Measuring Severe Maternal Morbidity: A Pilot OHDSI Electronic Health Record Network Study

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Background

Interest in severe maternal morbidity as a national outcome measure has been growing rapidly.[1,2] The U.S. Centers for Disease Control and Prevention (CDC) define severe maternal morbidity as "unexpected outcomes of labor and delivery that result in significant short- or long-term consequences to a woman's health."[2] The CDC and its partners established a composite index to identify severe maternal morbidity for public health surveillance and research in 2012.[3] Currently, the most widely endorsed version comprises a set of 20 indicators.[1,2] The most common indicators are hysterectomy, disseminated intravascular coagulation, and acute renal failure.[2] However, concerns exist about how well the CDC index captures true cases of severe maternal morbidity.[4,5] National estimates of severe maternal morbidity are derived from *International Classification of Diseases* codes in administrative inpatient discharge records.[1,2] These estimates are valuable, but are limited by inconsistencies in data collection and accuracy, long delays in data availability, high costs, and compatibility issues across coding systems.[5,6] Prior work from the OHDSI community has shown how OHDSI approaches of using a common data model (CDM) and comprehensive medical terminology mappings can mitigate some of these limitations, but the work has largely been conducted in claims databases.[7,8] Our aim for this study was to develop an approach to use OMOP electronic health record (EHR) data from healthcare systems to improve the measurement of severe maternal morbidity that can then be implemented at scale across a national network.

Methods

We conducted this study using EHR data structured using the OMOP CDM from the Stanford Health Care, Johns Hopkins University, and MaineHealth healthcare systems. The three healthcare systems are diverse in sociodemographic characteristics of patients, acuity of healthcare, patient volume, region and rural/urban locations, and history of OHDSI participation. We first created an ATLAS birth cohort definition to identify live births at Stanford Health Care hospitals. We validated the cohort definition using live birth record counts extracted from Stanford Epic Stork EHR data. Epic Stork is an add-on to Epic EHR systems that is widely used in obstetric practices. This cohort definition was then implemented at Johns Hopkins and MaineHealth, and compared with the number of live births reported by the healthcare systems to state health departments. Next, we created an ATLAS cohort definition for severe maternal morbidity, based on the CDC 20-indicator composite index, using Stanford EHR data. We used the cohort definition to calculate the incidence of severe maternal morbidity among live births and compared with the incidence reported from Stanford hospitalization discharge data. We also reviewed random sets of cases to confirm a severe maternal morbidity event occurred during pregnancy or birth. We modified the cohort definition accordingly based on these validation steps. We then generated record counts and calculated incidence of severe maternal morbidity among live births at Johns Hopkins and MaineHealth using the same ATLAS cohort definitions.

Results

We successfully used ATLAS to generate severe maternal morbidity cohorts using OMOP EHR data from three (3) healthcare systems. Each healthcare system had 24,000-40,000 births over the 5.5-year study period, for a total sample size of 102,488. The incidence of severe maternal morbidity among live births from January 1, 2019 to May 31, 2024 at Healthcare System A was 2.05%, at Healthcare System B was 1.41%, and at Healthcare System C was 1.74% (Figure 1). The total number of severe maternal morbidity cases was 1,827. Across the three (3) systems, the live birth cohort definition captured 92-99% of live births as reported to state health departments and in Stork EHR data. The incidence of severe maternal morbidity using the cohort definition at Stanford was within 0.05 percentage points of the most recent annual hospital-reported incidence.
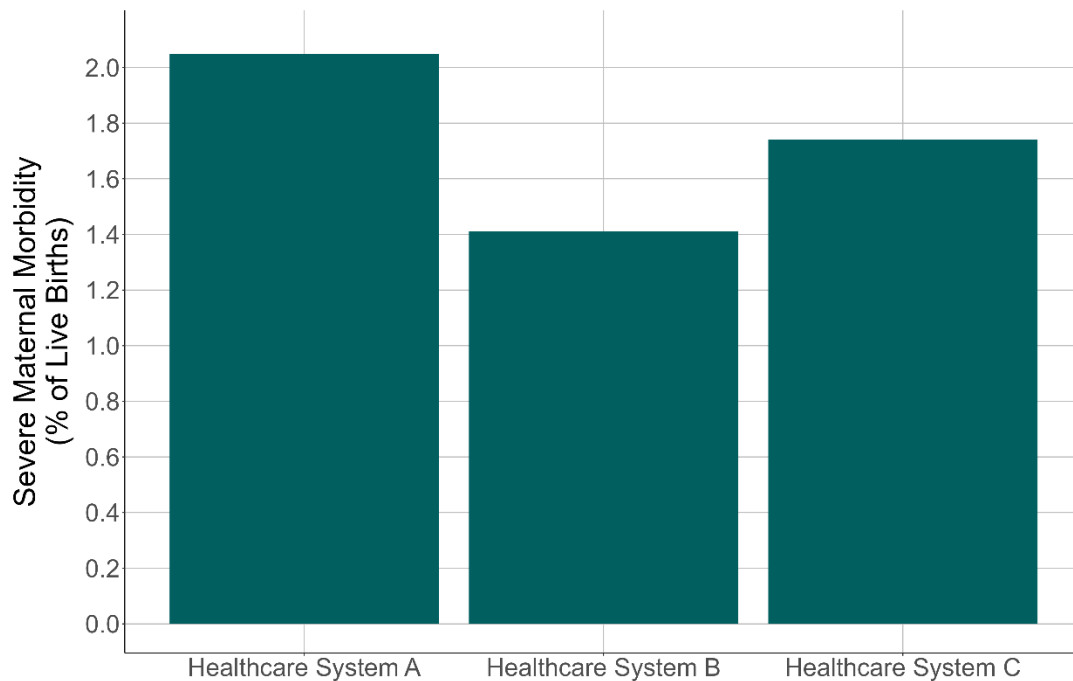

Figure 1. Severe maternal morbidity (percentage of live births) across OMOP electronic health record (EHR) datasets from three healthcare systems in the U.S.

Conclusion

This pilot study using ATLAS from three (3) healthcare systems generated evidence that supports the feasibility and accuracy of OHDSI network studies using EHR data sources to measure severe maternal morbidity. We also identified and overcame challenges unique to OMOP obstetric EHR data. Our approaches are informative for perinatal health OHDSI network studies and could facilitate an impactful addition to claims databases or aggregated multi-site EHR data. Based on our results, we are expanding the study to a broad national network of healthcare systems with ATLAS and EHR data in the OMOP CDM. Leveraging this network, we will evaluate how proposed modifications to the severe maternal morbidity index would affect incidence and we will characterize patient cohorts identified under the proposed modified cohort definitions.

References

1. National Outcome Measures.
   https://mchb.tvisdata.hrsa.gov/PrioritiesAndMeasures/NationalOutcomeMeasures.

2. Severe Maternal Morbidity in the United States | Pregnancy | Reproductive Health |CDC.
   https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html
   (2021).

3. Callaghan, W. M., Creanga, A. A. & Kuklina, E. V. Severe Maternal Morbidity Among Delivery and
   Postpartum Hospitalizations in the United States. *Obstet. Gynecol.* **120**, 1029 (2012).

4. Main, E. K. *et al.* Measuring severe maternal morbidity: validation of potential measures. *Am. J.
   Obstet. Gynecol.* **214**, 643.e1-643.e10 (2016).

5. Hirai, A. H., Owens, P. L., Reid, L. D., Vladutiu, C. J. & Main, E. K. Associations Between State-
   Level Severe Maternal Morbidity and Other Perinatal Indicators. *JAMA Netw. Open* **5**, e2224621
   (2022).

6. Hirai, A. H., Owens, P. L., Reid, L. D., Vladutiu, C. J. & Main, E. K. Trends in Severe Maternal
   Morbidity in the US Across the Transition to ICD-10-CM/PCS From 2012-2019. *JAMA Netw. Open*
   5, e2222966 (2022).

7. Matcho, A. *et al.* Inferring pregnancy episodes and outcomes within a network of observational
   databases. *PLOS ONE* **13**, e0192033 (2018).

8. Weaver, J. *et al.* Development and evaluation of an algorithm to link mothers and infants in two
   US commercial healthcare claims databases for pharmacoepidemiology research. *BMC Med.
   Res. Methodol.* **23**, 246 (2023).