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Prediction of Acute Kidney Injury in the Emergency Department Using Electronic Health Record Data and Machine Learning Methods

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Study Objectives: Acute kidney injury (AKI) is strongly associated with adverse clinical outcomes including prolonged hospitalization, progression to CKD, and death. Diagnosis of AKI relies on detection of changes in serum creatinine (sCr) and urine output, both of which lag days behind renal injury and are unreliable at initial presentation. Here, we utilized data mining and machine learning methods to develop a predictive model for AKI with capacity for identifying ED patients at high risk for development of AKI within 7 days of their ED visit.

Methods: A retrospective cross-sectional cohort of ED visits from 3 hospitals over 2 years was generated and used for model derivation and out-of-sample validation. Clinical data for all adult ED visits where initial sCr measurements were available at index visit and again within 7 days of ED departure were extracted from a relational database that underlies our electronic health record (EHR) by an experienced data user. Primary outcome for prediction was Stage 2 AKI within 7 days of ED visit, defined according to sCr-based Kidney Disease Improving Global Outcomes (KDIGO) criteria (sCr increase to ≥ 2 times baseline). Secondary outcomes included KDIGO Stage 1 AKI (sCr increase of ≥0.3 mg/dl above baseline or ≥1.5 times baseline) and Stage 3 AKI (sCr increase to ≥ 3 times baseline or to ≥ 4.0 mg/dl). Predictor variables extracted from the EHR included vital signs, laboratory results, chief complaints, demographics, past medical history, active problems, home medications and ED medication administrations. Only EHR data available prior to prediction, made at time of first metabolic panel result, was included. Predictor variables were normalized as follows: ED vital signs and laboratory results were processed to minimum and maximum values, nephrotoxic and nephroprotective medications were grouped by pharmacologic class and least absolute shrinkage and selection operator (LASSO) feature selection processing applied to chief complaints and active problems identify variables with predictive value for AKI. Multiple machine learning models (logistic regression, decision tree, linear discriminant analysis, support vector machine, and random forest) were generated and tested in the prediction of our primary outcome. All were developed using a training dataset comprised of 90% of encounters and evaluated in the remaining encounters using 10-fold cross validation. Performance of each model was assessed using binary classification measures and receiver operator curve (ROC) analyses.

Results: Our final cohort included 127,183 ED visits by 72,539 unique patients. Median age was 58 years (IQR: 43-71) and most common high-risk comorbidities were hypertension (51.8%) and heart failure (9.8%). Incidence of AKI in our cohort was as follows: Stage 1: 12.4%, Stage 2: 1.5%, Stage 3: 1.0%. Predictive model performance as measured by area under the ROC analysis ranged from 0.661 (95% CI: 0.637 - 0.685) using decision tree to 0.771 (95% CI: 0.759 - 0.783) using random forest.

Conclusions: Machine learning methods applied to EHR data identified ED patients at high risk for AKI well before patients met diagnostic criteria. The model developed here, when paired with nephroprotective point-of-care clinical decision support, has potential to improve outcomes for this patient population.

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Understanding Emergency Medicine Providers' Perceptions of the ACA in a Renewed Era of Health Care Reform: National Survey and Qualitative Mixed-Methods Approach

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Study Objectives: The 2010 ACA has been a source of divisive political conversation and widespread health care reform. In recent months, it has been the center of renewed national attention as many of the law's key provisions face potential restructuring or repeal. Amidst the changing health system, emergency physicians take on a unique role, serving as the first point of contact for many patients. The objective of this study was to understand their perspectives, illustrating how current and future emergency physicians view the ACA and its impact on patients.

Methods: The study consisted of 3 parts: a survey of a nationally representative subset of FACEP; a survey of current medical students intending to go into emergency medicine at 8 US medical schools; and a series of 35 qualitative in-depth interviews with current medical students, residents, and emergency physicians across the Yale New Haven Health System. All study parts were completed between September 2017-April 2018. Data were analyzed using descriptive statistics and a grounded theory approach. In order to compare outcomes between surveys, FACEP and medical students were matched on sex, race/ethnicity, and political ideology using coarsened-exact matching.

Results: A total of 945 FACEP and 137 medical students interested in EM completed the surveys (response rate: ≥98% FACEP and 36.9% of all medical students surveyed of whom 8.3% were interested in emergency medicine). Overall, 48.5% of physicians indicated having "good knowledge" of the ACA, 59.3% indicated support for the law, and 54.1% indicated that the ACA has resulted in better care for emergency medicine patients. Disagreement with parts of the law (31.9%) and issues with ACA design/implementation (18.8%) were cited as the most common reasons for opposition. Compared to practicing physicians, medical students planning a career in emergency medicine were significantly more likely to self-identify as having "good knowledge" of the ACA (RR[95% CI]: 2.10 [1.90-2.31]), indicate support for the ACA (1.53[1.39-1.69]), and believe that the ACA has resulted in better overall care for patients (1.35[1.23-1.49]).

When asked in interviews about their perceived knowledge of the ACA, EM providers at Yale were more cautious about their proficiency (10/35 reported having "good knowledge"). All acknowledged at least partial support of the law, noting in select comments that "broadening of health care coverage is a moral imperative [···] no other viable alternatives have been proposed." (resident) and that "while I struggle with the law as a whole, everyone deserves health insurance" (physician). All denied changes in their desire to practice medicine and the way that they perceive their work. They did, however, acknowledge an increased number of insured adult patients, awareness of cost-shifting within the hospital system, and concerns among patients with high-deductible private health insurance plans "about the costs of things like observation versus admission." Both pediatric and adult providers reported seeing more patients.

Conclusions: Despite differences in political ideology and concerns about aspects of the ACA, a majority of practicing physicians and medical students report support for the ACA. Future emergency physicians and residents were significantly more likely than board-certified physicians to favorably view the law and its impact on patients, providing insight into the potential direction of health care reform inspired by the next generation of front-line physicians.

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Characterization of Telemedicine Use Among US Emergency Departments

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Study Objectives: Telemedicine (TM) is commonly used in US emergency departments (EDs); however, the extent of TM adoption among U.S. EDs is not known. Our objective was to characterize the prevalence of TM use among all U.S. EDs, to describe clinical applications for which it is most commonly used, and to identify ED characteristics associated with TM use.

Methods: As part of the National ED Inventory (NEDI)-USA survey, we queried the directors of all 5,375 U.S. EDs open in 2016. The survey included 2 questions about TM use. We use descriptive statistics to report characteristics of EDs that do not use TM, EDs that receive TM services, and EDs that provide TM services. Two separate multivariable logistic regression analyses identified characteristics associated with ED receipt of TM services and ED provision of TM services. Variables in the models were defined a priori and included annual adult and pediatric visit volumes, academic status, freestanding ED, urban/rural location, and ED region.

Results: Overall, 4,509 (84%) responded to our survey, with 4,031 EDs responding to both TM questions (75%). Although 1,694 EDs (42%) did not use TM in 2016, most EDs did: 1923 EDs (48%) received TM services, while 414 EDs (10%) provided TM services. Among TM-using EDs, the most commonly cited applications for TM were stroke/neurology (76%), psychiatry (38%), pediatrics (15%), and trauma (11%). Characteristics of TM non-users, EDs receiving TM services, and EDs providing TM services are presented (Table). In multivariable analysis, characteristics associated with EDs' receipt of TM services were increased annual total visit volume