

Improved diagnosis and treatment of anaphylaxis in a pediatric emergency department (2013-2018)

Neta Cohen, MD^a, Tali Capua, MD^a, Dikla Pivko-Levy, MD^a, Moshe Ben-Shoshan, MD^b, Ayelet Rimmon, MD^{a,*}, and Shira Benor, MD^{c,*}



Clinical Implications

- Better recognition and treatment of anaphylaxis in pediatric emergency departments is facilitated by incorporating a structured protocol for anaphylaxis management, recommendations for avoiding allergens and prescribing epinephrine autoinjectors for future use, into the electronic medical records.

TO THE EDITOR:

Anaphylaxis is a severe, acute, and potentially fatal allergic reaction.¹ Recent studies have suggested an increased incidence and prevalence of anaphylaxis.²⁻⁵ Epinephrine is underused particularly in infants.⁶ Several studies have documented poor adherence to anaphylaxis guidelines in emergency settings where most cases of anaphylaxis are managed.²⁻⁷

Data on the prevalence, epidemiology, and management of pediatric food allergy and anaphylaxis in Israel are limited. We had examined the management of anaphylaxis in our pediatric emergency department (PED) before and after a revision of our institutional clinical guidelines for the management of anaphylaxis, focusing on the number of cases diagnosed and treated correctly over time.⁸ An electronic medical record (EMR) system was implemented in our institution in 2017. The aim of the present study was to compare the recognition and management of anaphylaxis in our PED before and after the implementation of the EMR system, with special focus on infant anaphylaxis.

After receiving approval from the local ethics committee, the medical records of patients aged 0 to 16 years who visited the PED of Tel Aviv Sourasky Medical Center between 2013 and 2018 with a final diagnosis of anaphylaxis or allergic reaction were retrospectively reviewed. The records included in the final analysis met the consensus criteria judged by 3 investigators, a PED physician (N.C.), a pediatrician (D.P.L.), and a pediatric allergist (S.B.). The diagnosis of anaphylaxis was based on consensus expert criteria from the 2005 Second Symposium on the Definition and Management of Anaphylaxis.¹ Anaphylaxis severity was graded on a scale proposed by Muraro et al.⁹

A total of 1843 charts were reviewed during the initial screen. We identified 1468 cases that fulfilled the National Institute of Allergy and Infectious Diseases/Food Allergy and Anaphylaxis Network diagnostic criteria for allergic reactions and 375 cases that fulfilled the diagnosis for anaphylaxis. The demographic and clinical features of the study patients are presented in Table E1 in this article Online Repository at www.jaci-inpractice.org. The most common allergens were tree nuts and milk (23.5% and 20.5% of the visits, respectively). The rate of anaphylaxis tripled

during the study period, from 0.1% in 2013 to 0.32% in 2018 (see Figure E1 in this article's Online Repository at www.jaci-inpractice.org). The Spearman correlation coefficient for the rise in percentage of anaphylaxis over time was 0.841 ($P = .036$). Table I lists the demographic and clinical features in the pre-EMR period compared with the EMR period. The rates of correct coding of the diagnosis increased significantly (from 42% to 72%; $P < .00001$) since implementation of the EMR (see Figure E2 in this article's Online Repository at www.jaci-inpractice.org), and there was significantly improved adherence to treatment guidelines with regard to the administration of intramuscular epinephrine (70.9% vs 58.4%; $P = .016$), provision of autoinjector prescriptions (83.4% vs 70.1%; $P = .006$), and a referral to an allergy clinic (94.7% vs 86.6%; $P = .013$). Associated atopic comorbidities were reported more frequently following the implementation of the EMR system.

Table II lists the demographic and clinical characteristics of the infant group, which was less likely to be correctly diagnosed in comparison with children older than 12 months. Urticaria and vomiting were the most common presenting symptoms in the infant group, and they were less likely to be correctly diagnosed compared with older children (42.3% vs 55.7%; $P = .07$). Moreover, rates of intramuscular epinephrine administration and the inclusion of an autoinjector prescription were significantly lower among the infants.

The rate of anaphylaxis was 0.32% of all PED visits, which is similar to the values reported in previous studies.^{2,3} We observed a significant rise in the rate of correct coding and diagnosis of anaphylaxis, which we attributed, at least, partly to the implementation of the EMR system. A separate code for "anaphylaxis" was added to the discharge diagnosis coding list of our EMR system, which had previously included only "allergic reaction" and "anaphylactic shock." This addition may well have facilitated correct coding. Moreover, the implementation of the EMR system included the introduction of an anaphylaxis order set and structured discharge recommendations for an autoinjector prescription and an allergist consultation follow-up. We also attribute the improvement to the increased awareness of the PED teams, as reflected by improved reporting of associated atopic comorbidities, thanks to their involvement in the anaphylaxis study and their cooperation with the allergy team. Finally, we added an instruction paper for the parents regarding recognition and treatment of anaphylaxis.

A major limitation of our study is its retrospective design. Because only the records labeled with the above diagnostic codes were reviewed, we may have missed some anaphylaxis cases that were filed under other diagnostic codes such as asthma, urticaria, and angioedema, although "angioedema" and "urticarial" were rarely used in our PED where the preferred code was "allergic reaction." Some of the increases in the incidence of anaphylaxis could be accounted for by the more accurate coding, but 2 factors support a real increase in the rate of anaphylaxis. The first is a parallel rise in the overall increase in all allergy visits, and the second is the observed rise in the rate of epinephrine administration, including in the prehospital setting.

The diagnosis of anaphylaxis in infants is particularly challenging because they cannot report subjective symptoms, and most

TABLE I. Patient characteristics and anaphylaxis management pre- and post-EMR implementation

Characteristic	Pre-EMR (n = 224)	Post-EMR (n = 151)	P value
Demographic			
Age (y), median (range)	5.2 (0.1-15.9)	4.3 (0.1-16)	.19
Sex: male	132 (58.9)	97 (64.2)	.33
Comorbidity			
Asthma/HRAD	20 (8.9)	24 (15.9)	.04
Atopic dermatitis	5 (2.2)	14 (9.3)	.003
Diagnosis			
Anaphylaxis coded	94 (42)	108 (72)	<.0001
Severity of anaphylaxis			
Mild	26 (11.6)	19 (12.6)	.87
Moderate	190 (84.8)	127 (84.1)	.88
Severe	8 (3.5)	5 (3.3)	1.00
IM epinephrine treatment			
Prehospital	61 (27.2)	44 (29.1)	.72
At the PED	77 (34.4)	67 (44.4)	.52
Total: Prehospital and/or at the PED	131 (58.4)	107 (70.9)	.016
Discharge recommendations			
Autoinjector prescription	157 (70.1)	126 (83.4)	.006
Allergist consultation	194 (86.6)	143 (94.7)	.013

EMR, Electronical medical record; HRAD, hyperreactive airway disease; IM, intramuscular.
Values are provided as n (%) unless indicated otherwise.

of them do not have a history of food allergy. We observed lower rates of correct diagnosis and treatment of anaphylaxis in infants who presented solely with objective complaints. This may reflect

the reluctance of physicians to treat or prescribe epinephrine to young infants, thus reinforcing recommendations that a high index of suspicion for anaphylaxis in this age group is needed.

TABLE II. Comparison of the demographic and clinical characteristics of infants younger than 12 mo and the older children (2013-2018)

Characteristic	0-12 mo (n = 52)	>12 mo (n = 323)	P value
Demographic			
Sex: Male	28 (53.8)	201 (62.2)	.25
Common allergens			
Milk	20 (38.5)	57 (17.6)	.0001
Tree nut	3 (5.8)	85 (26.3)	.0008
Peanuts	3 (5.8)	23 (7.1)	1.00
Sesame	10 (19.2)	12 (3.7)	.0002
Egg	9 (17.3)	5 (1.5)	<.05
Symptoms and signs			
Urticaria	43 (82.7)	204 (63.2)	.007
Angioedema	23 (44.2)	145 (44.9)	1.00
Breathing difficulties	24 (46.1)	178 (55.1)	.25
Wheezing	7 (13.4)	56 (17.3)	.56
Throat tightness	0 (0)	115 (35.6)	NA
Abdominal pain	0 (0)	40 (12.4)	NA
Vomiting	27 (51.9)	95 (29.4)	.002
Comorbidity			
Asthma/HRAD	0 (0)	44 (13.6)	NA
Atopic dermatitis	2 (3.8)	17 (5.3)	1.00
Diagnosis of anaphylaxis coded	22 (42.3)	180 (55.7)	.07
IM epinephrine (preadmission and PED)	24 (46.1)	214 (66.2)	.008
Admission to ward	1 (1.9)	9 (2.8)	1.00
Recommendations			
Autoinjector prescription	23 (44.2)	260 (80.5)	.00001
Allergist consultation	45 (86.5)	292 (90.4)	.45

HRAD, Hyperreactive airway disease; IM, intramuscular.
Values are provided as n (%) unless indicated otherwise.

To our knowledge, this is the first study to investigate the effect of an EMR system on the diagnosis and treatment of anaphylaxis in the pediatric setting. Our data revealed a significant improvement in the diagnosis and treatment of anaphylaxis, which we attributed to the implementation of the EMR and to improved education of the PED teams and parents. The persistence of undiagnosed and undertreated cases of anaphylaxis, especially in infants, mandates further efforts to improve detection.

^aPediatric Emergency Medicine, Dana-Dwek Children's Hospital, Tel Aviv, Israel, affiliated to the Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

^bDivision of Allergy Immunology and Dermatology, Montreal Children's Hospital, Montreal, Quebec, Canada

^cAllergy and Clinical Immunology, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel, affiliated to the Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

*These authors contributed equally to this work.

Conflicts of interest: The authors declare that they have no relevant conflicts of interest.

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Corresponding author: Neta Cohen, MD, Pediatric Emergency Medicine, Dana-Dwek Children's Hospital, Tel Aviv Sourasky Medical Center, 6 Weizman St, Tel Aviv 64239, Israel. E-mail: netarab81@gmail.com.

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REFERENCES

1. Sampson HA, Muñoz-Furlong A, Campbell RL, Adkinson NF Jr, Bock SA, Branum A, 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;117:391-7.
2. Sicherer SH, Sampson HA. Food allergy: a review and update on epidemiology, pathogenesis, diagnosis, prevention, and management. *J Allergy Clin Immunol* 2018;141:41-58.
3. Lee AY, Enarson P, Clarke AE, La Vieille S, Eisman H, Chan ES, et al. Anaphylaxis across two Canadian pediatric centers: evaluating management disparities. *J Asthma Allergy* 2017;10:1-7.
4. Alvarez-Perea A, Ameiro B, Morales C, Zambrano G, Rodríguez A, Guzmán M, et al. Anaphylaxis in the pediatric emergency department: analysis of 133 cases after an allergy workup. *J Allergy Clin Immunol Pract* 2017;5:1256-63.
5. Grabenhenrich LB, Dölle S, Moneret-Vautrin A, Köhli A, Lange L, Spindler T, Ruëff F, et al. Anaphylaxis in children and adolescents: the European Anaphylaxis Registry. *J Allergy Clin Immunol* 2016;137:1128-37.
6. Greenheart M, Gupta RS, Meadows JA, Pistiner M, Spergel JM, Camargo CA Jr, et al. Guiding principles for the recognition, diagnosis, and management of infants with anaphylaxis: an expert panel consensus. *J Allergy Clin Immunol Pract* 2019;7:1148-1156.e5.
7. Simons FE, Arduoso LR, Bilò MB, El-Gamal YM, Ledford DK, Ring J, et al. World Allergy Organization guidelines for the assessment and management of anaphylaxis. *World Allergy Organ J* 2011;4:13-37.
8. Cohen N, Capua T, Pivko D, Ben-Shoshan M, Benor S, Rimon A. Trends in the diagnosis and management of anaphylaxis in a tertiary care pediatric emergency department. *Ann Allergy Asthma Immunol* 2018;121:348-52.
9. Muraro A, Roberts G, Clark A, Eigenmann PA, Halken S, Lack G, et al. EAACI Task Force on Anaphylaxis in Children. The management of anaphylaxis in childhood: position paper of the European Academy of Allergy and Clinical Immunology. *Allergy* 2007;62:857-71.

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TABLE E1. Patients’ characteristics

Characteristic	Anaphylactic patients (n = 375)
Demographic	
Age (y), median (range)	4.89 (1 mo-16 y)
Sex: male, n (%)	197 (52.5)
Common allergens, n (%)	
Milk	77 (20.5)
Tree nut	88 (23.5)
Peanut	26 (6.9)
Sesame	22 (5.8)
Egg	14 (3.7)
Legumes (hummus)	5 (1.33)
Fish/shellfish	10 (2.6)
Kiwi	2 (0.53)
Peach	1 (0.26)
Wheat	1 (0.26)
Other/unknown food	71 (18.9)
Drug allergen	19 (5.06)
Insect venom	6 (1.6)
Unknown trigger	33 (8.8)

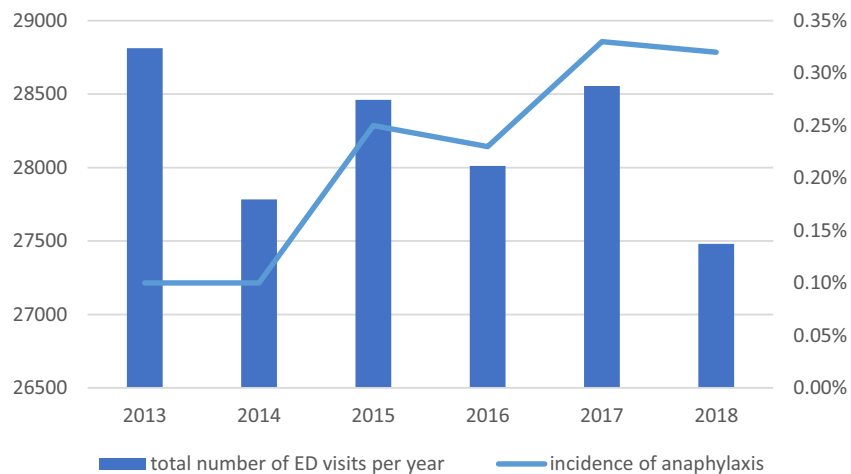


FIGURE E1. Incidence of anaphylaxis in the PED by year.

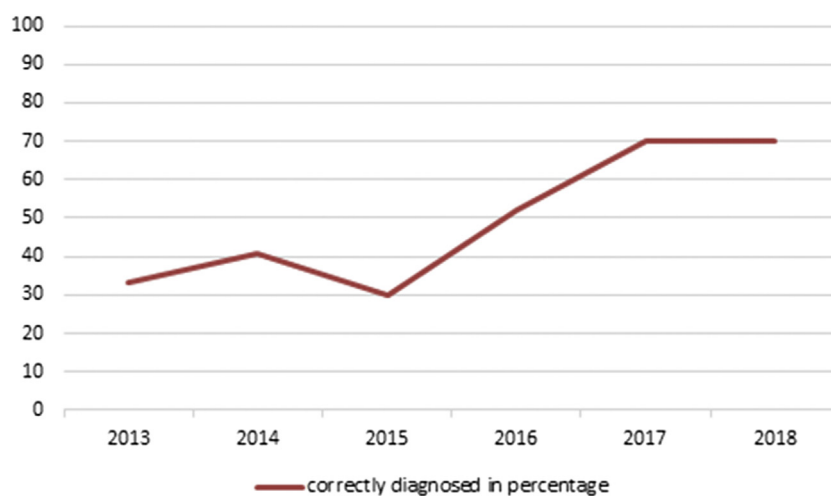


FIGURE E2. Percentage of anaphylactic reactions that were correctly diagnosed out of all anaphylactic reactions in the PED.