



THE CALIFORNIA PREGNANCY-ASSOCIATED MORTALITY REVIEW

Report from 2002 and 2003 Maternal Death Reviews

This project was supported by federal Title V block grant funds received from the California Department of Public Health; Center for Family Health; Maternal, Child and Adolescent Health Division

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We extend our gratitude to the many doctors, nurses, midwives and other health professionals who have volunteered considerable time and expertise for the CA-PAMR Committee to review the medical records of women who died in California. The names of the Committee members are listed on the following page. Each has shown remarkable dedication and concern for improving the health and health care of mothers in the state.

We sadly acknowledge the women who died during or after their pregnancies, the families who love and miss them, and the clinicians who cared for them. Each maternal death in this report represents a woman whose life ended early. This report seeks to honor the memories of these women by improving the experience of expectant mothers everywhere.

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EXECUTIVE SUMMARY

Maternal mortality, or deaths from pregnancy-related causes, is on the rise, both in California and the United States (U.S.). The rate of maternal deaths in California in 1999 was 8.0 deaths per 100,000 live births and by 2008 it was 14.0 deaths per 100,000 live births. African-American women are roughly four times more likely to die from pregnancy-related causes than women in all other racial/ethnic groups.

Maternal deaths are rare; yet rising rates serve as a warning sign and merit further investigation. Improved vital statistics data reporting may account for about a third of the rise, leaving about two-thirds of maternal deaths that are likely due to other causes such as changes in the health status of women, changes in health care services, or the emergence of other social/environmental factors. Another reason to investigate the rise in maternal mortality is the accompanying rise in rates of pregnancy-related injury or illness, referred to as maternal morbidity. While not directly addressed in this report, rising rates of morbidity increase the short- and long-term suffering and economic consequences of caring for sick or disabled women and their infants. Maternal deaths serve as a call to action: to investigate the deaths, understand the causes, and develop strategies for prevention.

In 2004, the California Department of Public Health; Maternal, Child and Adolescent Health Division started the California Pregnancy-Associated Mortality Review (CA-PAMR) project to investigate the rise in maternal deaths. CA-PAMR identifies maternal deaths using enhanced surveillance methodology and conducts in-depth review of the medical records by an expert panel of maternity care and public health professionals. The major goals of the project are to identify pregnancy-related deaths, causation and associated risks, and then recommend improvements in the quality of maternity care. These improvements will subsequently inform prevention strategies to reverse the alarming trend in maternal mortality.

Case reviews have been completed for 2002 and 2003. According to death certificate data, 386 women died during childbirth or within one year of a live birth or fetal death in this time period. Of these, the CA-PAMR Committee determined that 98 were due to causes directly related to the pregnancy or its management. Other important findings from the 2002-2003 CA-PAMR are as follows:

- The data revealed disparities in outcomes based on race, income and education.
 - African-American women had a four-fold higher risk of maternal death and were more likely to have been overweight or obese and to have risk factors identified in the prenatal period. (See page [35](#).)
 - Medi-Cal was the payer source for 45% of women who gave birth in California in 2002-2003, but was the payer for 57% of the pregnancy-related deaths. (See page [39](#).)
 - Lower educational attainment was also found among women with pregnancy-related deaths. While 11% of all women who gave birth in 2002-2003 had less than a high school education, 31% of the mothers who died had not completed high school. (See page [26](#).)
- There were high rates of obesity among the pregnancy-related deaths and obesity or excessive gestational weight gain was determined to be a contributing factor in one of four deaths where data on weight was available. (See page [31](#).)

- Medical record review resulted in improved identification of pregnancy-related deaths, greater specification of the underlying cause of death, as well as the leading causes of death. After case review, cardiovascular disease appears to be the leading cause of pregnancy-related deaths in 2002-2003 and yet this health problem did not appear in the top five causes when only death certificate data were examined. (See page 22.)
- Sixty-five of the women who died had a cesarean section performed and most were unplanned or emergency surgeries to try and save the life of the mother or the infant. However, 11 of the 65 women experienced complications attributed to the current or prior cesarean section that the CA-PAMR Committee determined to be one of the contributing factors in the mother's death. (See page 43.)
- More than a third of pregnancy-related deaths were determined to have had a good to strong chance of being prevented and some causes of death appeared to be more preventable than others. (See page 47.)

The major recommendations of the CA-PAMR Committee based upon the 2002-2003 findings are to:

- Continue CA-PAMR Committee reviews in order to thoroughly investigate the years with the greatest rise in maternal deaths (2005-2006).
- Explore methods for capturing data regarding social determinants of health that may contribute to maternal deaths and explore strategies for obtaining complete autopsy results on all deaths that may be pregnancy-related.
- Collaborate with other public health and health care strategies aimed at reducing health disparities, so that disparities in maternal health outcomes are included in long-term health promotion efforts.
- Prioritize nutrition and physical activity campaigns for adolescent girls and women of childbearing age so they can achieve a healthy pre-pregnancy weight and thus reduce obesity as a major risk factor for maternal death.
- Continue to study the potential relationship of cesarean section to maternal morbidity and mortality.
- Conduct further analysis of opportunities for quality improvement in maternity care to inform patient safety programs in hospital and outpatient settings.

CA-PAMR has relied on the collaboration of three major organizations: The California Department of Public Health, Center for Family Health, Maternal Child and Adolescent Health Division; the California Maternal Quality Care Collaborative at Stanford University and the Public Health Institute in Oakland, California. The CA-PAMR Committee is made up of distinguished health professionals from a variety of practice settings, specialties and geographic areas who have generously volunteered their time to this important project. CA-PAMR is supported by federal Title V Maternal and Child Health block grant funds from the California Maternal, Child and Adolescent Health Division.

All persons involved with this project feel honored to participate, in the hope and expectation that the tragedies represented in this report will inspire needed changes to reduce maternal morbidity and deaths in California.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	i
EXECUTIVE SUMMARY.....	iii
TABLE OF CONTENTS.....	v
I. BACKGROUND	2
II. METHODOLOGY FOR THE CALIFORNIA PREGNANCY- ASSOCIATED MORTALITY REVIEW	12
III. RESULTS.....	20
The 2002-2003 Pregnancy-Associated Cohort.....	20
CA-PAMR Committee Determination of Pregnancy-Related Deaths and their Causes	22
Demographics	26
Risk Factors	29
Disparities in Outcomes.....	35
Maternity Care.....	41
Preventable Deaths.....	47
IV. IMPLICATIONS AND NEXT STEPS.....	53
V. TECHNICAL NOTES	55

Background

Maternal deaths are sentinel events. We know that many of them are avoidable through changes in women's health, actions, clinical care and the health care system. Maternal mortality review can provide the information needed to help reduce the number of these devastating losses and to improve the health of the women in California.

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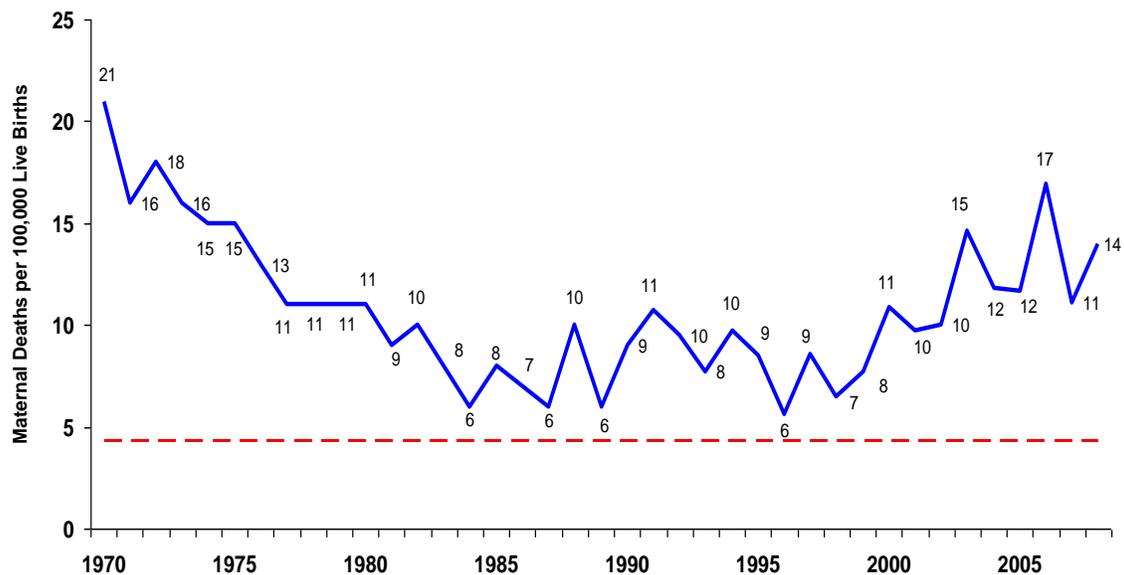


I. BACKGROUND

The California Pregnancy-Associated Mortality Review was started in 2004 to investigate the rise in maternal mortality and the widening racial/ethnic disparity and to identify possible reasons for the rise in order to appropriately direct policy and programmatic interventions. This document describes the background to the problem, methodology for the review and findings from the first two years of case review.

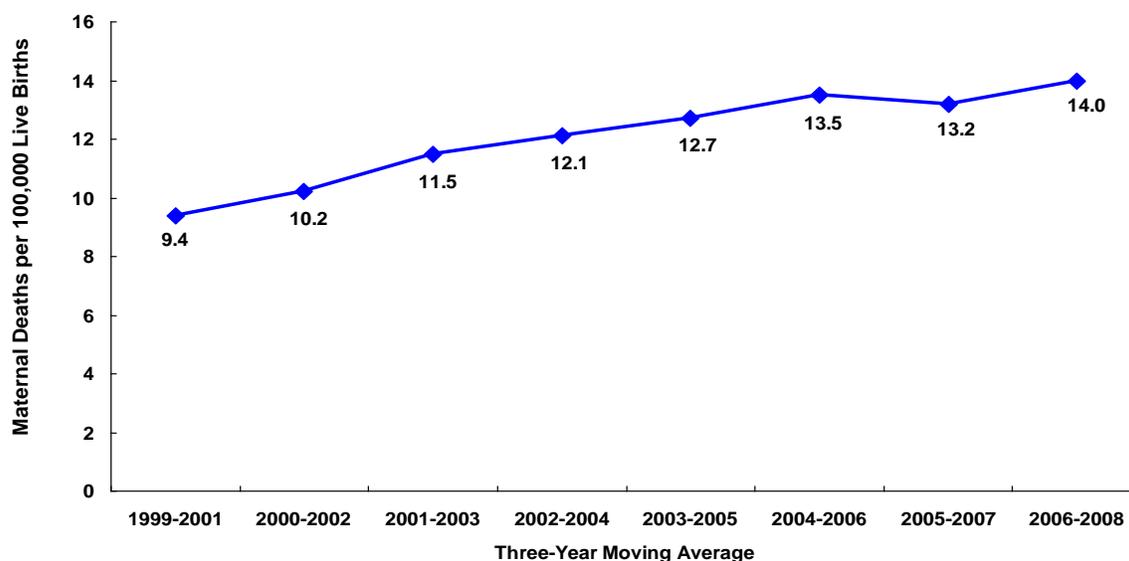
Over half a million women give birth each year in California and the state accounts for almost one in eight births nationally. In 2002 and 2003, respectively, 529,245 and 540,827 infants were born for a total of 1,007,072 births in the state. After several decades of declining rates of maternal mortality in California, rates began to rise in 1999 and proceeded to double in the next seven years. Rates of maternal deaths in California rose from 8.0 deaths per 100,000 live births in 1999 to 16.9 deaths per 100,000 live births in 2006. Rates dropped slightly to 11.0 in 2007 but rose again to 14.0 in 2008 (Figure 1). From 2007-2010 data, the National Report Card on Women's Health ranked California as 35 of 51 states (includes Washington, D.C.) in rates of maternal mortality for that year.¹ Maternal mortality has similarly risen across the U.S. so that in 2010, the U.S. was ranked 50th among the cohort of 59 developed countries.²

Figure 1. Maternal Mortality Rate, California Residents; 1970-2008



Although there were fluctuations from year to year, on average there was a statistically significant increase in annual maternal mortality from 1999 to 2008. The significant rise remains when maternal deaths among African-Americans are excluded from the calculation, suggesting that rising maternal mortality rates in California are not wholly explained by rising rates among African-American women. (See the Technical Notes, [page 55](#), for detail on trend testing.) When the statewide data is presented as a three-year moving average, the annual fluctuations inherent to rates for rare events disappear and the upward trend in maternal deaths is more clearly evident (Figure 2). The maternal mortality rate was 49% higher in 2006-2008 than in 1999-2001.

Figure 2.
Moving Average of Maternal Mortality Rates, California Residents; 1999-2008



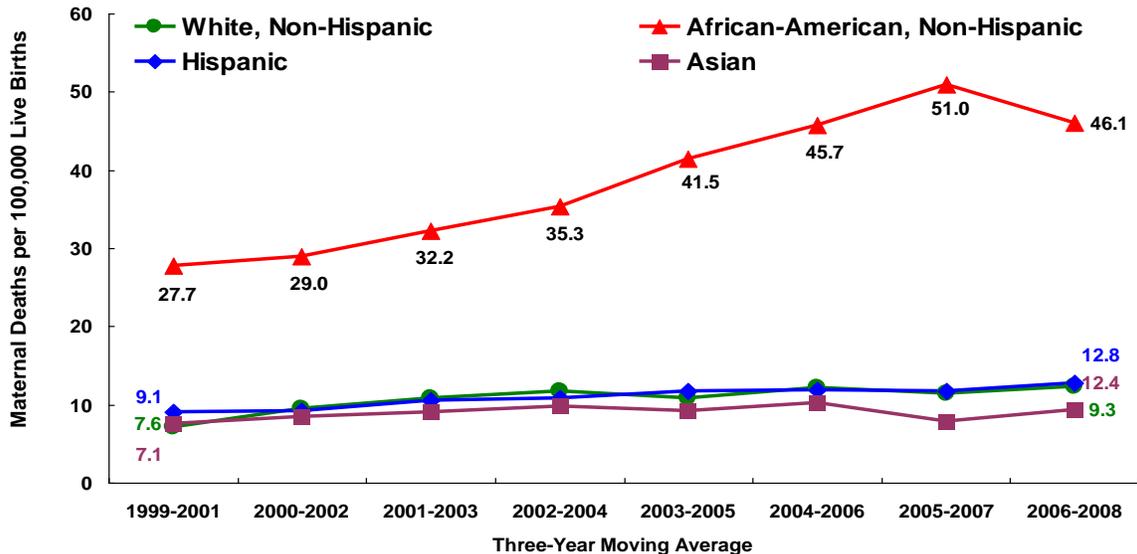
Key definitions

- The *maternal mortality rate* is defined as the number of women who die from a pregnancy-related cause within 42 days postpartum (numerator) divided by the number of live births in that year (denominator) multiplied by 100,000.⁵ (Note: This measure is sometimes referred to as the maternal mortality *ratio*. We have elected to use the term *rate* in order to be consistent with the term used by the Centers for Disease Control and Prevention (CDC) and Healthy People 2010 objectives. Maternal mortality is defined and calculated the same, regardless of which term is used.)
- The *pregnancy-related mortality rate* is defined as the number of women who die from a pregnancy-related cause up to one year postpartum (numerator) divided by the number of live births in that year (denominator) multiplied by 100,000. Therefore, the difference between maternal mortality and pregnancy-related mortality rates is the time period for inclusion (deaths up to 42 days postpartum versus deaths up to one year postpartum).
- A *pregnancy-related death* is due to cause(s) directly related to physiologic changes of pregnancy (direct obstetrical death) or due to causes aggravated by the pregnancy or its management (indirect obstetrical death). If a woman dies while pregnant or within one year of termination of a pregnancy from causes unrelated to pregnancy or its management (e.g., injuries or complications of other conditions) then the death is defined as *not-pregnancy-related*. When pregnancy-related deaths and not-pregnancy-related deaths are combined, the whole group is referred to as *pregnancy-associated deaths*.

Disparities in outcome by race/ethnicity and by age

African-American women die from pregnancy-related causes at higher rates than women in other racial/ethnic groups. A 2008 report from the CDC found that nationwide, non-Hispanic African-American women had a maternal mortality rate of 36.1 per 100,000 live births compared to a rate of 9.6 for White women and 8.5 for Hispanic women.⁶ In California, from 2006 to 2008, African-American women were roughly four times more likely to die from pregnancy-related causes with 46.1 deaths per 100,000 live births, compared to 12.8 for Hispanic women, 12.4 for White women, and 9.3 for Asian women (Figure 3). The widening disparity in maternal mortality rates for African-American women compared to White women is worse than it was in the 1940s. At that time, African-American women in California were 2.3 times more likely than White women to die from pregnancy-related causes.⁷

Figure 3.
Maternal Mortality Rates by Race/Ethnicity, California Residents; 1999-2008

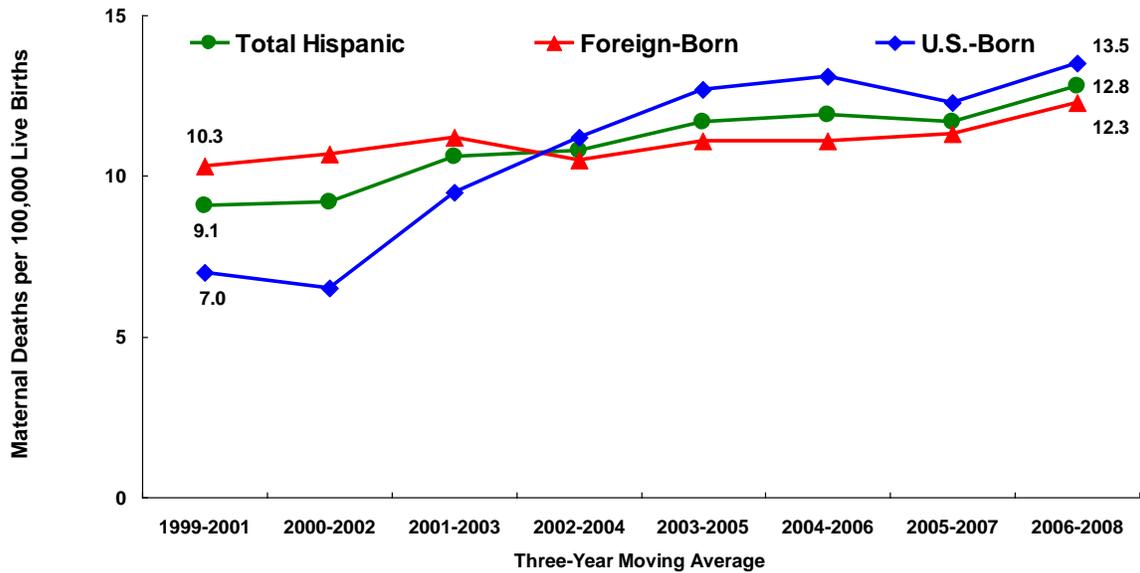


This disparity in maternal deaths between African-American women and women of other racial/ethnic groups is the largest disparity among major public health mortality indicators.⁸ It is not known whether this maternal health disparity is due to differences in health status (e.g., a higher burden of illness, injury, disability) or if it also represents a disparity in health care that can be attributed to differences in health insurance coverage, entry to prenatal care, access or quality of care.

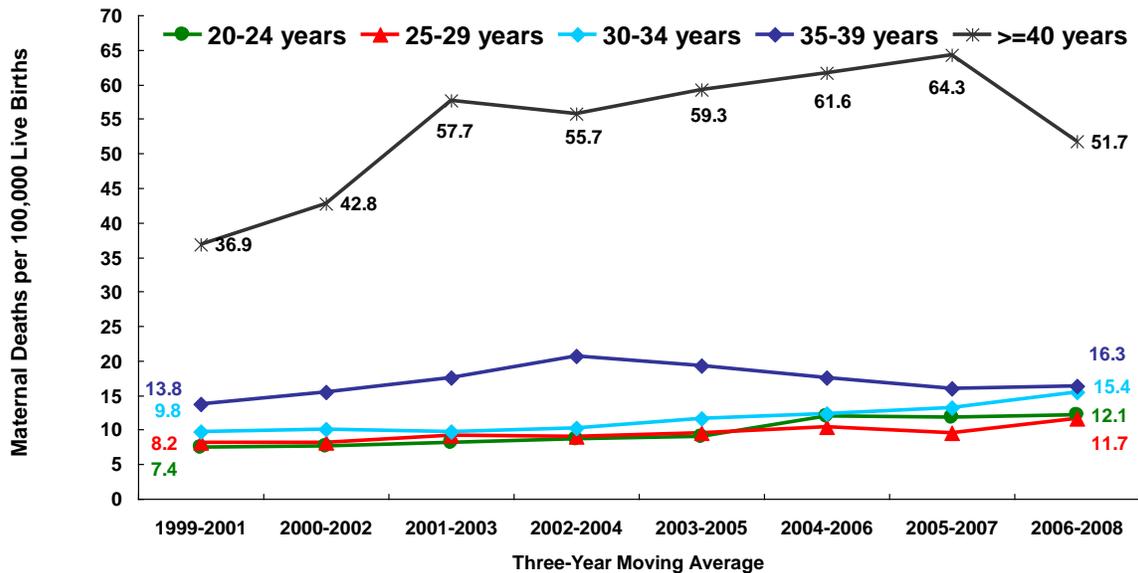
Another racial/ethnic disparity developing in California is a rise in maternal mortality among U.S.-born Hispanics. The rate of maternal death has nearly doubled in the past ten years for this group, rising from an average rate of 7.0 deaths per 100,000 live births in 1999-2001 to 13.5 deaths per 100,000 live births in 2006-2008 (Figure 4). This increase in maternal mortality among this group is a concerning development since approximately half of all births in California, or more than a quarter of a million births annually, are to Hispanic women. In particular, U.S.-born Hispanics account for an increasing proportion of births within California and among all Hispanic births. U.S.-born

Hispanics accounted for 22% of all births in California in 2008, up from 17% in 1999. Among all Hispanic births in California, births to U.S.-born Hispanic women accounted for 43% of Hispanic births in 2008, up from 35% in 1999.

Figure 4. Maternal Mortality Rates for U.S.- and Foreign-born Hispanic California Residents; 1999-2008



Rates of maternal mortality increase with age and, except among 25-29 year olds, the rates of death for all age groups have increased since 1999 (Figure 5). The average age for giving birth in California has significantly increased in the past ten years: in 1999 the average age of mothers was 27.6 years and in 2008 it was 28.1 ($t < .001$). This trend is projected to continue and by 2017 women aged 35-39 and 40-44 are projected to have the largest increases in births (respectively, up to 15.5% and 14% increase from 2007 rates). The maternal mortality rates are highest for women over 40 years of age. During the period of 1999 to 2008, the disparity in deaths for women 40 years or older has increased to be as much as three to four times higher than those of younger women. The largest numbers of maternal deaths, however, occurred in women ages 30-39, with deaths among 30-35 year olds showing a statistically significant rise in maternal mortality from 1999-2001 (9.8 maternal deaths per 100,000 live births) to 2006-2008 (15.4 deaths per 100,000 live births.) (See the Technical Notes, [page 55](#), for description of projected trends and detail on trend testing.)

Figure 5. Maternal Mortality Rates by Age Group, California Residents; 1999-2008

Rising maternal mortality correlates with rising rates of pregnancy complications

Maternal mortality is one of the most important indicators of population health and the quality of health care in a society. Along with a rise in maternal mortality we are seeing rising rates of maternal morbidities (illness or injury arising from complications of pregnancy or medical intervention.) Some of these complications are treatable while others are life-threatening with serious long-term consequences. Examples of maternal morbidity include gestational diabetes, preeclampsia, and hemorrhage. Examples of severe morbidity include peripartum hysterectomy, stroke, and septic shock. Danel and colleagues used National Hospital Discharge Survey Data from 1993 to 1997 to identify morbidity defined as “conditions that adversely affected a women’s physical health beyond what would be expected in a normal delivery.”⁹ They found that 43% of pregnant women experienced some form of maternal morbidity (defined as an obstetric complication, an aggravated pre-existing medical condition, a cesarean delivery or any combination of the three). Serious conditions (e.g., eclampsia, infection) affected less than 1% of women but this still represents tens of thousands of women among the nearly four million births each year in the U.S. In California, Lu and colleagues examined hospital discharge data between 1999 and 2005 and found increasing trends of key maternal morbidities among childbearing women. Significant increases were observed during this study period, including a 15% increase in maternal hypertension (both pregnancy-induced hypertension and underlying hypertension), a 43% increase in diabetes (pregestational, as well as gestational diabetes) and a 50% increase in chorioamnionitis.¹⁰

Kuklina et al also found the rate of severe morbidity in pregnancy appears to be increasing. Using national data, the prevalence of delivery hospitalizations in which woman suffered a severe morbidity (n=48,645) (e.g., renal failure, heart failure, pulmonary embolism, shock, hysterectomy) was 6.4 per 1,000 delivery hospitalizations

in 1998-1999 and increased by 27% to 8.1 per 1,000 deliveries in 2004-2005 (n=68,433)¹¹ Kuklina further found that rates of obstetrical hemorrhage have doubled and rates of thromboembolism (blood clots) in pregnancy have increased by 50% from 1999-2005.

Of interest is that cesarean delivery rates have been rising at the same time maternal morbidity has been rising. In California, cesarean deliveries have increased from 23% in 1999 to 32% in 2007, similar to national trends.¹² In 2007, 57% of cesarean births were primary cesareans and 43% were repeat cesareans. Prior cesarean delivery is associated with increased risk of experiencing a severe maternal morbidity in subsequent pregnancies.¹³ Cesarean birth is a surgical procedure, and therefore has higher risks of complications (e.g., infection, bleeding or blood clots) compared to vaginal births. In her study of severe maternal morbidity, Kuklina adjusted for mode of delivery and found that cesarean birth explained the increases in incidence of renal failure, adult respiratory distress syndrome and the need for mechanical ventilation, but did not fully explain the increased incidence of shock, pulmonary embolism or blood transfusion.¹¹

Costs associated with caring for complications of pregnancy

Caring for complications of pregnancy is costly. Publicly funded health insurance covers the cost for nearly half of the births in California. Medi-Cal paid for approximately 47% of perinatal and pregnancy-related costs in California in 2008. Medi-Cal fee-for-service data shows that from 1996 to 2006, the number of women diagnosed with postpartum hemorrhage increased by 36%, resulting in an average increase in expenditures of \$3,277 per woman affected. Total expenditures for postpartum hemorrhage rose from \$5 million in 1996 to \$9.1 million in 2006.¹⁴ Diabetes during pregnancy led to an average length of hospital stay of 3.1 days and an average charge of \$4,591 (1997 dollars) per woman in one commercial managed care plan.¹⁵ Data from a 2002 U.S. study showed that high blood pressure during pregnancy was associated with an average hospital stay of 3.5 days and an average total cost per stay of \$9,800 as compared to \$5,774 for a normal pregnancy and delivery. In the same managed care plan, premature rupture of membranes (water breaking before labor starts) led to an average length of stay in hospital of 12.6 days and an average charges of \$20,753 (1997 dollars) per woman.¹⁶ Further, the value of a life lost to premature mortality has significant “costs” associated with it and U.S. Health and Human Services agencies estimate the cost of a woman’s death to be between three and five million dollars.¹⁷

According to a March 2009 report to the California State Legislature from the California Benefits Review Program, most Californians (66%) enrolled in California Department of Insurance (CDI) regulated policies have coverage for maternity benefits including prenatal care and delivery services. However, in the CDI-regulated individual market, only 22% had coverage for maternity services in 2009, which is down from 82% in 2004. About one-quarter of enrollees are women of childbearing age (19 to 44 years). When maternity benefits are stratified by risk, the cost burden of insurance and pregnancy-related care is then shifted to women and/or California taxpayers. As of 2008, about 7% of women enrolled in Medi-Cal Aid to Infants and Mothers programs were simultaneously enrolled in private health insurance policies that did not cover maternity services.¹⁸

Why is maternal mortality rising?

The answer to why maternal deaths are on the rise is complex and likely to be multifactorial. We postulate that at least four interrelated explanations are likely.

- First, improved vital statistics data reporting may account for up to 33% of the increase. A national study found that implementation of more specific diagnostic codes may account for 13% of the rise while the addition of a specific query about pregnancy on the death certificate implemented in 2003 may have captured an additional 20% of reported cases that were previously missed.^{19, 20}
- Second, increasing age or increasing prevalence of maternal chronic conditions, such as hypertension, diabetes or obesity, could be contributing to the rise in maternal morbidity and mortality. Older women are also likely to have previously given birth possibly by cesarean delivery, which may increase the risk for complications in subsequent births. The major causes of pregnancy-related deaths in the U.S. in the 1990s were pulmonary embolism, hemorrhage, complications of other medical conditions and hypertensive disorders of pregnancy.²¹ Between the periods 1979-1986 and 1991-1999, the percentage of pregnancy-related deaths caused by cardiomyopathy and other medical conditions more than doubled.
- Third, social factors such as low levels of social support, lower socioeconomic status, chronic exposure to environmental hazards or social stressors such as racism, fragmentation of or difficulty accessing health care may be playing an important role in the increase of maternal mortality.²²⁻²⁷
- Fourth, factors related to health care systems and access to quality care, both inpatient and outpatient, are likely to be involved and could include possible overuse or underuse of obstetrical interventions. For example, rising rates of cesarean delivery are increasingly considered a source of increased morbidity and possibly of mortality. Nationally, the total cesarean delivery rates increased by over 50%, from a rate in 1996 of 21% to 32% in 2007, the highest level ever reported in the U.S.¹²

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Methodology

Neither social wealth, nor technology-based interventions appear to be sufficient solutions to the problem of maternal mortality. However, because California has access to both, we have an unprecedented opportunity to investigate and to conduct rigorous and creative quality improvement projects that hold the potential to improve maternal health on a broad scale.

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II. METHODOLOGY FOR THE CALIFORNIA PREGNANCY-ASSOCIATED MORTALITY REVIEW

Background

The Joint Commission considers each maternal death a sentinel health event because it is “an unexpected occurrence involving death or severe physical or psychological injury, or the risk thereof.”¹ Sentinel events should prompt a root cause analysis, which is a process for identifying the basic or causal factor(s) that lead to development of preventive measures. Mortality review is a tool for assessing information pertaining to a fatal event, and making recommendations to prevent future deaths and to improve health care and health in general. As the rate of maternal mortality has risen in recent years, many states have reestablished or recently developed maternal mortality reviews in accordance with guidance from the Centers for Disease Control and Prevention (CDC).²⁻⁶

California Pregnancy-Associated Mortality Review (CA-PAMR) is the first statewide maternal mortality review in California. The only sizeable maternal mortality review previously undertaken in the state was conducted over a decade ago by the Family Health Programs of the Los Angeles County Department of Health. In that study, a total of 63 pregnancy-related deaths occurring among Los Angeles County residents from 1994 to 1996 were reviewed.⁷ Results from that study suggested that approximately three-fourths of maternal deaths were in some way preventable.

In 2004, the California Department of Public Health (CDPH), the California Maternal Quality Care Collaborative (CMQCC) and the Public Health Institute (PHI) collaborated to convene and conduct an in-depth review of medical records by a statewide panel of experts from multiple disciplines. MCAH conducts this review on behalf of CDPH under the legislative authority granted by the California Health and Safety Code §§100325, 100330 and 100335 which gives CDPH the broad authority to investigate sources of morbidity and mortality. Funding is provided by the Federal Title V Maternal and Child Health Block Grant.

This phase of CA-PAMR consists of four components:

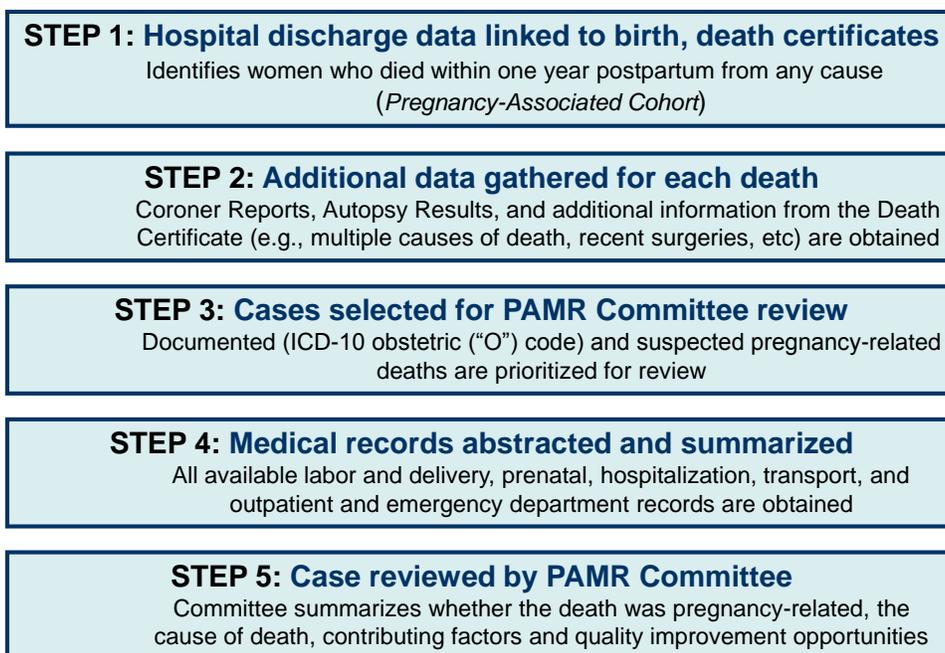
1. Enhanced surveillance through data linkage of birth certificates with maternal and fetal death certificates and hospital discharge data to identify all women who died within one year of being pregnant;
2. Collection and abstraction of medical records for deaths that are likely or known to be pregnancy-related to identify patient, health provider or health care facility factors that may have contributed to the fatal outcome;
3. Case review by a multidisciplinary group of experts to determine causation, opportunities for improvement, and what strategies might be employed to improve care and reduce morbidity and mortality, and;
4. Translation of findings into maternal health quality improvement initiatives that target obstetric care providers, maternity units, and local health departments.

Additional strategies will be needed to investigate cases currently coded as 'not pregnancy-related' such as homicides and suicides. Some of these violent deaths may be determined to be 'pregnancy-related' once investigated.

Cohort identification and selection for case review

In California, case ascertainment begins with the identification of maternal deaths through a linkage of birth, fetal death, and maternal death certificate vital records with hospital discharge data to determine the cohort of California women who have died within a year of pregnancy. Women were included in the cohort of *pregnancy-associated deaths* for any given year if they had given birth or had a fetal death in the target year and had died within 365 days. When the project began in 2006, the most recent data available was from 2002 and that formed the basis for the first year of case review.

Figure 6. Key Steps of CA-PAMR



Hospital admissions are identified for each case using the hospital discharge data obtained from the California Office of Statewide Health Planning and Development (OSHPD) for the nine months preceding and up to one year after the delivery or fetal loss (Figure 6, Step 1). This group is the pregnancy-associated cohort.

Cases are further sorted based on the cause of death into *pregnancy-related* or *not-pregnancy-related* categories, with pregnancy-related deaths assigned an International Classification of Disease (ICD-10) code for obstetric deaths (i.e., an "O code"). All early (≤ 42 days postpartum) pregnancy-related deaths based on death certificate data are selected for CA-PAMR Committee review. From the remainder of the pregnancy-associated cohort, death certificates and coroner reports are reviewed and additional cases are selected for review based on the likelihood of being pregnancy-related (Figure 6, Step 2). These deaths are identified by screening for key words, clinical phrases or

statements that suggested the deaths were related to pregnancy or its aftermath (Figure 6, Step 3).

Trained abstractors review the medical records available for each case. Medical records include prenatal records, hospitalizations, outpatient and emergency department visits and transport records as appropriate. Abstracted data include medical and psychosocial information relevant to determining the cause or causes of death (Figure 6, Step 4).

Abstractors record information from medical records on standardized de-identified abstraction forms. These data are transcribed into a chronological narrative case summary from pregnancy to birth to death. Case summaries contain medical history and interventions pertinent to the case, including laboratory or other diagnostic tests, medications, anesthesia and resuscitation records. Information packets containing case summaries, critical pieces of the medical record (e.g., anesthesia reports) and the autopsy and coroner reports are assembled for Committee review. All data regarding patients, providers and hospitals are de-identified within the documents available to reviewers on the CA-PAMR Committee (Figure 6, Step 5).

CA-PAMR Committee

The CA-PAMR Committee is a multidisciplinary committee charged with the review of each maternal death in the case review sample. The clinical specialties represented in the Committee include maternal fetal medicine, obstetrics, anesthesiology, neonatology, midwifery, and labor and delivery nursing. Emergency Medicine and cardiology specialists were added later and additional experts are consulted as appropriate to the case. Committee membership is drawn from throughout the State.

The CA-PAMR Committee meets quarterly for case review. Every committee member reviews a comprehensive summary of every case and two to three primary reviewers receive more extensive materials for each case (e.g., full autopsy report, anesthesia reports, etc). The primary reviewers independently assess each case before the meeting and then present the case to the full Committee for discussion. Current research on medical errors indicates that sentinel events, such as maternal deaths, are usually the result of failures at multiple steps in the processes of care.⁷ Accordingly, for each case, the Committee addresses the following questions:

- **Was the death pregnancy-related?** Deaths were considered pregnancy-related if the woman's death was directly related to the pregnancy or was aggravated by the pregnancy or its management.
- **What was the cause of death?** The Committee makes a consensus determination as to the clinical cause of death, using up to three categories.
- **What was the risk level at time of prenatal and intrapartum care?** Patients were classified as "low-risk" if there was an absence of any potentially complicating conditions and all others were categorized as "not-low-risk."
- **What are the patient, health care professional, and health care facility factors that may have contributed to the woman's death?** The Committee identified: *patient factors* such as patient delay or failure to seek care, financial or access barriers; *health professional factors* such as appropriate use of

pharmaceuticals and response to changing vital signs, and; *health care facility factors* such as the availability of critical equipment.

- **Were there opportunities for improvement identified in the course of care the woman received?** Committee members identified opportunities to improve the quality of care related to provider knowledge, skills or management or the health care delivery system.

At the conclusion of each case review, a summary statement of risk level, contributing factors and quality improvement opportunities is reviewed and approved by the Committee. The primary reviewers' assessments are discussed and contribute to an overall judgment by the Committee regarding preventability, or the chance to alter the outcome. A retrospective review to assess preventability has certain limitations because one cannot know for certain whether a different outcome would have occurred in the presence of a different set of factors or decision-making choices, and all relevant information may not be available to the Committee. However, given that the larger goal of CA-PAMR is to apply the lessons learned into better care for all childbearing women in California, judging a maternal death as potentially preventable and ranking the degree of preventability can inform efforts to improve maternity care overall and help set priorities for action.

Analysis of data

Comparisons were made between the overall cohort of women who gave birth in California, the pregnancy-associated death cohort and the case review sample. Administrative data (vital statistics and hospital discharge data) were analyzed to determine demographic characteristics, reported cause of death, timing of death, and other descriptive characteristics. Information on contributing factors for the pregnancy-related deaths was quantified and themes for quality improvement opportunities were identified to inform prevention recommendations.

Confidentiality and Institutional Review Board approval

All CA-PAMR Committee members and persons involved in data procurement and analysis signed confidentiality agreements before reviewing any material related to the maternal deaths. All CA-PAMR protocols, data abstraction forms and contact letters were approved by the Committee for the Protection of Human Subjects of the State of California Health and Human Services Agency, the Committee on Human Research at the University of California, San Francisco, and the Institutional Review Board of the Public Health Institute. All protocols comply with the Health Insurance Portability and Accountability Act (HIPAA) privacy rules. All data regarding patients, providers and hospitals have been de-identified within the documents available to reviewers.

Limitations

Interpretations of findings using these methods will be limited by the following facts:

- Women who died will be included in the category of pregnancy-associated deaths if their death certificate was linked to a live birth or fetal death (reported for fetal loss of 20 weeks gestation or more). Therefore, women who died less than 20 weeks into their pregnancy, for example from ectopic pregnancy, were

not identified and are not included in this review. Additionally, women whose records could not be linked are also not included in this review.

- Case reviews are retrospective and use information available at the time of medical record abstraction. As a result, the Committee's judgment is constrained by the documented information, which seldom fully captures the dynamic nature of the medical decision-making. A few cases lacked coroner or autopsy reports, prenatal care documentation, or had missing or limited documentation in the medical record that might have been helpful to the case reviews.
- Relying on hospital medical records to review maternity care limits the scope of information obtained and narrows understanding of the circumstances of the maternal death to a medical perspective. Other data sources could be considered in the future. Examples include surrogate interviews of family members or close friends, which could yield a fuller and more nuanced understanding of the context of women's lives and health. Access to social service, law enforcement, outpatient medical records, and mental health records could also be helpful when appropriate.
- This review process does not include any controls or comparison populations. The medical records of women who gave birth without complication, or the medical records of women who had complications but survived, were not reviewed. Such comparisons could allow for stronger conclusions to be drawn.
- The current CA-PAMR does not automatically review homicide and suicide cases within one year postpartum. Therefore, estimates of pregnancy-related deaths are likely underestimates as they will not include some violent deaths that were triggered by the pregnant status and condition of some women.

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Results

All California women and their families deserve the best care available. I have had the heartbreaking experience of reviewing maternal death cases and witnessing how women—the mothers, sisters, wives, and daughters of our state—are falling through the cracks in our health system. These deaths are all the more tragic because many seem to be potentially preventable.

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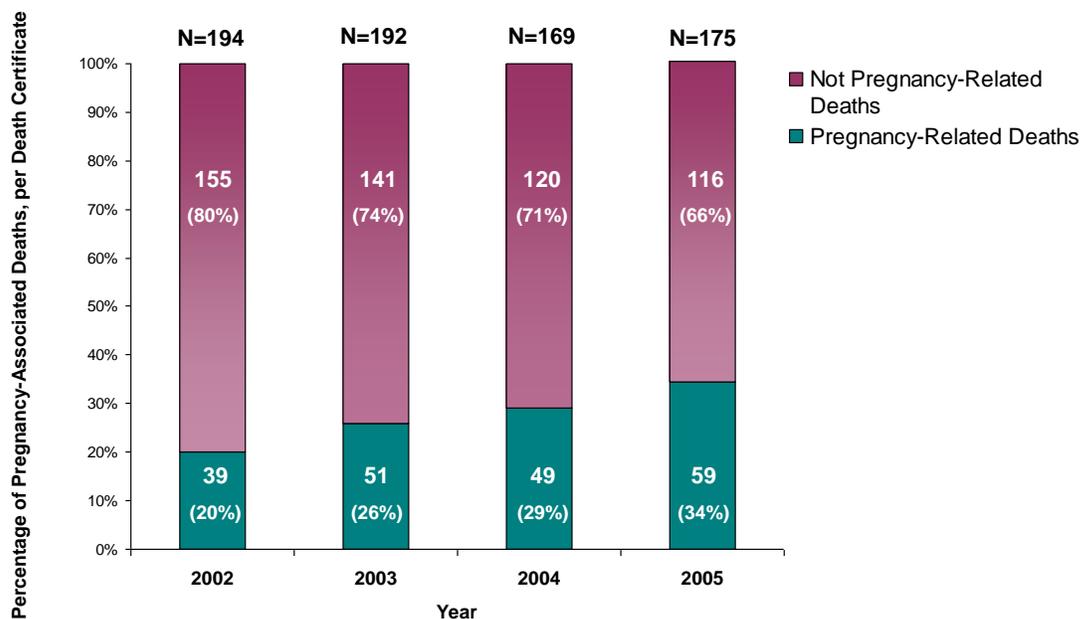


III. RESULTS

The 2002-2003 Pregnancy-Associated Cohort

CA-PAMR has obtained linked files for enhanced surveillance of maternal deaths for the years 2002-2005 and is acquiring additional linked files for 2006 and later. The total number of pregnancy-associated deaths (death of a woman while pregnant or within one year of the end of pregnancy, from any cause) has remained roughly the same from 2002 to 2005 (ranging from 169-194 deaths per year), but the proportion that are pregnancy-related deaths has increased from 20% in 2002 to 34% in 2005 (Figure 7).

Figure 7. Pregnancy-Associated Deaths, California Residents; 2002-2005



In 2002 and 2003, there were 194 and 192 pregnancy-associated deaths, respectively, in California for a two-year cohort of 386 pregnancy-associated deaths. This is the group under study for this report.

The leading causes of **pregnancy-related death** (n=90) as documented on death certificates prior to case review were:

- Preeclampsia/eclampsia (17%)
- Hemorrhage (15%)
- Amniotic fluid embolism (14%)
- Sepsis/infection (7%)
- Venous embolism complications (6%)
- Other complications of labor, delivery and pregnancy, excluding above (41%)

The leading causes of death in the **not-pregnancy-related** classification (n=296) as documented on death certificates were:

- Motor vehicle crash injuries (21%)
- Violent injuries (homicide and suicide) (16%)
- Cardiovascular disease (16%)
- Cancer or its complications (12%)
- Other unintentional injuries (i.e., drug overdose, non-motor vehicle accidents) (8%)

The leading causes of not-pregnancy-related deaths in California are similar to the causes of death for all women of reproductive age in the U.S. in 2002 and 2003.^{1,2}

After case review, the number of pregnancy-related deaths increased to 98 and the leading causes of death changed. Please see [page 22](#) for further details.

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CA-PAMR Committee Determination of Pregnancy-Related Deaths and their Causes

Background

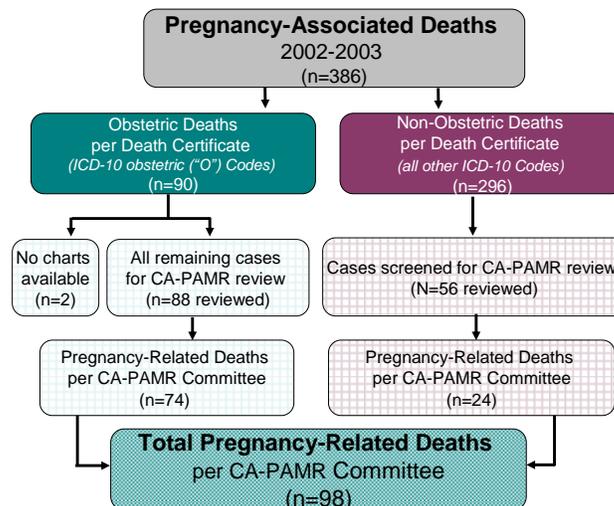
Examining the causes of death is essential to understanding why maternal mortality rates are rising and for developing appropriate prevention strategies. The review of clinical case data by an expert team builds on data obtained through the enhanced surveillance and permits a more detailed understanding of the causes of death. Case review is important because it is likely that some deaths are misclassified on death certificates.¹

All deaths reported as maternal deaths on the death certificate (i.e., those deaths assigned an ICD-10 obstetric “O code” as the underlying cause of death) were selected for review. Deaths from other causes (assigned non-obstetric codes for the underlying cause of death) but which appeared to be pregnancy-related based on a scan of the death certificates and coroner reports were also reviewed by the CA-PAMR Committee. The Committee systematically reviewed all available prenatal, labor and delivery records, as well as coroner reports, and made consensus determinations of whether a death was pregnancy-related or not, and the cause of death listing up to three causes. The clinical causes of death were then grouped into one of 14 categories, similar to other maternal mortality reviews.²⁻³

Results

Eighty-eight of the 90 pregnancy-related deaths identified via death certificates had medical records available for review by the CA-PAMR Committee. An additional 56 deaths identified as being possibly pregnancy-related were also reviewed by the CA-PAMR Committee for a total of 144 cases. Upon case review, 98 of these 144 were determined to be pregnancy-related by the CA-PAMR Committee (Figure 8).

Figure 8. Determination of Pregnancy-Related Deaths by the CA-PAMR Committee upon Case Review, California; 2002-2003



Cause of Death as Determined by the CA-PAMR Committee

The leading causes of pregnancy-related death (N=98) for 2002 and 2003 after case review as determined by the CA-PAMR Committee were:

- Cardiovascular disease, including cardiomyopathy (20%)
- Pre-eclampsia/eclampsia (15%)
- Amniotic fluid embolism (14%)
- Obstetrical hemorrhage (10%)
- Sepsis/infection (8%)

The leading causes of pregnancy-related deaths in California are similar to those reported by the United Kingdom and Florida where cardiac disease is also the most frequent cause of pregnancy-related death.^{2,4} This finding however, differs from the leading causes reported nationally and in other regions, such as New York City, where embolism, hemorrhage and hypertension were the leading causes of pregnancy-related deaths, thus underscoring the importance of state or regional mortality reviews.⁵

Additional detail regarding the causes of death can be seen in (Table 1), including how deaths reported on the death certificate (obstetric or non-obstetric deaths) compared to the CA-PAMR Committee determinations of cause of death. The largest difference between the death certificate and the CA-PAMR Committee determination were deaths from cardiac disease, both from cardiomyopathy and other cardiovascular conditions, which rose to account for a fifth of the pregnancy-related deaths.

Table 1. Clinical Causes of Death for the 2002-2003 Pregnancy-Related Deaths, per CA-PAMR Committee

	Initial Assignment Based on Death Certificate Information		Assignment After Case review
	Pregnancy-Related Deaths (ICD-10 obstetric "O" codes)	Not-Pregnancy-Related Deaths (ICD-10 non-"O" codes)	Total Pregnancy-Related Causes of Death
	N (%)	N (%)	N (%)
Cardiovascular disease	11 (15%)	9 (38%)	20 (20%)
Cardiomyopathy	7 (9%)	6 (25%)	13 (13%)
Other cardiovascular	4 (5%)	3 (13%)	7 (7%)
Pre-eclampsia/eclampsia	11 (15%)	5 (21%)	16 (16%)
Amniotic fluid embolism	14 (19%)	0	14 (14%)
Obstetric hemorrhage	10 (14%)	0	10 (10%)
Sepsis	7 (10%)	1 (4%)	8 (8%)
Deep vein thrombosis/ Pulmonary embolism	6 (7%)	2 (8%)	8 (8%)
Other	4 (5%)	1 (4%)	5 (5%)
Intracranial hemorrhage	4 (5%)	2 (8%)	6 (6%)
Anesthesia complications	3 (4%)	0	3 (3%)
Acute fatty liver	2 (3%)	0	2 (2%)
Suicide* (pregnancy-related)	0	2 (8%)	2 (2%)*
Cancer (diagnosis or treatment delayed by pregnancy)	2 (3%)	0	2 (2%)
Drug abuse complications	0	2 (8%)	2 (2%)
TOTAL	74	24	98

* See the Technical Notes, [page 55](#), for further information about the two pregnancy-related suicides.

Misclassification of Pregnancy-Related Deaths

Seventy-four (84%) out of 88 deaths reviewed were considered pregnancy-related both on the death certificate and by CA-PAMR Committee review (two of the 90 deaths coded as pregnancy-related on the death certificate lacked records by the time of review). An additional 24 cases documented as not-pregnancy-related deaths on the death certificate were determined to be pregnancy-related by the CA-PAMR Committee. The CA-PAMR Committee's review of deaths yielded the identification of eight additional pregnancy-related deaths overall. This finding is consistent with published literature suggesting that pregnancy-related deaths are underreported in this time period.⁶

Misclassification of pregnancy-related deaths on the death certificate appears to have occurred in both directions. Fourteen deaths originally documented as pregnancy-related on the death certificate were determined to be not-pregnancy-related after review of the medical records. Further analysis as to the cause and timing of death, as well as the impact of the pregnancy check box on death certificates implemented in 2003, is needed to better understand the misclassification and its impact on public health surveillance estimates of maternal mortality.

Conclusions and Recommendations

Three benefits of medical record review of maternal deaths are evident:

- First, unreported pregnancy-related deaths were identified. Nearly a fifth of the deaths were not classified as pregnancy-related on the death certificate, but after in-depth case review they were determined to be pregnancy-related.
- Second, the underlying cause of death is delineated with greater specificity. Prior to case review, the category named “Other complications of labor, delivery and pregnancy” made up 41% of the cases and after case review, only 5% of cases are designated as “Other.”
- Third, after review, cardiomyopathy rose as the third leading cause of death and when combined with other cardiovascular causes, became the leading cause of pregnancy-related mortality, in contrast to causes of death as ascertained from the death certificate. Of note, six (25%) of the 24 cases that were misclassified as non-O codes were determined to be cardiomyopathy related to pregnancy.

Recommendations are to:

- Continue CA-PAMR Committee review of maternal deaths in order to gain an accurate understanding of the magnitude of pregnancy-related deaths and to accurately capture increases in the leading causes of maternal death in California.
- Further investigate the reporting of pregnancy-related deaths and causes in vital statistics data to determine the nature and degree of misclassification of pregnancy-related deaths.
- The emergence of cardiomyopathy (i.e., dilated/peripartum and hypertrophic) as a leading cause of pregnancy-related death should prompt professional education regarding the earlier use of echocardiograms and EKGs for detection and monitoring.
- Autopsy investigations should be considered for women who die within a year of pregnancy, particularly for women who had cardiorespiratory manifestations, in order to accurately determine the cause of death.

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Demographics

Background

There were 386 pregnancy-associated deaths in total for the years 2002 and 2003. Brief demographic data is presented here for this pregnancy-associated cohort (n=386) as well as the 98 cases within this cohort determined to be pregnancy-related by the CA-PAMR Committee. For comparison purposes, demographic data is shown for all women who had a live birth or fetal death in California during 2002 and 2003 (referred to as the California birth cohort), as well as for the women among the pregnancy-associated and pregnancy-related death cohorts.

Data for this section are drawn from the linked files. We used three potential measures of socioeconomic status reported: insurance payer, marital status and education. Payer of labor and delivery services is used as a proxy measure for income and marital status is a proxy measure of social support, as well as potential income (Table 2).

Results

Table 2. Demographic Characteristics of Women in the California Birth Cohort and Pregnancy- Associated and Pregnancy-Related Death Cohorts, California; 2002-2003

	2002-2003 California Birth Cohort*	2002-2003 Pregnancy- Associated Death Cohort	2002-2003 Pregnancy- Related Deaths**
	N=1,076,073 (%)	N=386 (%)	N=98 (%)
Race			
White, non-Hispanic	332,886 (31)	116 (30)	27 (28)
Hispanic	535,636 (50)	161 (42)	42 (43)
U.S.-born Hispanic	193,482 (36)	61 (38)	17 (40)
Foreign-born Hispanic	342,154 (64)	100 (62)	25 (60)
African American	63,036 (6)	61 (16)	22 (22)
Asian/ Pacific Islander	129,913 (12)	47 (12)	6 (6)
Native American	4,586 (0.4)	1 (<1)	1 (1)
Unknown/Missing	10,016 (0.9)	~	~
Marital Status			
Married	363,601 (69)	192 (50)	53 (54)
Unmarried	165,644 (31)	164 (42)	41 (42)
Unknown/Missing	546,828***	30 (8)	4 (4)
Payer Source			
Medi-Cal or other government programs	486,140 (45)	202 (52)	56 (57)
Private or self-pay	585,102 (54)	128 (33)	39 (40)
Other/Unknown/Missing	4,831 (0.5)	56 (15)	3 (3)
Education			
Less than High School	118,973 (11)	38 (10)	30 (31)
High School/up to 12 th grade	480,047 (45)	192 (50)	31(32)
Beyond High School	452,321 (42)	113 (29)	29 (30)
Unknown/Missing	24,732 (2)	43 (11)	8 (8)

* Includes live births and fetal deaths.

** Pregnancy-related deaths as determined the CA-PAMR Committee after case review.

*** Marital status not available for 2003 and is presented for 2002 only.

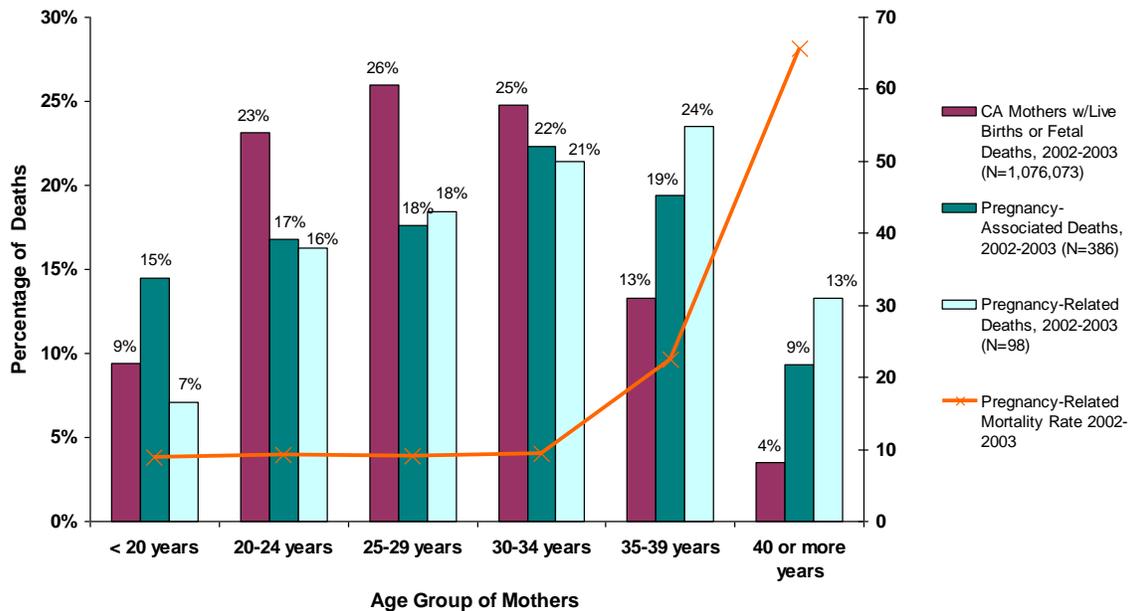
Race/Ethnicity: African-American women bear a disproportionate burden of pregnancy-associated and pregnancy-related deaths. While only six percent of births were to African-American women, they experienced 16% of pregnancy-associated deaths and nearly a fifth (22%) of the pregnancy-related deaths.

Socioeconomic Status: Women from the pregnancy-associated or pregnancy-related death cohorts were more likely than women from the California birth cohort to be unmarried and to have received public funding for pregnancy and childbirth services (i.e., Medi-Cal) in 2002 and 2003. A lower proportion of women with some education beyond high school died (29-30%) compared to the proportion of childbearing women overall (42%).

Age: California women ages 30 years and older accounted for 41% of all live births yet 52% of pregnancy-associated deaths (n=386) and 58% of the pregnancy-related deaths (n=98) occurred in this age group. Mortality rates for women ages 40 years and older are three-to-five times higher than mortality rates for younger women and the rates of death for older mothers have increased since 2000. However, while the greatest relative risk of dying is at the uppermost maternal age group, the highest numbers of deaths (n=161) occur in the 30-39 year old age group (Figure 9).

Figure 9.

Age of Mother at Death and Pregnancy-Related Deaths Rates, California; 2002-2003



Timing of maternal death: There were clear differences in the timing of the maternal death based on whether the death was pregnancy-related or not. Pregnancy-related deaths were far more likely to have occurred within six weeks of the end of pregnancy. This was true for both the 90 pregnancy-related deaths documented on the death certificate (91% occurred within six weeks postpartum, median of 17 days), as well as the 98 cases determined to be pregnancy-related by the CA-PAMR Committee (93% occurred within six weeks postpartum, median of 3 days). In contrast, 72% of the not-pregnancy-related deaths (as documented on the death certificate, n=296) occurred

after the sixth week postpartum and at regular intervals up to a year later (median of 156 days).

Coroner investigations: Of the 98 pregnancy-related cases, 89% were reported to the coroner and 58% of these had an autopsy performed by the hospital or local health jurisdiction where the woman died. The lack of coroner and autopsy reports in 11% and 42% of the deaths, respectively, hindered case review and cause of death analysis. The reasons for the lack of coroner and autopsy investigations were not well-documented, but when noted included the following: family refusal, local jurisdiction policy to not investigate medical deaths, and time constraints because the decedent was an organ donor.

Fetal and infant deaths: Among the 386 pregnancy-associated deaths during 2002-2003, 56 infants or fetuses also died (14.5%), which is consistent with statistics listing maternal complications of pregnancy as a leading cause of infant mortality. There were nine fetal deaths and seven infant deaths among the 98 cases determined by the CA-PAMR Committee to be pregnancy-related.

Motherless children: There were 89 live births among the 98 pregnancy-related cases and medical records revealed 179 other children still living for a total of 268 children who lost their mother as a result of a pregnancy-related death.

Conclusions and Recommendations

- The number of women who die from causes directly related to pregnancy is rising in California. Additional years need to be examined to determine whether this trend continues.
- African-American women have a four-fold risk of maternal mortality and U.S.-born Hispanics account for an increasing number of maternal deaths in California. Please see [page 35](#) for further data on racial/ethnic disparities.
- Two out of three available measures of socioeconomic status, specifically payer source and marital status were associated with higher rates of maternal mortality.
- There was increased risk of mortality associated with advanced maternal age (≥ 40).
- Pregnancy-related deaths were far more likely to have occurred within six weeks of the end of pregnancy.
- The development of investigation methodology and consultations as necessary for Coroners and Medical Examiners is likely to improve the identification of pregnancy-related deaths and their causes. Given that maternal deaths are rare and considered to be sentinel health events, local jurisdictions should consider performing coroner and autopsy investigations on all deaths that appear to be pregnancy-related.
- When estimating the costs of consequences of each maternal death, the long- and short-term impact on surviving children and family should be included as they are likely to be significant.

Risk Factors

Prenatal and Intrapartum Risk

Background

One hypothesis for the rising rates of maternal mortality is that the health status of women before or during pregnancy is worsening and contributing to poorer pregnancy outcomes. Women may be entering pregnancy with preexisting health conditions or developing health conditions during pregnancy that increase their risk for complications of pregnancy. Using data from the National Hospital Discharge Survey, Berg, et al (2009) estimated rates of preexisting medical conditions during 2001-2005 and compared them with rates published for 1993-1997.¹ They found that the prevalence of pre-existing co-morbid medical conditions (e.g., chronic hypertension, diabetes, asthma, and preexisting cardiac and renal disease) at delivery increased from 4.1% to 4.9%. Preexisting conditions can, in turn, increase the risk for developing complications during the course of pregnancy. For example, obesity is associated with an increased risk of pregnancy-induced hypertension.²

The CA-PAMR Committee examined each pregnancy-related death for any patient factors that contributed to the fatal outcome. The committee also differentiated patient status as “low-risk” or “not-low-risk” at two points during pregnancy: 1) upon entry to prenatal care (up to 10 weeks gestation) and 2) at presentation to labor and delivery. Patients were classified as “low-risk” if there was absence of potentially complicating medical conditions, advanced maternal age, twins, maternal or fetal medical complications, or postdate delivery. All others were categorized as “not-low-risk.” Such an aggregate risk classification was based on the presence of one or more factors and is intended to look at the overall risk status of women who died from pregnancy-related causes.

Results

The CA-PAMR Committee was able to determine a prenatal risk classification for 96 of the 98 cases reviewed. Approximately a third (n=32) of the women were determined to be low-risk and almost two-thirds (n=64) were determined to be not-low-risk at their first prenatal visit. Some of the reasons women were designated as not-low-risk (n=64) at the prenatal period include:

- **Advanced Maternal Age** 47% of the not-low-risk women were 35 years or older.
- **Obesity:** Among not-low-risk women with available pre-pregnancy BMI data, 28% were obese (BMI=30 or more).
- **Parity:** 22% of the not-low-risk women were grand multiparous (i.e., had five or more prior births).
- **Multiple Births:** Two not-low-risk women (3%) presented with twins.
- **Prior Cesarean Section:** 25% of not-low-risk women had had a prior cesarean section.

Of the 32 low-risk women, 20 women developed medical conditions during pregnancy that moved them to the not-low-risk category so that upon presentation to labor and delivery 84 of the 96 (88%) pregnancy-related deaths with risk assessment information were considered to have some risk factor for pregnancy complications. For the women considered low-risk at the prenatal period who then developed health problems during pregnancy, the most common problems included infections (n=6), hypertension/pre-eclampsia (n=4), and gestational diabetes mellitus (n=3). The remaining women developed a variety of conditions such as asthma, preterm labor, hyperemesis, and excessive weight gain during pregnancy.

No differences were found between low-risk and not-low-risk women in terms of education level, payer source, marital status, or mode of delivery. Not-low-risk women, however, experienced significantly more emergency department visits during the prenatal period than low-risk women. It is unclear whether this was due to new conditions, acute deterioration of existing conditions, or a lack of a primary care provider for non-pregnancy related complaints.

Conclusions and Recommendations

- Overall, a high proportion of the women who suffered pregnancy-related deaths had identified risk factors in the prenatal period and additional risk factors recognized at the time of delivery.
- However, 12% of deaths occurred among women considered low-risk with no identified risk factors (neither during prenatal care nor at labor and delivery), suggesting that prevention strategies beyond reducing the women's health risk are likely to be important.

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Risk Factors

Obesity and Gestational Weight Gain

Background

Obesity in pregnant women is associated with higher risk for gestational diabetes, pre-eclampsia, cesarean delivery and infectious complications.¹⁻³ Obese women are also more likely to be admitted earlier in labor, require labor induction, require more medical intervention during induction and have longer labors and longer hospital stays. Excessive gestational weight gain is another risk factor for maternal morbidity and mortality.⁴⁻⁸ Limiting weight gain in women who are overweight or obese at the onset of pregnancy is associated with significantly lower risk of preeclampsia and cesarean delivery.⁹

Body mass index (BMI) is a standard measure of body fat based on a calculation of height and weight ($BMI = \text{weight}/\text{height}^2$) and is used to define weight categories.¹⁰ Appropriate limits of gestational weight gain for each weight category have been defined by the Institute of Medicine.¹¹ (Table 3)

Weight and height data were obtained from prenatal records, hospital labor and delivery admission records and sometimes from outpatient specialty visits. If pre-pregnancy weight was not recorded, the weight from the first prenatal visit up to 10 weeks gestation was used.

Table 3. Body Mass Index Definitions and Recommended Weight Gain During Pregnancy

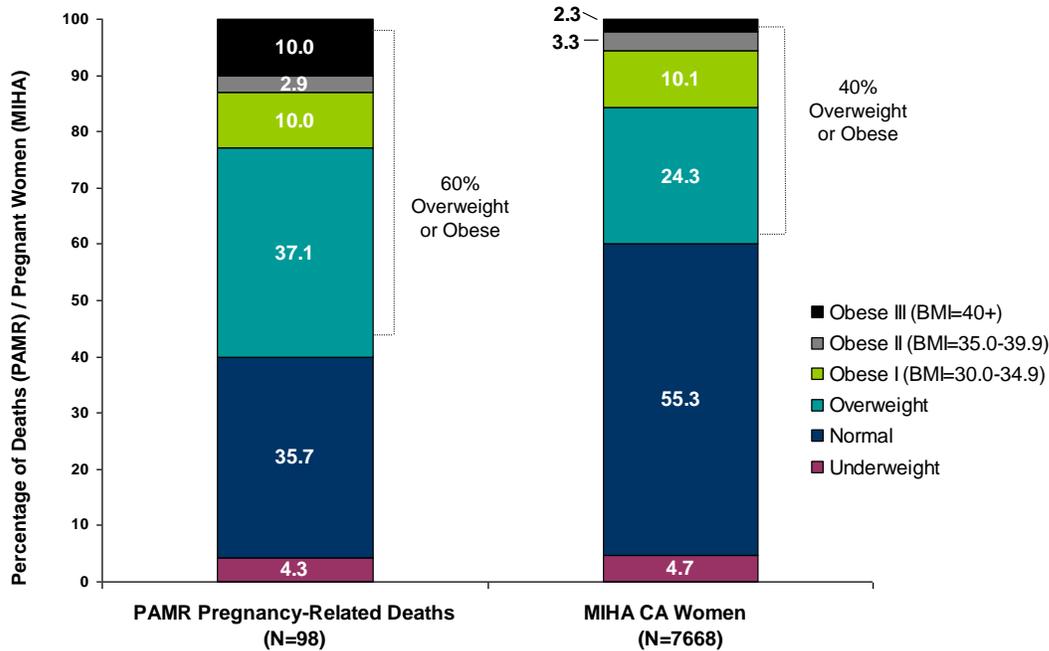
BMI	Pre-Pregnancy Weight Category	Recommended Upper Limits for Gestational Weight Gain
Below 18.5	Underweight	40 lbs
18.5 - 24.9	Normal	35 lbs
25.0 - 29.9	Overweight	25 lbs
30.0 - 34.9	Obese (Class I)	20 lbs
35.0- 39.9	Obese (Class II)	20 lbs
>40	Extreme Obese (Class III)	20 lbs

Results

Pre-pregnancy BMI was available in 71% of the pregnancy-related cases (n=70) and of these 36% were normal weight, 37% were overweight, and 23% were in one of the obese subcategories (Figure 10). For comparison, we have pre-pregnancy weight status from the California Maternal Infant Health Assessment (MIHA) survey, a survey of over 7000 women who gave birth in California in 2002 and 2003. From MIHA survey data, 55% of women self-reported they were normal weight, 24% were overweight, and 16% were in one of the obese subcategories. Therefore, a greater percentage of overweight or obese women (60%) were among the pregnancy-related deaths compared to women in the MIHA sample (40%). Also, there was a much larger proportion of women in the extremely obese classification (10.0% with BMI \geq 40) among the pregnancy-related

deaths than in the MIHA population (2.3%), although there were similar proportions of obesity in Classes I and II. While there might be some degree of self-reporting bias among MIHA respondents (i.e., a tendency to minimize any stigmatized health condition when self-reporting), the difference between the CA-PAMR cohort and the general population that is represented by the MIHA survey is large and likely real.

Figure 10. Pre-pregnancy BMI Status of CA-PAMR Pregnancy-Related Deaths and all Women with Live Births, California; 2002-2003



Obesity among the women who died from pregnancy-related causes was fairly evenly distributed by age and did not differ significantly by insurance type. However, greater proportions of African-American (83%) and U.S.-born Hispanic (80%) women who died were either overweight or obese at the beginning of pregnancy compared to Whites (50%), foreign-born Hispanics (44%), and Asian/Pacific Islanders (20%). African-American women had significantly higher mean BMI (mean=32.6) than foreign-born, Hispanic women (mean=25.5) ($p<0.05$), but did not significantly differ from the other racial/ethnic groups (range of means=25.9 - 31.0).

Gestational weight gain is considered an independent risk factor from pre-pregnancy obesity, therefore weight gain exceeding IOM guidelines was also analyzed. These guidelines were published in 2009 and thus patients in 2002 and 2003 may not have received clinical guidance regarding weight gain recommendations. Nevertheless, the risks associated with excess weight gain were the same in the past as they are currently. Of the women with data to calculate gestational weight gain ($n=68$) available, 50% ($n=34$) exceeded the recommended weight gain, and most of the excessive weight gain (82%) occurred among women whose pre-pregnancy BMIs were in the overweight or obese categories. (Table 4) Among the pregnancy-related deaths, U.S.-born Hispanics showed the largest proportion (70%) of excessive weight gain.

Table 4. Gestational Weight Gain* for CA-PAMR Pregnancy-Related Deaths, 2002-2003

Pre-Pregnancy BMI	N (%)*	PAMR Average Weight Gain (pounds)	PAMR Weight Gain Exceeding IOM Guidelines** N (%)
Underweight	3 (4)	26	0
Normal	23 (34)	29	6 (26)
Overweight	26 (38)	35	18 (69)
Obese (all classes)	16 (24)	29	10 (63)
Unable to calculate	30 (31)	N/A	N/A

*Total weight gained from pre-pregnancy to labor and delivery, averaged for the pre-pregnancy BMI category.

**Note: guidelines published in 2009; study cohort likely did not receive care based on these recommendations.

After CA-PAMR Committee review, obesity or gestational weight gain were determined to be a direct contributing factor to the maternal death in 18 of the 70 cases with weight data. Of the 18 cases where obesity was determined to be a contributing factor, nearly all (n=17, 94%) were based on pre-pregnancy overweight or obese status -- only one case was from excessive weight gain during pregnancy.

Given that obesity is a known risk factor for cardiovascular disease in general and peripartum cardiomyopathy in particular,^{12, 13} it is important to note that of 13 cases of peripartum cardiomyopathy, almost all (85%) were overweight or obese and five of seven (71%) women who died from other cardiovascular causes were obese.

Conclusions and Recommendations

- There were high rates of obesity among the pregnancy-related deaths.
- U.S.-born Hispanic and African-American women were more likely to have been overweight or obese compared to other racial/ethnic groups and were at high risk of maternal death.
- Almost all of the deaths from peripartum cardiomyopathy and over half of the deaths from other cardiovascular disease were among obese or overweight women.
- Practice guidelines and best practices for the preconception management of obese women need to be established, as well as for management of gestational weight gain.
- National and State education campaigns should target adolescents and women of child-bearing age to promote attainment of a healthy pre-pregnancy weight and appropriate weight gain during pregnancy through better nutrition and increased activity.

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Disparities in Outcomes

Racial/Ethnic Disparities

Background

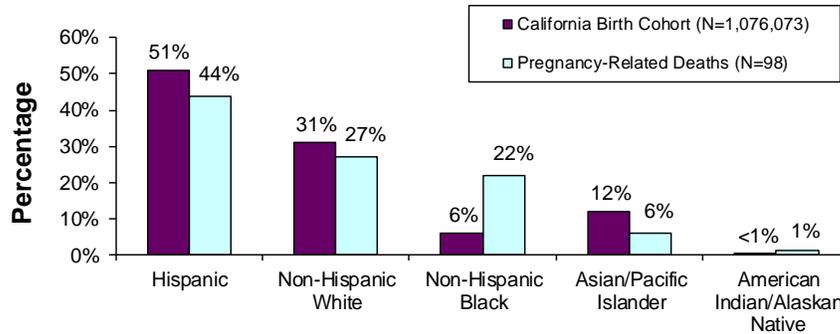
African-American women die from pregnancy-related causes at higher rates than women in other racial/ethnic groups and this risk appears to be independent of age, parity or education.^{1, 2} In California, from 2006 to 2008, African-American women were roughly four times as likely as women in other racial/ethnic groups to die from pregnancy-related causes, with 46.1 deaths per 100,000 live births, compared to 12.8 for Hispanic women, 12.4 for White women, and 9.3 for Asian women.

It is not known whether this maternal health disparity is due to differences in health status (e.g., a higher burden of illness, injury, disability) or differences in health care that can be attributed to differences in coverage, entry to prenatal care, access or quality of care, or both. One study found higher case fatality rates among African-American women from five major causes of death during labor and delivery and postpartum hospitalizations, despite having the same prevalence of these conditions as White women.³ Other studies suggested that African-American women were less likely to begin prenatal care in the first trimester and less likely to receive adequate care.⁴⁻⁵ Differences in the quality of care provided to African-American women have also been demonstrated.⁵ Two comprehensive reviews published by the Institute of Medicine and by the Department of Health and Human Services Agency for Healthcare Research and Quality (AHRQ) examined a large body of evidence and provided extensive evidence that racial and ethnic disparities in quality of health care exist across a range of illnesses and health care services, including maternal care processes and outcomes.^{6,7} Culturally and linguistically competent primary care has been shown to improve patient satisfaction, some health outcomes markers and higher levels of preventive care.

As described in the Background and Demographics section, the racial/ethnic distribution of pregnancy-related deaths does not mirror the distribution of all births in California. Although African Americans account for only 6% of all California births, they constituted 22% (n=22) of the 2002-2003 pregnancy-related deaths, representing a nearly four-fold relative risk (Figure 11). Overall however, Hispanic women have the largest number of pregnancy-related deaths (n=42; 44%), largely owing to the demographic composition of California wherein births to Hispanic women account for 51% of all births in the state. Within the Hispanic population, there is also the troubling development of increasing maternal mortality rates among U.S.-born Hispanics, which have doubled in the past decade. Such a trend is consistent with literature describing what is referred to as the “Hispanic Paradox” whereby immigrant Hispanics tend to have better health than the average American population in spite of what their aggregate socioeconomic indicators would predict.⁸

Results

Figure 11. Race/Ethnicity of Pregnancy-Related Deaths and all California Births, 2002-2003



In our analysis of pregnancy-related deaths (n=98), we found the following racial differences to be significant ($p < 0.05$) (Table 5).

1) Demographic Characteristics of Women who Died

Education: Data on level of education were available for 83 women. Foreign-born Hispanics were less likely to have completed at least 12 years of education compared to women of all other racial/ethnic groups.

Marital status: African-American women were more likely to be single than women in all other racial/ethnic groups combined (65% single compared to 38%, respectively).

Payer of delivery services 68% of the births among African-American women were paid for by Medi-Cal compared to 54% of women among all other racial/ethnic groups combined, although this difference was not statistically significant.

2) Risk Factors and Causes of Death

Body Mass Index (BMI): African-American women had significantly higher average BMI (mean=32.6) than foreign-born Hispanic women (mean=25.5) ($P < 0.05$), but did not significantly differ from women of the other racial/ethnic groups (range of means=25.9-31.0). See the Risk Factors, Obesity and Gestational Weight Gain section for more detail on [page 31](#).

Overall risk assessment: Women were categorized as either “low-risk” or “not-low-risk” at both the prenatal and the intrapartum periods. Hispanic women and women of other racial/ethnic groups (except non-Hispanic Whites) were more likely than African Americans to be classified as “low-risk” upon entry to prenatal care. By the time of intrapartum care however, there were no longer significant differences in risk level by race/ethnicity ([Table 5](#)).

Cause of Death: Upon case review by the CA-PAMR Committee, the clinical causes of death varied by racial/ethnic groups. Cardiomyopathy was disproportionately identified as the clinical cause of death among African-American pregnancy-related deaths accounting for 36% of the 22 deaths in that group, and 62% of all deaths due to cardiomyopathy ($p < 0.001$). Hispanic women were more likely to have died from pre-eclampsia/eclampsia than other

racial/ethnic groups and accounted for 21% of deaths among the 42 deaths among Hispanic women, and 56% of all deaths due to pre-eclampsia/eclampsia.

Table 5. Race/Ethnicity by Risk Level at Entry to Prenatal Care and during Intrapartum Care (n=96)[†]

	Identified “not-low-risk” upon entry to prenatal care	Identified “not-low-risk” upon entry to intrapartum care
Hispanic (All)	56%*	85%
Hispanic – U.S.-born	50%*	88%
Hispanic – Foreign-Born	60%*	83%
White	78%	93%
African American	82%	91%
Other	33%*	71%

[†] Two cases had insufficient data for the committee to determine risk level

*p<0.05 when compared to African Americans.

Conclusions and Recommendations

- Among the pregnancy-related deaths, African-American women were more likely to be unmarried and have had higher average body mass index than all other racial groups combined. However there was no statistical difference in education or payer of delivery services.
- Cardiomyopathy was the leading clinical cause of death for African-American women with pregnancy-related deaths, which is consistent with literature reporting higher risk for peripartum cardiomyopathy among this racial group.⁹
- Pre-eclampsia/eclampsia was the leading clinical cause of death among Hispanic women.
- The rising rates of maternal death among U.S.-born Hispanic women suggest either protective health factors for foreign-born Hispanic women beyond socioeconomic factors or detrimental factors associated with living in the U.S.
- The nature of the disparate high rates of maternal mortality among African-American women may be better understood through methodologies such as surrogate interviews or focus groups that complement the current CA-PAMR process. Such methods may shed light on the context of women’s lives and the communities in which they lived, as well as the context of medical care and health information they received.
- Race-specific comparisons will require additional years of review to provide a large enough sample for future analysis.

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Disparities in Outcomes

Economic Disparities

Background

Socioeconomic status is a widely used indicator to measure health and social status.¹ Low-income women receiving publicly-funded health care may experience financial barriers to care as well as social disparities that may contribute to poorer health outcomes than women with private health insurance. Disparate health outcomes are known to exist between groups differentiated by race, education and economic status.²

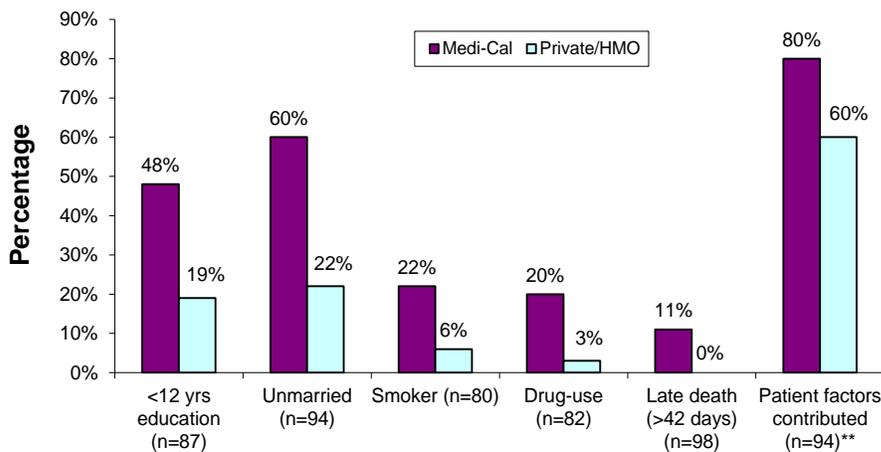
In this section potential economic disparities are presented. Since income is not recorded in medical records, we examined the type of health care coverage (public versus private funding) at the time of labor and delivery admission as a proxy for income. We examined whether there were differences between women with publicly funded delivery services (i.e., Medi-Cal, California's Medicaid program) and those with privately funded delivery services among the pregnancy-related deaths.

Results

Medi-Cal was the payer source for 45% of women who gave birth in California in 2002-2003 (n=1,076,073 total live births and fetal deaths) and 57% of the pregnancy-related deaths (n=98) indicating that women who died from pregnancy-related causes were poorer than the average California woman giving birth.

Among the pregnancy-related deaths, characteristics that significantly differ (p<0.05) between Medi-Cal enrollees and women with private insurance are presented in [Figure 12](#). Characteristics that did not statistically differ, such as race/ethnicity, are not presented.

Figure 12. Disparities in Payer Source among Pregnancy-Related Deaths, California; 2002-2003*



* Denominators differ for each characteristic depending on whether data was available for that characteristic.

** At least one of the following contributory patient factors was identified: underlying significant medical conditions; obesity; delay in or failure to seek care, treatment or follow-up; language or cultural barriers, domestic violence, or; substance abuse.

Women whose delivery services were covered by Medi-Cal were much more likely than women with private plans to have less than 12 years of education (48% versus 19%) and to be unmarried (60% versus 22%). There were no significant differences in race/ethnicity, median age, and the presence of obesity or gestational weight gain between the two groups.

There may be differences in how women with private insurance, versus public insurance, are screened for drug or alcohol use during pregnancy and their responses may be documented differently.³ Nonetheless, there were differences in the medical records between these two groups in terms of tobacco and drug use. Women who died and were enrolled in Medi-Cal reported higher rates of tobacco use (22% versus 6%) and use of drugs such as cannabis, methamphetamine, or cocaine (20% versus 3%) than women with private plans. Very few women in both groups reported alcohol use during pregnancy.

When both groups were compared regarding the timing of the pregnancy-related death, six of the 56 women covered by Medi-Cal (11%) died after 42 days, and none (0%) of the privately insured women died during this later interval. This finding raises the question whether time limits for “pregnancy-only, emergency Medi-Cal,” which expires at 42 days postpartum, might be affecting access to follow-up care.

The CA-PAMR Committee identified a greater proportion of women with Medi-Cal having at least one patient factor that contributed to the death compared to women in private/HMO plans (80% versus 60%). There were no differences in the numbers of contributing factors identified as health care professional- or facility-related. (See the “Contributing Factors” section ([page 49](#)) in this report for further description of these classifications.) However, the CA-PAMR Committee also differentiated women into “low-risk” and “not-low-risk” categories based on medical risk assessment and Medi-Cal enrollees were not more likely to be found in one category or the other.

Conclusion and Recommendations

- Pregnancy-related deaths were overrepresented among childbearing women receiving public funds for delivery services. This finding is consistent with other studies showing poverty as a determinant of health, including maternal health.²
- For the women who died between 42 and 365 days postpartum, it will be important to analyze whether postpartum care (i.e., access to care, quality of care and continuity of care) impacted the women’s death.
- Women with Medi-Cal insurance had less education, were more likely to be unmarried and to report use of tobacco and other drugs during pregnancy.

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Maternity Care

Characteristics of Hospitals Where Women Died

Background

Most women do not require specialized care during pregnancy or delivery.¹ However some women have preexisting conditions or complications of pregnancy that increase their need for case management and access to specialized care.¹ Matching the needs of patients with hospital capacity and clinical expertise has been shown to improve outcomes for high-risk maternity patients who experience major medical and obstetric complications. Similarly, regionalization of neonatal intensive care has also been shown to reduce neonatal morbidity and mortality.²⁻⁴ Higher hospital volume has been shown in one study to be associated with lower mortality in women who experienced peripartum hysterectomy.⁵ These data could inform the development of hospital-level quality improvement strategies and aid in the conceptualization and development of regionalized, risk-appropriate systems of maternity care.^{4,6}

For this analysis we examined deaths stratified by hospital volume of births, as well as patient risk assessment, and whether health care facility or health professional factors were thought to have contributed to the maternal death.

Results

Location of maternal death: Of the 98 cases reviewed, 68 (69%) women died as in-patients in an acute care hospital, 25 (26%) died in the Emergency Department or other outpatient clinical setting, and five (5%) women died outside a health care setting.

Hospital volume of delivery: In 2002 and 2003, over a million California women gave birth in 281 different hospitals; 91 (32%) of these hospitals had less than 1000 births per year, 138 (49%) had 1000-3000 births per year and 52 (19%) had more than 3000 births per year. There was no significant difference in the ratios of pregnancy-related deaths to live births based on hospital classification by volume of births. ([Table 6](#))

Table 6. Pregnancy-Related Mortality by Hospital Volume of Delivery, California; 2002-2003

	<1,000 live births	1,000-3,000 live births	>3,000 live births	Totals
	N (%)	N (%)	N (%)	
California hospitals with at least one delivery in 2002 and 2003	91 (32)	138 (49)	52 (19)	281
Hospitals with a pregnancy-related death at delivery	10 (15)	51 (54)	34 (36)	95*
Total Number of live hospital births during 2002 and 2003	89,584	522,470	437,082	1,049,136
Ratio of pregnancy-related deaths per 100,000 live births	11.2	9.8	7.8	9.1

* Three women lacked hospital records and are excluded from the analysis.

Risk factors: The CA-PAMR Committee found that the high-volume hospitals had a higher percentage of “not-low-risk” patients (94%) than mid- and lower volume hospitals at the time of labor and delivery (97% versus 78% respectively). This might be expected given that high-volume hospitals are more likely to be tertiary referral centers. All ten of the women who died at low-volume hospitals were also classified as “not-low-risk” patients, but it may be that the low-volume hospitals were in rural areas where transport may be difficult for women in need of higher levels of care. Further analysis is needed to understand the meaning of differences in outcome by hospital volume.

Contributing factors: The CA-PAMR Committee also examined each case for contributing factors and found that in 57% of the deaths, facility factors were identified and in 78% of the deaths health professional contributing factors were identified. The number of contributing facility or health care professional factors did not significantly differ between the hospitals with lower, mid and higher volume of births.

Conclusions and Recommendations:

- Hospitals were categorized by volume of births because there are no other standardized designations for maternity hospitals based on capacity assessment in California.
- Although there appears to be a trend in the ratio of pregnancy-related deaths, there were no significant differences in outcomes based on hospital volume of deliveries.

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Maternity Care

Type of Labor and Delivery

Background

Cesarean sections can be a life-saving procedure for a woman or her baby. However, regardless of the indication, cesarean section has some risks to the woman due to surgical complications (e.g., infection, blood loss, injury to other organs and venous thromboembolism), anesthesia-related complications and potential complications for subsequent pregnancy due to permanent scarring of the uterus (e.g., placenta previa, placenta accreta and uterine rupture).¹⁻⁶ As most ill or near death mothers will likely have an emergency cesarean birth, maternal mortality directly attributable to cesarean surgery itself is hard to calculate. Recent investigations in low-risk populations have given estimates of direct cesarean surgery-related mortality that range from 5.6 to 28 per 100,000 procedures.^{7, 8} As a rough comparison, the mortality from appendectomy in 20-29 year olds is seven per 100,000 surgeries.⁹ So while cesarean birth-related mortality is several times higher than vaginal birth-related mortality, it appears to be one of the safer major surgeries performed.^{7,8,10}

The rates of surgical births have risen in California and the U.S. by over 50% from 1996 to 2007. The National Center of Health Statistics reported that nearly one third of all births in the U.S. and California in 2007 were via cesarean.¹¹ During the study period of 2002-2003, there were almost 300,000 cesarean deliveries in California. The reasons for the rise in cesarean deliveries are complex and not a topic for this report and have been described elsewhere.¹²⁻¹⁴ It should be noted that in this cohort of maternal deaths, an urgent, emergent or “perimortem” cesarean delivery was often indicated in order to address the deteriorating status of the woman or fetus.

During case review, the CA-PAMR Committee was asked if cesarean section for the presenting pregnancy or for a prior pregnancy was a contributing factor to the woman’s death. Cesarean section may have been one of several factors contributing to the fatal outcome. This report presents preliminary descriptive data about the mode of delivery, risk categorization, the circumstances of the cesarean and information about the cases where the CA-PAMR Committee determined the cesarean delivery to have been one of the contributing factors to the fatal outcome.

Results

Of the 98 pregnancy-related deaths, three women died before giving birth; thus there were 95 deliveries with labor and delivery records available for review. In this cohort, over two-thirds of the births (n=66, 70%) were via cesarean section. Of these, the majority of deliveries (n=46, 70%) were primary (first-time) cesarean sections ([Table 7](#)).

Table 7. Mode of Delivery and Type of Cesarean Section among Pregnancy-Related Deaths, California; 2002-2003

Mode of Delivery	Number of Deliveries N (%)
Vaginal	
Spontaneous Vaginal*	28
Vacuum	1
Total Vaginal Births	29 (30%)
Cesarean Section	
Primary	46 (70%)
Repeat	19 (29%)
Unknown **	1
Total Cesarean Sections	66 (70%)
Total Delivered	95
Deaths before delivery	3

* Includes one vaginal delivery after multiple previous cesarean (VBAC) with a placenta accreta/percreta.

** Includes one death with no delivery record (suicide six days postpartum) but the autopsy report indicated a recent cesarean incision.

Among the women who died with a cesarean section and had a medical record for review (n=65), the circumstances surrounding the cesarean section were categorized as either planned (scheduled prior to admission), unplanned (surgery performed due to compromise in maternal or fetal condition) or crash/emergency (surgery performed due to an immediate threat to the life of the mother or fetus, including perimortem intervention) (Table 8). During the course of case review, the Committee did not clearly distinguish “emergent” from “crash” or perimortem.

Table 8. Clinical Circumstance for each Cesarean Section among Pregnancy-Related Deaths, California; 2002-2003

	Number of Deliveries N (%)
Cesarean Section	
Planned	6 (9)
Unplanned	22 (34)
Crash/Emergency	37 (57)
Total Cesarean Sections*	65

* Total cesarean sections for which there were medical records to review

Each case (n=65) was reviewed to determine whether immediate or subsequent complications of the cesarean section or anesthesia-related complications during cesarean section were contributing factors in the maternal death. The cesarean section or surgical anesthesia may have been one of a number of contributing factors in the death and does not imply causality, i.e., that the death would have been prevented if the women gave birth vaginally, nor does it imply that the cesarean section was not medically necessary.

The CA-PAMR Committee identified 11 women who had complications related to the current or prior cesarean section that appeared to contribute to the maternal death. Of these, five died secondary to post-operative pulmonary embolism; three died from intrapartum hemorrhage (one due to intraoperative injury; one due to placenta accreta likely related to a prior cesarean section; and one due to a ruptured uterus in a woman

with a prior cesarean section); two died from post-operative sepsis, and one died from adult respiratory distress syndrome where intra-operative fluid overload was determined to be a contributing factor. In addition to the 11 surgery-related deaths, there were four added cases where spinal anesthesia for the cesarean section contributed to severe hypotension and subsequent cardiac arrest.

Of note, none of the five women who died from a post-operative pulmonary embolism received thromboprophylaxis, and three had additional risk factors for venous thrombosis including obesity and/or prolonged bedrest.

Conclusions and Recommendations

- The CA-PAMR Committee determined that the cesarean section or the anesthesia administered during a cesarean section was one of the contributing factors in 15 of the 65 (23%) maternal deaths with cesarean section.
- Screening and measures to prevent blood clots (i.e., the use of pharmacologic agents [thromboprophylaxis] or sequential compression devices) should be considered in all women undergoing cesarean delivery. The use of thromboprophylaxis for pregnant women having a cesarean section, particularly if they have known risk factors, has been encouraged by the Joint Commission in a recent Sentinel Alert and by the United Kingdom's Confidential Enquiries into Maternal Death.^{15, 16}
- While primary cesarean section is a safe surgical procedure when medically indicated, patient and public education regarding the health risks of both primary and subsequent cesarean births is recommended.
- Continued study of the possible relationship of cesarean section to maternal morbidity and mortality is recommended, including stratification by primary and repeat cesarean section and the analysis of both early and late complications.

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Preventable Deaths

Chance to Alter Outcome

Background

One of the major benefits of convening a multidisciplinary committee of experts in maternity care to review maternal mortality is the opportunity to discuss case histories and formulate consensus opinion as to whether there were opportunities for change that, if implemented, might have led to a better outcome. The CA-PAMR Committee reaches consensus on an overall assessment of the preventability of the woman's death and categorizes the degree - none, some, good or strong - to which there was chance to alter the fatal outcome. The CA-PAMR Committee weighs the degree to which a death may have been prevented to better inform quality improvement efforts: cases with a strong or good chance to alter outcome suggest priority areas to target strategies in order to prevent maternal deaths and injuries.

Results

The chance to alter outcome was determined for the 96 cases for which medical records could be abstracted. Among those, 38% were found to have a good or strong chance to alter the fatal outcome. (Table 9)

Table 9. Chance to Alter Outcome by Grouped Cause of Death, Pregnancy-Related Deaths, California; 2002-2003

Clinical Causes of Death	Chance to Alter Outcome				Total
	Strong/ Good (N)	%Strong/ Good	Some (N)	None (N)	
Obstetric hemorrhage	7	70%	2	1	10
Sepsis/Infection	5	63%	3	0	8
Preeclampsia/eclampsia	9	60%	6	0	15
Deep vein thrombosis/ pulmonary embolism	3	37%	4	1	8
Cardiomyopathy and other cardiovascular causes	5	29%	12	2	19
Amniotic fluid embolism	0	0	12	2	14
All other causes of death*	7	32%	8	7	22
TOTAL	36	38%	47	13	96**

* Causes of death with fewer than five deaths are not broken out for chance to alter outcome because of small cell size.

** Two of the 98 pregnancy-related deaths lacked sufficient records to make a determination of preventability, one among the deaths from preeclampsia/eclampsia and one among deaths from cardiomyopathy and other cardiovascular causes.

When the chance to alter outcome was examined by causes of pregnancy-related death, seven of the ten cases of obstetrical hemorrhage (70%), five of the eight cases of sepsis/infection (63%), and nine of the 15 cases of preeclampsia (60%) had a good-to-strong chance to alter outcome. In comparison, none of the 14 deaths from amniotic fluid embolism had a good-to-strong chance to alter outcome.

Of the 36 cases with a good-to-strong chance to alter the outcome, the Committee determined that health care professional factors contributed to the fatal outcome in 35 deaths (97%), facility factors contributed to the fatal outcome in 27 (75%) deaths, and patient factors contributed to the fatal outcome in 27 (75%) deaths.

Conclusions and Recommendations:

- More than a third of the pregnancy-related deaths were determined to have had a good-to-strong chance of being prevented.
- Preliminary analysis suggests some causes of maternal death may be more preventable than others. Several major causes of death were found to be more preventable, such as obstetric hemorrhage, sepsis/infection, and preeclampsia/eclampsia. These data help direct and set priorities for statewide quality improvement efforts, such as the Obstetric Hemorrhage Toolkit developed by CMQCC (www.cmqcc.org/ob_hemorrhage).
- More deaths need to be reviewed to strengthen conclusions about the chance to alter outcome from other specific causes of pregnancy-related deaths.
- Evidence for identifying preventable maternal deaths may not be fully captured in medical records.

Preventable Deaths

Contributing Factors

Background

A contributing factor is any behavior or systems issue, or the deficiency thereof, which increases the severity of morbidity or the likelihood of mortality. These factors do not necessarily cause the fatal outcome, but may be one of a number of factors occurring in the chain of events leading to the maternal death. Contributing factors can thus be analyzed to help guide development of quality improvement efforts.

For this analysis, factors contributing to pregnancy-related deaths were identified and categorized into those relating to 1) the patient history, 2) the health care professional, and 3) the health care facility. When a contributing factor was identified, the CA-PAMR Committee was asked to weight whether the contributing factor definitely or probably contributed to the death.

Results

Of the 98 deaths reviewed, the CA-PAMR Committee identified at least one contributing factor that probably or definitely contributed to death in 87% (n=85) of cases and most deaths had more than one factor identified. Contributing factors related to the **health care professionals** involved in the care of the patient were identified in 75 (77%) of the cases, and of these, the factors which definitely contributed to the fatal outcome were delays or inadequacies in diagnosis or treatment (n=41; 55%); the use of ineffective treatments (n=34; 45%); and misdiagnosis of a condition (n=21; 28%). Contributing factors related to **patient history** were also frequently identified and 66 (67%) of the 98 deaths had at least one factor identified and of these, the presence of multiple medical conditions (n=24; 36%) was most often considered to have definitely contributed to the fatal outcome. At least one **health care facility** factor was identified in 56 (57%) of the deaths, but no one particular factor was overwhelmingly considered as having definitely contributed to fatal outcome.

Conclusions and Recommendations:

- Eighty-seven percent of deaths reviewed had at least one factor related to the patient, the health care professional or the health care facility that contributed in some way to the fatal outcome.
- Maternity care quality improvement efforts should focus on strategies to improve health professional diagnosis and treatment (e.g., standardized care guidelines and team training) of obstetric emergencies.
- Efforts to maximize the health of women should start before and continue during pregnancy, especially for women with chronic disease or other preexisting health conditions.
- CA-PAMR investigated only pregnancy-related deaths through available medical records and therefore is inherently more likely to identify patient, health care

professional and health care facility factors, as opposed to social determinants of health that may be contributing to the fatal outcome.

- Better strategies are needed to assess the contribution of non-medical factors to maternal deaths.

Preventable Deaths

Opportunities for Quality Improvement

Background

In the past, maternal mortality reviews have often addressed what went wrong in patient care without outlining clear strategies and priorities for improving care and maximizing patient safety. For each case reviewed, the CA-PAMR Committee identified one or more quality improvement opportunities that could be implemented to improve maternity care and services in California. This approach is consistent with an Institute of Medicine report for achieving quality care.¹

Preliminary Results

Opportunities for quality improvement in maternity care were identified in 93 of the 95 cases with medical records for review and more than one opportunity was identified for most of the cases. While additional analyses are needed, persistent themes emerged regarding opportunities to improve quality and reduce preventable maternal deaths.

These include education and system improvements in the following:

- Timely diagnosis and standardized, evidence-based management of specific clinical conditions, namely obstetrical hemorrhage, preeclampsia/eclampsia, cardiomyopathy and amniotic fluid embolism;
- Recognition and response to clinical triggers (i.e., warning signs) in clinical status such as pain, heart rate, oxygen saturation, and respiratory rate;
- Coordination of care issues such as, multidisciplinary management and timely consultations for pregnant women, leadership and communication between providers, coordination among hospital units, transfer between hospitals and availability or completeness of pre-hospital and hospital records;
- Optimal resuscitation of pregnant women, specifically prompt initiation of basic and advanced life support, and earlier consideration of cesarean birth during resuscitation in order to improve outcomes;
- Access to care, including timely referrals to and the availability of medical consultants or subspecialist care, and;
- Maximizing the health of women before and during pregnancy and postpartum.

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Implications and Next Steps

The rising rate of maternal death in California has affected African-American women disproportionately, and demonstrates the need for quality improvement in maternity care for all California women. This report is a call to action!

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IV. IMPLICATIONS AND NEXT STEPS

With this report, California joins other states and nations in issuing findings from its investigation into rising rates of maternal morbidity and mortality. Findings from the first two years of maternal death review are already suggesting important directions for public health and maternity care.

Implications for Public Health

Maternal Health Policy and Programs: The 2002 and 2003 case reviews showed that women who died are more likely to have identifiable risk factors and to be recipients of public health insurance.

We therefore recommend that findings from CA-PAMR continue to be applied to MCAH programs and policies in order to:

- Provide education and services aimed at optimizing women's health and that support the continuum of care before, during, and after pregnancy;
- Target the identification and management of common underlying maternal morbidities;
- Appropriately address the needs of African-American and U.S.-born Hispanic women of childbearing age, as these populations account for nearly half of the maternal deaths;
- Work with state partners whose programs and policies impact the health and well-being of women of childbearing age (e.g., WIC, Medi-Cal);
- Support and replicate local maternal health demonstration projects such as the current projects aimed at improving response to obstetric hemorrhage and reducing non-medically indicated, elective deliveries, and;
- Develop other review methodologies to complement CA-PAMR which will permit better understanding and response to racial disparities, severe obstetric morbidities (including 'near-misses') and pregnancy-associated deaths from accidents, including suicides, homicides and motor vehicle accidents.

Investigation of Maternal Deaths: The findings from 2002 and 2003 have already helped identify opportunities for intervention and will serve as baseline years for comparison with subsequent years when the number of maternal deaths has increased.

We therefore recommend that CA-PAMR Committee reviews be continued in order to:

- Further examine reasons for the rise in maternal mortality;
- Perform case finding, identify areas of preventability and analyze cause-specific increases in maternal deaths, and;
- Identify underlying etiology of racial/ethnic disparities including exploring additional methodologies to collect data on social determinants of health.

Public Health Surveillance: Twenty four unreported maternal deaths were identified by the CA-PAMR Committee. These deaths are not included in the calculation of

maternal mortality rates for the years 2002 and 2003 and without case review, these deaths would have otherwise been missed as pregnancy-related deaths. In 2003, California added a question to the death certificate to capture whether a woman had been pregnant in the year prior to her death, and it may be that additional pregnancy-related deaths will be reported in the years following implementation of this change in vital statistics collection.

We therefore recommend that public health surveillance of maternal mortality continue to be improved by:

- Identifying gaps in the reporting of maternal deaths, and;
- Identifying how maternal deaths are being investigated, recorded and reported.

Implications for Maternity Care

Most of the deaths occurred among women who died soon after delivery and in the hospital or emergency room setting. In addition, most women had identifiable risk factors and over a third of the deaths were considered to have had a good-to-strong chance to have altered the fatal outcome.

We therefore recommend that CA-PAMR findings be translated into targeted quality improvement efforts that:

- Help health care providers recognize and respond to critical clinical obstetric events;
- Identify and manage maternal risk factors, including obesity, hypertension and underlying heart disease, and;
- Improve the ability of health care facilities to respond to obstetric emergencies.

Implications for Women Planning a Pregnancy

Case reviews of maternal deaths revealed that women who died were older, less educated, more likely to receive Medi-Cal and more obese than the average California mother.

We therefore recommend that women who intend to become pregnant are provided with the information, tools and resources to effectively:

- Manage their weight and other health conditions across their lifetime, and in particular while of childbearing age;
- Interact with the health care system to access necessary services or specialty care during pregnancy, and continuing care in the postpartum and interconception period, and;
- Understand and manage their particular risk in pregnancy, whether it be from age, race, underlying health condition, multiple pregnancy or mode of delivery.

V. TECHNICAL NOTES

FIGURES 1-6 (pp 2-13):

Data Source: State of California, Department of Public Health (CDPH), California Birth and Death Statistical Master Files, 1970-2006. Maternal mortality for California (deaths \leq 42 days postpartum) was calculated using the ICD-8 cause of death classification for 1970-1978, ICD-9 classification for 1979-1998 and ICD-10 for 1999 to 2006. Produced by CDPH Maternal, Child and Adolescent Health Division. Sacramento California: February 2010.

STATISTICAL SIGNIFICANCE TESTING (pp 3-6):

Fig 2: On average, the mortality rate (all races) increased by 5% each year [(95% CI: 2.2%, 4.9%) $p < 0.001$ Poisson regression] for a statistically significant increasing trend from 1999-2008 ($p < 0.001$ one-sided Cochran-Armitage).

On average, the mortality rate (excluding African-American women) increased by 5% each year [(95% CI: 1.9%, 8.2%) $p = 0.001$ Poisson regression] for a statistically significant increasing trend from 1999-2008 ($p < 0.001$ one-sided Cochran-Armitage).

Fig 5: On average, the mortality rate for women aged 30-34 increased by 7% between the years 1999-2001 and 2006-2008 [(95% CI: 1.9%, 12.3%) $p < 0.001$ Poisson regression]

References for statistical testing provided on page 8 of this report.

PROJECTED BIRTHS (p 5)

Data Source: State of California, Department of Finance, Demographic Research Unit, Historical and projected birth by county, 1990-2017, with actual and projected state births and fertility rates by mother's age and race/ethnicity. Sacramento California: October 2008.

CA-PAMR COMMITTEE CLASSIFICATION OF CAUSE OF DEATH (p 24):

The classification of the clinical causes of death used by the CA-PAMR Committee may not reflect the standard definitions for 'immediate' or 'direct' cause of death used for filling out death certificates. However, because they are the same categories used in other reviews of maternal mortality, they allow for comparisons across states and countries. For example, "pre-eclampsia/eclampsia" is not strictly speaking a cause of death, rather it is a diagnosis. Within this diagnostic category, women typically die from stroke, hemorrhage/disseminated intravascular coagulopathy (DIC) and pulmonary edema/acute respiratory distress syndrome (ARDS). By identifying these clinical causes of death, the classification process helps to inform the quality improvement goals of the CA-PAMR project.

LIMITATIONS OF REVIEWING SUICIDES

Methodology (pp 12-16) and Cause of Death Section (pp 22-25):

During 2002 and 2003 there were a total of 16 suicides reported within the pregnancy-associated cohort. The CA-PAMR reviewed a sample ($n=7$) of these suicides based on mention of postpartum depression in the death certificate or Coroner report to determine if the deaths were pregnancy-related. Of the seven cases reviewed, there was sufficient information in the medical records to determine that only two of them were pregnancy-related, while the other five deaths lacked sufficient information to make a determination. At the conclusion of the review of these seven suicides, it was concluded that the current CA-PAMR methodology does not support the proper investigation of such deaths and that additional records and expertise would be needed to fairly evaluate suicides related to pregnancy.



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