

# Maternal Mental Health and Infant Mortality for Healthy-Weight Infants

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In 2012, Ohio ranked 47th nationally for infant mortality (7.56 per 1000 live births)<sup>1</sup>—a rate significantly higher than the overall US infant mortality rate (6.05 per 1000 live births) and the Healthy People 2020 goal (6.0 per 1000 live births).<sup>2</sup> State and local entities in Ohio, like the Ohio Department of Medicaid and Office of Mental Health and Addiction Services (MHA), as well as other human services agencies, have joined forces to address this issue.<sup>1</sup> These organizations have been working in conjunction with Medicaid Managed Care plans (MMCP) within Ohio to emphasize the need to better coordinate care for pregnant mothers from preconception through the baby's first year of life. Because CareSource is the largest MMCP in Ohio, covering approximately 60% of enrollees, the nonprofit provider took this as a call to action and focused analytic efforts to better understand details behind infant mortality.

The published causes of infant mortality in Ohio are identical to those seen at the national level: premature birth or low birth weight (LBW), serious birth defects, sudden infant death syndrome, maternal complications during pregnancy, and injuries/trauma.<sup>1,3</sup> Pregnant mothers are at an increased risk for these outcomes when they engage in high-risk behaviors, such as smoking, drug use, and alcohol consumption—all of which are more prevalent among low-income, underserved individuals, like those covered by Medicaid.<sup>4,5</sup> Given that 40% of births in Ohio occur among Medicaid beneficiaries, this population is the focus of many efforts to reduce infant mortality.<sup>6</sup> Traditionally, these efforts have focused on prenatal care, with a goal of reducing the number of LBW infants. These babies, weighing less than 2500 grams, have a significantly higher mortality rate than those over 2500 grams (5.5 pounds) at birth.

In 2010, the infant mortality rate for infants less than 2500 grams was 50.98 per 1000 live births, while the rate for infants born at or over 2500 grams was 2.13 per 1000.<sup>7</sup> In the CDC report referenced for these statistics, the authors also noted that 91.8% of all US born infants weighed at least 2500 grams.<sup>7</sup> According to unpublished CareSource data from a 2015 report, LBW infants, covered by CareSource accounted for approximately 60.7% of infant deaths

## ABSTRACT

**OBJECTIVES:** The objective of this study was to determine if severe mental illness and/or a history of substance use in mothers of babies of a healthy weight was associated with infant mortality.

**STUDY DESIGN:** This was a cross-sectional observational study using CareSource historical billed Medicaid Managed Care plan (MMC) claims in Ohio.

**METHODS:** CareSource is Ohio's largest MMCP, serving approximately 1.2 million Medicaid consumers. Claims from 89,159 babies of a healthy weight ( $\geq 2500$  grams) and their mothers were selected from the CareSource Ohio MMCP population from January 2011 through December 2014. The mental health and substance abuse status of the mother was identified from claim history. A logistic regression model was used to estimate the odds ratio for infant mortality based on the presence or absence of maternal severe mental illness (MSMI) or maternal substance abuse (MSU).

**RESULTS:** The logistic regression model fit showed that the odds of infant mortality for infants born weighing 2500 grams or more was significantly higher when the mother was treated either for MSMI ( $\chi^2(1)$ :  $P = .026$ ) or MSU ( $\chi^2(1)$ :  $P = .006$ ) at any time before or after delivery.

**CONCLUSIONS:** Findings indicate that to address infant mortality, a focus on only babies born premature or low birth weight will result in missing a notable segment of the population that requires attention. Mothers who have babies with a healthy weight of at least 2500 grams, but who are diagnosed with either MSMI or MSU, need at least equal attention if inroads are to be made in reducing infant mortality.

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TAKE-AWAY POINTS

Findings of this study indicate that:

- ▶ To address infant mortality, a focus only on babies born prematurely or with a low birth weight will be missing a notable segment of the population that requires attention.
- ▶ Babies born with a healthy weight of 2500 grams but whose mothers are diagnosed with either severe mental illness or substance use need at least equal attention to premature or low birth weight babies if inroads are to be made in reducing infant mortality.
- ▶ Managed care strategies should include an integration of mental and physical health to maximize impact.

(48.3% of infant births) from January 1, 2011, through December 31, 2014, while the remainder of deaths (39.3%) represent infants who were reported as healthy weight, or at least 2500 grams. Although the mortality rate is significantly lower for infants of a healthy weight, even a relatively low rate represents a significant number. The overall volume of healthy-weight infants resulting in infant mortality and a lack of literature in this area led to exploratory research for this study.

One factor that may explain some of the deaths among infants born at a healthy weight is the presence of maternal severe mental illness (MSMI) or maternal substance use (MSU). The link between MSU during pregnancy and infants born at a low birth weight, pre-term, and/or with physical deformities has been well established in the literature.<sup>8-10</sup> However, the relationship between MSMI and infant mortality has not been extensively studied beyond the impact of postpartum depression on the health of the infant, and little has been done to evaluate the influence of MSU on infants born at a healthy weight. Any mental or physical health problems experienced by the mother may be further exacerbated by the inherent lack of communication or coordination of care between certified Community Mental Health Centers (CMHCs) and MMCPs. In Ohio Medicaid, mental health services are currently “carved out” to CMHCs and are fully paid for through Medicaid fee-for-service arrangements—unlike other health services, which are covered and paid for through the MMCPs. The CMHC may or may not be aware of medical issues, such as early pregnancy or the birth of an infant, and the MMCP has little knowledge of the mental health or substance abuse treatment received by enrollees, as there are no reporting requirements between the programs. This benefit design is quite common in MMCPs and results in fragmented care that may increase the risk of mortality in otherwise healthy infants.<sup>11</sup>

Given that 86.5% of Medicaid enrollees in Ohio participate in an MMCP,<sup>12</sup> understanding the relationship between MSMI and MSU status in the context of infant mortality may help optimize future program design and inform strategic policy decisions. Thus, the purpose of the present study was to address recommendations from the Ohio Infant Mortality Taskforce and explore possible associations between MSMI and MSU to mortality for infants of a healthy birth weight included within the Ohio Medicaid popula-

tion.<sup>13</sup> These analyses utilized information gathered by the Ohio Infant Mortality Task Force and incorporated claims data from CareSource’s Medicaid population, focusing on mortality rates among infants born weighing at least 2500 grams.

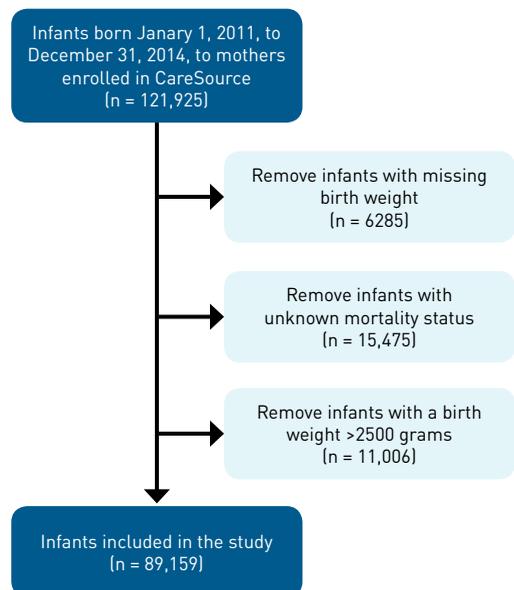
METHODS

This retrospective, cohort study included a de-identified sample of 121,925 infants born alive

from January 1, 2011, through December 31, 2014. Inclusion criteria stipulated that the baby and mother be continuously enrolled in CareSource, an Ohio-based MMC, for 12 months or until the date of the infant’s death. Infant mortality was defined as any baby who died within 365 days of birth (DOB). Approximately 27% of the available samples (n = 32,766) were excluded based on the following criteria: no recorded birth weight, n = 6285 (5.1%); unknown mortality status, n = 15,475 (12.7%); and infants born weighing less than 2500 grams, n = 11,006 (9%). Mortality status would be unknown if no information was received from the mother, hospital, or state Medicaid entity; mortality status, as well as birth weight, might also be missing if the baby was not eligible for Medicaid coverage until birth (no delivery claim received). Additionally, gestational age was excluded from the analysis due to approximately 44% of the sample missing this information or issues with inconsistency across facility claims data. The data flow is presented in **Figure 1**.

Mothers’ MSU status was determined by examining the claims submitted to CareSource. More specifically, this MMCP utilizes

FIGURE 1. Data Flow Diagram



**TABLE.** Infant Mortality, MSU, and MSMI Rates Among Healthy-Weight Births

Birth Weight Category	Sample Size	MSU Rate (SE)	MSMI Rate (SE)	Mortality Rate (SE)
≥2500 grams	89,159	12.1% (0.1%)	5.6% (0.1%)	0.2% (0.02%)

MSMI indicates maternal severe mental illness; SE, standard error; MSU, maternal substance use.

assignment of the Expanded Diagnostic Cluster (EDC) of substance use as defined by the Johns Hopkins Adjusted Clinical Groups System (ACG).<sup>14</sup> The indicator for MSU was flagged “yes” if the mother was treated for a diagnosis that was identified as a part of an EDC for Substance Use any time after the date of the estimated last menstrual period through 1 year post delivery. MSMI issues were identified using similar methodology: if the mother was treated for a diagnosis that was identified as part of an EDC that included psychosis, bipolar, or personality disorders, and the diagnosis occurred any time after the date of the estimated last menstrual period through 1 year post delivery, the indicator for MSMI was flagged as “yes.” The distributions of mothers’ MSU and MSMI were similar between the full sample and those excluded from analyses.

Given the lack of normality and homoscedasticity of variables, as well as the binary nature of the dependent variable (infant mortality), a logistic regression model was fit to assess the odds ratio of infant mortality given 2 diagnostic flags: 1) MSU or MSMI status and 2) maternal race. A stepwise method was used to fit the best model, which included the 3 maternal variables and all possible interactions of the 3 as independent variables. The best fit model was assessed using the Hosmer and Lemeshow Goodness of Fit Test.<sup>15</sup> SAS version 9.4 (SAS Institute Inc, Cary, North Carolina) was used for all analyses.

This study was conducted using de-identified claims data. No human subjects review by an internal review board was required because the finding will be used internally at CareSource for quality improvement of health programs for CareSource beneficiaries. Also, the receipt and analysis of de-identified data does not constitute research involving human subjects.

## RESULTS

The 2500 grams or more birth weight cohort represented 73.1% of the live births recorded in the state of Ohio during the target time period. Thirty-nine percent of the infant deaths recorded during this time occurred within this segment of the population. Of the 89,159 infants included in the study 59% were white, 30.5% black, 3.5% other, and 7% were not provided; 12.1% had mothers with MSU, 5.6% had mothers with MSMI, and 2.1% had mothers with both MSU and MSMI (Table).

The logistic regression model fit showed that the odds of infant mortality for those born at healthy weights were significantly higher when the mother was treated either for MSMI ( $\chi^2(1): P =$

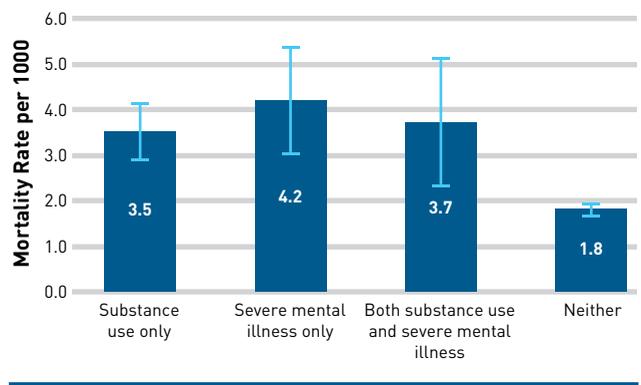
.026) or MSU ( $\chi^2(1): P = .006$ ). The interaction of MSMI and MSU on infant mortality was not a significant factor in the stepwise logistic regression ( $\chi^2(1): P > .05$ ). The odds ratio estimate for MSU was 1.689 (95% confidence interval [CI], 1.167-2.445), indicating the likelihood of infant mortality is 69% higher when MSU is present. Similarly, the likelihood of infant mortality for mothers with MSMI is 73% higher than it is for those without it, with an odds ratio estimate of 1.726 (95% CI, 1.066-2.795). Interaction with maternal race was not significant ( $\chi^2(3)$  and  $\chi^2(1): P > .05$  for both). The goodness of fit test showed no evidence of lack of fit ( $P = .505$ ) for the selected model. Visual representations of these results are provided in Figure 2.

## DISCUSSION

The majority of studies addressing infant mortality include maternal physical health, but not maternal mental health. Studies also address the poor health status of the baby at birth (ie, prematurity, birth defects), but very little research focuses on healthy-weight babies.<sup>1-8</sup> This study explored the possible association of elevated odds of infant mortality of healthy-weight babies as impacted by MSMI or MSU. The increased odds of infant mortality associated with MSMI and prevalence of MSU combine to create new opportunities for focused efforts to reduce infant mortality outside of what is traditionally known.

While beneficiaries tend to face unique challenges related to health disparities and access to healthcare, behavioral health carve-out in Ohio creates an additional challenge of fragmented care.<sup>4,5,11,16</sup> For pregnant mothers with MSMI or MSU, this can compound current barriers that negatively impact care coordination needed and potentially increase the risk of infant mortality to babies of a healthy weight. In an effort to bridge this gap, CareSource expanded their High Risk Case Management program to engage all women with a severe mental health illness or substance use diagnoses who have delivered a baby of a healthy weight in the year immediately following

**FIGURE 2.** Infant Mortality by Maternal Group<sup>a</sup>



<sup>a</sup>Error bars represent 1 standard error.

## TRENDS FROM THE FIELD

delivery. Ongoing evaluations will be performed to assess the impact of CareSource's approach to addressing the fragmentation of care.

### Limitations

A retrospective cohort study does not allow any temporal conclusions to be made. The study shows that there are increased odds of infant mortality when the mother is diagnosed with severe mental illness or substance use, but no cause-and-effect inference can be made from the available data. Prior health information and behavioral health treatment is limited to what is available during the time of eligibility or sent by CMHCs after claims have been processed. Additionally, no relationships could be established with this data using socioeconomic status (ie, poverty, marital status, and educational attainment), since demographic data is limited to information provided by the state at the time of enrollment.<sup>7</sup> Analyses were exploratory, conducted using CareSource Ohio MMCP claims only. Generalizability to other locations and payer mixes may or may not be appropriate. Further research is needed to assess socioeconomic status and timing of MSMI/MSU events in relation to infant mortality status.

## CONCLUSIONS

Limiting the focus of infant mortality prevention to only babies born premature or low birth weight eliminates a large portion of potentially preventable deaths. Prevention efforts must also include social support and mental health/substance use treatment for mothers of infants born at a healthy weight and diagnosed with MMSI/MSU which could lead to better health outcomes for the mother and baby.

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**Authorship Information:** Concept and design (RWG, SEW); acquisition of data (RWG, SEW); analysis and interpretation of data (RWG, SEW); drafting of the manuscript (RWG, SEW); critical revision of the manuscript for important intellectual content (RWG, SEW); statistical analysis (SEW); obtaining funding (SEW); and supervision (RWG).

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