



SEVERE MATERNAL MORBIDITY SURVEILLANCE & REVIEW PILOT PROGRAM

Severe Maternal Morbidity (SMM) includes potentially life-threatening conditions or complications during pregnancy, labor and delivery, and postpartum. SMM 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

The review of SMM events at the facility level allows for:

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

By identifying preventable or 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 from occurring.

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 of the 32 birthing hospitals in Maryland⁴, and now includes 20 hospitals, covering more than 70% of births in the state.

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

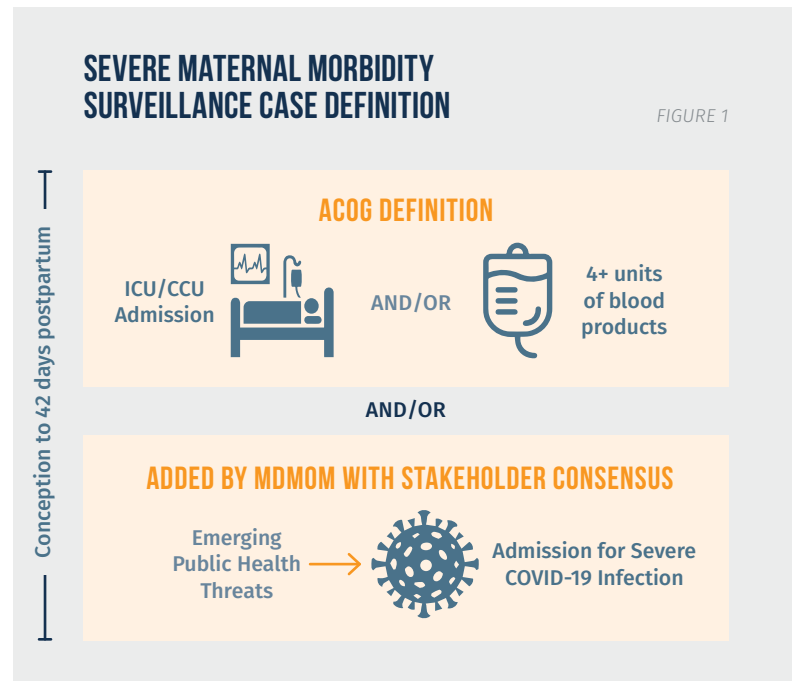
- Admission to an intensive/critical care unit (ICU/CCU) and/or
- Transfusion of 4 or more units of blood products and/or
- Hospitalization for management of emerging public health treats (e.g. severe COVID-19 infection).

Trained clinical abstractors reviewed all available maternal and newborn medical records for each SMM event using a standardized, de-identified review form (Table 1).

Hospital-based review committees met regularly to review and discuss SMM events and made recommendations for preventing similar events from occurring.

This report presents key findings from the SMM Surveillance and Review program from July 1, 2020 – December 31, 2022 and includes SMM events contributed by 13 hospitals, with varying timeframes of participation. 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:

- Readiness
- Recognition and Prevention
- Response
- Reporting and System Learning
- Respectful Care



Notes: Adapted from ACOG’s definition^{2,3} for facility based SMM surveillance and informed by the Illinois SMM surveillance system and the UK Obstetric Surveillance System (UKOSS); Blood transfusion criteria changed over period of analysis. Prior to January 2022, threshold was ≥ 4 units of packed red blood cells transfused. Starting January 1, 2022, criteria included ≥ 4 units of any blood product. COVID-19 criteria changed over period of analysis. Prior to December 2021, criteria included all pregnant and postpartum patients admitted with COVID-19 infection. Starting December 1, 2021, criteria included pregnant and postpartum patients admitted with a COVID-19 infection and with a length of stay >1 day and treatment for COVID-19 infection.

¹American 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. ²Kilpatrick 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. ³Callaghan 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. ⁴Wolfson 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.



SEVERE MATERNAL MORBIDITY ABSTRACTION FORM MODULES

TABLE 1

SMM TYPE	ABSTRACTION	CASE NARRATIVE AND TIMELINE	CASE REVIEW ASSESSMENT	FINAL REVIEW COMMITTEE ANALYSIS
<ul style="list-style-type: none"> SMM case definition Timing of morbidity 	<ul style="list-style-type: none"> Patient sociodemographic characteristics and medical history Prenatal care Delivery information and blood loss ICU/CCU admission Surgery and other follow-up after SMM event COVID-19 	<ul style="list-style-type: none"> Narrative synopsis Timeline of key events 	<ul style="list-style-type: none"> Underlying causes of morbidity Sequence of clinical causes of morbidity 	<ul style="list-style-type: none"> Opportunities to alter outcome Practices that were done well Overall recommendations for improvements
Completed by the Data Abstractor(s) in advance of the Hospital Review Committee meeting			Completed during the Hospital Review Committee meeting	
Data Abstractor(s) revise the information entered in the database as a result of Hospital Review Committee meeting				

SEVERE MATERNAL MORBIDITY EVENTS IDENTIFIED AND REVIEWED

- 374 SMM events were identified and abstracted in the 13 participating hospitals
- 59.9% of SMM events involved ICU/CCU admission, 52.1% involved blood transfusion of 4+ units of blood products, and 20.3% involved hospitalization for management of severe COVID-19 infection (Table 2)
- The average number of units of blood products transfused in events requiring transfusion was 9.1, ranging from 1* to 49 units (*cases with <4 units transfused qualified as an SMM event due to ICU admission). The massive transfusion protocol was called in 81 events (38.9% of events requiring blood transfusion)
- About 3 in 10 SMM events met more than one definition criteria (Figure 2)

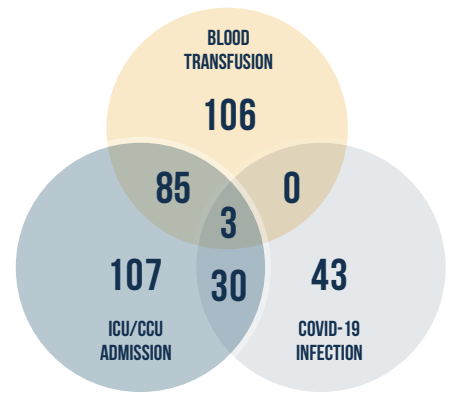
SEVERE MATERNAL MORBIDITY EVENT TYPES

TABLE 2

EVENT TYPE	N	%
ICU/CCU Admission	224	59.9
Blood Transfusion	195	52.1
COVID-19 Infection	76	20.3

OVERLAP IN CASE DEFINITION CRITERIA

FIGURE 2

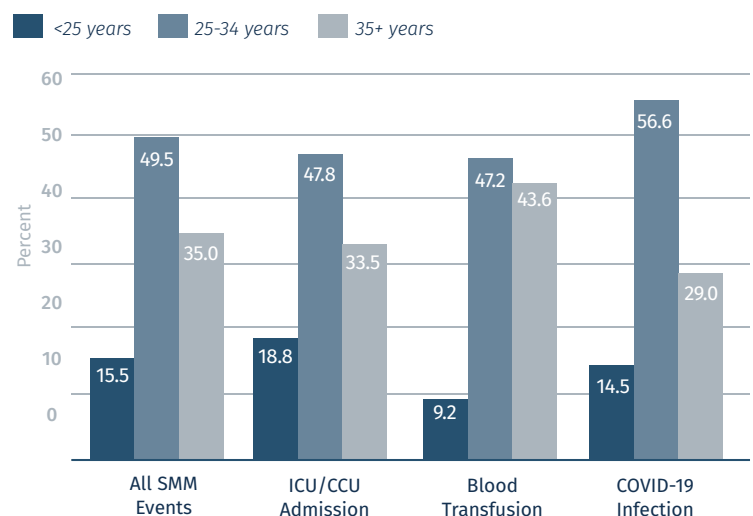


KEY SOCIO-DEMOGRAPHIC CHARACTERISTICS OF PATIENTS WITH SEVERE MATERNAL MORBIDITY

- Almost half of SMM events occurred in patients 25-34 years of age and just over a third in patients ≥35 years (Figure 3)
- 51.3% of patients with SMM events had private insurance, 42.0% were covered by Medicaid, and 4.6% had no insurance or self-paid for their hospitalization

SEVERE MATERNAL MORBIDITY BY MATERNAL AGE

FIGURE 3

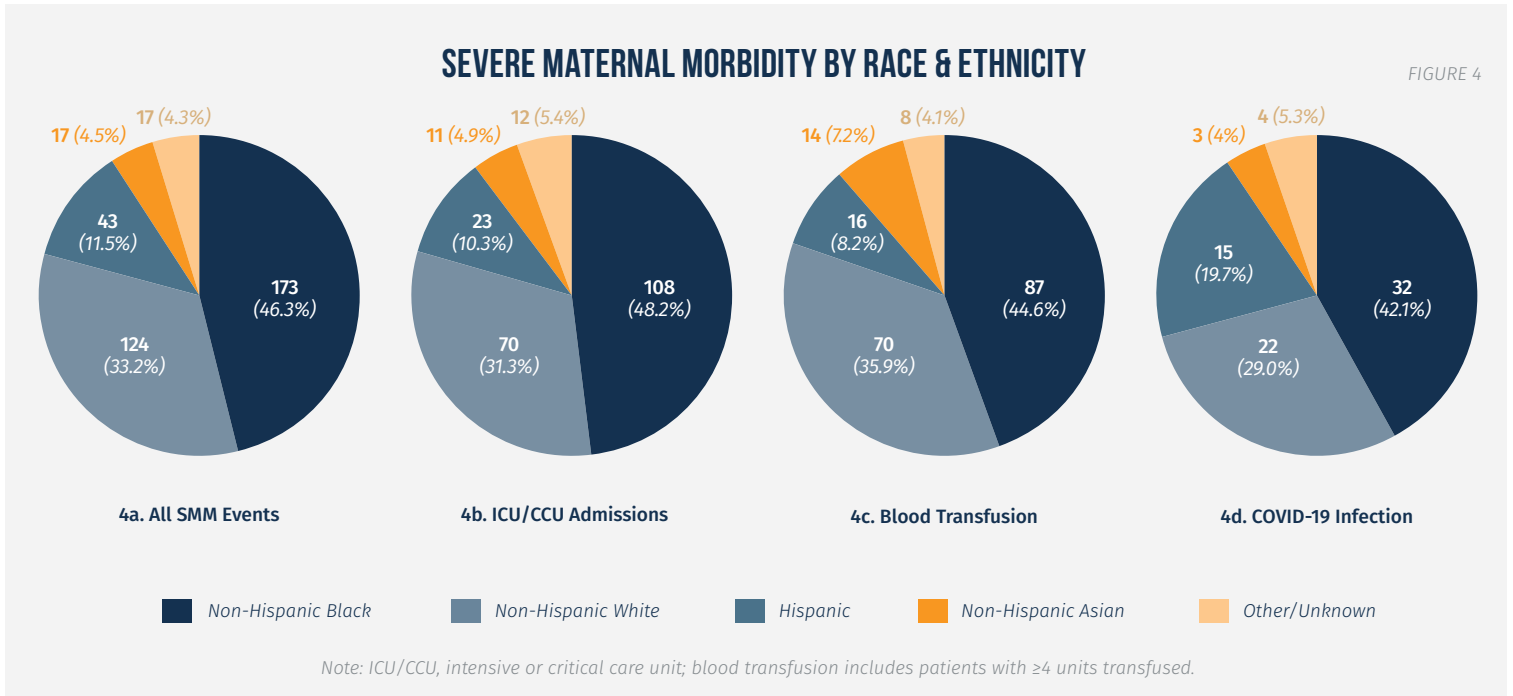


Note: ICU/CCU, intensive or critical care unit; blood transfusion includes patients with ≥4 units transfused.



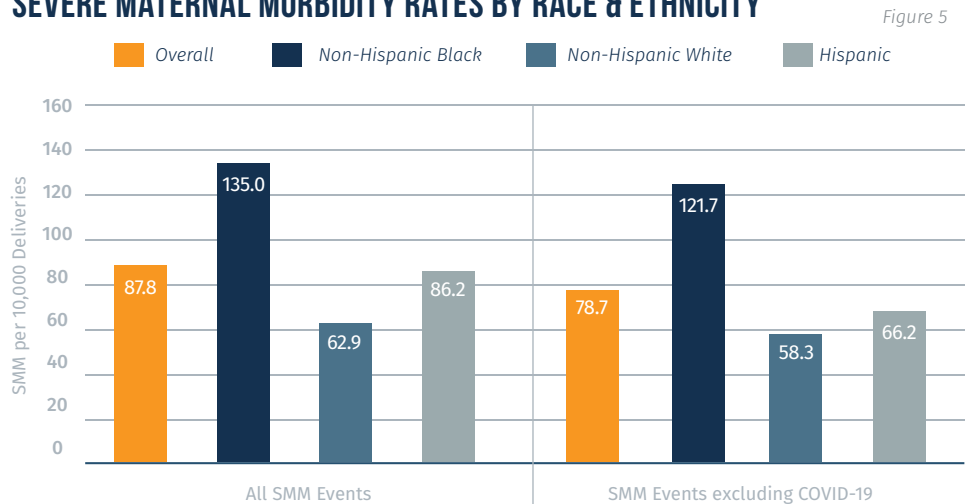
SEVERE MATERNAL MORBIDITY BY RACE & ETHNICITY

- Almost half (46.3%) of SMM events were experienced by non-Hispanic Black patients, a third by non-Hispanic White (33.2%) patients, 11.5% by Hispanic patients and 4.6% by non-Hispanic Asian patients (Figure 4a)
- Non-Hispanic Black patients comprised the largest group requiring ICU admission (48.2%), blood transfusion (44.6%), and hospitalization for severe COVID-19 infection (42.1%, Figures 4b, 4c, and 4d)



- The SMM rate was highest for non-Hispanic Black patients (135.0 per 10,000 deliveries); more than double that of non-Hispanic White patients (62.9 per 10,000 deliveries) (Figure 5)
- While lower than for non-Hispanic Black patients, the SMM rate among Hispanic patients (86.2 per 10,000 deliveries) was 37% higher than in non-Hispanic White patients (62.9 per 10,000 deliveries)
- Exclusion of severe COVID-19 infection from the case definition would have reduced the overall SMM rate from 87.8 to 78.7 per 10,000 deliveries

SEVERE MATERNAL MORBIDITY RATES BY RACE & ETHNICITY



Note: Denominators are based on 2020-2022 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.

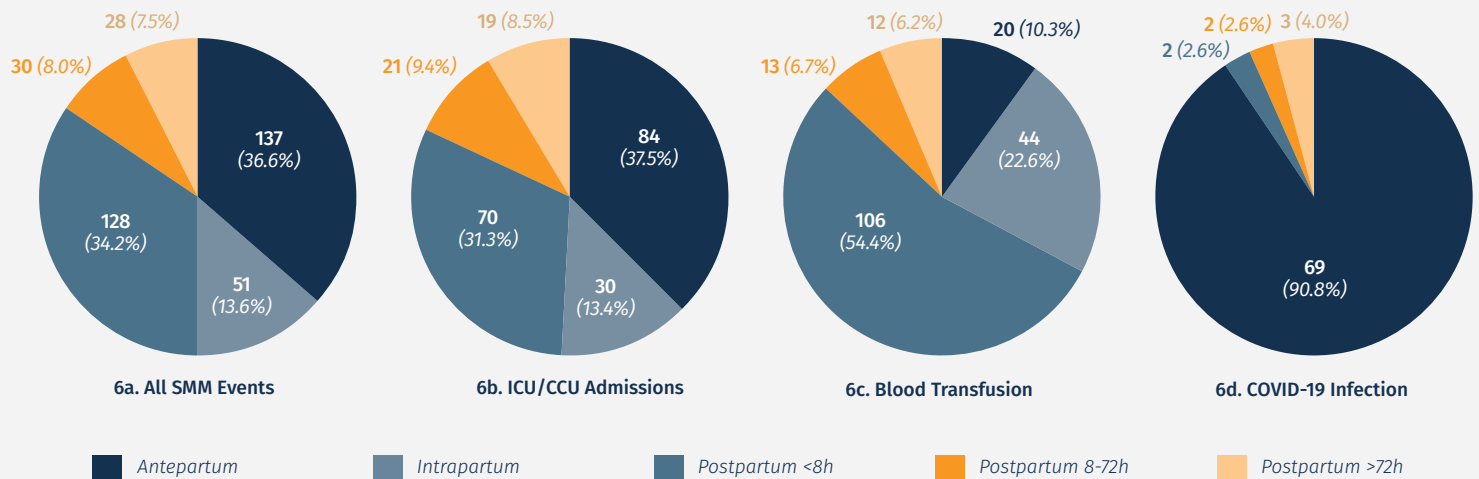


TIMING OF SEVERE MATERNAL MORBIDITY EVENTS

- Over one-third (36.6%) of the SMM events occurred during the antepartum period and during the first 8 hours after delivery (34.2%) (Figure 6a)
- The antepartum period was most common time for SMM events that involved hospitalization for COVID-19 infection (90.8%) and those requiring ICU admission (37.5%)
- Among all postpartum SMM events (n=99), 71.7% occurred on the day of delivery and 8.1% the day after delivery; the latest SMM event reported occurred 39 days after delivery
- 54.4% of SMM blood transfusion events occurred, as expected, during the first 8 hours after delivery (Figures 6c)

TIMING OF SEVERE MATERNAL MORBIDITY EVENTS

FIGURE 6



Note: ICU/CCU, intensive or critical care unit; blood transfusion includes patients with ≥4 units transfused.

LENGTH OF HOSPITAL STAY

- The average length of hospital stay for patients with an SMM event was 6.7 days, ranging from 0 to 84 days
- Among patients with SMM and an ICU admission (n=224), the average length of stay in the ICU was 2.9 days, ranging from 0 to 35 days

MEDICAL & OBSTETRIC HISTORY OF PATIENTS WITH SEVERE MATERNAL MORBIDITY

- The most common pre-existing medical condition prior to the index pregnancy was obesity (41.2%), followed by a mental health disorder (31.3%) and chronic hypertension (19.1%) (Table 3)
- Among those who reported substance use (n=70), marijuana (62.9%), tobacco (25.7%), and opioids (14.3%) were most frequently reported
- 27.8% of patients with SMM events had no prior births, 27.8% had one prior birth, 21.4% had two prior births, and 23.0% had three or more prior births
- About one in ten patients (10.4%) used assisted reproductive technology to conceive the index pregnancy

MEDICAL HISTORY AND CARE SEEKING

TABLE 3

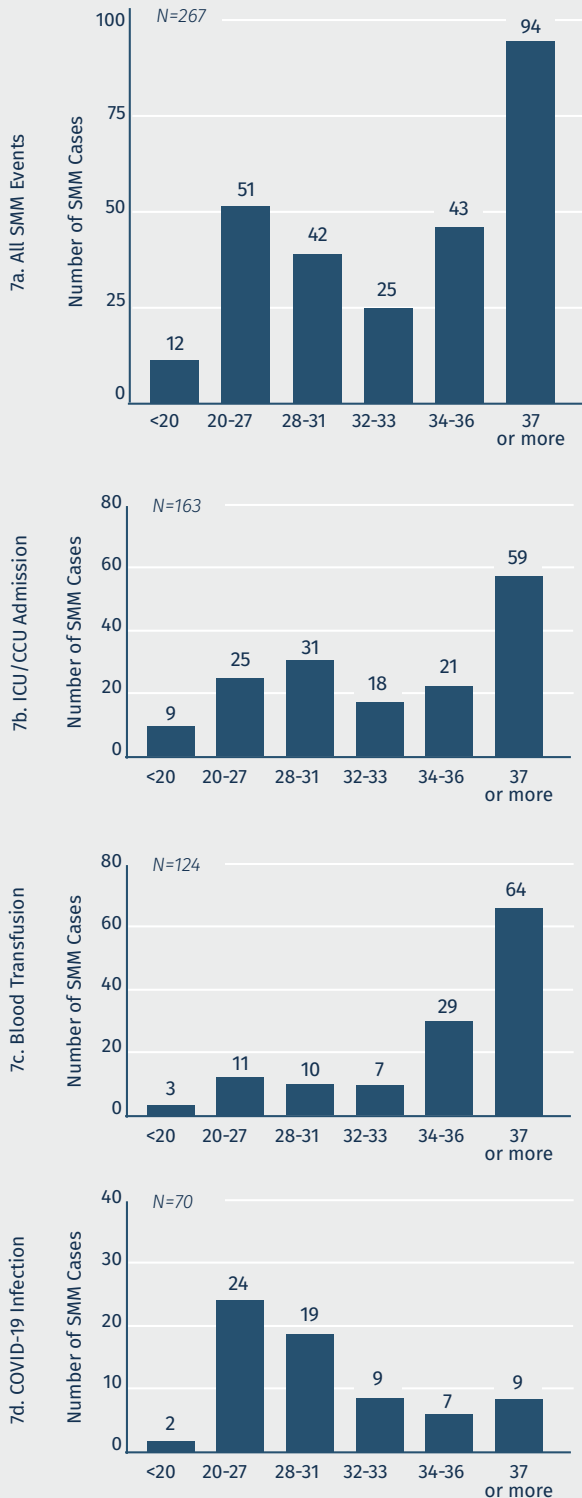
PATIENT CHARACTERISTICS		
Significant medical history	77.4%	287 of 371
Obesity	41.2%	153 of 371
Mental health disorder	31.3%	116 of 371
Chronic hypertension	19.1%	71 of 371
Asthma	18.6%	69 of 371
Substance use	18.9%	70 of 371
Anemia	14.6%	54 of 371
Diabetes	6.7%	25 of 371
Cardiovascular condition	5.9%	22 of 371
Complications in prior pregnancy	66.3%	165 of 249
Pregnancy loss	36.9%	92 of 249
Cesarean delivery	26.1%	65 of 249
Hypertensive disorder of pregnancy	15.7%	39 of 249
Gestational diabetes	5.6%	14 of 249
Complications in current pregnancy	65.4%	233 of 356
Hypertensive disorder of pregnancy	16.3%	58 of 356
Placental abnormality	14.9%	53 of 356
Gestational diabetes	8.1%	29 of 356
Prenatal care		
Prenatal care initiated in first trimester	76.3%	251 of 329
No prenatal care	3.3%	12 of 367

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



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

FIGURE 7



Note: ICU/CCU, intensive or critical care unit; blood transfusion includes patients with ≥4 units transfused.

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

- Of the SMM events that occurred antepartum or intrapartum (n=267), 23.6% occurred before 28 weeks, 41.2% between 28 and 36 weeks, and 35.2% at 37 weeks or more gestation (Figure 7a)
- Over one third (36.2%) of ICU admission events and one half of blood transfusion events (51.6%) occurred at 37 weeks or more (Figures 7b-c)
- More than two-thirds (64.2%) of events involving severe COVID-19 infection occurred before 32 weeks of gestation (Figures 7d)

DELIVERY OUTCOMES AMONG PATIENTS WITH SEVERE MATERNAL MORBIDITY

- A total of 264 (70.6%) SMM events occurred during the delivery hospitalization, of which 25.8% were vaginal and 72.3% were cesarean deliveries (Table 4)
- The majority of deliveries were live births (91.3%), with an average gestational age of 37 weeks
- Nearly half (45.6%) of infants were born preterm, 36.1% were low birthweight, and 47.3% were admitted to the neonatal intensive care unit (NICU)

DELIVERY CHARACTERISTICS OUTCOMES AMONG PATIENTS WITH SEVERE MATERNAL MORBIDITY

TABLE 4

SMM Event Occurred During Delivery Hospitalization ¹	70.6%	264 of 374
Vaginal delivery	25.8%	68 of 264
Spontaneous	92.6%	63 of 68
Assisted	7.4%	5 of 68
Cesarean delivery ²	72.3%	191 of 264
Planned	35.3%	65 of 184
Emergency	64.7%	119 of 184
Live birth	91.3%	241 of 264
Gestational age, mean (range)	37w2d	(20w4d-41w2d)
Preterm birth	45.6%	110 of 241
Low birthweight	36.1%	87 of 241
NICU admission	47.3%	114 of 241
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. ¹Five other delivery outcomes include ruptured uterus, hysterectomy, and dilation and curettage; ²Cesarean delivery type unknown among 7 patients.

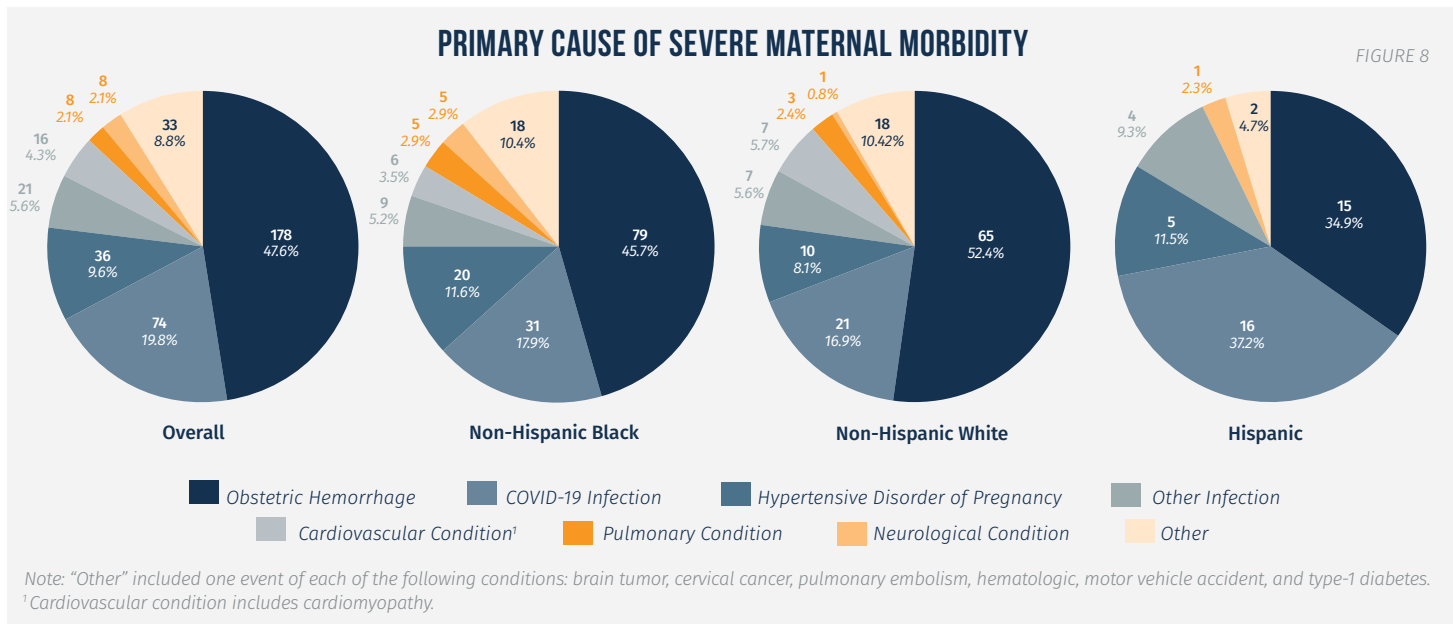


PRIMARY CAUSE OF SEVERE MATERNAL MORBIDITY EVENTS

- The most common primary cause of SMM was obstetric hemorrhage (47.6%), COVID-19 infection (19.8%), hypertensive disorder of pregnancy (9.6%), other infection (5.6%), and cardiovascular condition, including cardiomyopathy (4.3%, Figure 8)
- Among the 224 events requiring ICU admission, the top 5 primary causes of SMM were obstetric hemorrhage (36.2%), COVID-19 infection (15.6%), hypertensive disorder of pregnancy (14.3%), other infection (8.9%), and cardiovascular condition (6.7%)

- Common contributing morbidities for all types of SMM events were hypertensive disorder of pregnancy (12.3%), infection, including COVID-19 (10.4%), obstetric hemorrhage (10.7%), pulmonary condition (7.7%), obesity (6.7%), and cardiovascular condition (5.8%)

32% OF SEVERE MATERNAL MORBIDITY EVENTS WERE POTENTIALLY PREVENTABLE



PREVENTABILITY OF SEVERE MATERNAL MORBIDITY

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

- Preventability of SMM events varied by the primary cause of SMM, ranging from 16.7% for cancer to 66.7% for metabolic/endocrine condition (Table 5)
- Among non-Hispanic Asian, Black, and White patients, approximately two-thirds of SMM events (35.3%, 32.4%, and 33.9%, respectively) were deemed preventable (Figure 9, next page)
- SMM preventability was lower for Hispanic patients at 23.3%
- Obstetric hemorrhage was the most common primary cause of preventable SMM events for non-Hispanic Asian (83.3%), Black (46.4%), and White patients (57.1%), while other infection was the most common preventable primary cause for Hispanic patients (40.0%)

PREVENTABILITY OF SEVERE MATERNAL MORBIDITY

TABLE 5

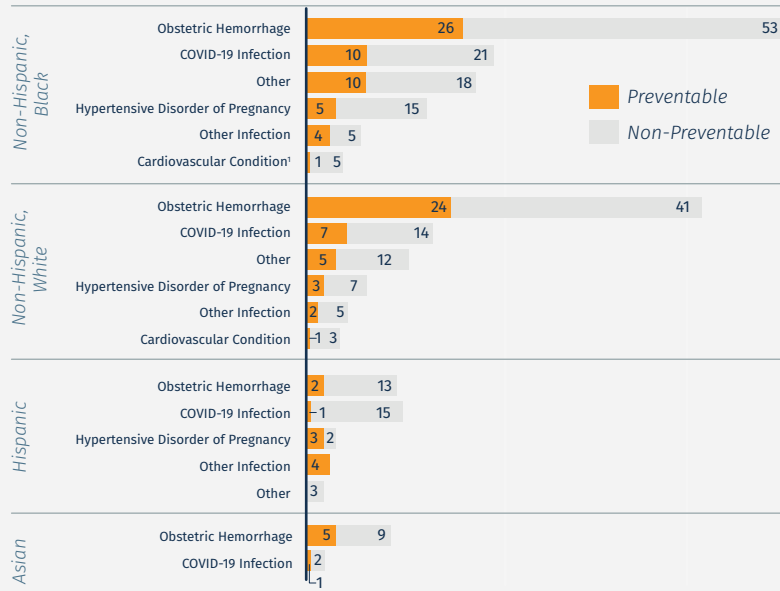
CAUSE	%	N
Metabolic/endocrine condition	66.7	4 of 6
Other infection	52.4	11 of 21
Hematologic	50.0	3 of 6
Obstetric hemorrhage	32.6	58 of 178
Hypertensive disorder of pregnancy	30.6	11 of 36
COVID-19 infection	27.0	20 of 74
Neurologic condition	25.0	2 of 8
Pulmonary condition	25.0	2 of 8
Other	20.0	3 of 15
Cardiovascular condition ¹	18.8	3 of 16
Cancer	16.7	1 of 5

Note: ¹Cardiovascular condition includes cardiomyopathy.



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

FIGURE 9



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 95 (21.7%), 45 (11.0%), and 53 (12.6%) SMM events, respectively (Figure 10).

About **17%** of SMM could have been prevented by addressing factors in the **antepartum** period. Most of these factors related to the Recognition, Response, and Respectful Care domains (Figure 11).

- Provider-level factors included enhanced monitoring of high-risk patients and earlier recognition of patient decompensation
- System-level factors included guidelines for outpatient management of high-risk patients
- Patient-level factors included utilization of prenatal care, management of preexisting medical conditions, and COVID-19 vaccination

About **12%** 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 11).

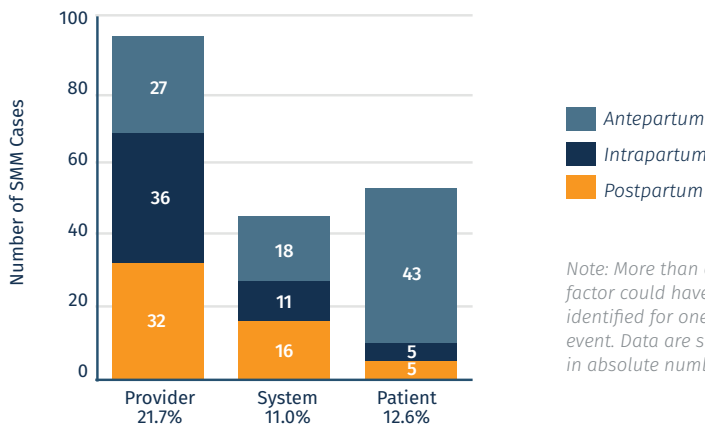
- Provider-level factors included referral to higher level of care, use of safe surgical technique and improved labor management
- System-level factors included availability of platelets and other resources including point of care testing

About **19%** 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 11).

- Provider-level factors included earlier initiation of appropriate treatment, improved care coordination within unit and enhanced monitoring of high-risk patients
- System-level factors included higher readiness to address obstetric emergencies, better care coordination across labor and delivery, anesthesia, and ICU units, and enhanced training for travel nurses
- Patient-level factors included improved patient-provider communication and compliance with medical recommendations

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

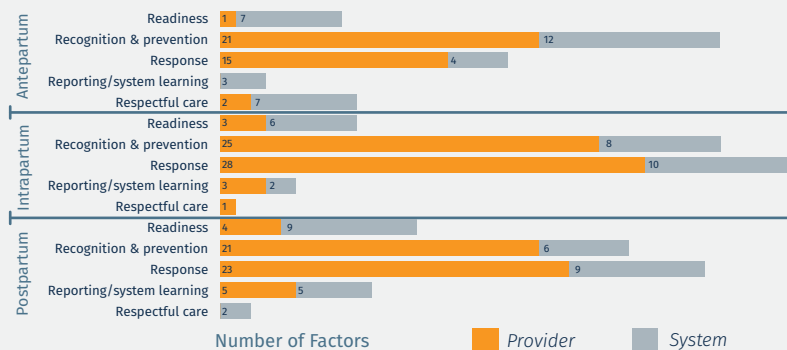
FIGURE 10



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 11



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



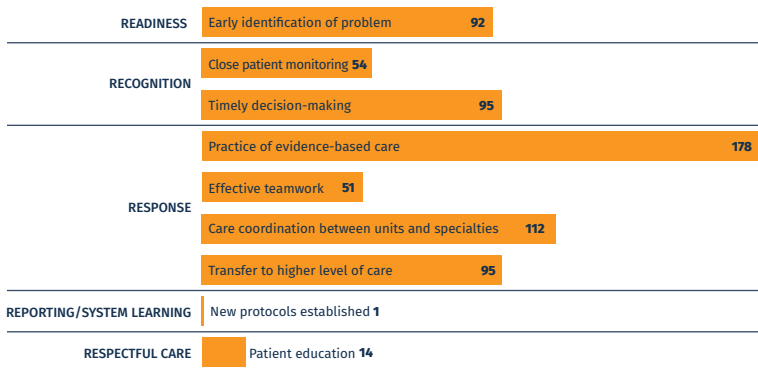
PRACTICES DONE WELL IN RELATION TO SEVERE MATERNAL MORBIDITY EVENTS

For all SMM events, Hospital Review Committees listed up to three practices that were done well and should be reinforced in their hospitals. Nine themes emerged from the 374 SMM events (Figure 12).

- The most commonly reported practices were practice of evidence-based care (mentioned in 178 reviews of SMM events, 47.6%) and care coordination between units (mentioned in 112 reviews, 29.9%)

PRACTICES DONE WELL IN RELATION TO SEVERE MORBIDITY EVENTS REVIEWED

FIGURE 12



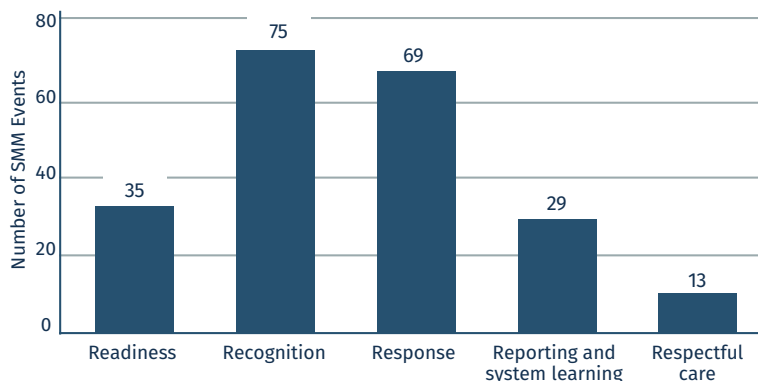
Note: Data are shown in absolute numbers; Fields for capturing this information were open-ended and unprompted; not mentioning these practices for a larger number of events does not mean that it did not occur.

KEY RECOMMENDATIONS FOR SEVERE MATERNAL MORBIDITY PREVENTION IN MARYLAND HOSPITALS

The most frequent recommendations by Hospital Review Committees were within the Recognition (75), Response (69), and Readiness (35) domains of the “5Rs” framework (Figure 13).

RECOMMENDATIONS FOR CARE IMPROVEMENT BY QUALITY IMPROVEMENT DOMAIN IN THE “5RS” FRAMEWORK

FIGURE 13



Note: Data are shown in absolute numbers. Recommendations were made in 194 SMM reviews. Hospital committees could make up to 3 recommendations for each event.

READINESS *The ability to use an institution’s resources, protocols and procedures when needed*

- Establish or strengthen Emergency Department protocols for OB emergencies
- Ensure 24/7 availability of assigned clinical staff and services (Anesthesia and OR) to assist with OB emergencies
- Enhance rapid availability of all blood products, especially platelets
- Require that all staff new to the OB unit be educated on emergency OB procedures and location of needed equipment

RECOGNITION *Assessment and measurement*

- Improve the recognition of patients in need of closer monitoring during the antenatal period
- Reinforce staff education in the recognition of clinical markers signaling patients at risk for decompensation intrapartum and in the immediate postpartum period
- Closer inspection and longer observation in the immediate postpartum period for adequate hemostasis and evidence of organ injury
- Discern aberration of clinical values upon patients’ presentation

RESPONSE *Treatment and management*

- Reinforce TeamSTEPSS communication strategies with OB care teams
- Establish communication pathways to enhance clinical specialties involvement in the coordination of OB patient care
- Review guidelines for escalating patient care to a higher level with frontline staff
- Provide readily assessable clinical pathways to guide new or inexperienced staff in OB emergencies to reduce care variation

REPORTING AND SYSTEM LEARNING *Communication, debrief and review*

- Encourage the reporting of critical values directly to the clinician as well as in the EHR
- Encourage system learning to better manage hemorrhage and blood transfusion events
- Reinforce established guidelines allowing for open communication among all staff to enhance OB patient care

RESPECTFUL CARE *Recognizing the patient’s right to be educated, informed and supported*

- Provide a listing and contact number of available support and resources at first contact with high-risk patients (e.g. those with medical risk due to pregnancy conditions, comorbidities, substance use; and patients with barriers to care).
- Periodic follow up calls to establish rapport and/or offer support to high-risk patients

Note: OB, obstetric; OR, operating room; EHR, electronic health record.