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SUPPORTING INFORMATION

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DOI: 10.1111/pai.13091

Gaps in the management of food-induced anaphylaxis reactions at school

To the Editor,

Food allergy affects 4%-7% of primary schoolchildren, and 8%-18% of pediatric food-induced anaphylaxis reactions occur at school.¹⁻³ Few studies reported detailed information on anaphylaxis at school. In the United States (US), 115 anaphylaxis reactions requiring adrenaline at school (2001-2003) have been reported, and the Epipen4schools[®] program provided data on allergic reactions that occurred in the 6574 responding schools (2013-2014).^{4,5} In France, prevention measures to improve the acceptance of children with allergic disease and reduce the risk of anaphylaxis at school through individual healthcare plans (IHP) were introduced into law in 2003.

Our aim was to assess food-related anaphylaxis cases that occurred in children at school in order to identify the main gaps in the management of these reactions. We conducted a retrospective analysis from 2005 to 2018 of all food-induced anaphylaxis (Ring severity grade 2-4) cases recorded by the Allergy Vigilance Network[®] (AVN) that occurred in children (3-16 years) at school⁶ (Table S1). All cases were recorded using a structured questionnaire, reviewed and validated by an expert panel of allergists in accordance with current anaphylaxis criteria.⁷ Detailed information about the allergic reaction at school was obtained from the family, allergists, emergency physicians, and/or general practitioners. Data were analyzed anonymously in accordance with the legislation of the French Commission for Data Protection. This study was approved by the National Committee for Data and Patients Protection. Comparisons of the main characteristics of our study group and those of children who experienced anaphylaxis outside school were performed using Student's *t* test for age, and Fisher's exact or chi-square

tests for categorical variables; statistical tests were 2-sided and *P*-value < 0.05 was considered statistically.

Of the 1725 food-induced anaphylaxis reactions recorded in the AVN database, 538 involved school-aged children and 105 (19.5%) occurred at school (boys: 63%, mean age: 10.0 years; SD: 4.0; Figure 1). The main characteristics, allergy history of these children, and the food triggers are detailed in Table 1. These data were similar to those of 433 pediatric anaphylaxis reactions that occurred outside the school, except for the distribution of food allergens, history of asthma and food allergy, and adrenaline use (Table 1). Fifty-seven (54%) children had a previous food allergy and 19 (18%) a past history of food anaphylaxis; 33 of 57 (58%) children had received an IHP with an emergency kit (including an adrenaline autoinjector [AAI] in 12). Table 2 describes the 105 anaphylaxis cases. Medications (antihistamines and oral corticosteroids) and AAI were used in 21 (20%) and 6 (6%) cases, respectively. Four deaths due to milk's allergy were recorded.

We have identified gaps in the management of anaphylaxis cases at different levels.

1. **Prevention.** Five children had a history of food allergy not investigated before the anaphylaxis; 24 (23%) children with a food allergy had no IHP; and seven children with a history of food-related anaphylaxis had no AAI in their emergency kit.
2. **Allergen exposure.** Six patients developed anaphylaxis due to accidental exposure during culinary activities at school ("week of taste," world culinary discoveries, cooking activities). Food avoidance was not respected by school or canteen staff in seven cases.

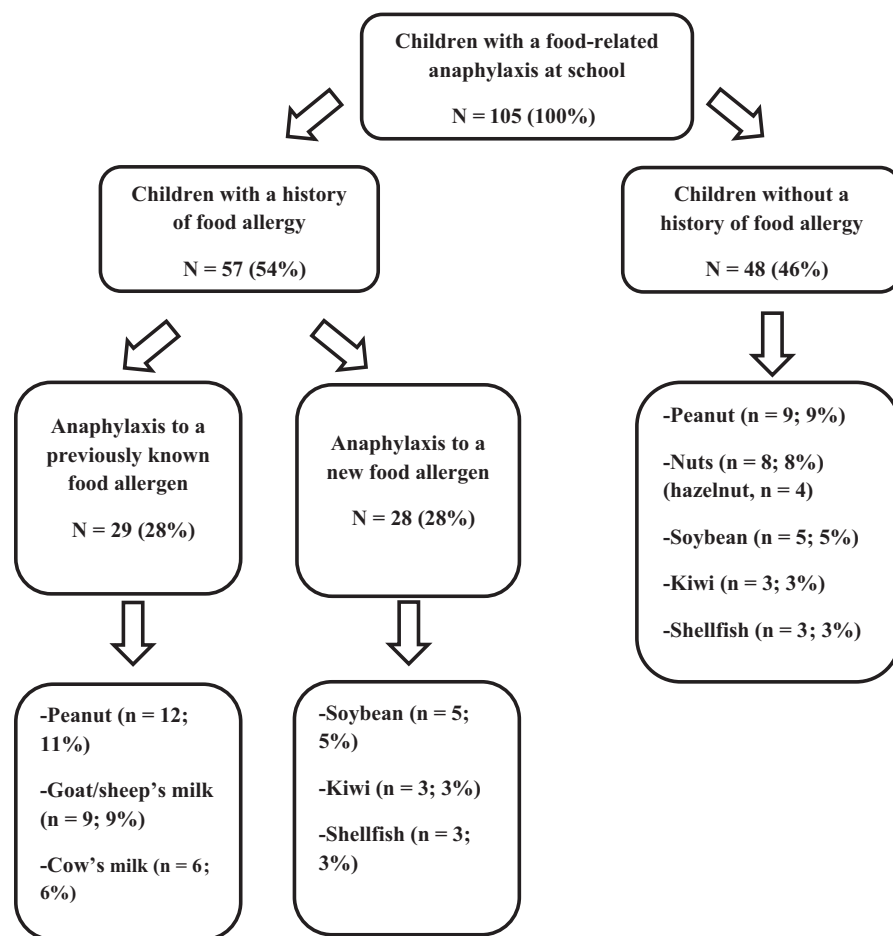


FIGURE 1 Distribution of the main food allergens involved in anaphylaxis reactions at school in 105 children reported with the Allergy Vigilance Network (2005-2018)

TABLE 1 Main characteristics of the 105 children with food-related anaphylaxis at school compared to 433 children with food-related anaphylaxis that occurred outside of school recorded by the Allergy Vigilance Network®

Characteristics	Children experiencing an anaphylaxis at school n = 105 (%)	Children experiencing an anaphylaxis out of school n = 433 (%)	P Value
Mean age, year (SD)	10.0 (4.0)	8.2 (3.9)	0.64
Gender, male (%)	66 (62.9)	274 (63.3)	0.94
The five main allergens involved in anaphylaxis at school			
Peanut	26 (24.8)	108 (24.9)	0.97
Goat/sheep's milk	9 (8.6)	4 (0.9)	<0.001
Soybean	9 (8.6)	1 (0.2)	<0.001
Cow's milk	6 (5.7)	14 (3.2)	0.25
Kiwi fruit	6 (5.7)	4 (0.9)	0.005
History of food allergy	57 (54.3)	182 (42.0)	0.023
History of multiple food allergy	21 (20.0)	78 (18.0)	0.64
History of past food-related anaphylaxis	19 (18.1)	96 (22.2)	0.36
History of asthma	27 (25.7)	181 (41.8)	0.002
Injection of adrenaline	16 (15.2)	204 (47.1)	<0.001

Three children forgot themselves to check for ingredients in pre-packaged food products and two adolescents deliberately ate prepackaged peanut-containing food products while they knew they were allergic to peanut.

3. *Management of the allergic reaction by school staff.* A call to the first-aid medical service was made in 39 (37%) cases; an ambulance without any medical team was sent to the school in 25 (24%) cases and an emergency medical team was sent in 14 (13%) cases.

TABLE 2 Description of the 105 anaphylaxis reactions that occurred in children at school, recorded by the Allergy Vigilance Network®

Characteristics of the anaphylaxis reactions at school	N = 105 (%)
Place of occurrence	
Canteen	59 (56)
Playground	15 (14)
Classroom	4 (4)
Other	4 (4)
Undefined	23 (22)
Ring severity grade	
2	73 (70)
3	28 (27)
4	4 (4)
Clinical manifestations	73 (70)
Mucocutaneous	62 (85)
Bronchospasm	49 (67)
Gastrointestinal	23 (32)
Laryngeal edema	23 (32)
Neurologic	13 (18)
Cardiovascular	11 (15)
Adrenaline injection by school nurse or staff at school before medical emergency care	6 (6)
Phone call to first-aid medical department	39 (37)

Only six of the 12 children having AAI available at school received adrenaline by school nurse or staff who refused to inject adrenaline in six cases because the clinical manifestations had not been recognized as severe. Only 16 (15%) children were treated with adrenaline injection at school (by school staff or nurse, $n = 6$; by the emergency medical team, $n = 10$).

In this study, we reported detailed characteristics of anaphylaxis reactions occurred at school and described many gaps at different levels.

The distribution of the main food allergens involved in anaphylaxis at school differs from that reported in the European Anaphylaxis Registry.² Peanut remained the most frequent food trigger (25%), but, surprisingly, milks (15%), soybean (9%), and kiwi (6%) were frequently involved. We also found that most of reactions (56%) occurred in the canteen compared to other countries (9%-12% in the United States).^{4,8} In France, unlike other countries, most meals are cooked onsite or provided by catering companies, served in a school canteen, and do not consist of packed lunches brought from home which may explain these findings.

We found that only 58% of children with a known food allergy had an IHP. This rate is similar to that reported in the United States (51%) but remains lower than expected.⁹ Recently, the French

Allergy Society provided a position statement about the indications for an IHP for allergic children at school and the content of the emergency kit.¹⁰

In children with a food allergy, the majority of reactions are due to accidental exposure. In our study, we identified failure on respecting food avoidance: failure in communication between families and school/canteen staff, lack of vigilance from school/canteen staff with respect to food labels, failure to provide adequate information to the child on food allergens contained in the meal provided in the canteen, failure to respect the Food Information to Consumers legislation, exposure to food allergens during culinary discoveries, lack of vigilance from children, and failure to check for ingredients in food products.

In our study, only half of children who had AAI available at school received adrenaline by the school nurse/staff. This rate is similar to that reported in France (47%) but higher than reported in Europe (27%).² Anaphylaxis symptoms are badly recognized by school staff, as reported in our study as well as in Italy.¹¹ Other barriers to adrenaline use at school should be explored: lack of clear emergency action plans, fear of injecting a medication, fear of using adrenaline for a wrong indication, and fear for judicial accountability...In addition, difficulties in the accessibility of the AAI have been reported.¹⁰

We also found that a high proportion (46%) of children experiencing food-induced anaphylaxis had no known food allergy before as reported in the United States.⁴ This raises the question of making available unassigned AAIs at school to treat any child experiencing an anaphylaxis even out of the context of an IHP. Contrary to France, the United States, the UK, and Australia, legislation allows schools to source their own AAI for emergency use but further cost-benefit analysis deserves to be explored.

Our study has some limitations. In France, there is no available national platform designed to record all allergic reactions at school. Based on voluntary declarations by allergists, the AVN database records a small proportion of all allergic reactions that occurred at school in France which may induce reporting bias.

Our results highlight many gaps at different levels with regard to the occurrence of anaphylaxis at school. We here summarized action points that may be useful to reduce the risk of severe anaphylaxis reactions at school: (a) implementation of academic recommendations for school policies and IHP, (b) wide dissemination of the guidelines to non-allergists physicians and healthcare professionals, (c) promotion of training programs to school and canteen staff on food allergy and anaphylaxis, (d) implementation of the Food Information to Consumers legislation, and (e) promotion of a unique emergency action plan available at school.

ACKNOWLEDGMENTS

We would like to acknowledge all allergists from the Allergy Vigilance Network® and the members of the "Allergy at school" working group of the French Allergy Society: P Beaumont, M Braire, V Cordebar, P Dumond, C Favre-Metz, V Grandjean-Ceccon, L

Guenard-Bilbault, C Hoarau, P Krieger, C Lapeyre-Santos, F Le Pabic, V Liabeuf, A Martin-Blondel, B Moltrecht, D Nouar, G Pouessel, JM Rame, D Sabouraud-Leclerc, G Schoder, and P Sergeant. We would like to acknowledge A Corne for his help to the data collection.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING INFORMATION

Guillaume Pouessel received Bausch + Lomb, Meda/Mylan, and ALK-Abello grants for consultant and speaker's participation and financial grants for research. Luciana Kase Tanno received an unrestricted Novartis and MEDA/Mylan Pharma grants through CHRUM administration.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Online Supplementary. Table S1. Severity scale for classification of anaphylactic reactions (6).

Grade	Skin and subjective generalized symptoms	Abdomen	Respiratory tract	Cardiovascular
I	Itching Flushing Urticaria Angioedema	-	-	-
II	Itching Flushing Urticaria Angioedema	Nausea Cramps Vomiting	Rhinorrhea Hoarseness Dyspnea	Tachycardia (rise>20/min) Hypotension (fall>20 mmHg systolic) Arrhythmia
III	Itching Flushing Urticaria Angioedema	Vomiting Diarrhea	Laryngeal edema Bronchospasm Cyanosis	Shock
IV	Itching Flushing Urticaria Angioedema	Vomiting Diarrhea	Respiratory arrest	Cardiovascular arrest

