What About the Nonsurgical Geriatric Trauma Patient? How to Standardize Quality in Retrospective "Look-Backs" Using the Charlson Comorbidity Index to Predict the American Society of Anesthesiologists' (ASA) Score

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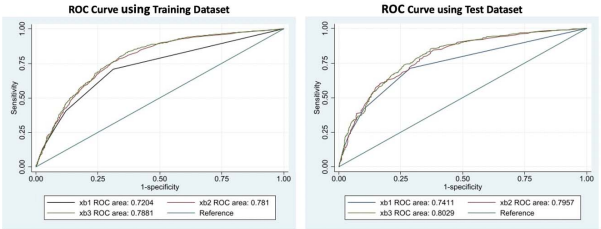
INTRODUCTION:
The American Society of Anesthesiologists (ASA) score has been shown to have much better risk stratification of geriatric trauma patients' quality measures when compared to the commonly utilized Charlson Comorbidity Index. However, the ASA score is only calculated in patients who undergo surgery. In order to standardize quality comparisons between surgical and nonsurgical orthopaedic trauma patients during retrospective quality "look-backs" (as is routinely done is trauma centers' quality improve programs mandated by the American College of Surgeons), we hypothesized that the Charlson Comorbidity Index could acceptably predict a patient's ASA score.

METHODS: A single academic institutional trauma database of cases between 2014 to 2020 was used for the analysis. We restricted the cases to adults 55 years and older with both ASA and CCI values (N= 4,223). We divided the final dataset into training (n=2,956, 70%) and test (n=1,267, 30%) datasets, for modeling and internal validation, respectively. The dependent variable was the ASA Score and we defined this variable as a five-point ordinal variable (1 to 5) and a binary variable (<3 (low-risk surgical group) and ≥3 (high-risk surgical group)). The main predictor was the CCI Score, non-age adjusted, defined as a five-point categorical variable (0,1,2,3,4+). We adjusted for age, sex, marital status, and body mass index. We assessed the relationship between CCI and the ordered ASA values using partially proportional ordinal logistics. We reported the predicted probabilities of CCI for each ASA value. We assessed the unadjusted and adjusted odds of the binary ASA category (<3 vs. ≥3) using univariate and multivariate logistic regression. We assessed the discriminant property of the models using the receiver operating characteristic analysis.

RESULTS: The sample population was predominantly female (70%), married (43%), with a CCI of 0 (44%) and an ASA of 3 (50%). In the univariate model, CCI was significantly associated with the ASA Score. The predictive probability of CCI of 0 has the highest probability of being an ASA value of 2. The predictive probability of CCI of 2 had the highest probability of being an ASA value of 3 while the predictive probability of CCI value of 4 or higher had the highest probability of being an ASA value of 4. While CCI of 1 was three times more likely to have an ASA value of 3 or higher (Adjusted OR (AOR): 3.26; 95% CI: 2.65 – 4.02), a CCI of 4 and higher was nine times more likely to be an ASA value of 3 or higher (AOR: 9.21; 95% CI: 6.07 – 13.99). The area under the curve (AUC) for discriminating ASA of 3 and higher from ASA of less than 3 in the training dataset was 72.04% (95% CI: 70.29 – 73.78) when the model consisted of only CCI, and the discriminative ability increased to 78.81% (95% CI: 77.06 – 80.56) when age and BMI were added to the model. Similar estimates were generated from the internal validation using the test dataset, with the univariate CCI model producing an AUC value of 74.11% (95% CI: 71.56 – 76.66) and the multivariate model producing an AUC value of 80.29% (95% CI: 77.74 – 82.84).

DISCUSSION AND CONCLUSION: The CCI Score demonstrated an acceptable level of accuracy in predicting ASA values of 3 or higher (high-risk surgical group) and the predictiveness of the CCI Score was strengthened by the addition of BMI and age into the model. The predicted probabilities of the ASA values from the CCI Score will allow for improved quality comparisons between patients with similar injuries who did not require surgery versus those who did during ACS mandated quality improvement initiatives at trauma centers.

Figure 1: AUROC Comparison of Training vs. Test Dataset



Receiver Operating Characteristics of the CCI in predicting ASA score

Models	ROC Area Training Dataset	ROC in Test Dataset
CCI	72.04 (70.29 – 73.78)	74.11 (71.56 – 76.66)
CCI + Age	78.10 (76.33 – 79.87)	79.57 (76.98 – 82.16)
CCI + Age + BMI	78.81 (77.06 – 80.56)	80.29 (77.74 – 82.84)

Table 1: Predicted probabilities of each CCI category for each ASA score using unadjusted estimates (Adjusted R squared: 9.67%)

CCI	ASA 1 (95% CI)	ASA 2 (95% CI)	ASA 3 (95% CI)	ASA 4 (95% CI)	ASA 5 (95% CI)
0	**5.3 (4.07 – 6.52)**	**51.28 (48.55 – 54.02)**	**38.60 (35.94 – 41.26)**	**4.44 (3.31 – 5.56)**	**3.89 (0.05 – 0.73)**
1	0.4 (-0.01 – 0.82)	**25.55 (22.47 – 28.63)**	**60.05 (56.59 – 63.51)**	**13.75 (11.32 – 16.18)**	0.26 (-0.10 – 0.62)
2	0.26 (-0.24 – 0.75)	**15.82 (12.20 – 19.42)**	**61.99 (57.19 – 66.80)**	**21.68 (17.60 – 25.76)**	0.26 (-0.24 – 0.75)
3	**2.20 (0.29 – 4.11)**	**14.54 (9.95 – 19.12)**	**54.19 (47.70 – 60.67)**	**28.63 (22.75 – 34.51)**	0.44 (-0.42 – 1.30)
4+	0.00 (-0.00 – 0.00)	**9.96 (6.46 – 13.47)**	**52.67 (46.83 – 58.51)**	**37.01 (31.36 – 42.65)**	0.36 (-0.34 – 1.05)