Black Moms Matter – A Literature Review of Postpartum Hemorrhage in Black Women

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Abstract

While the United States has an abysmal maternal mortality rate for a developed country (17.4 deaths for every 100,000 live births), this national maternal mortality rate is further exacerbated by racial and socioeconomic differences, with non-Hispanic black women 3.3 times more likely to die from pregnancy-related complications than non-Hispanic white women. However, the state of California leads the nation in having the lowest maternal mortality rate (4.5 for every 100,000 live births). The purpose of this project was to conduct a literature review on the black maternal mortality rate, specifically focusing on postpartum hemorrhage and how the state of California has been successful in reducing their postpartum hemorrhage rage and overall maternal mortality rate through public-private partnerships, in particular the California Maternal Quality Care Collaborative (CMQCC). The ultimate goal of this literature review was to examine the specific factors that lead to California's success in reducing the maternal mortality rate and to provide a framework for other states to follow to reduce their maternal mortality rates.

Black Moms Matter – A Literature Review of Postpartum Hemorrhage in Black Women

Currently, the United States has the highest maternal mortality rate of any developed country. According to a 2019 report from the Centers for Disease Control (CDC), 700 women die each year from pregnancy-related complications, with the vast majority of these pregnancy-related deaths being preventable. Of those 700 women, non-Hispanic black women were 3.3 times as likely to die from pregnancy-related complications compared to non-Hispanic white women (Petersen et al., 2019). Postpartum hemorrhage is one of the leading causes of maternal mortality and morbidity. Racial disparities are evident in the outcomes of postpartum hemorrhage with black women at a higher risk of morbidity and mortality. Thus, the purpose of this project was to conduct a literature review on postpartum hemorrhage as it relates to the black maternal mortality rate from a public health policy perspective and critically analyze how the state of California has been successful in reducing their postpartum hemorrhage rate through the California Maternal Quality Care Collaborative (CMQCC).

There are a large number of studies on the black maternal mortality rate in the US. However, since the focus of this literature review was on the black maternal mortality rate as it relates to specific public health policies at the state level, these studies will only be referred to as appropriate. I used the following databases to search for relevant studies to include in this literature review – PubMed, CINAHL, Cochrane library, and Google Scholar. The key search terms I used were postpartum hemorrhage, obstetric hemorrhage, maternal mortality rate, black maternal mortality rate, California maternal mortality rate, California Maternal Quality Care Collaborative, and public-private partnerships. The relevant studies were limited to those published in the last five years, due to the fast-changing nature of healthcare and healthcare delivery. These studies reflect the most current information, new knowledge, and best practices.

This literature review is organized by first providing a broad overview on the postpartum hemorrhage and the role it plays in the disparate maternal mortality rate in black women, then providing context on the role of public-private healthcare partnerships in the delivery of healthcare in the US, analyzing the CMQCC and its role in reducing the black maternal mortality rate and postpartum hemorrhage in California, and finally providing recommendations for other states to follow based off of the success of the CMQCC. I initially identified 149 articles using the aforementioned search terms. After reviewing the articles, I removed 133 of them due to their presentation of topics that are outside of the focus of this literature review. As a result 16 articles met the inclusion criteria. Of these articles eight were articles on racial disparities in the maternal mortality rate, postpartum hemorrhage rate, and racial disparities. Four articles were on the role of public-private partnerships in providing healthcare in the United States. Four articles were on interventions taken by the CMQCC and their impact on the maternal mortality rate, postpartum hemorrhage rate, and racial disparities. See Appendix A for the Literature Review Matrix.

Postpartum Hemorrhage – A Preventable Cause of Death

With over 700 women dying each year from pregnancy related complications, the maternal mortality rate is a growing public health concern in the United States. One of the leading causes of maternal mortality is postpartum hemorrhage, which most often occurred on the day of delivery but also frequently occurred within six days postpartum with deadly consequences (Petersen et al., 2019). Postpartum hemorrhage is the most common complication in the perinatal period, the most preventable complication of childbirth, and the most frequent cause of severe maternal morbidity (Main et al., 2020). Overall, postpartum hemorrhage is on a decline as a cause of maternal death (Gyamfi-Bannerman et al., 2018). Regardless, non-Hispanic black women suffer from this condition at an increased rate compared to non-Hispanic white

women. Black women were five times more likely to die from postpartum hemorrhage as compared to white women, even when accounting for comorbidities (Erickson et al., 2020).

According to a report by the Center of Disease Control (CDC), approximately three out of five pregnancy-related deaths were preventable (Petersen et al., 2019). Other studies estimate that 66-93% of postpartum hemorrhage-related deaths were preventable (Gyamfi-Bannerman et al., 2018). “Preventable deaths” were determined by state maternal mortality review committees as deaths that could have been adverted by one or more changes to the health facility, delivery of patient care, or systemic factors within the care system. Regarding postpartum hemorrhage, preventable deaths were related to the delivery of care at health facilities such as the staff’s limited experience with obstetric emergencies and lack of protocols or standardized bundles to identify high risk patients and treat patients suffering from postpartum hemorrhage (Petersen et al., 2019).

“Failure to rescue” is a patient safety indicator that addresses how the preparedness of the hospital, early recognition of complications, and an appropriate response to issues in the presence of severe morbidity (e.g. postpartum hemorrhage) can prevent mortality (Guglielminotti et al., 2021). It is clear to see how failure to rescue can lead to fatal consequences in the presence of postpartum hemorrhage. Healthcare professional issues such as misdiagnosis and lack of coordination between members of the patient’s interdisciplinary team accounted for over 50% of preventable pregnancy-related deaths, which highlights the significant role failure to rescue plays in maternal mortality (Joseph et al., 2021). Overall, there are decreases in failure to rescue rates, but racial disparities are also present with black women at an increased risk at experiencing failure to rescue (Friedman et al., 2016).

In essence, failure to rescue statistics highlight how the disparate black maternal mortality rate does not solely rely on individual or community-based factors in the prehospital setting (Gyamfi-Bannerman et al., 2018). Research shows that hospital level characteristics are the main determinants of failure to rescue (Guglielminotti et al., 2021). Although the black maternal mortality rate is a multifaceted problem that is influenced by social determinants of health (e.g. income, education, housing, access to healthcare), postpartum hemorrhage is a complication that can be addressed and managed at the individual-provider level of healthcare (Joseph et al., 2021). A crucial part of preventing maternal death from postpartum hemorrhage is the manner in which the surrounding complication is prevented, identified, and managed.

The Role of Public-Private Partnerships in Healthcare

In this interwoven, increasingly complex era, both public and private entities play a crucial role in delivering quality healthcare. Public-private partnerships are a collaboration between public and private entities to provide a public service. In the healthcare setting, a public-private partnership usually entails a contract between the government and private entity where there is shared responsibility in providing healthcare. Through this partnership, the private entity assumes the risks associated with fulfilling the terms of their contract while the public entity will often withhold payment until the contract is fulfilled (Abuzaineh et al., 2018).

Examples of such partnerships are the government subsidizing companies to construct hospitals or research vaccines. Proponents of public-private partnerships claim that these partnerships address the critical gaps that the public sector fails to address, thus giving more people equal access to quality care. On the other hand, some have concerns about the underlying motivation of profit-seeking, lack of accountability, or unsustainability of the private sector interventions (Gideon et al., 2017). In order to support the success of public-private partnerships,

the following conditions are essential – regulatory framework, transparency, capacity of the public sector, contract completion and built in flexibility, and stakeholder engagement throughout the entire process (Abuzaineh et al., 2018).

The vast majority of private-public partnerships can be categorized through their chief operations of (1) renovation or construction of healthcare facilities and operations, (2) provision of clinical services or (3) a combination of the aforementioned two with construction or refurbishment of existing infrastructure along with provision of clinical services. In the typical public-private partnership, the public sector provides the funds for the private partner to provide the service. Through use of public-private partnerships, governments are able to leverage the resources available in the private sector to advance both national and local public health goals (Abuzaineh et al., 2018).

After a significant rise in the maternal mortality rate, the California State Department of Public Health launched the California Maternal Quality Care Collaborative (CMQCC). There was a shared understanding that improving the maternal mortality rate was beyond the scope and capabilities of any single organization or discipline, thus highlighting a need for a public-private partnership. The CMQCC was developed as a collaboration of a broad set of stakeholders who would create solutions and leverage resources to address the maternal mortality rate (Main et al., 2018). According to its website, the public-private partnership is committed to "ending preventable morbidity, mortality, and racial disparities in California maternity care" Since its founding, California has experienced a 55 percent decline in maternal mortality rates. (*Who We Are | California Maternal Quality Care Collaborative*, n.d.). There is clear evidence that supports the success of the interventions taken by the CMQCC in reducing the maternal

mortality rate, postpartum hemorrhage rates, and racial disparities (Lyndon & Cape, 2016; Main et al., 2017; Main et al., 2018; Main et al., 2020).

California Maternal Quality Care Collaborative and Postpartum Hemorrhage

While the maternal mortality rate in the United States has increased, since the formation of the California Maternal Quality Care Collaborative (CMQCC) the maternal mortality rate in California dropped to level comparable to the average rate in Western European Countries. Currently, California has the lowest maternal mortality rate of all the states in the US. Since its formation in 2006, the CMQCC and the California Department of Public Health reviews maternal deaths through a multidisciplinary committee of key stakeholders such as maternal, perinatal, and public health experts. This committee analyzes each case and identifies areas of improvement. The findings from the committee are entered into a database where there is a shared communication of findings with other clinical experts, the design and implementation of standardized perinatal toolkits, and the development and implementation of quality improvement interventions focused on addressing the areas of improvement identified from the review (Main et al., 2018).

The first two years of review revealed that obstetric hemorrhage was one of the leading preventable causes of maternal mortality. This led to the formation of a multidisciplinary OB Hemorrhage Task Force that was tasked with designing a quality improvement package to address obstetric hemorrhage and raise awareness of maternal mortality by speaking to perinatal healthcare professionals. This task force later developed an Obstetric Hemorrhage Toolkit that was eventually used throughout the state (Main et al., 2018). Numerous studies show that women experience lower rates of maternal morbidity from postpartum hemorrhage in hospitals that use the obstetric hemorrhage toolkit (Lyndon & Cape, 2016; Main et al., 2017; Main et al., 2020).

Women that delivered in hospitals that were part of the CMQCC experienced a 20.8% reduction in postpartum hemorrhage as compared to women that delivered in non-collaborative hospitals (Main et al., 2017).

The toolkit developed by the CMQCC laid the groundwork for the National Partnership for Maternal Safety Consensus Bundle for Obstetric Hemorrhage, a tailorable patient safety bundle used to address postpartum hemorrhage (Main et al., 2017). These toolkits and bundles provide evidence-based practice guidelines and quality improvement recommendations that support the implementation of interventions to prevent, recognize, and manage postpartum hemorrhage (D'Alton et al., 2019). In preventing postpartum hemorrhage, certain risk factors must be taken into account, such as long labor induction, a prolonged second stage of labor, and intra-amniotic infection (Erickson et al., 2020). The elements of the obstetric hemorrhage toolkit were categorized into three domains – readiness, response, and reporting and systems learning. Each domain addressed the aforementioned interventions needed to prevent, identify, and manage postpartum hemorrhage. The reporting and systems learning domain provided an organized way to debrief post-event and contribute to a process of continuous quality improvement (Main et al., 2020).

Implementation of the obstetric hemorrhage toolkit is also related to a reduction in racial disparities in postpartum hemorrhage. The CMQCC demonstrated clear success in reducing postpartum hemorrhage and racial disparities through its use of obstetric hemorrhage toolkits as compared to the US at large, which is experiencing worsening maternal mortality rates (Main et al., 2018). Prior to implementation of the obstetric hemorrhage toolkit, a cross-sectional study of 99 Californian hospitals showed that black women experienced severe maternal morbidity related to postpartum hemorrhage at a rate of 28.6% as compared to white women who

experienced the same at a rate of 19.8%. After implementation and controlling for sociodemographic and clinical factors, the relative risk for both with and black women was 0.99. In essence, black women and white women experienced equal risk of experiencing postpartum hemorrhage with the implementation of the obstetric hemorrhage toolkit. While the obstetric hemorrhage toolkit is successful in reducing postpartum hemorrhage in all races, of significant importance to this paper is the research which supports its reduction of racial disparities in postpartum hemorrhage (Main et al., 2020).

Public-Private Partnerships in Reducing Postpartum Hemorrhage – Implications for the Future

Since California is so successful in reducing maternal mortality, postpartum hemorrhage, and racial disparities between the two, can we implement this in other states? The California model is composed of the following key steps – linking public health surveillance activities to actions, mobilizing a coalition of public and private partners, developing a collective database of relevant maternal data to support quality improvement initiatives, and implementing quality improvement projects on a large scale. Most states have accomplished the first step with a clearly identified maternal mortality rate and postpartum hemorrhage rates linked to the formation of committees Maternal Mortality Review Committees (Petersen et al., 2019). In essence, this identification creates a statewide call to action to reduce the maternal mortality rates, postpartum hemorrhage rates, and racial disparities (Main et al., 2018).

The maternal mortality rate at large is a multifaceted, multidisciplinary problem with numerous causes; postpartum hemorrhage is a largely preventable complication of childbirth that could easily be addressed through the mobilization of a public-private partnership, databases for information sharing, and the implementation of public health and clinical intervention projects. It

is evident that there is a need that the public sector alone cannot address, which highlights the importance of a public-private partnership in closing the gap and reducing the maternal mortality rate (Singh, 2020). Through public-private partnerships, similar to the CMQCC, states would be able to address the maternal mortality rate and postpartum hemorrhage through a collaboration. A collaborative also allows for more expansive, multidisciplinary stakeholder involvement at all levels of care. Thus, the responsibility of improving the rates falls on a collaborative, not a single organization or discipline (Main et al., 2018).

The CMQCC uses a system to collect and share maternal data in real time. While maternal mortality review committees are effective in establishing priorities and recommendations, a database allows for assessment of progress towards attaining these priorities and other quality improvement initiatives. Certain attributes are necessary for a successful database as it relates to data on maternal health such as low burden and low cost for data entry to promote widespread usage, flexibility for changing quality improvement initiatives, frequent feedback, and benchmarking ability to compare facilities (Main et al., 2018). States should utilize a database similar to the CMQCC to promote collective sharing of information that supports quality improvement efforts as they relate to maternal mortality, postpartum hemorrhage, and racial disparities.

As aforementioned, the obstetric hemorrhage toolkit developed by the CMQCC laid the groundwork for the National Partnership for Maternal Safety Consensus Bundle for Obstetric Hemorrhage (Main et al., 2017). This is one of many interventions used to address postpartum hemorrhage through quality improvement projects (Main et al., 2018). Studies show that quality improvement can have variable impacts on addressing racial disparities. Despite this, the systematic approach to the management of postpartum hemorrhage found in the obstetric

hemorrhage toolkits highlights a clear reduction in racial disparities in experiencing severe maternal morbidity and mortality (Main et al., 2020). In implementing the toolkit, a multidisciplinary team proves essential in providing best practices for patient care. Notably, nurses play a key role in ensuring that the best practices from the toolkit are implemented, and as a result, they shared the vast majority of the burden of implementation. States should implement the usage of these toolkits with the support of change leaders and a change management team in the clinical setting (Lyndon & Cape, 2016).

Although the CMQCC provides a statistically significant, positive framework for other states to follow in reducing maternal mortality and racial differences related to postpartum hemorrhage, evidence shows that no single intervention is sufficient and multiple factors contribute to pregnancy-related deaths from postpartum hemorrhage (Peterson et al., 2019). The first barrier to implementation is the limited ability of public-private partnerships at a state level to address the maternal mortality rate. Of the 50 states, 43 were reported as having a state-based perinatal collaborative. These collaboratives consist of multidisciplinary teams of stakeholders in both the public and private sector, patients and their families, and clinicians working together to improve perinatal outcomes. During a 2017 conference organized by the National Network of Perinatal Quality Collaboratives, the common challenges these state-based collaboratives experienced were related to lack of resources such as funding, personnel, and lack of support for data systems integration, and data collection. Not all states have the same financial power as California, therefore federal funding may be needed to support state-led efforts to create more effective perinatal collaboratives that will ultimately reduce the maternal mortality rate, postpartum hemorrhage rate, and racial disparities between the two (Henderson et al., 2018)

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Another barrier to implementation of the CMQCC framework at a state-level is resistance and limited involvement at a healthcare provider level. In the Obstetric Hemorrhage toolkit, the CMQCC already identified implementation strategies to mitigate barriers on the hospital level such as holding multidisciplinary obstetric hemorrhage grand rounds each week, developing a quality improvement measurement grid, and utilizing debriefs after an obstetric hemorrhage occurs (Bingham, Melsop, & Main, 2010). During actual use of the Obstetric Hemorrhage toolkit, involvement of providers was a facilitator of implementation and a barrier when provider involvement was absent. Nurses were also significantly involved in the implementation of the toolkit. Other key aspects to implementation were organization structure and culture and administrative support and previous experience with quality improvement initiatives (Lyndon & Cape, 2016). Taking these into consideration, clinician engagement and nurse involvement of implementing obstetric hemorrhage toolkits are essential to their successful use in the clinical setting. The Obstetric Hemorrhage toolkit already provides several strategies to overcome the previously mentioned barriers of resistance and limited involvement from providers

Conclusion

The maternal mortality rate in the US is the highest of any developed country. Postpartum hemorrhage is a significant, preventable cause of maternal mortality, because it often occurs while women are in the hospital setting. Racial disparities exist with the maternal mortality rate with black women 3.3 times as likely to die from pregnancy-related complications compared to non-Hispanic white women (Petersen et al., 2019). Public-private healthcare partnerships are unique in their ability to address gaps that the public sector alone cannot provide, thus expanding access to equitable care. The California Maternal Quality Care Collaborative (CMQCC), a public-private partnership, was formed in response to rising rates of

maternal mortality in the state of California. Since its formation, California reduced the maternal mortality rate to 7 deaths per 100,000 live births, which is the lowest in the US (Main et al., 2018). With the success of the CMQCC, other states can use their methodology as an example to potentially reduce the maternal mortality rate, postpartum hemorrhage rates, and racial disparities between the two by mobilizing public-private partnerships, creation of maternal databases, and the implementation of public health and clinical intervention projects.

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Appendix A

Research Methodology

Table 1

Summary of Reviewed Studies

No. Author(s), Year	Design	Population	Intervention/Purpose	Results
1. Abuzaineh, N., Brashers, E., Foong, S., Feachem, R., Da Rita, P. (2018)	Report of models and lessons learned around healthcare public-private partnership (PPP) projects	Assessment of global PPP from previous reports by the UCSF Global Health Group/PwC PPP report □ Health System Innovation in Lesotho: Design and early operations of the Maseru public-private integrated partnership (2013) □ Lessons from Latin America: The early landscape of healthcare public-private partnerships (2015) □ Innovation rollout: Valencia's experience with public-private integrated partnerships (2017) □ PPPs in healthcare: Models, lessons and trends for the future (2018) □ Lessons from India: An overview of 'asset-light' healthcare public-private partnerships (2018)	Purpose is to document and raise awareness of innovative PPP models in global healthcare and to use lessons learned to inform both current and future healthcare partnerships.	Global insights on the nature, opportunities, and considerations of the most common PPP models

2. Bingham, D., Melsop, K., Main, E. (2010)	Hospital level Obstetric Hemorrhage Toolkit Implementation Guide	Hospitals participating in the CMQCC	To fulfill the CMQCC mission to transform maternity care in California and end preventable death and injury through evidence-based practice and quality improvement	N/A
3. D'Alton, M. E., Friedman, A. M., Bernstein, P. S., Brown, H. L., Callaghan, W. M., Clark, S. L., Grobman, W. A., Kilpatrick, S. J., O'Keeffe, D. F., Montgomery, D. M., Srinivas, S. K., Wendel, G. D., Wenstrom, K. D., & Foley, M. R. (2019)	5 year report on a collaborative effort to address maternal morbidity and mortality in the United States	N/A	To assess the progress made in the 5 years since the first Maternal-Fetal Medicine meeting and analyze what further works needs to be done in the next 5 years.	2012 MFM meeting Progress ✓ MFM fellows conduct mandatory rotations in L&D and ICU ✓ MFM fellows use simulations and case-based learning ✓ MFM providers have active ACLS certifications ✓ MFM fellows receive training in leadership skills via formal leadership courses and participate in hospital level QA and QI initiatives □ In progress = MFM fellows undergo a yearly exam similar to those given to residents on OB/GYN material 2012 MFM meeting Recommendations MFM guidelines and bundles, QA of severe maternal morbidity, career support and advancement for maternal care, improving reimbursement for maternal care, models of comprehensive maternal care, address critical research gaps

4. Erickson, E. N., Lee, C. S., & Carlson, N. S. (2020)	Retrospective cohort study – Latent class analysis	N = 24,729 term, singleton, vaginal births from the Consortium for Safe Labor dataset (2002-2008)	To describe distinct labor process phenotypes	Maternal race and ethnicity, nulliparity, macrosomia, hypertension, and depression were associated with increased odds of postpartum hemorrhage.
5. Friedman, A. M., Ananth, C. V., Huang, Y., D'Alton, M. E., & Wright, J. D. (2016)	Retrospective cohort study	N = 50,433,539 delivery hospitalizations across the United States from 1998-2010	To determine maternal risk for severe morbidity during delivery hospitalizations in the US and to characterize the risk for death in the setting of failure to rescue, by hospital volume	The prevalence of severe maternal morbidity (SMM) increased from 1998 to 2010 by 59.5%. Low and high delivery volume were associated with increased risk of SMM and failure to rescue. Other factors also include characteristics of individual care centers.
6. Gideon, J., Hunter, B. M., & Murray, S. F. (2017)	Report of the factors that lead to proliferation of public-private partnerships in healthcare	N/A	To analyze the factors related to the proliferation of PPP in healthcare with a focus on sexual and reproductive health	When applying the existing literature on gendered health systems in a case study of the usage of maternal health vouchers in India, the researchers found that PPP are limited in their ability to confront gender norms and deeply embedded power

				relations in households and health systems.
7. Guglielminotti, J., Wong, C. A., Friedman, A. M., & Li, G. (2021)	Retrospective cohort study	N = 73,934,559 delivery hospitalizations with severe maternal morbidity, as defined by the Centers for Disease Control and Prevention, from the 1999–2017 National Inpatient Sample.	To analyze the racial and ethnic disparities in failure to rescue associated with severe maternal morbidity and the trends of this over time	The failure to rescue rate has improved over time, with an annual adjusted percent change of -5.4%. Failure to rescue is a major contributing factor to the disparate maternal mortality rate in minority women with black women at a 1.79 increased risk of experiencing failure to rescue.
8. Gyamfi-Bannerman, C., Srinivas, S. K., Wright, J. D., Goffman, D., Siddiq, Z., D'Alton, M. E., & Friedman, A. M. (2018)	Retrospective cohort study	N = 360,370 women aged 15-54 with a diagnosis of postpartum hemorrhage from the National Inpatient Sample	To assess the association between race and adverse maternal outcomes in the setting of postpartum hemorrhage	The risk for experiencing SMM was higher for black women (26.6%) than any other ethnic group. Risk for experiencing disseminated intravascular coagulation and hysterectomy was also higher for black women. Risk for death was higher for black women at 121.8 per 100k deliveries.
9. Henderson, Z. T., Ernst, K.,	Report	National representatives from the 48 states with	To address the shared needs for state PQCs	Common challenges that PQCs face are

Simpson, K. R., Berns, S. D., Suchdev, D. B., Main, E., McCaffrey, M., Lee, K., Rouse, T. B., & Olson, C. K. (2018)		state-level perinatal quality collaboratives (PQC)	and enable collaboration between the national PQC, CDC, March of Dimes, and other perinatal quality improvement experts across the country	funding, personnel, staff time, and additional support for data collection. The National Network of PQCs stands ready to support state PQCs to increase their capacity and foster information sharing between states.
10. Joseph, K. S., Boutin, A., Lisonkova, S., Muraca, G. M., Razaz, N., John, S., Mehrabadi, A., Sabr, Y., Ananth, C. V., & Schisterman, E. (2021)	Commentary	N/A	Summarization of the findings of the National Center for Health Statistics Report on the temporal trends and the current status of maternal mortality in the US	There was a reduction of maternal mortality between 2002 and 2018 (21% decline). Despite this, racial disparities are prevalent with the black maternal mortality rate 2.5 times higher than the rate of white women in 2018.
11. Lyndon, A., & Cape, V. (2016)	Descriptive qualitative study	N = 22 implementation team members interviewed during a 31 hospital quality improvement learning collaborative	To describe the end-user experience using the obstetric hemorrhage	Most elements of the toolkit were deemed “critical to retain”. Nurses were critical stakeholders in implementation of the toolkit. In order to facilitate widespread improvement initiatives in maternal-fetal care, greater understanding of and attention to

				organizational context are needed.
12. Main, E. K., Cape, V., Abreo, A., Vasher, J., Woods, A., Carpenter, A., & Gould, J. B. (2017)	Retrospective cohort study	N = 99 collaborative hospitals (256,541 annual births) and 48 noncollaborative comparison hospitals (81,089 annual births) from 2011 to March 2016	To determine whether the obstetric hemorrhage toolkit can be scaled to reduce SMM within a larger maternal quality collaborative	Participation in the collaborative was associated with reduced instances of SMM in the presence of postpartum hemorrhage (-20.8%). In hospitals that had prior hemorrhage collaborative experience, women experienced a 28.6% reduction in SMM from postpartum hemorrhage.
13. Main, E. K., Chang, S.-C., Dhurjati, R., Cape, V., Profit, J., & Gould, J. B. (2020).	Cross-sectional study	N = 99 hospitals that participated in the hemorrhage quality improvement collaborative in California from 2011 to 2016	To assess the impact of a hemorrhage quality-improvement collaborative on racial disparities in SMM from postpartum hemorrhage	After the introduction of the QI collaborative, the rates of postpartum hemorrhage fell for all women. The baseline risk of experiencing postpartum hemorrhage was the same for black and white women after the large-scale quality improvement collaborative.
14. Main, E. K., Markow, C., & Gould, J. (2018)	Commentary	NA	Describe the steps taken by the California Department of Public Health and the CMQCC that supported change	The key steps taken by the PPP of the CMQCC were linking public health surveillance to actions, mobilizing public and private

			and the reduction of the maternal mortality rate	partners, developing a maternal data center to support and sustain QI initiatives, and implementing a series of data-driven QI projects.
15. Petersen, E. E., Davis, N. L., Goodman, D., Cox, S., Mayes, N., Johnston, E., Syverson, C., Seed, K., Shapiro-Mendoza, C. K., Callaghan, W. M., & Barfield, W. (2019)	Report	N = 3410 pregnancy-related deaths from the CDC's national Pregnancy Mortality Surveillance System (PMSS) from 2011–2015	To describe the timing and characteristics of pregnancy-related deaths in the US	60% of pregnancy-related deaths were preventable. The leading causes of pregnancy-related death varied by timing of death during the pregnancy. Postpartum hemorrhage most frequently occurred on the day of delivery and during the first week postpartum.
16. Singh, G. K. (2020)	Retrospective cohort study	N =4246 maternal deaths from 2013-2017 from the National Vital Statistics System	To analyze the trends and inequalities in maternal mortality by race, socioeconomic status, marital status, area deprivation, urbanization, and cause of death.	There was an increase in maternal mortality from 9.9 deaths/100k in 1999 to 17.4 deaths/100k in 2018. Compared to white women, black women had a 2.4 higher risk of maternal mortality. Hemorrhage was one of the leading causes of death.

Figure 1

Research Matrix