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Systematic review

Diagnostic accuracy of neuroimaging in children with first-time afebrile seizures presenting to the emergency department: a systematic review

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Abstract

Background: Neuroimaging after a first afebrile seizure addresses urgent intracranial disease and longer term etiological diagnosis. These objectives require distinct outcome definitions and our review examined imaging yield, urgent findings, and reported diagnostic performance in children presenting to emergency care. **Methods:** Original articles available through 31 Jan 2026 were examined. Computed tomography and magnetic resonance imaging findings were classified by clinical relevance and urgency. Study populations, imaging denominators, additional magnetic resonance findings, and clinical prediction measures were synthesized narratively, with attention to selection and incomplete diagnostic verification. **Results:** Ten original articles described heterogeneous pediatric emergency and acute care populations. In a multicenter prospective cohort, clinically relevant abnormalities occurred in 40 of 354 imaged children, including three urgent findings. A focal seizure cohort identified urgent abnormalities in 13 of 319 children. In an infant cohort, computed tomography findings required acute management in 27 of 298 examinations. MRI identified additional abnormalities following normal computed tomography, although immediate management changed infrequently. One recent clinical rule achieved 100% sensitivity and 39.7% specificity for emergent magnetic resonance findings. These estimates described clinical risk stratification rather than imaging accuracy. **Conclusion:** Imaging urgency depended on neurological examination, seizure characteristics, developmental history, and population selection. MRI contributed additional structural diagnoses. The available reports supported differentiated imaging pathways without establishing pooled sensitivity or specificity for either imaging modality.

Keywords: Neuroimaging; afebrile seizure; first seizure; children; emergency department; computed tomography; magnetic resonance imaging.

Introduction

A first afebrile seizure requires evaluation of both its underlying cause and the child's subsequent risk of epilepsy, since a single unprovoked event and an established epilepsy diagnosis represent distinct clinical circumstances (1). The diagnostic assessment integrates seizure description, neurological examination, developmental history, and selected investigations, with attention to findings that identify an acute cerebral disorder requiring immediate treatment (2). Structural neuroimaging serves two related purposes: identifying urgent intracranial pathology during emergency evaluation and establishing an anatomical explanation that informs subsequent classification, prognosis, and treatment planning, with the timing of investigation determined by the clinical question and the presence of features suggesting an acute lesion (2,3).

Magnetic resonance imaging (MRI) provides assessment of cortical development, white matter injury, vascular abnormalities, and other structural substrates, and the clinical relevance of each finding depends on its relationship to the presenting seizure (3). International recommendations emphasize dedicated epilepsy protocols and expert interpretation because sequence selection and image quality affect the recognition of subtle lesions that remain undetected on routine examinations (4). The presence of any radiological abnormality, the identification of an epileptogenic lesion, and the detection of pathology requiring immediate intervention represent separate outcomes with different implications for emergency management (3,4).

Computed tomography (CT) is relevant when assessment of an acute intracranial process is required, although childhood exposure to ionizing radiation introduces a measurable long term consideration when selecting investigations (2,5). A large retrospective cohort linked increasing radiation dose from childhood CT to leukemia and brain tumors, and emphasizing that the estimated absolute increase in risk remained small (5). Research examining pediatric computed tomography utilization and delivered doses identified substantial dose variation, reinforcing the importance of matching imaging decisions and

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examination protocols to the diagnostic question and the child's age (6).

Infancy requires consideration because incomplete myelination, developmental abnormalities, and age dependent seizure presentations affect the expected yield and technical requirements of magnetic resonance imaging. The 2026 International League Against Epilepsy (ILAE) recommendations conditionally supported magnetic resonance imaging in infants with first afebrile seizures or new onset epilepsy, with prioritization informed by focal features, examination abnormalities, developmental delay, and prolonged events (7). The present review examined original emergency and acute care studies to distinguish diagnostic yield from diagnostic accuracy, compare urgent and nonurgent structural findings, and describe the clinical characteristics associated with abnormal neuroimaging after a first afebrile seizure.

Methods

This review addressed structural neuroimaging in children and adolescents through 18 years of age presenting with a first recognized afebrile seizure, with literature search from inception to 31 Jan 2026. The reporting structure followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, with diagnostic questions organized around population, index examination, target condition, and reference assessment. Emergency department cohorts and closely related acute care pathways were considered, including first presentation seizure clusters, while neonatal-only cohorts, established epilepsy, febrile seizures, and traumatic presentations were excluded from the primary review population.

Source identification used PubMed-indexed records, original journal reports, and examination of reference lists. Search concepts combined child, infant, adolescent, pediatric, first seizure, new onset, afebrile, unprovoked, neuroimaging, computed tomography, and magnetic resonance imaging, with publication dates restricted to the specified cutoff. Reviews and professional recommendations informed the introduction and discussion, whereas the results synthesis used original observational studies; reports containing mixed presentations were interpreted according to the population and outcomes explicitly described.

Two authors screened titles and abstracts, examined relevant articles, and extracted study information using a standardized form. Extracted variables comprised country, setting, design, age range, cohort size, numbers undergoing each examination, imaging timing, abnormal findings, urgent lesions, management changes, and reported clinical predictors. Disagreements were resolved through discussion and rechecking the original report, and denominators were retained separately for enrolled participants, imaged participants, and individual imaging modalities to prevent substitution of the full cohort for the tested population.

Diagnostic yield was defined as the proportion of examined children with an abnormal scan, while clinically relevant and urgent abnormalities retained each study's stated definitions. Sensitivity and specificity were considered measures of imaging accuracy only when an index examination was compared with an appropriate reference assessment; clinical prediction rules using imaging as their outcome were analyzed separately. Methodological interpretation examined patient selection, selective imaging, reference assessment, incomplete verification, imaging intervals, and outcome definitions.

A structured synthesis grouped findings by clinical population, imaging modality, urgency, and additional detection after an initially normal examination. Meta-analysis was not performed

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because the reports differed in patient selection, imaging thresholds, lesion definitions, and verification pathways, and did not provide a comparable set of independent imaging accuracy estimates. Study-specific proportions and published confidence intervals were retained when available, while unreported accuracy measures and missing outcome counts were not reconstructed from unrelated denominators.

Results

The ten reports represented infant pathways, general pediatric emergency populations, and cohorts selected for focal manifestations, with differing imaging thresholds and outcome definitions (8-17). Hsieh and colleagues enrolled 317 infants, of whom 298 underwent CT and 182 underwent MRI, identifying abnormalities in 105 and 104 examinations, respectively (8). Aprahamian and colleagues identified urgent intracranial pathology in 13 of 319 children with first afebrile focal seizures, corresponding to 4.1% with a 95% confidence interval of 2.2-7.0% (9).

In the six-center prospective study by Dayan et al, 475 children were enrolled and 354 underwent imaging during the emergency visit or subsequent four months (10). Clinically relevant abnormalities occurred in 40 imaged children, corresponding to 11.3% with a reported 95% confidence interval of 8.0-14.6%, while three children had emergent or urgent abnormalities, corresponding to 0.8% with an interval of 0.1-1.8% (10). Al-Shami et al. reported abnormal imaging in 32 of 96 children, with higher proportions among children younger than two years and those presenting with prolonged seizures, this indicate that these features identified groups with greater structural diagnostic yield; the authors reported that imaging informed clinical decision making in 6-8% of children (11).

Besli et al. found abnormalities in 42 of 173 imaged children and emergent pathology requiring immediate intervention in nine, with all urgent cases exhibiting focal seizures and new neurological deficits. Among 36 children undergoing the two examinations, nine had abnormal magnetic resonance imaging despite normal computed tomography, including one acute infarct requiring urgent attention (12). Amagasa et al. evaluated 611 children, reporting abnormalities in 4.2% of computed tomography recipients and 7.1% of children receiving either modality, with six urgent abnormalities and associations involving seizure clusters, prolonged events, focal features, and neurological abnormalities, although the tested population differed from the full enrolled cohort (13).

The 333-patient study by Aksu Uzunhan et al. linked clinically significant CT findings with seizures exceeding five minutes (14). Ali et al. examined 201 children, of whom 102 underwent imaging and 37 had abnormal findings; focal seizure onset remained associated with abnormal imaging after multivariable analysis (15). Woo et al. identified abnormalities in 95 of 323 children, with Todd's paralysis associated with increased odds of abnormal imaging, with an odds ratio of 3.72 and a 95% confidence interval of 1.03-13.36 with associations involving lactate and bilirubin concentrations; these laboratory associations concerned any imaging abnormality and did not establish a rule excluding urgent intracranial pathology (16).

Han et al. identified epileptogenic lesions in 84 of 222 children undergoing MIR, including 18 children with emergent findings, equivalent to 8.1% of the imaged cohort (17). Their rule, based on multiple seizures, events lasting at least five minutes, or developmental delay, achieved 100% sensitivity and 39.7% specificity for emergent magnetic resonance findings in its derivation cohort (17). These estimates measured clinical selection performance against MRI findings, rather than the verified

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sensitivity or specificity of either imaging modality against a separate reference assessment (17).

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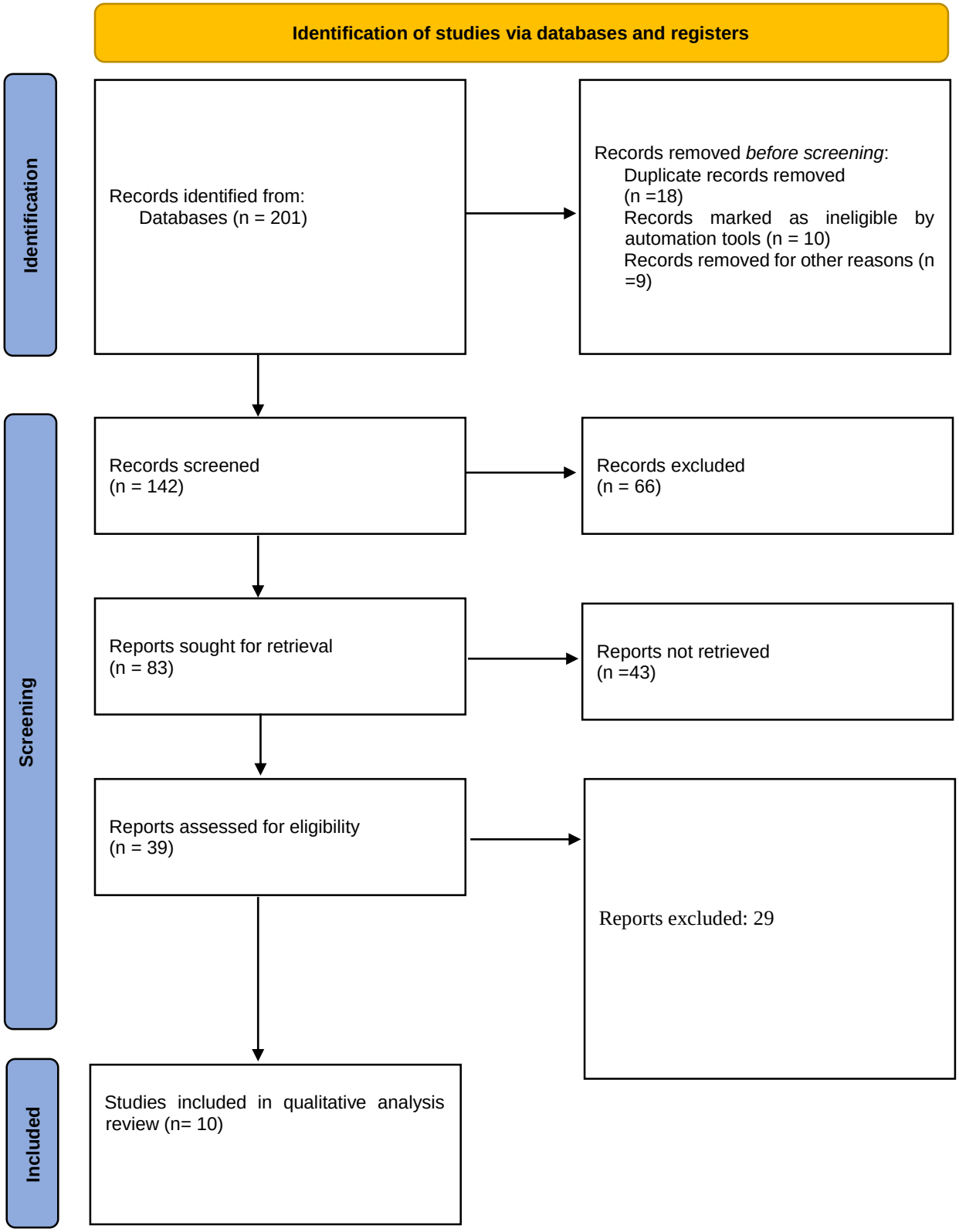


Figure 1: PRISMA flow chart

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Table 1. Characteristics and principal findings of the ten original reports

Study	Country and design	Cohort and imaging	Principal reported findings
Hsieh, 2010 (8)	USA; prospective infant pathway	317 infants aged 1-24 months; 298 CT, 182 MRI	Abnormal: CT 105/298; MRI 104/182; acute management affected by 27 CT examinations
Aprahamian, 2014 (9)	USA; retrospective focal-seizure cohort	319 imaged, aged 1 month-18 years	Urgent intracranial pathology: 13/319 (4.1%)
Dayan, 2015 (10)	USA; prospective, six EDs	475 enrolled, aged >28 days-18 years; 354 imaged	Relevant abnormalities: 40/354 (11.3%); urgent: 3/354 (0.8%)
Al-Shami, 2016 (11)	Qatar; retrospective ED cohort	96 imaged, aged <14 years	Abnormal: 32/96 (33%); greater yield below two years and with prolonged seizures
Besli, 2017 (12)	Turkey; retrospective ED cohort	173 imaged, aged 1-204 months; 36 received both modalities	Abnormal: 42/173 (24.3%); emergent: 9/173 (5.2%)
Amagasa, 2021 (13)	Japan; retrospective ED cohort	611 enrolled, aged <19 years; selectively imaged	Abnormal: 14 CT (4.2% of CT recipients); 26 CT/MRI (7.1% of recipients); six urgent findings
Aksu Uzunhan, 2022 (14)	Turkey; retrospective ED cohort	333 enrolled, aged 1 month-18 years	Significant CT findings associated with seizures exceeding five minutes
Ali, 2022 (15)	Pakistan; retrospective cross-sectional ED study	201 enrolled, aged 1 month-18 years; 102 imaged	Abnormal: 37/102; focal onset remained associated after adjustment
Woo, 2023 (16)	South Korea; retrospective, three EDs	323 analyzed, aged 1 month-18 years	Abnormal: 95/323 (29.4%); Todd's paralysis associated with abnormal imaging
Han, 2025 (17)	South Korea; retrospective MRI cohort	222 imaged, aged 0-18 years	Epileptogenic lesions: 84/222 (37.8%); emergent: 18/222 (8.1%, calculated)

Table 2. Additional MRI detection and clinical prediction performance

Study	Comparison or rule	Reported result	Interpretation
Hsieh (8)	MRI after normal CT	32/97 had abnormal MRI; one acute management change	Incremental detection in selectively verified CT-negative infants
Besli (12)	CT and MRI	9/36 had normal CT and abnormal MRI; one urgent infarct	Additional MRI detection; uniform independent verification absent
Han (17)	Any clinical risk factor predicting epileptogenic MRI lesions	Sensitivity 94.0%; specificity 55.1%	Clinical prediction accuracy against MRI findings
Han (17)	Same rule predicting emergent MRI findings	Sensitivity 100%; specificity 39.7%	Derivation performance; distinct from MRI test accuracy

Discussion

We found that the structural diagnostic yield and emergency therapeutic relevance represented different clinical outcomes. The multicenter prospective cohort identified clinically relevant abnormalities in approximately one ninth of imaged children, while urgent findings affected fewer than one in one hundred (10). Higher yields in selected infant and focal seizure populations reflected different clinical spectra, and their proportions did not establish a universal probability of urgent disease after every first afebrile seizure (3,7,9).

Earlier longitudinal findings provide useful context for this distinction, as Shinnar et al. identified

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abnormal imaging in 45 of 218 examined children while only four of the complete 411-child cohort had lesions requiring intervention. Their observation that magnetic resonance imaging identified migration abnormalities in children with normal neurological examinations also highlights the distinction between reassuring immediate assessment and a complete structural evaluation (18). Kalnin and colleagues reported any MRI abnormality in 31% of 281 children with first recognized seizures, compared with 14% having abnormalities classified as significant or potentially seizure related, illustrating the consequences of broader imaging definitions (19).

The additional yield of MRI is consistent with its role in detecting cortical malformations and other structural substrates that escape computed tomography, particularly when dedicated sequences and expert interpretation are available (4). Hourani et al. identified epileptogenic lesions in 26% of a prospective cohort of 1,000 children with new onset seizures, with developmental delay and seizure type retaining associations after multivariable analysis. This neurological population strengthens the rationale for etiological MRI while its inclusion criteria and diagnostic setting limit direct transfer of its yield to immediate emergency decisions (20).

Verma et al, reported abnormalities in 40 of 115 children with first unprovoked seizures in northern India, with inflammatory granulomas dominating the abnormal findings (21). Such differences reinforce the importance of local infectious disease patterns and referral populations when interpreting imaging proportions or adopting clinical selection criteria developed elsewhere (11,16,21). Imaging selection involves procedural burden: the Pediatric Sedation Research Consortium recorded airway events in 8.4% and serious events in 0.06% of 109,947 magnetic resonance related sedations, supporting individualized consideration of examination timing and sedation requirements (22).

The available clinical rules provide promising risk stratification and their reported sensitivity and specificity describe prediction of imaging findings rather than the accuracy of CT or MRI (13,17). Selective verification, retrospective ascertainment, variable imaging intervals, inconsistent lesion definitions, and differing developmental profiles limit comparison and prevent a defensible pooled imaging accuracy estimate from these reports, particularly when magnetic resonance imaging was preferentially obtained after concerning clinical findings or ambiguous tomography (8-17). Future prospective emergency cohorts require consecutive recruitment, standardized urgent lesion definitions, blinded reference assessment, and follow-up of nonimaged children, with evaluation of missed diagnoses and clinical consequences before a low risk classification is treated as an established discharge pathway (10,13,17).

Conclusion

Neuroimaging after a first afebrile seizure identified structural abnormalities more frequently than lesions requiring urgent intervention. MRI detected additional abnormalities following normal computed tomography, with immediate management changes occurring in a smaller subset. Focal manifestations, persistent neurological deficits, prolonged or multiple seizures, developmental delay, and younger age characterized higher yield populations across the reviewed reports. The findings support separating emergency lesion detection from subsequent etiological investigation and interpreting imaging results within the presenting clinical context.

List of abbreviations

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CT: Computed tomography.

ED: Emergency department.

ILAE: International League Against Epilepsy.

MRI: Magnetic resonance imaging.

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

USA: United States of America.

References

1. Fisher RS, Acevedo C, Arzimanoglou A, et al. ILAE official report: a practical clinical definition of epilepsy. Epilepsia. 2014;55(4):475-482. doi: 10.1111/epi.12550.
2. Hirtz D, Ashwal S, Berg A, et al. Practice parameter: evaluating a first nonfebrile seizure in children: report of the Quality Standards Subcommittee of the American Academy of Neurology, the Child Neurology Society, and the American Epilepsy Society. Neurology. 2000;55(5):616-623. doi: 10.1212/WNL.55.5.616.
3. Gaillard WD, Chiron C, Cross JH, et al. Guidelines for imaging infants and children with recent-onset epilepsy. Epilepsia. 2009;50(9):2147-2153. doi: 10.1111/j.1528-1167.2009.02075.x.
4. Bernasconi A, Cendes F, Theodore WH, et al. Recommendations for the use of structural magnetic resonance imaging in the care of patients with epilepsy: a consensus report from the International League Against Epilepsy Neuroimaging Task Force. Epilepsia. 2019;60(6):1054-1068. doi: 10.1111/epi.15612.
5. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet. 2012;380(9840):499-505. doi: 10.1016/S0140-6736(12)60815-0.
6. Miglioretti DL, Johnson E, Williams A, et al. The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. JAMA Pediatrics. 2013;167(8):700-707. doi: 10.1001/jamapediatrics.2013.311.
7. Winston GP, Salemme S, Cantalupo G, et al. Recommendations for structural magnetic resonance imaging in infants with first afebrile seizure or new onset epilepsy: evidence-based recommendations from the ILAE Neuroimaging Task Force. Epilepsia. Published online March 27, 2026. doi: 10.1002/epi.70205.
8. Hsieh DT, Chang T, Tsuchida TN, et al. New-onset afebrile seizures in infants: role of neuroimaging. Neurology. 2010;74(2):150-156. doi: 10.1212/WNL.0b013e3181c91847.
9. Aprahamian N, Harper MB, Prabhu SP, et al. Pediatric first time non-febrile seizure with focal manifestations: is emergent imaging indicated? Seizure. 2014;23(9):740-745. doi: 10.1016/j.seizure.2014.06.003.
10. Dayan PS, Lillis K, Bennett J, et al. Prevalence of and risk factors for intracranial abnormalities in unprovoked seizures. Pediatrics. 2015;136(2):e351-e360. doi: 10.1542/peds.2014-3550.
11. Al-Shami R, Khair AM, Elseid M, et al. Neuro-imaging evaluation after the first afebrile seizure in children: a retrospective observational study. Seizure. 2016;43:26-31. doi: 10.1016/j.seizure.2016.10.008.
12. Besli GE, Karatoprak EY, Saltık S, Özdoğan Ş, Özümüt S. First afebrile seizure in children: which patients require emergent neuroimaging? Journal of Pediatric Emergency and Intensive Care Medicine. 2017;4(2):47-52. doi: 10.4274/cayd.07108.

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13. Amagasa S, Uematsu S, Tsuji S, Nagai A, Abe Y, Kubota M. Identification of children with first afebrile seizure for whom neuroimaging is unnecessary. Seizure. 2021;93:140-144. doi: 10.1016/j.seizure.2021.10.022.
14. Aksu Uzunhan T, Kaçar A, Mısırlı Özdemir E, Yapıcı Ö. First afebrile seizures: clinical and radiological view with emergent testing. Pediatrics International. 2022;64(1):e15089. doi: 10.1111/ped.15089.
15. Ali N, Haider S, Mustahsan S, et al. Predictors of abnormal electroencephalogram and neuroimaging in children presenting to the emergency department with new-onset afebrile seizures. BMC Pediatrics. 2022;22:619. doi: 10.1186/s12887-022-03668-6.
16. Woo S, Nah S, Kim M, et al. Factors associated with neuroimaging abnormalities in children with afebrile seizure: a retrospective multicenter study. Western Journal of Emergency Medicine. 2023;24(2):279-286. doi: 10.5811/westjem.2022.12.57505.
17. Han J, Kim D, Chun MK, et al. When is brain MRI indicated for children with the first unprovoked seizure presenting to the pediatric emergency department? A retrospective cohort study. American Journal of Emergency Medicine. 2025;97:116-122. doi: 10.1016/j.ajem.2025.07.044.
18. Shinnar S, O'Dell C, Mitnick R, Berg AT, Moshé SL. Neuroimaging abnormalities in children with an apparent first unprovoked seizure. Epilepsy Research. 2001;43(3):261-269. doi: 10.1016/S0920-1211(00)00206-0.
19. Kalnin AJ, Fastenau PS, deGrauw TJ, et al. MR imaging findings in children with first recognized seizure. Pediatric Neurology. 2008;39(6):404-414. doi: 10.1016/j.pediatrneurol.2008.08.008.
20. Hourani R, Nasreddine W, Dirani M, et al. When should a brain MRI be performed in children with new-onset seizures? Results of a large prospective trial. AJNR American Journal of Neuroradiology. 2021;42(9):1695-1701. doi: 10.3174/ajnr.A7193.
21. Verma M, Kumar C, Alam A, et al. Role of neuroimaging in children with first unprovoked seizure: a prospective observational study. Epilepsy & Behavior. 2021;124:108317. doi: 10.1016/j.yebeh.2021.108317.
22. Mallory MD, Travers C, Cravero JP, Kamat PP, Tsze D, Hertzog JH. Pediatric sedation/anesthesia for MRI: results from the Pediatric Sedation Research Consortium. Journal of Magnetic Resonance Imaging. 2023;57(4):1106-1113. doi: 10.1002/jmri.28392.

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