Magnitude of Maternal Morbidity During Labor and Delivery: United States, 1993–1997

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Objectives. This study sought to determine the prevalence of maternal morbidity during labor and delivery in the United States.

Methods. Analyses focused on National Hospital Discharge Survey data available for women giving birth between 1993 and 1997.

Results. The prevalence of specific types of maternal morbidity was low, but the burden of overall morbidity was high. Forty-three percent of women experienced some type of morbidity during their delivery hospitalization. Thirty-one percent (1.2 million women) had at least 1 obstetric complication or at least 1 preexisting medical condition.

Conclusions. Maternal morbidity during delivery is frequent and often preventable. Reducing maternal morbidity is a national health objective, and its monitoring is key to improving maternal health. (*Am J Public Health.* 2003;93:631–634)

Nearly 4 million women give birth in the United States each year.[1] Until recently, the only national outcome indicator of maternal health—a woman's health during pregnancy, childbirth, and the puerperium—was maternal mortality.[2] However, if priorities are to be established and effective interventions designed to improve maternal health, the burden of morbidity among women giving birth must be defined, and protective and risk factors must be identified. The *Healthy People 2010* objectives include a new maternal health indicator: maternal morbidity during labor and delivery.[3]

Several studies have shown that antepartum hospitalizations for pregnancy complications are common, with 15 to 25 hospital admissions for every 100 deliveries.[4–7] However, most maternal deaths and serious complications occur at approximately the time of labor and delivery.[8] Population-based rates of certain specific complications (e.g., preeclampsia, placenta previa, abruptio placentae) have been reported[9]; to our knowledge, however, no population-based data summarizing maternal morbidity during labor and delivery have been published. In this article, we describe national estimates during the period 1993 to 1997.

METHODS

Data and Analysis

We used 1993 through 1997 data from the National Hospital Discharge Survey (NHDS), conducted annually since 1965 by the National Center for Health Statistics.[10,11] The NHDS is the principal source of information on inpatient use of short-stay, nonfederal hospitals in the United States; data are collected on patient characteristics, lengths of stay, and medical diagnoses and procedures.

Each year, about 200 000 inpatient records are selected from approximately 400 hospitals. Information is abstracted from each record, and data are weighted to represent all hospitalizations nationally. We used SUDAAN[12] in all analyses to incorporate the NHDS sample design, and we used statistical weights to adjust for the complex survey design and for nonresponse.

In the NHDS, medical data are coded according to the *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM). The NHDS data tape contains fields for up to 7 discharge diagnoses and 4 procedure codes. We included all available discharge and procedure fields in our analysis. We estimated the total number of complications for the 5-year period, using SUDAAN and divided by 5 to obtain average annual figures.

Maternal Morbidity Defined

Maternal morbidity during labor and delivery was defined as a condition that adversely affects a woman's physical health during childbirth beyond what would be expected in a normal delivery. Three of the authors—an internist (I. Danel) and 2 obstetricians (C. Berg and H. Atrash)—reviewed ICD-9-CM codes, including those outside the standard pregnancy codes (640–676), to determine whether they met the definition. Including codes outside the 640 to 676 range increased the prevalence of total maternal morbidity by about 1%. We identified hospitalizations for delivery with ICD-9-CM code V27.

We did not consider all complications of pregnancy as representing maternal morbidity. We excluded, under our definition, conditions that affected the fetus but had no repercussions in terms of the woman's physical health. We also excluded mental health complications. Only serious mental health problems are identified by ICD-9 codes, and the number of deliveries with such codes was very small (less than 0.02% of the total).

Maternal morbidity was divided into obstetric complications, preexisting medical conditions, and cesarean delivery. An obstetric complication is a condition caused by the pregnancy itself or by its management. A preexisting medical complication is an underlying condition that may be aggravated by the pregnancy. We analyzed cesarean delivery, a major surgical procedure, separately and then included data on such deliveries in the final maternal morbidity totals.

Examples of conditions included in ICD-9-CM codes 640 to 676 that were not classified as maternal morbidity were first- and second-degree vaginal lacerations (considered normal occurrences during delivery) and episiotomies. Conditions that were managed adequately without a substantial effect on the woman's health also were not classified as instances of maternal morbidity. For example, obstructed labor and placental abnormalities (e.g., retention, abruptio, previa) were not included if they were not associated with hem-

TABLE 1—Maternal Morbidity During Labor and Delivery: National Hospital Discharge Survey, 1993–1997

Type of Morbidity	Women Giving Birth, %	95% Confidence Interval	Estimated Annual No.[a]
Obstetric complications			
Hemorrhage			
Antepartum	1.6	1.47, 1.73	61 208
Postpartum	2.0	1.79, 2.18	75 729
Preeclampsia and eclampsia			
All	3.0	2.79, 3.23	115 001
Severe preeclampsia	0.6	0.56, 0.70	24 084
Eclampsia	0.1	0.06, 0.13	3 660
Transient hypertension of pregnancy	2.1	1.89, 2.27	79 205
Obstetric trauma			
3rd/4th-degree laceration or hematoma	5.0	4.61, 5.28	188 803
4th-degree laceration	1.7	1.50, 1.81	63 112
Other obstetric trauma	3.8	3.49, 4.09	146 133
Ruptured uterus	0.1	0.07, 0.11	3 365
Infection			
Genitourinary infection	2.7	2.42, 2.96	102 744
Amnionitis	1.9	1.74, 2.10	73 252
Other infection	1.5	1.32, 1.72	57 922
Fever	1.1	0.95, 1.31	43 127
Major puerperal infection	0.8	0.69, 0.88	30 118
Postpartum fever of unknown origin	0.3	0.29, 0.40	13 280
Sepsis	<0.1	0.01, 0.04	931
Other			
Other puerperal complication	0.9	0.8, 1.1	35 884
Other major obstetric complication	0.4	0.33, 0.45	14 807
Anesthesia complication	0.4	0.28, 0.42	13 422
Wound complication	0.3	0.22, 0.29	9 701
Deep venous thrombosis	<0.1	0.02, 0.06	1 500
Gestational liver disease	<0.1	0.03, 0.06	1 797
Late vomiting	<0.1	0.01, 0.04	977
Pulmonary or amniotic embolism	<0.1	0.01, 0.03	607
Cerebrovascular accident	<0.1	0.01, 0.01	340
Gestational diabetes (abnormal GTT)	2.8	2.58, 2.94	105 377
Preexisting medical conditions			
Chronic hypertension	1.5	1.37, 1.67	57 914
Cardiac disease	0.9	0.78, 0.94	32 884
Asthma	0.7	0.59, 0.78	25 977
Diabetes (excluding abnormal GTT)	0.6	0.54, 0.73	24 126
Renal disease	0.1	0.06, 0.11	3 282
Obstetric complications, total	28.6	27.7, 29.5	1 091 188
Preexisting medical conditions, total	4.1	3.8, 4.3	155 335
Any morbidity, excluding cesarean	30.7	29.81, 31.71	1 173 846
Cesarean delivery	21.8	20.87, 22.77	842 997
Total morbidity	43.0	42.54, 43.68	1 663 873

Note. The total sample of deliveries was 154 001. Individual women were counted only once, no matter how many complications they had. Therefore, summary prevalence estimates are not the sum of the individual types of morbidity listed but represent the percentage of women with at least 1 reported morbidity within a given category. GTT = glucose tolerance test.
[a]Based on total US births (n = 19 081 038).

orrhage, disseminated intravascular coagulation, or infection. Preterm and operative vaginal deliveries were not included unless there was associated maternal morbidity.

RESULTS

We analyzed a total sample of 154 001 records of vaginal and cesarean deliveries, representing 19 081 038 deliveries occurring between 1993 and 1997. Among women who gave birth in this 5-year period, 21.2% had a vaginal delivery and experienced some type of maternal morbidity, 9.5% had a cesarean delivery and some type of maternal morbidity (obstetric complications or preexisting medical conditions), and 12.3% had a cesarean delivery with no occurrence of morbidity. Overall, 30.7% of the women who gave birth (nearly 1.2 million women annually) were reported to have an obstetric complication, a preexisting medical condition, or both, and 43% (nearly 1.7 million women annually) experienced some form of maternal morbidity (i.e., an obstetric complication, a preexisting medical condition, a cesarean delivery, or any combination of these 3 types of morbidity).

Table 1 shows point estimates of the percentages of women giving birth and experiencing specific types of maternal morbidity, the 95% confidence intervals for these point estimates, and the estimated numbers of women affected annually by each type of morbidity; 28.6% of women who gave birth had at least 1 obstetric complication (1 million women annually), and 4.1% had at least 1 preexisting medical condition (155 000 women annually). The most common obstetric complications were third- and fourth-degree lacerations (5.0%), other obstetric traumas including cervical lacerations and pelvic trauma (3.8%), preeclampsia and eclampsia (3.0%), gestational diabetes (2.8%), genitourinary infections (2.7%), postpartum hemorrhages (2.0%), and amnionitis (2.0%). The most common preexisting medical condition was chronic hypertension (1.5%).

Table 1 also includes estimates for other serious conditions. Some occurred in fewer than 1% of women giving birth. However, even these less common conditions affected thousands of women. For instance, eclampsia

was reported in only 0.1% of women during childbirth. However, this life-threatening complication occurred in nearly 4000 women annually. Severe preeclampsia, also a potentially life-threatening complication, occurred in only 0.6% of deliveries but affected approximately 24 000 women annually. Similarly, major puerperal infections occurred in only 0.8% of deliveries but affected approximately 31 000 women annually.

For each individual type of morbidity, the prevalence estimates obtained included all women for whom that outcome was reported. Some women had more than 1 obstetric complication or more than 1 preexisting medical condition. Nevertheless, in the case of each of the 4 summary prevalence estimates, women were counted only once, regardless of how many obstetric complications, preexisting medical conditions, and so forth they may have had.

DISCUSSION

The present study is the first, to our knowledge, to involve the use of population-based data to summarize the prevalence of maternal morbidity during labor and delivery hospitalizations in the United States. The results show that the magnitude of the problem is greater than generally appreciated. Although the prevalence of any specific type of morbidity is low, the burden of total morbidity is high. Only 57% of women experienced a delivery involving no form of maternal morbidity; 31% of women experienced some type of maternal morbidity during labor and delivery (excluding cesarean delivery alone), and an additional 12% had a cesarean delivery but experienced no other form of maternal morbidity (presumably such deliveries were the result of fetal indications or were elective procedures). Furthermore, some serious forms of morbidity, although reported in a small percentage of women (<1%), affect thousands of women each year because there are nearly 4 million deliveries annually. Many of the types of morbidity reported are life threatening, and many are preventable.

Maternal morbidity is a public health problem that affects nearly 1.7 million women annually, can have an impact on fetal and infant health, and can lead to maternal death. *Healthy People 2010* contains several new guidelines for reducing maternal morbidity, including an aggregate measure involving reductions in rates of maternal complications during labor and delivery.[3] Primary prevention is possible for some of these complications, including certain causes of hemorrhage, infection, and complications of obstructed labor. In the case of complications that cannot be prevented, the goal is appropriate management to keep them from becoming severe or life threatening. If the maternal mortality ratio, unchanged since 1982,[13,14] is to be reduced and the *Healthy People 2010* objective (a maternal mortality ratio of 3.3 per 100 000 live births) is to be achieved,[3] maternal morbidity, particularly severe morbidity, must be addressed and monitored.

Measuring morbidity during labor and delivery has advantages over the previously used indicator of antepartum hospitalizations.[15] Although the rate of antepartum hospitalizations decreased between 1987 and 1992, this change was probably due to an increase in ambulatory management of complications rather than to reductions in the occurrence of the conditions themselves.[7] In addition, multiple admissions for certain conditions may occur, further complicating interpretation of antepartum hospitalization rates. In contrast, morbidity during labor and delivery involves hospitalizations not associated with other conditions. Furthermore, the percentage of women hospitalized for delivery (99%) has been stable for many years.[1]

The present analysis was based on ICD codes, use of which involves certain limitations. Most ICD codes do not distinguish degrees of severity of complications and thus cannot always be used to assess the impact of interventions targeted at secondary prevention. For example, severe preeclampsia and eclampsia are coded separately from preeclampsia, but severe hemorrhage is not coded separately from hemorrhage. One of the challenges of monitoring maternal health is this inability to assess severity. Length of hospital stay after delivery may constitute a measure of severity, but its validity for this purpose must be evaluated.

Monitoring complications associated with preexisting medical conditions is increasingly important as the average age of women giving birth rises.[14] However, it is unclear whether preexisting medical conditions are reported simply because of their existence or because of the development of problems during labor and delivery. The prevalence of chronic hypertension observed here (1.5%) seemed to reflect its prevalence among women of reproductive age. However, the prevalence of asthma (0.9%) was much lower than its general prevalence, suggesting that this condition was reported only if an exacerbation occurred.

If hospital discharge data are to be used to monitor maternal morbidity, misclassification of conditions in terms of ICD codes must be examined (including specificity and sensitivity). For example, a hospital discharge survey conducted in Massachusetts during 1990 to 1997 showed that, after chart reviews, the average positive predictive value of a diagnosis of uterine rupture was only 50.7%.[16]

A complete picture of the burden of maternal morbidity would include antepartum and postpartum complications. In the case of conditions that occur only during childbirth or that do not resolve until after childbirth, the prevalence rates reported here accurately reflect rates during pregnancy (e.g., obstetric trauma, preeclampsia). Conditions that occur and resolve antepartum or that begin after the delivery hospitalization are not adequately estimated with this methodology (e.g., antepartum infections, mastitis).

Two recent studies on postpartum hospitalizations showed readmission rates of 1.2% among women giving birth in the state of Washington[17] and of approximately 0.5% among women covered by a large private insurer.[18] An additional unknown number of women require outpatient treatment for postpartum complications. A complete assessment of the burden of maternal morbidity requires a longitudinal study that takes into account multiple complications or multiple hospitalizations occurring over the entire pregnancy and postpartum period.

Women's burden of disease during labor and delivery is high, and reducing maternal morbidity is a national objective. Many of the serious types of morbidity reported here are preventable. If *Healthy People 2010* objectives are to be achieved, national, state, and local

policies must address women's needs during pregnancy and gaps in prevention programs and research. Improved monitoring of maternal morbidity is key to assessing the impact of policies aimed at reducing maternal illness and death and improving maternal health. ■

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Contributors

I. Danel, C. Berg, and C.H. Johnson all contributed to the design of the study. C.H. Johnson analyzed the data. I. Danel was primarily responsible for preparing the article, with substantial contributions from C. Berg, C.H. Johnson, and H. Atrash.

Human Participant Protection

No protocol approval was needed for this study, as the data are publically available and contain no personal identifiers.

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