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Epidemiology of Obstetric-Related Intensive Care Unit Admissions in Maryland: 1999–2008

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Abstract

Objective—To define the incidence, indications, and temporal trends in obstetric-related intensive care unit (ICU) admissions

Design—Descriptive analysis of utilization patterns

Setting—All hospitals within the State of Maryland

Patients—All antepartum, delivery and postpartum patients who were hospitalized between 1999 and 2008

Interventions—None

Measurements and Main Results—We identified 2,927 ICU admissions from 765,598 admissions for antepartum, delivery, or postpartum conditions using appropriate International Classification of Diseases, 9th revision-Clinical Modification (ICD-9 CM) codes. The overall rate of ICU utilization was 419.1 per 100,000 deliveries, with rates of 162.5, 202.6 and 54.0 per 100,000 deliveries for the antepartum, delivery and postpartum periods, respectively. The leading diagnoses associated with ICU admission were pregnancy-related hypertensive disease (present in 29.9% of admissions), hemorrhage (18.8%), cardiomyopathy or other cardiac disease (18.3%), genitourinary infection (11.5%), complications from ectopic pregnancies and abortions (10.3%), non-genitourinary infection (10.1%), sepsis (7.1%), cerebrovascular disease (5.8%) and pulmonary embolism (3.7%). We assessed for changes in the most common diagnoses in the ICU population over time and found rising rates of sepsis (10.1 per 100,000 deliveries to 16.6 per 100,000 deliveries, $p=0.003$) and trauma (9.2 per 100,000 deliveries to 13.6 per 100,000 deliveries, $p=0.026$) with decreasing rates of anesthetic complications (11.3 per 100,000 to 4.7 per

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100,000, $p=0.006$). The overall frequency of obstetric-related ICU admission and the rates for other indications remained relatively stable.

Conclusions—Between 1999 and 2008, 419.1 per 100,000 deliveries in Maryland were complicated by ICU admission. Hospitals providing obstetric services should plan for appropriate critical care management and/or transfer of women with severe morbidities during pregnancy.

Keywords

Maternal mortality; maternal health; maternal health services; critical care; intensive care

Introduction

The United States has among the highest incidences of maternal mortality in the developed world and this incidence has increased within recent years. (1) Maternal mortality exists on a continuum, ranging from little to no morbidity, to severe morbidity, “near-miss” events, and ultimately to maternal death. (2) Understanding the epidemiology of severe obstetric morbidity and “near miss events” may help target interventions aimed at improving the full range of maternal outcomes.

Analyzing intensive care unit (ICU) utilization during pregnancy is an accepted approach to identifying severe and “near-miss” maternal morbidity, (3) but there are few relevant US studies (4–8); for those that have been conducted most are single-institution (4, 5, 7) and the one investigation that is population-based contains only delivery-related admissions through 1997. (6) Given the paucity of data and the significant changes in obstetric practice including an increase in Cesarean deliveries, (9) women of advanced maternal age, (10) pregnancies resulting from assisted reproduction, (11) and pregnancies complicated by chronic medical conditions, (12–14) we sought to define the contemporary epidemiology of ICU utilization in the pregnant population. To do so, we analyzed the data from the Maryland State Inpatient Database (1999–2008), (15) which contains information on all inpatient hospitalizations and specifically provides data on ICU utilization.

Materials and Methods

Study Data Source

Data were derived from the Maryland State Inpatient Database which was collected as part of the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality. (15) The database contains information on all inpatient hospitalizations in Maryland, including patients’ age, gender, race, length of stay (LOS), number of days spent in the ICU, primary payer type and up to 15 diagnoses and procedures coded using the Classification of Diseases, 9th revision-Clinical Modification (ICD-9-CM). (15) As these data are de-identified, this study was exempt from Institution Review Board review.

Study Population

We identified all antepartum, delivery and postpartum admissions from 1999–2008 using appropriate ICD-9-CM codes. Admissions were categorized hierarchically using ICD-9-CM codes as delivery admissions (ICD-9-CM codes 72–75, V27 or 650–659), antepartum admissions (ICD-9-CM codes 630–648 without a delivery code), or postpartum admissions (ICD-9-CM codes 660–677 without a delivery code), as has been previously described. (16). Maternal admissions for stillbirth were identified using delivery codes (ICD-9-CM codes V27.1, V27.3, V27.4, V27.6, V27.7 and 656.4). Using the admission source and discharge disposition parameters, we identified the percentage of antepartum admissions that were

discharged to another healthcare facility and the percentage of postpartum admissions admitted from another healthcare facility, as these admissions may represent intrapartum transfers.

Patient comorbidities and complications

ICU utilization was defined as a non-zero length of ICU stay recorded in the discharge record. Diagnoses and morbidities associated with ICU admission were identified using ICD-9-CM codes (Appendix A). Changes in ICD-9-CM codes for the time period of interest as documented by the National Center for Health Statistics were reviewed. (17) Coding changes were identified and incorporated into our diagnoses' definitions. A new code was defined for peripartum cardiomyopathy (674.5) in 2003 which resulted in the exclusion of heart failure from our trend analysis. Patient demographic variables were obtained directly from the dataset as previously described. Average yearly hospital delivery volume was determined by identifying the number of delivery admissions associated with each unique hospital identifier over the time period studied and then dividing this by the number of years in the study period.

Non-obstetric admissions

All non-obstetric ICU admissions for female patients aged 15 to 44 were identified in the Maryland State Inpatient database from 1999 to 2008 based on ICU utilization during a hospitalization and the absence of diagnostic codes indicating antepartum, delivery or postpartum conditions. We calculated the rate of ICU admission per 100,000 at-risk person-years by first obtaining age-stratified population data for women aged 15 to 44 living in Maryland as recorded by the 2000 Census, (18) which were multiplied by the number of years in our study period. Non-obstetric ICU admissions were stratified in the same manner as the 2000 Census data. The rate of ICU admission per 100,000 at-risk person-years was obtained for each age group by dividing the number of ICU admissions in that age group by the number of 100,000 at-risk person-years for that age group. We additionally calculated the overall rate of ICU admission per 100,000 at-risk person-years by dividing the total number of non-obstetric ICU admissions for women aged 15 to 44 years, by the sum of the age-stratified at-risk person-years.

Statistical Analysis

The distribution of demographic characteristics and obstetric/medical conditions and sources of organ dysfunction were compared between obstetric intensive care admissions and obstetric admissions without ICU admission. Similarly, the distributions of maternal conditions associated with ICU admission were compared based on the timing of intensive care admission. The proportion of ICU admission for each cause during the antepartum and postpartum periods were compared with those of the delivery admission. For obstetric admissions, the leading causes of maternal mortality were compared between those with and those without ICU admission. All of these comparisons were performed using chi-square analyses. The overall incidence of ICU utilization was determined by dividing the number of admissions during the study period by the number of deliveries, and incidences for antepartum, delivery and postpartum utilization were calculated in the same manner. A rate of ICU utilization per pregnancy was computed by dividing the total number of ICU admissions by the number of deliveries during the period of study.

For comparison with the age-matched non-obstetric population, the incidence of ICU admission per 100,000 at-risk person-years was calculated for the antepartum, delivery and postpartum periods, by using the following estimation procedures. We identified the overall number of deliveries and stillbirths as described above. Gestational age at delivery was imputed as previously described; (19) in brief, stillbirths were presumed to occur at 28

weeks while the remaining births were assumed to occur at 38 weeks. The delivery-related at risk period was defined to last 1 week, and the postpartum period was defined as 6 weeks following delivery. At-risk person-years for the antepartum period were computed by subtracting stillbirths from the number of deliveries and multiplying by 38/52 years, and then adding to that figure the number of stillbirths multiplied by 28/52 years. Postpartum at-risk person-years were calculated by multiplying the number of deliveries by 6/52 years. Delivery at-risk person-years were determined by multiplying the number of deliveries by 1/52 years. These at-risk person-year periods were additionally stratified by maternal age and compared to at-risk person-year periods in non-pregnant females in the same age stratification.

Finally, trend analysis was performed for each of the maternal conditions associated with ICU admission by comparing cause-specific rates of ICU admissions in 1999–2003 to 2004–2008. This approach was taken given the small number of outcomes for some conditions that precluded examination using smaller time intervals. Trend analysis was not performed for cardiomyopathy or other cardiac diseases due to the ICD-9-CM code changes noted above.

Statistics were performed using SSPS (SSPS Inc., Version 17.0, Chicago, IL).

Results

Within the 10 year study period (1999–2008), 765,598 obstetric admissions and 698,379 deliveries were identified. Of those obstetric admissions, 2,927 utilized the ICU; 1415 of the ICU admissions occurred during the hospitalization for delivery, including 109 hospitalizations for stillbirth (7.7%). The median ICU LOS was 2 days (range of 1–94 days). As shown in Table 1, compared to the general obstetric population, those admitted to the ICU had a higher proportion of extremes of maternal age, were more likely to be black and/or covered by Medicaid insurance. Also, a larger fraction of these patients were either admitted from the emergency department or by transfer from another healthcare facility. In addition, more of them were treated at small delivery volume hospitals.

Incidence of Intensive Care Utilization

The overall rate of ICU utilization was 419.1 per 100,000 deliveries, with rates of 162.5, 202.6 and 54.0 per 100,000 deliveries for the antepartum, delivery and postpartum periods, respectively. The incidence of ICU utilization in at-risk person-years was 222.9, 10,535.8 and 467.9 per 100,000 person-years for the antepartum, delivery and postpartum periods, respectively. During the same study period, 57,055 non-obstetric ICU admissions were identified for females age 15–44, resulting in an incidence of ICU admission of 497.4 per 100,000 person-year. Figure 1 shows the incidence of non-obstetric, antepartum, delivery, and postpartum ICU admission by patient age group. Obstetric patients above the age of 35 and below the age of 20 had higher rates of delivery ICU utilization compared to those age 20–24 and age 25–34. The highest rate of non-obstetric and postpartum ICU utilization occurred in patients above the age of 35, while the highest rate of antepartum ICU utilization was found in those under the age of 20. Assuming that each patient has no more than one ICU admission per pregnancy, we derived a rate of 1 ICU admission per 238 pregnancies. There were 167 antepartum patients (15%) who were discharged to another healthcare facility and 108 postpartum patients (29%) who were admitted from another healthcare facility.

Diagnoses Associated With ICU Admission

We identified the most common diagnoses associated with admission to the ICU (Table 2); these diagnoses were not defined in an exclusive fashion, such that one patient can be

represented in multiple diagnosis groups: by order of decreasing frequency among the obstetric ICU admissions, these were obstetric-related hypertensive disease (present in 29.9% of admissions), hemorrhage (18.8%), cardiomyopathy or other cardiac disease (18.3%), genitourinary infection (11.4%), complications from ectopic pregnancies and abortions (10.3%), non-genitourinary infection (10.1%), sepsis (7.1%), cerebrovascular disease (5.8%) and pulmonary embolism (3.7%). The most frequent organ dysfunction associated with ICU admission was respiratory failure (24.6%).

Adverse Outcomes by ICU Admission Category

Respiratory failure, liver failure and coagulopathy were the most common end-organ injuries among obstetric patients who received intensive care. With the exception of liver failure (1.1%), all other complications were exceedingly rare in the population of obstetric patients who did not receive intensive care. There were 53 deaths in the obstetric ICU admissions (1.8% mortality) and 75 deaths in the non-ICU obstetric admission population (0.01% mortality). The leading maternal conditions associated with maternal mortality were cardiomyopathy or other cardiac disease, hypertensive disorders of pregnancy, hemorrhage and cerebrovascular disease (Table 4).

Diagnoses by Admission Category

We classified each obstetric admission as antepartum, delivery or postpartum as previously described and determined the prevalence of diagnoses by admission category (Table 3). ICU admissions related to abortions and ectopic pregnancies were considered separately and accounted for 300 admissions (10.3% of all ICU admissions among pregnant or postpartum women). The most common three diagnoses associated with antepartum ICU admission were obstetric-related hypertensive disease (22.6%), trauma (16.9%) and cardiomyopathy or other cardiac disease (13.0%). For delivery-related ICU admissions, the most common diagnoses were obstetric-related hypertensive disease (38.0%), hemorrhage (33.2%) and cardiomyopathy or other cardiac disease (17.5%). In contrast, the top three diagnoses associated with postpartum ICU admission were cardiomyopathy or other cardiac disease (37.4%), obstetric-related hypertensive disease (21.2%) and cerebrovascular disease (20.2%).

Temporal Trends

No temporal trend was identified for the overall rate of obstetric ICU admissions (Table 5). However, increasing rates were identified for sepsis (10.1 per 100,000 deliveries to 16.6 per 100,000 deliveries, $p=0.003$) and trauma (9.2 per 100,000 deliveries to 13.6 per 100,000 deliveries, $p=0.026$). Decreasing rates of anesthetic complications were noted (11.3 per 100,000 to 4.7 per 100,000, $p=0.006$). Rates were stable for the remaining diagnoses.

Discussion

Using the Maryland State Inpatient Database to study obstetric-related ICU admissions, we determined that approximately 0.4% of pregnancies is complicated by a maternal ICU admission. Hypertensive disorders of pregnancy, hemorrhage, cardiomyopathy or other cardiac disease were the most frequent diagnoses associated with maternal ICU admission. While overall rates of ICU admission remained stable through the study period (1994 through 2008), we observed increasing rates of ICU admission for sepsis and trauma and decreasing rates of intensive care to manage anesthesia complications. ICU utilization most commonly occurred during delivery admission (48.3%), followed by antepartum (38.8%) and postpartum (12.9%) periods.

The overall frequency of ICU utilization that we report (419 per 100,000 deliveries) is greater than the international median rate of 270 ICU admissions per 100,000 deliveries (range: 70 to 1350 per 100,000 deliveries) and at the top of the previously reported range in US studies, most of which were single center (range: 250 to 470 per 100,000 deliveries) (4, 5, 7, 20). Approximately half of the admissions (51.7%) took place during antepartum and postpartum hospitalizations, and may have been missed in previous population-based studies of ICU admissions in pregnancy that focused on only delivery hospitalizations (6, 21).

Availability of ICU beds may also impact admission thresholds. There are 20 adult ICU beds per 100,000 persons available in the US on average; this availability is at the top of the international range of 3.3 to 24.0 beds per 100,000 persons. (22) Maryland had 893 ICU beds in 2005, (23) or approximately 16.0 beds per 100,000 persons. The increase in ICU utilization that we noted in the low delivery-volume hospitals as compared with the higher volume centers suggests that ICU admission thresholds may vary by facility size, with either a decreased intensity of care available in low volume labor and delivery units, or a more cautious approach to obstetric care of women with serious comorbid conditions.

Our observed mortality rate of 1.8% for maternal ICU admissions is below the developed world median of 3.4% (range 0–18.4%) and the developing world median of 14.0% (range 0–40%) (20), suggesting that the threshold for ICU admission in Maryland may be lower than elsewhere. However, the majority of maternal mortalities (58.6%) occurred without an ICU admission. This raises the possibility that many maternal deaths are too acute to permit ICU transfer or that ICUs may be underutilized in this population. Support for this possibility comes from a recent study of peripartum cardiomyopathy in North Carolina, where of the 7 patients who died, only 1 survived to hospital admission. (24) The large size of our study sample facilitated the identification of the most common conditions for all obstetric ICU admissions in the antepartum, delivery, and postpartum periods.

These included pregnancy-related hypertensive disorders, hemorrhage, and cardiomyopathy or other cardiac disease. These conditions are the same as those identified as the leading cause of maternal mortality in the current study as well as in a recent national study covering the entire US (25) thus reinforcing the notion that studying patterns of severe maternal morbidity provides important insight into both morbid and mortality events. The most frequent organ dysfunction associated with obstetric ICU admission was respiratory failure, potentially as a common outcome for critically ill patients who have suffered cardiovascular collapse or aggressive fluid resuscitation. This information can then provide impetus for targeted systems-based improvements at an institutional, local and national level.

While our study found a higher rate of ICU utilization during the delivery hospitalization when compared with Maryland's previously reported rate of 124.4 per 100,000 deliveries for the period of 1984–1997 based on delivery admissions only, (6) we did not observe an increase in the overall frequency of ICU utilization during the time period of the current analysis (1999–2003 and 2004–2008). This finding contrasts with a previous study (21) based on delivery admissions recorded in the Nationwide Inpatient Sample that used discharge diagnoses without ICU status to document a substantial rise in the rate of maternal morbidity. Possible explanations for this discrepancy include a changing threshold for ICU admission over the study period, changes in coding practices and the possibility that trends in maternal morbidity in Maryland do not correlate with national trends.

We did, however, observe substantial increases in obstetric ICU utilization for specific indications: sepsis and trauma. The increasing rate of sepsis in obstetric patients reflects national and international trends. In the United Kingdom during an overlapping time period (2000–08), there has also been an increase in maternal mortality due to genital tract sepsis,

specifically from community acquired Group A streptococcal infection. (26) Within the general hospital population, (27) and those who have undergone elective surgery, (28) rates of sepsis in the US have doubled in recent years. As the cause of this deadly trend is unclear, this should be a priority for future obstetric research.

Trauma was also an important and increasing source of maternal ICU admission during our study period. Notably, Maryland has a higher incidence of assault compared with the national average. (29) Other sources of trauma in obstetric patients typically include motor vehicle accidents, during which pregnant patients are at increased risk for adverse outcomes, (30) and partner violence. (31) The prevalence of trauma as an increasing source of maternal ICU admission provides fertile ground for public health prevention efforts.

Our data revealed a temporal trend of decreasing rates of obstetric ICU utilization for complications from anesthesia consistent with a recent analysis of data from the Nationwide Inpatient Sample. (21) This finding may be attributable to the increase use of neuraxial anesthesia and the corresponding decrease use of general anesthesia and/or improved airway management in this population.

Our study is limited by the availability of relevant data; Maryland and Rhode Island are the only states that specifically report ICU utilization, thereby allowing identification of patients with sufficient disease burden to require a higher level of care. A limitation of using state-specific data is that the sample may not be fully representative of the population nationwide. Compared to the US in 2004, Maryland had an increased population of mothers greater than 35 years of age (19.0% vs 14.2%), a larger percentage of black mothers (34.5% vs 15.0%) and more premature births (13.3% vs 12.4%); (32) these differences may or may not be representative of the overall obstetric population.

Also, diagnoses associated with ICU admission were determined by ICD-9-CM codes, which are assigned at discharge by medical coding specialists and are not subject to strict definitions. Additionally, the ICD-9-CM classification definitions have been modified over the time period of the study. While diagnosis classification methodology for the purpose of this study has been defined to account for these changes, it was not possible to adapt all conditions, such as heart failure, to include trend analysis. Another limitation of this database is the absence of strict criteria for ICU admission. Labor and delivery units may vary in their threshold for patient acuity before a transfer to an ICU is arranged. Additionally, the HCUP data use agreement prohibits reporting details derived from 10 or fewer admissions due to privacy concerns, which then prevents detailed analysis of rare events. As the HCUP data does not identify patients uniquely across hospital admissions, it was not possible to determine the timing between delivery admissions and postpartum admissions, or between antepartum admission and delivery admissions. This prevented further analysis of the timing of postpartum admissions. We excluded obesity as a factor in our evaluation due to lack of consistent coding. Finally, gestational age was not a reported element of the admission data and thus we were unable to analyze the impact of gestational age on ICU admission.

Conclusions

Our study provides insights into maternal morbidity severe enough to require the use of intensive care and highlights the increasing role of sepsis and trauma. We have determined that a significant proportion of maternal morbidity occurs outside of the delivery admission and that maternal mortality extends beyond the ICU setting. With 1 in 238 pregnant patients requiring ICU care, hospitals should develop multidisciplinary teams involving obstetricians, anesthesiologists, and nursing to provide care for these patients.

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Appendix A

Coded Category	ICD-9-CM Codes
Hysterectomy	PR 68.3–68.7, PR 68.9
Cesarean section	PR 74
Acute renal failure	584, 669.3, 958.5, 639.3
Pulmonary edema	518.4
Respiratory failure	518.81, 518.82, 518.84, 518.5, 799.1, PR 96.00–96.05, PR 96.7, PR 93.90, 96.01, 96.02, 96.03, 96.04, 96.05
Cerebrovascular accident	671.5, 674.0, 430–432, 436, 997.02, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 325, 348.3, 348.5, 437.1, 437.6, 346.6, 348.3
Disseminated Intravascular Coagulation	666.3, 286.6, 286.7, 286.9, 287.4
Shock	669.1, 998.0, 995.4, 995.0, 785.5, 999.4, 995.94
Blood transfusion	PR 99.0
Blood transfusion reaction	999.5–999.8

Coded Category	ICD-9-CM Codes
Coma	780.01, 780.03
Status epilepticus	345.3
Status asthmaticus	493.01 493.11, 493.21, 493.91
Cardiomyopathy or other cardiac disease	648.63, 427.5, 428.1, 428.21, 428.31, 428.41, 997.1, 669.4, 428.23, 428.33, 428.43, 415.0, 425, 674.5, 410, 518.4
Pregnancy-related hypertensive disorder	642
Hemorrhage	666, 640, 641
Sepsis	038, 995.92, 995.91, 785.52
Other infections	320–325, 420–421, 540–542, 562.01, 562.11, 562.13, 566–567, 572, 590, 575.0, 575.1, 599, 680–686, 730, 999.3, 998.5, 487, 488, 461–465, 481–486, 510, 513. Excluded in presence of sepsis or genitourinary tract infection.
Genitourinary tract infection	614–616, 646.6, 670. Excluded in presence of sepsis
Pulmonary embolism	673, 415.1
Anesthesia complications	668, 995.86
Aspiration pneumonia	507.0, 997.3, 668.0
Liver failure	646.7, 674.8, 570
Trauma	800–959
Hyperemesis	643
Abnormal pregnancy / Abortion	PR69.01, PR69.51, PR75.0, 630, 631–639

Figure 1. Incidence per 100,000 person-years of antepartum, delivery, postpartum and non-obstetric intensive care admissions by age group.

Table 1

Comparison of the demographics of obstetric-related intensive care unit admissions with obstetric-related non-intensive care unit admissions

	Obstetric intensive care unit admissions (n=2,927)	Obstetric non-intensive care unit admissions (n=762,671)
Age, years		
<20	324 (11.1%)	74939 (9.8%)
20–34	1907 (65.2%)	554621 (72.7%)
35–39	516 (17.6%)	108359 (14.2%)
>40	179 (6.1%)	24694 (3.2%)
Admission type		
Emergency department	565 (19.8%)	23598 (3.1%)
Hospital or Healthcare Facility Transfer	424 (14.5%)	17838 (2.3%)
Routine	1859 (65.3%)	718786 (94.2%)
Race/ethnicity		
White	1208 (41.4%)	390216 (51.1%)
Black	1374 (47.1%)	248104 (32.5%)
Hispanic	140 (4.8%)	62193 (8.2%)
Asian/Pacific Islander	81 (2.8%)	29653 (3.9%)
Native American	**	2885 (0.4%)
Other	106 (3.6%)	27860 (3.7%)
Primary payer		
Medicare	38 (1.3%)	2372 (0.3%)
Medicaid	1202 (41.1%)	278356 (36.5%)
Private	1551 (53%)	457918 (60.0%)
Self-pay	101 (3.5%)	13309 (1.7%)
No charge	**	193 (0%)
Other	33 (1.1%)	8600 (1.1%)
Hospital annual delivery volume		
<500	154 (5.3%)	14954 (2.0%)
500–999	240 (8.2%)	65825 (8.6%)
1000–2999	1873 (64%)	408859 (53.6%)
>2999	660 (22.5%)	273042 (35.8%)

* Differences between all and ICU admissions were statistically significant ($p < 0.01$ on chi-square analysis) for each group.

** Not reported due restrictions on reporting small cell sizes.

*** Data missing from age (n=59), admission type (n=2528), race/ethnicity (n=1778), primary payer (n=1924) and hospital annual delivery volume (n=9).

Table 2

Occurrence of maternal conditions and organ dysfunction, obstetric intensive care admissions versus obstetric non- intensive care unit admissions

	Obstetric intensive care unit admissions (n=2,927)	Obstetric non-intensive care unit admissions (n=762,671)
Maternal conditions		
Hypertensive disorders of pregnancy	875 (29.9%)	68159 (8.9%)
Hemorrhage	551 (18.8%)	39397 (5.2%)
Cardiomyopathy or other cardiac disease	536 (18.3%)	3723 (0.5%)
Genitourinary infection	335 (11.4%)	47037 (6.2%)
Complications from ectopic pregnancy or abortion	300 (10.3%)	18349 (2.4%)
Non-genitourinary infection	296 (10.1%)	7566 (1.0%)
Sepsis	207 (7.1%)	853 (0.1%)
Cerebrovascular disease	170 (5.8%)	475 (0.06%)
Pulmonary embolism	109 (3.7%)	535 (0.07%)
Aspiration	89 (3.0%)	245 (0.03%)
Trauma	87 (3.0%)	598 (0.08%)
Anesthetic complications	66 (0.4%)	3090 (2.3%)
Hyperemesis	63 (2.2%)	9617 (1.3%)
Status asthmaticus	56 (1.9%)	343 (0.04%)
Status epilepticus	14 (0.5%)	18 (<0.01%)
Blood transfusion reaction	11 (0.4%)	58 (0.01%)
Organ dysfunction		
Respiratory failure	721 (24.6%)	659 (0.1%)
Coagulopathy	289 (9.9%)	2092 (0.3%)
Liver failure	206 (7.0%)	8487 (1.1%)
Shock	201 (6.9%)	197 (0.03%)
Acute renal failure	176 (6.0%)	437 (0.06%)
Pulmonary edema	56 (1.9%)	204 (0.03%)
Coma	14 (0.5%)	12 (<0.01%)

Differences between non-ICU and ICU admissions were statistically significant ($p < 0.01$ on chi-square analysis) for all comparisons between each group.

** Not reported due restrictions on reporting small cell sizes.

Table 3

Occurrence of maternal conditions by timing of intensive care unit admission

	Antepartum admission (n=1135)	Delivery admission (n=1415)	Postpartum admission (n=377)	P (antepartum vs delivery)*	P (delivery vs, postpartum)*
Hypertensive disorders of pregnancy	257 (22.7%)	538 (38.0%)	80 (21.2%)	<0.01	<0.01
Hemorrhage	33 (2.9%)	470 (33.2%)	48 (12.7%)	<0.01	<0.01
Cardiomyopathy or other cardiac disease	147 (13.0%)	248 (17.5%)	141 (37.4%)	<0.012	<0.01
Trauma	192 (16.9%)	80 (5.7%)	**	<0.01	0.01
Genitourinary infection	120 (10.6%)	158 (11.2%)	57 (15.1%)	0.633	0.36
Other infection (including pneumonia, cholecystitis, appendicitis, post-operative infection, etc)	141 (12.4%)	104 (7.4%)	51 (13.5%)	<0.01	<0.01
Sepsis	69 (6.1%)	94 (6.6%)	44 (11.7%)	0.563	<0.01
Cerebrovascular disease	39 (3.4%)	55 (3.9%)	76 (20.2%)	0.055	<0.01
Pulmonary embolism	**	58 (4.1%)	43 (11.4%)	<0.01	<0.01
Aspiration	19 (1.7%)	65 (4.6%)	**	<0.01	<0.01
Anesthetic complications	**	55 (3.9%)	**	<0.01	0.29
Hyperemesis	40 (3.5%)	19 (1.3%)	**	<0.01	0.67
Status asthmaticus	40 (3.5%)	15 (1.1%)	**	<0.01	0.15

* Statistical significance of difference in maternal conditions between admission categories as determined by chi-square analysis.

** Not reported due restrictions on reporting small cell sizes.

Table 4

Occurrence of maternal mortality

	ICU mortality (n=53)	Non-ICU mortality (n=75)	Combined mortality (n=128)
Cardiomyopathy or other cardiac disease	22 (41.5%)	24 (32.0%)	46 (35.9%)
Hypertensive disorders of pregnancy	13(24.5%)	20 (26.7%)	33 (25.8%)
Hemorrhage	13 (24.5%)	18 (24.0%)	31(24.2%)
Cerebrovascular disease	14 (26.4%)	**	24 (18.8%)

A subset of admissions with maternal mortality had multiple associated conditions; thus the combined conditions sum to more than 100%.

Not reported due restrictions on reporting small cell sizes.

Table 5

Comparison of the occurrence of intensive care unit admission per 100,000 deliveries by associated maternal condition in 1999–2003 versus 2004–2008.

	1999–2003	2004–2008	P
Overall			
Hypertensive disorders of pregnancy	78.9	75.3	0.419
Hemorrhage	71.5	63.4	0.806
Genitourinary infection	23.7	21.6	0.962
Other infection (including pneumonia, cholecystitis, appendicitis, post-operative infection, etc)	16.6	13.3	0.520
Sepsis	10.1	16.6	0.013 *
Anesthetic complications	11.3	4.7	0.016 *
Aspiration	10.7	8.0	0.450
Trauma	9.2	13.6	0.026 *
Pulmonary embolism	8.9	7.7	0.887
Cerebrovascular disease	7.1	8.6	0.278

* Indicates statistically significant difference by chi-square analysis for p-value indicated.