

Pediatric Anaphylaxis in the Emergency Department

Clinical Presentation, Quality of Care, and Reliability of Consensus Criteria

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Objectives: The objective of this study was to describe the quality of emergency department (ED) care for pediatric patients with anaphylaxis. The secondary objectives were to describe (1) the clinical presentation of pediatric patients with anaphylaxis including the proportion of patients meeting each of the National Institute of Allergy and Infectious Diseases (NIAID) consensus criteria and subcriteria and (2) the Interrater reliability (IRR) for applying the NIAID criteria.

Methods: We conducted a retrospective cross-sectional chart review of patients seen in a pediatric ED during a 2-year period. All charts were reviewed by a trained chart reviewer with 10% abstracted by a second reviewer. Data were analyzed using descriptive statistics including proportions, medians, and interquartile range. Interrater reliability was calculated using Cohen unweighted κ or percent agreement.

Results: Of the 250 charts reviewed, 84% (211) met the NIAID criteria for anaphylaxis (IRR, 1.0). Only 68% of patients received epinephrine in the ED or within 3 hours of the ED visit. Adherence was poor and IRR was variable, for measures reflecting documentation of discharge instructions and follow-up with a specialist. The IRR of reviewers for determining which patients met the NIAID criteria overall and for each subcriterion was high.

Conclusions: Our findings highlight a gap between best practice and ED care. In addition, our results suggest that the NIAID criteria can reliably be used to retrospectively identify pediatric patients with anaphylaxis. Accurately identifying cases is a prerequisite for measuring gaps in management and developing interventions to improve care.

Key Words: anaphylaxis, interrater reliability, quality of care, pediatrics

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Anaphylaxis is a severe, potentially fatal allergic reaction, which involves multiple organ systems (cardiovascular, gastrointestinal, respiratory, and/or dermatologic).¹ Although the reported incidence and prevalence of anaphylaxis vary widely depending on study design and setting, most studies conclude that the incidence has increased in the past decades.² Research and guidelines support the use of intramuscular (IM) epinephrine as the first-line treatment for anaphylaxis.³ Recent work based on best evidence and expert consensus prioritized measures reflecting the receipt of epinephrine via the appropriate route as an important quality indicator when managing anaphylaxis.⁴ Unfortunately, previous studies have documented poor adherence to guidelines for treating anaphylaxis and variable receipt of IM epinephrine in the emergency settings where most cases of anaphylaxis are managed.^{5,6}

Low use of a standard definition of anaphylaxis in the emergency department (ED) setting has been identified as a potential explanation for the gap between evidence and practice, despite a widely disseminated consensus definition of anaphylaxis (Table 1).⁷ However, it is difficult to determine whether the low proportion of patients treated with epinephrine in previous studies is due to underdiagnosis, suboptimal management of anaphylaxis, or due to misclassification (ie, conditions of patients who do not meet clinical criteria for anaphylaxis are diagnosed/coded as anaphylaxis). Research on the retrospective application of the National Institute of Allergy and Infectious Disease (NIAID) criteria showed that the criteria have a high sensitivity and are likely to be useful in the ED for the diagnosis of anaphylaxis.⁸

The objective of this study was to describe the quality of ED care for pediatric patients with anaphylaxis, as defined by the NIAID definition. The secondary objectives were to describe (1) the clinical presentation of pediatric patients with anaphylaxis including the proportion of patients meeting each of the NIAID criteria (1, 2, and 3) and subcriteria (ie, respiratory compromise, reduced blood pressure [BP]) and (2) the interrater reliability (IRR) of the NIAID consensus criteria, overall and for each criteria, in retrospectively identifying pediatric patients with anaphylaxis.

METHODS

This was a retrospective cross-sectional chart review of patients seen in a pediatric ED during a 2-year period (January 2009–December 2010) with anaphylaxis as defined by the NIAID consensus definition.⁷ The Alberta Children's Hospital is an urban, tertiary care pediatric hospital in the City of Calgary, with an ED census of approximately 70,000 patients per year. For this study, patients were identified using the *International Classification of Diseases, Tenth Revision, (ICD-10)* diagnostic codes. Two hundred fifty charts with ICD-10 codes indicating anaphylactic reaction due to food, serum, medication, or anaphylactic shock unspecified were reviewed. All charts were reviewed by a trained chart reviewer with 10% of the charts abstracted by a second reviewer. A standardized database (ACCESS 2010), piloted on a randomly selected sample of 10 patient visits, was used to collect demographic and clinical data. The data collected included the following: age, sex, triage category (based on the Canadian Triage and Acuity Scale (CTAS))⁹ type of exposure, organ system involvement, length of stay in the ED, management in the ED, discharge instructions, and disposition.

The quality of ED care was measured by performance on quality indicators developed on the basis of a review of the existing literature and expert consensus.⁴ Receipt of epinephrine in the ED (or in 3 hours before ED visit) and receipt of epinephrine in ED by the appropriate route are the indicators prioritized by an expert panel.⁴ Data were analyzed using descriptive statistics including proportions, medians, and interquartile range (IQR). Interrater reliability was calculated using Cohen unweighted κ or percent agreement in cases where κ was undefined.¹⁰ Ethics approval for

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TABLE 1. National Institute of Allergy and Infectious Diseases Clinical Criteria for Diagnosing Anaphylaxis*

Anaphylaxis is highly likely when 1 of the following 3 criteria is met:

1. Acute onset of an illness (minutes to several hours) with involvement of the skin, mucosal tissue, or both (eg, generalized hives, pruritus or flushing, swollen lips-tongue-uvula)
AND AT LEAST 1 OF THE FOLLOWING:
 - a. Respiratory compromise (eg, dyspnea, wheeze-bronchospasm, stridor, reduced PEF, hypoxemia)
 - b. Reduced BP or associated symptoms of end-organ dysfunction (eg, hypotonia [collapse], syncope, incontinence)
2. Two or more of the following that occur rapidly after exposure to a likely allergen for that patient (minutes to several hours):
 - a. Involvement of the skin-mucosal tissue (eg, generalized hives, itch-flush, swollen lips-tongue-uvula)
 - b. Respiratory compromise (eg, dyspnea, wheeze-bronchospasm, stridor, reduced PEF, hypoxemia)
 - c. Reduced BP or associated symptoms (eg, hypotonia [collapse], syncope, incontinence)
 - d. Persistent gastrointestinal symptoms (eg, crampy abdominal pain, vomiting)
3. Reduced BP after exposure to known allergen for that patient (minutes to several hours):
 - a. Infants and children: low systolic BP (age specific) or more than 30% decrease in systolic BP
 - b. Adults: systolic BP less than 90 mm Hg or more than 30% decrease from baseline

*Sampson HA, Munoz-Furlong A, Campbell RL, et al. Second symposium on the definition and management of anaphylaxis: summary report—Second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium. *J Allergy Clin Immunol*. 2006;117(2):391–397.

PEF indicates peak expiratory flow.

this study was obtained by the conjoint research ethics board of the University of Calgary.

RESULTS

Of the 250 charts reviewed, 84% (211) met the NIAID criteria for anaphylaxis as determined by the chart reviewers ($\kappa = 1.0$). Although it is difficult to determine retrospectively, the 39 patients who did not meet the NIAID criteria were likely miscoded as anaphylaxis. All of the 39 patients had only a single system involved (38 skin, 1 gastrointestinal), and none of them received epinephrine in the ED. Table 2 shows the demographic and clinical characteristics of the 211 patients with anaphylaxis. Table 3 shows the quality of care for the patients with anaphylaxis. Thirty-three percent ($n = 69$) of patients received epinephrine in the 3 hours before the ED visit, and of those, 5% ($n = 11$) received a dose in the ED. Of the 69 patients who received epinephrine before the ED visit, 97% received the epinephrine IM or via epi-pen, 1% subcutaneous, and 1% via an intravenous route. For the patients who received epinephrine in the ED ($n = 82$), 6 patients received 2 doses and 1 patient received 3 doses. Table 4 shows the proportion of patients meeting each criteria, each subcomponent, and the IRR (or proportion agreement where the Cohen κ was undefined). Most patients (81%) met more than 1 criteria, no patients met only criteria 3 (isolated reduced blood pressure). The most common organ system involved was skin-mucosal tissue, followed by respiratory compromise and gastrointestinal symptoms.

A very small proportion of patients had reduced blood pressure. The IRR was high for each subcomponent of the NIAID criteria.

DISCUSSION

We described a retrospective chart review of 211 patients who presented to a pediatric ED with anaphylaxis as defined by the NIAID criteria. The results of this study contribute to the existing literature by providing the following: (1) further evidence of gaps in the quality of ED care for patients with anaphylaxis, (2) support for the reliability of the NIAID criteria in retrospectively identifying pediatric patients with anaphylaxis, and (3) data on the clinical presentation of anaphylaxis in the ED setting.

Current guidelines for anaphylaxis recommend the following: (1) diagnosis using standard criteria, (2) first-line treatment with epinephrine, and (3) discharge with a prescription for an epinephrine auto-injector, written instructions regarding long-term management, and a referral for follow-up.^{3,11} Timely use of IM epinephrine is deemed the first-line treatment for anaphylaxis and is an important indicator for care quality.⁴ However, only 68% of patients in our study had documentation of epinephrine receipt either in the ED or in 3 hours before their visit. Of note, Most patients (94%) who received epinephrine in the ED did receive it by the appropriate route (IM). Despite the publication of guidelines that emphasize the importance of epinephrine, our results highlight the gap between optimal care and practice. Two studies in pediatric ED settings suggested that the introduction of an anaphylaxis protocol⁶ and a standard order form¹² improved anaphylaxis care including administration of epinephrine and the prescription of EAI. Although both studies had limitations, including small sample size and before-after design, these results suggest that there is the potential for improvement and that awareness of guidelines,

TABLE 2. Patient Characteristics ($n = 211$)

Age, y	
Median	7.33
IQR	9.8
Maximum	17.9
Sex, male, %	64
Triage category,* %	
1 (requires resuscitation)	5
2 (emergent)	45
3 (urgent)	47
4 (less urgent)	4
Length of stay, min	
Median	245
IQR	125
Maximum	658
Discharge disposition, %	
Discharged home	98.10
Admitted—intensive care unit	0.90
Deceased	0.50
Unknown/not charted	0.50
Allergy to food or insect	
Yes	82
No	7
Unknown/not charted	11

*Warren D, Jarvis A, Leblanc L; the National Triage Task Force members. Canadian Paediatric Triage and Acuity Scale: implementation guidelines for emergency departments. *Can J Emerg Med*. 2001;3(suppl 4):S1–S27.

TABLE 3. Quality of ED Care

Indicator	Indicator Results	κ With 95% CI (n = 23)
% of patient visit with:	% (n/N)	
Epinephrine given in ED (or in 3 hours before ED visit)	68 (144/211)	0.89 (0.68, 1.00)
Epinephrine given in ED by the appropriate route*	94 (77/82)	0.68 (0.27, 1.00)
Documentation of EAI at discharge	85 (180/211)	0.02 (0.00, 0.25)
Documentation of discharge instructions to avoid offending allergen [†]	17 (29/173)	0.41 (0.26, 0.92)
Documentation of instruction for epinephrine self-administration	38 (81/211)	0.39 (0.00, 0.79)
Documentation of specialist referral	56 (119/211)	1.00 (1.00, 1.00)

*Denominator is patients given epinephrine in ED.

[†]Denominator is patients with reaction to food or insect sting.

CI indicates confidence interval.

physician comfort with the management of anaphylaxis, and concerns about potential adverse effects may account in part for the gap between practice and recommended management.

We also identified gaps in care with respect to patient education and follow-up. Guidelines for optimal outpatient management and follow-up for anaphylaxis include the following 3 steps: auto-injector epinephrine prescription, patient education, and follow-up with an allergist.^{3,11} The documentation of EAI prescriptions at discharge had the highest compliance (85%) with guidelines. However, the IRR for this indicator was very low. Overall, the indicators that were based on chart documentation measurements had variable results with respect to adherence and IRR. A better understanding of compliance with these documentation-based indicators requires either better documentation or the use of alternate data sources such as pharmacy data, physician billing data, and patient/family report.

Despite the presence of the NIAID criteria in both the allergy and emergency medicine literature, a survey conducted⁵ in North American EDs found that the primary gap identified in anaphylaxis management is low use of a standard definition for anaphylaxis. Overall, 90% of EDs in the survey did not use a formal definition of anaphylaxis to diagnose patients. Lack of a definition affects all components of care, and it has been estimated that at

least 50% of anaphylaxis episodes are misdiagnosed in the ED when the diagnostic criteria of guidelines are not used.⁵ Our results support the utility of the NIAID criteria in retrospectively identifying anaphylaxis as evidenced by the high IRR when applying criteria to chart review. The IRR was high for both determining whether a patient meets the criteria overall ($\kappa = 1.0$) and for the proportion of patients meeting each subcomponent of the criteria. Our results on the reliability of the NIAID criteria in retrospectively identifying patients with anaphylaxis are consistent with previous work. For example, the charts of 214 ED patients (adult and pediatric) were reviewed by chart reviewers and by 2 experienced allergists (considered the reference standard). The chart reviewers and allergists had substantial agreement ($\kappa = 0.70$) regarding the diagnosis of anaphylaxis.⁸ Our results substantiate that the NIAID criteria can be reliably applied in the pediatric ED setting.

With respect to clinical presentation, only 2 patients (1%) in our sample met criterion 3 (reduced blood pressure after exposure to a known allergen for that patient). Both of these patients also had involvement of the skin or mucosa and had respiratory symptoms; therefore, they also met criterion 1 and 2. Previous work in the ED setting⁸ also found that only a small proportion of patients (5%) met criterion 3, and these patients also met criterion 1 and 2.

TABLE 4. Proportion of Patients Meeting Each Subcomponent of the National Institute of Allergy and Infectious Diseases Criteria With IRR

Criteria	Proportion of Patients (%) Meeting Criteria (n = 211)	Proportion of Patients (%) Meeting Subcriteria (n = 211)	Cohen Unweighted κ (95% CI) (n = 23)	Proportion of Agreement (95% CI) (n = 23)
Criteria 1:	81			
a. Respiratory compromise		80	0.71 (0.40–1.00)	0.87 (0.65–0.97)
b. Reduced blood pressure or associated symptoms of end-organ dysfunction		2	Undefined	1.00 (0.82–1.00)
Criteria 2:	99.5			
a. Involvement of skin-mucosal tissue		98	1.00 (1.00–1.00)	1.00 (0.82–1.00)
b. Respiratory compromise		82	0.71 (0.40–1.00)	0.87 (0.65–0.97)
c. Reduced blood pressure or associated symptoms		3	Undefined	1.00 (0.82–1.00)
d. Persistent gastrointestinal symptoms		44	0.82 (0.59–1.00)	0.91 (0.70–0.98)
Criteria 3:	1			
Reduced blood pressure		1	Undefined	1.00 (0.82–1.00)

This suggests that in the ED setting, isolated hypotension is a rare presentation for anaphylaxis. Overall, only 3% of patients in our study who met the criteria for anaphylaxis had low blood pressure as a subcriterion (3%). However, both patients admitted to the intensive care unit and the 1 deceased patient all experienced low blood pressure. Similar work in a pediatric ED setting¹³ also reported a low proportion (8%) of anaphylaxis patients with cardiovascular system involvement and showed that patients who were admitted to hospital were more likely to have hypotension than those that were discharged from the ED. These findings suggest that hypotension, although rare in the ED presentation of anaphylaxis, may be a marker of severity. In our study, 98% of patients were discharged home from the ED, in contrast to previous work where 26% were admitted.¹³ The reason for this notable difference in admission rates is unclear but may be due to differences in practice regarding admission and ED length of stay. The median length of stay in our study was 245 minutes, compared with 150 minutes (reported only for patients who were not admitted) in the Russell study, which likely represents differences in institutional practice regarding length of observation in the ED.

One of the strengths in our study compared with previous work on pediatric patients with anaphylaxis is our larger sample size.^{6,12,13} In much of the existing literature on anaphylaxis in the pediatric ED setting, charts were only reviewed by 1 investigator.^{12,13} Including independent review of a sample of charts by 2 experienced chart reviewers enabled us to evaluate the IRR of the NIAID criteria in retrospectively identifying pediatric patients with anaphylaxis.

A limitation of our study and most of the existing literature on pediatric anaphylaxis in the ED setting are its retrospective nature. Much of our data on ED management, with the exception of medications, which are based on electronic order entry, are dependent on what is or is not documented in the chart. As a result, we cannot accurately determine whether lack of adherence to guidelines represent gaps in care or poor documentation. Another potential limitation is that we only included patients with ICD-10 coding for anaphylaxis and not other codes such as allergic reaction. This may have resulted in an underrepresentation of the true incidence of anaphylaxis during our 2-year study period. Similarly, we may have also underestimated the proportion of patients who should have received epinephrine but did not. At the outset of the study, we reviewed a random sample of charts (n = 100), which were coded as allergic reaction, and none of them met the criteria for anaphylaxis. As a result, the impact of misclassification on our results is likely to be very small.

Anaphylaxis is a life-threatening condition with most cases managed in an ED setting. This work contributes to the existing body of literature by providing information on the clinical presentation and management of anaphylaxis in a pediatric ED. Our findings highlight a gap between best practice and ED care. To the best of our knowledge, this is the first study in a pediatric ED setting to provide data on the IRR of the NIAID criteria in retrospectively identifying patients with anaphylaxis. Accurately identifying cases

is a prerequisite for measuring gaps in management and developing interventions to improve care. Future work should include prospective, multicenter data collection on pediatric patients with anaphylaxis. This should include the application of consensus criteria by more than 1 provider to evaluate the real-time IRR and diagnostic test characteristics of the criteria. Future work should also focus on identifying barriers to optimal care, elucidating factors, such as hypotension, that might predict severity, and evaluating the impact of knowledge translation and quality improvement initiatives on care processes and patient outcomes.

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