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1. Woolf SH, Chapman DA, Sabo RT, Weinberger DM, Hill L, Taylor DDH. Excess deaths from COVID-19 and other causes, March-July 2020. *JAMA*. 2020;324(15):1562-1564. doi:[10.1001/jama.2020.19545](https://doi.org/10.1001/jama.2020.19545)

2. Cunningham JW, Vaduganathan M, Claggett BL, et al. Clinical outcomes in young US adults hospitalized with COVID-19. *JAMA Intern Med*. Published online September 9, 2020. doi:[10.1001/jamainternmed.2020.5313](https://doi.org/10.1001/jamainternmed.2020.5313)

3. Centers for Disease Control and Prevention. Underlying cause of death, 1999-2018. Accessed October 28, 2020. <https://wonder.cdc.gov/ucd-icd10.html>

4. Centers for Disease Control and Prevention. Monthly provisional counts of deaths by age group and HHS region for select causes of death. Accessed October 28, 2020. <https://data.cdc.gov/NCHS/Monthly-provisional-counts-of-deaths-by-age-group-/ezfr-g6hf>

COMMENT & RESPONSE

Risk of Spinal Hematoma After Lumbar Puncture

To the Editor The recently published article by Dr Bodilsen and colleagues reported the association between lumbar puncture and spinal hematoma in patients with coagulopathy.¹ When interpreting their results, some issues should be con-

sidered. First, this study defined spinal hematoma based on diagnosis codes regarding spinal hematoma-related symptoms or treatments. The diagnosis of spinal hematoma should be based on neuroimaging data, including magnetic resonance imaging and computed tomographic scan results² since diagnosis codes without regard to neuroimaging data may cause a misdiagnosis of spinal hematoma. Second, the location of lumbar puncture-related spinal hematoma was not mentioned in this article. The location of spinal hematoma (eg, lumbar, cervical, thoracic, epidural, intradural, subarachnoid) may affect the outcome of spinal hematoma² so should have been included in this study. Third, because differentiating traumatic spinal tap from subarachnoid hemorrhage can be difficult in clinical practice,³ the authors should have more clearly stated how these conditions were distinguished. Fourth, this article did not include cases with failed attempts of lumbar puncture. Among patients with successful lumbar puncture, some may have to undergo multiple attempts, which can be associated with higher risk of lumbar puncture-related injury. Fifth, although not mentioned in this study, in clinical practice, some patients may have more than 1 coagulation disorder, such as thrombocytopenia and an increased international normalized ratio, which may increase their risk of spinal hematoma.

In summary, while this study can aid in decision-making, the safety of lumbar puncture in patients with coagulopathy deserves further investigation via prospective studies and clinical trials.

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1. Bodilsen J, Mariager T, Vestergaard HH, et al. Association of lumbar puncture with spinal hematoma in patients with and without coagulopathy. *JAMA*. 2020;324(14):1419-1428. doi:[10.1001/jama.2020.14895](https://doi.org/10.1001/jama.2020.14895)

2. Kreppel D, Antoniadis G, Seeling W. Spinal hematoma: a literature survey with meta-analysis of 613 patients. *Neurosurg Rev*. 2003;26(1):1-49. doi:[10.1007/s10143-002-0224-y](https://doi.org/10.1007/s10143-002-0224-y)

3. Perry JJ, Alyahya B, Sivilotti ML, et al. Differentiation between traumatic tap and aneurysmal subarachnoid hemorrhage: prospective cohort study. *BMJ*. 2015;350:h568. doi:[10.1136/bmj.h568](https://doi.org/10.1136/bmj.h568)

To the Editor Dr Bodilsen and colleagues showed very low rates of spinal hematoma in patients both with and without coagulopathy in their large patient cohort.¹ In a subgroup analysis of 1694 lumbar punctures among 1237 patients, the authors reported that the median needle size was 22 gauge (interquartile range, 22-22), and listed the number of procedures performed with traumatic vs atraumatic needles. Needle size and the use of atraumatic pencil-point needles have been previously shown to modulate the risk of other post-lumbar puncture complications; the use of smaller, atraumatic needles reduces the risk of complications such as postdural puncture

headache.² In a recent series of more than 800 lumbar punctures performed with 25-gauge pencil-point atraumatic needles, we observed no spinal hematomas and a postdural puncture headache rate of less than 1%.³ Therefore, it would be interesting to know if needle gauge and type were independently associated with spinal hematoma in this study's larger cohort of 83 711 lumbar punctures. In addition, because the use of larger or traumatic needles might be expected to cause more bleeding in patients with coagulopathy, it would be important to know if there was an interaction between needle gauge or needle type and coagulopathy in modulating the risk of spinal hematoma in this study cohort.

Although the low spinal hematoma rates reported in this study should be reassuring to both patients undergoing and physicians performing lumbar punctures, we suggest that lumbar punctures in patients with coagulopathy should be performed with the smallest-gauge atraumatic needle possible.

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1. Bodilsen J, Mariager T, Vestergaard HH, et al. Association of lumbar puncture with spinal hematoma in patients with and without coagulopathy. *JAMA*. 2020;324(14):1419-1428. doi:10.1001/jama.2020.14895
2. Monserrate AE, Ryman DC, Ma S, et al; Dominantly Inherited Alzheimer Network. Factors associated with the onset and persistence of post-lumbar puncture headache. *JAMA Neurol*. 2015;72(3):325-332. doi:10.1001/jamaneurol.2014.3974
3. Nobuhara CK, Bullock WM, Bunning T, et al; MADCO-PC and INTUIT Investigators Teams. A protocol to reduce self-reported pain scores and adverse events following lumbar punctures in older adults. *J Neurol*. 2020;267(7):2002-2006. doi:10.1007/s00415-020-09797-1

In Reply Dr Xu and colleagues raise several interesting questions about our study.¹ First, they correctly point out that neuroimaging is the gold standard for the diagnosis of spinal hematoma and suggest that we may have missed some asymptomatic cases. However, neuroimaging data were unavailable for the registry-based part of the study, and we focused on clinically meaningful end points of neurological deficits requiring hospitalization. Reassuringly, in a medical record review of all lumbar punctures performed in patients with coagulopathy in the North Denmark Region during a 20-year period, we confirmed the very low absolute risk observed in the registry-based study, suggesting that any potential misclassification likely resulted in an overestimation of risk. Second, the anatomical location of spinal hematoma was unknown in the registry-based part of the study since we relied on diagnosis codes for their detection. Third, we are unaware of an official definition

of traumatic spinal tap,² and the red blood cell count thresholds in cerebrospinal fluid have ranged from more than $10 \times 10^6/L$ to more than $1000 \times 10^6/L$ in previous studies.³⁻⁵ In spite of the relatively low red blood cell count cutoff used in our study, the 28% with traumatic spinal tap was comparable with some studies^{2,6} but was higher than one study using a more refined definition.³ As described in the Methods section, we excluded patients with a diagnosis code of subarachnoid hemorrhage within 14 days of lumbar puncture without any changes in the results. Fourth, data on the number of attempts for successful lumbar puncture were restricted to medical record review; as mentioned in the Supplement, only 1 case of spinal hematoma was diagnosed in a patient with severe thrombocytopenia after multiple lumbar puncture attempts. Fifth, cross-tabulation of platelet levels and international normalized ratio are available in eTable 5 in the Supplement.

Ms Nobuhara and Dr Berger highlight 2 important aspects regarding risk of adverse events after lumbar puncture: needle size and type, traumatic vs atraumatic. Unfortunately, these data were unavailable in the registry-based part of our study. Although we agree that the smallest-gauge atraumatic needle should always be used whenever possible, our data do not support a strong recommendation for this concerning risk of spinal hematoma given the very low incidence of this complication, regardless of needle type, observed by medical record review.

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Conflict of Interest Disclosures: None reported.

1. Bodilsen J, Mariager T, Vestergaard HH, et al. Association of lumbar puncture with spinal hematoma in patients with and without coagulopathy. *JAMA*. 2020;324(14):1419-1428. doi:10.1001/jama.2020.14895
2. Perry JJ, Alyahya B, Sivillotti MLA, et al. Differentiation between traumatic tap and aneurysmal subarachnoid hemorrhage: prospective cohort study. *BMJ*. 2015;350:h568. doi:10.1136/bmj.h568
3. Lee PW, Levy M. Risk of hematoma from aspirin or clopidogrel owing to lumbar puncture. *Mayo Clin Proc*. 2019;94(8):1552-1555. doi:10.1016/j.mayocp.2019.05.018
4. Howard SC, Gajjar A, Ribeiro RC, et al. Safety of lumbar puncture for children with acute lymphoblastic leukemia and thrombocytopenia. *JAMA*. 2000;284(17):2222-2224. doi:10.1001/jama.284.17.2222
5. Eskey CJ, Ogilvy CS. Fluoroscopy-guided lumbar puncture: decreased frequency of traumatic tap and implications for the assessment of CT-negative acute subarachnoid hemorrhage. *AJNR Am J Neuroradiol*. 2001;22(3):571-576.
6. Marton KI, Gean AD. The spinal tap: a new look at an old test. *Ann Intern Med*. 1986;104(6):840-848. doi:10.7326/0003-4819-104-6-840

The Effect of Surgical Treatment on Obstructive Sleep Apnea

To the Editor The recent trial by Dr MacKay and colleagues,¹ undertaken in a cohort of patients with sleep apnea, supported previous research that uvulopalatopharyngoplasty, with or without other surgical procedures, produces some benefits to patients.² However, we have concerns not addressed by this