Maternal Mortality in Utah

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Objective: To determine trends in maternal deaths in Utah, identify opportunities for preventive intervention, and analyze the mechanism of reporting maternal deaths.

Methods: A retrospective review was performed of maternal death certificates and medical records in Utah from January 1, 1982, through December 31, 1994.

Results: Sixty-two maternal deaths were identified. The risk of maternal death increased with maternal age and parity. The classic triad of hemorrhage ($n = 8$), infection ($n = 5$), and preeclampsia-eclampsia ($n = 3$) remains an important contributor (16 of 62 or 25.8%). However, trauma ($n = 10$), pulmonary embolism ($n = 10$), and maternal cardiac disease ($n = 9$) now account for 46.8% (29 of 62) of maternal deaths. A greater number of direct obstetric causes of maternal death ($n = 20$) were deemed preventable than indirect obstetric causes ($n = 1$) or nonobstetric causes ($n = 4$).

Conclusion: Trauma, pulmonary embolism, and maternal cardiac disease have emerged as the most common identifiable causes of maternal death. Improvements in prevention, earlier diagnosis, and aggressive treatment of these conditions are necessary to achieve the Public Health Service year 2000 objective of a 50% reduction in maternal mortality ratios (using the 1987 ratio as a baseline). (Obstet Gynecol 1998;91:187–91. © 1998 by The American College of Obstetricians and Gynecologists.)

The United States Public Health Service year 2000 objective is a 50% reduction in the maternal mortality ratio (using 1987 ratio as a baseline).[1] Despite marked decreases in the United States during the past 5 decades, maternal deaths remain devastating obstetric complications. Maternal mortality reviews traditionally have been used to identify and analyze trends in maternal deaths and to assess the quality of obstetric health care delivery. National maternal mortality surveillance studies compiled by the Centers for Disease Control and Prevention (CDC) were published in 1991[2] and 1996[3] to complement previously published statewide reviews for the past 5 decades.[4–9]

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The goals of this study were to analyze trends in maternal deaths in Utah, to identify at-risk groups along with potential opportunities for preventive intervention, and to analyze the mechanism of maternal death reporting to determine possible improvements for future reviews.

Materials and Methods

During the years 1982 through 1994, 41 maternal deaths were identified by the Utah Department of Health, Bureau of Vital Records. The interval of study was selected because computerized birth and death certificate data were available and because medical practices were similar to current practice. The Bureau of Vital Records definition for maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, despite the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.

The Bureau of Vital Records identified maternal deaths by the following methods: 1) delivery mentioned on death certificate, 2) pregnancy mentioned on death certificate, 3) delivery-related operation (eg, cesarean) mention on death certificate, 4) postpartum listed on death certificate, or 5) anything associated with pregnancy mentioned on death certificate. If any of the above are indicated by the physician who completes the death certificate, a vital records staff person checks the live birth and fetal death file to ascertain if the delivery has occurred within 42 days of the death. This method is known to miss a significant proportion of actual cases because some women are not identified as pregnant and other deaths are not linked to a concurrent pregnancy on the death certificate.[10] The Utah death certificate does not include a provision to indicate specifically whether the deceased was pregnant at the time of death. Because underreporting was suspected, we performed a further review of birth and death certificates by the Bureau of Vital Records using the CDC criteria

0029-7844/98/$19.00 **187**
PII S0029-7844(97)00664-9

Table 1. Number and Ratios of Maternal Deaths (per 100,000 live births) in Utah by Classification and Year

Classification	1982–1984	1985–1987	1988–1990	1991–1992	1993–1994	1982–1994
Direct	11	10	5	6	3	35
Indirect	3	2	2	4	2	13
Nonobstetric	2	1	3	2	5	13
Unknown	0	0	1	0	0	1
Total	16	13	11	12	10	62
Maternal mortality ratio	13.4	11.9	10.2	16.4	13.3	12.8

and a search of computerized discharge summaries of the state's four tertiary referral centers; we identified an additional 21 cases. Data then were extracted from patient medical records. The Utah State Medical Examiner's Office also was used as a resource to supplement missing or incomplete medical records. Causes of death were classified according to the 1991 CDC maternal mortality review guidelines.[2] All maternal deaths identified were deemed either preventable or nonpreventable by the authors on the basis of standards of care and medical technology currently available.

After the data were reviewed and coded, maternal mortality ratios (number of maternal deaths per 100,000 live births) were calculated. Correlations with maternal age, parity, level of education, urban versus rural residence, and marital status were determined using χ^2 statistics. The expected number of deaths for the χ^2 table were determined on the basis of actual number of deaths in each category with the assumption that the deaths would be proportional to the number of live births in each category if the variable in question had no effect on maternal mortality. Multivariate analysis should have permitted the elimination of any spurious relationships by controlling for interrelationship between exogenous variables, but the number of cases under study were not large enough to permit sensible multivariate analysis.

Results

During the 13 years included in this review, 62 maternal deaths were identified. During this same interval, 484,789 live births were registered in the state of Utah, resulting in an overall maternal mortality ratio of 12.8 per 100,000 live births. Table 1 shows the distribution and respective classifications of maternal deaths. Of all maternal deaths, 56.5% were related directly to obstetric causes, 21% were related indirectly to obstetric causes, 21% were related to nonobstetric causes, and 1.6% were the result of unknown causes.

Maternal ages ranged from 15–39 (mean 27.7) years. χ^2 goodness-of-fit testing demonstrated a positive correlation between the number of deaths and the maternal mortality ratio for progressive maternal age ($\chi^2 = 8.35$, $P < .05$), with ratios increasing from 8.5 for maternal ages 15–19 years to 27.1 for maternal ages 35–39 years.

The risk of maternal mortality increased with progressive parity, through the χ^2 test revealed that correlation was statistically nonsignificant ($\chi^2 = 1.40$). The mean gravidity during the study period was 3.1.

Thirty-three (53.2%) of pregnancies resulted in live births. Eleven pregnancies (17.7%) ended in stillborn fetuses, and an additional ten (16.1%) died undelivered. The remaining eight cases included tubal ectopic pregnancies ($n = 3$), miscarriage ($n = 2$), unknown neonatal outcomes ($n = 2$), and gestational trophoblastic disease ($n = 1$).

Of the 62 women whose cases were reviewed, 85.5% (53) were married; the maternal mortality ratio was higher for unmarried women than for married women (14.3 versus 12.4, not significant). Fifty-seven women (91.9%) were white, four (6.5%) were Asian–Pacific Islander, and one (1.6%) was Native American. Maternal death ratios were highest among Asian-Pacific Islander patients (22.3), followed by white patients (12.6), Hispanic patients (12.1), and Native American patients (12.1). The average education was 12.4 years for patients in this review, with higher maternal mortality ratios among women with less than high school education (17.3) than among those with high school diplomas (10.5) or 1 or more years of college (11.1). The average number of prenatal visits was 7.6, with the second month of pregnancy being the mode for the initiation of prenatal care. All deaths included in the review were to Utah residents; maternal death ratios were higher among rural residents (19.1) than among urban residents (12.4). Thirty-three deaths were investigated by autopsy (53.2%).

Thirty-five of the deaths (56.5%) were due to direct obstetric causes (Table 2). The leading cause of direct obstetric death was pulmonary embolism. Of the ten women who died as a result of a pulmonary embolism, two were primigravidas who died following uncomplicated spontaneous vaginal deliveries. Two others died following operative vaginal deliveries and two after scheduled cesarean. The remaining four deaths were antepartum.

Hemorrhage was the second most common cause of

Table 2. Classification of Maternal Deaths in Utah by Etiology

Category	Cause	Number	Preventable
Direct (n = 35)			
	Pulmonary embolism	10	1
	Hemorrhage	8	7
	Retained products of conception	1	
	Ruptured ectopic pregnancy	5	
	Uterine rupture	1	
	Placenta previa	1	
	Infection	5	5
	Group B streptococcus sepsis	2	
	Puerperal endometritis	3	
	Amniotic fluid embolism	4	0
	Anesthetic complications	3	3
	Intravascular injection	2	
	Failed intubation	1	
	Preeclampsia/eclampsia	3	3
	Intracranial hemorrhage	2	
	HELLP syndrome	1	
	Adult respiratory distress syndrome	1	1
	Acute fatty metamorphosis of pregnancy	1	0
Indirect (n = 14)			
	Cardiac	11	1
	Congenital	4	
	Myocardial infarction	2	
	Arrhythmia	3	
	Cardiomyopathy	2	
	Cerebrovascular accident	3	0
Nonobstetric (n = 13)			
	Trauma	10	3
	Motor vehicle accident	8	
	Homicide	2	
	Malignancy	1	0
	Infection	2	1
	Pneumonia	1	
	Urosepsis	1	

HELLP = hemolysis, elevated liver enzymes, low platelets.

direct obstetric death. Ruptured tubal ectopic pregnancies accounted for five of these eight deaths. Two additional women died of hemorrhagic complications during home births, and one died from uncontrollable intraoperative hemorrhage from complete placenta previa.

Five women died from puerperal infection. Two were caused by group B streptococcus, one by *Bacteroides fragilis*, and one by *Klebsiella pneumoniae* in association with adult respiratory distress syndrome. The fifth woman died at 5 weeks postpartum of clinical sepsis in association with immunosuppression for concurrent systemic lupus erythematosus.

Amniotic fluid embolism caused four deaths. One of these deaths occurred in a woman who suffered the acute onset of shock and hemorrhage following a suction curettage for an 11-week missed abortion. Two others died following the acute onset of shock and respiratory decompensation immediately following operative vaginal deliveries. The fourth woman, who had a 1-month history of chronic abruption, died undelivered at 16 weeks' gestation after the sudden onset of seizures and shock.

Anesthetic complications accounted for three deaths. Two resulted from the intravascular injection of anesthetic agents during placement of regional anesthesia for cesarean delivery. The third woman died from aspiration pneumonitis following general anesthesia for cesarean delivery.

Complications of preeclampsia-eclampsia were the cause of three deaths, two as a result of intracranial hemorrhage and one from a cardiac arrhythmia from an atrioventricular nodal hemorrhage.

Fourteen maternal deaths (21%) were from indirect obstetric causes, primarily the result of cardiac disease (Table 2). Of the 11 deaths from cardiac causes, four were the result of maternal congenital heart disease. Three of these women had ventricular septal defects and Eisenmenger physiology, two unrecognized before autopsy. Cardiac arrhythmias accounted for three deaths. In addition, acute myocardial infarction and myocardiopathy identified preconceptionally each accounted for two additional deaths. Cerebrovascular accidents accounted for three deaths. All were embolic in nature and occurred during the puerperium.

Thirteen women (21%) died from nonobstetric causes (Table 2). The most common cause was trauma (n = 10). Nonobstetric infections accounted for two additional deaths, and the final nonobstetric death was the result of a pancreatic malignancy.

An assessment of preventability was performed (Table 2). The percentage of deaths determined to be preventable was greatest for direct obstetric causes and lowest for indirect obstetric causes. The only deaths deemed preventable in the nonobstetric category were those caused by motor vehicle accidents in which a single car was involved and in which the patient's failure to wear a seatbelt was documented.

Discussion

Our review of maternal mortality in Utah found a ratio of 12.8 deaths per 100,000 live births over the 13-year study period. Although slightly higher than that reported in the recent CDC reviews,[2,3] this rate is comparable to other recently published state-wide reviews.[4–9,11] Despite the fact that Utah's population is

largely white and relatively well-educated,[12] maternal mortality remains an important issue facing pregnant women, their families, and health care professionals in Utah. Maternal mortality in Utah increases with progressive age and parity, confirming previous other state's reviews.[2–3,6,13] This finding is of concern because the percent of births to women 35 years or older increased from 5.7% of total births in 1975 to 8.9% of total births in 1995. These observations support Grimes'[14] recent observation that, in spite of recent and impressive improvements, pregnancy remains a risky business.

Pulmonary embolism is now the most common cause of direct obstetric death in Utah. Although low-dose heparin has yet to be proven effective for prophylaxis during pregnancy,[15] a recent review suggests that low-dose aspirin plus prophylactic heparin may be efficacious in at-risk women.[16] However, the majority of women in our series had no obvious clinical risk factors. Certainly, further studies aimed at improving medical management and prophylaxis for at-risk pregnant and puerperal women are critical to reduce this prominent cause of maternal death.

Hemorrhage was the second leading cause of direct obstetric death in this series. Of these eight maternal deaths, seven were considered preventable, five from ruptured tubal ectopic pregnancies and two from complications associated with home deliveries (uterine rupture and uterine atony). Although improved diagnostic techniques (transvaginal ultrasound, discriminatory serum hCG assays[17]) have decreased overall maternal morbidity and mortality associated with ectopic pregnancy, these deaths attest that continued clinical vigilance and suspicion are necessary.

Despite the availability of antibiotics and improvements in the management of labor, infection remains an important cause of maternal mortality. Physicians must appreciate the clinical significance of fever in obstetric patients and should be aggressive in the evaluation of such patients. Improved patient education regarding the warning signs and symptoms of postpartum infection seem increasingly important given the recent emphasis on shortened hospital stays following childbirth.

Cardiovascular disorders were the leading cause of indirect maternal death in this series. Particularly striking was the proportion of patients who died of complications of pulmonary hypertension. A recent report[18] from Utah demonstrated the potential risks to women with structural heart defects, often repaired early in life, who then survive to reproductive age. Despite apparently normal cardiac function, thorough cardiac examinations, including echocardiography, should be considered in all patients with a known history of repaired congenital heart disease. Careful monitoring during labor also may improve outcome.

Peripartum cardiomyopathy also accounted for two deaths in this series. This condition is nearly always unforeseen and thus not preventable. Cardiac transplantation is a more recent therapeutic option for such patients, with recent estimates showing that 11–17% of patients with peripartum cardiomyopathy eventually receive cardiac transplants.[19] Although open-heart surgery during pregnancy has been performed, exposure to cardiopulmonary bypass may have serious consequences for the fetus.[20]

Although some international,[21] national,[22] and statewide[5] reviews have chosen not to include nonobstetric deaths in their results, some have focused exclusively on them.[23] We have included these deaths because the impact of maternal death on a family is devastating despite the cause. In addition, there exists the potential for improvement of maternal and fetal outcomes through education in these areas. Three of the eight deaths resulting from motor vehicle accidents were deemed preventable because of documented failure of the patient to wear her seatbelt. Seatbelt use during pregnancy reduces low birth weight and premature delivery rates related to automobile accidents.[24] Patients should be educated regarding the relative risks and benefits of seatbelt use during pregnancy.[25]

Despite the dramatic decrease in maternal death rates over the past half-century, recent studies[26–27] continue to estimate the degree of under-reporting to be as high as 20 to 75%. In our study, 33.9% (21 of 62) of our eligible cases were missed by traditional death certificate searches, partially as a result of the continuing problem of inaccurate death certificate data entry.[10,28,29] Modification of death certificates to include pregnancy status enhances the reporting of pregnancy-related deaths.[30] Furthermore, a recent study from New York City showed that a review of state medical examiner reports proved to be the most useful in the ascertainment of maternal deaths.[31] Perhaps the most cost-efficient and systematic monitoring system is a computerized linkage of birth and fetal death certificates to death certificates of reproductive-age female decedents. Because this system cannot identify pregnancy-related deaths that do not generate a record of pregnancy outcome (eg, ectopic pregnancies, gestational trophoblastic disease, induced or spontaneous abortions), traditional methods need to be retained to identify these deaths.[10] The Utah Department of Health, Bureau of Vital Records has agreed to run a pilot program of this system in an attempt to more thoroughly identify maternal deaths in the future.

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Received May 29, 1997.
Received in revised form October 15, 1997.
Accepted October 29, 1997.