

SUPPLEMENTAL DIGITAL CONTENT (SDC)

Major neurologic complications associated with post-dural puncture headache in obstetrics: A retrospective cohort study

Guglielminotti J, Landau R, Li G.

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This supplementary material has been provided by the authors to give readers additional information about their work.

SDC-Table 1: ICD-9-CM definition of delivery-related discharges ^a

Inclusion criteria	Diagnosis codes	Procedure codes
Outcome of delivery	V27.0-V27.9	-
Normal delivery	650	-
Forceps, vacuum, and breech extraction	-	72.0-72.9
Internal and combined version and extraction	-	73.22
Other manually-assisted deliveries	-	73.59
Episiotomy	-	73.6
Cesarean delivery	-	74.0-74.2, 74.4, 74.9
Exclusion criteria	Diagnosis codes	Procedure codes
Ectopic or molar pregnancy	630-633	-
Pregnancy with abortive outcome	634-639	-
Abortion	-	69.01, 69.51, 75.0

^a Adapted from Kuklina EV, Whiteman MK, Hillis SD, Jamieson DJ, Meikle SF, Posner SF, Marchbanks PA: An enhanced method for identifying obstetric deliveries: Implications for estimating maternal morbidity. *Matern Child Health J* 2008; 12: 469-77

SDC-Table 2: ICD-9-CM definitions of maternal complications

Clinical label	ICD-9-CM diagnosis code	ICD-9-CM label
Major neurologic complications		
<i>Non-traumatic subdural hematoma</i>	432.1	Subdural hematoma
<i>Cerebral venous thrombosis</i>	671.5	Cerebral venous thrombosis and thrombosis of intracranial venous sinus
<i>Bacterial meningitis</i>	320	Bacterial meningitis
Other complications		
<i>Depression</i>	296.2	Major depressive disorder, single episode
	296.3	Major depressive disorder, recurrent episode
	296.82	Atypical depressive disorder
	300.4	Dysthymic disorder
	301.12	Chronic depressive personality disorder
	309.0	Adjustment disorder with depressed mood
	309.1	Prolonged depressive reaction
	309.28	Adjustment disorder with mixed anxiety and depressed mood
	311	Depressive disorder, not elsewhere classified
<i>Headache and migraine</i>	346.0	Migraine with aura
	346.1	Migraine without aura
	346.2	Variants of migraine, not elsewhere classified
	346.3	Hemiplegic migraine
	346.5	Persistent migraine aura without cerebral infarction
	346.7	Chronic migraine without aura
	346.8	Other forms of migraine
	346.9	Migraine, unspecified
	784.0	Headache
	339.1	Tension type headache
<i>Low back pain^a</i>	721.3	Lumbosacral spondylosis without myelopathy
	722.10, 722.32, 722.52, 722.93	Intervertebral disc disorders of the lumbar and sacral region
	724.02	Spinal stenosis of the lumbar region
	724.2	Lumbago
	724.3	Sciatica
	724.5	Backache unspecified
	724.6	Disorders of sacrum
	724.7	Disorders of coccyx
	739.3, 739.4	Osteopathies, chondropathies, and acquired musculoskeletal deformities of the lumbar and sacral region
	846, 847.2	Sprains and strains of sacroiliac and lumbar region

^a Adapted from Shafrin J et al. Inquiry. 2017;54:1-9 and the National Quality Forum-endorsed low back pain measure (NQF # 0052)

SDC-Table 3: Other ICD-9-CM definitions

Conditions	Diagnosis codes	Procedure codes
Obesity	278.0, 649.1, V85.3, V85.4	-
Multiple gestation	V27.2-V27.7, 651	-
Induction of labor		
Medical induction	-	73.4
By artificial rupture of membranes	-	73.01
By cervical dilatation	-	73.1
Indications for emergent cesarean delivery		
Abnormality in FHR	763.81, 763.82, 659.7	-
Abruptio placenta	641.2, 762.1	-
Uterine rupture	665.0, 665.1	-
Cord prolapse	663.0	-
Placenta praevia with hemorrhage	641.1	-

SDC-Table 4: Imputation of missing values. Imputations used the R package mice (Multivariate Imputation by Chained Equations) with 5 iterations and five imputed datasets created.

Variables with missing value	Number of missing values
Race or ethnicity	20,346
Elective admission	3165
Hospital location (CBSA type)	4639
Hospital teaching status	4639
Neonatal level-of-care designation	169,537
Percent minority women in deliveries	125
Variables without missing value used in the predictor matrix	
Exposure	
Post-dural puncture headache	
Outcomes	
Cerebral venous thrombosis and non-traumatic subdural hematoma	
Bacterial meningitis.	
Depression	
Headache and migraine	
Low back pain	
Patient-level characteristics	
Age	
Insurance status	
Admission during a weekend	
Comorbidity index for obstetric patients ≥ 2	
Charlson comorbidity index ≥ 1	
Obesity	
Multiple gestation	
Induction of labor	
Delivery mode	
Hospital-level characteristics	
Hospital identifier	
Annual volume of delivery	
Cesarean delivery rate	
Percent admission during weekend	
Percent neuraxial anesthesia in deliveries	
Percent women with comorbidity index for obstetric patients ≥ 2 in deliveries	
Percent women with Charlson comorbidity index ≥ 1 in deliveries	
Percent Medicaid/care beneficiaries in deliveries	
Intensity of coding	
Miscellaneous predictors	
Year of delivery	

SDC-Table 5: Variables included in the mixed-effect model to calculate the individual probability of post-dural puncture headache (propensity score). The C-index of the model is 0.680 (95% CI, 0.672-0.687).

Random effect
Hospital identifier (random intercept and constant slope)
Fixed effects
1. Patient-level characteristics
Age
Race/ethnicity
Insurance status
Elective admission
Admission during a weekend
Comorbidity index for obstetric patients ≥ 2
Charlson comorbidity index ≥ 1
Obesity
Multiple gestation
Induction of labor
Delivery mode
2. Hospital-level characteristics
Hospital location (CBSA type)
Hospital teaching status
Neonatal level-of-care designation
Annual volume of delivery
Cesarean delivery rate
Percent admission during a weekend
Percent neuraxial anesthesia in deliveries
Percent women with comorbidity index for obstetric patients ≥ 2 in deliveries
Percent women with Charlson comorbidity index ≥ 1 in deliveries
Percent minority women in deliveries
Percent Medicaid/care beneficiaries in deliveries
Intensity of coding
3. Other characteristics
Year of delivery

SDC-Table 6: Maternal complications in women with and without post-dural puncture headache (PDPH) in the 1,003,803 women who received neuraxial anesthesia during labor and delivery in the State Inpatient Database for New York, January 2005-September 2014: Sensitivity analyses with identification of maternal complications during readmissions limited to the first and second diagnosis codes.

	No PDPH (N = 998,995)		PDPH (N = 4808)		P-value ^a	Crude OR (95% CI)	Adjusted OR ^b (95% CI)	P-value ^c
	N	Incidence per 1000 (95% CI)	N	Incidence per 1000 (95% CI)				
Major neurologic complications								
Stroke and non-traumatic extra- or subdural hematoma	132	0.13 (0.11-0.16)	12	2.50 (1.29-4.36)	< 0.001	18.93 (10.48-34.21)	19.04 (10.57-34.29)	< 0.001
Bacterial meningitis	20	0.02 (0.01-0.03)	- ^d	≈ 0.83(0.23-2.13)	< 0.001	41.59 (14.21-121.72)	41.68 (14.25-121.90)	< 0.001
Other complications								
Depression	2150	2.15 (2.06-2.24)	20	4.16 (2.54-6.42)	0.005	1.94 (1.25-3.01)	1.71 (1.11-2.64)	0.015
Headache and migraine	2461	2.46 (2.37-2.56)	120	24.96 (20.74-29.77)	< 0.001	10.37 (8.61-12.48)	9.36 (7.77-11.28)	< 0.001
Low back pain	1127	1.13 (1.06-1.20)	26	5.41 (3.54-7.91)	< 0.001	4.81 (3.26-7.11)	4.43 (3.00-6.56)	< 0.001

Abbreviations: CI: confidence interval; N: number; OR: odds ratio

^a From Chi-square test. The threshold for statistical significance is 0.01.

^b Using the inverse probability of treatment method

^c From Wald test for the adjusted odds ratio. The threshold for statistical significance is 0.01.

^d Because of HCUP data use agreement restrictions on small cell size, the number of observed cases and exact proportions are not presented.

SDC-Table 7: Maternal complications in women with and without post-dural puncture headache (PDPH) in the 1,003,803 women who received neuraxial anesthesia during labor and delivery in the State Inpatient Database for New York, January 2005-September 2014: Sensitivity analysis with limitation of the follow-up to 3 months post-delivery.

	No PDPH (N = 999050)		PDPH (N = 4753)		P-value ^a	Crude OR (95% CI)	Adjusted OR ^b (95% CI)	P-value ^c
	N	Incidence per 1000 (95% CI)	N	Incidence per 1000 (95% CI)				
Major neurologic complications								
Cerebral venous thrombosis and non-traumatic subdural hematoma	156	0.16 (0.13-0.18)	15	3.16 (1.77-5.20)	< 0.001	20.27 (11.92-34.46)	20.21 (11.92-34.25)	< 0.001
Bacterial meningitis	- ^d	≈ 0.01 (0.00-0.02)	- ^d	≈ 0.63 (0.13-1.84)	< 0.001	78.87 (20.92-297.39)	79.47 (20.87-302.53)	< 0.001
Other complications								
Depression	1815	1.82 (1.73-1.90)	26	5.47 (3.58-8.00)	< 0.001	3.02 (2.05-4.46)	2.66 (1.81-3.89)	< 0.001
Headache and migraine	2750	2.75 (2.65-2.86)	125	26.30 (21.94-31.26)	< 0.001	9.79 (8.16-11.73)	8.77 (7.31-10.53)	< 0.001
Low back pain	1031	1.03 (0.97-1.10)	30	6.31 (4.26-9.00)	< 0.001	6.15 (4.27-8.85)	5.67 (3.93-8.19)	< 0.001

Abbreviations: CI: confidence interval; N: number; OR: odds ratio

^a From Chi-square test. The threshold for statistical significance is 0.01.

^b Using the inverse probability of treatment method

^c From Wald test for the adjusted odds ratio. The threshold for statistical significance is 0.01.

^d Because of HCUP data use agreement restrictions on small cell size, the number of observed cases and exact proportions are not presented.

SDC-Table 8: Comparison of women with and without neuraxial anesthesia during labor and vaginal delivery in the State Inpatient Database for New York, January 2005-September 2014

	Vaginal delivery without neuraxial (N = 530,500)	Vaginal delivery With neuraxial (N = 416,797)	P-value ^a
Patient characteristics			
Age (year)	28 (23-32)	29 (24-33)	< 0.001
Race/ethnicity (missing = 21,786)			< 0.001
- White	252,161 (48.8%)	246,293 (60.2%)	
- Black	81,281 (15.7%)	48,801 (11.9%)	
- Hispanic	97,547 (18.9%)	56,243 (13.7%)	
- Other	85,285 (16.5%)	57,900 (14.1%)	
Insurance			< 0.001
- Medicare and Medicaid	264,119 (49.8%)	153,631 (36.9%)	
- Private insurance	237,834 (44.8%)	248,800 (59.7%)	
- Self-pay	16,375 (3.1%)	4713 (1.1%)	
- Other	12,172 (2.3%)	9653 (2.3%)	
Hospital admission			
Elective admission (missing = 3116)	277,266 (52.4%)	260,820 (62.8%)	< 0.001
Admission during weekend	123,848 (23.3%)	94,094 (22.6%)	< 0.001
Comorbidity and comorbidity indexes			
Comorbidity index for obstetric patients ≥ 2	70,495 (13.3%)	66,318 (15.9%)	< 0.001
Charlson comorbidity index ≥ 1	19,021 (3.6%)	20,070 (4.8%)	< 0.001
Obesity	8907 (1.7%)	9864 (2.4%)	< 0.001
Pregnancy and delivery			
Multiple gestation	3395 (0.6%)	3964 (0.1%)	< 0.001
Induction of labor	86,961 (16.4%)	94,879 (22.8%)	< 0.001
Hospital			
Hospital location (missing = 2769)			< 0.001
Core metropolitan division	359,188 (67.7%)	256,373 (61.9%)	
Core metropolitan	131,262 (24.8%)	146,256 (35.3%)	
Core micropolitan	34,144 (6.4%)	10,953 (2.6%)	
Non-core	5722 (1.1%)	630 (0.2%)	
Teaching hospital (missing = 2769)	515,469 (97.2%)	404,681 (97.7%)	< 0.001
Neonatal level-of-care designation (missing = 158,543)			< 0.001
- 1	102,163 (23.3%)	75,170 (21.5%)	
- 2	108,344 (24.7%)	41,926 (12.0%)	
- 3	228,357 (52.0%)	232,794 (66.5%)	

SDC-Table 8 (continued)

	Vaginal delivery without neuraxial (N = 530,500)	Vaginal delivery With neuraxial (N = 416,797)	P-value ^a
Hospital			
Annual volume of delivery	2386 (1545-3858)	2753 (1745-4258)	< 0.001
Cesarean delivery rate	33.0 (28.9-38.5)	33.8 (29.6-39.1)	< 0.001
Percent admission during a weekend	20.7 (18.7-21.8)	20.2 (18.4-21.6)	< 0.001
Percent neuraxial anesthesia in deliveries	18.0 (0.0-44.8)	74.4 (59.3-85.4)	< 0.001
Percent comorbidity index for obstetric patients ≥ 2 in deliveries	20.6 (17.0-25.0)	24.0 (18.8-28.3)	< 0.001
Percent Charlson comorbidity index ≥ 1 in deliveries	3.4 (2.0-5.2)	4.5 (2.5-7.1)	< 0.001
Percent minority women in deliveries (missing = 319)	41.4 (27.3-81.6)	37.2 (29.0-54.1)	< 0.001
Percent Medicaid/care in deliveries	44.8 (29.2-66.3)	33.2 (18.8-50.7)	< 0.001
Intensity of coding	6.6 (5.7-7.7)	7.0 (6.1-8.6)	< 0.001

Results are expressed as count (%) or median (IQR).

^a Comparisons used Chi-squared test and Wilcoxon rank-sum test with a P value threshold for statistical significance of 0.05.

SDC-Table 9: Maternal complications in women with and without neuraxial anesthesia during labor and vaginal delivery in the State Inpatient Database for New York, January 2005-September 2014.

	Vaginal delivery without neuraxial anesthesia (N = 530,500)		Vaginal delivery with neuraxial anesthesia (N = 416,797)		P-value ^a	Crude OR (95% CI)	Adjusted OR ^b (95% CI)	P-value ^c
	N	Incidence (per 1000; 95% CI)	N	Incidence (per 1000; 95% CI)				
Major neurologic complications								
Cerebral venous thrombosis and non-traumatic subdural hematoma	49	0.09 (0.07-0.12)	64	0.15 (0.12-0.20)	0.009	1.66 (1.15-2.41)	1.69 (1.13-2.53)	0.011
Bacterial meningitis	- ^d	≈ 0.02 (0.01-0.03)	14	0.03 (0.02-0.06)	0.156	1.98 (0.86-4.57)	2.34 (0.96-5.73)	0.063
Other complications								
Depression	1757	3.31 (3.16-3.47)	1240	2.98 (2.81-3.15)	0.004	0.90 (0.83-0.97)	0.99 (0.89-1.09)	0.769
Headache and migraine	1160	2.19 (2.06-2.32)	1283	3.08 (2.91-3.25)	< 0.001	1.41 (1.30-1.53)	1.37 (1.23-1.52)	< 0.001
Low back pain	617	1.16 (1.07-1.26)	775	1.86 (1.73-1.99)	< 0.001	1.60 (1.44-1.78)	1.64 (1.42-1.88)	< 0.001

Abbreviations: CI: confidence interval; N: number; OR: odds ratio

^a From Chi-square test. The threshold for statistical significance is 0.01.

^b Using the inverse probability of treatment method. The C-index of the mixed-effect model used to calculate the individual probability of receiving neuraxial anesthesia (propensity score) model is 0.912 (95% CI, 0.911-0.913).

^c From Wald test for the adjusted odds ratio. The threshold for statistical significance is 0.01.

^d Because of HCUP data use agreement restrictions on small cell size, the number of observed cases and exact proportions are not presented.