



July 2024

SEVERE MATERNAL MORBIDITY SURVEILLANCE & REVIEW PROGRAM IN MARYLAND

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 six of the 32 birthing hospitals in Maryland, and now includes 27 hospitals, covering more than 80% of births in the state.⁴

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 four 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 2023 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:

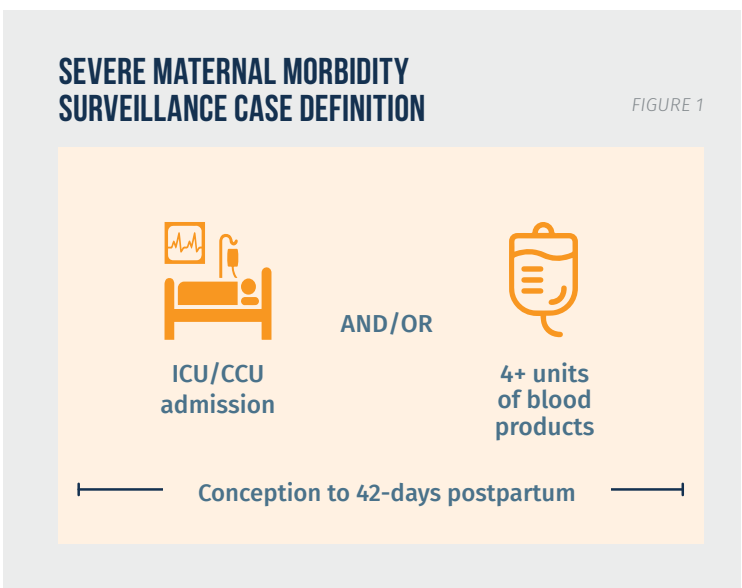
Readiness

Recognition and Prevention

Response

Reporting and System Learning

Respectful Care



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, Kilpatrick SJ, Main EK, D'Alton M. Facility based identification of women with severe maternal morbidity: It is time to start. *Obstet 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

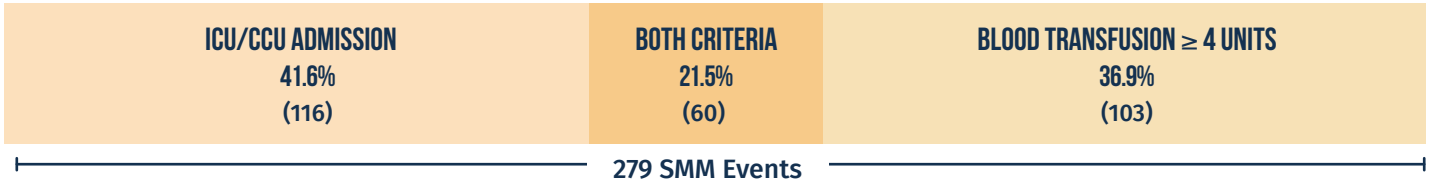
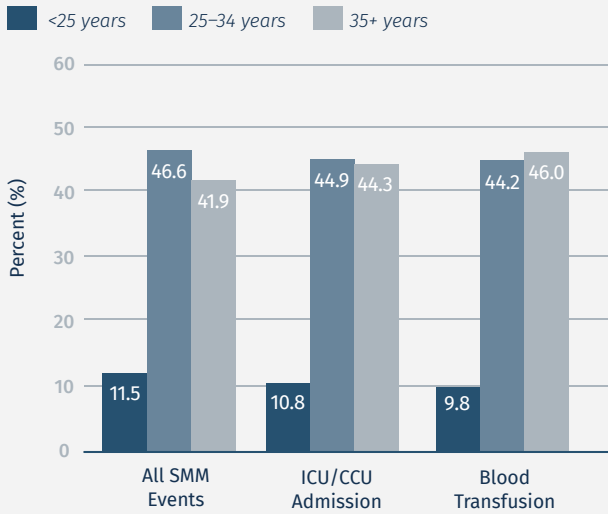


FIGURE 3

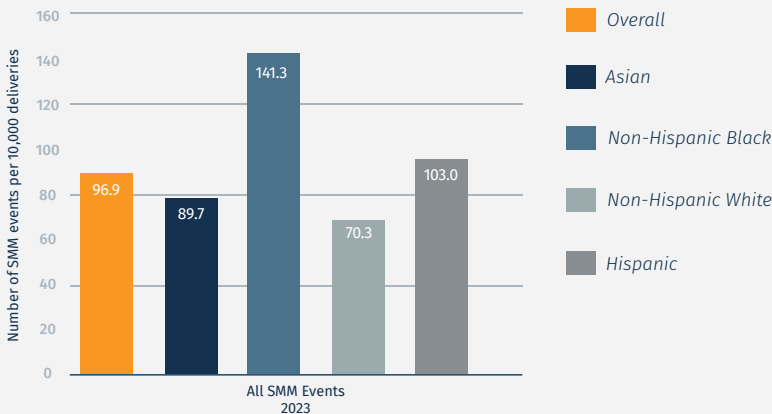
SEVERE MATERNAL MORBIDITY BY MATERNAL AGE



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

Figure 4

SEVERE MATERNAL MORBIDITY RATES BY RACE & ETHNICITY



Note: Denominators are based on 2022 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

- 279 SMM events were identified and abstracted in 2023.
- 41.6% of SMM events involved ICU/CCU admission only, 36.9% involved blood transfusion of 4+ units of blood products only, and 21.5% involved both (Figure 2).
- The average number of units of blood products transfused in events requiring transfusion was 8.4, ranging from <1 to 92 units (n.b. cases with <4 units transfused qualified as an SMM event due to ICU admission). The massive transfusion protocol was called in relation to 60 SMM events (35.9% of events requiring blood transfusion).

KEY SOCIO-DEMOGRAPHIC CHARACTERISTICS OF PATIENTS WITH SEVERE MATERNAL MORBIDITY

- Patients 25–34 years of age comprised the largest share of patients experiencing SMM (46.6%); 41.9% of all SMM events were in patients ≥35 years (Figure 3).
- 50.2% of patients with SMM had private insurance, 41.9% were covered by public insurance, and 4.3% had no insurance or self-paid for their hospitalization (data not shown).

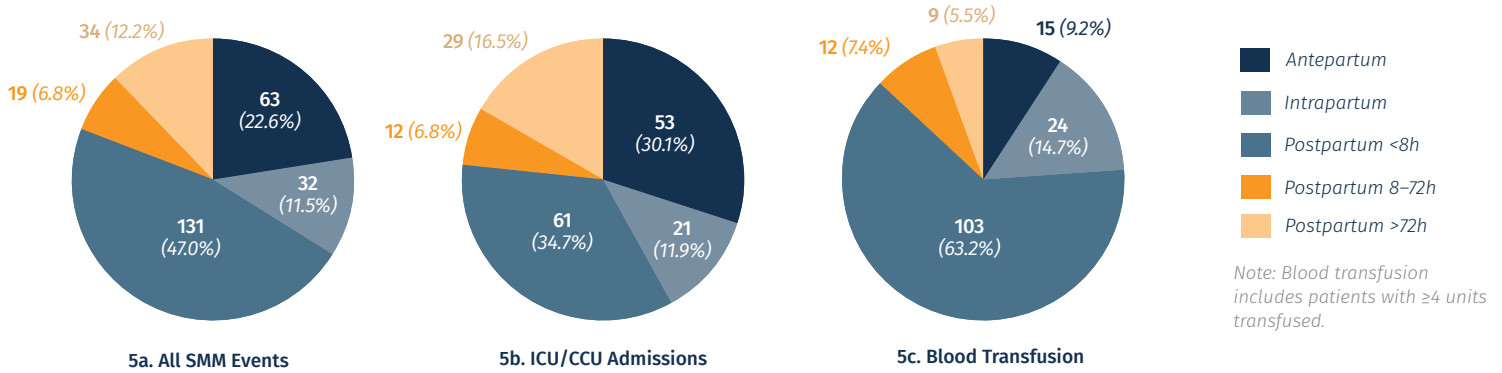
SEVERE MATERNAL MORBIDITY BY RACE & ETHNICITY

- The SMM rate was highest for non-Hispanic Black patients (141.3 per 10,000 deliveries), which was double the rate of non-Hispanic White patients (70.3 per 10,000 deliveries) (Figure 4).
- Though lower than for non-Hispanic Black patients, the SMM rate among Hispanic patients (103.0 per 10,000 deliveries) was 47% higher than in non-Hispanic White patients.



FIGURE 5

TIMING OF SEVERE MATERNAL MORBIDITY EVENTS



TIMING OF SEVERE MATERNAL MORBIDITY EVENTS

- Two-thirds of the SMM events occurred during the postpartum period; most occurred within eight hours of delivery (Figure 5a).
- Most patients with antepartum and postpartum SMM >72 hours following delivery involved ICU admission (Figure 5b).

LENGTH OF HOSPITAL STAY

- The average length of hospital stay for patients with an SMM event was 6.5 days, ranging from 1 to 79 days.
- Among patients with SMM and an ICU admission (n=176), the average length of stay in the ICU was 2.5 days, ranging from 0 to 25 days (data not shown).

MEDICAL & OBSTETRIC HISTORY OF PATIENTS WITH SEVERE MATERNAL MORBIDITY

- The most common medical condition prior to the current pregnancy was obesity (38.7%), followed by a mental health condition (35.1%) and chronic hypertension (19.0%) (Table 1).
- Among those who reported substance use (n=45), marijuana (59.0%), cocaine (30.8%), tobacco (28.2%), and opioids (18.0%) were most frequently reported (data not shown).
- More than one in four patients with SMM did not initiate prenatal care during the first trimester, and more than 7% had no prenatal care.
- 30.5% of patients with SMM events had no prior births, 29.8% had one prior birth, 21.5% had two prior births, and 18.3% had three or more prior births (data not shown).
- About one in 10 patients (9.7%) used assisted reproductive technology to conceive the current pregnancy (data not shown).

TABLE 1

MEDICAL HISTORY AND CARE SEEKING

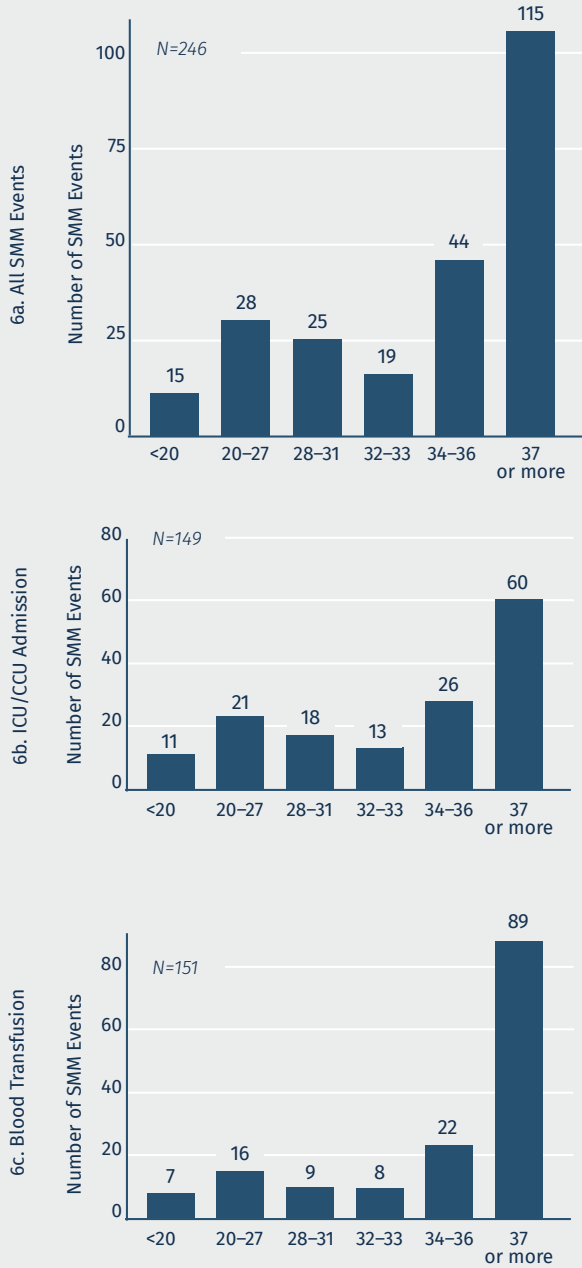
PATIENT CHARACTERISTICS	%	N
Significant medical history	80.3%	224 of 279
Obesity	38.7%	108 of 279
Mental health condition	35.1%	98 of 279
Chronic hypertension	19.0%	53 of 279
Anemia	18.6%	52 of 279
Asthma	17.9%	50 of 279
Substance use	16.1%	45 of 279
Cardiovascular condition	9.0%	25 of 279
Diabetes	7.9%	22 of 279
Complications in prior pregnancy	73.1%	141 of 193
Pregnancy loss	43.0%	83 of 193
Cesarean delivery	36.8%	71 of 193
Hypertensive disorder of pregnancy	19.7%	38 of 193
Gestational diabetes	7.8%	15 of 193
Complications in current pregnancy	73.0%	197 of 270
Hypertensive disorder of pregnancy	29.6%	80 of 270
Placental abnormality	15.6%	42 of 270
Gestational diabetes	12.6%	34 of 270
Prenatal care	92.4%	255 of 276
Prenatal care initiated in first trimester	73.9%	176 of 238
No prenatal care	7.6%	21 of 276

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=246), 17.5% occurred before 28 weeks, 35.8% between 28 and 36 weeks, and 46.7% at 37 weeks or more gestational age (Figure 6a).
- Over one third (40.2%) of ICU admission events and over half of blood transfusion events (58.9%) occurred at 37 weeks or more gestational age (Figure 6c).

DELIVERY OUTCOMES AMONG PATIENTS WITH SEVERE MATERNAL MORBIDITY

- 219 (78.5%) SMM events occurred during the delivery hospitalization, of which 21.0% were vaginal and 73.5% were cesarean deliveries (Table 2).
- Most deliveries were live births (90.0%), with an average gestational age of 35 weeks and 6 days (Table 2).
- Nearly half (44.7%) of infants were born preterm, 35.5% were low birthweight, and 50.3% were admitted to the neonatal intensive care unit (NICU).

DELIVERY OUTCOMES AMONG PATIENTS WITH SEVERE MATERNAL MORBIDITY

TABLE 2

SMM Event Occurred During Delivery Hospitalization	78.5%	219 of 279
Vaginal delivery	21.0%	46 of 219
Spontaneous	91.3%	42 of 46
Assisted	8.7%	4 of 46
Cesarean delivery	73.5%	161 of 219
Planned	47.2%	76 of 161
Emergency	52.2%	84 of 161
Surgical evacuation	7.5%	12 of 161
Live birth	90.0%	197 of 219
Gestational age, mean (range)	35w6d (23w6d-41w2d)	
Preterm birth	44.7%	88 of 197
Low birthweight	35.5%	70 of 197
NICU admission	50.3%	99 of 197
Stillbirth	9.5%	23 of 241
Gestational age, mean (range)	32w5d (18w6d-40w2d)	

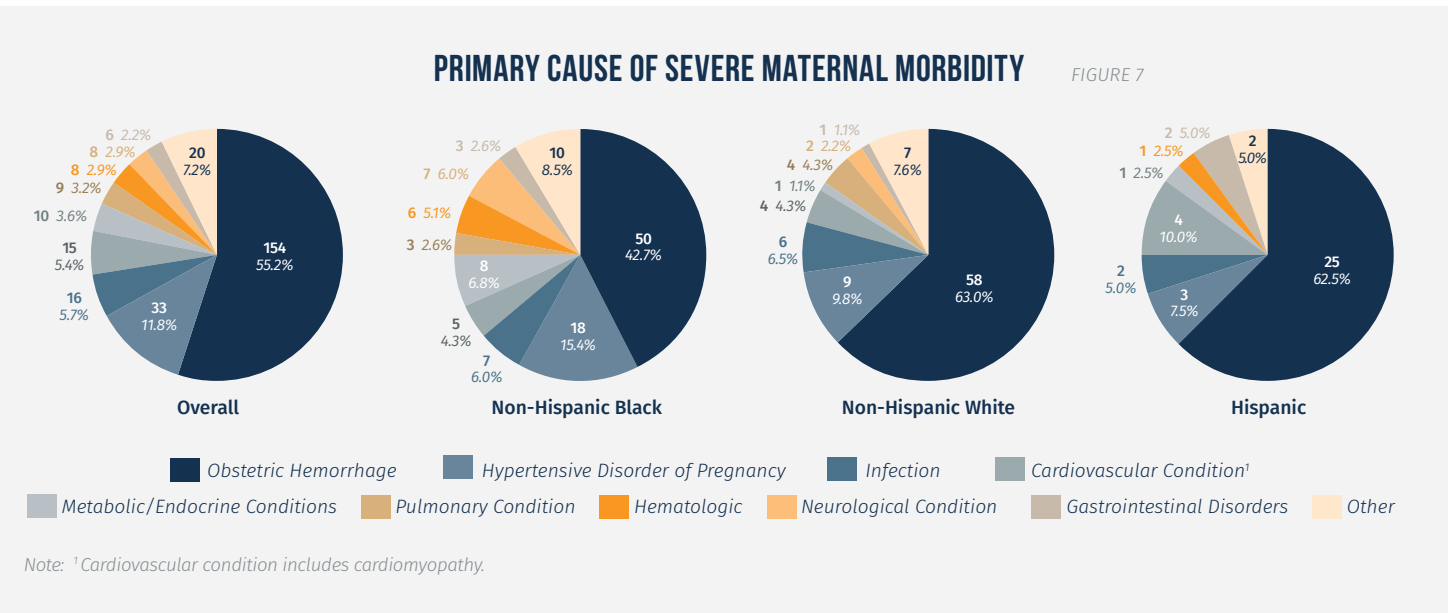
Note: w=weeks, d=days, NICU=Neonatal intensive care unit; Reported denominators are based on events with available data for the relevant characteristic.



PRIMARY CAUSE OF SEVERE MATERNAL MORBIDITY

- The most common primary cause of SMM was obstetric hemorrhage (55.2%), followed by hypertensive disorders of pregnancy (11.8%), infection (non-COVID) (5.7%), cardiovascular conditions (5.4%), and metabolic/endocrine conditions (3.6%) (Figure 7).
- Among the 176 events requiring ICU admission, the top five primary causes of SMM were obstetric hemorrhage (36.4%), hypertensive disorders of pregnancy (15.9%), infection (8.6%), cardiovascular conditions (6.3%), and metabolic/endocrine conditions (5.7%) (data not shown).
- Common contributing morbidities for all types of SMM events were hypertensive disorders of pregnancy (15.8%), hematologic conditions (9.3%), obstetric hemorrhage (9.0%), pulmonary conditions (7.9%), metabolic/endocrine conditions (6.8%), infection, including COVID-19 (5.0%), and mental health conditions (5%) (data not shown).

34% OF SEVERE MATERNAL MORBIDITY EVENTS WERE POTENTIALLY PREVENTABLE.



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 20% for cardiovascular conditions to 70% for metabolic/endocrine conditions (Table 3).
- Preventability varied by race and ethnicity with 49.0% of SMM events among non-Hispanic Black patients were considered preventable, compared to 34.4% among non-Hispanic White patients, 8.3% among Hispanic patients, and 6.3% among Asian patients (Figure 8).
- Obstetric hemorrhage was the most common primary cause of preventable SMM events for all racial and ethnic groups.

PREVENTABILITY OF SEVERE MATERNAL MORBIDITY

TABLE 3

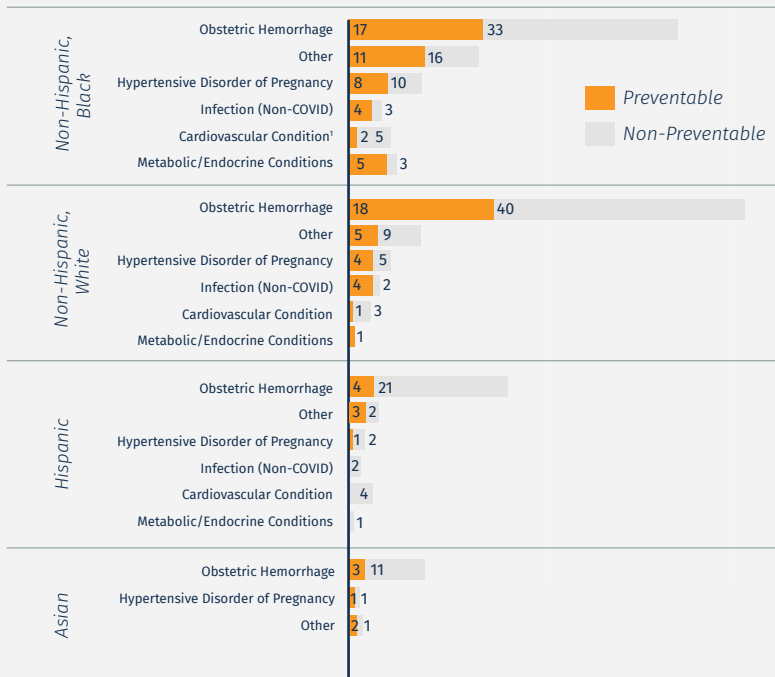
CAUSE	%	N
Metabolic/endocrine condition	70.0%	7 of 10
Gastrointestinal condition	50.0%	3 of 6
Infection (non-COVID)	50.0%	8 of 16
Pulmonary condition	44.4%	4 of 9
Hypertensive disorder of pregnancy	42.4%	14 of 33
Other	40.0%	8 of 20
Hematologic condition	37.5%	3 of 8
Neurologic condition	37.5%	3 of 8
Obstetric hemorrhage	27.9%	43 of 154
Cardiovascular condition ¹	20.0%	3 of 15

Note: ¹ Cardiovascular condition includes cardiomyopathy.



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 Cardiovascular condition includes cardiomyopathy.

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 64 (22.9%), 49 (17.6%), and 54 (19.4%) SMM events, respectively (Figure 9).

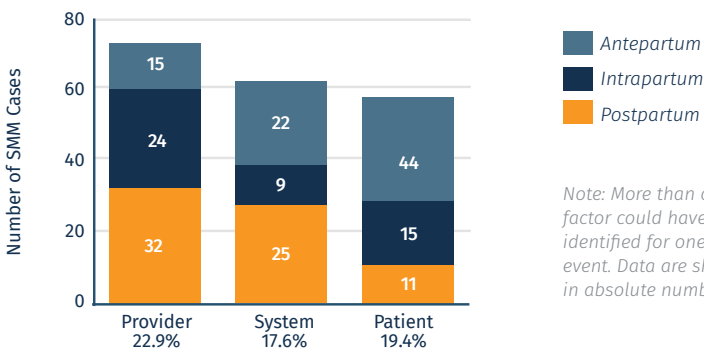
ANTEPARTUM PERIOD

About 19.4% of SMM could have been prevented by addressing factors in the antepartum period. Most of these factors related to the Recognition, Response, and Reporting domains (Figure 10).

- Provider-level factors included enhanced monitoring of high-risk patients and diagnosis of high-risk conditions.
- System-level factors included enhanced guidelines for management of obstetric patients in emergency departments as well as improved coordination of care between emergency departments and obstetrical units.

LEVEL, TIMING, AND 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.

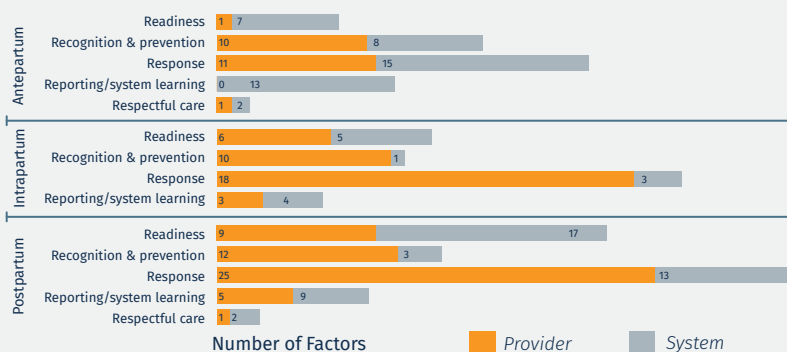
INTRAPARTUM PERIOD

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

- Provider-level factors included earlier identification of lacerations and bleeding or need for transfusion.
- System-level factors included availability of platelets and other resources including resources to support monitoring in patients with obesity.

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.

POSTPARTUM PERIOD

About 12.9% of SMM could have been prevented by addressing factors in the postpartum period. Most of these factors related to the Readiness, Recognition, and Response domains (Figure 10).

- Provider-level factors included earlier initiation of appropriate treatment and more timely recognition of patient decompensation.
- System-level factors included higher readiness to address obstetric emergencies through staffing, medication, and device availability.



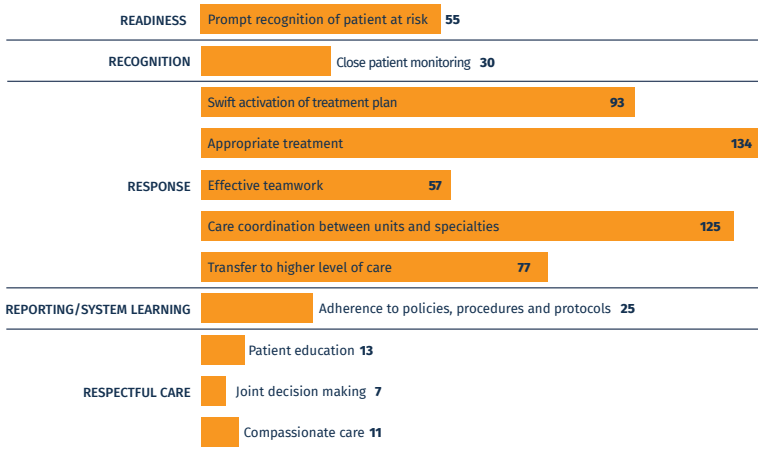
PRACTICES DONE WELL IN RELATION TO SEVERE MATERNAL MORBIDITY EVENTS

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 from the 279 SMM events (Figure 11).

- The most commonly reported practices were appropriate treatment (mentioned in 134 reviews of SMM events, 48.0%) and care coordination between units (mentioned in 125 reviews, 44.8%).

PRACTICES DONE WELL IN RELATION TO SEVERE MORBIDITY EVENTS REVIEWED

FIGURE 11



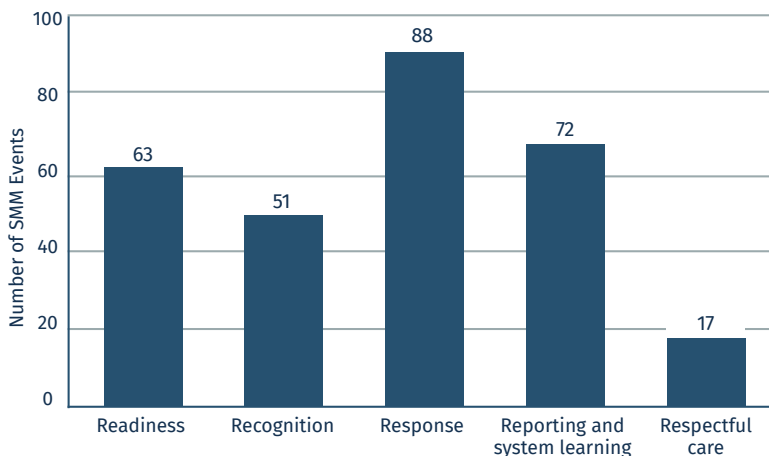
Note: Data are shown in absolute numbers; Fields for capturing this information were open-ended and unprompted; not mentioning these practices for a larger number of events does not mean that it did not occur.

KEY RECOMMENDATIONS FOR SEVERE MATERNAL MORBIDITY PREVENTION IN MARYLAND HOSPITALS

The most frequent recommendations by hospital review committees were within the Response (88), Reporting and system learning (72), and Readiness (63) 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 165 SMM reviews. Hospital committees could make up to three recommendations for each event.

GENERAL RECOMMENDATIONS TO PREVENT SMM

- Establish and maintain 24/7 access to multidisciplinary teams for managing the most prevalent causes of SMM.
- Ensure clear protocols and regular trainings on early warning signs and emergency interventions for the top causes of SMM for all staff treating OB patients.
- Establish clear protocols for timely consultation, escalation of care, and transfer of OB patients based on identified risks.
- Establish linkages and assist patients with entry into outpatient services for seamless post-discharge follow-up.

RECOMMENDATIONS TO PREVENT SMM DUE TO HEMORRHAGE

- Standardize the continuous measurement, documentation, and communication of quantitative blood loss in L&D units.
- Implement regular training on early recognition of hemorrhage, use of massive transfusion protocol, use of uterine tamponade devices and intraoperative compression suturing.
- Implement training to increase the use of bedside ultrasound to identify intraabdominal bleeding and retained products of conception.

RECOMMENDATIONS TO PREVENT SMM DUE TO HYPERTENSIVE DISORDERS OF PREGNANCY

- Remove barriers to communication with patients experiencing hypertension, including ensuring 24/7 language interpretation services.
- Establish follow up procedure and flexible emergency contact systems for patients, including phone, text, and online messaging options.

RECOMMENDATIONS TO PREVENT SMM DUE TO CARDIOVASCULAR CONDITIONS

- Remove barriers to patients accessing cardiovascular medications, including using prescription home delivery services.
- Establish follow-up plan with cardiologist prior to hospital discharge.
- Ensure obstetric cardiac protocols are up to date and that all L&D staff are trained to respond to cardiac conditions.

RECOMMENDATIONS TO PREVENT SMM DUE TO INFECTION

- Review pre-discharge patient education regarding hygiene and signs of infection.

RECOMMENDATIONS TO PREVENT SMM DUE TO METABOLIC AND ENDOCRINE CONDITIONS

- Improve hospital-wide systems for OB-specific management of diabetes, including prenatal targets for glycemic control, appropriate inpatient interventions, and 24/7 access to endocrinology and subspecialists.

Note: OB=obstetric, L&D=labor and delivery, ICU=intensive care unit.