Original Article

Increased Use of Adrenaline in the Management of Childhood Anaphylaxis Over the Last Decade

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What is already known about this topic? Emergency department physicians play a key role in identifying and addressing anaphylaxis. However, there is evidence that adrenaline has been significantly underused in this life-threatening condition and other management and follow-up procedures have been suboptimal.

What does this article add to your knowledge? This is the first study to find evidence that identification and management of anaphylaxis in a pediatric emergency department (PED) significantly improved over a 10-year period after an intensified training program for medical staff and improved interdisciplinary cooperation.

How does this study impact current management guidelines? The use of well-developed training programs for the recognition, management, and follow-up of anaphylaxis in the PED environment is urgently required. PEDs and allergy/immunology departments need to cooperate to optimize anaphylaxis education and management.

BACKGROUND: We recently determined that allergy training programs have improved physician recognition and diagnosis of pediatric anaphylaxis in the last decade.

OBJECTIVE: To investigate for changes in management, in particular the appropriate use of adrenaline for the treatment of anaphylaxis in a tertiary pediatric emergency department (PED).

METHODS: We conducted a retrospective case note study including children aged 0 to 16 years coded and verified for anaphylaxis comparing cases in years 2003/2004 with 2012. This included standardized information on clinical presentation, demographic characteristics, vital signs, mode of transport, and management of anaphylaxis including the use of adrenaline and/or adjunct therapy. Follow-up management plans were also recorded.

RESULTS: In 2003/2004, a total of 92 cases were coded and verified for anaphylaxis from 83,832 PED presentations compared with 159 cases from 71,822 PED presentations in 2012. A significantly higher proportion of cases were appropriately managed with adrenaline in 2012 compared with 2003/2004, when intensive training programs had not yet been introduced ($P = .03$). Vital signs were more frequently documented in 2012 ($P < .001$) than in 2003/2004, and there was significantly less administration of other medications (corticosteroids, bronchodilators, and antihistamines) ($P < .05$). Also, changes in discharge management occurred with an improved dispensing/prescription of adrenaline autoinjectors and more frequent follow-up arrangement with specialist allergy services ($P < .001$).

CONCLUSIONS: There was a significant improvement in the management of anaphylaxis over this 10-year period. This change was observed after the introduction of intensified physician training programs in which anaphylaxis management was a key component highlighting the importance of cooperation between pediatric emergency and allergy services. © 2018 Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2017;■:■-■)

Key words: *Childhood; Anaphylaxis; Food allergy; Physician training; Anaphylaxis management; Adrenaline*

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Abbreviations used
GP- general practitioner
ICD-10- International Classification of Diseases, Tenth Revision
PED- pediatric emergency department

INTRODUCTION

Anaphylaxis is a severe and potentially fatal systemic allergic reaction involving 2 or more organ systems within minutes to a few hours after contact with allergy-causing substances.[1] The dramatic increase in anaphylaxis has occurred in parallel to the worldwide increase in allergic diseases in general, particularly in the pediatric population.[2-5] Prompt treatment with adrenaline, the only first-line intervention for anaphylaxis, is recommended for all age groups to prevent potentially fatal progression. However, there is evidence that adrenaline has been significantly underused.[6-8] Although other drugs are often given in anaphylaxis including H_1 antihistamines, corticosteroids, and inhaled β_2-sympathomimetics,[9,10] there is limited evidence for the effectiveness of these in the acute treatment of anaphylaxis.[11]

There is also concern that other management and follow-up procedures are suboptimal or incomplete.[12,13] Current practice guidelines recommend that patients are observed in a clinical setting for at least 4 hours after an episode of anaphylaxis or treatment with adrenaline and that adrenaline autoinjectors should be prescribed before discharge.[14] Patients and/or carers should also be provided with appropriate instruction and training in the use of the device.[14] It is also recommended that all patients who experienced anaphylaxis are referred to specialist allergy services to assist with identifying the offending trigger, appropriate allergy testing, and additional support and education.[15] Given that the rates of this potentially fatal condition are rising,[4] and contributing significantly to morbidity and health care costs, appropriate management is of critical importance and has been identified as a major issue.[6,7,16,17] To our knowledge, no studies have investigated whether this has been addressed with improved medical education.

We recently determined that allergy training programs had improved physician recognition and diagnosis of pediatric anaphylaxis in the last decade.[5] The aim of the present study was to determine whether the management of anaphylaxis in children had also improved over this 10-year period after the introduction of intensified training programs and new anaphylaxis guidelines, relating in particular to the use of adrenaline. This study also provided an opportunity to examine changes in the characteristics of presenting cases (features of anaphylaxis, suspected triggers, and rate of biphasic anaphylaxis) over the time period.

METHODS

Emergency department anaphylaxis data

We compared data from the years 2003/2004, when the *International Classification of Diseases, Tenth Revision* (*ICD-10*), codes were introduced in the Perth metropolitan area, with data from 2012, after intensified training programs, new anaphylaxis guidelines, and enhanced cooperation between pediatric emergency specialists and allergists/immunologists were introduced in our tertiary pediatric emergency department (PED). We focused on comparing the mode of arrival to the hospital, documentation of vital signs, adrenaline administration, use of adjunct therapy, adrenaline prescription, and arrangement of follow-up with an allergist/clinical immunologist. Information about ethnicity was obtained along with other personal details by clerking the patient before the medical assessment in the emergency department (ED). Ethnicity was reported by the patient's parent or guardian.

The methodology for the identification of anaphylaxis has been previously reported.[5] We conducted a detailed retrospective chart examination of all cases coded as anaphylaxis (aged 0-16 years) presenting to the main tertiary PED in Perth, Western Australia. We compared data from January 1, 2003, to December 31, 2004 (period 1), when *ICD-10* codes were introduced, with data from January 1, 2012, to December 31, 2012 (period 2), after intensified training programs and new anaphylaxis guidelines were introduced. Because the number of cases was small in 2003, we included an additional year (2004) to provide an adequate sample size for the pre-intervention phase. *ICD* codes were automatically assigned to patients on the basis of the diagnoses entered onto the ED information system by the treating physician. Charts with *ICD-10* codes including anaphylactic shock after sting (T63.9), anaphylaxis (T78.2), food anaphylaxis (T78.0), anaphylaxis, unknown cause (T78.2), anaphylaxis, adverse drug reaction (T78.2), anaphylaxis not due to serum, not shock (T78.2), anaphylactic shock due to immunization (T80.5), anaphylactic shock due to serum (T80.5), and anaphylaxis due to drug (T88.6) were reviewed.

We used criteria from the 2006 Second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium for the definition and management of anaphylaxis.[14] A *biphasic reaction* was defined as an initial anaphylactic reaction with a period of resolution of 1 hour or longer, during which there were no new symptoms or treatment administered, followed by a second-phase anaphylactic reaction within the next 72 hours, not caused by antigen reexposure.[18,19] In our chart review, we also examined potential biphasic reactions, defined as representations to the hospital with anaphylaxis within 72 hours of initial presentation.

All cases (aged 0-16 years) coded as anaphylaxis were independently reviewed by 2 allergists/clinical immunologists to verify the diagnosis. Information was collected on standardized forms. Demographic characteristics, identification of anaphylaxis, mode of transport, asthma history, clinical symptoms, medications administered, disposition, prescriptions of adrenaline autoinjectors, and arrangement to be followed up by an allergist were recorded for cases coded as anaphylaxis comparing period 1 with period 2.

Anaphylaxis education

From February 2010, the Australian Society for Clinical Immunology and Allergy anaphylaxis guidelines[20,21] were incorporated into electronic PED guidelines with online access to management and training information. Printed copies of anaphylaxis action plans were maintained in a separate and easily accessible location.

In each term (of 10 weeks), 36 junior doctors rotated through our PED. All major decisions made by the junior staff were discussed with the senior staff. Number of staff, composition of staff (percentage of general practitioner [GP] trainees, ED trainees, and pediatric trainees in the group of junior doctors), and level of training were consistent during both time periods. Senior staff remained the same and consisted of a mixture of pediatricians, pediatric ED physicians, and ED physicians. The training was performed by a consultant pediatric allergist and emergency physician who was also available for any questions and concerns regarding allergic