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LETTER

Methodological Considerations for CAUTI Risk Prediction in Stroke Patients [Letter]

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Dear editor

We read with great interest the recently published article by Lu et al,[1] which systematically investigated risk factors for catheter-associated urinary tract infections (CAUTI) in stroke patients and subsequently developed a predictive model utilizing a random forest algorithm The authors are to be highly commended for their rigorous analysis of a large retrospective cohort comprising 7486 patients with indwelling catheters. By identifying key predictors such as age, duration of catheterization (DaysCAU), and time from admission to catheterization (TTCAU), and achieving a commendable area under the curve (AUC) of 0.778 in the validation cohort, the authors have developed a practical nomogram that facilitates early risk assessment. To further enhance the methodological robustness, precision, and systemic impact of such predictive tools, we respectfully offer several methodological perspectives.

The foremost issue pertains to potential unmeasured confounding and confounding by indication, stemming primarily from the unaddressed heterogeneity of stroke. Although the authors collected foundational data, critical variables such as baseline neurological severity (eg, National Institutes of Health Stroke Scale [NIHSS] or Glasgow Coma Scale [GCS]), and the presence of aphasia, sensory deficits, or impaired consciousness were omitted. These factors significantly dictate a patient's physiological dependence on an indwelling catheter and their ability to express early lower urinary tract discomfort. More importantly, stroke frequently induces neurogenic lower urinary tract dysfunction (NLUTD), which significantly alters post-void residual (PVR) volume; when the average PVR exceeds 100 mL, the rate of urinary tract infections increases significantly.[2] We sincerely recommend that future iterations of this machine learning model incorporate these specific neurological and urodynamic covariates, which would markedly enhance both the explanatory power and the clinical interpretability of the model.

Secondly, one concern is the methodological handling of catheterization duration (DaysCAU). The authors defined this variable as the cumulative number of days with a catheter prior to infection. By definition, this renders it a post-baseline, time-varying exposure; it is inherently a time-dependent longitudinal event rather than a baseline characteristic available to physicians when making initial clinical decisions. Because patients must survive, remain hospitalized, and stay CAUTI-free to accumulate more catheter days, incorporating this as a fixed variable in a standard logistic regression inevitably introduces immortal-time bias. Furthermore, if the model's strongest predictor is a cumulative total that only becomes definitively quantifiable as the hospitalization progresses, designating it as a tool for "early" identification upon admission or catheter insertion is somewhat paradoxical, thereby limiting its clinical generalizability. Introducing catheter duration as a time-varying covariate within a Cox proportional hazards model would align the analysis much more closely with the actual clinical scenario.[3]

Finally, the conclusion that CAUTI significantly prolongs length of stay (LOS) and increases hospitalization costs should be interpreted with caution. In the current analysis, unadjusted intergroup comparisons were used to contrast LOS and costs between patients with and without CAUTI. However, patients with a longer LOS inherently have a more extended period of catheterization and, consequently, greater opportunities to develop CAUTI. Similarly, patients with more severe baseline illness are likely to incur higher medical costs from the outset and are concurrently more

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susceptible to infections. Given that the paper explicitly characterizes CAUTI as a factor impacting "healthcare quality", clarifying this distinction is of paramount importance. Employing methodologies such as multi-state models or time-varying exposure modeling can more adequately address the temporal nature of CAUTI occurring during the hospital stay and substantially mitigate time-dependent bias.[4]

In conclusion, Lu et al provide valuable insights into an under-researched area. Addressing these epidemiological considerations—specifically, integrating indicators of stroke severity, utilizing time-varying exposure models, and resolving potential reverse causation in LOS—will vastly elevate the rigor and applicability of future CAUTI predictive models.

Artificial Intelligence Statement

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