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The impact of Model for End-Stage Liver Disease-Na in predicting morbidity and mortality following elective colon cancer surgery irrespective of underlying liver disease

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Abstract

BACKGROUND: The Model for End-Stage Liver Disease Sodium Model (MELD-Na) is a validated scoring system that uses bilirubin, international normalized ratio, serum creatinine, and sodium to predict mortality in cirrhotic patients awaiting liver transplantation. The aim of this study was to identify the utility of MELD-Na to predict patient outcomes, with and without liver disease, after elective colon cancer surgery.

METHODS: A review of the American College of Surgeons National Surgical Quality Improvement Program database (2005 to 2010) was conducted to calculate risk-adjusted 30-day outcomes using regression modeling.

RESULTS: A total of 10,842 patients (mean age, 68 years; 51% women) were included. MELD-Na scores were higher in men (10.2 vs 9.1, $P < .001$) and in open procedures (9.9 vs 9.1, $P < .001$). The overall complication and mortality rates were 26.3% and 3.3%, respectively. Incremental increases in MELD-Na score correlated with a 1.2% increase in mortality and a 1.1% increase in complications. On multivariate analysis, complications increased with MELD-Na score (odds ratio [OR], 1.05 per 1 point increase; 95% confidence interval [CI], 1.038 to 1.066). MELD-Na score was also associated with increased mortality (OR, 1.13; 95% CI, 1.1 to 1.16), along with ascites (OR, 5.7; 95% CI, 3.7 to 8.8) and corticosteroids (OR, 2.1; 95% CI, 1.3 to 3.3).

The investigators have adhered to the policies for the protection of human subjects as prescribed in 45 CFR 46. The views expressed are those of the authors and do not reflect the official policy of the US Department of the Army, the US Department of Defense, or the US government. This report has been approved by the Madigan Army Medical Center Human Use Institutional Review Board. The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in it are the sources of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

The authors declare no conflicts of interest.

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CONCLUSIONS: Elevated preoperative MELD-Na score is significantly associated with worse outcomes after elective resection for colon cancer.
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The medical community has attempted to quantify surgical risk for decades, resulting in a wide array of configurations that encompass several different variables.[1–3] The most common risk stratification tests use patient preoperative comorbidities, physiologic laboratory data, or a combination of both.[4–6] No more is this more apparent than in transplantation surgery, in which risk assessment plays a major role in the selection of organ recipients. Yet a major limitation of many of these assessment methods involved the inclusion of subjective measures, which led to the adoption of a more standardized approach and use of newer risk adjustment tools.

The Model for End-Stage Liver Disease (MELD) was developed and validated originally as an accurate predictor of survival in patients with chronic liver disease.[7,8] The success achieved with this method led to a broader application of MELD in predicting operative mortality for cirrhotic patients undergoing various surgical procedures as a more generalized risk assessment tool.[9–12] Current evidence demonstrates that a revised MELD formula incorporating serum sodium is superior compared with the original model, especially in those patients with lower MELD scores.[13] One advantage of the MELD Sodium Model (MELD-Na) scoring system is that it uses the readily available laboratory values of bilirubin, international normalized ratio (INR), serum creatinine, and serum sodium.[13–15] Because of the simplicity of the scoring system and success in other settings, we sought to study the effectiveness of MELD-Na in predicting postoperative adverse outcomes after elective colon cancer surgery.

Methods

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database (2005 to 2010) was used to calculate risk-adjusted 30-day outcomes using regression modeling, accounting for patient demographics, comorbidities, and surgical procedures. The ACS-NSQIP database gathers information on health care quality through a compilation of preoperative risk factors, intraoperative factors, and postoperative 30-day morbidity and mortality in patients who undergo major surgical procedures.[16] The data are collected by a dedicated surgical clinical nurse reviewer at each site after both inpatient and outpatient procedures for 30 days postoperatively on 21 defined complications.[17] Data in the ACS-NSQIP database are deidentified to ensure no patient identifiable factors. The Madigan Healthcare System Institutional Review Board approved this study. Specific details of the data collection, inclusion and exclusion criteria, training of the actuaries, and the method of random sampling are described by the ACS-NSQIP.[17]

Patients were identified using Current Procedural Terminology codes for colectomy (44140, 44141, 44134, 44144, 44145, 44146, 44150, 44155, 44160, 44202, 44204, 44205, 44207, 44210, 44211, 44212, 45110, and 45123) and International Classification of Diseases, Ninth Revision, codes for colonic malignancy (230.3, 230.4, 230.5, 153.0, 153.1, 153.19, 153.2, 153.3, 153.4, 153.5, 153.7, 153.6, 153.69, 153.8, 153.9, 154.0, 154.19, 154.1, 154.2, 154.3, and 154.8). Only elective cases were included. Suspected liver disease was defined as patients with >2 drinks per day, esophageal varices, or ascites. Operative procedures were categorized into 4 separate categories: open partial colectomy, total abdominal colectomy, laparoscopic partial colectomy, and laparoscopic total abdominal colectomy. To calculate the MELD-Na score, we initially determined the MELD score using the following methodology: MELD score = $3.8 \times [\log (e)\ (\text{bilirubin mg/dL})] + 11.2 \times [\log (e)\ (\text{INR})] + 9.6 \times [\log (e)\ (\text{creatinine mg/dL})] + 6.43$, with a lower limit of 1 for all variables and with creatinine capped at 4; creatinine was set at 4 if the patient was receiving renal replacement therapy. The MELD score (rounded to the nearest integer) ranges from 6 to 40, with higher values indicating more severe disease. This was then applied to the MELD-Na equation (MELD-Na score = MELD score − Na − $\{0.025 \times$ MELD score $\times [140 - \text{Na}]\} + 140$), where the serum sodium concentration (Na) is bound between 125 and 140 mmol/L. Like the MELD score, the MELD-Na score was rounded to the nearest integer.

A receiver operating characteristic curve was used to determine the optimal cutoff point for MELD-Na score for analysis of the primary end points of morbidity and mortality, and this was entered into the multivariate model.[18] Statistical analysis was performed using PASW version 19.0 (SPSS, Inc, Chicago, IL). Categorical variables are represented as rates and continuous variables as mean ± SD. Categorical variables were analyzed using chi-square analysis and continuous variables using Student's t tests. Preoperative comorbidities, physiologic data, and MELD-Na score were entered into multivariate logistic regression analysis a priori. Statistical significance was reported on the multivariate model using a 95% confidence interval with an α level of .05.

Results

Within the study period, 10,842 patients (mean age, 68 years; 51% women) met the inclusion criteria (Table 1). By procedure, 47% (n = 5,055) underwent open partial colectomy, 19% (n = 2,031) total abdominal colectomy, 34% (n = 3,685) laparoscopic partial colectomy, and .7%