Evaluation of AIIMS Modified INCLEN Tool for Diagnosis of Epilepsy

PRIYANKA GOYAL, MONIKA SHARMA, VARUGHESE PV

From Department of Pediatrics, Christian Medical College, Ludhiana, Punjab.

Correspondence to:
Dr Priyanka Goyal,
Department of Pediatrics,
Christian Medical College,
Ludhiana, Punjab.
Received: June 04, 2022;
Initial review: July 31, 2022;
Accepted: October 19, 2022.

Objectives: To evaluate the AIIMS Modified INCLEN tool for the diagnosis of epilepsy. **Methods:** This cross-sectional study enrolled 250 children aged 1 month to 18 years presenting with complaints of abnormal body movements to either the pediatric or neurology outpatient departments in our institution between October 1, 2018 and June 30, 2020. The All India Institute of Medical Sciences (AIIMS) modified International Clinical Epidemiology Network (INCLEN) diagnostic tool for epilepsy (AIIMS modified INDT-EPI) was administered and a diagnosis was made, which was further verified by a pediatrician or a neurologist. Specificity, sensitivity, positive predictive value (PPV) and negative predictive value (NPV) were calculated. **Results:** The study tool had a sensitivity of 87.6% and specificity of 84.0%. The PPV and NPV of the study tool were 86.8% and 84.9%, respectively. **Conclusion:** The study tool has good psychometric properties for physician assessment with regard to diagnosis of epilepsy.

Keywords: *Diagnosis, Seizure, Sensitivity, Specificity.*

Epilepsy accounts for 0.5% of the global disease burden [1]. The diagnosis of epilepsy is usually made on the basis of clinical history supported by brain imaging and electroencephalography (EEG). Misdiagnosis may occur in nearly one third of cases, even when physicians are involved [2-5]. Multiple possible reasons for epilepsy misdiagnosis have previously been reported [2,5,6]. Most health centers in our country do not have adequate resources or ready access to diagnostic facilities, which may contribute to misdiagnosis and increase in referral of several patients [7,8]. Approximately 80% of specialist physicians are practicing in urban India. In this scenario, primary health center (PHC) based care can be essential to decrease treatment gap [6].

Questionnaires that are inexpensive, freely available, and easy to use by a general pediatrician can aid in correct management of epilepsy in children. The International Clinical Epidemiology Network (INCLEN) developed a simple questionnaire-based tool in multiple Indian languages for epilepsy diagnosis in the community (INDT-EPI), which had good psychometric properties [9]. This was subsequently modified as the AIIMS Modified INCLEN diagnostic tool for epilepsy (AIIMS Modified INDT-EPI) [10]. This study was planned to evaluate the diagnostic accuracy of the AIIMS Modified INDT-EPI tool for epilepsy.

METHODS

This cross sectional study was conducted in the outpatient clinics of pediatric and neurology department in a tertiary level healthcare institution in Northern India from October 1, 2018 to June 30, 2020. Ethical approval was obtained from the institutional ethics committee. A written informed consent was obtained from the primary care-giver, and written assent was obtained from children bet-ween 12 and 18 years. Children aged one month to 18 years present-ing with abnormal body movements or seizures were enrolled. Children with severe acute illness, which required hospital admission, were excluded from the study.

Demographic details and pre-diagnosed comorbid neurodevelopmental disorders (NDDs) were recorded. AIIMS Modified INDT-EPI 10-item questionnaire [11] was administered to primary caregivers, and the diagnosis of "epilepsy", "No epilepsy", "single seizure" or "indetermi-nate" was made after assessing as per the scoring men-tioned in the INCLEN tool. The diagnosis of epilepsy was further verified by either a pediatrician or a neurologist (labelled as 'experts'), who were blinded to the scoring on the tool. Diagnosis of "epilepsy" or "No epilepsy" made by the expert was considered as the gold standard.

Statistical analysis: The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were expressed as percentages with 95% CI. Cohen

Kappa test was used to compare diagnosis by study tool and the gold standard. The data of indeterminate category patients were excluded from statistical analysis while comparing the study tool with the experts' diagnosis.

RESULTS

Clinico-demographic profile of the enrolled 250 children is illustrated in **Table I**. As per gold standard, 138 children were diagnosed as epilepsy. Seizures were found secondary to underlying etiologies in 80.3% (*n*=90) of children diagnosed with 'No epilepsy' and most common etiology was febrile seizures (*n*=44, 48.8%), followed by toxic and metabolic causes (*n*=21, 23.3%). As per the study tool, 114 (45.6%) children had epilepsy, 93 (37.2%) children did not have epilepsy and rest 43 (17.2%) children were classified as indeterminate.

There was substantial agreement between physician diagnosis and study tool diagnosis (κ=0.717, *P*<0.001). The sensitivity, specificity, PPV and NPV of the study tool were >80% (**Table II**). The study tool showed maximum sensitivity and NPV among age group of 1 month-2 years, whereas maximum specificity and PPV was found among age group of 2-5 years. However, this tool showed least accuracy with least specificity among age group of 5-18 years as compared to other age groups (**Table II**).

DISCUSSION

Utility of pediatric management protocols such as Integrated management of neonatal and childhood illness (IMNCI) for management of common childhood illnesses have exemplified the importance and usefulness of simple management tools that can help a primary care physician in the peripheral settings to manage patients satisfactorily [12,13]. The present study demonstrates acceptable psychometric properties of the AIIMS modified INDT-EPI tool for diagnosis of epilepsy in children.

Table I Clinico-demographic Characteristics of Children With Abnormal Movements Assessed for Epilepsy (*N*=250)

Characteristics	Value
Males	161 (64.4)
Age group	
1 mo-2 y	70 (28)
2 y-5 y	64 (25.6)
5-18 y	116 (46.4)
Urban residence	194 (77.6)
Comorbid NDDs	88 (35.2)
Intellectual disability	42 (47.7)
Neuromotor disability	34 (38.6)
Behavioral disorder	12 (13.6)

Values in no. (%). NDDs-neurodevelopmental disorders.

The psychometric properties of a questionnaire will help qualify their usefulness as a diagnostic screening tool in primary health care level where tertiary level diagnostic aids are not available. Earlier researchers have attempted to study the utility of questionnaire-based epilepsy diagnostic or screening tools. Most of the earlier screening questionnaires for epilepsy concentrated on diagnosis of only tonic clonic seizures [14]. However, the AIIMS Modified INDT-EPI includes questions to detect various seizure types, including myoclonic seizures, epileptic spasms, atonic seizures, absence seizures and focal seizures [10,11].

Questionnaires for diagnosis of epilepsy used in the earlier studies were designed based on experience of experts rather than standard international definitions or classification of seizures. AIIMS Modified INDT-EPI is based on ILAE classification, which could be possible explanation for high sensitivity for this study tool as compared to most of the previous studied tools [14,15]. Second possible reason for high sensitivity in our study is

Table II Psychometric Properties of AIIMS Modified INDT-EPI in Various Age Groups (*N*=250)

Value	1 mo-18 y (overall)	1 mo-2 y (n=70)	2 - 5 y (n=64)	5-18 y (n=116)
Sensitivity	87.61% (80.09% to 93.06%)	94.44% (72.71% to 99.86%)	77.42% (58.90% to 90.41%)	90.62% (80.70% to 96.48%)
Specificity	84.04% (75.05% to 90.78%)	85.71% (71.46% to 94.57%)	96.00% (79.65% to 99.90%)	70.37% (49.82% to 86.25%)
Positive predictive value	86.84% (80.50% to 91.34%)	73.91% (57.25% to 85.70%)	96.00% (77.70% to 99.40%)	87.88% (80.13% to 92.87%)
Negative predictive value	84.95% (77.42% to 90.28%)	97.30% (84.22% to 99.59%)	77.42% (64.00% to 86.86%)	76.0% (58.72% to 87.57%)
Accuracy	85.99% (80.50% to 90.41%)	88.33% (77.43% to 95.18%)	85.71% (73.78% to 93.62%)	84.62% (75.54% to 91.33%)

AIIMS modified INDT-EPI - All India Institute of Medical Sciences (AIIMS) modified International Clinical Epidemiology Network (INCLEN) diagnostic tool for epilepsy.

WHAT THIS STUDY ADDS?

• The AIIMS Modified INDT-EPI tool has a good sensitivity and specificity, and can be used in the outpatient setting for a diagnosis of epilepsy or no epilepsy among children aged between 1 month and 18 years.

---

due to ability of our study tool to diagnose wide range of epileptic seizures as compared to earlier studies that focused on specific seizure types only. Similarly, our study yielded high specificity as compared to previous studies due to ability of the tool to diagnose more types of non-epileptic events like breath holding spells and syncope. A high specificity of study tool translates into high positive predictive value and low false positive rates.

We observed a lower sensitivity of study tool as compared to previous studies [10,16,17]. This can be attributed to the different type of study population as these studies enrolled children with higher risk of seizures. Parents of such children are more familiar with terminologies which can increase chances of a positive response and thus higher sensitivity with a study questionnaire [10,16,17]. In our study, we enrolled children coming to the general pediatric and neurology outpatient department with history of any abnormal body movements. Similarly, low specificity of diagnostic questionnaire in our study as compared to some previous studies can be attributed to the different type of study population as unlike these studies, our study did not include healthy children as controls [14,16,17]. Specificity of a test usually increases with healthy controls.

In subgroup analysis for age, in our study, AIIMS Modified INDT-EPI tool showed highest utility in age group of 1 month-2 years. This was in contrast to the results of the validation study [10], which showed least sensitivity (86.5%) and positive predictive value (88.4%) in age group of 1 month-2 years as compared to age >2 years, and also demonstrated that the best diagnostic accuracy was found among age group of 2-9 years. A higher sensitivity in children with comorbid NDDs could possibly be because parents of children with comorbid NDDs were more likely to understand the terminologies in the questionnaire. The original study [9] also demonstrated the increase in sensitivity (97.4%) of diagnostic questionnaire when administered to children with comorbid NDDs, as also reported later [10].

The data of children with 'indeterminate' category on the tool was removed from analysis, which may have had a modifying effect on the psychometric properties in this study. However, as the study setting was a general out-patient setting, it makes our findings more relatable to a peripheral health care setup. Thus, our findings support the usefulness of this questionnaire as a screening tool for diagnosis of abnormal body movements as possible epilepsy or otherwise.

To conclude, AIIMS modified INDT-EPI questionnaire had a high diagnostic accuracy, and can be used in the outpatient setting for a reliable diagnosis of seizure or seizure-like events in children and young adults aged 1 month to 18 years.

REFERENCES

1. World Health Organization. Fact sheets: Epilepsy. Accessed June 1, 2022. Available from: *https://www.who.int/ en/news-room/fact-sheets/detail/epilepsy*
2. Udani V. Improving diagnosis of epilepsy in India–How difficult is it?. Indian Pediatr. 2014;51:535-6.
3. Chapman M, Iddon P, Atkinson K, et al. The misdiagnosis of epilepsy in people with intellectual disabilities: A systematic review. Seizure. 2011;20:101-6.
4. Indrayan A. Diagnostic questionnaire and its validation. Biostatistician's perspective. Indian Pediatr. 2014;51:536-8.
5. Ferrie CD. Preventing misdiagnosis of epilepsy. Arch Dis Child. 2006;91:206-9.
6. Ganapathy K. Distribution of neurologists and neuro-surgeons in India and its relevance to the adoption of telemedicine. Neurol India. 2015;63:142-54.
7. Kumar R, Tripathy JP, Singh N, et al. Rapid assessment of health services in Punjab using a mixed method approach. Indian J Comm Health. 2015;27:197-203.
8. Singh T, Kankaria A, Bhatnagar N, et al. Assessment of functioning of public health facilities in a North Indian state. Int J Community Med Public Health. 2019;6:3358-63.
9. Konanki R, Mishra D, Gulati S, et al. INCLEN Diagnostic Tool for Epilepsy (INDT-EPI) for primary care physicians: development and validation. Indian Pediatr. 2014;51:539-4.
10. Gulati S, Patel H, Chakrabarty B, et al. Development and validation of AIIMS modified INCLEN diagnostic instrument for epilepsy in children aged 1 month–18 years. Epilepsy Res. 2017;130:64-8.
11. Child Neurology division, AIIMS New Delhi. INDT-EPI Module for epilepsy. Accessed June 1, 2022. Available from: *http://pedneuroaiims.org/training_module_for_ epilepsy.html*

12. Kaur S, Singh V, Dutta AK, et al. Validation of IMNCI algorithm for young infants (0-2 months) in India. Indian Pediatr. 2011;48:955-60.

13. Bhandari N, Mazumder S, Taneja S, et al. Effect of implementation of Integrated Management of Neonatal and Childhood Illness (IMNCI) programme on neonatal and infant mortality: cluster randomised controlled trial. BMJ. 2012;344:e1634

14. Placencia M, Sander JW, Shorvon SD, et al. Validation of a screening questionnaire for the detection of epileptic seizures in epidemiological studies. Brain. 1992;115:783-94.

15. Patel AA, Ciccone O, Njau A, et al. A paediatrics epilepsy diagnostic tool for use in resource-limited settings: a pilot study. Epilepsy Behav. 2016;59:57-61.

16. Melbourne-Chambers R, Clarke D, Gordon-Strachan G, et al. The UWIMONA paediatrics epileptic seizure screening questionnaire was equivalent to clinical assessment in identi-fying children with epilepsy. J Clin Epidemiol. 2015;68: 988-93.

17. Carpio A, Lisanti N, Calle H, et al. Validation of a question-naire for epilepsy diagnosis in primary care services. Rev Panam Salud Publica. 2006;19:157-62.

———————