

Severe Maternal Morbidity in Pennsylvania, 2023

**Bureau of Epidemiology &
Bureau of Family Health**

June 2026



pennsylvania
DEPARTMENT OF HEALTH

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Executive Summary

For every pregnancy, there is a continuum of potential outcomes, from an uncomplicated pregnancy, the most common occurrence, to maternal death, the rarest but most severe outcome (Figure 1).¹ Severe maternal morbidity (SMM) is defined as the unexpected outcomes of labor and delivery that result in significant short- or long-term consequences to a

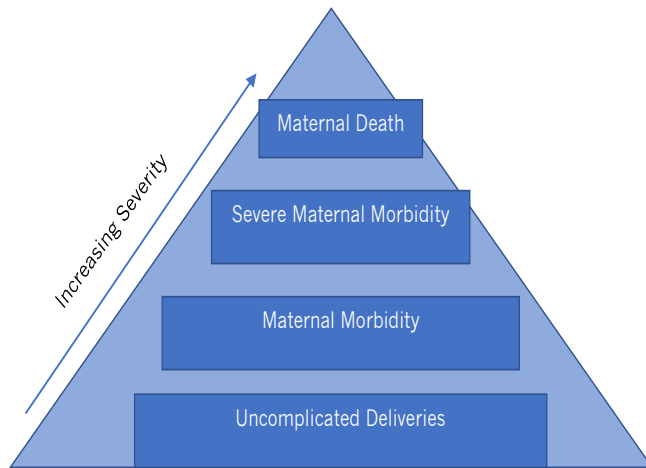


Figure 1 Continuum of Pregnancy Outcomes

woman's health.² Although SMM is considered a rare outcome of pregnancy, the rates of SMM in the United States (US) have steadily increased in recent years.² The negative effects of SMM include, but are not limited to, increased postpartum hospitalization, adverse infant outcomes, and a higher financial burden for more intensive medical care. Preventing SMM and identifying opportunities to improve access and quality of maternal health care to reduce SMM would, in turn, decrease the rate of maternal mortality.³

Generally, SMM risk factors include older maternal age, plurality (twins, triplets, etc.), and pre-existing health conditions.³⁻⁵ There are persistent disparities in SMM rates by race/ethnicity. With trends similar to those seen in maternal mortality, non-Hispanic Black women are at the highest risk for SMM in the U.S. Furthermore, studies have shown a disproportionate burden of SMM on historically marginalized racial/ethnic groups regardless of educational attainment, age, and/or socioeconomic status.^{4,6} In acknowledging the individual-level factors, the coexisting influence of regional and systemic factors can increase the likelihood of SMM for many across the U.S.. Research shows that pregnant individuals living in the Northeast and Southern states, from lower-income communities, and giving birth in public hospitals experience higher rates of SMM on average than their respective counterparts.³ Policy-level factors such as housing affordability have also been linked to higher rates of SMM.⁷

The goal of this report is to provide an update on key contributing factors for SMM in Pennsylvania in 2023, in compliance with the amendment of the Maternal Mortality Review Act to include surveillance of SMM in Pennsylvania.⁸ As with the previous report on 2016-2022 SMM rates and patient characteristics in Pennsylvania, data analyzed for this report were obtained from the Pennsylvania Health Care Cost Containment Council (PHC4). SMM was assessed per 10,000 delivery hospitalizations, and further in categories of seven SMM indicator groups - Hemorrhage Complications, Respiratory Complications, Cardiac Complications, Renal Complications, Sepsis Complications, Other Obstetric Complications, and Other Medical Complications.^{2,9} The individual-level factors that were available to assess include maternal age, racial/ethnic group, health insurance, mode of delivery, and discharge status. At the regional level, the geographic area of residence and the region of the

healthcare facility were assessed. Information obtained from the hospital facility included average length of stay and average total charge for delivery hospitalization. Below are key findings from this report:

- The overall 2023 rate of SMM in Pennsylvania from the 118,268 in-hospital deliveries included in this analysis was 99.9 per 10,000 delivery hospitalizations, a decrease from the 2022 SMM rate of 105.2 per 10,000 delivery hospitalizations.
- As in previous years, more SMM events were categorized as hemorrhage complications compared to other SMM indicator groups.
- The highest rate of SMM in 2023 was observed among women aged 35 years and older, Non-Hispanic American Indian/Alaska Native women, women residing in urban geographic areas, those with Medicaid/Medicare as their primary payer, and women who delivered by cesarean section. -
- Women who experienced an SMM had an average length of stay that was almost four days longer and had approximately \$68,000 higher total charge for delivery discharge compared to those who did not experience an SMM event.

Methods

Data Source and Identification of Severe Maternal Morbidity

The data source for this report is the 2023 inpatient hospital discharge data and healthcare facility information from the Pennsylvania Health Care Cost Containment Council (PHC4), comparing to data from previous years. The inpatient hospitalization discharge data contain patient demographic characteristics such as age, gender, and race/ethnicity, and patient county of residence at the time of hospitalization, in addition to the International Classification of Diseases-10-Clinical Modification (ICD-10-CM) diagnoses and procedure codes (including Medicare Severity Diagnosis Related Groups (MS-DRG) which were used to determine delivery hospitalization (Appendix).

The Centers for Disease Control and Prevention (CDC) developed an algorithm to identify SMM events during delivery hospitalization. This algorithm consists of 21 indicators of SMM, with 16 diagnoses (serious complications during pregnancy or labor and delivery) and 5 procedural (procedures used to manage serious conditions). Each indicator has one or more corresponding ICD-10-CM or ICD-10-PCS diagnosis and procedure codes (Appendix). The ICD-10-CM and ICD-10-PCS codes were used in this analysis to categorize SMM conditions into seven SMM indicator groups as recommended by the Alliance for Innovation on Maternal Health (AIM, Table 1).⁹

Table 1: Severe Maternal Morbidity Indicators and Indicator Groups

SMM Indicator Groups	SMM Indicators
Hemorrhage Complications	Disseminated intravascular coagulation Shock Hysterectomy
Respiratory Complications	Adult respiratory distress syndrome Temporary tracheostomy Ventilation
Cardiac Complications	Acute myocardial infarction Aneurysm Cardiac arrest/ventricular fibrillation Conversion of cardiac rhythm Heart failure/arrest during surgery or procedure Pulmonary edema/acute heart failure
Renal Complications	Acute renal failure
Sepsis Complications	Sepsis
Other Obstetric Complications	Amniotic fluid embolism Eclampsia Severe anesthesia complications Air and thrombotic embolism
Other Medical Complications	Puerperal cerebrovascular disorders Sickle cell disease with crisis

As patients may have multiple SMM indicators, including diagnoses of complications and managing procedures, the inputs of this data set were analyzed as events, and the SMM rate

was calculated per 10,000 delivery hospitalizations. In addition, only the initial inpatient hospitalization for delivery was included in this analysis; subsequent hospitalizations were not included. To ensure that only the SMM cases were captured, the analysis was applied to deliveries among females ages 12-55 years at the time of admission for delivery hospitalization at community hospitals (i.e., excluding freestanding birth centers, federal hospitals, long-term, rehabilitation hospitals). Patients that were missing information on age or sex were excluded from this analysis, as were delivery hospitalizations that only indicated a blood transfusion procedure.

Findings

SMM Rates in Pennsylvania, 2023

There were 300,082 inpatient hospitalizations among patients reported to be females age 12-55 years with a discharge record in 2023. Forty of all female patients were missing information on age, one of whom had an ICD-10 delivery code. Of all the patients age 12 to 55 years in 2023, 130 had missing or unknown sex, one of whom had an ICD-10 delivery code. The analytic sample for 2023 included a total of 118,268 female patients age 12 to 55 years with delivery hospitalization discharge records, 1,181 (1%) of which experienced at least one SMM event.

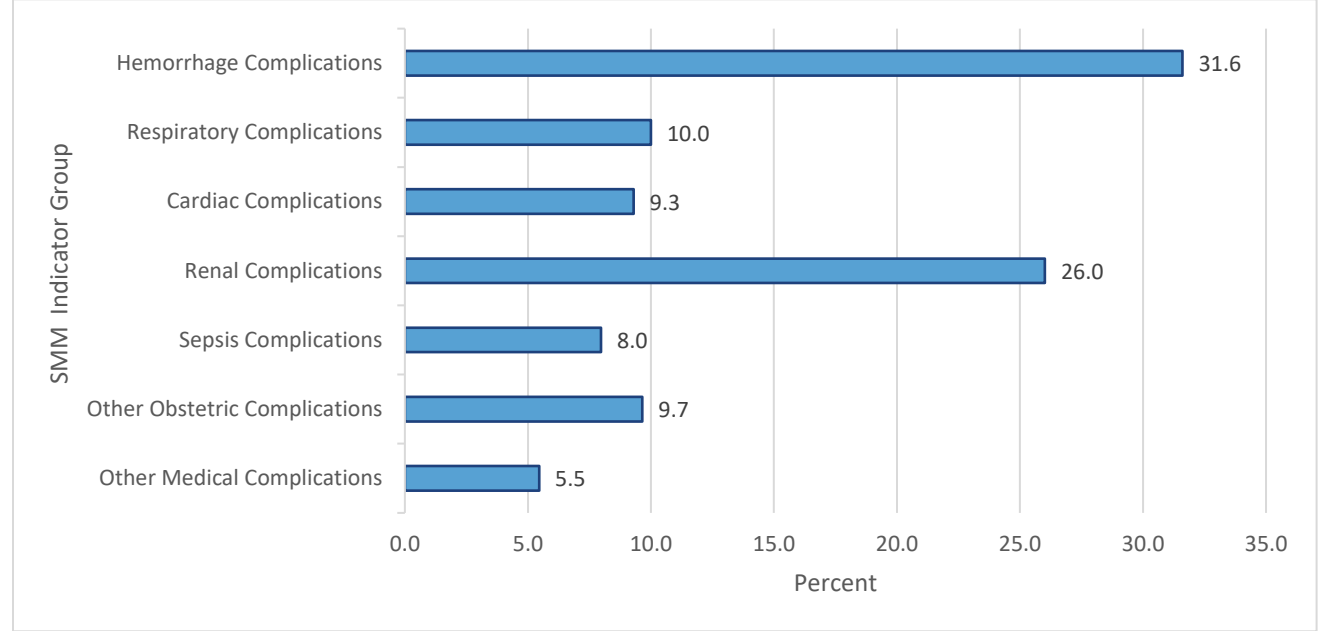
The SMM rate was 99.9 per 10,000 total delivery hospitalizations in 2023, a 5% decrease from 2022. Looking at the data over multiple years, the rate of SMM in Pennsylvania peaked in 2021 (Table 2). Specifically, the SMM rate increased an annual average of 7.8% from 2016 to 2021 and decreased an annual average of 4.7% from 2021 to 2023.

Table 2: Number and Rate of SMM in Pennsylvania Hospital Deliveries, 2016 to 2023

Year	SMM In-Hospital Deliveries	Total In-hospital Deliveries	Rate per 10,000 delivery hospitalizations
2016	995	132,320	75.2
2017	1,006	130,359	77.2
2018	1,014	128,428	79.0
2019	1,121	126,329	88.7
2020	1,133	122,433	92.5
2021	1,359	123,569	110.0
2022	1,266	120,366	105.2
2023	1,181	118,268	99.9
Total	9,075	1,002,072	90.6

Among all SMM events in 2023, Hemorrhage Complications and Renal Complications were the most common (Figure 2).

Figure 2: SMM Indicator Groups Among All SMM Events, 2023



Patient Characteristics

Table 3 summarizes the proportion and rates of SMM by the available patient characteristics, for which the rates are subsequently further explored by SMM indicator group. Figure 3 compares the proportions of patient characteristics among all hospital deliveries and deliveries in which an SMM was experienced.

Summary of SMM rates by patient characteristics:

- *Age*: The highest rate of SMM was observed among women aged 35 years and older, followed by ages 30-34 and the lowest rate was among women age <20 years.
- *Race/ethnicity*: Non-Hispanic Black women had the highest rate of SMM.
- *Geographic area of residence*: Women who resided in urban counties at the time of delivery hospitalization had a higher rate of SMM compared to those residing in rural counties
- *Health Insurance*: Women with Medicaid/Medicare coverage had the highest rates of SMM (115.7 per 10,000 delivery hospitalizations), and those who were uninsured had the lowest rates of SMM (81.4 per 10,000 delivery hospitalizations). To note, only 2.5% of all the deliveries were among women without health insurance..
- *Mode of Delivery*: Women who delivered via cesarean section had higher rates of SMM (199.3 per 10,000 delivery hospitalizations) than women who had a vaginal delivery(52.1 per 10,000 delivery hospitalizations).
- *Discharge Status*: Four of the five women who died in-hospital following a delivery also experienced an SMM event.

Table 3: Characteristics of Women Ages 12-55 years Who Experienced an SMM Event, Pennsylvania, 2016-2022

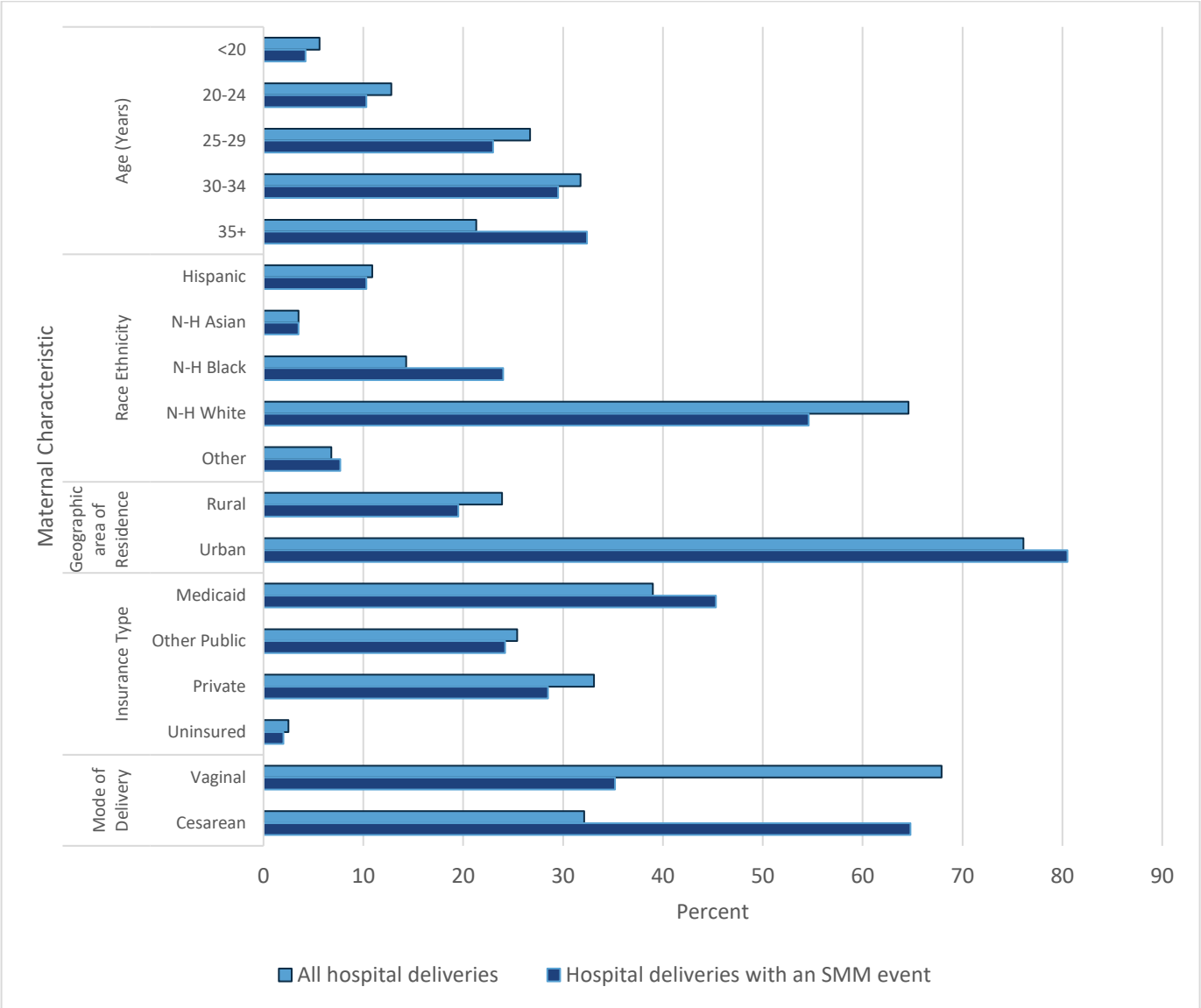
Patient characteristics	Number of deliveries with any SMM	Percent of Deliveries with any SMM N=1181	Total delivery hospitalizations (% of total) N=118,268	Rate of any SMM per 10,000 total delivery hospitalizations
Age group (years)				
<20	49	4.2	6,575 (5.6)	74.5
20-24	121	10.3	15,120 (12.8)	80.0
25-29	271	23.0	31,584 (26.7)	85.8
30-34	357	30.2	39,630 (33.5)	90.1
35+	383	32.4	25,363 (21.4)	151.0
Race/Ethnicity				
Hispanic	121	10.3	12,829 (10.9)	94.3
Non-Hispanic Asian	41	3.5	4,098 (3.5)	100.0
Non-Hispanic Black	283	24.0	16,850 (14.3)	167.9
Non-Hispanic White	645	54.6	76,416 (64.6)	84.4
Other *	91	7.7	8,075 (6.8)	112.7
Geographic area of Residence				
Rural	230	19.5	28,263 (23.9)	81.4
Urban	951	80.5	90,009 (76.1)	105.7
Health Insurance **				
Medicaid/Medicare	535	45.3	46,224 (39.1)	115.7
Other Public	286	24.2	30,021 (25.4)	95.3
Commercial Insurance	336	28.5	39,079 (33.0)	86.0
Uninsured	24	2.0	2,948 (2.5)	81.4
Mode of Delivery				
Vaginal	416	35.2	79,894 (67.5)	52.1
Cesarean Section	765	64.8	38,378 (32.5)	199.3
Discharge Status				
Discharged/Transferred	1177	99.7	118,267 (100)	99.5
Died in-hospital	4	0.3	5 (0.0)	8,000

χ^2 p-value for all characteristics < 0.001

*'Other' race/ethnicity includes individuals who had two or more races, unknown race/ethnicity, Non-Hispanic Native Hawaiian or Pacific Islander, and Non-Hispanic American Indian/Alaska Native

**Health insurance status indicates the primary payer for the delivery as recorded on the hospital discharge form. Commercial insurance includes commercial carriers, private health maintenance organizations (HMOs), and preferred provider organizations (PPOs); Other Public Insurance includes military insurance, Indian Health Service, and other federal, state, or local government payment sources; Uninsured includes self-pay and charity/indigent care.

Figure 3. Maternal Characteristics Among All Hospital Deliveries in Pennsylvania (N=118,268) and Among Hospital Deliveries with an SMM (n=1181), 2023

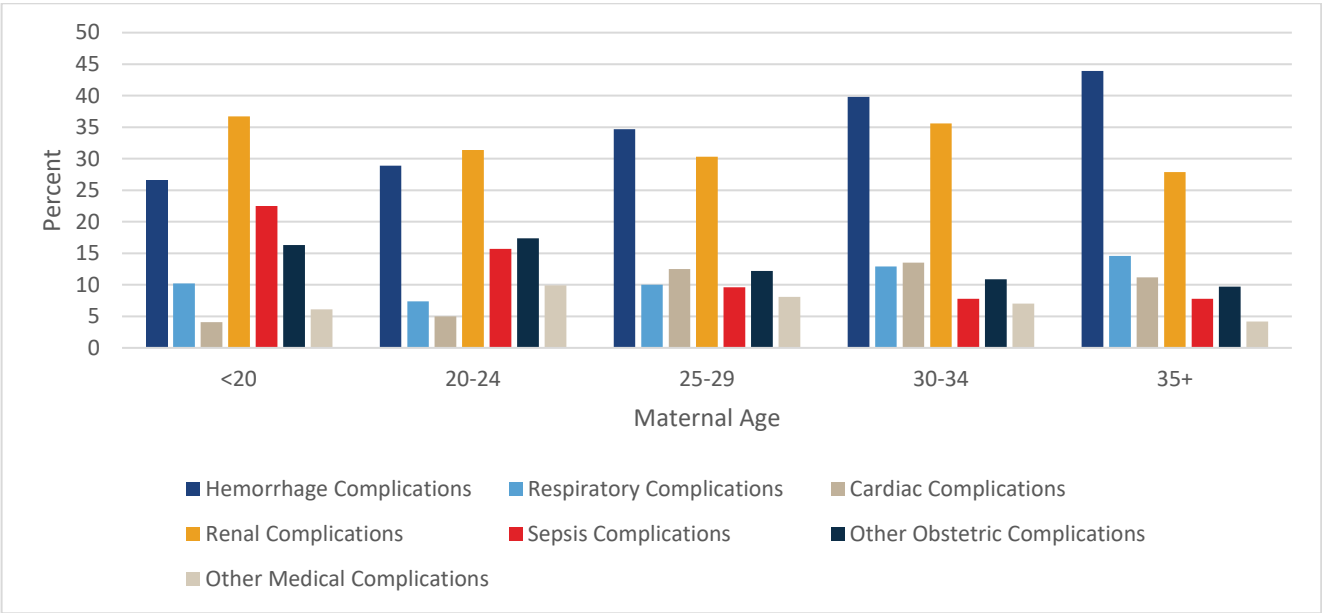


Note: ‘Other’ includes individuals who had two or more races, unknown race/ethnicity, Non-Hispanic Native Hawaiian or Pacific Islander, and Non-Hispanic American Indian/Alaska Native

SMM & Maternal Age

Figure 4 shows the proportion of each SMM indicator group within age categories. Among those aged 25-29, 30-34, and 35+ years old, Hemorrhage Complications were the most frequent SMM events. Furthermore, the proportion of Hemorrhage Complications increased with increasing age groups, from 26.5% in the <20-year-old group to 43.9% in the 35+ age group. Conversely, among those aged <20 and 20-24 years old, Renal Complications were the most frequent SMM events.

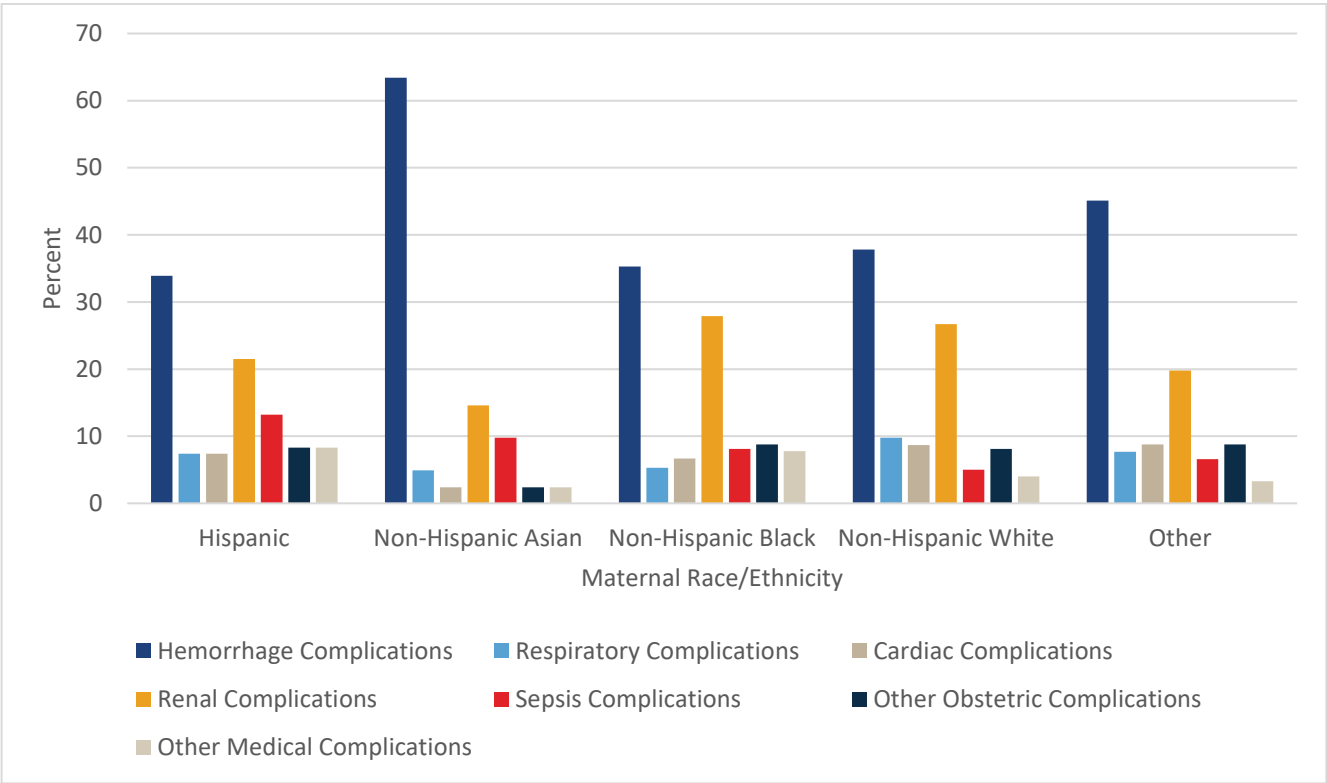
Figure 4: SMM Indicator Groups by Age Category, 2023



Severe Maternal Morbidity & Maternal Race/Ethnicity

For all race/ethnicity groups, Hemorrhage Complications was the most common SMM indicator group (Figure 5).

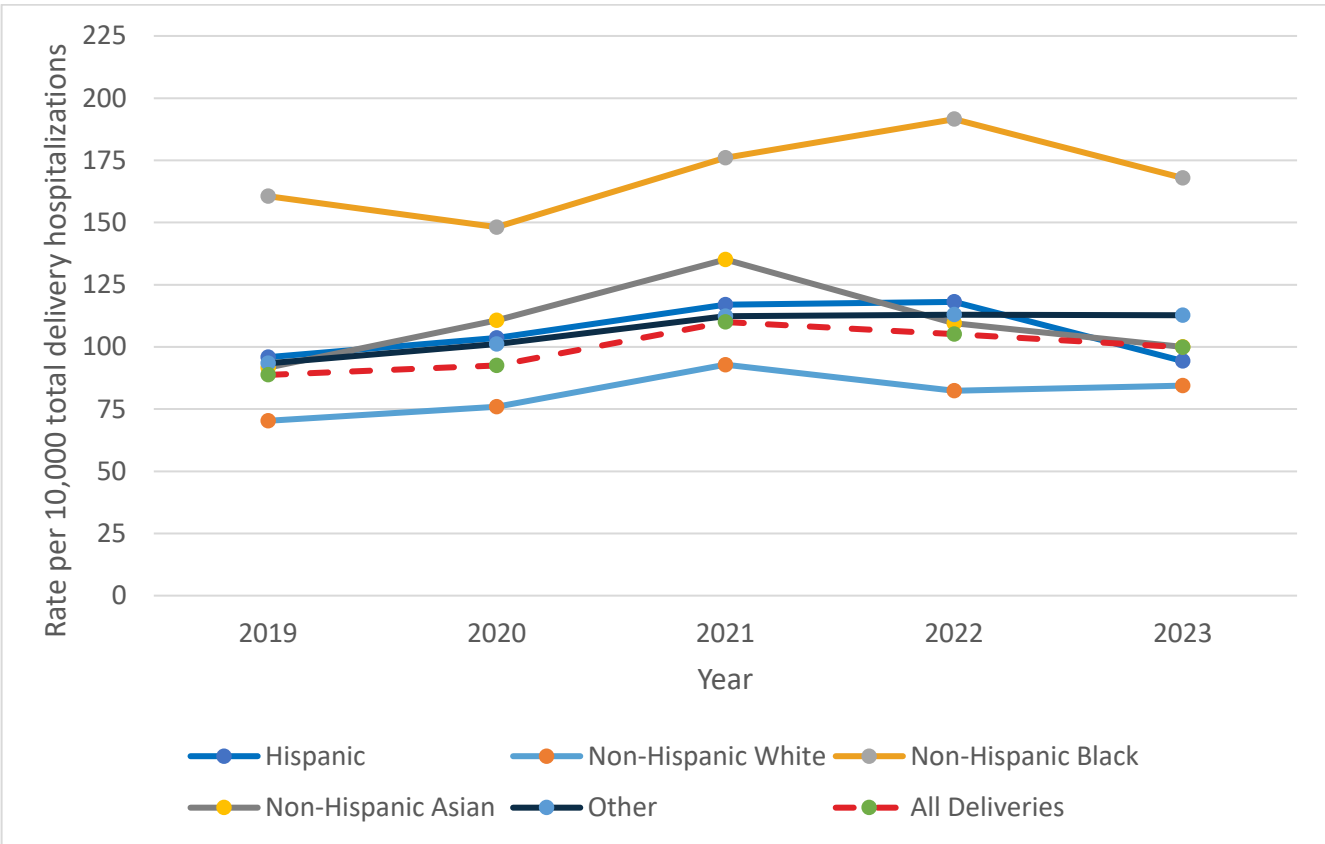
Figure 5: SMM Indicator Groups by Race/Ethnicity Among Hospital Deliveries with an SMM (N=1181), 2023



Note: 'Other' includes individuals who had two or more races, unknown race/ethnicity, Non-Hispanic Native Hawaiian or Pacific Islander, and Non-Hispanic American Indian/Alaska Native

Figure 6 and Table 4 provide insights into trends in the rate of overall SMM by race/ethnicity in Pennsylvania over a 5-year period, from 2019 to 2023. The SMM rates were highest among non-Hispanic Black women compared to the other race/ethnicities.

Figure 6: Rates of SMM by Race/Ethnicity, 2019-2023



Note: 'Other' includes individuals who had two or more races, unknown race/ethnicity, Non-Hispanic Native Hawaiian or Pacific Islander, and Non-Hispanic American Indian/Alaska Native

Table 4 displays the rates of SMM per 10,000 delivery hospitalizations for all deliveries and for each race/ethnicity group by year from 2019 to 2023. The table also includes the average annual percent change, which provides an estimate of the average increase or decrease in SMM rates each year over this five-year period. The SMM rates for Non-Hispanic white women were the only rates that increased between 2022 and 2023.

The overall trend in SMM across all race/ethnicity groups indicates an increase in rates across the five-year period. The increasing trend was statistically significant for Non-Hispanic white women. The average annual percent increase for non-Hispanic white women (4.5%) was higher than the percent increase in SMM events among all deliveries over this period (3.6%).

Table 4: Rates of SMM & Average Annual Percentage Change by Race/Ethnicity, 2019-2023

			Year				
Race/Ethnicity	2019	2020	2021	2022	2023	Average Annual percentage change (%) [±]	P-value for trend
<i>All deliveries</i>	88.7	92.5	110.0	105.2	99.9	3.6	<0.001
Hispanic	95.9	103.6	116.9	118.1	94.3	0.9	0.745
Non-Hispanic Asian	91.7	110.7	135.1	109.5	100	1.4	0.772
Non-Hispanic Black	160.6	148.2	176.0	191.5	167.9	3.6	0.050
Non-Hispanic White	70.3	75.9	92.8	82.4	84.4	4.5	0.001
Other**	93.4	101.1	112.3	112.9	112.7	4.9	0.152

[±] Average annual percentage change estimated using log-binomial models

**Other race/ethnicity includes individuals who had two or more races, unknown race/ethnicity, Non-Hispanic Native Hawaiian or Pacific Islander, and Non-Hispanic American Indian/Alaska Native

SMM & Geographic Area of Residence

County of residence at the time of hospitalization for each patient was categorized into urban or rural based on the definitions provided by The Center for Rural Pennsylvania.¹⁰ Based on the patient's residential location, 80.5% of deliveries with an SMM occurred among women living in an urban county at the time of hospitalization, and 19.5% were among those living in rural counties. Of the total delivery hospitalizations in Pennsylvania in 2023, 76.1%, among women living in urban counties and 23.9% were among women living in rural counties.

Rates of the SMM Indicator groups by urban or rural areas of residence (Table 5) show:

- The overall rate and the rate for the Renal SMM Indicator group were higher in urban than in rural areas (statistically significant).
- The only rate that was higher for those residing in rural than urban areas was the Other Obstetric Complications SMM Indicator group. However, this difference was not statistically significant.

As previously noted, it is possible for a patient to have multiple SMM indicators; thus, in the following tables, the sum of all indicators may be greater than the overall number of individuals who experienced at least one SMM.

Table 5: SMM Indicator Group Rates by Geographic Area of Residence, 2023

Geographic Area					
Severe Maternal Morbidity Indicator Group	Urban		Rural		p-value
	N	Rate	N	Rate	
Overall	951	105.7	230	81.4	<0.001
Hemorrhage Complications	359	39.9	93	32.9	0.097
Respiratory Complications	111	12.3	32	11.3	0.670
Cardiac Complications	107	11.9	26	9.2	0.240
Renal Complications	318	35.3	54	19.1	<0.001
Sepsis Complications	94	10.4	20	7.1	0.112
Other Obstetric Complications	98	10.9	40	14.2	0.161
Other Medical Complications	65	7.2	13	4.6	0.134

Note: rate of SMM calculated per 10,000 delivery hospitalizations

SMM & Health Insurance

In 2023, rates of SMM were highest for women whose primary health insurance was Medicaid/Medicare (and lowest for individuals who were uninsured).

Examining the SMM Indicator groups by primary health insurance (Table 6):

- Hemorrhage Complication were the highest SMM Indicator group for people with all insurance types except those who had other public insurance; for them, Renal Complications was the most common SMM.
- The differences in SMM Indicator group rates between health insurance types were statistically significant for Respiratory, Sepsis, and Other Medical Complications, but not overall.

Table 6: SMM Indicator Group Rates by Health Insurance, 2023

SMM Indicator Group	Health Insurance								P-value
	Medicare/ Medicaid		Other Public		Commercial		Uninsured		
	N	Rate	N	Rate	N	Rate	N	Rate	
Overall	535	115.7	286	95.3	336	86.0	24	81.4	<0.001
Hemorrhage Complications	192	41.5	110	36.6	139	35.6	11	37.3	0.173
Respiratory Complications	74	16.0	31	10.3	35	9.0	3	10.2^	0.004
Cardiac Complications	60	13.0	24	8.0	46	11.8	3	10.2^	0.528
Renal Complications	139	30.1	111	37.0	116	29.7	6	20.4^	0.685
Sepsis Complications	74	16.0	19	6.3	20	5.1	1	3.4^	<0.001
Other Obstetric Complications	62	13.4	32	10.7	40	10.2	4	13.6^	0.238
Other Medical Complications	42	9.1	14	4.7	20	5.1	2	6.8^	0.032

Note: rate of SMM calculated per 10,000 hospitalizations

^ – Rates for <10 events may not be statistically reliable

**Commercial insurance includes commercial carriers, private health maintenance organizations (HMOs), and preferred provider organizations (PPOs); Other Public Insurance includes military insurance, Indian Health Service, and other federal, state, or local government payment sources; Uninsured includes self-pay and charity/indigent care.

SMM & Mode of Delivery

A larger proportion of cesarean section deliveries had an SMM event compared to vaginal deliveries (64.8% vs 35.2%). This is consistent with findings that the risk of SMM is increased among cesarean deliveries.⁵ Furthermore, some SMM indicators, such as eclampsia, may lead to delivery by cesarean section.¹¹

There was a statistically significant increased rate of all SMM Indicator groups among cesarean section deliveries compared to vaginal deliveries (X^2 p-value < 0.001). The highest rate of SMM Indicator groups was Hemorrhage Complications among cesarean section deliveries (Table 7).

Table 7: SMM Indicator Group Rates by Mode of Delivery, 2023

SMM Indicator Group	Mode of Delivery			
	Vaginal		Cesarean Section	
	N	Rate	N	Rate
<i>Overall</i>	416	52.1	765	199.3
Hemorrhage Complications	163	20.4	289	75.3
Respiratory Complications	30	3.8	113	29.4
Cardiac Complications	38	4.8	95	24.8
Renal Complications	109	13.6	263	68.5
Sepsis Complications	54	6.8	60	15.6
Other Obstetric Complications*	58	7.3	80	20.8
Other Medical Complications	32	4.0	46	12.0

Note: rate of SMM calculated per 10,000 delivery hospitalizations

Hospital and Delivery Characteristics

Table 8 shows the hospital and delivery characteristics provided by the medical facilities.

Hospital Type: The majority of SMM cases occurred at General Acute Care Hospitals (99.9%), which are the most common type of facilities that provide short-term inpatient medical care, as opposed to long-term care facilities (excluded for this analysis).

Hospital Region: The highest rate of SMM during this period was observed in PHC4 Region 9 while the lowest rate was in Region 2 (see Appendix for PHC4 region map). The difference in SMM prevalence by hospital region was statistically significant ($p < .0001$).

Type of Visit: Of all deliveries with any SMM,

- 7.0% were indicated as an emergency, meaning the patient required immediate medical intervention as a result of severe, life threatening, or potentially disabling conditions.
- 41.0% were indicated as urgent, meaning the patient required immediate attention for the care and treatment of a physical or mental disorder.
- 51.5% were indicated as elective, meaning the patient's condition permitted adequate time to schedule the services.
- 0.3% were indicated as trauma, meaning a visit to a trauma center/hospital as licensed or designated by the state or local government authority authorized to do so, or as verified by the American College of Surgeons and involving a trauma activation.

Table 8: Hospital and Delivery Characteristics, Pennsylvania, 2023

Hospital and Delivery Characteristics	Number of deliveries with any SMM	Deliveries with any SMM (%)	Rate of any SMM per 10,000 total delivery hospitalizations	p-value
Hospital Type				
Specialty General Acute Care Hospital	1	0.08	20.1	0.073
General Acute Care Hospital	1180	99.9	100.2	
Hospital Region*				
1	266	22.5	125.1	< 0.001
2	28	2.4	42.3	
3	17	1.4	52.0	
4	45	3.8	78.8	
5	153	13.0	78.7	
6	47	4.0	67.0	
7	177	15.0	136.3	
8	192	16.2	75.3	
9	256	21.7	155.3	
Priority (Type) of Visit				
Emergency	83	7.0	208.2	<0.001
Urgent	484	41.0	114.6	
Elective	608	51.5	84.8	
Trauma	4	0.3	1739.1	

*See Appendix of Map of Regions Designated by PHC4
Rates calculated for n <10 may not be reliable

SMM, Average Length of Stay, & Total Charge

In 2023, the average length of stay for deliveries with an SMM was 6 days in the hospital, compared to less than 3 days for deliveries with no SMM (Table 9). The average total charge for a delivery discharge with an SMM event was \$99,592.81. For deliveries with no SMM, the average total charge was \$30,776.36. Total charge is defined by PHC4 as the sum of room and board, ancillary, drug, equipment, specialty, and miscellaneous charges (does not include professional fees).

Table 9: Average Length of Stay and Total Charge for Delivery Hospitalizations, 2023

	<i>Deliveries with no SMM</i>	<i>Deliveries with any SMM</i>
Average Length of Stay	2.7 days	6.1 days
Average total charge for delivery discharge	\$30, 776.36	\$99,592.81

By health insurance, the longest average length of stay and highest total charge was among Medicaid/Medicare recipients who experienced any SMM (Table 10). Uninsured patients who did not experience an SMM had the shortest stay and lowest total charges.

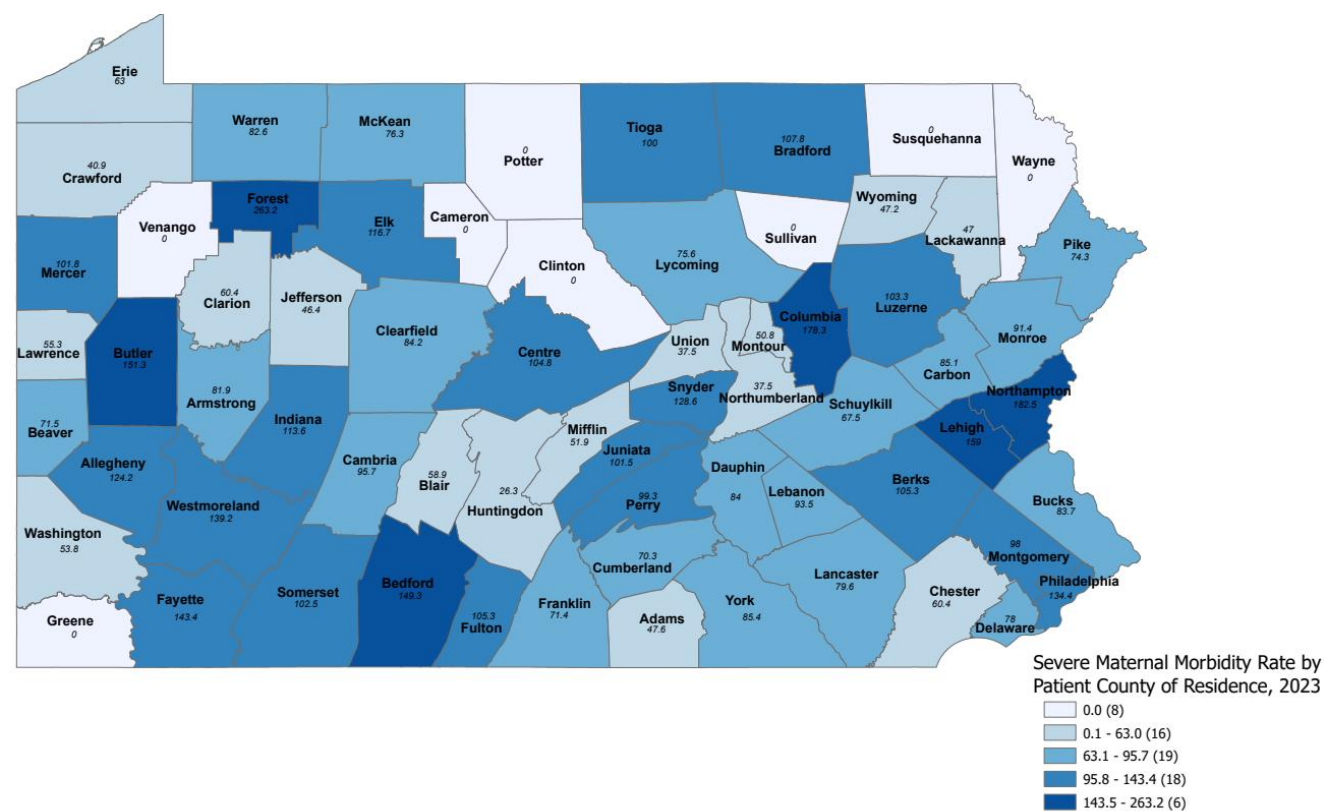
Table 10: Average Length of Stay and Total Charge by Health Insurance and SMM, 2023

	<i>All deliveries</i>		<i>Deliveries with no SMM</i>		<i>Deliveries with any SMM</i>	
Health Insurance	Average Length of Stay (days)	Total Charge	Average Length of Stay (days)	Total Charge	Average Length of Stay (days)	Total Charge
Medicaid /Medicare	2.7	\$ 33,134	2.7	\$ 32,278	6.2	\$ 106,220
Other Public	2.7	\$ 30,321	2.7	\$ 29,627	6.0	\$ 99,354
Commercial Insurance	2.7	\$ 30,654	2.7	\$ 30,130	5.9	\$ 91,060
Uninsured	2.4	\$ 27,635	2.4	\$ 27,254	5.5	\$ 74,164

SMM Rates by County in Pennsylvania, 2023

Figure 7 shows the overall rates of SMM per 10,000 delivery hospitalizations within each Pennsylvania county in 2023, based on the patient county of residence at the time of hospitalization. Counties with lower rates of SMM are indicated in a very light blue, and counties with higher rates are a dark blue. Using natural groupings of rates from high to low (Jenks Natural Breaks algorithm),¹² the maps allow for comparison of rates of SMM across counties.

Figure 7: Rates of SMM in PA per 10,000 Delivery Hospitalizations, 2023



Discussion

As with previous years, the majority of all SMM events in Pennsylvania were Hemorrhage Complications. Furthermore, pregnant women who experienced SMM are disproportionately older and of a racial and ethnic minority group. Although the majority of SMM events occur among non-Hispanic white women, the rate of SMM in Pennsylvania shows continued racial and ethnic disparities, with the highest rates in 2023 among non-Hispanic Black women. In addition, women insured with Medicaid had higher rates of SMM events as did women living in urban counties. Most of the SMM cases observed occurred in hospitals designated as general acute care. The hospital region with the highest SMM rate was Region 9, which includes only Philadelphia County. Maternal age, race/ethnicity, geographic area of residence, health insurance status, and mode of delivery were all significantly associated with SMM in 2023. The characteristics of SMM cases in Pennsylvania are consistent with data from other states and studies that examine the individual risk factors associated with SMM.^{3–5}

Compared to previous years, the overall rate of SMM in Pennsylvania continued to decrease following a peak in 2021. Notable differences in SMM rates between the various race/ethnicity groups, counties, and regions warrant further research and analysis. A better understanding of the underlying factors contributing to these observed patterns can help inform public health efforts and policies to improve maternal health outcomes.

Limitations of Analysis

While this report provides continued understanding of SMM and the associated individual and regional level factors in Pennsylvania, several limitations should be considered when reviewing these findings. The primary intended use of inpatient hospital billing and coding data is for reimbursement and therefore may have inaccuracies in patient sociodemographic characteristics and may introduce biases in coding related to variability across facilities.¹³ The findings obtained in this analysis capture neither the SMM occurrences among non-hospital deliveries (5% of live births in PA in 2023¹⁴), nor the events that occur after delivery hospitalization discharge. It has been noted that 14%-16% of SMM cases occur postpartum, within six weeks after hospital discharge.¹⁵ In addition, the effect of pre-existing conditions, comorbidities, or the diagnosis of more than one SMM indicator was not examined for this report. The indicators used were only primary indicators and only coded once. This report cannot be used to determine SMM rates when two complications occur at the same time (e.g., hemorrhage leading to acute renal failure). Lastly, although approximately 95% of PA births occur in hospitals, the sum of the delivery hospitalizations in this analysis is based on the accurate recording of delivery related ICD-10 codes on maternal discharge records among females age 12-55 years. The total number of delivery hospitalizations included in this analysis is not directly comparable to the total number of live births in PA based on birth certificate records of all infants born in PA.

Conclusion

SMM is an important public health concern which, without intervention, can lead to poor quality of life and mortality. Through Commonwealth-led initiatives such as the Pennsylvania Maternal Health Strategic Action Plan, multiple state and local government agencies have

prioritized efforts to decrease maternal morbidity and mortality rates and inequities in adverse maternal pregnancy outcomes, including SMM.¹⁶

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Appendix

Key variables from Pennsylvania Health Care Cost Containment Council Inpatient Data used in the assessment of Severe Maternal Mortality in PA

<i>PHC4 Variable/ Variable group</i>	<i>Description</i>
<i>Patient Data</i>	
Patient Sex	Gender
Hispanic/Latino Origin or Descent	Patient's ethnic descent as submitted by the facility - combined with Race
Race	Patient race as submitted by the facility - combined with Hispanic/Latino origin Other Race includes Two or More Race Groups and Unknown race
Patient Age in Years	Age of patient
Patient Home County	PA county code (1 – 67) or Federal County Code
<i>Discharge data</i>	
Patient Discharge Status	The patient disposition or intended destination upon discharge as supplied by the facility.
Length of Stay	The number of days the patient stayed in the facility
<i>Payer identification</i>	
Primary Payer	The primary payer type as submitted by the facility.
<i>Facility Profile</i>	
Facility Type	Describes the type of facility.
<i>Facility ID</i>	
Facility Region	PHC4 assigned Region code (1 - 9)
<i>Admission data</i>	
Priority (Type of Visit)	Defines urgency level of admission: Emergency, Urgent, Elective, Trauma
<i>Summary Charges</i>	
Total Charges	Total charges excluding professional fees/charges

Severe Morbidity Indicators and Corresponding ICD-9-CM/ICD-10-CM/PCS Codes During Delivery Hospitalizations

The table below includes the list of 21 indicators and corresponding ICD codes used to identify delivery hospitalizations with SMM.

Severe Maternal Morbidity Indicator	Diagnosis (DX) or Procedure (PR) Code	ICD-9	ICD-10
Acute Myocardial Infarction	DX	410.xx	I21.xx, I22.x
Aneurysm	DX	441.xx	I71.xx, I79.0
Acute Renal Failure	DX	584.5, 584.6, 584.7, 584.8, 584.9, 669.3x	N17.x, O90.4
Acute Respiratory Distress Syndrome	DX	518.5x, 518.81, 518.82, 518.84, 799.1	J80, J95.1, J95.2, J95.3, J95.82x, J96.0x, J96.2x, J96.9x, R06.03, R09.2
Amniotic Fluid Embolism	DX	673.1x	O88.112, O88.113, O88.119, O88.12, O88.13
Cardiac Arrest / Ventricular Fibrillation	DX	427.41, 427.42, 427.5	I46.x, I49.0x
Conversion of Cardiac Rhythm	PR	99.6x	5A12012, 5A2204Z
Disseminated Intravascular Coagulation	DX	286.6, 286.9, 641.3x, 666.3x	D65, D68.8, D68.9, O45.002, O45.003, O45.009, O45.012, O45.013, O45.019, O45.022, O45.023, O45.029, O45.092, O45.093, O45.099, O46.002, O46.003, O46.009, O46.012, O46.013, O46.019, O46.022, O46.023, O46.029, O46.092, O46.093, O46.099, O67.0, O72.3
Blood Transfusion*	PR	99.0x	30230H0, 30230K0, 30230L0, 30230M0, 30230N0, 30230P0, 30230R0, 30230T0, 30230H1, 30230K1, 30230L1, 30230M1, 30230N1, 30230P1, 30230R1, 30230T1, 30233H0, 30233K0, 30233L0, 30233M0, 30233N0, 30233P0, 30233R0, 30233T0, 30233H1, 30233K1, 30233L1, 30233M1, 30233N1, 30233P1, 30233R1, 30233T1, 30240H0, 30240K0, 30240L0, 30240M0, 30240N0, 30240P0, 30240R0, 30240T0, 30240H1, 30240K1, 30240L1, 30240M1, 30240N1, 30240P1, 30240R1, 30240T1, 30243H0, 30243K0, 30243L0, 30243M0, 30243N0, 30243P0, 30243R0, 30243T0, 30243H1, 30243K1, 30243L1, 30243M1, 30243N1, 30243P1, 30243R1, 30243T1
Eclampsia	DX	642.6x	O15. X
Heart Failure / Arrest During Surgery or Procedure	DX	997.1	I97.120, I97.121, I97.130, I97.131, I97.710, I97.711
Puerperal Cerebrovascular Disorders	DX	046.3, 348.39, 362.34, 430.xx, 431.xx, 432.xx, 433.xx, 434.xx, 435.xx, 436.xx, 437.xx, 671.5x, 674.0x, 997.02	A81.2, G45.x, G46.x, G93.49, H34.0x, I60.xx, I61.xx, I62.xx, I63.00, I63.01x, I63.1xx, I63.2xx, I63.3xx, I63.4xx, I63.5xx, I63.6, I63.8x, I63.9, I65.xx, I66.xx, I67.xx, I68.xx, O22.50, O22.52, O22.53, I97.810, I97.811, I97.820, I97.821, O87.3
Pulmonary Edema / Acute Heart Failure	DX	428.0, 428.1, 428.20, 428.21, 428.23, 428.30, 428.31, 428.33,	I50.1, I50.20, I50.21, I50.23, I50.30, I50.31, I50.33, I50.40, I50.41, I50.43,

		428.40, 428.41, 428.43, 428.9, 518.4	I50.810, I50.811, I50.813, I50.814, I50.82, I50.83, I50.84, I50.89, I50.9, J81.0
Severe Anesthesia Complications	DX	668.0x, 668.1x, 668.2x, 995.4, 995.86	O29.112-O29.119, O29.122-O29.129, O29.192-O29.199, O29.212-O29.219, O29.292-O29.299, O74.0, O74.1, O74.2, O74.3, O89.0x, O89.1, O89.2, T88.2XXA, T88.3XXA
Sepsis	DX	038.xx, 449, 785.52, 995.91, 995.92, 998.02, 670.2x (after October 1, 2009)	A32.7, A40.x, A41.x, I76, O85, O86.04, R65.20, R65.21, T81.12XA, T81.44XA
Shock	DX	669.1x, 785.50, 785.51, 785.59, 995.0, 998.0*, 998.00, 998.01, 998.09 *998.0 is not a valid code but was used prior to 2012	O75.1, R57.x, T78.2XXA, T81.10XA, T81.11XA, T81.19XA, T88.6XXA
Sickle Cell Disease with Crisis	DX	282.42, 282.62, 282.64, 282.69, 289.52	D57.00, D57.01, D57.02, D57.211, D57.212, D57.219, D57.411, D57.412, D57.419, D57.811, D57.812, D57.819
Air and Thrombotic Embolism	DX	415.0, 415.1x, 673.0x, 673.2x, 673.3x, 673.8x	I26.x, O88.012-O88.03, O88.212-O88.23, O88.312-O88.33, O88.812-O88.83, T80.0XXA
Hysterectomy	PR	68.39, 68.49, 68.59, 68.69, 68.79, 68.9 (also include 68.3, 68.4, 68.5, 68.6, 68.7; non-specific codes used frequently)	OUT90ZL, OUT90ZZ, OUT97ZL, OUT97ZZ
Temporary Tracheostomy	PR	31.1	0B110F4, 0B113F4, 0B114F4
Ventilation	PR	96.70, 96.71, 96.72	5A1935Z, 5A1945Z, 5A1955Z

*Excluded but could be examined separately.

Source: https://www.cdc.gov/maternal-infant-health/php/severe-maternal-morbidity/icd.html?CDC_AAref_Val=https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/severe-morbidity-ICD.htm

PHC4 Hospital Region Map

