted Therapy (MAT)*

12. Improve/expand Case Management (CM) with emphasis on communication regarding: history, all social services, risk factors (drugs, depression) to prevent the disconnect between a woman's symptoms and documentation regarding their history/contact/involvement with any social services.

13. Initiate the Screening, Brief Intervention, and Referral and to Treatment (SBIRT) protocol (includes, tobacco, alcohol, substance use, mental health and domestic violence) as a screening tool to identify high-risk patients.

C. Universal protocols for preconception, prenatal, intrapartum and postpartum care (including baby): Clinical interventions that require limited contact but confer long-term protection, ongoing direct clinical care. The MMMRC committee had eight recommendations:

1. Develop standard practice guidelines for managing patients with diagnosis of Mental Health including psychotropic medications and management of maternal health issues.

2. Assure universally accepted drug rehabilitation for all pregnant women that includes access and availability.

3. Develop training on maternal mental health and require staff to demonstrate proficiency in screening and referring for maternal behavioral health including emotional health, unhealthy use of substances and domestic violence.

4. Expand the MMMRC to include a broader array of professional disciplines including, but not limited to, medical social workers, providers with specific expertise in substance use, mental health and domestic violence.

5. Develop training and require staff to demonstrate proficiency in the administration of psychotropic medications in pregnancy.

6. Encourage hospitals to develop community outreach provisions (based on social concerns) to all women, especially women who leave against medical advice.

7. Provide comprehensive counseling and/or screening, for Medicated Assisted Therapy (MAT) (methadone/suboxone) for pregnant women.

8. Initiate the SBIRT protocol (includes: tobacco, alcohol, substance use, mental health, and domestic violence) as a screening tool to identify high risk patients.

D. Change social and health context to make a woman's default decisions healthy during her childbearing years: Interventions that change the context to make individuals' default decisions healthy. The MMMRC had one recommendation.

1. Ensure all pregnant women receive treatment for substance use disorders.

E. Implement policies to support an environment that promotes healthy women and their families. At the base of this pyramid, which indicates interventions with the greatest potential impact, are efforts to address socioeconomic determinants of health. The MMMRC had five recommendations.

1. *Create a system of care that includes universal behavioral health services that are within societal/governmental responsibility.*
2. *Ensure universal access to behavioral health services.*
3. *Explore models of care in other countries.*
4. *Improve the connection and coordination between social services, health services, and the criminal justice system.*

Appendix A: Committee Members and DPH and Office of Chief Medical Examiner Staff

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**Appendix A: Committee Members and
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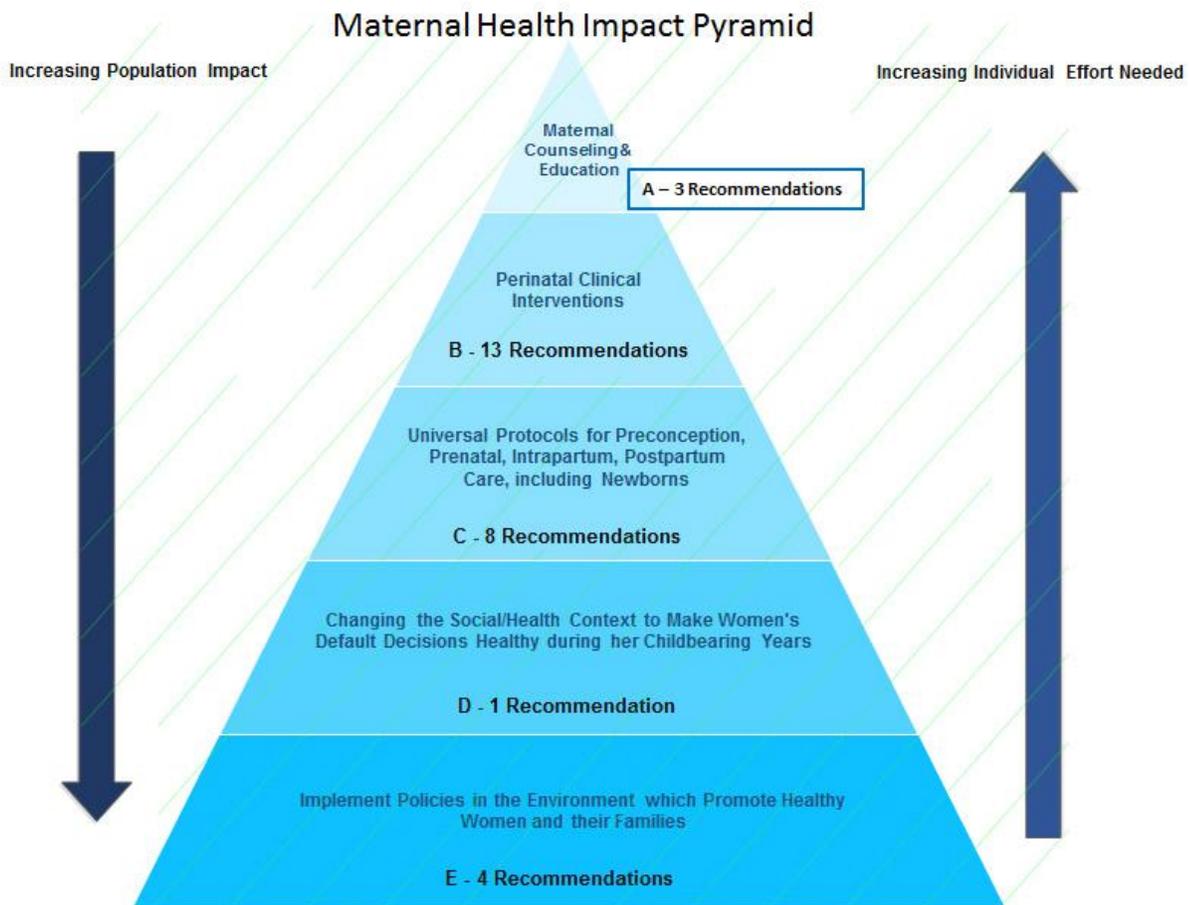
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Appendix B: Maternal Health Impact Pyramid Guiding Recommendations



Adapted from Frieden, TR. A framework for public health action: the health impact pyramid. [Am J Public Health](#). 2010 Apr;100(4):590-5. Epub 2010 Feb 18.