

Severe Maternal Morbidity Nevada, 2016

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Background

Maternal morbidity is a continuum from mild adverse effects to life-threatening events or maternal death (Figure 1).¹ Severe Maternal Morbidity (SMM) refers to conditions and diagnoses that indicate potentially life-threatening maternal complication, including unexpected outcomes of labor and delivery resulting in significant short- or long-term consequences to a woman's health.² SMM relates to higher risks of adverse pregnancy outcomes like preterm birth and infant death. With a high rate of preventability, SMM can be considered a near miss for maternal mortality because in some cases, without identification and treatment, conditions could lead to maternal death. Identifying SMM is important for preventing injuries leading to mortality and for highlighting opportunities to avoid repeat injuries.

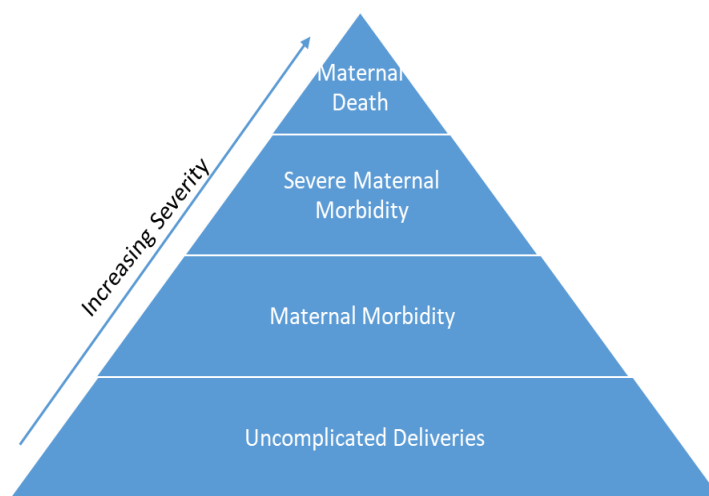


Figure 1. Continuum of Maternal Morbidity Showing Variation in Severity

The Health Resources Services Administration (HRSA) reports that SMM has increased by about 75% over the past decade³, while the Centers for Disease Control and Prevention (CDC) reports that it has been steadily increasing in recent years and affected more than 50,000 women in the United States in 2014.⁴ The overall rate of SMM per 10,000 deliveries increased almost 200% over the years, from 49.5 in 1993 to 144.0 in 2014.⁴ This increase has been mostly driven by blood transfusion.⁴ A blood transfusion in this context refers to the procedure in which women are given donated blood around their delivery hospitalization. The rate of blood transfusions per 10,000 deliveries increased from 24.5 in 1993 to 122.3 in 2014.⁴ After excluding blood transfusions, the rate of SMM per 10,000 deliveries increased by about 20% over time, from 28.6 in 1993 to 35.0 in 2014.⁴

Methodology

Data Sources

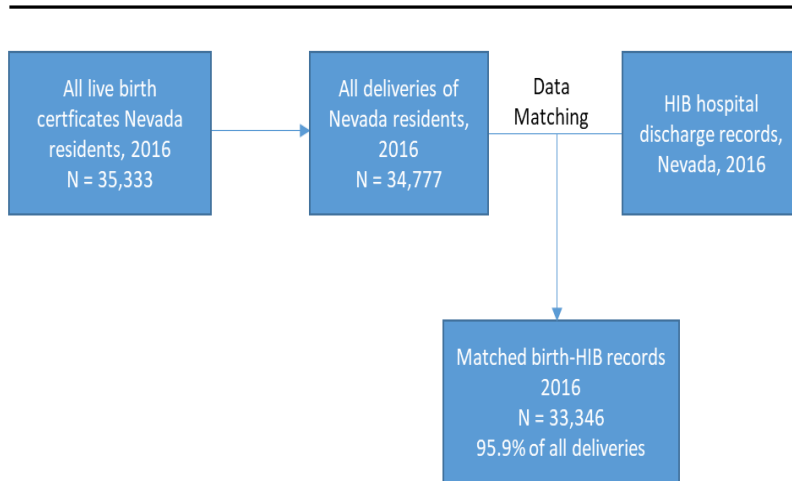
Nevada Electronic Birth Registry: Nevada Department of Health and Human Services, Division of Public and Behavioral Health, Office of Vital Records uses Web-enabled Vital Records Registry System (WEVRRS) to collect information on all live births in Nevada and issues birth certificates. The birth certificate contains demographic information, such as mother's age, race/ethnicity, and education, as well as information about the pregnancy, such as number of previous live birth (parity), prenatal care, and complications of labor and delivery.

Hospital Inpatient Billing (HIB) Data: The Hospital Inpatient Billing data provides health billing data for patients discharged from Nevada's non-federal hospitals. NRS 449.485 mandates all hospitals in Nevada report information as prescribed by the director of the Department of Health and Human Services. The data are collected using a standard universal billing form. For patients who were admitted for at least 24 hours as an inpatient, but do not include patients who were discharged from the emergency room. The data includes demographics such as age, gender, race/ethnicity and uses the International Classification of Diseases-10-Clinical Modification (ICD-10-CM) diagnoses codes (up to 33 diagnoses respectively). In addition, the data includes billed hospital charges, procedure codes, length of hospital stay, and discharge status. The billing data information is for billed charges and not the actual payment received by the hospital.

Data Matching

Nevada birth certificates were matched with the mother's delivery hospitalization record from Hospital Inpatient Billing (HIB) data. Multiple births (e.g. twins, triplets) were counted as one delivery, (only one birth certificate was matched per hospital discharge record, even when there was a multiple birth). The total number of live births to Nevada residents was 35,333 in 2016. The total number of all live deliveries was 34,777, comprising all records from singleton births and one record per multiple births. Approximately 96% of all live deliveries were matched with a hospital discharge record. All analyses are based on matched data (n=33,346). Birth certificates and hospital discharge records were matched on mother's social security number, name, birth date, home address, medical number, and the facility of the delivery hospitalization. Non-matched birth certificates may due to home births, missing social security number, misspelled names, etc.

Figure 2. Data Matching Process for Birth Certificates and HIB Records, Nevada, 2016



Identification of Severe Maternal Morbidity (SMM)

SMM events were identified during delivery hospitalizations using an algorithm developed by researchers at the CDC.⁵ The algorithm used ICD-9 codes to identify 25 indicators of SMM that represent either serious complications of pregnancy or delivery, such as disseminated intravascular coagulation or eclampsia, or procedures used to manage serious conditions, such as blood transfusion or hysterectomy. The Alliance for Innovation on Maternal Health (AIM) methods were used to identify pregnancy deliveries and ICD-9 were converted to ICD-10 to identify SMM indicators. Four out of 25 ICD-9 indicators did not have corresponding ICD-10 codes. Of the 21 indicators remaining, 16 were identified using ICD-10 diagnosis codes and five were identified using ICD-10 procedure codes. A complete list of conditions and ICD-10 codes is listed in Appendix A.

To ensure that only the most severe cases of these 21 indicators during delivery hospitalizations were captured, these indicators were classified as SMM only if they additionally met one of the following criteria:

- The mother's length of stay was equal to or greater than the 90th percentile by delivery method.
- The mother was transferred before or after delivery to a different facility.
- The mother died during delivery hospitalization.
- At least one of the five procedure indicators was present.

Analysis

All SMM rates were calculated per 10,000 live deliveries that successfully matched with a HIB record. Chi-square tests and bivariate logistic regression were used to test the significance of the association between maternal characteristics and SMM. The analyses in the report includes blood transfusion in the calculation of SMM unless otherwise noted. P-values less than 0.05 were deemed statistically significant.

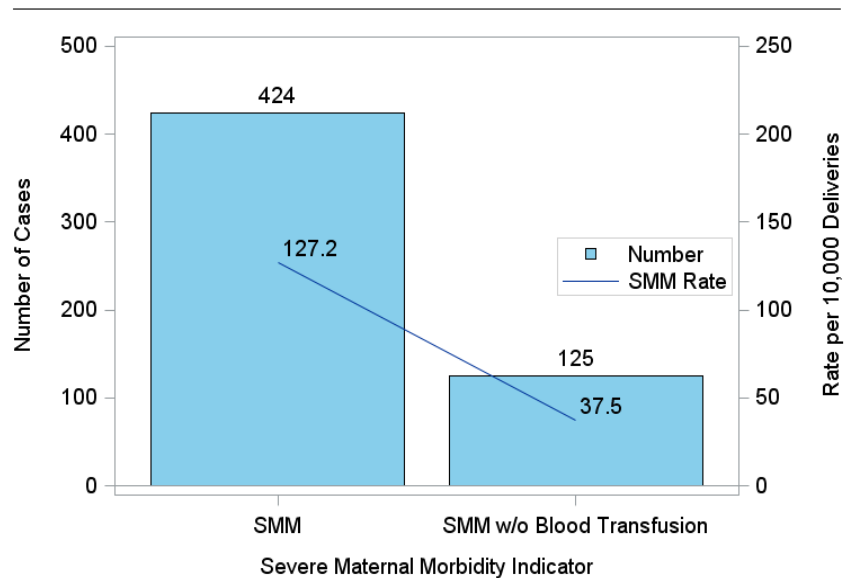
Records with missing data on a variable of interest were not represented in the graph of SMM but are represented in the tables.

All analyses were conducted using SAS 13.2.

Leading Indicators

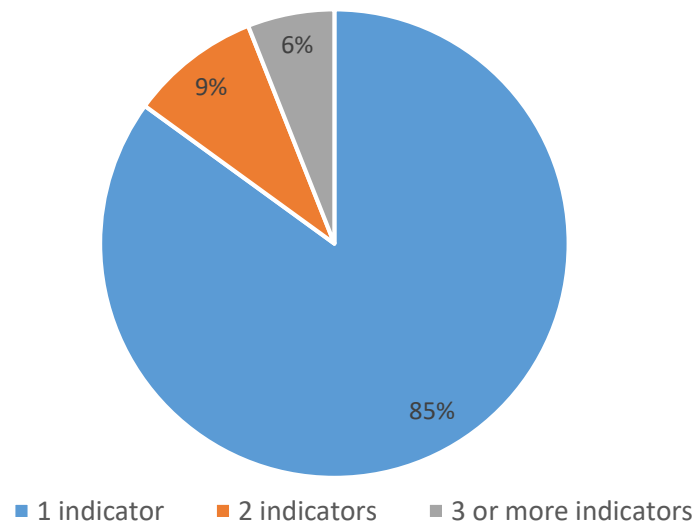
There were a total of 424 cases of SMM in 2016 with rate of 127.2 per 10,000 deliveries. If blood transfusion was not included in the calculation, SMM cases dropped to 125 and rate dropped to 37.5 per 10,000 deliveries. The analyses in the report includes blood transfusion in the calculation of SMM unless otherwise noted.

Figure 3. Severe Maternal Morbidity Rate per 10,000 Deliveries and Number of Cases, Nevada, 2016



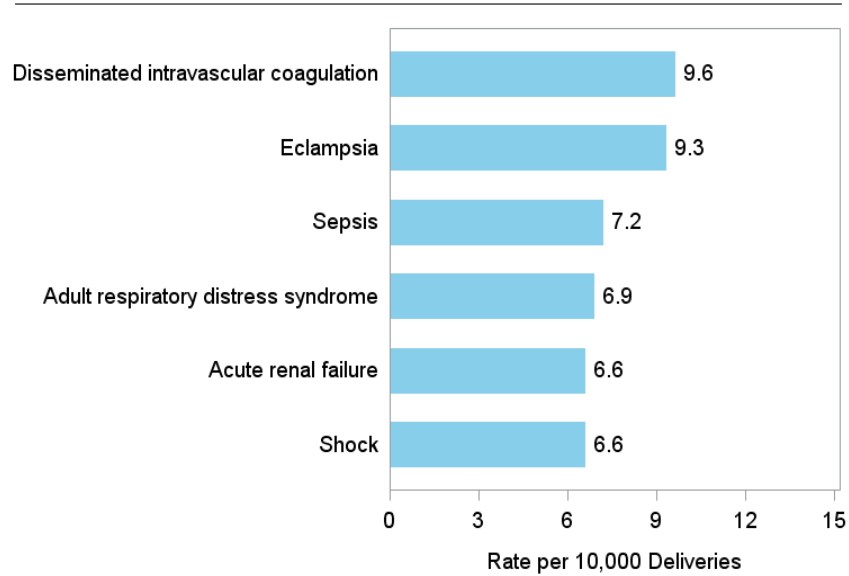
The majority of deliveries with SMM (85%) had one indicator (out of a total of 21 SMM indicators), nine percent of deliveries had two indicators and six percent had three or more indicators present.

Figure 4. Distribution of Severe Maternal Morbidity Indicators, Nevada, 2016



The leading diagnosis-based indicators of SMM were disseminated intravascular coagulation (9.6 per 10,000 deliveries), eclampsia (9.3 per 10,000 deliveries), sepsis (7.2 per 10,000 deliveries), adult respiratory distress syndrome (6.9 per 10,000 deliveries), acute renal failure (6.6 per 10,000 deliveries) and shock (6.6 per 10,000 deliveries). See Table 1 and Appendix A for a complete list and description of SMM indicators.

Figure 5. Leading Diagnosis-Based Indicators of Severe Maternal Morbidity, Nevada, 2016



Leading procedure-based indicators of SMM were blood transfusion (102.3 per 10,000 deliveries), hysterectomy (13.8 per 10,000 deliveries). See Table 1 and Appendix A for a complete list and description of SMM indicators.

Figure 6. Leading Procedure-Based Indicators of Severe Maternal Morbidity, Nevada, 2016

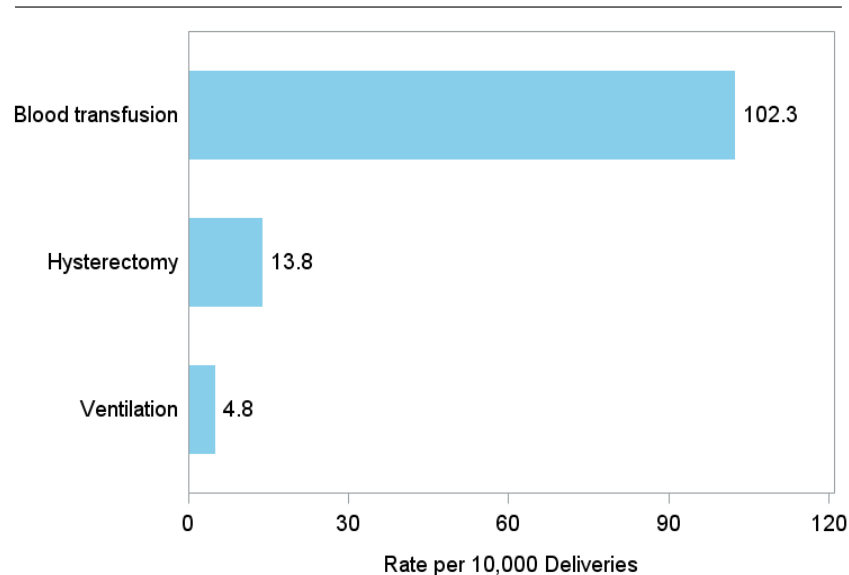


Table 1. Rate of Severe Maternal Morbidity Indicators per 10,000 Deliveries, Nevada, 2016

SMM Indicator	Rate per 10,000 Deliveries
Diagnosis-based Indicators	
Disseminated intravascular coagulation	9.6
Eclampsia	9.3
Sepsis	7.2
Adult respiratory distress syndrome	6.9
Acute renal failure	6.6
Shock	6.6
Pulmonary edema	4.5
Puerperal cerebrovascular disorders	3.0
Thrombotic embolism	1.8
Acute myocardial infarction	0.3
Aneurysm	0.3
Cardiac arrest/ventricular fibrillation	0.3
Amniotic fluid embolism	0.3
Sickle cell anemia with crisis	0.3
Intracranial injuries*	-
Internal injuries of the thorax, abdomen, and pelvis*	-
Heart failure during procedure or surgery	-
Severe anesthesia complication	-
Procedure-based Indicators	
Blood transfusion	102.3
Hysterectomy	13.8
Ventilation	4.8
Conversion of cardiac rhythm	0.6
Cardio monitoring*	-
Operations on the heart and pericardium*	-
Temporary Tracheostomy	-
SMM Rate Overall	127.2

* 4 indicators were not carried over to ICD-10 codes system.

Maternal Demographic Characteristics

Table 2. Severe Maternal Morbidity by Maternal Demographics, Nevada, 2016

	SMM Cases	Rate per 10,000 Deliveries	Total Deliveries	Percent of Total Deliveries	Percent of SMM Cases	Chi-Square P-value
Maternal Age						
<=19	27	137.5	1,963	5.9%	6.4%	0.25
20-24	105	140.1	7,493	22.5%	24.8%	
25-29	113	114.6	9,860	29.6%	26.7%	
30-34	99	115.7	8,554	25.7%	23.3%	
35-39	60	136.1	4,408	13.2%	14.2%	
>=40	20	187.3	1,068	3.2%	4.7%	
Race/Ethnicity						
White non-Hispanic	132	102.3	12,903	38.7%	31.1%	0.006
Black non-Hispanic	76	174.8	4,349	13.0%	17.9%	
AI/AN non-Hispanic	4	127.4	314	0.9%	0.9%	
API non-Hispanic	45	148.1	3,038	9.1%	10.6%	
Hispanic	163	129.9	12,548	37.6%	38.4%	
Other	0	0.0	39	0.1%	0.0%	
Unknown	4	258.1	155	0.5%	0.9%	
Education						
Less than High School	74	121.5	6,092	18.3%	17.5%	0.41
High School Graduate	145	140.4	10,331	31.0%	34.2%	
Some College	122	125.8	9,700	29.1%	28.8%	
College Graduate or Higher	70	109.1	6,415	19.2%	16.5%	
Unknown	13	160.9	808	2.4%	3.1%	
Insurance[^]						
Medicaid	223	136.7	16,310	48.9%	52.6%	0.35
Other Government	12	181.3	662	2.0%	2.8%	
Private	179	115.6	15,489	46.4%	42.2%	
Self-pay	8	121.6	658	2.0%	1.9%	
Other	1	54.3	184	0.6%	0.2%	
Unknown	1	232.6	43	0.1%	0.2%	

[^] Health insurance status indicates the primary payer for the delivery as recorded on hospital discharge form.

When considering the SMM rate including blood transfusions, the SMM is significantly different among mothers with different race and ethnicity (P = 0.006). See page 14 for comparisons of SMM rate among different race and ethnicity groups.

Table 3. Severe Maternal Morbidity without Blood Transfusion by Maternal Demographics, Nevada, 2016

	SMM Cases	Rate per 10,000 Deliveries	Total Deliveries	Percent of Total Deliveries	Percent of SMM Cases	Chi-Square P-value
Maternal Age						
<=19	5	25.5	1,963	5.9%	4.0%	0.004
20-24	19	25.4	7,493	22.5%	15.2%	
25-29	37	37.5	9,860	29.6%	29.6%	
30-34	29	33.9	8,554	25.7%	23.2%	
35-39	25	56.7	4,408	13.2%	20.0%	
>=40	10	93.6	1,068	3.2%	8.0%	
Race/Ethnicity						
White non-Hispanic	43	33.3	12,903	38.7%	34.4%	0.20
Black non-Hispanic	26	59.8	4,349	13.0%	20.8%	
AI/AN non-Hispanic	0	0.0	314	0.9%	0.0%	
API non-Hispanic	12	39.5	3,038	9.1%	9.6%	
Hispanic	44	35.1	12,548	37.6%	35.2%	
Other	0	0.0	39	0.1%	0.0%	
Unknown	0	0.0	155	0.5%	0.0%	
Education						
Less than High School	23	37.8	6,092	18.3%	18.4%	0.51
High School Graduate	40	38.7	10,331	31.0%	32.0%	
Some College	34	35.1	9,700	29.1%	27.2%	
College Graduate or Higher	22	34.3	6,415	19.2%	17.6%	
Unknown	6	74.3	808	2.4%	4.8%	
Insurance[^]						
Medicaid	70	42.9	16,310	48.9%	56.0%	0.29
Other Government	4	60.4	662	2.0%	3.2%	
Private	47	30.3	15,489	46.4%	37.6%	
Self-pay	4	60.8	658	2.0%	3.2%	
Other	0	0.0	184	0.6%	0.0%	
Unknown	0	0.0	43	0.1%	0.0%	

[^] Health insurance status indicates the primary payer for the delivery as recorded on hospital discharge form

When considering the SMM rate without blood transfusions, the SMM is significantly associated with mother’s age (P = 0.004). See page 13 for comparisons of SMM rates among different age groups.

Age was a significant risk factor of SMM without blood transfusion ($P = 0.004$), but age was not a significant factor associated with SMM with blood transfusion ($P = 0.25$), (Tables 2, 3).

Figure 7a. Severe Maternal Morbidity by Maternal Age, Nevada, 2016

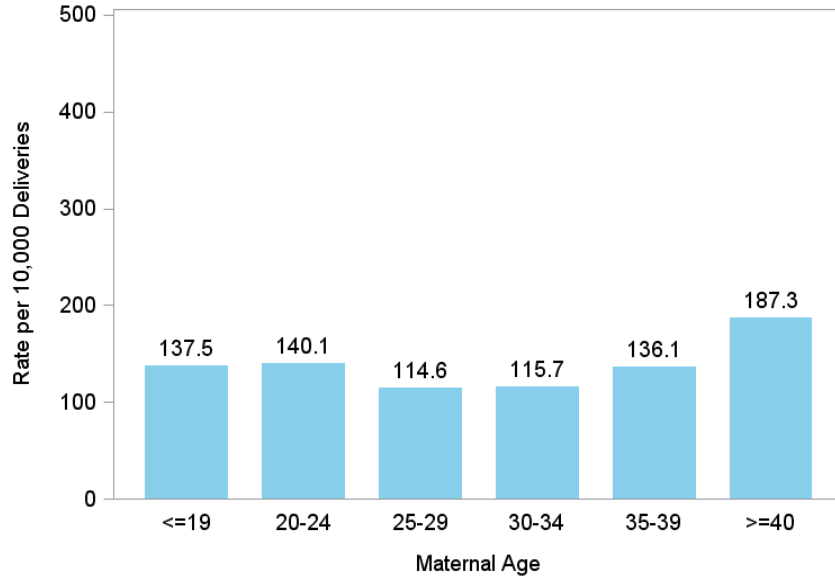
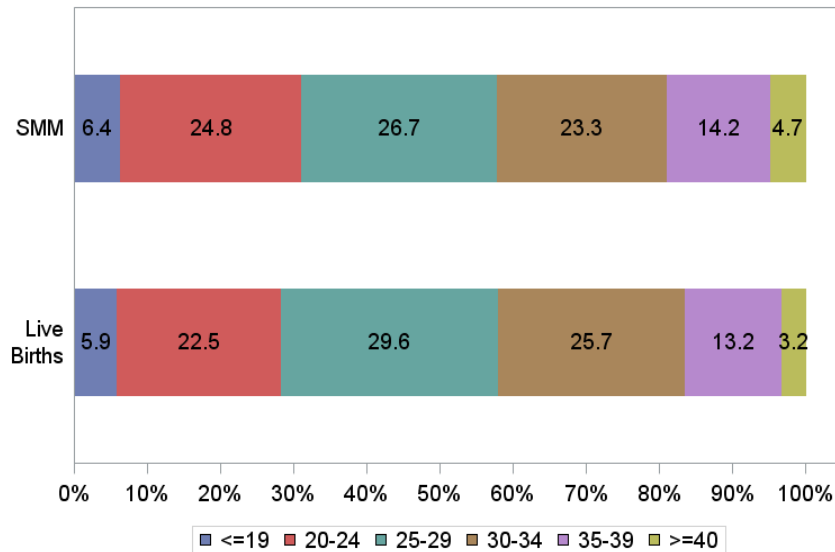


Figure 8a. Distribution of Live Births and Severe Maternal Morbidity by Maternal Age, Nevada, 2016



While women 40 and older giving birth represent over three percent of all deliveries, they comprised eight percent of all SMM cases (Table 3). SMM rate is highest for women ages 40 and older (93.6 per 10,000 deliveries).

Figure 7b. Severe Maternal Morbidity w/o Blood Transfusion by Maternal Age, Nevada, 2016

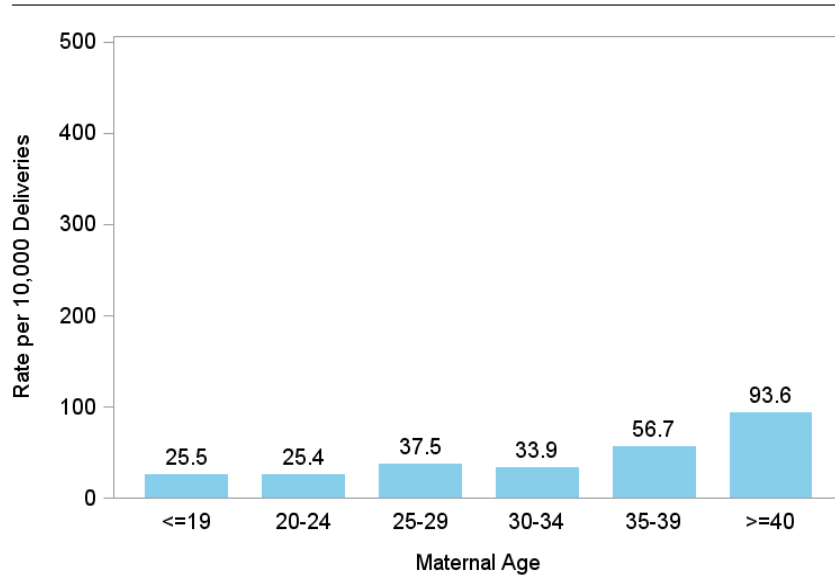
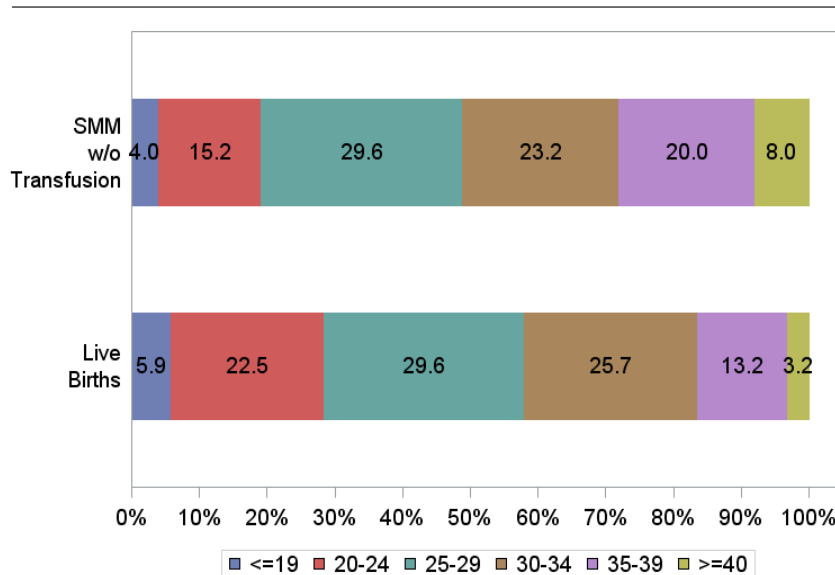


Figure 8b. Distribution of Live Births and Severe Maternal Morbidity w/o Blood Transfusion by Maternal Age, Nevada, 2016



Mother's race/ethnicity is significantly associated with SMM rates with blood transfusion, with $P=0.006$ (Table 2). The SMM rate among Black non-Hispanic women (174.8 per 10,000 deliveries) was higher than that of White non-Hispanic women (102.3 per 10,000 deliveries). Black non-Hispanic women accounted for 13.0% of all deliveries but 17.9% of SMM cases (Table 2). Asian Pacific Islander (API) non-Hispanic (148.1 per 10,000 deliveries) and Hispanic (129.9 per 10,000 deliveries) women also had higher SMM rate than White non-Hispanic women.

Figure 9. Severe Maternal Morbidity by Maternal Race/Ethnicity, Nevada, 2016

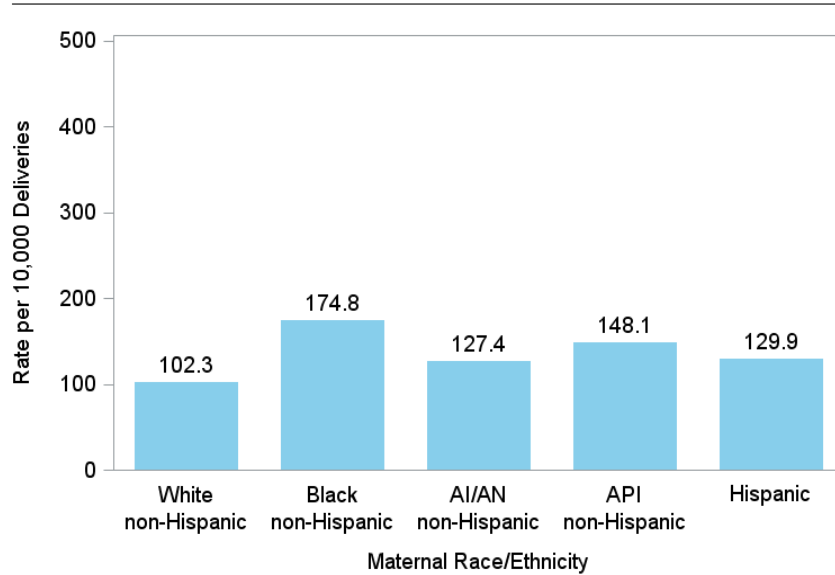
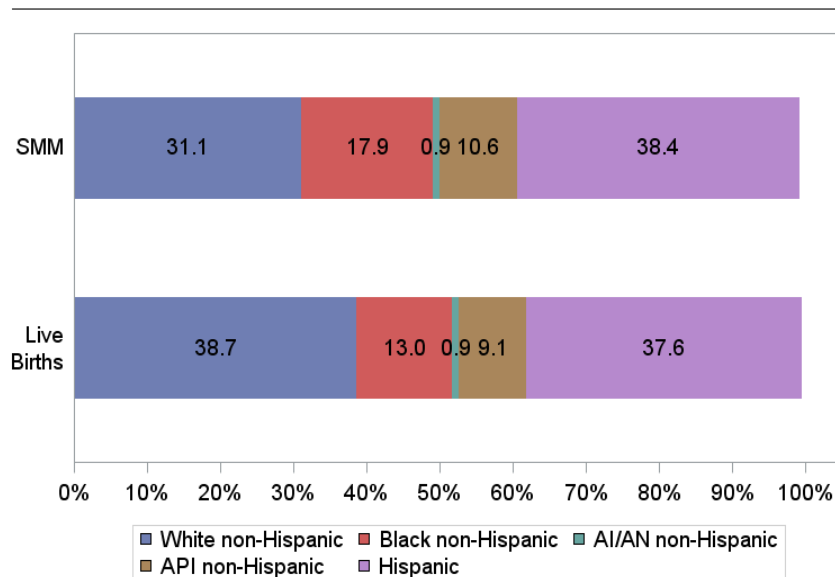


Figure 10. Distribution of Live Births and Severe Maternal Morbidity by Maternal Race/Ethnicity, Nevada, 2016



Prenatal and Delivery Characteristics

Table 4. Severe Maternal Morbidity by Prenatal and Delivery Characteristics, Nevada, 2016

	SMM Cases	Rate per 10,000 Deliveries	Total Deliveries	Percent of Total Deliveries	Percent of SMM Cases	Chi-Square P-value
Prenatal Care Initiation						
No Care	37	251.9	1,469	4.4%	8.7%	<.0001
First Trimester	260	113.4	22,922	68.7%	61.3%	
Second Trimester	78	130.0	5,999	18.0%	18.4%	
Third Trimester	11	100.9	1,090	3.3%	2.6%	
Unknown Start Date	21	298.7	703	2.1%	5.0%	
Unknown	17	146.2	1,163	3.5%	4.0%	
Adequacy of Prenatal Care						
Inadequate	48	123.6	3,882	11.6%	11.3%	<.0001
Intermediate	24	96.4	2,489	7.5%	5.7%	
Adequate	104	85.9	12,103	36.3%	24.5%	
Adequate Plus	171	150.6	11,356	34.1%	40.3%	
Data Missing/Unknown	77	219.0	3,516	10.5%	18.2%	
Parity						
0 Previous Live Births	183	147.6	12,401	37.2%	43.2%	0.0001
1 Previous Live Births	81	83.7	9,679	29.0%	19.1%	
2+ Previous Live Births	160	142.3	11,241	33.7%	37.7%	
Unknown	0	0.0	25	0.1%	0.0%	
Method of Delivery*						
Repeat Cesarean	122	214.5	5,688	17.1%	28.8%	<.0001
Primary Cesarean	153	251.4	6,086	18.3%	36.1%	
Vaginal	149	69.1	21,572	64.7%	35.1%	
Plurality						
Singleton Birth	398	121.3	32,814	98.4%	93.9%	<.0001
Multiple Birth	26	488.7	532	1.6%	6.1%	
Pre-Pregnancy BMI~						
Underweight (<18.5)	18	133.6	1,347	4.0%	4.2%	0.007
Normal Weight (18.5- 24.9)	167	114.7	14,559	43.7%	39.4%	
Overweight (25.0 - 29.9)	117	137.4	8,516	25.5%	27.6%	
Class I (30.0 - 34.9)	47	102.7	4,577	13.7%	11.1%	
Class II (35.0 - 39.9)	28	132.8	2,108	6.3%	6.6%	
Class III (>=40)	26	193.3	1,345	4.0%	6.1%	
Unknown	21	234.9	894	2.7%	5.0%	
Chronic Disease^						
No Chronic Disease	399	122.5	32,563	97.7%	94.1%	<.0001
Any Chronic Disease	25	319.3	783	2.3%	5.9%	

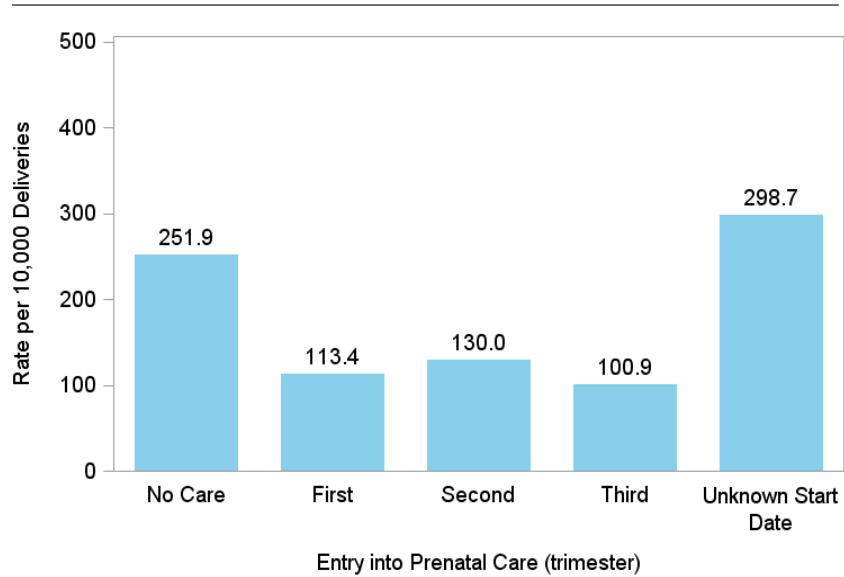
* Method of delivery was identified from hospital discharge data using ICD-10 codes.

~ Pre-pregnancy BMI was calculated using formula (weight (lb) / height (in)²)x 703 with mother's weight and height as recorded on birth certificate.

^ Any chronic disease includes deliveries to women with chronic hypertension, pre-existing diabetes or chronic heart disease as recorded on birth certificate.

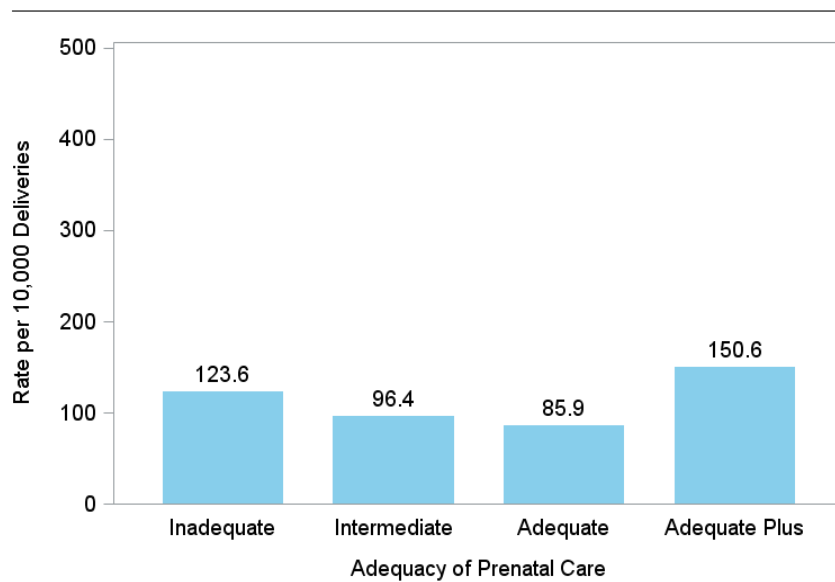
The SMM rate was highest among women who received no prenatal care (251.9 per 10,000 deliveries) or had prenatal care but with an unknown start date (298.7 per 10,000 deliveries). Women who received no prenatal care or received prenatal care but did not know the start date accounted for nearly seven percent of all deliveries but 13.7% of SMM cases (Table 4).

Figure 11. Severe Maternal Morbidity by Time of Entry to Prenatal Care, Nevada, 2016



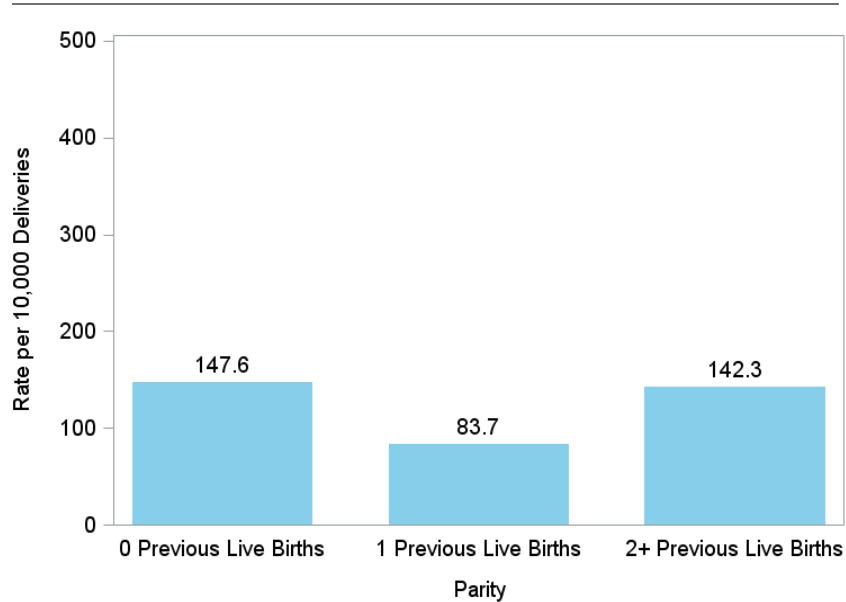
Women with inadequate and adequate plus prenatal care had highest SMM rates (123.6 and 150.6 per 10,000 deliveries, respectively).

Figure 12. Severe Maternal Morbidity by Adequacy of Prenatal Care, Nevada, 2016



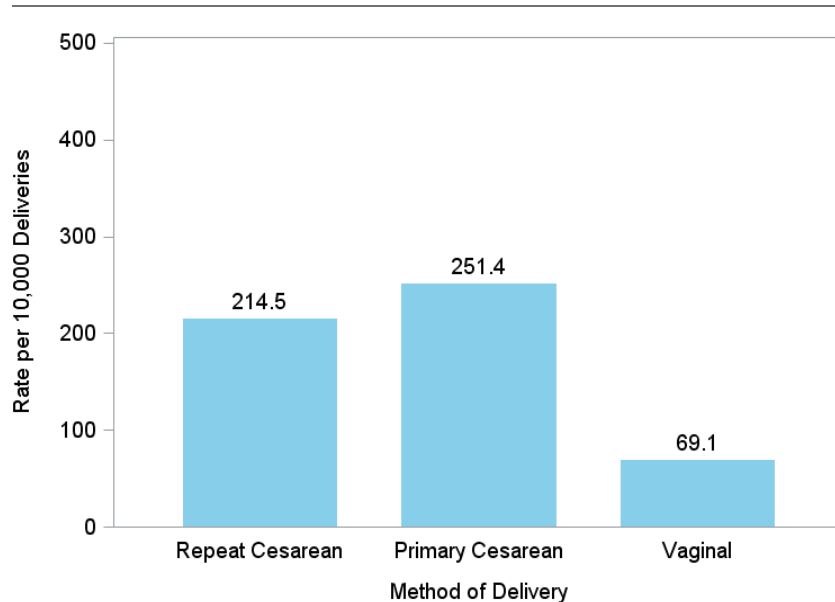
Women with zero previous live births or with two or more previous live births had higher SMM rates (147.6 and 142.3 per 10,000 deliveries, respectively) than women with one previous live birth (83.7 per 10,000 deliveries).

Figure 13. Severe Maternal Morbidity by Parity, Nevada, 2016



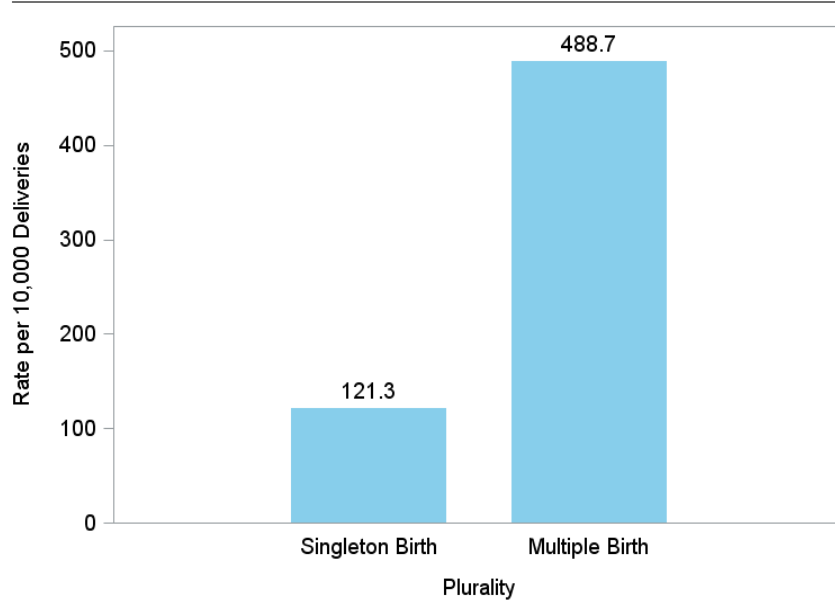
Cesarean deliveries accounted for 35.4% of all live deliveries but 62.3% of SMM cases (Table 4). The SMM rate was higher among women with a repeated or primary cesarean (214.5 and 251.4 per 10,000 deliveries, respectively), compared to women with vaginal birth (69.1 per 10,000 deliveries). Results should be interpreted with caution, since it was difficult to differentiate between morbidity caused by cesarean delivery versus morbidity requiring a cesarean delivery.

Figure 14. Severe Maternal Morbidity by Delivery Type, Nevada, 2016



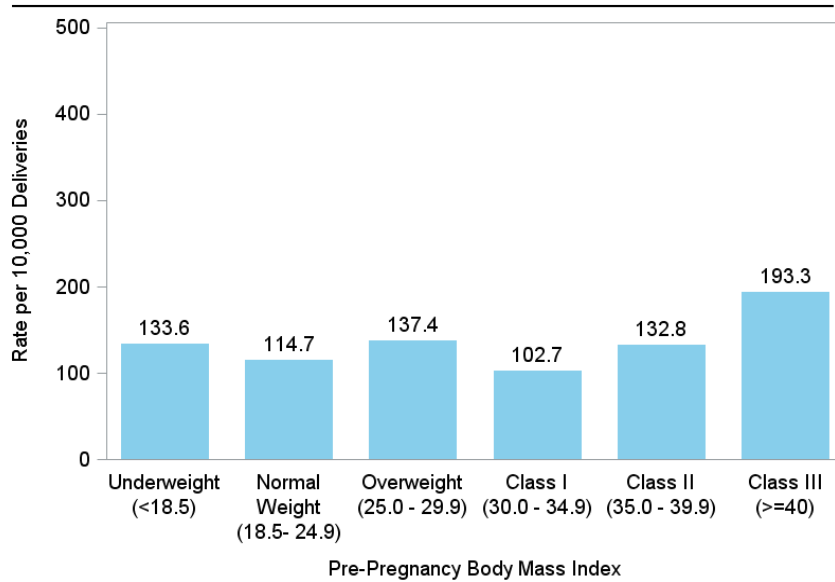
Multiple births accounted for nearly two percent of all deliveries but over six percent of SMM cases (Table 4). The SMM rate was four times higher among women with multiple birth deliveries as among women with singleton births (488.7 versus 121.3 per 10,000 deliveries, respectively).

Figure 15. Severe Maternal Morbidity by Plurality, Nevada, 2016



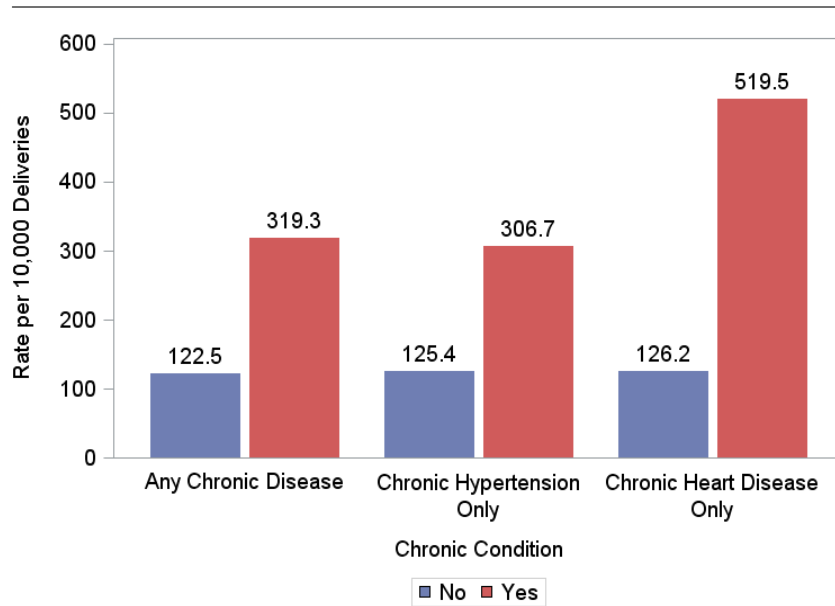
Women who were class III obesity at the time they became pregnant accounted for four percent of all live deliveries but over six percent of SMM cases (Table 4), and had higher rate of SMM than women in the normal weight class (193.3 versus 114.7 per 10,000 deliveries, respectively).

Figure 16. Severe Maternal Morbidity by Pre-Pregnancy Body Mass Index, Nevada, 2016



Women with pre-existing diabetes, chronic heart disease, or chronic hypertension were more than two times as likely to have SMM as women with none of these chronic conditions (319.3 versus 122.5 per 10,000 deliveries, respectively). Women with chronic hypertension only were more than two times as likely to have SMM as women without chronic hypertension (306.7 versus 125.4 per 10,000 deliveries, respectively). Women with chronic heart disease only were more than four times as likely to have SMM as women without chronic heart disease (519.5 versus 126.2 per 10,000 deliveries, respectively). When considering diabetes independent from the other chronic diseases listed here, no significant association was found.

Figure 17. Severe Maternal Morbidity by Chronic Condition, Nevada, 2016



Conclusions

The SMM rate for Nevada was 127.2 per 10,000 deliveries in 2016. The leading indicators of SMM included blood transfusion, hysterectomy, disseminated intravascular coagulation, eclampsia, sepsis and adult respiratory distress syndrome. Mother's age and race/ethnicity are risk factors of SMM. Women 40 and older had the highest SMM rate. Black non-Hispanic women had higher SMM rate than White non-Hispanic women. Prenatal and delivery characteristics such as prenatal care initiation, adequacy of prenatal care, parity, method of delivery, plurality, pre-pregnancy BMI and chronic disease are all risk factors of SMM. Women with no prenatal care had higher SMM rates than women with prenatal care. Women with multiple births are at higher risk to have SMM than women with single births. Women who were class III obesity at the time they became pregnant had higher rates of SMM than women in the normal weight class. Women with an underlying chronic condition such as hypertension, diabetes or heart disease were more than two times as likely to have SMM as women with no chronic conditions.

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Appendix A. Complete List of SMM Indicators and Associated ICD-10-CM Codes

Classification	Severe Maternal Morbidity Indicator	ICD-10/Procedure Codes
Diagnosis	Acute myocardial infarction	121.xx, 122.x
	Aneurysm	171.xx, 179.0
	Acute renal failure	N17.x, O90.4
	Adult respiratory distress syndrome	J80, J95.1, J95.2, J95.3, J95.82x, J96.0x, J96.2x, R09.2
	Amniotic fluid embolism	O88.1x
	Cardiac arrest/ventricular fibrillation	I46.x, I49.0x
	Disseminated intravascular coagulation	D65, D68.8, D68.9, O72.3
	Eclampsia	O15.0x, O15.1, O15.2, O15.9
	Heart failure/arrest during surgery or procedure	I97.12x, I97.13x
	Puerperal cerebrovascular disorders	I60.xx-I68.xx, O22.51, O22.52, O22.53, I97.81x, I97.82x, O873
	Pulmonary edema/Acute heart failure	J81.0, I50.1, I50.20, I50.23, I50.30, I50.31, I50.33, I50.40, I50.41, I50.43, I50.9
	Severe anesthesia complications	O74.0, O74.1, O74.2, O74.3, O89.0x, O89.2
	Sepsis	O85, T80.211A, T81.4XXA, R65.20, A40.x, A41.x, A32.7
	Shock	O75.1, R57.x, R65.21, T78.2XXA, T88.2XXA, T88.6XXA, T81.10XA, T81.11XA, T81.19XA
	Sickle cell disease with crisis	D57.0x, D57.21x, D57.41x, D57.81x
Air and thrombotic embolism	I26.x, O88.0x, O88.2x, O88.3x, O88.8x	
Procedure	Conversion of cardiac rhythm	5A2204Z, 5A12012
	Blood transfusion	30233H1, 30233K1, 30233L1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30240H1, 30240K1, 30240L1, 30240M1, 30240N1, 30240P1, 30240R1, 30240T1, 30243H1, 30243K1, 30243L1, 30243M1, 30243N1, 30243P1, 30243R1, 30243T1, 30233N0, 30233P0, 30240N0, 30240P0, 30243N0, 30243P0
	Hysterectomy	OUT90ZZ, OUT94ZZ, OUT97ZZ, OUT98ZZ, OUT9FZZ
	Temporary tracheostomy	OB110Z4, OB110F4, OB113Z4, OB113F4, OB114Z4, OB114F4
	Ventilation	5A1935Z, 5A1945Z, 5A1955Z