

Maternal Mortality: Strategies in Prevention and Care

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Despite advances in modern obstetric practice, maternal mortality remains a worldwide problem. Unintended pregnancies, socioeconomic variables, and inequalities in access to reproductive and general health care contribute to unacceptably high maternal mortality rates throughout the world. Yet a general underreporting of deaths and lack of consensus about how to define maternal mortality hinder efforts to understand and address this topic of growing import. This article discusses some of the issues involved in maternal mortality, touching on the semantics, epidemiology, and causes of maternal mortality and detailing how an increased emphasis on prenatal care and preconceptional counseling can lead to more effective interventional strategies and to a new, improved focus on women's health.

DEFINING THE PROBLEM

Documenting maternal deaths has been complicated by the use of different nomenclature by various agencies, making a single accepted definition elusive. The Centers for Disease Control and Prevention (CDC) and the American College of Obstetricians and Gynecologists (ACOG) established the Maternal Mortality Study Group (MMSG) in 1987. Its primary goal was to develop and maintain an efficient system of communication and documentation of maternal deaths. The group distinguished those deaths temporally associated with pregnancy from those directly caused or aggravated by pregnancy (**Table 1**).¹ However, *The International Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)*, established different criteria.^{2,3} The inclusive time period for maternal death proposed by *ICD-10* is shorter than that used by the MMSG, and certain issues are not addressed as clearly or thoroughly as they are by MMSG (**Table 1**).^{1,2} Other major institutional groups and investigative panels have proposed further refinements. Moreover, many countries interpret the classification schemes differently, an inconsistency that complicates data collection and interpretation even more.^{1,2,4}

Maternal deaths may be from obstetric or nonobstetric causes. *The International Classification of Diseases,*

Ninth Revision, described maternal mortality as either direct or indirect.⁵ Direct obstetric deaths result from complications either attributable to pregnancy or labor or associated with the postpartum period. Indirect obstetric deaths result from preexisting medical problems or illnesses that develop during pregnancy and are worsened by the physiologic changes of pregnancy. Nonobstetric deaths, as defined by the European Concerted Action on Mothers' Mortality and Severe Morbidity group, include deaths resulting from accidents, suicides, malignancies, some communicable diseases, and unknown causes.^{2,4}

A variety of sources can be used when collecting data on maternal deaths in the United States, as listed briefly in **Table 2**.^{1,6} Each has limitations and biases, however, and may be more or less applicable depending on the cause of death and its temporal relationship to the pregnancy. More comprehensive death certificates (eg, including a check-box indicating pregnancy and information on prenatal care utilization), linkage to vital records, and periodic reviews by committees would all be useful ways of improving data collection. The most accurate compilation of total numbers of deaths requires use of all available information networks. Consequently, internationally accepted standardized definitions and information sources must be established.^{1,2,4,6}

THE SCOPE OF THE PROBLEM

Approximately 500,000 to 1 million women die each year worldwide as a consequence of pregnancy complications.⁶⁻⁹ The vast majority of these deaths occur in developing countries. According to the World Health Organization, 55% of maternal deaths occur in Asia, 40% occur in Africa, and only 1% occur in developed countries.^{8,9} The available statistical data most likely underestimate the actual numbers of deaths because of underreporting and misclassification.^{2,4,9}

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Table 1. Classification Schemes of Maternal Mortality

Investigative Groups	Definitions	Problems with Both Classifications
Centers for Disease Control and Prevention–American College of Obstetricians and Gynecologists (Maternal Mortality Study Group)	<p>Pregnancy-related: death occurring during pregnancy, or within 1 year after delivery and resulting from pregnancy-specific complications</p> <p>Pregnancy-associated: death occurring during pregnancy, or within 1 year after delivery regardless of etiology</p>	<ul style="list-style-type: none"> • Causality often difficult to establish • Death certificates may not specify duration of time between pregnancy and death • A small proportion of deaths related to pregnancy may occur more than 1 year after delivery, given life-sustaining technology • Deaths from first trimester complications may not be properly recorded • No universal and comprehensive data collection system
International Classification of Diseases, Tenth Revision	<p>Maternal death: death occurring during pregnancy, or within 42 days of delivery from pregnancy-specific complications</p> <p>Late maternal death: death between 42 days to within 1 year of delivery regardless of cause</p>	

Adapted from Atrash HK, Alexander S, Berg CJ. Maternal mortality in developed countries: not just a concern of the past. *Obstet Gynecol* 1995;86:700–5 and World Health Organization (WHO). Report of the International Conference on International Classification of Diseases. In: *International Classification of Diseases and Related Health Problems, Tenth Revision*. Vol. 1. Geneva: WHO, 1992 and Hibbard BM, Milner D. Maternal mortality in Europe. *Eur J Obstet Gynecol Reprod Biol* 1994;56:37–41.

The maternal mortality ratio (MMR) is defined as the number of maternal deaths per 100,000 live births. In the United States, this ratio has remained unchanged at roughly 7.7 deaths per 100,000 live births over the past 17 years. This number represents a drastic reduction from the estimated 670 deaths per 100,000 live births earlier in the century but is still far short of the Healthy People 2000 and 2010 goal of 3.3 deaths per 100,000 live births.^{10–12} In addition, almost half of maternal deaths in the United States may be preventable through timely intervention.^{11,12} As many as 20 other countries have succeeded in lowering their maternal mortality rates to below that of the United States.¹¹ Such statistics are sobering.

EPIDEMIOLOGY OF MATERNAL MORTALITY IN THE UNITED STATES

Maternal mortality is a basic indicator of inequities in the health care of women of reproductive age among countries and among regions within a country.^{8,11} The National Pregnancy Mortality Surveillance System was established in 1988 by the CDC and the MMSG¹² and has been a valuable source of information on maternal mortality statistics in the United States. The epidemiologic data it provides have revealed disturbing disparities between ethnic groups.^{10,12–15}

In the United States, African American women generally have a 4 times greater risk than white women of dying as a result of pregnancy. This disparity applies to every cause of maternal mortality.^{10,12–15} Current race-specific mortality ratios are 5.7 per 100,000 live births for white women and 18.6 per 100,000 live births for African American women.^{12–14} Similarly, the maternal mortality ratio for other races (eg, Hispanic, Asian, Pacific Islander, Native American) is nearly twice that of white women.¹² It is unclear why these differences exist, although such racial differences might serve as proxies for socioeconomic and cultural factors that influence quality of life in general. More attention also needs to be focused on the quality of cultural interactions between health care providers and their female patients.^{10,12–14}

The MMR for African American women is consistently higher for all age groups and for each cause of death.^{10,12–14} The difference is greatest for pregnancies not ending in live births.¹² A larger percentage of African American women do not seek prenatal care early in their pregnancies compared with white women (39.4% versus 20.8%).^{12,14} One of the Healthy People 2010 goals is to reduce this racial disparity and to further decrease the MMR for African American women.^{12,13}

The risk for death also increases with maternal age, with the ratio again rising more steeply for African

Table 2. Sources of Maternal Mortality Data

Autopsy reports
Medical records
Maternal and fetal death certificates
Vital statistics records
Linkage of death certificates to infant birth and death certificates
Maternal mortality committees
Interviews with family members
Individual health care providers
Federal, state, and local natality statistics and reports
Questionnaires
Scientific publications

Adapted from Atrash HK, Alexander S, Berg CJ. Maternal mortality in developed countries: not just a concern of the past. *Obstet Gynecol* 1995;86:700–5 and Fikree FF, Gray RH, Berendes HW, Karim MS. A community-based nested case-control study of maternal mortality. *Int J Gynaecol Obstet* 1994;47:247–55.

American women.^{10,12} Age-specific mortality ratios for all women are especially high after age 40 years, a particular concern because more women are postponing childbearing until later in life. Single pregnant women have nearly twice the risk for mortality as married women. Maternal mortality is also higher in women who have lower educational levels, more pregnancies, and less prenatal care.¹²

There are also regional disparities in the distribution of maternal deaths within the United States. The MMR ranges from 1.9 deaths per 100,000 live births in New Hampshire to 22.8 deaths per 100,000 live births in the District of Columbia.^{10,13} State-specific statistics can reveal patterns or conditions that might influence maternal health, such as degree of urbanization, violence rate, overall quality of health care, and prevalence of certain cultural practices within a specific region.

Finally, an understanding of the epidemiology of maternal deaths in a woman's country of origin is crucial for physicians in the United States because some conditions and risks remain unaltered, even after immigration to this country.

MAJOR CAUSES OF MATERNAL MORTALITY

The causes of maternal mortality in this country vary widely, depending on a woman's country or region of origin, her social and religious influences, the availability of health care services, and the overall state of health of her particular community. In past decades, the 3 leading causes of maternal mortality in the United

States were hemorrhage, infection, and preeclampsia (a hypertensive disorder specific to pregnancy). Deaths resulting from infection have decreased with the widespread use of antimicrobial drugs and the legalization of abortion. The current leading causes of maternal death in the United States are pulmonary embolism, complications of hypertensive disorders, hemorrhage, infection, anesthetic complications, and cardiomyopathies.^{10,12–15} A greater percentage of African American women died of complications of ectopic pregnancies or early pregnancy loss through miscarriage or induced abortion.^{12,14}

Causes of maternal mortality can also be analyzed by pregnancy outcome (**Table 3**).^{10,12,15} The majority of maternal deaths are associated with live births and can be attributed to pulmonary embolism (primarily thrombotic), hypertensive disorders (primarily resulting from cerebrovascular accidents), hemorrhage, and infection. Over 60% of these deaths occur within the first postpartum week. Pulmonary embolism and cardiomyopathies are leading causes of death occurring more than 42 days postpartum.^{12,15} The 3 leading causes of death in pregnancies associated with a stillbirth are hemorrhage, complications from hypertensive disease, and infection. More than 90% of deaths in ectopic pregnancies result from hemorrhage caused by rupture of the fallopian tube, and infection and sepsis account for up to 50% of maternal deaths in cases of miscarriage or abortion (especially self-induced abortions). Antepartum deaths (ie, deaths occurring before delivery) are most likely to result from hemorrhage caused by placental abruption, infection, and thrombotic or amniotic fluid embolism.^{12,15}

Maternal death from complications of anesthesia is the sixth leading cause of death in the United States.^{15,16} The majority of these deaths are associated with cesarean, as opposed to vaginal, delivery. General anesthesia poses a greater risk to a parturient woman than does regional anesthesia. Contributing risk factors include obesity, presence of hypertensive disease, and emergent cesarean delivery.¹⁶ Deaths resulting from anesthesia are nearly 7 times higher for African American women than for white women.¹²

Cardiomyopathy (all types) is a major cause of maternal mortality in the United States. Peripartum cardiomyopathy is a form of dilated cardiomyopathy that has an increased risk of recurring in subsequent pregnancies.¹⁷ Nearly 50% of deaths from cardiomyopathies occur more than 42 days postpartum. Once again, African American women are at greater risk for dying from cardiomyopathies than are white women.^{12,15}

Physicians caring for women of reproductive age should also be familiar with the major causes of death in nonpregnant women, although how these causes might influence maternal mortality in most cases remains unclear.¹⁸ The leading causes of death in nonpregnant women are accidents, malignancies, cardiac disease, infectious diseases (such as HIV), and acts of violence.^{1,2,4,18,19} Any preexisting condition can increase the risk of death both during pregnancy and in the postpartum period. Conversely, pregnancy itself can lead to more rapid deterioration in certain diseases.

Causes of maternal death in developing countries are similar to those recorded in the United States, but deaths from illegal abortions, sepsis, infectious diseases, and cardiac conditions are far greater in developing countries. Hemorrhage, preeclampsia, and infection account for the majority of cases of maternal mortality worldwide.^{6,7}

STRATEGIES FOR REDUCING MATERNAL MORTALITY

Prenatal Care

The concept of prenatal care in the United States has become much more prominent in the 20th century than ever before. In the past, it was unusual for a pregnant woman to receive any type of care from a physician and rarer still for a delivery to take place in a hospital. Organized systems of prenatal care clinics did not exist until the early part of this century when they were established in New York City and Boston.²⁰ Gradually, prenatal care became much more accepted, and refinements were made in the components of prenatal visits.

Originally, clinics were established in order to study preterm labor and preeclampsia in a more organized fashion. However, it soon became apparent that other facets of a women's life such as nutritional status, personal habits, financial situation, domestic situation, and general prepregnancy health²¹ also required evaluation. Prenatal care services have evolved throughout the century into a critical part of primary health care and prevention.

There is a relationship between use of prenatal services and pregnancy outcome. In an analysis of pregnancies resulting in a live birth between 1987 and 1990, approximately 9% of the women who died had not received any form of prenatal care.¹² This figure is in contrast to a 2% incidence of death among women who did attend prenatal clinics. Any level of prenatal care appeared to have a protective effect against maternal mortality. Pregnant women who did not receive prenatal care were generally older, unmarried, and

Table 3. Classification of Causes of Maternal Mortality in the United States by Pregnancy Outcome

Pregnancy Outcome	Causes of Death
Live births (55% of maternal deaths)	Pulmonary embolism Hypertensive complications Hemorrhage Infection
Stillbirths (7% of maternal deaths)	Hemorrhage Hypertensive complications Infection
Abortion* (6% of maternal deaths)	Infection Hemorrhage Pulmonary embolism Anesthetic complications
Antepartum (7% of maternal deaths)	Pulmonary embolism Hemorrhage Infection
Ectopic† (11% of maternal deaths)	Hemorrhage

*Spontaneous and elective.

†In a location other than the uterus, such as the fallopian tube.

Adapted from Scott JR. Victories won, victories deferred. *OBG Management* 1999;48:68-68 and Koonin LM, MacKay AP, Berg CJ, et al. Pregnancy-related mortality surveillance—United States, 1987-1990. *MMWR Mor Mortal Wkly Rep CDC Surveill Summ* 1997;46:17-36 and Berg CJ, Atrash HK, Koonin LM, Tucker M. Pregnancy-related mortality in the United States, 1987-1990. *Obstet Gynecol* 1996;88:161-7.

African American; they also tended to have had more children and less education.¹²

Interestingly, although the percentage of African American women who do not receive prenatal care is higher than that of white women,^{12,14} this fact does not seem to affect mortality rates, which are higher in African American than in white women regardless of level of prenatal care. Some authors have suggested that the content of prenatal visits and the interaction between the physician and African American patient may differ when compared with experiences of white women.¹²

Although health care personnel realize the positive health effects of routine prenatal care, the exact mechanisms by which pregnant women benefit remain unclear. Part of the difficulty in knowing how prenatal care affects maternal mortality and morbidity lies in

defining what constitutes adequate versus inadequate prenatal care.

In 1973, the Institute of Medicine developed a scoring index based on the month of the first clinic visit and the total number of subsequent visits. This index was subsequently modified and became known as the Kessner Index.²⁰ Kotelchuck²² subsequently developed the Adequacy of Prenatal Care Utilization (APNCU) Index in 1994 to address some weaknesses inherent within the Kessner Index. The APNCU index evaluates adequacy of care not only by the timing of initiation of clinic visits but also by the continuity of care received until delivery. This index also provides a method of quantifying the number of women receiving a larger number of visits. A pregnant women's care is categorized as either inadequate, intermediate, adequate, or adequate plus. According to these measures, the United States has the dubious distinction of having higher rates of insufficient prenatal care than several other industrialized countries do.²³ However, these indices all evaluate utilization of services, not quality of care received.²²

Among the obstacles preventing wider use of prenatal services are patients' negative feelings (eg, guilt, shame, fear) about their pregnancies and about health care providers, inability to afford child care, transportation problems, lack of appreciation of the necessity of good health care, and previously discussed demographic factors.^{12,22}

Preconceptional Counseling—A Role for All Physicians

A physician, regardless of his or her specialty, should view every woman of reproductive age as a potential pregnancy. Opportunities for identifying at-risk women and providing the appropriate interventions exist in many medical settings. Ideally, the social, financial, and medical problems that can adversely affect a pregnant woman's health should be addressed prior to pregnancy. The preconceptional period is also the best time to deal with emotional issues surrounding past poor outcomes or difficult pregnancies. Evaluation for anxiety disorders, depression, and unresolved grief or anger is vital, and referrals to social services or psychiatry should be made as necessary.

The goals of preconceptional counseling are basically fourfold: (1) to identify any preexisting conditions that may affect an anticipated pregnancy; (2) to allow time for interventions that could lead to more favorable outcomes; (3) to educate the patient about the importance of prenatal care and overall good health; and (4) to address home, social, financial and emotional issues that could affect attitudes toward pregnancy and prenatal care.²⁴ Good preconceptional care thus

consists of risk assessment, education, intervention or modification, and counseling.²⁴

Appropriate preconceptional care actually begins with counseling about contraceptive choices. Approximately 40% to 50% of pregnancies in the United States are unplanned,²⁴ and women with unplanned pregnancies are less likely to seek prenatal care, thus increasing their risk for mortality. Consequently, every woman seen in an office or hospital setting should be asked about her reproductive plans, especially women who have medical or genetic disorders; it should never be assumed that a specific medical disorder such as chronic renal failure guarantees anovulation. The choice of contraception should be appropriate for a woman's lifestyle and general medical condition, but any form of contraception generally is associated with fewer risks overall than is pregnancy.²⁵

A thorough family history should also be taken. A high incidence of a specific disease within a family pedigree that can adversely affect a mother's health during pregnancy (such as diabetes mellitus and hypertension) should prompt the physician to evaluate the patient for that particular disease. The preconceptional period is also a good time to check for genetic risk factors and to discuss antenatal diagnostic modalities such as amniocentesis that are available to the couple once pregnancy is achieved.²⁶

Adequate risk assessment includes a thorough evaluation of all aspects of a woman's life, including medical, emotional, social, and gynecologic history. Past reproductive performance must be assessed to help identify factors that may predispose a woman to poor obstetric outcomes, such as recurrent miscarriages. Conditions such as uterine or cervical malformations, endocrine and autoimmune diseases, or specific gynecological infections can be managed prior to conception.²⁴ In addition, some recurring obstetric problems (eg, premature labor and delivery, preeclampsia, placental abruption, and gestational diabetes) are associated with an increased risk for maternal and fetal morbidity and mortality. Prospective parents need to be aware of these risks because this knowledge may alter their reproductive plans.

The primary care physician should be cognizant of the medical risks posed by certain conditions during pregnancy, as well as the possible teratogenic effects of any medications the patient is taking.²⁴ Some disorders may become exacerbated in the postpartum period, so patients should be counseled about the expected antepartum and postpartum course of their diseases. If the primary care physician is unsure of the risks posed by a specific condition, a maternal fetal medicine specialist

should be consulted, as should a geneticist or teratogen information center in the assessment of potential risk of medications.

Specific cardiac lesions may pose increased risks to the mother because of the cardiovascular changes that occur during pregnancy. Maternal mortality approaches 40% to 50% for Eisenmenger's syndrome, primary pulmonary hypertension, and Marfan's syndrome with aortic root involvement.^{24,27,28} Women with these conditions should be strongly discouraged from attempting pregnancy, and optimal contraceptive choices should be discussed with them.

Diabetes mellitus poses special risks to an expectant mother (eg, an increased risk for preeclampsia, preterm delivery, infectious morbidity, and progression of proliferative retinopathy^{29,30}), and these risks should be communicated to the woman preconceptionally. In addition, women with the disease who are considering pregnancy should be assessed for the presence of underlying microvascular disease.

Women with chronic hypertension also should be evaluated for the presence of microvascular disease, the presence of which may alter their prognosis during pregnancy. These women are at risk for developing superimposed preeclampsia, which poses potential significant risks to the mother.³¹

Medical risk assessment also includes evaluation for infectious diseases and immunization status. Women at risk for contracting varicella should be offered the vaccine if they are not already immune because pneumonia is a common complication of varicella infection during pregnancy and the mortality rate of varicella pneumonia during pregnancy approaches 35%.³² Exposure to tuberculosis also mandates testing and treatment, preferably prior to pregnancy. Similarly, those women considered at risk for contracting hepatitis B should be offered a vaccination series in the preconceptional period, and vaccination for rubella should be offered to nonimmune women preconceptionally.²⁴

Nutritional assessment and recommendations for appropriate modifications to eating habits prior to conception are appropriate and can lead to healthier women and infants. Thus, evaluation for obesity, malnutrition, pica, excess ingestion of vitamins, and eating disorders such as bulimia or anorexia is appropriate.

A psychosocial evaluation can help the physician learn about social, psychological, financial, and other factors that can adversely affect pregnancy. Certain hobbies and home or work environments may pose special risks to mothers and fetuses.^{24,33} For example, approximately 33% of pregnant women smoke during the periconceptional period. Besides posing general

health risks to the mother (lung cancer, cardiovascular disease, ulcer formation, and cervical cancer³⁴), tobacco use can lead to problems specific to pregnancy, including bleeding complications, placental abnormalities, low birth weight of infants, and perinatal mortality; the adverse effects of nicotine during pregnancy have yet to be fully elucidated. Women thus should be strongly encouraged to stop smoking prior to pregnancy, and educational materials should specifically target the pregnant population.^{33,34} Alcohol ingestion and illicit drug use are associated with risk-taking behaviors that increase the likelihood of serious injury or death. Women who abuse substances thus should receive rehabilitative care and even psychiatric assessment prior to attempting pregnancy. Women should also be screened preconceptionally for evidence of domestic violence, which carries an increased risk for preterm labor, bleeding complications, uterine rupture, other serious physical injury, and depression; such screening is crucial because domestic violence often escalates during pregnancy, having a reported incidence as high as 20% to 37% of pregnancies.^{24,33}

Infection with HIV is of special concern during pregnancy. Although the risk of transmission to the fetus in untreated women is as high as 40%, it can be reduced by as much as 66% with antiretroviral treatment.^{24,35}

Adams and colleagues³⁶ performed a population-based survey of women 3 to 6 months postpartum in order to determine the percentage of women with selected predetermined risk factors who utilized preconceptional counseling. The authors found that approximately 38% of women who had indication(s) for counseling and preconceptional care did not avail themselves of this service. Because the availability and location of family planning services may not be thoroughly disseminated throughout the community, women must be identified in other care settings and receive counseling there on the advantages of optimal health before, during, and after pregnancy.

Addressing Cultural Differences

The question of whether a woman's cultural background affects the content of her interactions with health care providers and influences the interventional strategies and preventive care services offered (as well as her attitude toward them) raises some interesting issues relevant to maternal mortality. As previously mentioned, maternal mortality rates have been shown to be higher in African American women, even after correcting for degree of utilization of prenatal care services.¹² Another study³⁷ found that amniocentesis and prenatal

ultrasonography were used less frequently by African American women and that African American women were only as likely as white women to receive treatment for premature labor, although their risk of preterm labor is higher. A study performed to evaluate whether there are racial differences in prenatal advice given by health care providers found that African American women were less likely to receive advice on smoking cessation, alcohol use, and the benefits of breast-feeding.³⁸ Single African American women were also less likely to receive advice on the detrimental effects of drug use than were single white women. Marital status, socioeconomic class, and site at which care was received also influenced the content of prenatal care advice. More studies are needed to determine to what extent the content and quality of prenatal care affect the racial disparity seen with maternal mortality rates.

Education, Documentation, Participation and Collaboration

Physicians can do much at the community level to reduce maternal mortality rates. Some useful steps include developing educational programs on health maintenance and prenatal care within the community, disseminating information through the news media and the Internet, educating all patients of reproductive age on the benefits of family planning, and promoting research in areas such as women's health, cultural competency, and maternal mortality.³⁹

Improvements must be made in the documentation of maternal deaths. Death certificates should be revised to include information on any recent pregnancy prior to the time of death, as well as details concerning reproductive health. Establishment of maternal mortality surveillance systems and review committees will enhance collaboration between physicians and other organizations within the health care field. Physicians in specialties other than obstetrics should participate in educational conferences on women's reproductive health issues and on obstetric care and complications.³⁹

CONCLUSION

Maternal mortality remains an important indicator of the status of health care in the modern world. Many different factors interact in complex ways to increase a pregnant women's risk for death. The focus must be on preconceptional care and counseling, rather than on attempting to minimize risk after the fact. Encouraging planned pregnancies and addressing racial and cultural disparities in medical and prenatal care are indispensable components in the care of pregnant women.

HP

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