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Severe Maternal Morbidity, A Tale of 2 States Using Data for Action—Ohio and Massachusetts

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Abstract

Purpose—Describe how Ohio and Massachusetts explored severe maternal morbidity (SMM) data, and used these data for increasing awareness and driving practice changes to reduce maternal morbidity and mortality.

Description—For 2008–2013, Ohio used de-identified hospital discharge records and International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes to identify delivery hospitalizations. Massachusetts used existing linked data system infrastructure to identify delivery hospitalizations from birth certificates linked to hospital discharge records. To identify delivery hospitalizations complicated by one or more of 25 SMMs, both states applied an algorithm of ICD-9-CM diagnosis and procedure codes. Ohio calculated a 2013 SMM rate of 144 per 10,000 delivery hospitalizations; Massachusetts calculated a rate of 162. Ohio observed no increase in the SMM rate from 2008 to 2013; Massachusetts observed a 33% increase. Both identified disparities in SMM rates by maternal race, age, and insurance type.

Assessment—Ohio and Massachusetts engaged stakeholders, including perinatal quality collaboratives and maternal mortality review committees, to share results and raise awareness about the SMM rates and identified high-risk populations. Both states are applying findings to

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inform strategies for improving perinatal outcomes, such as simulation training for obstetrical emergencies, licensure rules for maternity units, and a focus on health equity.

Conclusion—Despite data access differences, examination of SMM data informed public health practice in both states. Ohio and Massachusetts maximized available state data for SMM investigation, which other states might similarly use to understand trends, identify high risk populations, and suggest clinical or population level interventions to improve maternal morbidity and mortality.

Purpose

Severe maternal morbidity (SMM) has risen 75% over the past decade and affects more than 52,000 women annually in the United States (Callaghan et al. 2012). SMMs are physical and psychological conditions, relating directly or indirectly to pregnancy, that negatively impact a woman's health (Callaghan et al. 2008). While each condition is relatively rare, collectively, SMM occurs 100 times more frequently than maternal death (Callaghan et al. 2012). Because SMM occurs more frequently than the related outcome of maternal mortality, tracking SMM is recommended for both monitoring poor maternal outcomes that did not result in death and providing population-level context for deaths reviewed by maternal mortality reviews (Building U.S. Capacity to Review and Prevent Maternal Deaths 2018). For instance, the U.S. Department of Health and Human Services has designated "reduction of maternal illness and complications due to pregnancy", a Healthy People 2020 objective (https://www.healthypeople.gov/2020/topics-objectives/objective/mich-6). SMM has likewise been identified as a National Outcome Measure for the Title V Maternal and Child Health Block Grant, which funds all states (https://mchb.tvisdata.hrsa.gov/PrioritiesAndMeasures/NationalOutcomeMeasures).

While various definitions have been proposed (Geller et al. 2006), recent work on methods for identifying SMM at the population-level has focused on using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes for identifying 25 separate conditions, within delivery and postpartum hospitalization discharge data, to characterize SMM (Callaghan et al. 2012). Consequently, states are now challenged to understand and use a diversity of administrative data systems to examine SMM patterns, trends, and risk factors to inform maternal morbidity and mortality interventions. However, little published information establishes how states are using administrative data to monitor SMM or how data are informing policy and interventions. Our purpose is to describe how two states, Ohio and Massachusetts, with access to different data, but similar in infrastructure for addressing maternal morbidity and mortality (e.g., maternal mortality review committees and perinatal quality collaboratives), used SMM data for monitoring maternal health, increasing awareness, and driving actions.

Description

Ohio

Ohio established the Pregnancy Associated Mortality Review (PAMR) in 2010 to better understand maternal deaths through multidisciplinary review and inform prevention efforts

(Shellhaas and Conrey 2018). With maternal deaths occurring in low numbers, PAMR leadership became interested in examining SMM to provide context to maternal deaths to enhance understanding of adverse maternal events and further inform prevention efforts. A team comprising a clinician, an epidemiologist, and an analyst assembled in 2014 to assess SMM trends and risk factors. They accessed de-identified hospital discharge records owned by the Ohio Hospital Association, representing approximately 98% of hospital-based births, but excluding non-hospital births and births occurring in military facilities or other states.

The team used published algorithms of ICD-9-CM diagnosis and procedure codes to identify delivery hospitalizations that occurred during 2008–2013, and then further classify whether these hospitalizations were complicated by one or more of 25 SMM conditions (Kuklina et al. 2008; Callaghan et al. 2012) (i.e., acute renal failure; cardiac arrest or ventricular fibrillation; heart failure during procedure or surgery; shock; sepsis; disseminated intravascular coagulation; amniotic fluid embolism; thrombotic embolism; puerperal cerebrovascular disorders; severe anesthesia complications; pulmonary edema; adult respiratory distress syndrome; acute myocardial infarction; eclampsia; blood transfusion; ventilation; hysterectomy; sickle cell anemia with crisis; intracranial injuries; internal injuries of thorax, abdomen, and pelvis; aneurysm; operations on the heart and pericardium; cardio monitoring; temporary tracheostomy; conversion of cardiac rhythm). Hospitalizations with implausibly short length of stay for the delivery type were excluded (Callaghan et al. 2012). The team calculated SMM rates per 10,000 delivery hospitalizations overall and by sociodemographic characteristics. Race and ethnicity were available for 2012–2013 only. Estimates were calculated with and without ICD-9-CM blood transfusions codes because a study by Main and colleagues (2015) suggested that these codes had low specificity for hemorrhage ($\geq$ 4 units of blood products), the SMM concept that the transfusion codes were intended to capture.

Massachusetts

Since 1997 the Massachusetts Maternal Mortality and Morbidity Review Committee (MMMMRC) has reviewed all pregnancy-associated deaths and made recommendations to improve clinical practice, healthcare systems, and public health. Massachusetts' low number of deaths limits capability to conduct robust analysis. MMMMRC therefore looked to SMM to increase information available for guiding prevention strategies.

The Massachusetts Perinatal Quality Collaborative (MPQC) was established in 2011 to promote sharing of best practices in maternity care, and routinely convene representatives of Massachusetts maternity hospitals and key perinatal organizations, to address perinatal quality issues. In 2014, CDC awarded a State-Based Perinatal Quality Collaborative cooperative agreement to enhance the MPQC's capabilities, including a specific goal to decrease severe pregnancy-related morbidity by 10%, by 2017. A focus on hemorrhage and pregnancy-induced hypertension was identified following MMMMRC reviews and analysis of condition-specific SMM. The MPQC worked to identify and decrease variability in management of severe hypertensive episodes, and develop a hospital toolkit for improving quality of care for postpartum hemorrhage.

To monitor SMM occurrence, assess health disparities, and identify further areas for improvement in maternal care practices, the Massachusetts Department of Public Health (MDPH), in 2016, analyzed SMM. Instead of using hospital discharge data alone, as in Ohio, MDPH could use the Pregnancy to Early Life Longitudinal (PELL) data system. This health data system links infant birth certificates and fetal death records to corresponding hospital discharge records for Massachusetts resident women (99% linkage rate), enabling identification and monitoring of SMM among delivery hospitalizations and examination of information from two sources of maternal and infant data (vital statistics and hospital discharge data), thereby increasing available information, completeness and accuracy of certain data elements. SMM were identified using condition-specific ICD-9-CM diagnosis and procedure codes from delivery discharge records and rates were adjusted for severity based on length of-stay. Analysis of SMM with and without blood transfusion during 2008–2013 were performed using independent variables from the hospital discharge records with addition of PELL-created composite variables, such as delivery payer, which used multiple sources of information.

Ohio analyses were approved by the Institutional Review Board of the Ohio Department of Health. Massachusetts analyses were approved by the Institutional Review Board of the MDPH. CDC Research Determination was completed for both states and determined as public health practice.

Assessment

Ohio: Data Findings

The Ohio team found that the overall SMM rate during 2008–2013 was 144 per 10,000 delivery hospitalizations; after excluding transfusion, the rate was 71 per 10,000. The most common morbidity overall was transfusion (84/10,000), followed by disseminated intravascular coagulation (22/10,000) and heart failure during a procedure or surgery (15/10,000). The SMM rate was relatively stable over the 6 years examined (Fig. 1), in contrast to national trends, which were increasing over this time (https://www.healthypeople.gov/2020/topics-objectives/objective/mich-6). The three most common morbidities in Ohio during 2008–2013 are identical to the three most common morbidities identified nationally during 2008–2009 (Callaghan 2012).

When assessing variation in demographics among SMM excluding transfusions, rates increased with maternal age (Table 1); however, age demonstrated a J-shaped relationship with SMM when transfusions were included (data not shown). Women with a primary insurance payer of Medicaid or other public source had a higher SMM rate than women with a private payer (Chi square $p < 0.05$). Race and ethnicity data were not reliably collected within the hospital discharge data system prior to 2012, however during 2012–2013 racial and ethnic disparities were evident. While 18% of deliveries occurred among non-Hispanic black women, they represented 30% of SMM. In contrast, 67% of deliveries occurred among non-Hispanic white women, but accounted for 54% of SMM.

Ohio: Data Dissemination and Application

In reporting results to PAMR, the team highlighted the most common SMMs and racial/ethnic disparities. The team also developed a SMM fact sheet for the Title V program that highlighted differences by maternal age, race, and insurance status (https://odh.ohio.gov/wps/portal/gov/odh/know-ourprograms/pregnancy-associated-mortality-review/resources/SMM-factsheet). Team members shared results as a poster for both statewide and national conferences, and data were included in presentations with the Ohio Perinatal Quality Collaborative at regional birth registry workshops. PAMR also promoted findings to inform public health action. Specifically, since two of the three common SMMs, hemorrhage and cardiomyopathy/cardiac arrest were also common causes of pregnancy-related mortality, PAMR selected them as topics for simulation trainings in obstetric emergencies. Simulation scenarios, composites of PAMR cases, were used within day-long, in-person trainings; from 2014 to 2017, over 150 Ohio health professionals (primarily nurses) received direct simulation training and close to 100 have completed "Train the Trainer" (http://www.amchp.org/programsandtopics/BestPractices/InnovationStation/ISDocs/Ohio%20Simulation%20Training_2015.pdf). SMM findings and PAMR reviews informed updates related to levels of maternal care within Ohio's Administrative Code for Maternity Units, which provides mandatory standards for licensed maternity units and newborn care nurseries. Updated rules could help ensure that complicated obstetric patients are delivered at the appropriate level of care, in alignment with current professional standards introduced by the American Congress of Obstetricians and Gynecologists (2015).

Massachusetts: Data Findings

During 2008–2013, Massachusetts experienced an increase in the overall SMM rate from 122 to 162 per 10,000 delivery hospitalizations, with blood transfusions included, and 50 to 66 per 10,000 without transfusions (Fig. 2). The most common morbidity was transfusion (101/10,000), followed by operations on the heart or pericardium (11/10,000) and heart failure during a procedure or surgery (10/10,000). The increase over time was consistent with national trend (Callaghan et al. 2012) that is attributed in part to delayed childbearing and increasing comorbid conditions such as obesity and hypertension (Hinkle et al. 2012). However, the three most common morbidities identified in Massachusetts during 2008–2013 differ from published national findings during 2008–2009 in that the second most common morbidity in Massachusetts was operations on the heart and pericardium but nationally it was the eighth most common morbidity (Callaghan 2012).

Similar to Ohio, MDPH analyzed demographic characteristics of women with SMM without blood transfusions (Table 2). Women ages 35 years and older had SMM rates higher than younger women, and Non-Hispanic black women had more than twice the rate of non-Hispanic whites. Women who self-paid for delivery care or were publicly insured experienced SMM rates higher than privately insured women. Women who delivered via primary or repeat cesarean had higher rates than women delivering vaginally or by vaginal birth after cesarean.

Massachusetts: Data Dissemination and Application

SMM trend data, along with further analyses of SMM occurring among women with hypertensive disorders and other chronic conditions, and postpartum rehospitalizations among women with SMM, were presented to the MPQC. Longitudinally linked data, like PELL, enables examination of comorbid conditions and repeat hospital utilization in the postpartum period among women with SMM. These data bolstered support for ongoing activities of the MPQC related to obstetric hypertension and hemorrhage.

Results were also shared to promote awareness among public health practitioners and clinicians caring for perinatal women of increasing rates of SMM in Massachusetts. Findings were presented at national and local conferences during 2016. Through the 2014 Title V Needs Assessment process, Massachusetts selected promoting health and racial equity and reducing disparities in maternal and child health outcomes as a new Title V priority for 2015–2020. Identifying and highlighting racial/ethnic disparities in SMM may inform efforts to tailor prevention strategies and mitigate adverse consequences among the highest risk populations. Future analyses will be used to monitor racial/ethnic differences in SMM and inform strategies to reduce inequities. Ongoing analyses take full advantage of linked data to study SMM by comorbidity status to elucidate population-level strategies for decreasing the distribution of risk at delivery, such as decreasing cesarean deliveries among low risk women, since previous cesarean delivery can increase SMM risk in subsequent deliveries (Bateman 2013).

Conclusion

This paper recounts the use of state data by Ohio and Massachusetts to understand SMM trends and disparities, and to apply that understanding for raising awareness and implementing prevention activities. These two states were operating in different contexts, but each maximized use of available data to prompt action, including clinical training to prepare for obstetric emergencies, updates to licensure rules, and perinatal quality collaborative expansion. These examples may be useful for other states interested in embarking on similar efforts.

Though reporting differences limit cross-state comparison, most states have access to an overall estimate of SMM burden, which Title V has calculated and publicized (https://mchb.tvisdata.hrsa.gov/uploadedfiles/Documents/FADResourceDocument.pdf). Additionally, most states can access a source for monitoring over time and investigating disparities and risk factors. For instance, Ohio had access to de-identified hospital discharge data while Massachusetts accessed individual-level hospital discharge data linked with birth certificates. Both sources permitted these states to supplement overall estimates provided by Title V with more in-depth analysis of trends, disparities, and the relative contribution of individual SMM. Linked data increases available information (e.g., maternal characteristics), and often higher quality (e.g. racial/ethnic group designation) or more complete information (e.g., composite variables such as delivery payer derived from both sources). However, as Ohio has demonstrated, access to de-identified hospital discharge data can provide actionable information.

In both states, engagement of stakeholders, including maternal mortality review committees and perinatal quality collaboratives, helped assure data dissemination and use for informing efforts to improve perinatal outcomes. Sharing information in multiple formats also increased awareness and reach. Ohio shared state-specific SMM data as an easily-accessible, infographic-type fact sheet posted on the Ohio Pregnancy Associated Mortality Review and Title V websites, within a more detailed poster at state and national meetings, and as supporting information during presentations at regional Ohio Perinatal Quality Collaborative workshops. Massachusetts presented findings at state and national conferences and to the MPQC and MMMRC. Both states applied findings to efforts aimed at reducing mortality related to SMM. Ohio's data informed the selection of clinical topics (hemorrhage, cardiomyopathy/cardiac arrest, and hypertensive emergency) addressed within simulation trainings for obstetric emergencies. Massachusetts used data to support the selection of maternal hypertension and obstetrical hemorrhage foci for improving hospital care quality.

The analyses and intervention efforts described above focus on identifying and minimizing poor outcomes, but do not address primary prevention or mitigating inequities in SMM. As with mortality, racial and ethnic disparities exist in maternal morbidity (Grobman et al. 2015; Brown et al. 2011); both states found, as has been found elsewhere (Creanga et al. 2014), that Non-Hispanic black women have more than double the rates of SMM compared with non-Hispanic white women. While reasons for this disparity are likely multifactorial, recent studies suggest that hospital quality plays a role (Howell and Zeitlin 2017). Beyond improvements to clinical care, greater reduction of maternal morbidity will require addressing women's health in general and root causes, including an emphasis on addressing social determinants of health. The analyses described here using administrative data (e.g., hospital discharge, birth and death certificates) have limited ability to explore root causes of SMM. To study this, linkages of clinical data to the birth certificate, such as through PELL or similar integrated state data sources, are an opportunity to extend analyses by exploring prenatal risk factors (e.g., smoking, obesity) and geocoding residences to identify community-level social determinants of health.

Deeper understanding of circumstances surrounding poor outcomes is obtained through multidisciplinary review committees that also examine medical charts, social services provision, and other records. For example, maternal mortality review committees examine direct and underlying causes, often including social determinants, and use findings to implement systems-based improvement strategies (Callaghan 2014; Goodman et al. 2013; Kilpatrick et al. 2012; Main 2012). While typically not reviewing morbidity cases, some committees propose that selected SMMs should trigger facility-level, formal case review (Callaghan 2014; Kilpatrick et al. 2014; The Joint Commission 2017). Facility level reviews serve a different purpose than population-level monitoring described here, may use different methods to identify SMM (Geller et al. 2004; Geller et al. 2006; Cal- laghan 2014), and are intended inform quality improvement initiatives within the institution (Pettker and Grobman 2015; Main 2017).

While these examples are specific to Ohio and Massachusetts, they demonstrate that most states should be able to use existing data to understand trends, identify high risk populations, and suggest clinical or population level interventions. Updated guidance on identifying

SMM using ICD-10-CM codes for October 2015 and beyond are available (https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html). From our experience, we advise that states interested in exploring SMM engage multiple stakeholders such as quality collaboratives, maternal mortality review committees, Medicaid programs, and quality assurance or licensing entities. By sharing findings using multiple formats (fact sheets, infographics, posters, and presentations) critical findings can be effectively disseminated to a wide variety of stakeholder audiences. By applying a broad morbidity framework for SMM surveillance, the maternal and child health workforce can then advance a deeper understanding of the health of the pregnant population overall and population-level causes of adverse maternal health outcomes.

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Significance

What is Already Known on this Subject

Severe Maternal Morbidity rates have risen nationally in the United States over the past decade. Recent work has sought to standardize measurement across states.

What this Study Adds

We describe how two states explored and used administrative data to examine severe maternal morbidity (SMM) for driving prevention efforts. These examples demonstrate that despite differences in data access, examination of SMM data may be achievable in many states for understanding trends, identifying high-risk populations, and suggesting preventive actions.

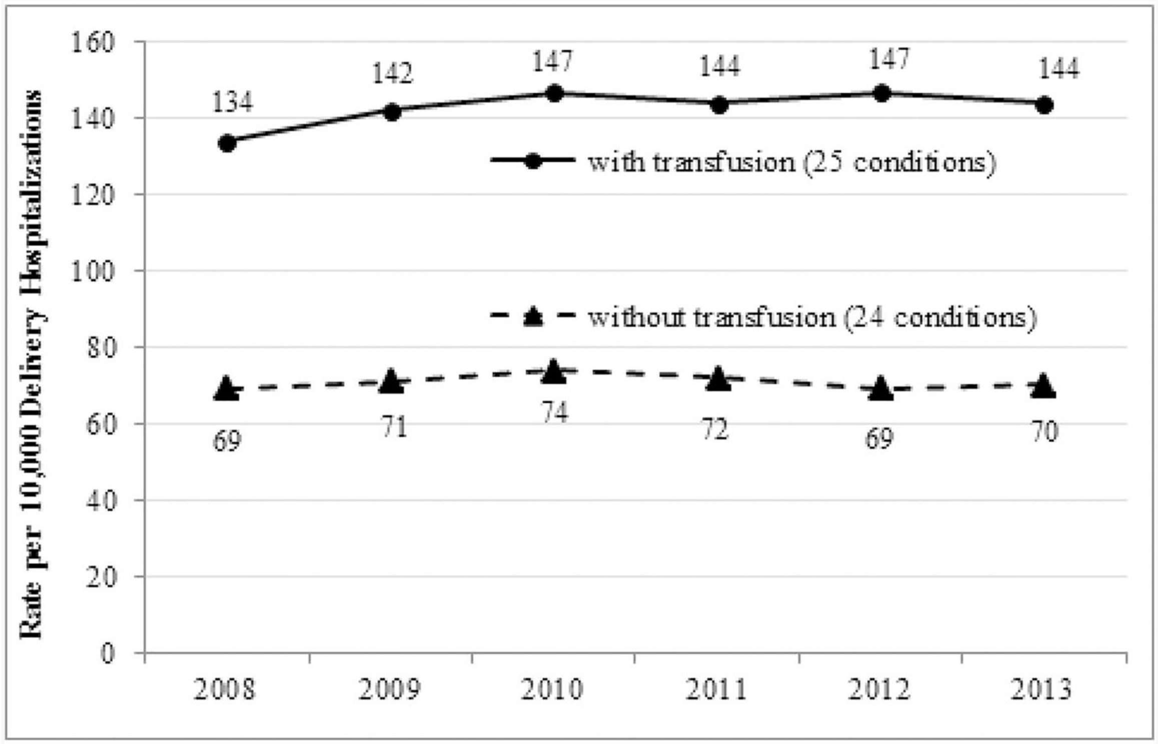

Fig. 1.

Severe maternal morbidity rates with and without transfusions, by year[a], Ohio 2008–2013

[a] Trends significant as assessed by Cochran-Armitage tests for trend

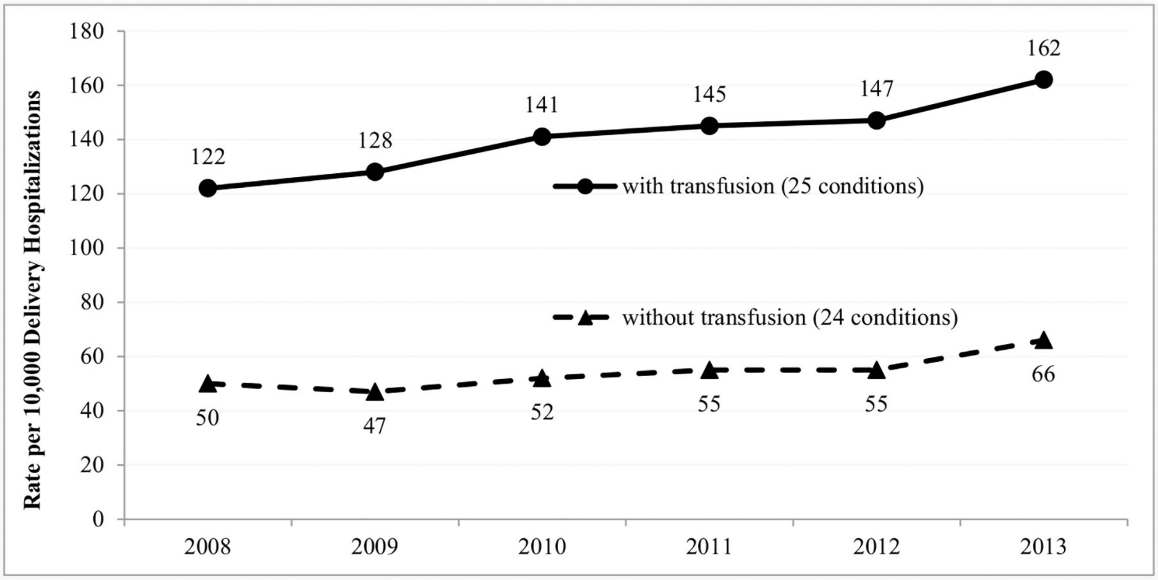

Fig. 2.

Severe maternal morbidity rates with and without blood transfusion indicator, by year[a]—Massachusetts, 2008–2013

[a] Trends significant as assessed by Cochran-Armitage tests for trend

Table 1

Characteristics of women with delivery hospitalizations and prevalence of severe maternal morbidity (SMM) —Ohio, 2008–2013

Demographic characteristic	Ohio deliveries		Deliversies with SMM (without transfusion)	
	n	%	n	Rate per 10,000
Age (years)				
<20	73,216	9.07	407	56
20–24	207,139	25.7	1135	55
25–29	237,347	29.4	1460	62
30–34	190,034	23.6	1549	82
35–39	81,076	10.1	879	108
≥40	18,213	2.3	288	158
Race/ethnicity[a]				
Non-hispanic white	176,940	67.2	981	55
Non-hispanic black	48,556	18.4	537	111
Hispanic	9336	3.5	78	84
Non-hispanic other	28,548	10.8	236	83
Delivery payer source				
Medicaid	339,984	42.2	2622	77
Other public	12,073	1.5	161	133
Private	422,488	52.4	2742	65
Self-pay/uninsured	31,337	3.9	190	61
Method of delivery				
Vaginal	543,404	67.3	1394	26
Vaginal birth after cesarean	13,452	1.7	95	71
Primary cesarean	136,354	16.9	2184	160
Repeat cesarean	11,315	14.1	2045	180
Total	807,036	100.00	5718	71

Calculated without blood transfusion indicator

[a]Available only for 2012 and 2013

Table 2

Characteristics of women with delivery hospitalizations and severe maternal morbidities (SMM)—Massachusetts, 2008–2013

	Massachusetts deliveries		**Deliveries with SMM (without transfusion)**	
	n	**%**	**n**	**Rate per 10,000**
Age (years)				
<20	22,284	5.3	101	45
20–24	66,189	15.7	253	38
25–29	105,003	24.9	483	46
30–34	135,091	32.0	656	49
35–39	75,437	17.9	566	75
≥40	18,518	4.4	199	108
Missing	6	< 0.1	0	0
Race/ethnicity				
Non-hispanic white	270,079	64.0	1166	43
Non-hispanic Black	40,349	9.6	420	104
Hispanic	69,299	16.4	419	60
Other	40,698	9.7	239	59
Missing/unknown	2103	0.5	14	66
Delivery payer source				
Private	221,059	52.3	1053	48
Public	180,606	42.7	1086	60
Self-pay	9713	2.3	78	80
Free care	11,103	2.6	41	37
Missing/unknown	47	< 0.1	0	0
Method of delivery				
Vaginal	277,367	65.6	675	24
Vaginal birth after cesarean	9533	2.3	59	62
Primary cesarean	77,982	18.5	933	120
Repeat cesarean	57,007	13.5	584	102
Missing/unknown	639	0.2	7	110
Total	422,528	100.0	2258	53.4

Calculated without transfusion indictor