Critical Review Form
Clinical Prediction or Decision Rule

Predictors of Abnormal Findings of Computed Tomography of the Head in Pediatric Patients Presenting with Seizures, *Annals of EM* 1997; 29:518-523

Objective: **"To identify clinical characteristics that predict abnormal head CT findings in pediatric patients to an ED with seizures". (p. 519)**

Methods: **Pediatric patients presenting to Children's Hospital and Medical Center, a non-trauma center in Seattle, between Jan 1992 and Dec 1994 with an ED discharge diagnosis of "seizure" or "febrile seizure" who underwent a head CT while in the ED were eligible. No exclusion criteria are otherwise stated for this retrospective chart review.**

The following variables were abstracted: age, gender, length and number of seizures, seizure focality, anticonvulsant medication use, focal neurologic deficits before or after the seizure, prodromal fever, illness, headache or trauma, baseline cerebral palsy or development delay, underlying malignancy, neurocutaneous disorder or bleeding disorder, vital signs, medications used, and ED physical exam findings.

Where possible, elements of the history and exam were dichotomized after inspecting the distributions of abnormal CT findings for each variable. An abnormal scan was defined as any abnormality not present on a prior head CT scan and "we made no attempt to determine the clinical significance of the abnormalities noted". (p. 520)

Based upon a preliminary bivariate analysis of clinical variable associated with abnormal head CT, five patient characteristics were most significantly associated: age <6 months, history or evidence of a CHI, CSF shunt revision in the preceding six weeks, underlying malignancy or neurocutaneous disorder. These five characteristics were combined into a single variable labeled "pre-existing patient characteristics" which represented the first branch in the χ^2 recursive partitioning decision tree. Subsequently, additional branches were added by ranking the remaining dichotomous variables by the value of its Pearson χ^2 statistical association with an abnormal head CT. This was continued until all abnormal head CT's were identified by the simplest model.

Guide		Comments
I.	***Is this a newly derived instrument* (Level IV)?**	
A.	Was validation restricted to the retrospective use of statistical techniques on the original database? (If so, this is a Level IV rule & is not ready for clinical application).	Yes. This is a newly derived CDR -- done so retrospectively on a pre-existing database. Therefore, this is a Level IV CDR.
II.	**Has the instrument been validated? (Level II or III). If so, consider the following:**	
1a	Were all important predictors included in the derivation process?	No discussion of glucose or Na+ levels. What about overdoses?
1b	Were all important predictors present in significant proportion of the study population?	Unknown. The authors do not provide the prevalence for all variables.
1c	Does the rule make clinical sense?	Yes – very simple 3-component rule using information related to seizures and readily available at the bedside.
2	Did validation include prospective studies on several different populations from that used to derive it (II) or was it restricted to a single population (III)?	No validation occurred.
3	*How well did the validation study meet the following criteria?*	
3a	Did the patients represent a wide spectrum of severity of disease?	No. *"The retrospective case-series design, which did not permit us to analyze the potential biases of the various attending physicians in determining which seizure patients, warranted emergency head CT. Given the low frequency with which scans were ordered in our ED population, this pre-selection may have led to an inflated frequency of CT scan abnormality"*. This population likely represents the most clinically concerning seizure patients and therefore suffers a selection bias.

3b	Was there a blinded assessment of the gold standard?	Yes. "All scans were read by a pediatric radiology fellow, attending radiologist, or both before ED disposition". Although these radiologists were probably not blinded to every variable in the CDR, they did not have access to the 3-component rule because it hadn't yet been derived.
3c	Was there an explicit and accurate interpretation of the predictor variables & the actual rule without knowledge of the outcome?	Uncertain since no reliability assessment was performed. No missing data is reported.

3d	Did the results of the assessment of the variables or of the rule influence the decision to perform the gold standard?	Almost certainly individual variables resulted in clinicians defining patients at high-risk after seizure prompting head CT.
4	How powerful is the rule (in terms of sensitivity & specificity; likelihood ratios; proportions with alternative outcomes; or relative risks or absolute outcome rates)?	• Over 3-years, 69,648 patients were registered in the ED including 2,312 (3.3% of total) with a diagnosis of "seizure" or "febrile seizure" and 206 (9% of those with seizure) had a head CT. • Among the 206 median age 3.1 years, 53% male, and 18% transferred from another facility. Pre-existing seizure disorder was present in 32% and 14% were on an anti-convulsant therapy. Additionally, the following prevalence rates were noted: CSF shunt 15%, malignancy 6%, neurofibromatosis or tuberous sclerosis 4%, fever 30%, and CHI 6%, seizure meds pre-hospital 25% or in ED 38%. • Head CT findings were abnormal in 25 patients (12%) with hemorrhage the most common finding (8 patients, 32%) followed by cerebral edema, CVA, non-specific enhancement, shunt obstruction, or NCD in two patients each. • Long-term anti-convulsant therapy was initiated in 16% of patients. • In the χ^2 recursive-partitioning analysis the following variables were selected based upon their odds ratio: presence of age <6 months or CHI or CSF shunt revision in preceding 6-weeks or underlying malignancy or NCD (OR 7.30, 95% CI 2.99-17.80); then seizure duration $\leq$ 15 minutes (OR 7.53, 95% CI 1.54-36.78); finally history of a pre-existing focal neurologic deficit (OR undefined). • This 3-component rule identified all abnormal head CT with sensitivity 100% (98 – 100%), specificity 47% (40 – 54%), $LR^+ = 1.9$ (95% CI; 1.6-2.2) and $LR^- = 0$ (95% CI; 0-0.64) . • Use of this rule would have voided an unnecessary head CT on 41% of the total cohort.

III.	**Has an impact analysis demonstrated change in clinical behavior or patient outcomes as a result of using the instrument? (Level I). If so, consider the following:**	
1	How well did the study guard against bias in terms of differences at the start (concealed randomization, adjustment in analysis) or as the study proceeded (blinding, co-intervention, loss to follow-up)?	No impact analysis was performed, but certainly *selection bias* towards the most clinically worrisome pediatric seizure patients and *work-up bias* since components of CDR undoubtedly influenced decision to order head CT.
2	What was the impact on clinician behavior and patient-important outcomes?	No assessment of clinician accuracy or acceptance applying this rule. Furthermore, no assessment of patient-important outcomes or long-term follow-up.

Limitations

1) **Retrospective derivation not ready for wide-spread use. Requires prospective validation to ensure reproducibility, clinician application accuracy and reliability, and acceptability.**

2) **Selection-bias since not every child with seizure had a head CT. We cannot state with certainty that seizure patients that did not have a head CT would have no findings since they did not have the Gold standard test performed.**

3) **Authors fail to report prevalence, confidence intervals, or odds ratios for every potential predictor variable. Therefore, how do we know they selected the most appropriate predictor variables?**

4) **The authors fail to report LR's which are more useful for bedside application of diagnostic tests.**

5) **Authors fail to state whether outcome assessors, the radiologists, were blinded to clinical data. If not, the results may suffer from incorporation bias.**

6) **The authors fail to incorporate known seizure-precipitants hypoglycemia, hyper or hypo natremia, or overdoses into their model.**

7) **Under-powered with only 25 abnormal CT scans. In general, should have 10 outcomes per predictor variables included in the model. Therefore, the current rule with 7-variables total would need roughly 70 abnormal CT scans to avoid over-fitting the model.**

Bottom Line

Under-powered, single-center, retrospectively derived clinical decision rule demonstrating the potential to avoid unnecessary (negative) head CT's on pediatric patients presenting to the ED with seizures. Before widespread application of this rule, it will require prospective validation to more accurately assess prognostic test performance, clinician reliability and physician/patient acceptability.

The Rule

CT scans are always normal in patients lacking any of the following findings:

1) **Underlying high-risk condition (malignancy, neurocutaneous disorder, recent closed head injury, or recent CSF shunt revision);**
2) **age < 6 months;**
3) **seizure > 15-minutes;**
4) **new-onset focal neurologic deficit.**