SEVERE MATERNAL MORBIDITY

SURVEILLANCE & REVIEW PROGRAM IN MARYLAND

May 2025

Severe maternal morbidity (SMM) includes potentially life-threatening conditions or complications during pregnancy, labor and delivery, and postpartum. SMM events can be considered near-misses for maternal mortality and can have significant consequences for women's health.[1,2] The Centers for Disease Control and Prevention (CDC), the American College of Obstetricians and Gynecologists (ACOG), and the Society for Maternal-Fetal Medicine (SMFM) recommend that birthing facilities routinely identify and review SMM events.[1-3]

Reviewing SMM events at the facility level allows for the:

- Characterization of causes and factors that led to morbidity.
- Determination of whether the event was preventable.

By identifying potentially preventable SMM events and associated factors, facilities learn what worked and did not work in the process of care, enabling them to recommend and implement practice changes or quality improvement initiatives to prevent future SMM and other adverse maternal outcomes.

In July 2020, the Maryland Maternal Health Innovation Program (MDMOM) initiated facility-based SMM Surveillance and Review supported by Maryland House Bill 837/2020. The program began as a pilot in 6 hospitals in Maryland.[4] Following the passage of the Maternal Health Act of 2024 (HB 1051/2024), birthing hospitals in the state are required to participate in SMM surveillance and review beginning in 2025.

All SMM events in pregnant and up to 42-day postpartum patients admitted at participating hospitals are identified and reviewed using the following case definition (Figure 1):

1. Admission to an intensive/critical care unit (ICU/CCU); and/or

2. Transfusion of 4 or more units of blood products.

Trained clinical abstractors review all available maternal and newborn medical records for each SMM event using a standardized electronic, de-identified review form.

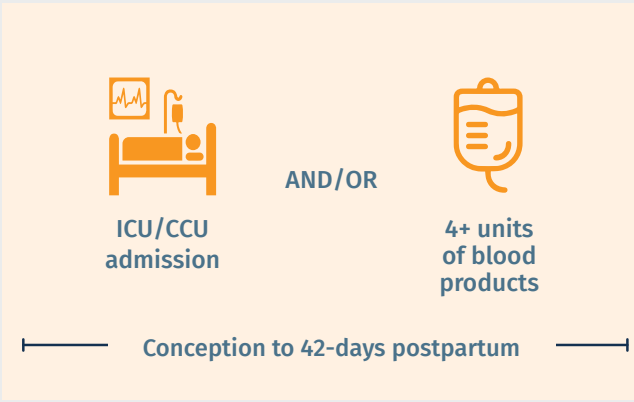
Hospital-based review committees meet regularly to review and discuss SMM events, identify primary causes of each SMM event, determine whether each event was preventable, and make recommendations for preventing similar events from occurring.

This report presents key findings from the SMM Surveillance and Review program in 2024 and includes all SMM events contributed by participating hospitals during the reporting period. Analyses of preventable factors, practices done well, and recommendations are organized by domains in the "5Rs" framework, which is widely used in maternal mortality and morbidity reviews and includes the following:

Readiness
Recognition and Prevention
Response
Reporting and System Learning
Respectful Care

SEVERE MATERNAL MORBIDITY SURVEILLANCE CASE DEFINITION

FIGURE 1



Notes: Adapted from ACOG's definition for facility-based SMM surveillance and informed by the Illinois SMM surveillance system and the UK Obstetric Surveillance System (UKOSS).[2,3]

1 *American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine, Kilpatrick SJ, Ecker IL. Severe maternal morbidity: screening and review. Am. J. Obstet Gynecol. 2016;215:817-22.*

2 *Kilpatrick SJ, Berg C, Bernstein P, Bingham D, Delgado A, Callaghan WM, Harris K, Lanni S, Mahoney J, Main E, Nacht A, Schellpfeffer M, Westover T, Harper M. Standardized severe maternal morbidity review: rationale and process. Obstet Gynecol. 2014;124(2Pt1):361-366.*

3 *Callaghan WM, Grobman WA, Kilpratick SJ. Main EK, D'Alton M. Facility based identification of women with severe maternal morbidity: It is time to start. Obstst Gynecol, 2014; 123(5):978-981.*

4 *Wolfson C, Qian J, Chin P, et al. Findings From Severe Maternal Morbidity Surveillance and Review in Maryland. JAMA Netw Open. 2022;5(11):e2244077. doi:10.1001/jamanetworkopen.2022.44077.*

FIGURE 2

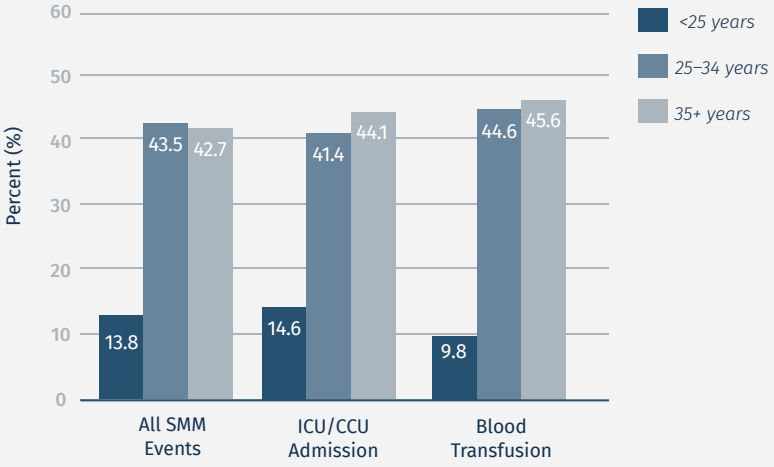
SEVERE MATERNAL MORBIDITY EVENT TYPES

ICU/CCU ADMISSION	BOTH CRITERIA	BLOOD TRANSFUSION ≥ 4 UNITS
40% (136)	24.7% (84)	35.3% (120)

340 SMM Events

FIGURE 3

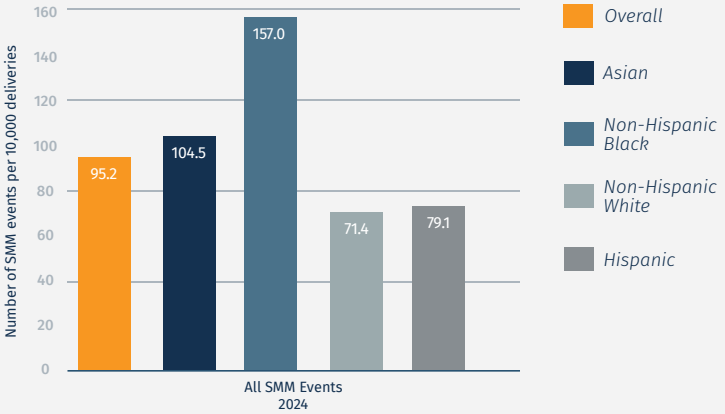
SEVERE MATRNAL MORBIDITY BY MATERNAL AGE



Note: Blood transfusion includes patients with ≥4 units transfused.

Figure 4

SEVERE MATERNAL MORBIDITY RATES BY RACE & ETHNICITY



Note: Denominators are based on 2023 births in participating hospitals as available from AHRQ's Maryland Statewide Inpatient Database. Rates for other racial/ethnic groups are not shown given small numbers yielding unstable rates.

SEVERE MATERNAL MORBIDITY EVENTS IDENTIFIED AND REVIEWED

- 340 SMM events were identified and reviewed in 2024.
- 40% of SMM events involved ICU/CCU admission only, 35.3% involved blood transfusion of 4+ units of blood products only, and 24.7% involved both (Figure 2).
- The average number of units of blood products transfused in events requiring transfusion was 7.5, ranging from <1 to 48 units (cases with <4 units transfused qualified as an SMM event due to ICU admission). The massive transfusion protocol was called in relation to 69 SMM events (32.9% of events requiring blood transfusion).

KEY SOCIODEMOGRAPHIC CHARACTERISTICS OF PATIENTS WITH SEVERE MATERNAL MORBIDITY

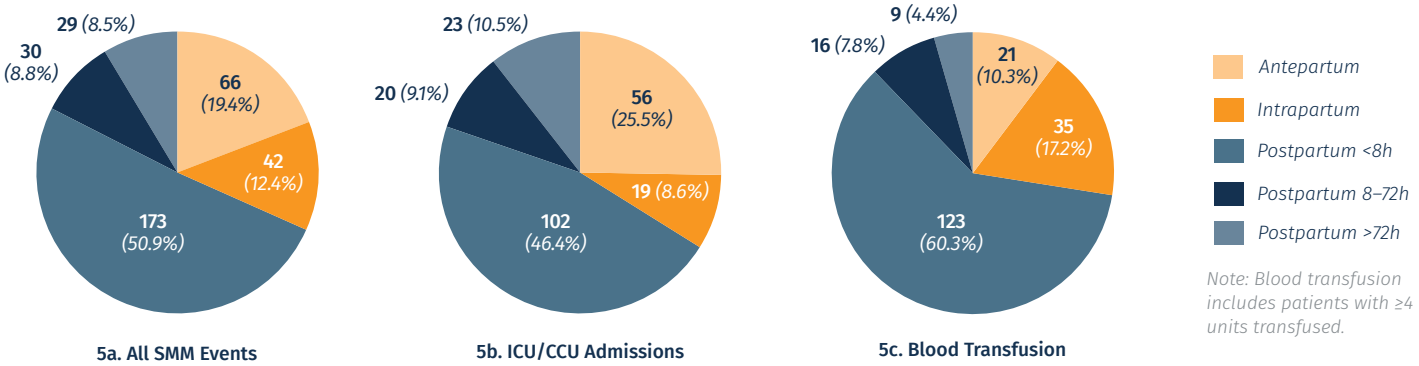
- Patients 25–34 years of age comprised the largest share of patients experiencing SMM (43.5%); 42.7% of all SMM events were in patients ≥35 years (Figure 3).
- 54.4% of patients with SMM were covered by public insurance and 41.2% had private insurance (data not shown).

SEVERE MATERNAL MORBIDITY BY RACE & ETHNICITY

- The SMM rate was highest for non-Hispanic Black patients (157.0 per 10,000 deliveries), which was more than double the rate of non-Hispanic White patients (71.4 per 10,000 deliveries) (Figure 4).
- Though lower than for non-Hispanic Black patients, the SMM rate among Asian patients (104.5 per 10,000 deliveries) was 46% higher than in non-Hispanic White patients.

FIGURE 5

TIMING OF SEVERE MATERNAL MORBIDITY EVENTS



5a. All SMM Events

5b. ICU/CCU Admissions

5c. Blood Transfusion

Note: Blood transfusion includes patients with ≥4 units transfused.

TIMING OF SEVERE MATERNAL MORBIDITY EVENTS

- More than two-thirds of the SMM events occurred during the postpartum period, most within 8 hours of delivery (Figure 5a).
- Most patients with antepartum SMM and postpartum SMM more than 72 hours after delivery involved ICU admission (Figure 5b).

LENGTH OF HOSPITAL STAY

- The average length of hospital stay for patients with an SMM event was 6.8 days, ranging from 0 to 73 days.
- Among patients with SMM and an ICU admission (n=220), the average length of stay in the ICU was 2.2 days, ranging from <1 to 18 days (data not shown).

MEDICAL & OBSTETRIC HISTORY OF PATIENTS WITH SEVERE MATERNAL MORBIDITY

- The most common medical condition prior to the index pregnancy was obesity (35.3%), followed by a mental health disorder (31.2%) and anemia (27.9%) (Table 2).
- Among those who reported substance use (n=58), marijuana (41.4%), opioids (27.5%), and tobacco (24.1%) were most frequently reported (data not shown).
- More than 1 in 3 patients with SMM did not initiate prenatal care during the first trimester, and more than 7% had no prenatal care.
- 32.9% of patients with SMM events had no prior births, 29.1% had one prior birth, 13.5% had two prior births (data not shown).
- One in ten patients (10%) used assisted reproductive technology to conceive the index pregnancy (data not shown).

TABLE 1

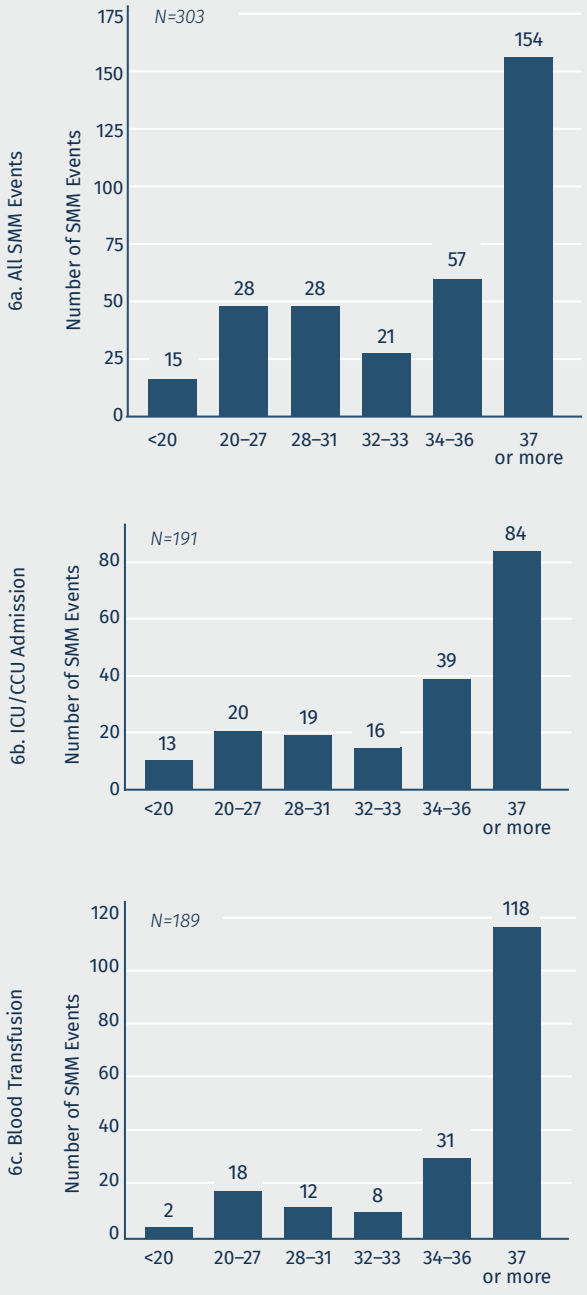
MEDICAL HISTORY AND CARE SEEKING

PATIENT CHARACTERISTICS	%	N
Significant medical history	**72.1%**	**245 of 340**
Obesity	35.3%	120 of 340
Mental health disorder	31.2%	106 of 340
Anemia	27.9%	95 of 340
Substance use	17.1%	58 of 340
Chronic hypertension	16.2%	55 of 340
Asthma	15.6%	53 of 340
Diabetes	9.1%	29 of 340
Cardiovascular condition	3.5%	12 of 340
Complications in prior pregnancy	**77.6%**	**197 of 254**
Pregnancy loss	45.7%	116 of 254
Cesarean delivery	40.9%	104 of 254
Hypertensive disorder of pregnancy	16.9%	43 of 254
Gestational diabetes	6.3%	16 of 254
Complications in current pregnancy	**77.1%**	**262 of 340**
Hypertensive disorder of pregnancy	33.8%	115 of 340
Placental abnormality	17.6%	60 of 340
Gestational diabetes	9.4%	32 of 340
Prenatal care	**91.8%**	**312 of 340**
Prenatal care initiated in first trimester	64.4%	219 of 340
No prenatal care	7.1%	24 of 340

Note: Reported percentages are based on events with available data for the characteristic shown.

FIGURE 6

GESTATIONAL AGE (WEEKS) FOR ANTEPARTUM/INTRAPARTUM SEVERE MATERNAL MORBIDITY EVENTS



Note: Blood transfusion includes patients with ≥4 units of blood products transfused.

GESTATIONAL AGE FOR ANTEPARTUM/INTRAPARTUM SEVERE MATERNAL MORBIDITY EVENTS

- Of the SMM events that occurred antepartum or intrapartum (n=303), 14.2% occurred before 28 weeks, 35% between 28 and 36 weeks, and 50.8% at 37 weeks or more gestational age (Figure 6a).
- Nearly half (44%) of ICU admission events and nearly two-thirds of blood transfusion events (62.4%) occurred at 37 weeks or more gestational age (Figure 6c).

DELIVERY OUTCOMES AMONG PATIENTS WITH SEVERE MATERNAL MORBIDITY

- 273 (80.3%) SMM events occurred during the delivery hospitalization, of which 22.7% were vaginal and 73.6% were cesarean deliveries (Table 2).
- Most deliveries were live births (90.5%), with an average gestational age of 36 weeks and 2 days.
- Nearly half (43.7%) of infants born were admitted to the neonatal intensive care unit (NICU), 40.9% were preterm (<37 weeks gestational age), and 32.4% were low birthweight (<2,500 grams).

DELIVERY OUTCOMES AMONG PATIENTS WITH SEVERE MATERNAL MORBIDITY

TABLE 2

SMM Event Occurred During Delivery Hospitalization	80.3%	273 of 340
Vaginal delivery	22.7%	62 of 273
Spontaneous	87.1%	54 of 62
Assisted	12.9%	8 of 62
Cesarean delivery	73.6%	201 of 273
Dilation & evacuation	3.7%	10 of 273
Live birth	90.5%	247 of 273
Gestational age, mean (range)	36w2d (17w3d–41w6d)	
NICU admission	43.7%	108 of 247
Preterm birth	40.9%	101 of 247
Low birthweight	32.4%	80 of 247
Stillbirth/fetal death	9.5%	26 of 273
Gestational age, mean (range)	25w3d (6w6d–38w1d)	

Note: w=weeks, d=days, NICU=Neonatal intensive care unit; Reported denominators are based on events with available data for the relevant characteristic.

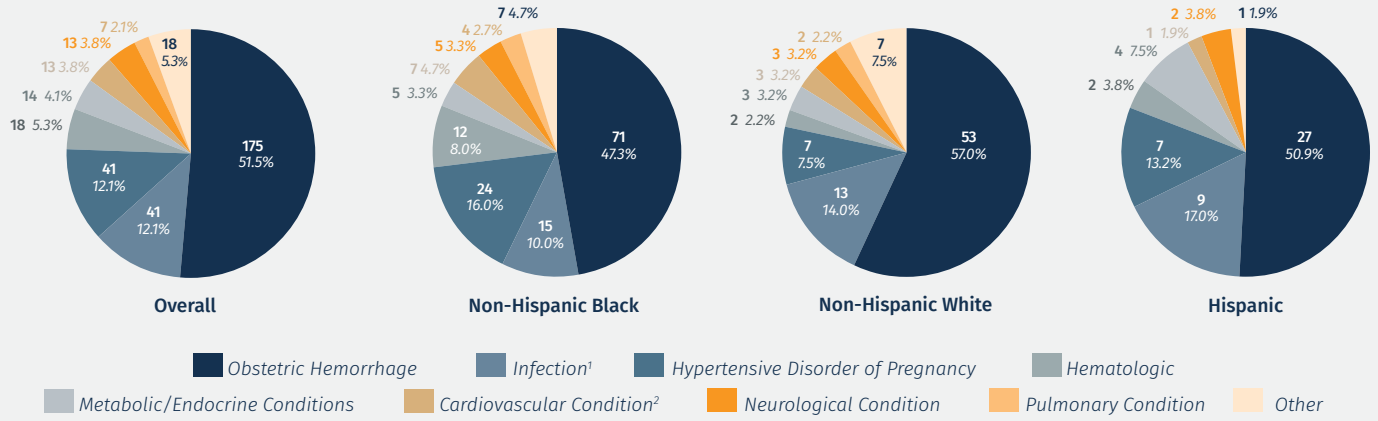
PRIMARY CAUSE OF SEVERE MATERNAL MORBIDITY

- The most common primary causes of SMM were obstetric hemorrhage (51.5%), infection (12.1%), hypertensive disorders of pregnancy (12.1%), hematologic conditions (5.3%) and metabolic/endocrine conditions (4.1%, Figure 7).
- Among the 220 events requiring ICU admission, the top 5 primary causes of SMM were obstetric hemorrhage (35%), infection (18.6%), hypertensive disorders of pregnancy (15.9%), metabolic/endocrine conditions (6.4%), and cardiovascular conditions (5.9%) (data not shown).
- Common contributing morbidities for all types of SMM events were obstetric hemorrhage (12.9%), hypertensive disorders of pregnancy (14.1%), infection (8.2%), and hematologic conditions (6.5%) (data not shown).

32% OF SEVERE MATERNAL MORBIDITY EVENTS WERE **POTENTIALLY PREVENTABLE.**

PRIMARY CAUSE OF SEVERE MATERNAL MORBIDITY

FIGURE 7



Note: [1]Infection includes COVID-19 (n=1); [2]Cardiovascular conditions include cardiomyopathy (n=2)

PREVENTABILITY OF SEVERE MATERNAL MORBIDITY

Events were considered preventable if changes in provider, system, and/or patient-level factors could have altered the SMM outcome.

- Preventability was determined by a facility-based multidisciplinary SMM Review Committee.
- Preventability of SMM events varied by the primary cause, ranging from 15.4% for cardiovascular conditions to 46.2% for neurological conditions (Table 3).
- Preventability varied by race and ethnicity with 34% of SMM events among Hispanic patients considered preventable, 33.3% among non-Hispanic White patients, 30.7% among non-Hispanic Black patients and 25.7% among Asian patients (Figure 7).
- Obstetric hemorrhage was the most common primary cause of preventable SMM events for all racial and ethnic groups (Figure 8).

PREVENTABILITY OF SEVERE MATERNAL MORBIDITY

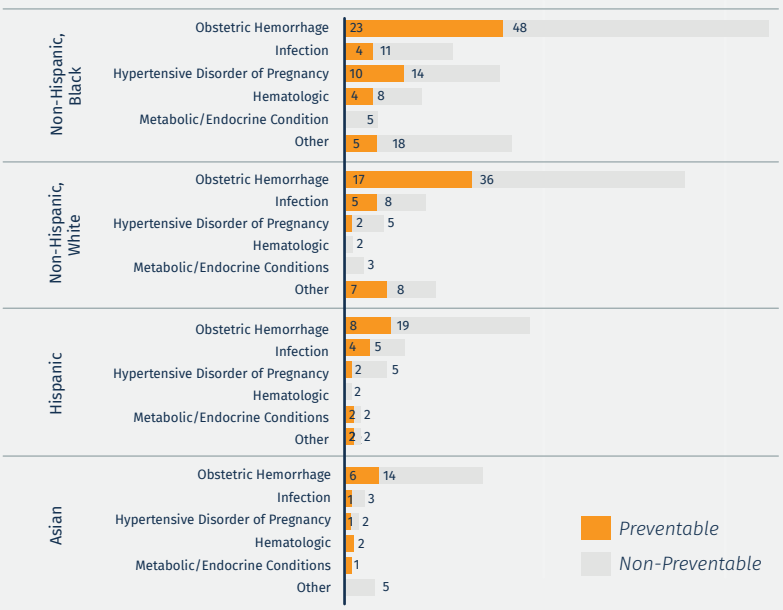
TABLE 3

CAUSE	%	N
Obstetric Hemorrhage	31.4%	55 of 175
Hypertensive Disorder of Pregnancy	36.6%	15 of 41
Infection[1]	34.1%	14 of 41
Hematologic	22.2%	4 of 18
Metabolic/Endocrine Conditions	28.6%	4 of 14
Cardiovascular Condition[2]	15.4%	2 of 13
Neurological Condition	46.2%	6 of 13
Pulmonary Condition	28.6%	2 of 7
Other	33.3%	6 of 18

[1]Infection includes COVID-19 (n=1);
[2]Cardiovascular conditions include cardiomyopathy (n=2)

PRIMARY CAUSE AND OPPORTUNITY TO ALTER THE SEVERE MATERNAL MORBIDITY OUTCOME BY RACE AND ETHNICITY

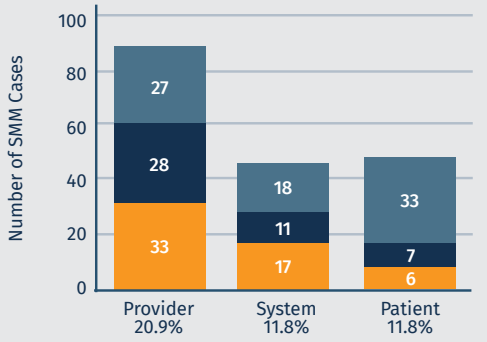
FIGURE 8



Note: Data are shown in absolute numbers; [1]Infection includes COVID-19 (n=1)

LEVEL AND TIMING OF FACTORS THAT COULD HAVE ALTERED THE SEVERE MATERNAL MORBIDITY OUTCOME

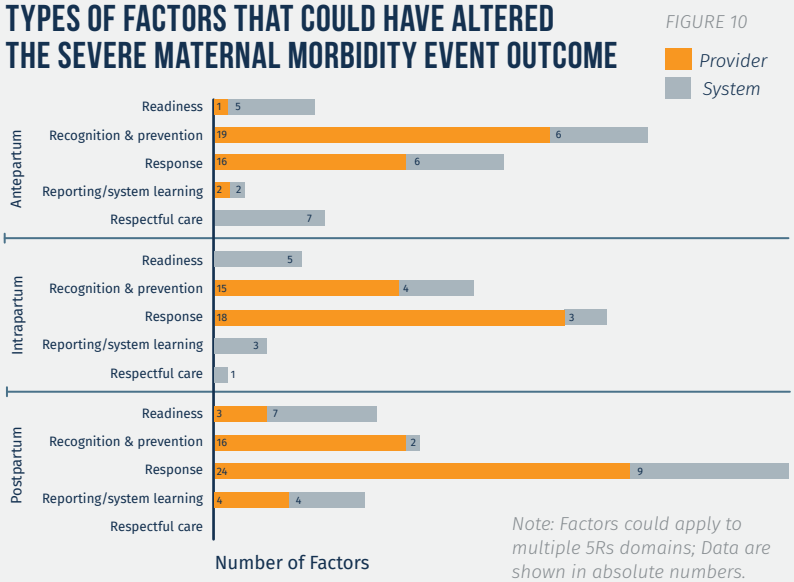
FIGURE 9



Note: More than one factor could have been identified for one SMM event. Data are shown in absolute numbers.

TYPES OF FACTORS THAT COULD HAVE ALTERED THE SEVERE MATERNAL MORBIDITY EVENT OUTCOME

FIGURE 10



Note: Factors could apply to multiple 5Rs domains; Data are shown in absolute numbers.

LEVEL, TIMING, AND FACTORS THAT COULD HAVE ALTERED THE SEVERE MATERNAL MORBIDITY OUTCOME

Hospital Review Committees determined that addressing provider, system, and patient-level factors could have altered outcomes in 71 (20.9%), 40 (11.8%), and 40 (11.8%) SMM events, respectively (Figure 9).

ANTEPARTUM PERIOD

About 17.4% of SMM could have been prevented by addressing factors in the antepartum period. Most of these factors were related to the Recognition and Response domains (Figure 10).

- Provider-level factors included allowing for longer observation and obtaining additional lab work in patients presenting with abnormal symptoms.
- System-level factors included assisting patients with enrolling in health insurance and accessing prenatal care as well as implementing QBL monitoring prior to delivery.

INTRAPARTUM PERIOD

About 11.5% of SMM could have been prevented by addressing factors in the intrapartum period. Most of these factors were related to the Recognition and Response domains (Figure 10).

- Provider-level factors included more rapid activation of MTP when warranted.
- System-level factors included the need for intraoperative QBL documentation and reporting in real time.

POSTPARTUM PERIOD

About 12.7% of SMM could have been prevented by addressing factors in the postpartum period. Most of these factors were related to the Recognition and Response domains (Figure 10).

- Provider-level factors included quicker recognition of patient hemodynamic instability and implementation of uterine tamponade devices.
- System-level factors included greater readiness to address obstetric emergencies through staffing, medication, and device (e.g. JADA) availability.

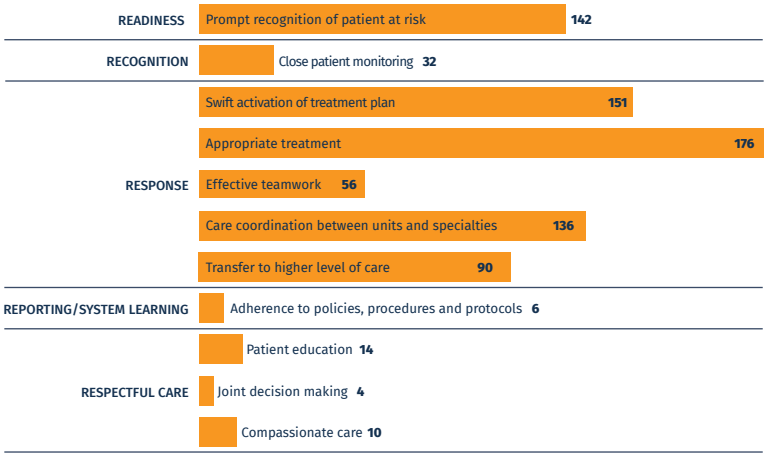
PRACTICES DONE WELL IN RELATION TO SEVERE MATERNAL MORBIDITY EVENTS

For all SMM events, Hospital Review Committees listed up to three practices that were done well and should be reinforced in their hospitals. Eleven themes emerged (Figure 11).

- The most commonly reported practices were appropriate treatment (mentioned in 176 reviews of SMM events, 51.8%) and swift activation of treatment plan (mentioned in 151 reviews, 44.4%).

PRACTICES DONE WELL IN RELATION TO SEVERE MORBIDITY EVENTS REVIEWED

FIGURE 11



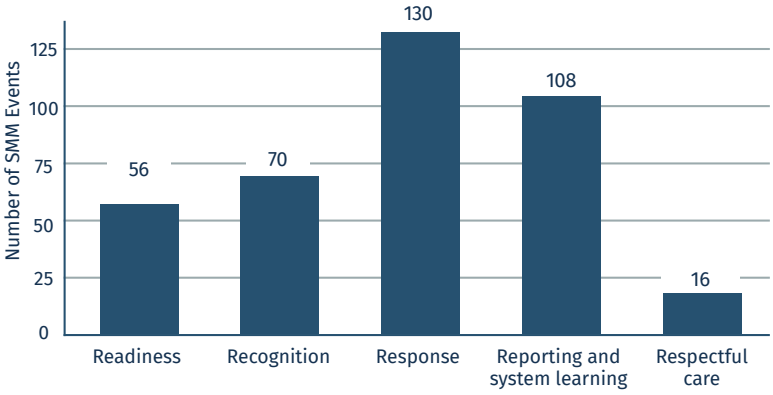
Note: Data are shown in absolute numbers; Fields for capturing this information were open-ended and unprompted; not mentioning these practices for a larger number of events does not mean that it did not occur.

KEY RECOMMENDATIONS FOR SEVERE MATERNAL MORBIDITY PREVENTION IN MARYLAND HOSPITALS

The most frequent recommendations by Hospital Review Committees were within the Response (130), Reporting and system learning (108), and Recognition (70) domains of the "5Rs" framework (Figure 12).

RECOMMENDATIONS FOR CARE IMPROVEMENT BY QUALITY IMPROVEMENT DOMAIN

FIGURE 12



Note: Data are shown in absolute numbers. Recommendations were made in 229 SMM reviews. Hospital committees could make up to three recommendations for each event.

GENERAL RECOMMENDATIONS TO PREVENT SMM

- Provider follow-up with patients to ensure understanding and feasibility/acceptability of medical guidance, including consultations, blood pressure monitoring, and medication adherence.
- Improve communications among OB providers, ORs, emergency departments, and ICUs regarding pregnant and postpartum patients.
- Develop clear policies for care escalation among OB teams, to ICUs, and for transferring patients to higher-level facilities when necessary.
- Improved documentation for obstetric patients including MTP activation, use of uterotonics, blood product administration, and QBL.

RECOMMENDATIONS TO PREVENT SMM DUE TO HEMORRHAGE

- Enhance QBL monitoring: 1) Ensure QBL is initiated upon admission and continues for at least 24 hours after obstetric hemorrhage; 2) Require real-time measurement and documentation of blood loss; 3) Integrate QBL updates into routine team communication during all obstetric procedures.
- Ensure transfusion guidelines for obstetric patients include clear specifications for blood product component ratios.
- Ensure pre-delivery planning occurs for patients who may decline blood products (e.g., for religious or personal reasons).

RECOMMENDATIONS TO PREVENT SMM DUE TO HYPERTENSIVE DISORDERS OF PREGNANCY

- Integrate daily weight and I/O measurement into the standard order set for patients with hypertensive disorders of pregnancy. Use weights to guide weight-based medication dosing effectively.
- Document blood pressure counseling at every outpatient encounter. Include information on recognizing warning signs, home monitoring, and when to seek care.

RECOMMENDATIONS TO PREVENT SMM DUE TO INFECTION

- Consider a broad list of differential diagnoses, including both obstetric and non-obstetric causes.
- Clarify policies and technique for drawing blood cultures.

POLICY RECOMMENDATIONS TO PREVENT SMM IN MARYLAND

- Reinforce documentation of a minimum set of SDoH screening questions during routine office visits for all obstetric patients.
- Support insurance coverage of iron transfusion within clear clinical guidelines and ensure insurance reimbursement for iron transfusion covers the full cost of service provision.
- Promote counseling and warm handoffs to psychological services for patients who experience birth-related trauma.

Note: OB=obstetric, ORs=operating rooms, MTP=massive transfusion protocol, QBL=quantitative blood loss, I/O=intake and output, SDoH=social determinants of health