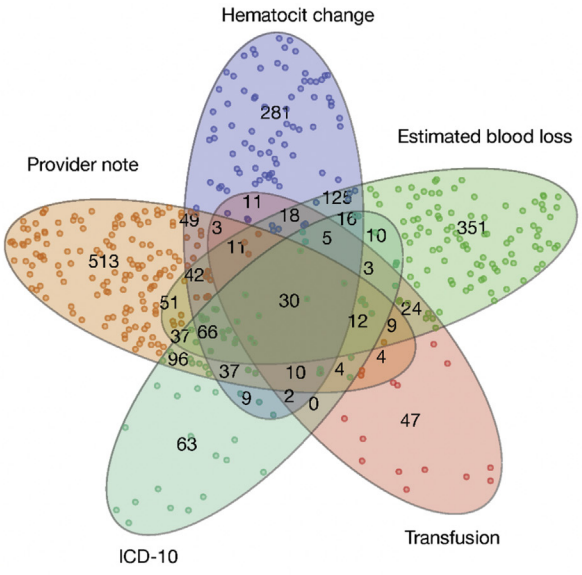
The utility of electronic health record data for identifying postpartum hemorrhage

OBJECTIVE: Studies of postpartum hemorrhage (PPH) have been primarily retrospective using clinician estimated blood loss (EBL) to define PPH, which has been demonstrated to be largely inaccurate.[1,2] As electronic health record (EHR) data become more readily available, alternative methods may be used to identify and study PPH. The primary objective of this study was to compare the incidences of PPH using various EHR data elements and their degree of overlap as a necessary first step toward large-scale applications of emerging EHR data analyses and machine-learning methods.

STUDY DESIGN: This study is a retrospective analysis of women delivering liveborn, viable (>24 weeks' gestation) infants at 2 academic medical centers from January 1, 2017, to December 31, 2017. Deliveries were identified from the delivery records within the EHR system (Epic). The delivery records were then linked to claims and EHR data from the delivery encounter to create the data set. Here, the following 5 data elements, which would likely to be routinely available in most EHR systems, were selected to define a PPH: (1) transfusion of at least 1 unit of packed red blood cells; (2)

FIGURE
Congruence of various data elements used to identify PPH



Element	Number of Additional Data Elements Present				
	0	≥ 1	≥ 2	≥ 3	All
Notes (n=974)	513 (52.7%)	461(47.3%)	261 (26.8%)	129 (13.2%)	30 (3.1%)
EBL (n=810)	351 (43.3%)	459 (56.7%)	249 (30.7%)	124 (15.3%)	30 (3.7%)
Hct change (n=715)	281 (39.3%)	434 (60.7%)	240 (33.6%)	112 (15.7%)	30 (4.2%)
ICD-10 code (n=400)	63 (15.8%)	337 (84.3%)	238 (59.5%)	145 (36.3%)	30 (7.5%)
Transfusion (n=193)	47 (24.0%)	146 (75.6%)	107 (55.4%)	69 (35.8%)	30 (15.5%)

The overlapping Venn diagram shows the relative congruence of the definitions used to identify PPH. The data elements used to define PPH include provider documentation in notes, estimated blood loss, hematocrit change of ≥10 points, ICD-10 code for PPH, or transfusion of ≥1 unit of packed red blood cells. The Table shows the number of additional data elements present (columns) relative to each definition that could be used to identify PPH. For example, 461 of 974 women (47.3%) with a clinical documentation of hemorrhage had at least 1 other data element indicating PPH.

EBL, estimated blood loss; *ICD-10*, International Classification of Diseases, Tenth Revision; *PPH*, postpartum hemorrhage.

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TABLE
Sensitivity of other data elements compared with various "gold standard" definitions

	Sensitivity of other data elements				
Gold standard	**Notes**	**EBL**	**Hct change**	**ICD-10 code**	**Transfusion**
Notes (n=974)	—	26.5	25.5	30.0	7.5
EBL (n=810)	31.9	—	38.6	22.1	12.0
Hct change (n=715)	34.7	43.8	—	24.5	10.4
ICD-10 code (n=400)	73.0	44.8	43.8	—	14.8
Transfusion (n=169)	43.2	57.4	43.8	34.9	—

The Table shows the sensitivity of other EHR data elements relative to the element being considered the "gold standard." Data are expressed as percentage.

EBL, estimated blood loss; *Hct*, hematocrit; *ICD-10*, International Classification of Diseases, Tenth Revision.

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EBL of ≥1000 mL documented in the delivery records; (3) documentation of PPH in the provider notes, identified using natural language processing; (4) ≥10 percentage point change between the admission and any postpartum hematocrit; and (5) the International Classification of Diseases, Tenth Revision (ICD-10), diagnosis code for PPH (O72).[3] A decrease of 10 or more percentage points was classified as a PPH, similar to previous studies; women without a postdelivery hematocrit were considered to not have had a hemorrhage.[4,5] ICD-10 codes were applied by clinical staff initially and then reviewed and updated by administrative staff in both institutions. Missing data, which occurred in 6% of observations, were imputed using multiple imputations with chained equations. The incidences were calculated and compared. All analyses were performed using StataSE (version 14.1; StataCorp, College Station, TX). This study was approved by the study institution's intuitional review board.

RESULTS: There were 9102 women included in the sample. The incidence of PPH varied by definition: 10.7% using provider documentation (n=974), 8.9% using documented EBL (n=810), 7.9% using hematocrit decrease (n=715), 4.4% using diagnosis codes (n=400), and 2.1% using transfusion (n=193). The Figure shows the congruence of the definitions. The Table shows the sensitivity of the other data elements depending on which is considered the "gold standard" for comparison. Provider documentation of PPH had the least overlap with the other data elements (52.8% of deliveries). Comparatively, 84% of encounters with the ICD-10 code had at least 1 additional EHR data element suggestive of PPH. Transfusion, often considered a marker of severity of PPH, was compared independently to show that 24% of transfusions occurred without other references to PPH.

CONCLUSION: We found that the incidence of PPH varied widely on the basis of the criteria used to define hemorrhage, ranging from 2% to 11%. This wide variation demonstrates the challenges in developing a single prediction model for a clinical outcome if multiple, non-inclusive definitions could be used, such as for PPH or severe maternal morbidity. The emerging use of EHR data and analytical methods to extract information offers the ability to efficiently conduct population-level analyses. Although individual data elements may lack specificity, the congruence may be helpful in identifying true positives or those considered to be clinically significant. Notably, the ICD-10 diagnosis code had a high degree of overlap with other accepted definitions of PPH, suggesting it may be an appropriate approach to study PPH, but this finding may not be generalizable to other institutions. The advancement of machine-learning methods in combination with EHR data provides a novel opportunity to conduct population-based analyses with more precisely identified outcomes and exposures. ■

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REFERENCES

1. Conner SN, Tuuli MG, Colvin R, Shanks AL, Macones GA, Cahill AG. Accuracy of estimated blood loss in predicting need for transfusion after delivery. Am J Perinatol 2015;32:1225–30.
2. Stafford I, Dildy GA, Clark SL, Belfort MA. Visually estimated and calculated blood loss in vaginal and cesarean delivery. Am J Obstet Gynecol 2008;199:519.e1–7.
3. Committee on Practice Bulletins-Obstetrics. Practice Bulletin no. 183: postpartum hemorrhage. Obstet Gynecol 2017;130:e168–86.
4. Combs CA, Murphy EL, Laros RK Jr. Factors associated with postpartum hemorrhage with vaginal birth. Obstet Gynecol 1991;77:69–76.
5. Petersen LA, Lindner DS, Kleiber CM, Zimmerman MB, Hinton AT, Yankowitz J. Factors that predict low hematocrit levels in the postpartum patient after vaginal delivery. Am J Obstet Gynecol 2002;186:737–44.

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