Published in final edited form as:

Ann Allergy Asthma Immunol. 2011 January ; 106(1): 42–48. doi:10.1016/j.anai.2010.10.011.

Predictors of Hospital Admission for Food-Related Allergic Reactions that Present to the Emergency Department

Aleena Banerji, MD¹, Susan A. Rudders, MD², Blanka Corel, MD³, Alisha P. Garth, MD³, Sunday Clark, MPH ScD⁴, and Carlos A. Camargo Jr., MD DrPH^{1,3}

¹Division of Rheumatology, Allergy and Immunology, Department of Medicine, Massachusetts General Hospital, Boston, MA

²Division of Allergy and Immunology, Children's Hospital Boston, Boston, MA

³Department of Emergency Medicine, Massachusetts General Hospital, Boston, MA

⁴Division of General Internal Medicine, University of Pittsburgh, Pittsburgh, PA

Keywords

Food Allergy; Epinephrine; Anaphylaxis; Emergency Department; Admission

Introduction

Food allergies affect approximately 4% of the US population and recent studies suggest a rising prevalence.^{1, 2} Food-related allergic reactions are the leading cause of anaphylactic reactions treated in the emergency department (ED) and it is estimated that there are 150-200 food allergy-related deaths in the United States each year.^{2, 3} Rates of hospitalization for food-related anaphylaxis continue to increase, not only in the United States⁴ but also in countries such as Australia⁵ and the United Kingdom.⁶ Specifically, the CDC estimates nearly 10,000 hospitalizations annually for food-related allergy among patients <18 years of age.⁷

Despite the tremendous burden of ED visits and hospital admissions caused by food-related allergic reactions, little is known regarding factors associated with hospital admission from the ED. Available guidelines do not provide specific hospitalization criteria for this growing patient population. As a result, consensus is lacking on the appropriate observation period,

© 2010 American College of Allergy, Asthma and Immunology. Published by Elsevier Inc. All rights reserved.

Corresponding Author: Aleena Banerji, MD, Division of Rheumatology, Allergy and Immunology, Massachusetts General Hospital, 55 Fruit Street, Cox 201, Boston, MA 02114 Tel: (617) 726-3850. Fax: (617) 724-0239. abanerji@partners.org.

Author Contributions: Aleena Banerji MD: (1) conception and design of the study; (2) data generation; (3) analysis and interpretation of the data and (4) preparation or critical revision of the manuscript

Susan A. Rudders MD: (1) conception and design of the study; (2) data generation; (3) analysis and interpretation of the data and (4) preparation or critical revision of the manuscript

Blanka Corel MD: (2) data generation; (4) preparation or critical revision of the manuscript

Alisha P. Garth MD: (2) data generation; (4) preparation or critical revision of the manuscript

Sunday Clark MPH ScD: (1) conception and design of the study; (2) data generation; (3) analysis and interpretation of the data and (4) preparation or critical revision of the manuscript

Carlos A. Camargo, Jr. MD DrPH: (1) conception and design of the study; (2) data generation; (3) analysis and interpretation of the data and (4) preparation or critical revision of the manuscript

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

and management of severe food-related allergic reactions presents a significant challenge. We studied the current management of patients presenting to the ED with food-related allergic reactions to better understand the factors associated with hospital admission. Identification of predictive factors could help in developing guidelines and determining who may benefit most from a longer observation period.

Methods

Study Design

This multicenter medical record review was performed as a part of the Multicenter Airway Research Collaboration, a division of the Emergency Medicine Network (www.emnet-usa.org). This study was an extension of an earlier pilot study.⁸ We have extended our review to encompass years 2001-2006 at the emergency departments at three academic hospitals in Boston (Massachusetts General Hospital, Children's Hospital Boston and Brigham and Women's Hospital) The study was approved by the institutional review boards of all three institutions.

We searched for all patients presenting to the emergency department (ED) between 1/1/01 and 12/31/06 with a physician-diagnosed, food-related acute allergic reaction using relevant ICD9 diagnosis codes.⁹ The codes included 995.60 (anaphylactic shock due to unspecified food), 995.61-995.69 (anaphylactic shock due to specified food), 995.0 (other anaphylactic shock), 693.1 (dermatitis due to food), 995.7 (adverse food reaction, not otherwise classified), 558.3 (allergic gastroenteritis), and 692.5 (contact dermatitis due to food). In addition, random samplings of the codes 995.3 (allergy, unspecified), 995.1 (angioedema) and 708.X (urticaria) were reviewed to identify cases of food-related allergic reactions within these non-specific allergy codes. All charts were reviewed by physicians and then reviewed by an allergist for both accuracy and internal consistency. Cases not consistent with a food-related acute allergic reaction were excluded.

Data collection

Standardized data abstraction forms were used to collect data on patient demographics, past medical history, food allergy triggers, clinical presentation, pre-ED and ED treatment (with a specific focus on epinephrine treatment) and disposition.

Definitions

A food-related acute allergic reaction was defined as an acute episode of symptoms suggestive of an IgE-mediated reaction in which the onset was temporally related to a known or suspected food allergen. Anaphylaxis was defined based on the diagnostic criteria established by the second symposium of the National Institute of Allergy and Infectious Disease and the Food Allergy and Anaphylaxis Network.¹⁰ Specifically, anaphylaxis was defined as an acute allergic reaction involving two or more organ systems or hypotension alone after exposure to a likely food allergen. For consistency with our earlier work, hypotension was defined as a systolic blood pressure <100 mmHg for adults in the ED setting. We examined the impact of using <90 mmHg as the threshold and it did not materially alter the results (data not shown). For children between the ages of 10 and 17 years, hypotension was defined as a systolic blood pressure less than 90 mmHg and (70 mmHg + [age multiplied by 2]) for children less than 10 years of age.¹⁰

Statistical Analysis

We used a stratified sampling method to reflect the population of patients treated in the ED within each ICD-9 code. Sample weights were assigned to account for unequal probabilities of selection, over-sampling, and non-response. The weights were applied for analyses using

the survey module in STATA 10.0 (StataCorp, College Station, Texas). Data are expressed as mean $\pm$ standard error (SE) and proportion, with 95% confidence interval (CI). Factors associated with hospital admission were evaluated using weighted Chi-square test and Student's t-test. A two-sided $P < 0.05$ was considered statistically significant. Multivariable logistic regression was used to identify independent predictors of hospital admission. The multivariable model was created using a manual stepwise approach. Factors associated with admission at $P < 0.2$ were evaluated for inclusion in the multivariable model. Results are presented as odds ratios (OR) with 95% CI.

Results

Over the six-year period, we reviewed charts for 1112 ED visits for food-related allergic reactions. With appropriate weighting, as described in Methods section, this represented a study cohort of 2583 patients. The majority (80%) of these patients were discharged home from the ED. Table 1 shows the demographics and medical history of patients, according to admission status, while Table 2 shows their presentation to the ED and initial treatments.

Demographics

The age and sex of patients admitted to the hospital and those discharged home were similar. Univariate analysis suggested that patients age 25+ years were less likely to be admitted to the hospital, but this result was not significant on multivariable analysis (Table 3). There were a slightly increased percentage of white patients among those admitted to the hospital (51%) compared to those who were discharged to home (45%) but, again, this unadjusted finding was not significant on multivariable analysis.

Medical History

Nearly half (46%) of all patients reported a known allergy to the offending agent and two-thirds of all patients reported a history of a known allergic problem. Patients admitted to the hospital were more likely to report a history of asthma and atopic dermatitis compared to the discharged patients. Admitted patients were also more likely to own an epinephrine auto-injector at the time of their ED presentation compared to the discharged patients.

Food Allergy Triggers and Setting

Peanuts and tree nuts were the most common triggers among all patients with food-related allergic reactions. Patients reporting a reaction triggered by peanuts or tree nuts were more likely to be admitted to the hospital than those discharged home while the opposite was true for patients reporting a reaction to shellfish, fish and egg. The location of exposure did not vary significantly between patients that were admitted or discharged home.

Clinical Presentation

Patients admitted to the hospital more frequently arrived by ambulance, had quicker onset of allergic symptoms (< 1 hour) and presented within a shorter period of time (< 3 hours) since exposure to the causative food. From a clinical perspective, patients admitted to the hospital more commonly presented with symptoms of angioedema, trouble swallowing, shortness of breath, wheezing, hoarse voice, stridor and diarrhea. Initial vital signs did not differ by hospital admission status (all $P > 0.20$), with two possible exceptions. Admitted patients, as compared to discharged patients, had a slightly higher initial heart rate (mean: 106 vs 103 beat/min, $P = 0.03$) and possibly higher respiratory rate (mean: 23 vs 22, $P = 0.13$). Patients admitted to the hospital more frequently met criteria for anaphylaxis compared to patients that were discharged home.

Pre-ED and ED Management

Compared to discharged patients, admitted patients were more likely to receive pre-ED treatments including epinephrine, antihistamines, steroids and β -agonists. Patients admitted to the hospital were also more likely to receive >1 dose of pre-ED epinephrine compared to discharged patients.

Predictors of Hospital Admission

Multivariate analysis showed that the presence of symptoms meeting criteria for anaphylaxis, treatment with epinephrine pre-ED or treatment with epinephrine within one hour of triage were associated with an increased likelihood of hospital admission (Table 3). By contrast, multivariate analysis showed that patients presenting with a food-related allergic reaction due to shellfish were less likely to be admitted to the hospital. None of the other specific food allergy triggers or history of any atopic conditions including asthma were associated with hospital admission on multivariable analysis.

Discussion

There are sparse data evaluating the admission decision process in the ED for patients presenting with food-related allergic reactions. This study provides a comprehensive review of the current management of patients with food-related allergic reactions presenting to three academic EDs over a six-year period. To our knowledge, this is the largest study of ED patients with food-related allergic reactions specifically examining factors associated with hospital admission. By studying current practices among several academic emergency rooms, a few novel predictors of hospital admission were identified.

Our data suggest that patients who meet symptomatic criteria for anaphylaxis are more likely to be hospitalized. In addition, patients treated with epinephrine pre-ED or within one hour of triage were more likely to be admitted to the hospital. Likely, the patients who received epinephrine treatment had more severe food-related allergic reactions compared to patients that did not receive epinephrine treatment. On the other hand, it is somewhat surprising that the patients who received appropriate treatment with epinephrine had a worse outcome – i.e. they were admitted. As noted above, the explanation for this paradoxical finding is probably “confounding by severity.”¹¹ This type of methodological problem suggests that demonstration of the benefits of epinephrine will need to look beyond hospital admission (e.g., the effect of epinephrine on timing and completeness of symptom relief) for even if patients' symptoms improve quickly, they may still be admitted for other reasons (i.e., concern about a biphasic reaction).

Epinephrine is widely accepted as the most effective treatment for anaphylaxis.¹⁰ Moreover, a delay in the administration of epinephrine is a clear risk factor for poor outcomes.¹²⁻¹⁴ Specifically, prompt treatment with epinephrine has been shown to decrease fatalities from food-related anaphylaxis,¹²⁻¹⁵ and potentially decrease the risk of a biphasic response.¹⁶ Despite this knowledge, food-related anaphylaxis continues to be inadequately treated.^{17, 18} In this study, only 41% of patients meeting criteria for anaphylaxis were treated with any epinephrine, indicating further work is still needed for EDs to comply with national guidelines for the management of patients presenting with food-associated anaphylactic reactions. Additionally, without clear guidelines for hospital admission among ED patients with food-related allergic reactions, it is even more important that we provide appropriate initial treatment.¹⁰

Among all the specific food allergy triggers evaluated, our data suggest that only patients with reactions to shellfish were less likely to be admitted to the hospital. This is inconsistent with prior data suggesting that shellfish allergies are associated with more severe food-

related allergic reactions.² Our findings suggest that while shellfish allergy is still a risk factor for food-related allergic reactions that the seriousness of these reactions may not be as well understood compared to other food triggers like peanuts or tree nuts. This finding warrants further study in another population of patients with food-related allergic reactions.

Individuals who have both IgE-mediated food allergy and asthma have been reported to be at a higher risk for food-related anaphylaxis.¹⁹ Asthma has also previously been associated with the need for multiple doses of epinephrine.²⁰ Our data suggested that patients with a history of asthma, as well as other allergic diseases like atopic dermatitis, were more commonly admitted to the hospital. However, this association was not an independent predictor of hospital admission. Collectively, the data suggest that when ED physicians are evaluating patients with food-related allergic reactions asking about a history of asthma, or other allergic diseases, is important and relevant but further studies are needed to determine whether these co-morbidities should influence the need for hospital admission or longer observation.

The period of hospital observation after emergency management of a severe allergic reaction has long been a dilemma and current guidelines do not provide specific criteria for hospitalization. One major concern is the potential development of biphasic anaphylaxis, which ranges in incidence from 1% to 23%.^{16, 21} In addition, there remains a lack of consistency between studies regarding reliable predictors of biphasic anaphylaxis.^{21, 22} Some reports recommend an 8-hour period of hospital observation for all patients presenting to the ED with anaphylaxis,²³ while others suggest 24-hour period of hospital observation.^{16, 24} A 24-hour observation for those who received epinephrine and 12 hours for all other patients has been suggested as a more “reasonable approach.”²⁵ While the rate of biphasic reactions was not investigated in our current study, this area needs further investigation in order to make clearer recommendations regarding appropriate observation times.

We believe that understanding admission decision making in the ED setting is critical as hospitalization rates for food-related anaphylaxis continue to rise.⁷ This increase could be related to increased awareness, reporting, and use of specific medical diagnostic codes for food allergy or could represent a real increase in patients experiencing food-allergic reactions.⁷ Regardless of the cause of this increase, it remains unclear whether choosing to admit these patients influences their outcome. Interestingly, it is important to note that previous smaller studies have found that the majority of patients admitted to the hospital for observation following anaphylaxis do not receive any further treatment.²⁶ Therefore, we clearly need to better understand who would benefit most from further observation or hospital admission. Further prospective studies to better understand predictors of admission for patients with food-related allergic reactions would help in the development of guidelines to better support physician decision-making in the ED.

A potential limitation of our study is reliance on the medical record and the possibility that the documentation was inaccurate or incomplete. Also, our findings may not be generalizable to all EDs as the three hospitals evaluated were located in an urban, academic setting in Boston. Furthermore, since we did not interview physicians, we cannot assess physician factors that were potentially associated with admission, such as diagnostic uncertainty or psychosocial factors that could influence the decision. Further prospective studies can help us better understand if treatment decisions have an effect on outcome and develop evidence-based criteria for hospitalization. Lastly, while we evaluated symptoms at presentation to the ED, analysis of symptoms after appropriate treatment in the ED as predictors of hospital admission merits further investigation.

In summary, food allergy is growing health care concern with numerous clinical challenges complicated by severe allergic reactions requiring ED management and hospitalization. The current study suggests that risk factors for hospital admission among ED patients with food-related allergic reactions are symptoms of anaphylaxis, pre-ED epinephrine treatment or epinephrine within one hour of ED triage. Conversely, we found that patients with food-related allergic reactions triggered by shellfish were less likely to be admitted to the hospital. Further study and identification of predictors of hospital admissions may help characterize patients at risk who would benefit most from a longer observation period and develop evidence based guidelines to improve their care

Acknowledgments

Funding: Dr. Rudders is supported by NIH training grant NRSA T32-AI-007512. Dr. Camargo has consulted for Dey (Basking Ridge, NJ) and sanofi-aventis (Bridgewater, NJ). This project was partly supported by an investigator-initiated research grant to Dr. Camargo from Dey.

References

1. Sampson HA. Update on food allergy. *J Allergy Clin Immunol.* 2004; 113(5):805–19. quiz 820. [PubMed: 15131561]
2. Munoz-Furlong A, Weiss CC. Characteristics of food-allergic patients placing them at risk for a fatal anaphylactic episode. *Curr Allergy Asthma Rep.* 2009; 9(1):57–63. [PubMed: 19063826]
3. Clark S, Camargo CA Jr. Emergency management of food allergy: Systems perspective. *Curr Opin Allergy Clin Immunol.* 2005; 5(3):293–298. [PubMed: 15864091]
4. Lin RY, Anderson AS, Shah SN, Nuruzzaman F. Increasing anaphylaxis hospitalizations in the first 2 decades of life: New York state, 1990–2006. *Ann Allergy Asthma Immunol.* 2008; 101(4):387–393. [PubMed: 18939727]
5. Poulos LM, Waters AM, Correll PK, Loblay RH, Marks GB. Trends in hospitalizations for anaphylaxis, angioedema, and urticaria in Australia, 1993–1994 to 2004–2005. *J Allergy Clin Immunol.* 2007; 120(4):878–884. [PubMed: 17931562]
6. Bohlke K, Davis RL, DeStefano F, et al. Epidemiology of anaphylaxis among children and adolescents enrolled in a health maintenance organization. *J Allergy Clin Immunol.* 2004; 113(3):536–542. [PubMed: 15007358]
7. Branum AM, Lukacs SL. Food allergy among children in the United States. *Pediatrics.* 2009; 124(6):1549–1555. [PubMed: 19917585]
8. Oren E, Banerji A, Clark S, Camargo CA Jr. Food-induced anaphylaxis and repeated epinephrine treatments. *Ann Allergy Asthma Immunol.* 2007; 99(5):429–432. [PubMed: 18051213]
9. Clark S, Gaeta TJ, Kamarthi GS, Camargo CA. ICD-9-CM coding of emergency department visits for food and insect sting allergy. *Ann Epidemiol.* 2006; 16(9):696–700. [PubMed: 16516491]
10. 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. *Ann Emerg Med.* 2006; 47(4):373–380. [PubMed: 16546624]
11. Clark S, Costantino T, Rudnitsky G, Camargo CA Jr. Observational study of intravenous versus oral corticosteroids for acute asthma: An example of confounding by severity. *Acad Emerg Med.* 2005; 12(5):439–445. [PubMed: 15860696]
12. Bock SA, Munoz-Furlong A, Sampson HA. Further fatalities caused by anaphylactic reactions to food, 2001–2006. *J Allergy Clin Immunol.* 2007; 119(4):1016–1018. [PubMed: 17306354]
13. Bock SA, Munoz-Furlong A, Sampson HA. Fatalities due to anaphylactic reactions to foods. *J Allergy Clin Immunol.* 2001; 107(1):191–193. [PubMed: 11150011]
14. Pumphrey RS. Lessons for management of anaphylaxis from a study of fatal reactions. *Clin Exp Allergy.* 2000; 30(8):1144–1150. [PubMed: 10931122]
15. Pumphrey RS, Gowland MH. Further fatal allergic reactions to food in the United Kingdom, 1999–2006. *J Allergy Clin Immunol.* 2007; 119(4):1018–1019. [PubMed: 17349682]

16. Tole JW, Lieberman P. Biphasic anaphylaxis: Review of incidence, clinical predictors, and observation recommendations. *Immunol Allergy Clin North Am.* 2007; 27(2):309–26. viii. [PubMed: 17493505]
17. Klein JS, Yocum MW. Underreporting of anaphylaxis in a community emergency room. *J Allergy Clin Immunol.* 1995; 95(2):637–638. [PubMed: 7852677]
18. Sheikh A, Ten Broek V, Brown SG, Simons FE. H1-antihistamines for the treatment of anaphylaxis: Cochrane systematic review. *Allergy.* 2007; 62(8):830–837. [PubMed: 17620060]
19. Shah E, Pongracic J. Food-induced anaphylaxis: Who, what, why, and where? *Pediatr Ann.* 2008; 37(8):536–541. [PubMed: 18751571]
20. Uguz A, Lack G, Pumphrey R, et al. Allergic reactions in the community: A questionnaire survey of members of the anaphylaxis campaign. *Clin Exp Allergy.* 2005; 35(6):746–750. [PubMed: 15969665]
21. Kemp SF. The post-anaphylaxis dilemma: How long is long enough to observe a patient after resolution of symptoms? *Curr Allergy Asthma Rep.* 2008; 8(1):45–48. [PubMed: 18377774]
22. Mehr S, Liew WK, Tey D, Tang ML. Clinical predictors for biphasic reactions in children presenting with anaphylaxis. *Clin Exp Allergy.* 2009; 39(9):1390–1396. [PubMed: 19486033]
23. Forrest-Hay A, Taylor C, Tochar S. Biphasic Anaphylaxis in a UK Emergency Department. Presented at Open Paper Presentations of the 2003 Symposium of the Resuscitation Council of the United Kingdom (Abstract).
24. Ellis AK, Day JH. Incidence and characteristics of biphasic anaphylaxis: A prospective evaluation of 103 patients. *Ann Allergy Asthma Immunol.* 2007; 98(1):64–69. [PubMed: 17225722]
25. Smit DV, Cameron PA, Rainer TH. Anaphylaxis presentations to an emergency department in hong kong: Incidence and predictors of biphasic reactions. *J Emerg Med.* 2005; 28(4):381–388. [PubMed: 15837017]
26. Lee JM, Greenes DS. Biphasic anaphylactic reactions in pediatrics. *Pediatrics.* 2000; 106(4):762–766. [PubMed: 11015520]

Abbreviations

ED	Emergency Department
CI	confidence interval
SE	standard error
OR	odds ratio

Table 1

Demographics and medical history of patients presenting to the emergency department with a food-related allergic reaction, according to disposition (proportion [95% confidence interval]).

	Discharged home (n=2064)	Admitted (n=519)	P value
<i>Demographic characteristics</i>			
Age, mean	22 (20 – 23)	20 (18 – 22)	0.17
Age 18 years	53 (50 – 56)	46 (41 – 52)	0.06
Age groups			0.002
<6 years	30 (27 – 33)	30 (26 – 35)	
6-11 years	10 (7 – 12)	9 (7 – 11)	
12-17 years	7 (5 – 10)	14 (11 – 17)	
18-24 years	11 (9 – 14)	15 (10 – 19)	
25+ years	42 (38 – 45)	32 (26 – 38)	
Female	49 (45 – 54)	54 (49 – 60)	0.18
Race/ethnicity			0.009
White	45 (41 – 49)	51 (45 – 57)	
Black	24 (20 – 27)	25 (20 – 31)	
Hispanic	13 (10 – 15)	13 (9 – 16)	
Asian	7 (4 – 9)	6 (5 – 8)	
Other race	12 (9 – 15)	5 (4 – 5)	
<i>Medical history</i>			
Known allergy to offending allergen	45 (40 – 49)	51 (45 – 56)	0.09
Known allergic problems	63 (59 – 67)	70 (65 – 75)	0.04
Asthma	41 (36 – 47)	52 (45 – 59)	0.03
Hayfever	14 (10 – 18)	18 (13 – 24)	0.19
Atopic dermatitis	16 (13 – 20)	24 (19 – 30)	0.02
Patient owns EpiPen	31 (27 – 36)	44 (38 – 50)	0.001
Patient on any chronic medications	40 (35 – 44)	49 (44 – 55)	0.008
<i>Specific food trigger causing current reaction</i>			
Peanuts	16 (13 – 19)	23 (19 – 27)	0.004
Tree nuts	15 (12 – 18)	23 (18 – 28)	0.002
Seeds	2 (1 – 3)	3 (0 – 6)	0.53
Fruits and vegetables	13 (10 – 16)	11 (7 – 15)	0.49
Shellfish	16 (13 – 20)	10 (7 – 14)	0.02
Fish	11 (8 – 13)	4 (2 – 6)	0.001
Milk products	10 (7 – 12)	11 (7 – 14)	0.64
Eggs	6 (4 – 8)	2 (2 – 3)	<0.001
Wheat	0.5 (0 – 1)	1 (0 – 1)	0.47
Other food	25 (21 – 28)	20 (15 – 25)	0.18

Table 2

Presentation of patients treated in the emergency department with a food-related allergic reaction, according to disposition (proportion [95% confidence interval]).

	Discharged home (n=2064)	Admitted (n=519)	P value
<i>Presentation</i>			
Arrive to ED by ambulance	30 (26 – 34)	45 (40 – 51)	<0.001
Time since exposure			<0.001
< 1 hour	24 (20 – 29)	30 (23 – 37)	
1-3 hours	47 (42 – 52)	52 (45 – 58)	
4-6 hours	10 (7 – 13)	13 (10 – 17)	
7-12 hours	3 (1 – 4)	0.5 (0.2 – 1)	
> 12 hours	17 (13 – 21)	4 (2 – 6)	
Onset of symptoms			0.02
<1 hour	30 (25 – 35)	36 (29 – 43)	
1-3 hours	44 (39 – 49)	48 (42 – 55)	
>3 hours	26 (21 – 30)	16 (12 – 20)	
Location of exposure			0.38
Home	53 (48 – 58)	59 (53 – 65)	
School/Daycare	9 (6 – 11)	6 (3 – 9)	
Work	3 (1 – 5)	4 (2 – 7)	
Restaurant	26 (22 – 31)	24 (18 – 30)	
Other	9 (6 – 12)	7 (5 – 8)	
Location immediately prior to ED arrival			0.02
Home	63 (58 – 68)	54 (48 – 59)	
School/Daycare	7 (5 – 10)	6 (3 – 9)	
Work	3 (1 – 6)	4 (1 – 6)	
Restaurant	12 (9 – 16)	15 (9 – 20)	
MD office/clinic	7 (4 – 10)	7 (5 – 10)	
Other	7 (4 – 10)	15 (12 – 18)	
Signs and symptoms			
Skin rash	72 (68 – 75)	64 (59 – 70)	0.03
Itching	46 (42 – 50)	40 (34 – 45)	0.08
Swelling	48 (44 – 53)	48 (42 – 53)	0.92
Peripheral edema	NC	2 (0 – 4)	--
Angioedema	5 (3 – 7)	18 (13 – 22)	<0.001
Trouble swallowing	15 (12 – 18)	26 (21 – 31)	<0.001
Trouble breathing/shortness of breath	27 (23 – 31)	47 (42 – 53)	<0.001
Wheezing	14 (11 – 17)	32 (28 – 37)	<0.001
Hoarse voice	5 (3 – 8)	10 (7 – 13)	0.02
Stridor	1 (0.4 – 2)	6 (4 – 8)	<0.001
Nausea/vomiting	14 (11 – 17)	17 (14 – 21)	0.20
Abdominal pain/cramps	5 (3 – 7)	3 (2 – 4)	0.10

	Discharged home (n=2064)	Admitted (n=519)	P value
Diarrhea	2 (1 – 4)	1 (0.4 – 1)	<0.001
Dizziness/fainting	3 (2 – 5)	4 (1 – 7)	0.80
Organ system involvement			
Respiratory	37 (33 – 67)	64 (59 – 70)	<0.001
Cutaneous	93 (90 – 95)	91 (88 – 94)	0.37
Gastrointestinal	30 (26 – 34)	41 (35 – 46)	0.001
Cardiac	4 (2 – 6)	5 (2 – 9)	0.48
Anaphylaxis*	53 (48 – 57)	80 (75 – 85)	<0.001
Pre-ED treatments (3 hrs before triage)	50 (46 – 55)	66 (60 – 71)	<0.001
Epinephrine	27 (22 – 33)	57 (50 – 65)	<0.001
Benadryl	80 (75 – 85)	80 (73 – 86)	0.93
Other antihistamines	6 (3 – 8)	12 (6 – 18)	0.04
Steroids	5 (2 – 7)	19 (14 – 23)	<0.001
IV fluids	3 (0.3 – 5)	4 (2 – 5)	0.68
Inhaled β -agonists	8 (4 – 11)	21 (16 – 27)	<0.001
Oxygen	NC	3 (2 – 4)	--
Other	4 (1 – 7)	4 (2 – 7)	0.82
Number of pre-ED epinephrine doses among patients receiving pre-ED epinephrine			0.01
1 dose	99 (99 – 100)	91 (89 – 92)	
2+ doses	1 (0.3 – 1)	9 (8 – 11)	
ED treatment with epinephrine within 1hr of ED triage	7 (5 – 9)	27 (22 – 32)	<0.001
Initial respiratory rate, mean (95% CI)	22 (21 – 23)	23 (22 – 23)	0.13
Initial heart rate, mean (95% CI)	103 (101 – 105)	106 (104 – 109)	0.03
Initial systolic blood pressure, mean (95% CI)	123 (121 – 124)	121 (118 – 123)	0.32
Initial temperature, mean (95% CI)	98.1 (98.0 – 98.2)	98.0 (97.8 – 98.1)	0.20
Initial oxygen saturation, mean (95% CI)	98 (98 – 98)	98 (98 – 99)	0.39
Oxygen saturation on room air	98 (97 – 99)	97 (96 – 98)	0.39

NC denotes non-calculable. When the number of observations was <30, robust estimates could not be produced.

* See methods section for details.

Table 3

Multivariable predictors of hospital admission among patients presenting to the emergency department with a food-related allergic reaction.

	Odds ratio	95% confidence interval	P value
Age groups			
<6 years	1.00	Reference	Reference
6-11 years	0.65	0.31 – 1.36	0.25
12-17 years	1.44	0.67 – 3.07	0.35
18-24 years	0.47	0.16 – 1.39	0.17
25+ years	0.67	0.32 – 1.41	0.29
Female	1.47	0.89 – 2.42	0.13
White race/ethnicity	1.07	0.61 – 1.88	0.81
Asthma	1.46	0.85 – 2.51	0.17
Peanut trigger	1.10	0.59 – 2.06	0.77
Tree nut trigger	0.84	0.43 – 1.62	0.60
Shellfish trigger	0.23	0.08 – 0.68	0.008
Anaphylaxis*	2.31	1.23 – 4.33	0.009
Pre-ED epinephrine treatment	6.65	3.04 – 14.57	<0.001
ED treatment with epinephrine within 1 hour of ED triage	3.78	1.68 – 850	0.001

* See methods section for details.