

Retrospective Application of BRUE Criteria to Patients Presenting With ALTE

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OBJECTIVES: To apply recently published brief resolved unexplained events (BRUE) guidelines to patients who presented with apparent life-threatening event (ALTE) to determine: (1) characteristics of these patients; (2) which patients meet BRUE criteria, including risk stratification; and (3) patient outcomes.

METHODS: A retrospective chart review of patients presenting to the emergency department or directly to the inpatient unit of a community hospital was performed over the 3 years preceding publication of BRUE guidelines. *International Classification of Diseases, Ninth Revision* and *International Classification of Diseases, 10th Revision* billing data for infants <1 year of age were used to screen for patients. After 2-physician review, patients presenting with ALTE diagnostic criteria were identified. Characteristics of the patients and event were analyzed.

RESULTS: A total of 321 charts were screened, of which 87 patients were determined to have been diagnosed with ALTE. Twenty patients (23%) met criteria for diagnosis of BRUE. Only 1 patient met criteria for lower-risk BRUE. Of patients with ALTE, 79% of patients presented to the emergency department, of which 65% were admitted, 25% were discharged from the hospital, and 9% were transferred to a tertiary care hospital. Of the 63 inpatients, most were discharged from the hospital after brief observation, and 5% required transfer to a higher level of care.

CONCLUSIONS: The majority of patients with ALTE presenting to this institution did not meet the BRUE definition primarily because of ongoing symptoms and/or a specific diagnosis explaining the event. With this finding, we highlight the importance of characterizing the events on the basis of history and physical examination when diagnosing and caring for these patients.

ABSTRACT

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The diagnosis of an apparent life-threatening event (ALTE) was a common reason for infants to present to the hospital, but its definition, evaluation, and management were not previously standardized. The diagnosis of ALTE was notoriously difficult to uniformly manage because it included any event that appeared to be life-threatening to the caregiver.¹ Additionally, there were a vast number of serious diagnoses that could have presented as an ALTE, including child abuse, seizure, and infection, but more often the cause of the event was a benign disorder and/or physiologic infant behavior.²

In April 2016, new guidelines were published by the American Academy of Pediatrics to more specifically define this diagnostic entity as “brief resolved unexplained events” (BRUE).³ In comparison with ALTE, the BRUE criteria are less subjective and exclude patients with an obvious cause for the event or are still symptomatic at the time of presentation. The BRUE guidelines also provide a risk stratification and provide management recommendations for lower-risk BRUE. Lower-risk infants are older than 60 days, do not have a history of very preterm birth, and cannot have concerning historical features or an abnormal physical examination. Additionally, the event must have lasted <1 minute, cannot occur in clusters, and there can be no history of cardiopulmonary resuscitation (CPR) performed by a trained medical provider. Management guidelines for infants who are deemed higher risk are not offered because there was lack of evidence from which to base recommendations.

Our purpose in this study is to apply BRUE criteria to patients who presented to the hospital with ALTE to (1) determine the characteristics of these patients, (2) identify which patients with ALTE would meet BRUE diagnostic criteria, (3) establish the risk level of the patients meeting BRUE criteria, and (4) analyze patient outcomes.

METHODS

Study Population

A retrospective chart review of patients with ALTE was performed at an urban community hospital over the 3-year period before the publication of the BRUE guidelines (April

2013 through April 2016). On a yearly basis, the emergency department (ED) sees ~17 000 pediatric patients, and the pediatric inpatient unit has ~500 pediatric admissions, of which ~40% are directly admitted from primary care offices. Government insurance makes up 63% of the payer mix, followed by 36% private insurance and 1% self-pay. Inpatients are managed by pediatric hospitalists, and otolaryngologists and speech and occupational therapists are available for in-house consultation. Pediatric subspecialists are available for phone consultation, and if in-person consultation is necessary, the patient is transferred to a tertiary children's hospital. Patients are also transferred if they are in need of critical care services.

To identify patients presenting with ALTE, *International Classification of Diseases, Ninth Revision* (ICD-9) and *International Classification of Diseases, 10th Revision* (ICD-10) billing codes of infants <1 year presenting to the ED or pediatric floor were used to extract a list from the electronic medical record (EMR; Cerner Power Chart) (Table 1). These search criteria have been used in previously published studies to query the EMR for patients with ALTE.^{4,5} A 2-physician team separately reviewed the list of extracted patients to determine which patients qualified as having presented with ALTE on the basis of the previously accepted ALTE definition. A third physician was used in the case of disagreement. Patients were excluded from the study if they had any other apparent diagnosis at the time of presentation (such as bronchiolitis, febrile seizure, overt trauma, or child abuse), previous diagnosis of epilepsy, chronic respiratory or cardiac disease, or if they were re-presenting to the hospital with similar symptoms because only the first presentation was included. This study was approved by the hospital's institutional review board.

Data Collection

The patients who met inclusion criteria underwent chart review by 2 physicians who were blinded to the other physician's results. Demographic information, characteristics of the event, any testing that was performed, and patient outcomes were

TABLE 1 ICD-9 and ICD-10 Codes Searched

Diagnosis	ICD-9/ICD-10 Codes
ALTE	799.82/R69/R68.13
Altered mental status	780.97/R41.82
Apnea	786.03/R06.81
Breath-holding spell	786.9/R06.89
Choking	933.1/T17.308A
Gastroesophageal reflux	530.81/K21.9
Hypotonia	781.3/R29.898
Lethargy	780.79/R53.83
Other convulsions	780.39/R53.9
Pallor	782.61/R23.1
Seizure	780.39/R56.9
Sleep apnea	780.57/G47.30
Syncope	780.2/R55
Unresponsiveness	780.09/R41.89

collected. Specific characteristics of the event that are included in the new BRUE definition and are used for BRUE risk stratification were identified, including reported length of the event, whether there was an obvious cause for the event, and presence of concerning historical or physical examination features. If there was a discrepancy between the 2 physicians' data collection, the study leader reviewed the chart and came to a conclusion.

Missing Data

Because of the retrospective nature of this study, some of the information that was being collected was not documented in the patient chart. While collecting data, it was noted if key event characteristics that define BRUE (cyanosis; pallor; absent, decreased, or irregular breathing; tone change; or altered mental status) were not documented. Patients with ALTE were excluded from BRUE classification if there was an explanation for the event or if they had an abnormal review of systems or physical examination. It was presumed that if these were not documented in the chart, then they were normal. It was also noted if there were missing data required for risk stratification. One of the criterion for lower-risk BRUE is that CPR cannot have been performed by a health care provider. It was presumed that if CPR had been performed, it would have been reported, so this was not used as an exclusion from lower risk if it was not reported.

Data Analysis

Descriptive statistics were performed in R (R Core Team).⁶ An unweighted Cohen's κ statistic was used to assess interrater reliability between physicians reviewing charts for study exclusion. Confidence intervals were calculated with an α of .05.

RESULTS

A total of 321 charts were identified from the EMR over the 3-year study period on the basis of ICD-9 and ICD-10 codes and age criteria. After excluding charts without complete EMR documentation, revisits for similar complaints, and a patient leaving without being seen, 311 charts were reviewed by 2 physicians (interrater reliability: 93.9%; $\kappa = 0.85$; 95% confidence interval: 0.78–0.92). In the 19 cases of disagreement, a third physician arbitrated the final decision for inclusion. Four additional patients were excluded because they were found to have a previous diagnosis of either cardiac disease or epilepsy. Ultimately, 87 patients were determined to have presented to the hospital with ALTE (Fig 1).

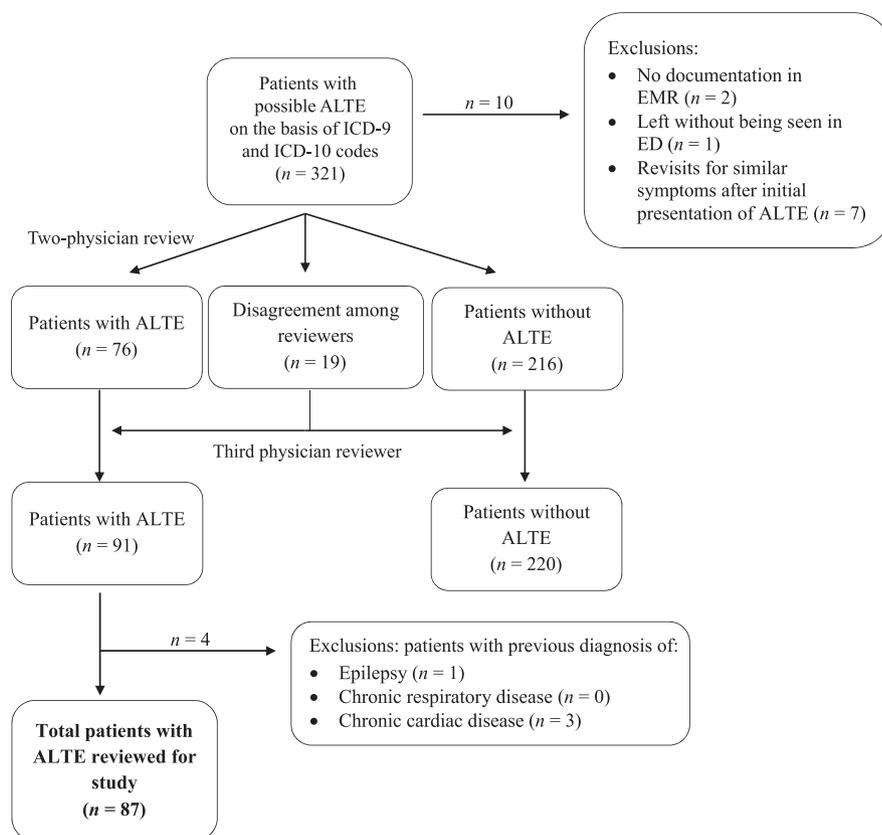


FIGURE 1 Chart review results.

Application of the BRUE Definition

Twenty patients (23.0%) would have been diagnosed with BRUE according to the new definition. The patients who did not qualify as having had a BRUE ($n = 67$) had an obvious cause for the event (eg, choking) ($n = 43$, 64.2%), respiratory symptoms on examination or by history ($n = 29$, 43.3%), and/or were not well-appearing, had neurologic symptoms on examination, or had notable abnormal vital signs ($n = 11$, 16.4%). Only 1 patient met criteria for lower-risk BRUE (5% of patients with BRUE and 1.1% of all patients). Of the patients who met BRUE criteria, patients did not meet lower-risk criteria because age was <60 days ($n = 9$, 45%), the event lasted more than 1 minute ($n = 12$, 60%), corrected gestational age was <45 weeks ($n = 8$, 40%), and/or the event was not the first event ($n = 6$, 30%).

Patient Characteristics and Outcomes

Patient characteristics and outcomes of patients with ALTE compared with patients who would have been diagnosed with BRUE

are described in Table 2. The patients with ALTE (ie, all patients inclusive of patients with BRUE) had a median age of 38 days (interquartile range: 16.5–60.0 days; range: 3–330 days). The patients with BRUE had a median age of 56 days (interquartile range: 29–67.5 days; range: 3–330 days).

Of the patients with ALTE who presented initially to the ED, 65.2% were admitted to the pediatric floor, 24.6% were deemed safe for discharge from the hospital, and 8.7% were transferred to a pediatric tertiary care center. One patient left the ED against medical advice. Most patients who were discharged from the hospital directly from the ED did not have a final discharge diagnosis of ALTE ($n = 12$, 70.6%) but rather a diagnosis that could explain the reason for the event for which they presented to the ED (eg, gastroesophageal reflux). Two of these patients had a discharge diagnosis of ALTE plus an additional diagnosis explaining the event (11.7%), and 3 of these patients were discharged directly from

the ED with a discharge diagnosis of ALTE only (17.6%).

Of the patients who were admitted to the pediatric floor ($n = 63$), 60 patients were discharged from the hospital (95.2%), and 3 patients were transferred to a tertiary center (4.8%). The average length of stay (measured from time of registration to time of discharge order) of the patients with ALTE was 27.4 hours (minimum 4 hours, maximum 142 hours, median 23 hours). The average length of stay for the BRUE subset of patients was 20.8 hours (minimum 4 hours, maximum 41 hours, median 20 hours). Seventeen patients (19.5%) had at least 1 recurrent event in the hospital, either in the ED or on the pediatric floor. Of the 9 patients who were transferred to a tertiary care center, the majority were transferred because of recurrent episodes in either the ED or on the pediatric floor, and they required either critical care or subspecialty consultation. One patient was transferred to a pediatric tertiary care

TABLE 2 Patient Characteristics, Outcomes, and Missing Data in Patients With ALTE Versus Patients With BRUE

	Patients Diagnosed With ALTE	Patients With ALTE Who Meet BRUE Criteria
Patient characteristics, <i>n</i>	87	20
Median age, d	38	56
Female sex, <i>n</i> (%)	55 (63.2)	13 (65)
Initial presentation to ED, <i>n</i> (%)	69 (79.3)	17 (85)
Direct admission to pediatric floor, <i>n</i> (%)	18 (20.7)	3 (15)
Disposition of ED patients, <i>n</i> (%)	69	17
Admit to pediatric floor	45 (65.2)	9 (52.9)
Discharge from the hospital	17 (24.6)	7 (35)
Transfer to tertiary-care center	6 (8.7)	0 (0)
Leave against medical advice	1 (1.4)	1 (5.9)
Disposition of floor patients, <i>n</i> (%)	63	12
Discharge from the hospital	60 (95.2)	12 (100)
Transfer to tertiary-care center,	3 (4.8)	0 (0)
Additional patient outcomes, <i>n</i> (%)	87	20
Recurrent events in the hospital (ED or floor)	17 (19.5)	2 (10)
Re-presentation within 30 d with similar complaint	6 (6.9)	1 (5)
Data not documented in chart, <i>n</i> (%)	87	20
Cyanosis	6 (6.9)	2 (10)
Pallor	44 (50.6)	9 (45)
Irregular breathing	8 (9.2)	1 (5)
Tone change	39 (44.8)	7 (35)
Altered level of consciousness	42 (48.2)	8 (40)
Event >1 min	15 (17.2)	2 (10)
Born <32 wk or corrected gestational age <45 wk	6 (6.9)	1 (5)
Cluster of events	2 (2.3)	0 (0)

missing required data (corrected gestational age and duration of event). Two of these patients were excluded from lower-risk characterization regardless, on the basis of other criteria. One patient, however, may have met lower-risk BRUE criteria if the length of the event was reported.

DISCUSSION

Our purpose in this study was to apply the new BRUE guidelines to patients who had previously presented with ALTE to determine how many would have fit into the lower-risk BRUE category and presumably could have undergone minimal workup and avoided hospitalization. Notably, we found that only 23% of all patients identified by the chart review as having presented with ALTE met the new BRUE classification, and only 1 patient met lower-risk BRUE criteria.

The BRUE classification excludes patients who present with symptoms that had an obvious cause, such as choking, which was the reason the majority of the patients with ALTE in this study were excluded. Historically, patients diagnosed with ALTE typically underwent a highly variable and often extensive workup. The wide-ranging differential diagnosis presented difficulty to the clinician evaluating a patient with ALTE. Because of the clinical uncertainties and anxiety surrounding such an episode, there was significant variation in practice.⁷ The ramifications of an ALTE diagnosis extended beyond the workup and treatment itself, ranging from increased health care and patient costs to potentially leading to increasing parental anxiety. The BRUE definition may allow providers not to be compelled to admit or pursue extensive workup for patients who present with an event caused by choking or other obvious cause. In our study, we show that there may be far fewer patients with BRUE than patients who would have been previously diagnosed with ALTE, thus potentially diminishing the costs, both financial and psychosocial, associated with this former diagnosis.

The finding that only 1 of the 87 patients included in this study met the criteria for lower-risk BRUE was unexpected.

center for observation because there were no pediatric beds available at the community hospital. Six patients re-presented either to the ED or the pediatric floor within 30 days after they had recurrent events at home (6.9%).

Of all the patients reviewed, 64 patients (73.6%) had a discharge diagnosis of ALTE. Additionally, 25 patients (28.7%) were diagnosed with gastroesophageal reflux. Other discharge diagnoses included choking (*n* = 8, 9.2%), apnea (*n* = 4, 4.6%), viral upper-respiratory infection (*n* = 3, 3.4%), breath-holding spell (*n* = 3, 3.4%), altered mental status (*n* = 2, 2.3%), hypotonia (*n* = 2, 2.3%), cyanosis of the newborn (*n* = 2, 2.3%), and bronchiolitis (*n* = 2, 2.3%). The following discharge diagnoses were made in 1 patient each (*n* = 1, 1.1%): apnea of the

newborn, bradycardia, constipation, dyspnea, failure to thrive, fever, jaundice, meningitis, milk protein allergy, overfeeding infant, seizure, and vomiting.

Of all of the patients with ALTE reviewed, 43 patients had at least 1 laboratory or radiographic test performed (49.4%). In Table 3, we show the number of patients who had specific testing.

Missing Data

All of the patients had at least 1 of the defining BRUE characteristics (cyanosis; pallor; absent, decreased, or irregular breathing; tone change; or altered mental status); however, many charts did not have all of these event characteristics documented (Table 2). When risk stratifying the patients with BRUE, 3 charts were

TABLE 3 Laboratory and Radiographic Testing Performed on All Patients With ALTE Versus Patients With BRUE

Test	Patients With ALTE, <i>n</i> = 87, <i>n</i> (%)	Patients With BRUE, <i>n</i> = 20, <i>n</i> (%)
Any laboratory or radiologic testing	43 (49.4)	8 (40)
Complete blood count	23 (26.4)	4 (20)
Blood culture	11 (12.6)	0 (0)
Cerebrospinal fluid analysis	4 (4.6)	0 (0)
Basic metabolic panel	20 (23.0)	5 (25)
Pertussis testing	1 (1.1)	0 (0)
Rapid RSV	13 (14.9)	1 (5)
Rapid influenza	6 (6.9)	1 (5)
Respiratory viral panel	1 (1.1)	1 (5)
Urinalysis	10 (11.5)	2 (10)
Blood glucose	21 (24.1)	6 (30)
Lactate	1 (1.1)	0 (0)
Chest radiograph	12 (13.8)	2 (10)
Head computed tomography	5 (5.7)	1 (5)
Head ultrasound	1 (1.1)	0 (0)
pH probe	1 (1.1)	0 (0)
Abdominal ultrasound	1 (1.1)	0 (0)
Electrocardiogram	13 (14.9)	2 (10)

RSV, respiratory syncytial virus.

Perhaps this reflects that BRUE cases presenting to the hospital (as opposed to a primary care physician's office) have a greater chance of being higher risk. Additionally, our results could have been skewed to higher risk because of the high proportion of direct admissions seen at this institution. Or, it may signify an epidemiologic trend that, overall, a greater proportion of patients with BRUE are higher risk. It must also be considered that 12 patients were deemed higher risk on the basis of events lasting >1 minute, which can be difficult to accurately assess from parents and caregivers. The high proportion of higher-risk patients with BRUE compared with lower-risk patients does suggest that the development of management guidelines for higher-risk patients with BRUE would be useful.

Additionally, it was interesting that among all patients, regardless of perceived risk, there was impressive variability in testing, as noted in Table 3. The importance for standardization of testing guidelines is highlighted in this variability.

There are a few limitations that must be kept in mind when reviewing these results. First, as noted above in our results, only a small number of patients actually met the BRUE criteria, so when stratified by risk, the number in each group was even smaller. The proportion of patients classified as lower versus higher risk also may not be generalizable because of the small numbers of this study, the high number of direct admissions, and the community hospital setting. Additionally, as is often the case with studies in which retrospective chart review is involved, key aspects of the history that had implications on BRUE risk stratification were often not documented (such as length of time of event). On review of the missing data, however, undocumented history only affected 1 patient who may have been characterized as lower risk had the length of time of the event been documented. Undocumented history or abnormal physical examination findings may have also falsely increased the number of patients who were characterized as BRUE in this study because if the history and physical examination documented in

the chart did not suggest an explanation for the event, the patient was classified as BRUE. Furthermore, there is an element of subjectivity in the interpretation of the descriptions of the events. Although our 2-physician-review approach reduces some of this variability, it does not eliminate it. Finally, this is a single-center study at a community hospital and may not be generalizable to other settings with different patient populations.

In the future, a larger cross-sectional prospective study could be conducted to better characterize the actual distribution of lower- versus higher-risk BRUE. Given the high percentage of higher-risk BRUE, further research should be conducted into the outcomes of these higher-risk patients to help better identify guidelines for care and testing in this population. Moreover, the finding that so many patients presenting with ALTE did not meet BRUE classification emphasizes the need to work on implementing these guidelines in outpatient settings because the majority of these patients may not need hospitalization.

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