

Initiatives to Reduce Maternal Mortality and Severe Maternal Morbidity in the United States

A Narrative Review

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Maternal mortality and severe maternal morbidity are critical health issues in the United States, with unacceptably high rates and racial, ethnic, and geographic disparities. Various factors contribute to these adverse maternal health outcomes, ranging from patient-level to health system-level factors. Furthermore, a majority of pregnancy-related deaths are preventable. This review briefly describes the epidemiology of maternal mortality and severe maternal morbidity in the United States and discusses selected initiatives to reduce maternal mortality and se-

vere maternal morbidity in the areas of data and surveillance; clinical workforce training and patient education; telehealth; comprehensive models and strategies; and clinical guidelines, protocols, and bundles. Related Health Resources and Services Administration initiatives are also described.

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Data from the Centers for Disease Control and Prevention's (CDC's) Pregnancy Mortality Surveillance System (PMSS) indicate that pregnancy-related death (defined as deaths during pregnancy or within 1 year of the end of pregnancy from a cause related to pregnancy or its management) occurs in 700 women each year in the United States (1). More recent data from the CDC's National Center for Health Statistics indicate that the U.S. maternal mortality rate (including deaths during pregnancy or within 42 days after the end of pregnancy from a cause related to pregnancy or its management) was 17.4 per 100 000 live births in 2018 (2). Together, these 2 measures of maternal mortality suggest that the risk for death during and after pregnancy is too high in the United States. The United States has a considerably higher maternal mortality rate than other developed countries, including the United Kingdom and Canada (3, 4). According to a report from 14 state Maternal Mortality Review Committees (MMRCs), two thirds of pregnancy-related deaths were preventable, with patient and health system factors noted as being associated with these deaths (4).

Severe maternal morbidity (SMM), defined as "unintended outcomes of the process of labor and delivery that result in significant short-term or long-term consequences to a woman's health," is more common than maternal mortality (5). For every pregnancy-related death, there are approximately 70 cases of SMM, and more than 50 000 women were affected by SMM in 2014. From 2006 to 2015, rates for most indicators of SMM increased, including blood transfusions (6).

This narrative review describes the leading causes of and contributing factors to maternal mortality and SMM in the United States. It also highlights selected initiatives for improving these adverse maternal health outcomes.

EPIDEMIOLOGY OF MATERNAL MORTALITY AND SMM IN THE UNITED STATES

Surveillance

The United States has 3 data sources on maternal mortality: the National Vital Statistics System, the PMSS, and MMRCs (7). Since the early 2000s, the United States has been working to improve its surveillance of maternal mortality. A key improvement has been the addition of the pregnancy checkbox question to the U.S. standard death certificate in 2003. This question was added after studies identified underreporting of maternal deaths during the 1980s and 1990s (8). Since that time, growing evidence suggests that the addition of the checkbox may have resulted in misclassification and overreporting of maternal deaths. Therefore, experts continue to call for further improvements in data collection to ensure accurate reporting of maternal deaths (9-11). In January 2020, the CDC released the first official MMR statistic since 2007 with accompanying methodology reports, including changes in coding to account for erroneous reporting of maternal deaths due to the adoption of the pregnancy checkbox (2, 12). Data on SMM are available from the National (Nationwide) Inpatient Sample through the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (6).

Leading Causes of Pregnancy-Related Mortality and Indicators of SMM

According to data from the CDC's PMSS, leading causes of pregnancy-related death in the United States from 2007 to 2016 were cardiovascular conditions, noncardiovascular medical conditions, and infection (1). From 2011 to 2015, more than half of all pregnancy-related deaths occurred after birth, including nearly 12% of deaths that occurred 43 to 365 days

Key Summary Points

Pregnancy-related mortality and severe maternal morbidity are unacceptably high in the United States.

Risk for pregnancy-related death is higher for non-Hispanic Black women and American Indian/Alaska Native women compared with non-Hispanic White women.

Many factors, ranging from patient-level factors to health system-level factors, contribute to maternal mortality and morbidity.

Emerging initiatives to improve maternal health include data and surveillance; telehealth; patient education and clinical workforce training; comprehensive models and strategies; and clinical guidelines, protocols, and bundles.

postpartum (4). On a related note, in terms of SMM, the 5 most common SMM indicators in the United States in 2015 were blood transfusion, disseminated intravascular coagulation, hysterectomy, acute renal failure, and adult respiratory distress syndrome (6).

Factors Contributing to Adverse Maternal Health Outcomes

Factors contributing to poor maternal health outcomes in the United States are complex and are only partially understood (13). A 2018 report from 9 MMRCs delineated 3 levels of contributing factors to pregnancy-related deaths: patient/family, provider, and systems of care (14). A 2019 *Morbidity and Mortality Weekly Report*, drawing on lessons from 13 state MMRCs, provides a similar typology of levels of contributing factors with the addition of health system-level factors (4).

Patient-Level Factors

Women of advanced maternal age have an elevated risk for pregnancy-related mortality; from 2011 to 2015, nearly one third of all pregnancy-related deaths in the United States occurred in women aged 35 years or older (4). The increasing prevalence of obesity and other chronic conditions among pregnant women may play a role in the high rates of pregnancy-related mortality in the United States (15, 16). Researchers have also suggested that increases in maternal age, prepregnancy obesity, preexisting chronic conditions, and cesarean delivery may contribute to the reported increase in U.S. SMM rates (17). These factors are similar to those that contribute to pregnancy-related mortality.

Several studies describe the potential roles of substance use and mental health conditions among pregnant women in contributing to maternal mortality. One study documented an increase in the prevalence of maternal opioid abuse or dependence in the United States from 0.17% in 1998 to 0.39% in 2011. Deliveries associated with maternal opioid abuse or dependence had more than 4 times the odds of maternal death compared with deliveries without opioid abuse or dependence (18).

Researchers have also documented racial and ethnic disparities in pregnancy-related mortality. Data from CDC's PMSS for 2007 to 2016 indicate that non-Hispanic Black women and American Indian/Alaska Native women have the highest pregnancy-related mortality ratios, which were 3.2 and 2.3 times those of non-Hispanic White women, respectively (1).

Community-Level Factors

The CDC's 2019 *Morbidity and Mortality Weekly Report* identified 4 community-level factors that contribute to pregnancy-related deaths in the United States: lack of "[a]ccess to clinical care"; "unstable housing"; "lack of, or inadequate, transportation options"; and "obesity and associated chronic disease complications" (4).

Women living in rural areas of the United States are at higher risk for SMM and maternal mortality than those living in urban areas; specifically, from 2007 to 2015, rural residents had a 9% higher probability of SMM and mortality during childbirth hospitalizations compared with urban residents (19). Rural women's lack of access to obstetric specialists may in part explain these disparities (20). On a related note, the closure of obstetric units has resulted in the loss of obstetric services in more than 50% of U.S. rural counties (21).

Health System-Level Factors

The lack of standardized approaches to emergency obstetric care may contribute to poor maternal health outcomes (4). Maternal health experts have noted gaps in responding to certain types of obstetric emergencies (such as hemorrhage) (22). The National Partnership for Maternal Safety has recognized the need for the development of safety bundles addressing obstetric emergencies, such as obstetric hemorrhage, severe hypertension, and venous thromboembolism, to standardize approaches to address these conditions (23). A 2018 report from 9 MMRCs identified "provider factors" and "systems of care factors" as contributors to pregnancy-related deaths (14).

The health care system's inattention to a woman's life course—especially during the postpartum period, when many pregnancy-related deaths and illnesses occur—may contribute to poor maternal outcomes. In response, the American College of Obstetricians and Gynecologists (ACOG) called for modifications in the way providers view the "fourth trimester"; ACOG has issued guidance for postpartum care that recommends shifting from a single visit at one point in time to a comprehensive set of visits customized to a woman's needs (24).

The importance of a woman's life course has been emphasized by federal health agencies. In June 2018, the U.S. Department of Health and Human Services (HHS), Health Resources and Services Administration (HRSA), hosted a Maternal Mortality Summit, a convening of maternal health experts from Brazil, Canada, Finland, India, Rwanda, the United Kingdom, and the World Health Organization (WHO), to discuss evidence-based approaches for improving maternal health (Figure 1) (25).

U.S. INITIATIVES TO REDUCE MATERNAL MORTALITY AND SMM

Several initiatives are currently under way to address the challenge of maternal mortality in the United States, including the Preventing Maternal Deaths Act (H.R. 1318) that was signed into law on 21 December 2018. This law authorizes federal funding to support the work of state MMRCs and represents a major step toward addressing high rates of maternal mortality and SMM (26). The MMRCs are state- and city-based multidisciplinary committees that perform comprehensive assessments of maternal deaths to help inform prevention activities at community levels.

Beyond these important population-based surveillance efforts, several federal and nonfederal initiatives are under way to reduce maternal mortality and morbidity in the United States. We have classified these initiatives into 5 areas: data and surveillance; telehealth; clinical workforce training and patient education; comprehensive models and strategies; and clinical guidelines, protocols, and bundles. Recent advances in each of these areas, as well as related HRSA initiatives, are described below.

Data and Surveillance

Improving the standardization and comparability of surveillance data has been a major focus of efforts to address maternal mortality. As of October 2020, 44 U.S. states and 3 U.S. cities had MMRCs (27). Several state MMRCs are using the findings from their reviews to inform the development of strategies to prevent maternal deaths (7). The CDC, along with MMRCs, developed the Maternal Mortality Review Information Application (MMRIA) data system to facilitate standardized review of maternal deaths in MMRCs (28). This data system is designed to help MMRCs with standardized data abstraction from multiple sources, including vital records, medical records, and social service records. The system includes 12 “forms” of various types of data (Figure 2) (29) and provides tools, such as committee facilitation guides and case narrative templates, to sup-

Figure 2. Types of data collected by the Maternal Mortality Review Information Application.

Death certificate
Birth certificate/fetal death certificate
Autopsy report
Prenatal care record
Emergency department visits and hospitalizations
Other medical office visits
Medical transport
Social and environmental profile
Mental health profile
Informant interviews
Case narrative
Committee decisions

port the work of MMRCs (28). The CDC's Enhancing Reviews and Surveillance to Eliminate Maternal Mortality (ERASE MM) Program supports 25 states and provides funding to their MMRCs to identify and review maternal deaths and develop recommendations to prevent future deaths. States may also use funding from the Maternal and Child Health Block Grant (Title V of the Social Security Act) to support their MMRCs.

Researchers have also developed data tools that can help identify opportunities for improving access to midwifery services in the United States. The Midwifery Integration Scoring System (MISS) is a tool that ranks U.S. states on how integrated midwives are into health systems. The scoring system covers certain domains, such as whether the state offers Medicaid reimbursement for certified midwives. Researchers found that states with higher levels of midwife integration are associated with desirable health outcomes, such as higher rates of spontaneous vaginal birth and lower rates of cesarean and preterm birth, suggesting that the tool could identify states where better integration of midwives could improve maternal health outcomes (30).

Telehealth

Maternal health-focused telehealth initiatives have been described in several states. The Georgia Department of Public Health implemented a telehealth intervention, CenteringPregnancy, with the Southwest Georgia Public Health District in 2011 among pregnant African American and Hispanic women in high-risk obstetric clinics. The intervention brings together pregnant women with similar delivery dates to participate in group discussions. Two-hour group discussions are facilitated by a clinical provider and support staff and occur immediately after prenatal visits (31). A maternal-fetal specialist participates remotely to provide women

Figure 1. Health Resources and Services Administration Maternal Mortality Summit recommendations.

Improve access to patient-centered, comprehensive care for women across the life course
Provide continuity of care for women across the life course by increasing the types and distribution of health care providers and using a team-based approach
Improve the quality and availability of national surveillance and survey data, research, and common terminology and definitions
Improve the quality of maternity services through such efforts as the utilization of safety protocols in all birthing facilities
Improve the quality and consistency of maternal mortality review committees through collaborations and technical assistance with U.S. states
Promote opportunities for productive collaborations

Figure 3. Center for Reproductive Rights and Black Mamas Matter Alliance: 6-point policy framework.

Improve access to reproductive health care
Improve quality of maternal health care
Ensure acceptability of maternal health care for women most at risk
Ensure widespread availability of maternal health services
Ensure nondiscrimination in access to maternal health care and social determinants of health
Ensure accountability to human rights standards on maternal health

with 1-on-1 consults and facilitates group discussions. Among the program's 500 deliveries, preterm labor rates decreased from 18.8% at baseline to 8% at the end of the 18-month intervention (32). In Wisconsin, researchers conducted a postpartum telehealth study in which women were provided with home blood pressure monitors to transmit data to a care team and a nurse scheduled telehealth visits or telephone calls with the patients, beginning at 48 hours and as needed, until a patient's 6-week clinic visit. The program enabled clinical staff to rapidly identify women who were hypertensive, and none of the women in the intervention experienced a hospital readmission (33).

In 2019, the HRSA initiated the remote pregnancy monitoring challenge to support innovative technology-based solutions that help providers remotely monitor the health of pregnant women and empower women to make informed decisions about their care. The use of remote monitoring increases virtual access to quality care for low-income pregnant women and benefits women who live in rural and medically underserved areas who have limited access to on-site prenatal care. Five organizations won a share of \$125 000 to finalize their remote monitoring innovations (34). In addition, HRSA's Screening and Treatment for Maternal Depression and Related Behavioral Disorders program supports states to develop new or expand existing telehealth access programs to offer psychiatric consultation, care coordination support, and training to frontline health care providers, especially in rural and medically underserved areas.

Some experts have proposed collaborative models to improve the referral process for women in rural areas who need more specialized care during childbirth (35). These improvements are informed by a joint consensus document from the Society for Maternal-Fetal Medicine and ACOG, "Levels of Maternal Care," which describes a concept of regionalized maternal care where high-risk pregnant women are transferred to higher levels of care on the basis of their medical needs (36). In a model called the "maternal health compact," clinical staff from higher-level facilities provide assistance to clinical staff from lower-level facilities to manage obstetric emergencies via a video link (35).

Clinical Workforce Training and Patient Education

Several state MMRCs have used their surveillance efforts to inform targeted activities to address maternal mortality. For example, on the basis of the Florida MMRC's identification of non-Hispanic Black women as a priority population, a community health organization called REACHUP partnered with the HHS Office of Minority Health to establish the Preconception Peer Educator program (37, 38). This program trained peer educators on racial disparities in maternal outcomes at 3 historically Black colleges and universities and led to the formation of a subcommittee focused on helping health care providers address social determinants of maternal mortality (37, 38). In Colorado, the state MMRC identified suicide, homicide, and substance use as major areas of concern and subsequently developed screening tools, medication algorithms, and other resources for health care professionals to use with their patients (39, 40). Ohio's MMRC identified the need for training for obstetric emergencies, and subsequently, the Ohio Department of Health and Ohio State University's Clinical Skills and Education Assessment Center developed a simulated obstetric emergency training series for health care professionals on hemorrhage, cardiomyopathy, and preeclampsia (41).

Academic researchers have developed patient education interventions to address perinatal mental health among specific populations. The Mothers and Babies Course, funded by HRSA's Maternal and Child Health Bureau, focuses on preventing perinatal depression among low-income women. Using a cognitive behavioral therapy model to promote mother-child bonding, the course can be delivered in different settings (for example, home visits or hospitals) and takes place over 6, 8, or 12 visits (42).

Various organizations are raising awareness about racial and ethnic disparities in maternal health. A partnership between the Center for Reproductive Rights and the Black Mamas Matter Alliance developed a toolkit that includes a policy framework to address disparities (Figure 3), talking points for advocates, and research and informational resources about maternal mortality (43). The Black Mamas Matter Alliance also implemented its first-ever Black Maternal Health Week in April 2018, and this continues to be observed on an annual basis (44).

The American College of Nurse-Midwives (ACNM) is also working to address these issues; ACNM's Diversity and Inclusion Task Force helped articulate the organization's role in reducing health disparities and led the organization to formally adopt "diversity and inclusion" as a component of its 2015-2020 Strategic Plan (45).

Comprehensive Models and Strategies

Several U.S. states are adapting the patient-centered medical home model to address maternal health. In 2011, the North Carolina Division of Public Health led the development of the Pregnancy Medical Home (PMH) program for the pregnant Medicaid pop-

ulation in North Carolina. The targeted outcomes are 2-fold: to reduce primary cesarean delivery rates and decrease the rate of very-low-birthweight and low-birthweight babies in the state. The PMH's reach with health care providers is extensive, with more than 1600 providers in North Carolina participating in the program. Key features of the model include nurse/social work care managers providing case management services to high-risk patients, payments being given to providers at multiple milestones (such as after risk screening and after the patient has completed the postpartum visit), and higher physician reimbursement for vaginal deliveries (46, 47).

Wisconsin's obstetric medical home program strongly emphasizes care coordination and meeting a woman's psychosocial needs (48). The state's health department pays HMOs for each woman meeting its inclusion criteria for being at high risk and issues an additional payment for each healthy birth. In turn, HMOs provide payment to participating clinics (49). The Strong Start for Mothers and Newborns initiative was a joint effort supported by the Centers for Medicare & Medicaid Services, HRSA, and the Administration for Children and Families. This federal initiative supported the implementation of 3 types of interventions—maternity care homes, group prenatal care, and birth centers—in nearly 30 states, the District of Columbia, and Puerto Rico. An evaluation of the program found, among other promising key findings, that Strong Start enrollees had a very low rate of gestational diabetes (5.5%) (50). Many Strong Start awardees focused on providing dietary guidance, nutritional counseling, and referrals to nutritionists or diabetes support groups and promoting use of the Special Supplemental Nutrition Program for Women, Infants, and Children. Some of the interventions also involved exercise promotion and other health education activities. Evaluation findings suggest these types of health and wellness services may have contributed to the low incidence of gestational diabetes (50).

Clinical Guidelines, Protocols, and Bundles

The HRSA-funded Alliance for Innovation on Maternal Health (AIM) seeks to reduce maternal morbidity and mortality by improving the quality and safety of maternity care services. The AIM program assists state-based teams in the implementation of maternal safety bundles, which are straightforward sets of evidence-based or best practices for maternity care. A variety of AIM patient safety bundles exist (Figure 4) to help health care professionals address and prevent key contributors to maternal morbidity and mortality (51). The AIM program data are regularly collected and analyzed to explore the effect of bundles on key outcomes. In October 2020, 38 states were enrolled in AIM, with participation from approximately 1500 hospitals (52).

In September 2019, HRSA also awarded a single cooperative agreement for an AIM-related and adjacent project, the AIM-Community Care Initiative (AIM-CCI). This project is tasked with convening a maternal safety workgroup comprising community-focused public health and clinical experts who will guide program

implementation, facilitate national implementation of 2 non-hospital-focused maternal safety bundles, develop new bundles for use in outpatient clinical settings, and collect and analyze data on bundle implementation.

The California Maternal Quality Care Collaborative (CMQCC), an influential public-private partnership formed in 2006 (53), makes extensive use of rapid-cycle data, which are used as a feedback loop to improve processes (54). The CMQCC has developed quality improvement toolkits focused on hemorrhage and preeclampsia and implemented targeted quality improvement projects that continue to have a substantive effect. For instance, the CMQCC's obstetric hemorrhage quality improvement project on SMM included nearly 100 hospitals and demonstrated a substantial reduction in SMM among women with hemorrhage (22).

Obstetric early-warning systems have been used in other countries to ensure timely clinical attention of pregnant women to prevent life-threatening illnesses. Drawing from previously designed systems, in 2015, the National Partnership for Maternal Safety developed its own system for implementation in the United States, the maternal early warning criteria (MEWC), to identify women at risk for morbidity and mortality (55). In 2018, researchers published a validation study of the MEWC among 400 deliveries in which women who did not meet the criteria specified in the screening tool had low risk for morbidity (56).

Related HRSA Initiatives

In 2019, HRSA funded 3 programs aimed at preventing and reducing maternal mortality and SMM in underserved communities. These programs support improvements in areas previously discussed, such as data and surveillance, clinical workforce training, and comprehensive models and strategies. The first program, the State Maternal Health Innovation Program, funds 9 states to collaborate and optimize resources to implement state-specific actions that address maternal health disparities and improve outcomes. Grantee states are expected to establish a Maternal Health Task

Figure 4. Patient safety bundles.

Core Alliance for Innovation on Maternal Health Patient Safety Bundles
Obstetric hemorrhage
Severe hypertension in pregnancy
Safe reduction of primary cesarean birth
Obstetric care for women with opioid use disorder
Supporting Alliance for Innovation on Maternal Health Patient Safety Bundles
Postpartum care basics for maternal safety
From birth to the comprehensive postpartum visit
Transition from maternity to well-woman care
Maternal venous thromboembolism
Reduction of peripartum racial and ethnic disparities
Support after a severe maternal event

Force, improve state-level data collection and analysis of maternal mortality and SMM data, and design a state strategic plan that addresses any gaps identified by states' Title V Maternal and Child Health Services (MCH) Block Grant needs assessments. The HRSA's MCH Block Grant (Title V of the Social Security Act) is a key source of funding to 59 states and jurisdictions to improve the health and well-being of women and children through the creation of federal-state partnerships.

The second initiative, the Supporting Maternal Health Innovation Program, funds 1 grantee to provide national-level technical assistance and training support to all HRSA award recipients focused on improving maternal health outcomes. In addition, through the Rural Maternity and Obstetrics Management Strategies program, the HRSA funded 3 rural maternal health networks to improve access to and continuity of maternal and obstetric care in rural communities by developing sustainable network approaches to coordinate maternal and obstetric care within a rural region; increase delivery and access to services; develop sustainable financing models for the provision of maternal and obstetric care; and improve maternal and neonatal outcomes.

Since its inception, the HRSA-supported Healthy Start Initiative: Eliminating Disparities in Perinatal Health program has aimed to improve health outcomes before, during, and after pregnancy and reduce racial/ethnic differences in rates of infant death and other adverse perinatal outcomes. In 2019, additional funds were provided to support efforts to specifically address maternal mortality by supporting the staffing of a maternal-child advance practice health professional at Healthy Start sites to provide access to well-woman care and maternity care services for high-risk clients.

In conclusion, maternal mortality and SMM rates in the United States are unacceptably high, and disparities in these rates persist. This review summarizes a set of initiatives that offer the potential to improve maternal mortality and SMM. Surveillance efforts may improve identification of contributory factors to maternal mortality and morbidity and inform interventions to prevent adverse maternal outcomes. Telehealth innovations can increase access to and improve the quality of care for high-risk pregnant women, especially in rural, medically underserved areas. Patient awareness and health care workforce training programs can heighten awareness about disparities in maternal outcomes. Medical homes can address the health needs of high-risk pregnant women. Quality improvement initiatives utilizing maternal safety bundles can improve care for women with hemorrhage and other life-threatening conditions. Finally, related initiatives funded by HRSA are designed to improve maternal outcomes while supporting improvements in the areas addressed by these various types of initiatives.

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References

- Petersen EE, Davis NL, Goodman D, et al. Racial/ethnic disparities in pregnancy-related deaths—United States, 2007–2016. *MMWR Morb Mortal Wkly Rep.* 2019;68:762–5. [PMID: 31487273] doi:10.15585/mmwr.mm6835a3
- Hoyert DL, Miniño AM. Maternal mortality in the United States: changes in coding, publication, and data release, 2018. *Natl Vital Stat Rep.* 2020;69:1–18. [PMID: 32510319]
- United Nations Population Fund. Trends in maternal mortality: 2000 to 2017. World Health Organization. 2019. Accessed at www.unfpa.org/featured-publication/trends-maternal-mortality-2000-2017 on 11 February 2020.
- Davis NL, Smoots AN, Goodman D. Pregnancy-related deaths: data from 14 U.S. Maternal Mortality Review Committees, 2008–2017. Centers for Disease Control and Prevention. Accessed at www.cdc.gov/reproductivehealth/maternal-mortality/erase-mm/MMR-Data-Brief_2019-h.pdf on 2 October 2020.
- Kilpatrick SK, Ecker JL; American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine. Severe maternal morbidity: screening and review. *Am J Obstet Gynecol.* 2016;215:B17–22. [PMID: 27560600] doi:10.1016/j.ajog.2016.07.050
- Fingar KF, Hambrick MM, Heslin KC, et al. Trends and disparities in delivery hospitalizations involving severe maternal morbidity, 2006–2015. HCUP statistical brief no. 243. Agency for Healthcare Research and Quality. 4 September 2018. Accessed at www.hcup-us.ahrq.gov/reports/statbriefs/sb243-Severe-Maternal-Morbidity-Delivery-Trends-Disparities.pdf on 2 March 2020.
- St Pierre A, Zaharatos J, Goodman D, et al. Challenges and opportunities in identifying, reviewing, and preventing maternal deaths. *Obstet Gynecol.* 2018;131:138–42. [PMID: 29215526] doi:10.1097/AOG.0000000000002417
- MacDorman MF, Declercq E, Cabral H, et al. Recent increases in the U.S. maternal mortality rate: disentangling trends from measurement issues. *Obstet Gynecol.* 2016;128:447–55. [PMID: 27500333] doi:10.1097/AOG.0000000000001556
- Davis NL, Hoyert DL, Goodman DA, et al. Contribution of maternal age and pregnancy checkbox on maternal mortality ratios in the United States, 1978–2012. *Am J Obstet Gynecol.* 2017;217:352.e1–352. [PMID: 28483570] doi:10.1016/j.ajog.2017.04.042
- MacDorman MF, Declercq E, Thoma ME. Making vital statistics count: preventing U.S. maternal deaths requires better data [Editorial]. *Obstet Gynecol.* 2018;131:759–61. [PMID: 29630026] doi:10.1097/AOG.0000000000002598
- Rossen LM, Womack LS, Hoyert DL, et al. The impact of the pregnancy checkbox and misclassification on maternal mortality trends in the United States, 1999–2017. *Vital Health Stat 3.* 2020:1–61. [PMID: 32510309]
- Hoyert DL, Uddin SFG, Miniño AM. Evaluation of the pregnancy status checkbox on the identification of maternal deaths. *Natl Vital Stat Rep.* 2020;69:1–25. [PMID: 32510312]
- Bhutta ZA, Black RE. Global maternal, newborn, and child health—so near and yet so far. *N Engl J Med.* 2013;369:2226–35. [PMID: 24304052] doi:10.1056/NEJMra1111853
- Review to Action. Building U.S. capacity to review and prevent maternal deaths. Report from nine maternal mortality review committees. 2018. Accessed at https://reviewtoaction.org/Report_from_Nine_MMRCs on 23 April 2020.
- Agrawal P. Maternal mortality and morbidity in the United States of America [Editorial]. *Bull World Health Organ.* 2015;93:135. [PMID: 25838608] doi:10.2471/BLT.14.148627
- Kuklina EV, Ayala C, Callaghan WM. Hypertensive disorders and severe obstetric morbidity in the United States. *Obstet Gynecol.* 2009;113:1299–306. [PMID: 19461426] doi:10.1097/AOG.0b013e3181a45b25
- Creanga AA, Berg CJ, Ko JY, et al. Maternal mortality and morbidity in the United States: where are we now? *J Womens Health (Larchmt).* 2014;23:3–9. [PMID: 24383493] doi:10.1089/jwh.2013.4617
- Maeda A, Bateman BT, Clancy CR, et al. Opioid abuse and dependence during pregnancy: temporal trends and obstetrical outcomes. *Anesthesiology.* 2014;121:1158–65. [PMID: 25405293] doi:10.1097/ALN.0000000000000472
- Kozhimannil KB, Interrante JD, Henning-Smith C, et al. Rural-urban differences in severe maternal morbidity and mortality in the US, 2007–15. *Health Aff (Millwood).* 2019;38:2077–85. [PMID: 31794322] doi:10.1377/hlthaff.2019.00805
- Mann S, Hollier LM, McKay K, et al. What we can do about maternal mortality—and how to do it quickly. *N Engl J Med.* 2018;379:1689–91. [PMID: 30380396] doi:10.1056/NEJMp1810649
- Hung P, Henning-Smith CE, Casey MM, et al. Access to obstetric services in rural counties still declining, with 9 percent losing services, 2004–14. *Health Aff (Millwood).* 2017;36:1663–71. [PMID: 28874496] doi:10.1377/hlthaff.2017.0338
- Main EK, Cape V, Abreo A, et al. Reduction of severe maternal morbidity from hemorrhage using a state perinatal quality collaborative. *Am J Obstet Gynecol.* 2017;216:298. [PMID: 28153661] doi:10.1016/j.ajog.2017.01.017
- D’Alton ME, Main EK, Menard MK, et al. The National Partnership for Maternal Safety. *Obstet Gynecol.* 2014;123:973–7. [PMID: 24785848] doi:10.1097/AOG.0000000000000219
- ACOG committee opinion no. 736: optimizing postpartum care. *Obstet Gynecol.* 2018;131:e140–50. [PMID: 29683911] doi:10.1097/AOG.0000000000002633
- Health Resources and Services Administration. HRSA maternal mortality summit: promising global practices to improve maternal health outcomes. 2019. Accessed at www.hrsa.gov/sites/default/files/hrsa/maternal-mortality/Maternal-Mortality-Technical-Report.pdf on 21 August 2019.
- The White House. Bill announcement. 21 December 2018. Accessed at www.whitehouse.gov/briefings-statements/bill-announcement-10 on 20 April 2019.
- Goodman D. Tribally-led Maternal Mortality Review Committees (MMRCs) as a preventative measure to address maternal mortality in Indian Country. Safe Motherhood: An Informational Webinar on Maternal Mortality in Indian Country. National Indian Health Board webinar. 5 October 2020.
- Centers for Disease Control and Prevention. Enhancing Reviews and Surveillance to Eliminate Maternal Mortality (ERASE MM). Updated 26 February 2020. Accessed at www.cdc.gov/reproductivehealth/maternal-mortality/erase-mm/index.html on 15 October 2020.
- Zaharatos J, St Pierre A, Cornell A, et al. Building U.S. capacity to review and prevent maternal deaths. *J Womens Health (Larchmt).* 2018;27:1–5. [PMID: 29240525] doi:10.1089/jwh.2017.6800
- Vedam S, Stoll K, MacDorman M, et al. Mapping integration of midwives across the United States: impact on access, equity, and outcomes. *PLoS One.* 2018;13:e0192523. [PMID: 29466389] doi:10.1371/journal.pone.0192523
- Centering Healthcare Institute. CenteringPregnancy. 2019. Accessed at www.centeringhealthcare.org/what-we-do/centering-pregnancy on 25 April 2019.
- Association of State and Territorial Health Officials. Using telehealth to improve maternal and child health outcomes in Georgia. 2018. Accessed at www.astho.org/Maternal-and-Child-Health/Georgia-Uses-Telehealth-to-Improve-Maternal-and-Child-Health-Outcomes on 20 April 2019.
- Hoppe KK, Williams M, Thomas N, et al. Telehealth with remote blood pressure monitoring for postpartum hypertension: a prospec-

- tive single-cohort feasibility study. *Pregnancy Hypertens.* 2019;15:171-6. [PMID: 30825917] doi:10.1016/j.preghy.2018.12.007
34. **Health Resources and Services Administration.** Notice of funding opportunity: screening and treatment for maternal depression and related behavioral disorders program. 2018. Accessed at www.hrsa.gov/grants/find-funding/hrsa-18-101 on 25 February 2020.
35. **Mann S, McKay K, Brown H.** The maternal health compact. *N Engl J Med.* 2017;376:1304-5. [PMID: 28379803] doi:10.1056/NEJMp1700485
36. **Kilpatrick SJ, Menard MK, Zahn CM, et al; American Association of Birth Centers.** Obstetric care consensus #9: levels of maternal care: (Replaces obstetric care consensus number 2, February 2015). *Am J Obstet Gynecol.* 2019;221:B19-30. [PMID: 31351999] doi:10.1016/j.ajog.2019.05.046
37. **REACHUP Incorporated.** 2019. Accessed at www.reachupincorporated.org on 27 April 2019.
38. **U.S. Department of Health and Human Services, Office of Minority Health.** Preconception Peer Educators (PPE) Program. 2019. Accessed at www.minorityhealth.hhs.gov/omh/content.aspx?ID=8394&lvl=3&lvlID=8 on 24 April 2019.
39. **Merck for Mothers.** Making pregnancy and childbirth safer in the U.S.: insights from 12 states. 2019. Accessed at www.merckformothers.com/docs/States-Insights.pdf on 20 April 2019.
40. **Colorado Department of Public Health and Environment.** Pregnancy-related depression resources for providers. 2019. Accessed at www.colorado.gov/cdphe/pregnancy-related-depression-resources-providers on 25 April 2019.
41. **Association of Maternal and Child Health Programs.** The Ohio pregnancy associated mortality review: the use of simulation training to prepare for obstetric emergencies. 2015. Accessed at www.amchp.org/programsandtopics/BestPractices/InnovationStation/ISDocs/Ohio%20Simulation%20Training_2015.pdf on 20 April 2019.
42. **Le HN, Perry DF, Mendelson T, et al.** Preventing perinatal depression in high risk women: moving the mothers and babies course from clinical trials to community implementation. *Matern Child Health J.* 2015;19:2102-10. [PMID: 25673369] doi:10.1007/s10995-015-1729-7
43. **Center for Reproductive Rights, Black Mamas Matter Alliance.** Black mamas matter: advancing the human right to safe and respectful maternal health care. 2018. Accessed at www.reproductiverights.org/sites/crr.civicactions.net/files/documents/USPA_BMMA_Toolkit_Booklet-Final-Update_Web-Pages.pdf on 24 April 2019.
44. **Black Mamas Matter Alliance.** 2020. Accessed at <http://blackmamasmatter.org/bmhw> on 22 October 2020.
45. **American College of Nurse-Midwives.** Forging our future: ACNM 2015-2020 strategic plan. 2020. Accessed at www.midwife.org /ACNM/files/ccLibraryFiles/FILENAME/000000005401/2015-20-strategicplanexecsummary-final-070915.pdf on 27 April 2020.
46. **Association of State and Territorial Health Officials.** North Carolina establishes Pregnancy Medical Homes Initiative. 2019. Accessed at www.astho.org/Maternal-and-Child-Health/Making-the-Case-for-MCH-Programs/North-Carolina-Making-an-Impact-on-Population-Health on 20 April 2019.
47. **Community Care of North Carolina.** CCNC pregnancy home risk screening form. 2013. Accessed at www.communitycarenc.org/sites/default/files/pmh-risk-screening-form-english.pdf on 20 April 2019.
48. **Forward Health.** Obstetric Medical Home Initiative. 2019. Accessed at www.forwardhealth.wi.gov/WIPortal/Tab/42/icscontent/Managed%20Care%20Organization/OBMH/OBMHome.htm on 20 April 2019.
49. **Davis A, Gessler T.** OB medical home updates. 2015. Accessed at www.forwardhealth.wi.gov/WIPortal/content/Managed%20Care%20Organization/Managed_Care_Medical_Homes/pdf/OBMHUpdates.pdf on 20 April 2019.
50. **Hill I, Courtot B, Benatar S, et al.** Strong start for mothers and newborns evaluation: year 5 project synthesis. Volume 1: Cross-cutting findings. U.S. Department of Health and Human Services Center for Medicare and Medicaid Innovation. October 2018. Accessed at <https://downloads.cms.gov/files/cmmti/strongstart-prenatal-finalvalrpt-v1.pdf> on 23 January 2020.
51. **Council on Patient Safety in Women's Health Care.** Patient safety bundles. 2020. Accessed at <https://safehealthcareforeverywoman.org/aim/patient-safety-bundles> on 15 October 2020.
52. **Health Resources and Services Administration.** Maternal/women's health. 2020. Accessed at <https://mchb.hrsa.gov/maternal-child-health-topics/maternal-and-womens-health> on 7 October 2020.
53. **California Maternal Quality Care Collaborative.** Who we are. 2019. Accessed at www.cmqqc.org/who-we-are on 28 April 2019.
54. **Main EK, Markow C, Gould J.** Addressing maternal mortality and morbidity in California through public-private partnerships. *Health Aff (Millwood).* 2018;37:1484-93. [PMID: 30179538] doi:10.1377/hlthaff.2018.0463
55. **Mhyre JM, D'Oria R, Hameed AB, et al.** The maternal early warning criteria: a proposal from the National Partnership for Maternal Safety. *Obstet Gynecol.* 2014;124:782-6. [PMID: 25198266] doi:10.1097/AOG.0000000000000480
56. **Arnolds DE, Smith A, Banayan JM, et al.** National Partnership for Maternal Safety recommended maternal early warning criteria are associated with maternal morbidity. *Anesth Analg.* 2019;129:1621-6. [PMID: 31743183] doi:10.1213/ANE.0000000000003889