Learning and Evaluating Clinical Decision Rules for Cervical Spine Injury

Jaewon Saw, Jeffrey Cheng, Ahmed Eldeeb, and Kaitlin Smith

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1 Introduction

The goal of this project is to create a clinical decision rule to identify children who are most likely to have a cervical spine injury (CSI). The adverse effects of immobilizing children and subjecting children to ionizing radiation motivates such a rule, as there is a desire to minimize the number of children unnecessarily subject to radiographic assessment while continuing to maintain high sensitivity.

2 Data

2.1 Data Collection

The data was taken from the Pediatric Emergency Care Applied Research Network (PECARN) public use dataset titled "Predicting Cervical Spine Injury (CSI) in Children: A Multi-Centered Case-Control Analysis". A total of 17 PECARN sites participated in the study, with a total of 3,314 subjects included in this dataset. This dataset was collected between January 2000 and December 2004 and was initially procured for the purpose of creating a decision rule for identifying factors associated with CSI. The results for this study are presented in "Factors Associated With Cervical Spine Injury in Children After Blunt Trauma" by Leonard et al.

Of the 3,314 records, 540 are deemed positive cervical spine injuries from radiology reports or spine consultation. These positive injury records were verified by the principal investigator of Leonard et al. and by a pediatric neurosurgeon[CITATION]. The remaining 2,774 controls fall into three control groups: 1,060 unmatched random controls, 1,012 mechanism-of-injury and age matched controls, and 702 age-matched EMS controls.

Leonard et al. 8 major variables that are associated with CSI: altered mental status, focal neurological deficits, complaint of neck pain, torticollis, substantial injury to the torso, predisposing condition, high-risk motor vehicle crash, and diving. Our analyses focused on these factors, as these were the only clinical variables that were provided for all 3,314 records.

2.2 Cleaning

From the original PECARN public use dataset, the amount of cleaning depended on the classifier used. The baseline rule from Leonard et al. and decision trees were both tolerant of missing data, so no additional cleaning was done for these processes. For the LASSO selection of variables and logistic regression, records with missing values were removed from the analysis.

2.3 Training and Evaluation Split

We assume that in practice, our decision rule will be deployed at hospitals not included in the dataset. Then, to simulate the performance of the models in practice, the data was split into test and training sets based on sites.

Sites 5, 16, and 17 were randomly chosen as the evaluation sites. Leave-one-out-cross-validation (LOOCV) was conducted over the remaining sites during training.

3 Stability

3.1 Model Perturbation

3.2 Data Perturbation