Derivation and Validation of Digital Signature For Seizures as a Comorbid Condition in Critically Ill Patients

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Abstract: We developed and validated an automatic data extraction “digital signature” for clinical concept of seizure as comorbidity in critically ill patients. Digital signature was derived and validated in a cohort of 513 and 1028 patients respectively. Cohen's kappa statistics between manual data extraction and automatic extraction using digital signature was 0.84 (95% CI, 0.78-0.91). Digital signature outperformed manual data extraction approach, with higher sensitivity and specificity when validated against the “reference” standard of comprehensive chart review.

Introduction: Seizures are a common neurological comorbidity in patients admitted to the intensive care unit (ICU). Late detection of patients with seizure as comorbidity in critically ill patients contributes in increasing mortality. Digital signatures have shown to be an accurate automatic method of extracting comorbidities from the EMR [Ref]. In the present study, we developed and validated an automated digital signature of seizure for the goal to accurately identify this comorbidity in the EMR.

Methods: We retrospectively analyzed 1541 adult patients (≥ 18 years) admitted to Mayo Clinic ICU during 2010 from the Olmsted county, Minnesota. We compared two independent comorbidity search strategies. First, we manually extracted seizure as comorbidity from the EMR and secondly, digital signature was applied to patient’s clinical notes to extract the same. We searched only the past medical and surgical history (PMH/PSH) section for the past 5 years to search for seizure in the EMR. Digital signatures are based on computerized queries applied to the EMR using a query building tool. For building a digital signature for seizure- we entered all the synonyms, abbreviations and most common symptoms associated with it. To increase the specificity, we excluded the negative terms which are mentioned in clinical notes e.g. doesn't, not, no, denies etc. The digital signature was refined till it achieved a sensitivity and specificity of ≥ 95%. Physician reviewers extracted seizure by manually screening through the clinical notes. If seizure was not identified in the PMH/PSH section of EMR, it was assumed to be negative for the study. Digital signature was derived in a cohort of 513 patients and later validated in a cohort of 1028 patients. Agreement between the two search strategies was assessed with Cohen's weighted \( \kappa \). For the validation of digital signature and manual data extraction strategy, after all the data was extracted each discordant result between the two strategies were extensively reviewed by two physicians reviewers to confirm the presence or absence of seizure in the clinical notes and 10% of concordant results were manually reviewed as a quality check. This was considered as the “reference” standard for the study. Sensitivity and specificity of both the automated digital algorithm and manual search was compared with the “reference” standard to measure the accuracy for the presence or absence of seizure. Data were analyzed using JMP statistical software (SAS Institute Inc).

Results: The prevalence of seizures as comorbidity in the ICU population was 7.3%. The agreement statistics between the digital signature and the manual data extraction search strategy were excellent \( \kappa = 0.846 \) (95% confidence interval [CI], 0.78-0.91). At the same time the sensitivity and specificity of the digital signature in validation cohort was 98.5% (95% CI, 91%-100%) and 99.5% (95% CI, 99%-100%) respectively, as compared to 91.3% (95% CI, 83%-97%) and 96.8% (95% CI, 95%-98%) for manual data extraction against the “reference” standard.

Conclusion: Our results show that automatic extraction (digital signature) of seizure as comorbidity from the EMR is feasible and has outperformed manual search with higher sensitivity and specificity. Digital signature of seizure has potential implications in the future EMR.