Table 2. Predictors of Complicated Appendicitis on Logistic Regression Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate &gt;90 beats/min</td>
<td>2.2 (1.7-2.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Neutrophil count &gt;85%</td>
<td>2.3 (1.8-3.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Duration of pain &gt;48 h</td>
<td>2.7 (2.1-3.6)</td>
<td>.002</td>
</tr>
<tr>
<td>Serum sodium &lt;135 mEq/L</td>
<td>2.8 (2.1-3.8)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

SI conversion factor: To convert sodium to millimoles per liter, multiply by 1.0.

Discussion Complicated appendicitis is associated with poor outcomes, and its early identification may have implications for patient management, specifically with regard to the timing of operative intervention and the appropriateness of nonoperative management strategies. The finding of hyponatremia at admission may help distinguish necrotizing soft-tissue infections from nonnecrotizing soft-tissue infections and is a known risk factor for mortality among patients presenting with necrotizing soft-tissue infections. Hyponatremia at admission is also predictive of gangrenous cholecystitis and, more recently, has been associated with perforated colonic pathology among elderly patients who underwent emergency general surgery.

The etiology for hyponatremia in patients with advanced surgical infectious pathology, including complicated appendicitis, is unknown but is likely an antidiuretic hormone-mediated phenomenon. Whether the increase in antidiuretic hormones is appropriate or inappropriate, however, remains to be elucidated. Future investigations accounting for the clinical volume status and key determinants of serum sodium concentration are potentially warranted.

Our study is limited by its retrospective design and lack of data regarding the etiology of hyponatremia in patients with complicated appendicitis. Also, we did not examine all the variables potentially associated with complicated appendicitis; however, the main objective of our study was to analyze readily available and routinely ordered data used in the workup of adult patients with suspected acute appendicitis.

In the appropriate clinical context, hyponatremia in patients with acute appendicitis may be suggestive of complicated appendicitis. Prospective studies are required to confirm this finding and to determine the potential effect of an earlier operative intervention on outcomes.

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Preventability of Hospital-Acquired Venous Thromboembolism

Venous thromboembolism (VTE) is a common, largely preventable condition. The Agency for Healthcare Research and Quality reports that VTE prophylaxis is among the top-10 strongly suggested practices for improving patient safety. Although optimal VTE prevention requires both prescription and administration of prophylactic medications, to date, most attempts to improve care have focused predominantly on medication prescription.

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National bodies (eg, the Centers for Medicare and Medicaid Services Cost Review Commission) impose financial penalties for hospitalized patients developing VTE despite evidence that not all events are preventable, even with prophylaxis. Publicly reported measures from both The Joint Commission’s Core Measures and the Centers for Medicare and Medicaid Services’ Hospital Compare report whether a patient received at least 1 dose of VTE prophylaxis within the first day of hospitalization, rather than considering all prescribed and administered doses for the entire hospitalization.

Current measures for the quality of VTE care provide limited insights into the extent to which VTE is preventable. The specific aim of our study was to characterize the true preventability of VTE by identifying the proportion of patients with VTE who had received “defect-free care.”

**Methods** | We conducted a retrospective review of patients with hospital-acquired VTE identified by the Maryland Hospital Acquired Conditions pay-for-performance initiative at the Johns Hopkins Hospital for 1 year (July 2010–June 2011). Our study was approved by the institutional review board of the Johns Hopkins University School of Medicine under a waiver of consent. Data on patient risk assessment for VTE (using our mandatory computerized clinical decision support tool), prescription of risk-appropriate prophylaxis, and pharmacological prophylaxis administration were abstracted from the electronic health record.

Because catheter-associated deep vein thrombosis (DVT) is not preventable with prophylaxis, we excluded patients with upper extremity, catheter-associated DVT. The remaining patients were dichotomized by whether or not they received defect-free care, which is defined as receiving all doses of risk-appropriate VTE prophylaxis as recommended by our validated, mandatory computerized clinical decision support tool prior to VTE diagnosis. Suboptimal care was further classified as prescription failures or dose-administration failures. We counted patients with a documented contraindication to pharmacologic prophylaxis (n = 6) who were prescribed sequential compression devices as defect-free care. We compared characteristics between groups using a 2-sided χ² test, an unpaired t test, or the Wilcoxon rank sum test using Stata version 12.0 (StataCorp).

**Results** | A total of 128 patients had hospital-acquired VTE. Of these 128 patients, 36 (28%) had nonpreventable, catheter-related DVT, leaving 92 patients (72%) who experienced VTE events (45 had DVT only, 43 had a pulmonary embolism only, 4 had other types of VTE).
and 4 had both DVT and a pulmonary embolism) that were potentially preventable with prophylaxis (Table). Of the 92 patients who experienced VTE events, 79 (86%) were prescribed optimal prophylaxis, yet only 43 (47%) received defect-free care. Of the 49 patients (53%) who received suboptimal care, 13 (27%) were not prescribed risk-appropriate VTE prophylaxis, and 36 (73%) missed at least 1 dose of appropriately prescribed prophylaxis (Figure). There was no difference in suboptimal care patterns between surgical and medical patients.

Discussion | Our study identifies a need to dramatically reevaluate the VTE outcome and process measures. Half of VTE events identified in a state-run pay-for-performance program were not truly preventable because patients received best-practice prevention, and there was no real opportunity for improvement. Venous thromboembolism outcome measures should not include these patients as having “potentially preventable events.”

The overwhelming cause (73%) of inadequate VTE prophylaxis was patients missing at least 1 medication dose, which is associated with VTE events. Until recently, the importance of missed VTE prophylaxis doses has been underappreciated. Perhaps targeting missed doses will have a significant effect on VTE events.

The current The Joint Commission/Centers for Medicare and Medicaid Services sampling method was likely adopted to reduce the burden of data collection. Our study questions the validity of this approach, which misclassifies suboptimal care as high-quality care, misinforms the public, and may limit efforts by health care professionals to improve VTE prevention when they already score well on these misleading measures. To reduce preventable harm, policy makers need to improve the measures, and clinicians need to ensure that patients receive all prescribed preventative therapies. As electronic health records are adopted nationally, information technology will allow us to use more advanced clinical analytics to base VTE process measures on every dose of VTE prophylaxis for every hospitalized patient.

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quality of care), the National Institutes of Health (acute lung injury research), and the American Medical Association (research related to improving blood pressure control); honoraria from various health care organizations for speaking on quality and patient safety (the Leigh Bureau manages these engagements); book royalties from the Penguin Group; and stock and fees to serve as a director for Cantel Medical. Dr Pronovost is a founder of Patient Doctor Technologies, a startup company that seeks to enhance the partnership between patients and clinicians with an application called Doctella. No other disclosures are reported.


COMMENT & RESPONSE

Some Important Deficiencies in the Development, Validation, and Reporting of a Prediction Model

To the Editor We read with great interest the study by Tevis et al1 describing the development of a nomogram to predict the 30-day risk of readmission for patients following hospital discharge after general surgery. However, deficiencies in the methods and in the reporting limit the usefulness and usability of this study.

It is vital that prediction models, at a minimum, should be assessed and reported in terms of discrimination and calibration.2 While the authors evaluated the discrimination of the new model (using the C statistic), no assessment of calibration was reported. Calibration is the agreement between the model predictions and what was observed. Plotting the predictions against observed outcomes, overlaid with a smoothed regression line,3 allows for an assessment of miscalibration (ie, overprediction or underprediction) across the spectrum of predictions. Poor calibration substantially limits the usefulness of a model and may require a recalibration to try salvage the model.

Tevis et al1 presented a nomogram, presumably in order to facilitate the use of the model by others. It is important to note that a nomogram is not a prediction model but merely a graphical representation of the underlying model. A prediction model is the mathematical equation resulting from the regression analysis, namely the regression coefficients for all predictors and the intercept (the latter is disappointingly not reported). In the absence of a fully specified model, other investigators are unable to assess the model on other data (ie, an external validation) to evaluate the model in another setting.

While the authors carried out a model validation, the sample size falls substantially below the 100 outcome events that are widely recommended.4 The effective sample size of prediction model studies is not the total number of individuals but the number of individuals who experience the outcome event; only 24 of 255 patients were readmitted in the validation data set.5 We caution against presenting a new prediction model as a nomogram unless there is supportive evidence from a sufficiently large external validation.

The Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis (TRIPOD) initiative (http://www.tripod-statement.org) recently published the TRIPOD reporting guideline for clinical prediction models. The checklist is designed to help authors, peer reviewers, and journal editors in ensuring that the essential items describing the development or validation of a clinical prediction model are clearly reported.2,5 To ensure investigators developing or validation prediction models produce published reports that are useful to others, we strongly recommend adherence to the TRIPOD Statement.

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In Reply The letter by Cook and Collins focuses on the details of the nomogram equation and promotes the use of the Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis (TRIPOD) Statement developed by their group.6 We acknowledge that individuals with a background in statistics may be interested in details...