An Externally Validated Algorithm for Prediction of In-Hospital and Ninety-Day Mortality after Spinal Epidural Abscess

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INTRODUCTION:
Despite advances in diagnosis and treatment, mortality rates remain unacceptably high for patients with spinal epidural abscess (SEA). Accurate prediction of mortality risk in patients with SEA may influence management and post-discharge surveillance to reduce the risk of short-term mortality and long-term mortality. The SORG Orthopaedic Research Group previously developed machine learning algorithms for preoperative prediction of short-term mortality in patients with SEA. With a contemporary independent cohort of patients, we aim to evaluate the performance of this algorithm and the assess its external validity for prediction of in-hospital and ninety-day mortality.
METHODS:
Adult patients diagnosed with SEA at a tertiary care academic medical center between 2003-2020 were included. Patients with SEA treated at an outside institution were not included in this analysis. The primary outcome was mortality within index admission or within 90 days of discharge. The SORG algorithm for short-term mortality in SEA was tested on the external validation cohort. Discrimination of the algorithm on the validation cohort was assessed with the area under the receiver operating characteristic curve (AUROC). Calibration was assessed with calibration slope, calibration intercept, and Brier score. Additionally, decision curve analysis was performed.
RESULTS:
A total of 212 patients were included in the validation cohort. The median age was 61.6 years, and the majority of patients were male (61.3%). Sixty-one cases (28.8%) occurred in 2017 or after. Most patients (58.0%) were treated nonsurgically. There were 36 cases (17.0%) of in-hospital or 90-day mortality with a median time to death of 41.5 days. Cohort demographics are outlined in Table 1. The SORG stochastic gradient boosting algorithm for in-hospital and ninety-day mortality performed excellently on the validation cohort with AUROC of 0.82 (Figure 1). The algorithm was well-calibrated with a calibration slope of 0.96, calibration intercept of -0.08, and Brier score of 0.09. The SORG algorithm showed greater net benefit than the default strategy of changing management for no patients or for all patients, resulting in a greater balance of true positives than false positives.
DISCUSSION AND CONCLUSION:
With a contemporary, geographically distinct cohort, we report successful external validation of the SORG algorithm for short-term mortality in patients with SEA. This model has excellent discrimination and is well-calibrated when tested on an independent cohort. By providing accurate prediction of short-term mortality risk, the externally validated SORG algorithm may improve patient counseling. Additionally, use of this tool may alert clinicians to high-risk patients, influencing management and post-discharge surveillance to reduce risk of short-term mortality for SEA. To facilitate use of this algorithm, the open-access SORG algorithm is available in a web interface: https://sorg-apps.shinyapps.io/seamortality/. Future studies with multi-institutional and international validation are necessary.

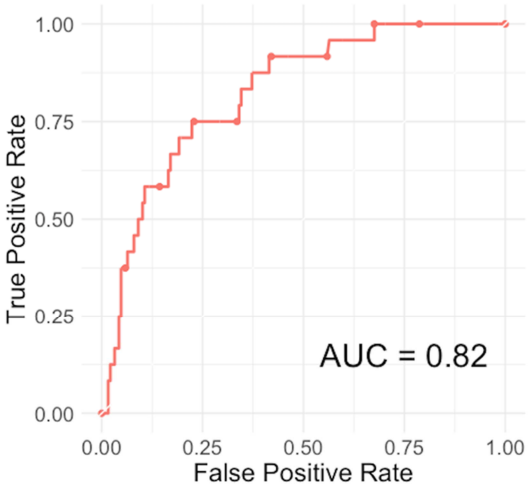

Table 1. Cohort characteristics and outcomes

Variable	All Patients (n = 212)
	Median (IQR)
Age (years)	61.6 (52.8, 73.4)
Pre-operative white blood cell count (10^9/L)	10.6 (7.4, 14.2)
Pre-operative albumin† (g/dL)	3 (2.5, 3.4)
Pre-operative platelet count (10^9/L)	285.5 (197.8, 378)
Neutrophil-to-lymphocyte ratio	6 (4, 11.8)
Number of vertebral levels involved	2 (2, 4)
	Number (%)
Non-operative management	123 (58.0)
Female	82 (38.7)
Medical comorbidities	
Diabetes mellitus	38 (17.9)
Malignancy	13 (6.1)
Dialysis dependence	10 (4.7)
Ninety-day or in-hospital mortality	22 (10.4)
Ninety-day mortality	21
In-hospital mortality	10
	Median (IQR)
Time to death (days)	41.5 (30, 52.8)

IQR = Interquartile range; g = gram; mL = milliliter; dL = deciliter
† Serum albumin, neutrophil-to-lymphocyte ratio had missing values imputed