Association Between Post–Dural Puncture Headache After Neuraxial Anesthesia in Childbirth and Intracranial Subdural Hematoma

Albert R. Moore, MD; Paul M. Wieczorek, MD; Jose C. A. Carvalho, MD, PhD

IMPORTANCE Women giving birth have high rates of dural puncture secondary to neuraxial anesthesia and are at high risk for a resulting headache. It appears to be unknown whether there is a significant association between post–dural puncture headache and subsequent intracranial subdural hematoma.

OBJECTIVE To determine the association of post–dural puncture headache with postpartum intracranial subdural hematoma.

DESIGN, SETTING, AND PARTICIPANTS This cohort study of patients used hospital discharges recorded in the US Agency for Healthcare Research and Quality National Readmission Database for women who experienced childbirth from January 2010 to December 2016. Patients were included if they had been admitted for childbirth, had 2 months of follow-up data, and did not receive a diagnostic lumbar puncture. Only the first delivery for a calendar year was studied. Data were analyzed from January 2018 to June 2019.

EXPOSURES Women with post–dural puncture headache associated with neuraxial anesthesia in the 2-month postpartum period were identified using International Classification of Disease (Ninth Edition and Tenth Edition) codes and were compared with those without post–dural puncture headaches.

MAIN OUTCOME AND MEASURES The primary outcome was intracranial subdural hematoma in the 2-month postpartum period. Secondary outcomes included in-hospital mortality and occurrence of neurosurgery.

RESULTS A total of 26 469 771 patients with 26 498 194 deliveries were included. Exclusion of repeated deliveries (n = 28 423), deliveries without 2 months of follow-up data (n = 4 329 621), and deliveries with diagnostic lumbar puncture (n = 9334) resulted in a final cohort of 22 130 815 patients and deliveries. For the cohort, the mean (SD) age was 28.1 (6.0) years, and there were 68 374 post–dural puncture headaches, for an overall rate of 309 (95% CI, 302-316) per 100 000. There were 342 cases of subdural hematoma identified, indicating a rate of 1.5 (95% CI, 1.3-1.8) per 100 000 women. Of these, 100 cases were in women with post–dural puncture headache, indicating a rate of 147 (95% CI, 111-194) hematoma cases per 100 000 deliveries in this subgroup. Post–dural puncture headache had an unadjusted absolute risk increase of 145 (95% CI, 117-174) subdural hematoma cases per 100 000 deliveries. After adjusting for confounders, post–dural puncture headache had an odds ratio for subdural hematoma of 199 (95% CI, 126-317; P < .001) and an adjusted absolute risk increase of 130 (95% CI, 90-169; P < .001) per 100 000 deliveries.

CONCLUSIONS AND RELEVANCE The presence of presumed post–dural puncture headache after neuraxial anesthesia in childbirth, compared with no headache, was associated with a small but statistically significant absolute increase in the risk of being diagnosed with intracranial subdural hematoma. Further research is needed to establish if this association is causal for this rare outcome.

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Supplemental content

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Corresponding Author: Albert R. Moore, MD, Department of Anesthesia, Royal Victoria Hospital, 1001 Decarie Blvd, Montreal, QC H4A 3J1, Canada (albert.moore@mcgill.ca).
Dural punctures are performed in emergency departments, operating theaters, labor wards, and neurology clinics. A common resulting complication is a post-dural puncture headache. This headache is thought to be caused by decreased intracranial pressure attributable to the leakage of cerebrospinal fluid through the dural disruption, which places traction on pain-sensitive structures. Effective treatment often involves a blood patch, which is the injection of autologous whole blood into the epidural space. Pregnant women frequently receive epidural or spinal analgesia and anesthesia for childbirth, and between 0.15% and 3% may experience post-dural puncture headache. Since these women can develop symptoms of a post-dural puncture headache after their hospital discharge, care may be provided by general practitioners, emergency physicians, neurologists, obstetricians, surgeons, and/or anesthesiologists.

Case reports describe women who are post partum with post-dural puncture headache have been reported to develop intracranial subdural hematomas, which can result in their tearing and subsequent hematoma formation (eFigure in the Supplement). However, this association has not been well established.

Subdural hematoma development in the obstetric population is poorly understood. For this reason, this study sought to determine its association with post-dural puncture headache and overall incidence.

Methods

Ethical approval for this study was provided by the McGill University Health Center Research Ethics Board. Patient consent was waived because data were anonymous. There were 4 objectives in this study: to (1) determine the incidence of subdural hematoma in the postpartum population; (2) determine the mortality and occurrence of neurosurgery in the presence of subdural hematoma; (3) determine if post-dural puncture headache was associated with postpartum subdural hematoma, even after accounting for confounding variables; and (4) explore the association of other potential risk factors with subdural hematoma. To do this, a cohort study was devised using information from an administrative database.

Description of the Database

The National Readmission Database is maintained as part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality, an agency of the US Department of Health and Human Services. It contains discharge information from states that link admissions to individual patients, allowing analysis of readmissions for a single patient for a single year. With regards to generalizability, this database contains information from 27 geographically distinct states, which accounts for 58% of the total US resident population and 57% of all US national hospitalizations. The database contains primary and secondary diagnostic and procedural International Classification of Diseases Ninth Revision (ICD-9) and Tenth Revision (ICD-10) codes and demographic information for the patient and admission. The database contains approximately 80% of all hospitals in participating US states. The reasons and numbers for excluded observations can be found on the website of the organization providing the data. Multiple quality-control procedures are in place in an effort to provide data validity and consistency, allowing use in epidemiologic studies.

A cohort was constructed of women who had delivered an infant and had a 2-month period of follow-up. Codes from the ICD-9 and ICD-10 indicating delivery (ICD-9 codes V27 and 650 and ICD-10 codes Z37080, 081, and 082) identified birth admissions. The database includes diagnoses categorized into disease related groups, which further identified birth admissions (disease related group codes 765-768, 774, and 775). Admissions with codes indicating ectopic pregnancy (ICD-9 code 633 and ICD-10 codes 000 and 008), hydatidiform moles (ICD-9 code 630 and ICD10 code 001), abnormal products of conception (ICD-9 code 631 and ICD-10 code 002), and abortion (ICD-9 codes 632, 634-639, 69,01, 69,51, 74,91, and 75,0 and ICD-10 codes 003, 004, 007, and 10A0) were excluded. Only the first delivery in a calendar year for any patient was included. The database provides patient linkage only for a calendar year. To ensure 2 months of follow-up data for all patients, deliveries in the last 2 months of each year were excluded as per the suggestion of the database-providing organization.

Exposures

Patient conditions were identified based on the presence of either ICD-9 or ICD-10 or Clinical Classification Software (CCS) codes. Clinical Classification Software codes are created by the database-providing organization and collapse ICD-9 and ICD-10 codes into clinical categories. The primary exposure was the presence of post-dural puncture headache (ICD-9 code 349.0 and ICD-10 codes 074.5 or 089.4) within 2 months of birth. These codes indicate a reaction to spinal or lumbar puncture (headache after lumbar puncture; ICD-9 code 349.0); a spinal and epidural anesthesia-induced headache during labor and cobination has not been wellestablished.

Subdural hematoma development in the obstetric population is poorly understood. For this reason, this study sought to determine its association with post-dural puncture headache and overall incidence.

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delivery (ICD-10 code O74.5.5); and a spinal and epidural anesthesia-induced headache during the puerperium (ICD-10 code O89.4). These were diagnosed at the discretion of the treating physicians and were taken from the patient discharge information. This code has been used in other studies of anesthesia complications in the postpartum period to identify post–dural puncture headache. To restrict analysis to patients who had neuraxial anesthesia, those who received a diagnostic lumbar puncture (ICD-9 code 03.31 and ICD-10 code G97.1) were excluded. Possible confounding exposures were chosen based on their association with subdural hematoma formation, including age,17,18 obesity (ICD-9 codes 278.00 and 278.01 and ICD-10 code E66),19 coagulopathy (CCS code 62),20 connective tissue disease (CCS codes 210 and 211),21 and cerebral arteriovenous anomalies (ICD-9 codes 210 and 211 and ICD-10 codes I67.1, Q28.2, and Q28.3).22 Hypertension23 was identified during the peripartum period and categorized into none, gestational (ICD-9 code 642.3 and ICD-10 O13), mild (ICD-9 code 642.4 and ICD-10 O14.0), or severe (ICD-9 codes 642.5 and ICD-10 codes O14.1 and O15) preeclampsia or eclampsia and chronic hypertension (ICD-9 codes 642.0, 642.7, 642.1, 642.2, 642.9, and 401-405 and ICD-10 codes O10 and O11). Delivery type was categorized into vaginal or cesarean (CCS code 134 and ICD9 codes 740-742, 744, 749.1, 749.9, and 649.8 and ICD-10 codes O15.82 and O82) with labor (ICD-9 codes 653, 660-662, 663, 652.1, 659.0, 659.1, 656.3, 652.9.0.1, 663.0, and 649.8 and ICD-10 codes O33, O32.1, O32.9, O61-4, O68, O69.0, O75.82, and O77) or without labor.24 Epidural blood patch (ICD-9 codes 03.95 and ICD-10 code 3E03S3GC) of any timing was also considered. Delaying a blood patch may be associated with subdural hematoma,7 so it was decided to also include an exposure of a delayed blood patch. Information on the actual day of diagnosis of post–dural puncture headache was not available, so a delayed blood patch was defined as one that occurred in a readmission after the admission with the initial post–dural puncture diagnosis. All secondary exposures were identified prior to or during the birth admission, except hypertension, which can develop in the postpartum period.25

Outcomes
The primary outcome was the incidence of subdural hematoma (ICD-9 code 432.1 and ICD-10 code I62.0), excluding those associated with trauma (ICD-9 codes 800-804 and 852 and ICD-10 codes S02.0, S02.1, S02.3, S02.8, and S02.9). These codes have been shown to have a positive predictive value of 74% to 86% and sensitivity of 85% when used to identify intracranial hemorrhage.26-28 Secondary outcomes were in-hospital mortality and occurrence of neurosurgery (CCS code 1).

Statistical Analysis
All analyses were performed with Stata version 15 (StataCorp) from January 2018 to June 2019. The sample was stratified by the database–providing organization on characteristics that include census region, rural or urban setting, academic status, hospital size, patient sex, and age. Hospitals were the clusters for the first stage of sampling. Each discharge was considered a second stage of the sampling and was weighted based on the number of discharges it represented nationally. This weighting was performed by the database–providing organization by dividing the total number of discharges recorded in a stratum in the target population (all hospitals in the American Hospital Association annual survey of hospitals) by the number of sampled discharges in the database for that same stratum. All analyses were performed with the svy: set of commands in Stata, with inference based on between-hospital variation that corrected for the correlation of measurements within hospitals and the variance calculations performed using the Taylor linearization method.

The sample size was based on all the available data. This included the years 2010 to 2016, because these were the only available years at the time of this study.

Two-tailed tests were used for all hypothesis testing, and a P value of .05 was used to reject the null hypothesis. No outliers were found, so no specific action was taken. Each variable was assessed for missing information. No missing information was found for the exposures, and missing information was found among the outcome data only with respect to in-hospital mortality. Of these, 4156 deliveries (0.02% [95% CI, 0.007%-0.05%]) had missing information in the nonsubdural group, compared with 0 in those with subdural hematoma (P = .98). Therefore, to compare the differences in in-hospital mortality, deliveries with missing mortality status were omitted.

Patient characteristics with and without subdural hematoma were compared using linearized 2-sample t tests or Pearson χ² tests. To control for confounders, a multiple logistic regression model was constructed. The initial model was constructed with all considered exposures entered in 1 step. Since model fit statistics based on the log likelihood were not appropriate for data with this complex structure,29 C statistics, specification-link testing,30 and calibration-belt testing31,32 were used to compare model fit. The primary exposure and the exposures of age, obesity, hypertensive disease, connective tissue disease, coagulopathy, epidural blood patch administration and timing, and delivery type were all decided on before data were accessed. After initiation, the presence of cerebral arteriovenous malformation was added as an exposure. To account for the interconnected nature of post–dural puncture headache and blood-patch categories, models with and without these terms were compared. The results of the modeling steps are included in the eAppendix and eTables 1, 2, and 3 in the Supplement. A logistic model with all considered exposures entered in 1 step was assessed and found to have poor fit. A model was then developed with the addition of interaction terms between the primary exposure and significant secondary exposures guided by the aforementioned fitting tests. Only interactions that reached statistical significance and improved model fit were retained. The final model was chosen based on model fit and included interaction terms between post–dural puncture headache and hypertension category. Inclusion of the blood patch exposure did not improve model fit, was found to inflate model variance, and was not included. The final model demonstrated adequate specification with link testing and calibration using calibration-belt testing, and the area under the curve of the receiver operator characteristic was 0.81.
Adjusted risk differences were calculated from the final model using the mean predictive margins. The primary hypothesis was that post–dural puncture headache would be associated with subdural hematoma. Because all other analyses were exploratory and hypothesis generating, no adjustment was made for multiple comparisons. Rare events can bias logistic regression,16 so a model using logistic regression for rare events was constructed and compared with the results from the final model.

Results

A total of 26,469,771 patients (mean [SD] age, 28.1 [6.0] years) with 26,498,194 deliveries were included. Exclusion of repeated deliveries (n = 28,423), deliveries without 2 months of follow-up data (n = 4,329,621), and deliveries with diagnostic lumbar puncture (n = 9334) resulted in a final cohort of 22,130,815 patients and deliveries (Figure 1). The baseline characteristics of these deliveries are presented in Table 1.

There were 68,374 deliveries identified with post–dural puncture headaches, for an overall rate of 309 (95% CI, 302-316) per 100,000 women. The number of cases of postpartum subdural hematoma was 342, for an incidence of 1.5 per 100,000 deliveries. The number diagnosed during the birth admission was 86 (25% [95% CI, 18%-33%]) vs 256 (75% [95% CI, 67%-82%]) diagnosed in a readmission. Compared with those without subdural hematoma (2440 of 22,130,473 [0.01%]), women with subdural hematoma were more likely to experience in-hospital mortality (10 of 342 [2.9%]; difference, 2.89% [95% CI, 0.32%-5.47%]; P = .02). Of the women with subdural hematoma, 75 of 342 (21.9%) underwent neurosurgery vs 740 of the 22,130,473 (0.003%) of those without subdural hematoma (difference, 21.9% [95% CI, 14.1%-30.0%]; P < .001). In the women with post–dural puncture headache, 100 had subdural hematoma, for an incidence of 147 (95% CI, 111-194) per 100,000 in this subgroup. This provided a crude absolute risk increase of 145 (95% CI, 117-174) cases per 100,000 population.

The unadjusted comparisons of clinical characteristics between women with and without subdural hematoma are presented in Table 2. The results of the final multiple variable model are presented in Table 3. The adjusted odds ratio for the association of post–dural puncture headache and subdural hematoma was 199 (95% CI, 126-317; P < .001) and the adjusted risk difference was 130 (95% CI, 90-169; P < .001) per 100,000 population. Coagulopathy, arteriovenous malformation, and delayed blood patch were positively associated with subdural hematoma, with respective adjusted odds ratios of 3.35 (95% CI, 1.55-7.22), 32 (95% CI, 5-215), and 39 (95% CI, 14-108). Obesity and cesarean delivery without labor had negative adjusted absolute risk differences for subdural hematoma of −0.6 (95% CI, −1.3 to 0.0) per 100,000 population and −0.6 (95% CI, −1.2 to 0.0) per 100,000 population, respectively. Interaction terms between post–dural puncture headache and severe preeclampsia and chronic hypertension were statistically significant (β, −3.154 [SE, 1.123]; P = .005; β, −1.581 [SE, 0.473]; P < .001, respectively; eTable 3 in the Supplement). In the absence of post–dural puncture headache, the odds ratios for severe preeclampsia and chronic hypertension with subdural hematoma were 15.86 (95% CI, 7.66-32.87) and 18.50 (95% CI, 10.52-32.54), respectively. In the presence of post–dural puncture headache, only chronic hypertension was

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**Table 1. Baseline Characteristics for the Deliveries in the 2010-2016 Weighted Cohort**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients, No. (%) [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cohort, No.</td>
<td>22,130,815</td>
</tr>
<tr>
<td>Age, mean (SD) [95% CI], y</td>
<td>28.1 (6.0) [28.1-28.2]</td>
</tr>
<tr>
<td>Subdural hematoma</td>
<td>342 (0.0015) [0.0013-0.0018]</td>
</tr>
<tr>
<td>Post–dural puncture headache</td>
<td>68,374 (0.31) [0.30-0.32]</td>
</tr>
<tr>
<td>Obesity</td>
<td>1,307,942 (5.9) [5.8-6.1]</td>
</tr>
<tr>
<td>Connective tissue disease</td>
<td>129,094 (0.58) [0.57-0.60]</td>
</tr>
<tr>
<td>Coagulopathy</td>
<td>449,996 (2.0) [2.0-2.1]</td>
</tr>
<tr>
<td>Arteriovenous malformation</td>
<td>2052 (0.0093) [0.0085-0.0101]</td>
</tr>
<tr>
<td><strong>Mode of Delivery</strong></td>
<td></td>
</tr>
<tr>
<td>Vaginal delivery</td>
<td>14,807,324 (66.9) [66.7-67.1]</td>
</tr>
<tr>
<td>Cesarean delivery with labor</td>
<td>2,090,862 (9.4) [9.4-9.5]</td>
</tr>
<tr>
<td>Cesarean delivery without labor</td>
<td>5,232,629 (23.6) [23.5-23.8]</td>
</tr>
</tbody>
</table>

*Results were estimated taking into account the weighted, stratified, and clustered nature of the sample. Characteristics are defined using International Classification of Diseases, Ninth or Tenth Revision or database-specific coding, as listed in the Methods section.

b Delayed epidural blood patch was defined as any happening in a hospital readmission after post–dural puncture headache diagnosis.*
Table 3. Characteristics of the Deliveries With and Without Subdural Hematoma, With Unadjusted Risk Differences and Odds Ratios, in the 2010-2016 Weighted Cohorta

<table>
<thead>
<tr>
<th>Condition</th>
<th>Patients, No. (%) [95% CI]</th>
<th>Subdural Hematoma (n = 342)</th>
<th>No Subdural Hematoma (n = 22 130 473)</th>
<th>Crude Risk Difference per 100 000 (95% CI)</th>
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<tr>
<td>Post–dural puncture headache</td>
<td>100 (29.3) [22.6-37.1]</td>
<td>68 274 (0.31) [0.30-0.32]</td>
<td>145 (117-174)</td>
<td>134 (94-190)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Age, mean (95% CI), y</td>
<td>29.3 (28.1-30.4)</td>
<td>28.1 (28.1-28.2)</td>
<td>NA</td>
<td>1.03 (1.00-1.06)</td>
<td>.05</td>
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<td>Obesity</td>
<td>25 (7.4) [4.4-12.1]</td>
<td>13 007 917 (5.9) [5.8-6.1]</td>
<td>0.39 (~0.38 to 1.16)</td>
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<td>Connective tissue disease</td>
<td>NA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>129 088 (0.58) [0.57-0.60]</td>
<td>3.1 (~0.6 to 6.8)</td>
<td>3.04 (0.94-9.84)</td>
<td>.06</td>
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<td>Coagulopathy</td>
<td>32 (9.3) [4.9-17.2]</td>
<td>449 965 (2.0) [2.0-2.1]</td>
<td>5.7 (3.2-8.2)</td>
<td>4.97 (2.46-10.01)</td>
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<td>NA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2050 (0.0093) [0.0086-0.0101]</td>
<td>96.0 (~39.1 to 230.9)</td>
<td>49.68 (6.93-356.03)</td>
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Table 2. Characteristics of the Deliveries With and Without Subdural Hematoma, With Unadjusted Risk Differences and Odds Ratios, in the 2010-2016 Weighted Cohorta

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Abbreviation: NA, not applicable.
<sup>a</sup> Results were estimated taking into account the weighted, stratified, and clustered nature of the sample.
<sup>b</sup> As per database regulations, cells with fewer than 10 events are suppressed. Delayed epidural blood patch was defined as any happening in a readmission after post–dural puncture headache diagnosis.
because of increased intracranial pressure,
associated with subdural hematoma, with an odds ratio of 3.81 (95% CI, 1.77-8.22). The rare events logistic regression demonstrated limited association of rare event bias with the final model (Figure 2; eTable 4 in the Supplement).

Discussion

In this study, post–dural puncture headache among women who received neuraxial anesthesia during childbirth was associated with an increased number of subdural hematomas. This was a small absolute increase because of the rarity of this outcome in this population. However, this is an important and devastating outcome for a common exposure in young and usually healthy mothers.

These findings are in agreement with multiple case reports that link these conditions. The proposed mechanism is through decreased intracranial pressure attributable to cerebrospinal fluid leakage. This leads to so-called sagging of the brain and tension on veins that run between the dura and the arachnoid. If these vessels rupture, a subdural hematoma could form (eFigure in the Supplement).

This study has determined that coagulation disorders and arteriovenous malformations are associated with subdural hematoma, as previously demonstrated. Obesity had a negative risk difference for subdural hematoma. Obesity is associated with a lower risk of headache after dural puncture, perhaps because of increased intracranial pressure, which may provide resistance to the development of subdural hematoma. Cesarean delivery was also negatively associated with subdural hematoma. This may be because of the absence of pushing efforts during labor or the usage of smaller-gauge spinal needles for spinal anesthesia. A significant interaction term was found between post–dural puncture headache and hypertension categories. In the absence of a post–dural puncture headache, preeclampsia and chronic hypertension were associated with subdural hematoma. In the presence of a post–dural puncture headache, only chronic hypertension was associated with subdural hematoma. The reason for this interaction is unclear but might reflect the resolution of pregnancy-associated hypertension after delivery. Subdural hematoma was associated with women in whom the first blood patch was delayed until a readmission after the diagnosis of post–dural puncture headache. It is possible that an early blood patch may be protective, perhaps by decreasing cerebrospinal fluid loss and restoring intracranial pressure. It is important to note that all secondary exposure analysis is considered exploratory and requires further confirmation.

It is difficult to study the association of subdural hematoma with post–dural puncture headache, because it is a rare complication that often happens many days after the initial neuraxial procedure. This current study used one of the largest databases available that tracks patients over readmissions and therefore provided the best current information available to study this association.

Limitations

This study had several limitations. First, as an observational study, this can only assess an association between post–dural puncture headache and subdural hematoma; it cannot establish causality. This is because of the risk of bias inherent to this study type, most importantly via the risk of measured and unmeasured confounding. This analysis included exposures that have been associated with subdural hematoma and adjusted for them using logistic regression. However, there remains the risk that other confounders were not included.

Second, this study is at risk for surveillance bias. It is possible that women with post–dural puncture headaches were more likely to receive brain imaging and have minor subdural hematomas detected, increasing the rate of subdural diagnosis compared with those without dural puncture headaches. However, imaging in clearly diagnosed cases of post–dural puncture headache is not indicated, so it is also possible that women with post–dural puncture headache had cases of minor subdural hematoma that were missed if the symptoms improved with standard therapy.

Third, there is the risk of misclassification. With regard to the main outcome and exposure, the risk of misclassification is likely to be low. The use of ICD-9 code 432 has been validated for identifying intracranial hemorrhage. Validation studies are lacking for the use of this ICD-9 code for identifying only post–dural puncture headache. Post–dural puncture rates depend on the size of the reporting institution and their experience with neuraxial techniques. This study identified a post–dural puncture headache rate across a large spectrum of hospital sizes and types that is in keeping with
the published estimates of post–dural puncture headache,3,4 suggesting a low risk of misclassification.

Fourth, there is the risk of rare event bias. Analyzing rare events using the maximum likelihood estimation in logistic regression can result in biased estimates.3,37 These can be accounted for by using penalized maximum likelihood or rare-event logistic regression.3,37 Both of these methods have limitations when analyzing weighted, clustered data, such as that found in the National Readmission Database. Because of these limitations, these methods were not used for construction of the final model. However, a rare-event logistic regression model was compared with the final logistic model and found to have very similar estimates.

Fifth, there are limitations of the National Readmission Database. The database does not track patients over calendar years, which means that deliveries in the last 2 months of a calendar year did not have a 2-month follow-up. This known issue is usually dealt with by excluding patients at year end. Including these would result in a falsely low estimate of incidence of subdural hematoma, because those who developed a subdural hematoma in the next calendar year would be falsely considered negative. Seasonal variations in subdural hematoma incidence could therefore bias the estimated rates, but it is unlikely that the time of year affect rates of subdural hematoma. In addition, approximately 80% of the hospitalizations for each contributing state are included in the database, because observations with unreliable patient linkage information are dropped by the database–providing organizations. Most of these exclusions occur in newborns with age equal to 0 years, which have little bearing on this study. A further database limitation is its use of only ICD–9 and ICD–10 codes. There are no ICD–9 and ICD–10 codes that are used specifically for neuraxial anesthesia in obstetrics; therefore, no analysis could be performed on the type of procedure that caused the post–dural puncture headache. However, since women with diagnostic lumbar punctures were excluded, the remaining cause of dural puncture in this population would be associated with anesthesia. In addition, the database does not contain information concerning the parity of the included women. An additional database limitation is the availability of only in-hospital mortality. Out-of-hospital mortality was not measured, and this outcome must be interpreted with caution.

Conclusions
The presence of presumed post–dural puncture headache after neuraxial anesthesia in childbirth, compared with the absence of headache, was associated with a small but significant absolute increase in risk of being diagnosed with intracranial subdural hematoma. Further research is needed to establish if this association is causal for this rare outcome.

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Acquisition, analysis, or interpretation of data: All authors.
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