# Reversing Maternal Morbidity and Mortality Trends with Digital Healthcare

Maternal healthcare is in crisis.

The Centers for Disease Control and Prevention (CDC) reports that in the United States, a woman dies from pregnancy-related complications every 12 hours. Black/African American and American Indian/Alaska Native women are two to three times more likely to die from pregnancy or childbirth, compared to white women. Yet up to 60 percent of these deaths are preventable[1] (CDC, 2019). Compounding the problem, an additional 50,000 women suffer from 'near misses' or severe morbidity that have can have serious and long-lasting consequences for their health.

Are these statistics that we bemoan but must accept? Or is it possible to turn the tide and create better maternal health outcomes?
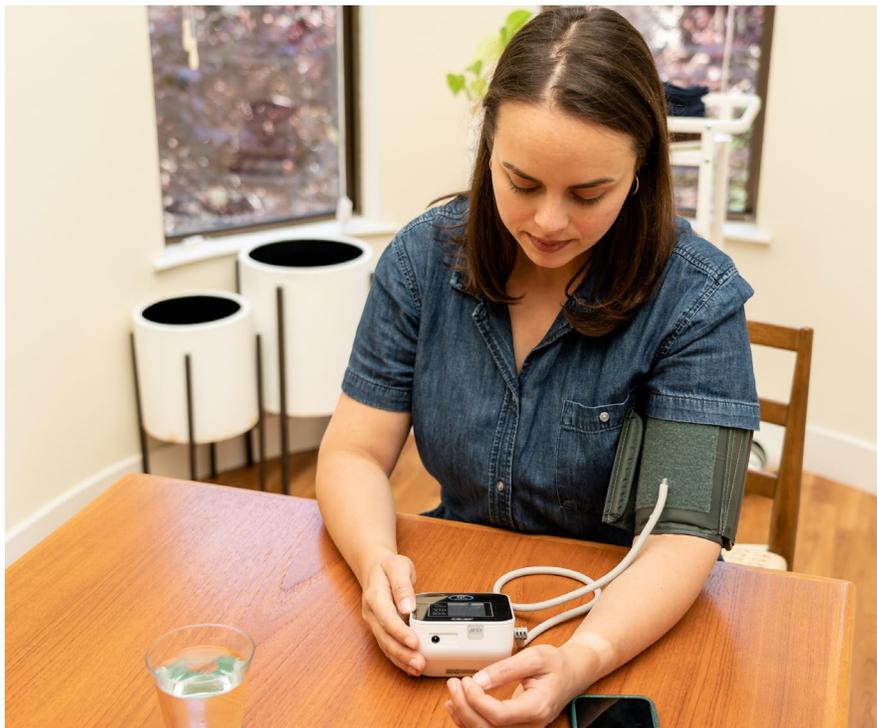
Innovative technology solutions can empower women to take greater control of their care, better support the entire pregnancy and post-partum journey, and equip providers with more patient data to personalize care and avoid complications.

This white paper explores the factors contributing to maternal morbidity and mortality rates and how digital solutions can advance maternal health by empowering women and equipping healthcare providers for better patient outcomes.

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>
> - Rolanda Lister, Attending Physician, Vanderbilt University Medical Center

Despite the technology and healthcare prowess in this country, the U.S. stands out as one of the only countries where maternal morbidity and mortality (MMM) rates have actually worsened over the last few decades. This trend continues to disproportionately affect people of color and those with social disadvantages.

The CDC found that in 2020, 861 women died of maternal causes in the U.S., compared with 754 in 2019[2] (CDC, 2020). That translates to 23.8 deaths per 100,000 live births in 2020 compared with a rate of 20.1 in 2019. For non-Hispanic Black women, the number of deaths was 2.9 times the rate for non-Hispanic White women. But even when data only reflects white women, the U.S. maintains the highest maternal mortality ratio among wealthy countries[3] (The Commonwealth Fund, 2020).

The cost to society is staggering: the total maternal morbidity costs for all U.S. births in 2019 was $32.3 billion from conception through the child's fifth birthday[4] (The Commonwealth Fund, 2021). However, the true costs are likely much higher and longer-lasting. A study published by The Commonwealth Fund found, "The lack of comprehensive data for other conditions suggests that maternal morbidity has the potential to exact a much higher toll on society than what we have found, rivaling that of expensive chronic conditions like diabetes, whose costs run into the hundreds of billions of dollars."

Along with high morbidity and mortality rates for pregnant and post-partum women, there is a corresponding higher risk of negative outcomes for their children and an associated economic toll. At-risk pregnancies cost three time more than the average, the mother's return to work is delayed or lost and/or they may require financial assistance.

The CDC estimates that three in five maternal deaths are preventable[5] (CDC, 2019). Recognizing the warning signs and providing timely treatment and quality care can prevent many pregnancy-related deaths and injuries. The scope and impact of the challenge is reflected in the dozens of bills introduced to Congress in the last two years including the Preventing Maternal Deaths Act of 2018, Black Maternal Health Momnibus Act, MOMMA's Act, MOMMIES Act, MOMS Act and Maternal CARE Act, and most recently a White House Maternal Health Call to Action. The latter includes a historic $3 billion investment in maternal health, encouraging states to provide 12 months of continuous postpartum coverage, and creating a new "Birthing-Friendly" hospital designation. This is the first-ever hospital quality designation by HHS specifically focused on maternity care[6] (White House Fact Sheet, 2021).

Maternal well-being influences the health of the next generation and boosting it can help mitigate future public health challenges. Digital solutions can bridge gaps in maternal healthcare by delivering ready access to relevant information and supportive care, increasing patient data for more timely diagnosis, and administering appropriate, immediate treatment.

This white paper will explore the causes of maternal morbidity and mortality and how technology can be a force for good in reversing these trends. We will discuss:

- Maternal health risks
- The promise of digital healthcare
- How digital platforms close gaps in care
- A solution in action: Happy Mama

Increasing Maternal Health Risks

More women are entering pregnancy with pre-existing conditions. There is a well-documented rise in cardio-vascular and diabetes or pre-cardio-vascular/diabetes conditions in the general population. For women over the age of 35, the likelihood of these diseases increases. Women who fall into these groups are twice as likely to have complications at or near birth[7] (*Disabilities Increase Maternal Morbidity, Mortality,* 2021). And a number of these conditions, particularly cardiomyopathy, occur up to a year after childbirth. During the post-partum stage, mental health conditions including substance abuse and suicide are among the leading causes of maternal death.

Four crucial delays. Putting aside factors such as age, data from the World Health Organization (WHO) reveals four delays are the primary reasons for undesirable maternal outcomes[8] (WHO, 2019):

- Delay in seeking medical care: women are too often dismissed when they report concerns, making it less likely for them to share their worries. The problem is so rampant that the CDC created the Hear Her campaign[9] to raise awareness of pregnancy-related complications and empower women to speak up.

- Delay in reaching the facility: delays in transportation due to lack of transport and/or distance to hospitals and clinics means it is not uncommon for a woman in a rural area to drive over an hour for care. Even in urban areas, access to ready, reliable transportation can be a challenge.

- Delay in diagnosis (and misdiagnosis): many early warning signs, such as bloating, headache, and extreme tiredness may be discounted or misdiagnosed both by the patient and caregivers. With accurate and timely attention, potential complications can be identified and treated before they become life-threatening.

- Delay in treatment: women receive information about care for their babies, but not necessarily about their own health. As an example, preeclampsia, which can lead to seizures and strokes kills an estimated five women an hour[10]—although it is highly treatable

if quick action is taken. While the UK has reduced preeclampsia deaths to one in a million, in the U.S. preeclampsia still accounts for approximately eight percent of maternal deaths.

Lack of adequate education. Contributing to delays in seeking care, health literacy (the ability to understand, engage and act upon health information) is critical. Patients with limited health literacy have more emergency department visits, more frequent and longer hospital stays, worse outcomes in healthcare, and lower utilization of preventive services than people who show an adequate level of health literacy[11] (NIH, 2011).

This is even more important during pregnancy when both the health of the mother and child are at stake. For instance, pregnant women with limited health literacy are less likely to take folic acid during pregnancy, are more apt to engage in prenatal care at a later gestational age, and have more hospital stays[12] (NIH, 2004). A 2021 survey shows that 60 percent of pregnant women did not know enough about pregnancy-related complications such as high blood pressure and anemia[13] (REACH, 2021). Nearly 50 percent believed they did not get sufficient information about possible risk factors and symptoms, and 40 percent felt that their care teams were not collecting enough clinical information about them.

Lack of empathy. The situation is compounded by an overall feeling of being discounted by the very systems designed to protect them. Regardless of socio-economic circumstances and racial/ethnic makeup, too many women believe that their healthcare providers (HCPs) simply don't care about them[14] (Reproductive Health

Journal, 2019) or their babies. An alarming one in six women reported experiencing one or more types of *mistreatment* during childbirth, including loss of autonomy; being yelled at, scolded, threatened, ignored or denied care; or by suffering a loss of autonomy[15] (White House Fact Sheet, 2021). Rates of mistreatment for women of color were consistently higher. Given this, it is not surprising that more than 15 percent of women would like to change their maternal care provider[16] (REACH, 2021).

Why Digital Healthcare?

The healthcare industry is transforming to improve quality of care while reducing costs. The North American digital health market size is expected to reach $712.3B by 2030, representing a CAGR of 27.8%[17] (Research & Markets, 2022). Factors driving this growth include the increasing prevalence of chronic disorders, growing geriatric population, and a shortage of healthcare professionals. In particular, the remote patient monitoring systems market is projected to reach $1.8B by 2026[18] (Grand View Research, 2022).

"The value of digital healthcare has always been there, but the pandemic illuminated that value in an undeniable way," explains Rolanda Lister, Attending Physician, Vanderbilt University Medical Center. She continues, "The pandemic forced the medical community to be more creative in how we deliver care to all, and it clearly and compellingly made the case for the transformative benefits of digital care options. Digital healthcare can make the difference between having care and not having it."

Diminish the four care delays. Digital healthcare effectively and efficiently addresses the principal contributors to maternal morbidity and mortality by making care accessible from anywhere; reducing reliance on transportation as a condition of care; helping patients understand when to seek care, recognize signs and symptoms; and giving providers more information to improve diagnosis and speed time-to-treatment. Done well, digital healthcare delivers more power to patients and more data to providers.

Sharla A. Smith, Ph.D., MPH, Assistant Professor, Population Health and Director of Birth Equity at Kansas University Medical Center (KUMC) articulates, "Digital health options diminish the barriers of time, distance and effort. Patients can reach a provider more readily and connect with a provider's team who can triage if the physician can't respond immediately, all without the need to wait for an appointment."

Digital health options are attractive. In a majority of cases, patients already have a device in hand. In the U.S., 95 percent of adults aged 18 to 49 own a smartphone[19] (Statistica, 2021) so they're already comfortable with, and even dependent on, these tools.

Lister reveals, "Even in rural areas or among under-resourced populations, smart phone use is high. We can harness that power to save lives."

Out of 11 countries surveyed, U.S. women overall have the greatest burden of chronic illness, highest rates of skipping health care because of cost, difficulty affording the health care, and are least satisfied with their care[20] (World of DTC Marketing, 2018). Digital options can alleviate many of these stressors.

A new mandatory. Digital healthcare is no longer a luxury but an integral part of a health systems' care strategy and increasingly can be a deal-maker or breaker. Driven in part by the COVID-19 pandemic, patients enjoy the freedom and comfort of remote care. Eighty-eight percent of patients under age 40 said they will choose their next provider based on the provider's online presence. And, a full 90 percent of patients said they feel no obligation to stay with a provider who doesn't offer a good digital experience[21] (Patient Engagement HIT, 2018).

The importance of digital health platforms is underscored by the addition of Digital Health Capacity as the sixth social determinant of health[22] (SDOH)—those economic and social conditions that influence health status. Digital health focuses on delivering clinical outcomes by offering education and guidance, reinforcing drug and health regimens, and tracking and capturing vital data. For providers, convenient access to patient data leads to improved health outcomes and enables them to care for more patients at a lower cost while also experiencing less burnout.

Breaking Down Barriers to Care

Digital health technologies make healthcare less intimidating and more approachable by providing a supportive and empowering experience that fits within patients' daily lives.

Remote monitoring. Traditional prenatal care models typically recommend 14+ in-person visits[23] (KFF, 2020) throughout pregnancy. This often requires significant travel and time away from work or family responsibilities. Remote monitoring stimulates interaction that's more thorough and efficient, but also more relaxed and intimate. Many prefer sending digital data to their healthcare provider at a convenient time and place rather than making an excursion to the doctor's office that disrupts their usual routine.

Even high-risk pregnancies benefit from the use of remote monitoring devices without having to enter a clinical setting, an advantage first fully appreciated during the pandemic. Blood pressure monitoring devices, fetal dopplers, blood sugar checkers and recommended digital scales are simple ways that can track the health of expectant mothers remotely.

Faith Butler, M.D., Family Medicine Physician and Assistant Professor of Family Medicine at Kansas University Medical Center expounds, "Diabetes and preeclampsia are significant challenges. Patients often do well at taking their information, like sugar levels or blood pressure, but getting that information into the hands of their doctors is a problem. It's hard to remember to grab that sheet of paper when you are rushing out of the house and are juggling a lot of responsibilities." She continues, "Without that information, it makes it challenging to adequately address the issue, and do so in a timely manner."

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Facilitating more meaningful linkages. With an accurate, consistent and near real-time assessment of a patient's vital information, HCPs can take corrective action sooner. Digital healthcare also enables HCPs to expand the amount of time they are engaged with a patient and to monitor and engage with disorders that might arise outside of clinical setting. It also gives providers a more informed, engaged and self-advocating partner in the patient.

Lister says, "The ability for women to self-monitor is self-empowerment. To know what's normal, to have the feedback loop, to have access to information and resources, it allows women to take control of their health and pregnancy like never before."

Case in point: Using a human-centered design method, Mayo Clinic Proceedings[24] (Mayo Clinic, 2018) envisioned a new model of care for women experiencing low-risk pregnancy. They found that patients who collected measurements in the comfort of their home (blood pressure, fetal heart rate, weight and fundal height) inspired similar confidence in the continued normalcy of the pregnancy as onsite visits. They also reported an increased sense of control, confidence and reassurance. In addition, self-monitoring of the fetal heart rate was not only a reassuring and joyous experience, but also allowed for meaningful participation in the pregnancy by the broader family.

Dr. Butler adds, "Digital healthcare keeps us closer to patients. Even if they miss an appointment, with one click we can see their dashboard and assess a broad spectrum of data, from blood pressure to their mood to nutrition."

Access to trusted information. Dr. Smith says, "Digital solutions raises awareness of and access to information

about disparities in conditions such as gestational diabetes, preeclampsia and post-partum issues so that patients are empowered to more effectively advocate for themselves. They offer women the tools and resources they need to recognize symptoms and ask the right questions and give providers access to more timely data, helping ensure a healthy pregnancy."

Lister says, "Trust is the foundation of any relationship, but in too many maternal health cases, trust has been broken, leading to breakdown in communication and creating an inability on the part of the woman to negotiate her wishes for her pregnancy and birth plan."

To earn and keep trust "companies in the health sector must address other determinants of health beyond medical care — including pollution and climate change, poverty and income inequality, the high cost of nutritious foods, and racial injustice." (Source: Jane Sarasohn-Kahn, Trust: A Determinant of the Health Economy[25], https://www.edelman.com/trust/2022-special-report-trust-in-health/trust-determinant-health-economy)

Dr. Smith adds, "Digital heath helps providers create a listening ear to drive different experiences for population disparities and to make healthcare more equitable across all segments of the population."

Social Determinants of Health. SDoH are the conditions where we are born, live, and work and encompass the risk factors that create and sustain health disparities. Digital health applications are uniquely suited to address SDoH, to increase health equity and save lives. AI-enabled technology can provide essential, easy access to credible information from trustworthy sources as well as ready links to social services including family support, transportation, job loss, food resources, domestic violence support and suicide prevention.

Since more than half of maternal deaths occur after birth, strengthening postpartum care should be a priority[26] (The Commonwealth Fund, 2020). The WHO recommends at least four health contacts in the first six weeks, yet U.S. women typically have a single office-based physician visit within this period, and some don't have one at all.

Postpartum care is intended to ensure the physical and emotional recovery of mothers and their babies. Home visits by a midwife or a nurse are associated with improved mental health and breastfeeding outcomes as well as reduced health care costs. All countries, apart from the U.S., guarantee at least one such visit within one week postpartum, although some U.S. states provide these for Medicaid beneficiaries. Home visits give providers an opportunity to address mental health concerns and allow them to assess social determinants of health, including needs for food, housing, financial security and protection from domestic violence. Digital solutions can help fill some of this void, providing care and guidance, connecting women to a broader community of people in similar circumstances, and serving up appropriate local resources.

Summary

Women in the U.S. are more likely to die from childbirth or pregnancy-related complications than women *in all other developed countries*. Delays in care, lack of access to trustworthy information, vitals and condition monitoring—these can all effectively and cost-efficiently be bridged with digital healthcare solutions. Digital solutions empower patients with greater agency during their pregnancy journey, arm HCPs with more data and insights, and can create stronger, more frequent and better-quality patient-provider communication.

A Solution in Action: Happy Mama

Designed for and with pregnant women, Happy Mama is the first fully comprehensive biopsychosocial wellness platform for maternity care. Much more than an app, Happy Mama offers an innovative, personalized response to the unique needs of women from pre-conception through pregnancy, labor and delivery, and up to 12 months postpartum.

Happy Mama broadly consists of two components: a mobile app to guide patients through their care journey; and a backend platform for user management, data management, care plan orchestration and a web portal for clinicians and provider administrators. The platform enables healthcare providers to leverage data cohesively across reproductive health and pregnancy specific use cases; as well as enable service delivery and device management, voice assistant and video platforms for maternal health purposes.

Highly secure, reliable, and scalable. Happy Mama is powered by the HARMAN Remote Care Platform (RCP), an innovative telehealth-enabling technology, running on Microsoft Azure. Apart from using various platform services from Azure like app services, application gateway, communication services, and Azure PostgreSQL, the platform also uses virtual machines with D v4 and Dd v4 instances, based on a custom Intel® Xeon® Platinum 8272CL processor, for

compute payloads. Intel Health Application Platform (iHAP software) is included as part of the HARMAN RCP to facilitate vitals data capture from smart medical devices over Bluetooth and Bluetooth Low Energy interface.

Happy Mama has a complete, cloud-first data management software platform fueling high-performance, machine learning-enabled applications that connect data and application silos to promote interoperability. Via a cloud platform, its robust standards-based interoperability hub allows patient data that is captured at home via the Happy Mama App to be viewed by providers within their EHR at the point of care. The first step in enabling this level of interoperability involves converting the clinical data collected within the Happy Mama application to the FHIR-based message format, a future proof solution which aligns with the new ONC regulations that all certified EHR vendors will need to meet in the near future. Once the data has been converted to FHIR resources, it can either be pushed or made available for query on demand by provider EHRs. This approach makes it easy to scale up to support a diverse ecosystem of health systems and EHR vendors.

Grounded in science, Happy Mama couples robust technology with health education from the American Heart Association, American Medical Association, Release the Pressure and Visual Health Solutions as well as a variety of partners in physical, mental, emotional, self-developmental and social-economic well-being. Beyond vitals, Happy Mama addresses the social determinants of maternal health, building the confidence of expectant moms and their care teams.

In recognition of design and engineering excellence, Happy Mama was named a CES® 2022 Innovation Awards Honoree.

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