

Short communication

Food anaphylaxis in schools: evaluation of the management plan and the efficiency of the emergency kit

Background: Children with severe food allergies can benefit from a personalized care project (PCP) in schools. The usefulness of the PCP and the residual risk of allergic emergencies are poorly appreciated. The objective was to evaluate the efficiency of the management plan and the training in the use of the emergency kit.

Methods: A telephone survey using a detailed questionnaire was performed in 45 families whose children had been previously referred to the department. The distribution of disorders was as follows: asthma, 37.7%; atopic dermatitis and asthma, 28.8%; atopic dermatitis, 15.5%; angioedema and urticaria, 13.3%; and anaphylactic shock, 4.2%. Food allergy had been diagnosed in the 45 children by past history, and double-blind or single-blind, placebo-controlled food challenges (DBPCFCs, or SBPCFCs) with evidence of specific IgE. Exactly 75.5% of the children had peanut allergy. Multiple food allergies characterized 46.8% of the subjects. They had benefited from a strict elimination diet and a protocol for emergency care including a ready-to-use intramuscular epinephrine injection. A PCP had been requested by the School Public Health Service.

Results: Thirty-nine PCPs were implemented (86.5% of the requests). They represented 63% of the PCPs for food allergy in the eastern region of France: one per 5800 school-age children. The retrospective period of evaluation was 25 months on average. The types of meals were very diverse, and medically acceptable in 83% of cases. The place where the emergency kit was stored in the school varied. Forty reactions occurred in 33% of the children (5/6 times in the absence of a PCP), asthma in 28%, shock in 1%, and immediate skin reactions in 11%. Reactions occurred at home in 78% of the subjects, and in school in 22% of the subjects. The cause of the reactions was not specifically known in 63% of cases. Twenty-seven percent of the reactions were linked to the ingestion of food allergens. In 10% of subjects, the reaction was due to a modification of ingredients by the food industry.

Conclusions: The frequency of respiratory symptoms during oral challenge tests was confirmed by the frequency of asthmatic reactions within the follow-up period. The role of hidden allergens and of misleading labeling validates the need for PCPs in the case of peanut and tree nut allergies, past history of severe reactions, multiple food allergies, reactions to a low dose in DBPCFCs, and asthmatic reactions to foods. This study provides encouraging data on the usefulness of PCPs and confirms the need for thorough instruction and training of the school staff in dealing with allergic emergencies. Addition of a β -agonist spray to the emergency kit is suggested.

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In recent years, food allergy has been characterized by an increase in prevalence, an increase in multiple allergies, and an increase in severe reactions such as anaphylactic shock, laryngeal angioedema, and severe acute asthma (1–12). In children, secondary prevention is necessary, entailing an elimination diet and the availability of injectable epinephrine, possibly complemented by inhaled β -agonists and corticosteroids. The risk of the occurrence of such disorders in schools has

been stressed by various authors (13–18). Consequently, in the USA, as well as in the UK and France, strategies have been implemented to protect children in schools (15–17). Safety regulations for food-allergic children in schools began to be enacted by the French Ministry of Education as early as 1993 and were completed in November 1999. They recommend the creation of a document indicating the food allergy, specifying the risks, and giving information concerning the first

symptoms and the steps to be given in case of emergency. This type of prevention requires the collaboration of the allergist who establishes the diagnosis with school physicians and teaching staff. The effect of these preventive approaches is beginning to be analyzed in some countries (18–20). This study reports the experience of our center, which was the first in France to institute personalized care projects (PCP), starting in 1995, for patients presenting IgE-dependent food allergy established by skin prick tests, CAP System RAST, and double-blind oral challenge tests. Collaboration with the School Health Care Service made it possible to evaluate the relative frequency of PCPs for food allergy in the school population. The observation of the frequency of reactions, despite the precautions taken, points to the need for better education of parents concerning the control of food intake, but also to the irresponsibility of the food industry, should it modify the contents of food without correct labeling (hidden allergens). This study also indicates the importance of PCPs in reducing the risk of food-allergy emergencies.

Material and methods

A telephone survey was conducted of 45 families whose children were cared for by our center. The same person conducted the entire study. All families agreed to answer the questions thoroughly.

The survey used a questionnaire including detailed questions concerning the evolution of the food allergy since the establishment of the PCP. The questions dealt with the length of time the PCP had been in operation, the clinical indications for the PCP, the elimination diet, the arrangements made for the meals (family, caregiver, school lunch, or lunch box), and the place in school where the emergency kit was stored. We examined the reactions that had occurred since the establishment of the PCP, their clinical characteristics, the triggering agents if known, and the treatment that was given. Lastly, the questionnaire enquired about the difficulties encountered or the reasons why it was not possible to establish a PCP.

At the same time, the School Health Services of the eastern region of France were consulted in order to find out the total number of PCPs registered for food allergy.

Results

Characteristics of the sample

Forty-five children, 22 boys and 23 girls, made up the survey sample: 29 children aged 4–10 years, 13 adolescents aged 11–17, and two young adults aged 20. They had been referred for the following disorders and in the following percentages: asthma, 37.7%; asthma and atopic dermatitis, 28.8%; atopic dermatitis, 15.5%; anaphylactic shock, 4.2%; and urticaria and angioedema, 13.3%. There was a total of 66 food allergies (Table 1).

The patients had IgE-dependent sensitization established by prick-in-prick tests to native foods (21) and by CAP System RAST. Food allergy was confirmed by placebo-controlled oral challenge tests (double- or

single-blind in young children) in 33 children (for 43 foods), by labial challenge test for 16 foods, and by airborne allergen exposure test (food powder: buckwheat, chestnut, and lupine) three times (Table 1). The methodology of these tests has been described previously (22–25).

Out of 33 cases involving peanut allergy, the level of specific IgE antibodies (CAP System) was higher than 100 kU/l in 14 cases and higher than the 95% predictive positive value (PPV) in 11 additional cases (26). In the cases of egg allergy, the PPV of specific IgE was reached six times out of 14. This was also the case for the subject allergic to fish (case 25). The food allergy was an isolated food allergy to peanuts in 44.4% of cases, but it was isolated to eggs in 8.8% of cases, while multiple food allergies existed in 46.8% of cases. Overall, peanut allergy existed in 75.5% of cases.

At the end of the evaluation, 30 children were considered to be at high risk of anaphylactic shock or of acute asthma, on the basis of the clinical picture, of the dose eliciting symptoms, or of the intensity of the positive oral challenge. An emergency kit with a ready-to-use epinephrine injection was prescribed (Anakit®), and a strict elimination diet was instituted. A PCP was requested from the School Health Services.

Follow-up of the recommendations

Out of 45 requested PCPs, 39 (86.6%) were retained in schools over a period of 5 months to 6 and a half years with an average duration of 25 months. The 39 PCPs established represent 63% of the PCPs for food allergy in our area. Considering all of them, this represents one PCP for 5800 children attending school (0.017%).

The recommended elimination diet was followed in all cases. The types of meals were diverse: 68.8% at home, 6.7% at home or at the caregiver's home, 4.5% at the caregiver's home, 8.8% at school with a meal prepared by the parents, 6.7% at home and with school lunches, and 4.5% having school lunches exclusively. All in all, the types of meals were considered medically acceptable in 83% of cases.

The emergency kit was stored in the classroom (51.3%), in the infirmary of the junior high school (23%), or in the director's office (25.7%).

Forty reactions occurred in 33% of the children benefiting from a PCP and in five out of six children who did not. Out of 30 children who had been considered to be at the highest risk, eight had further reactions, while we observed eight reactions in 15 others. These reactions were as follows: anaphylactic shock ($n=1$), asthma ($n=28$), and facial angioedema and urticaria ($n=11$). No fatal event was observed. The shock occurred in a child considered at risk of it on account of a history of identical reactions and the low reactive dose of milk.

Table 1. Clinical and biologic characteristics in 45 food-allergic children needing personalized care project at school

Subject no.	Sex	Age (years)	Symptoms	Food	CRD (mg or ml)	Symptoms induced by BPCFC	Labial challenge	Prick (mm)	RAST (kU/l)	At risk of	Further reaction
1	F	4	U	Peanut	965	U, AP, V, C	nd	10	46	A.S.	–
2*	F	20	AD	Peanut	–	nd	Grade 4	9	>100	A	+U
3*	F	20	AAD	Peanut	–	nd	Grade 1	15.5	>100	+U	
4*	M	16	A	Peanut	965	AP, C	nd	8	52	A	–
5*	F	9	A	Peanut	965	AP, Di, W	nd	17	>100	A	+U
6	M	10	AAD	Peanut	–	nd	Grade 3	11	61	+U	
7	M	12	A	Peanut	15	pP, A	nd	8.5	>100	A	–
8	M	8	A	Peanut	15	pP	nd	20	>100	A	–
9	M	4	A	Peanut	965	AS	nd	9.5	43	AS	–
10	F	5	AD	Peanut	65	pP	nd	11	>100	+A	
11	F	7	AAD	Peanut	965	AP, C, ↓ PFR	nd	6	>100	A	+A
12	M	7	A	Peanut	965	C, W, pP	nd	12	29	A	+A
13	M	4	A	Peanut	Oil: 5 ml	A	nd	10	>100	A	–
14	F	13	A	Peanut	7110	AP, pP, ↓ PFR 5 h later	nd	12	58	A	+A
				Lupine	7110	AP, pP, ↓ PFR 5 h later		–	3.8		
				Kiwi	Positive	AO		6			
15	M	13	AO	Buckwheat	Handling buckwheat	E, Co	nd	14	3	AS	–
16	M	14	U	Buckwheat	3000	pP, U, R, C	nd	2	11	AS	+A
17	F	6	A	Egg	965	AP, ↓ PFR	nd	5	44	A	–
18	M	3	AD recurrent	Milk	345 (20 ml)	E, AP		nd	30		+A
			AS	Cashew nut			Grade 2	9.5	nd	AS	
19	M	7	A	Egg	610	AP, V	nd	6	14.9		+A
20	M	5	AAD	Peanut	–	Nd	Grade 2	7	35		+A
				Lupine	965	R, C, Co		17	0.78	A	
21	F	8	U	Peanut	1000	nd	nd	8	63	A	–
			AO	Lupine		P, RC, C	nd	6	8		
22*	F	5	A	¹ Peanut		nd	¹ Grade 3	5.5	1.29	AS	+A
				² Sesame		nd	² Grade 3	11	44.4		
23	F	4	AD	Egg	965	Facial E, P		9	17.50		+A
				Milk	75 ml	Facial E		–	4.4		
24	F	5	AAD	Peanut	Oil: 6 ml	V, C	Grade 2	14	11.70		+A
				Egg				4	1.13		
25*	M	8	AD	¹ Peanut	2000	¹ AP	nd	8	36		+U
				² Fish		² nd		8.5	49.20		
				³ Egg	7000	³ AP, D		3	1.11		
26	M	5	AD	Milk	5 ml	E, P, C	nd	7	4.30		–
				Egg	5	U, C	nd	14	52.1		
27	F	6	AD	Egg	nd	nd	+ Grade 4	8.5	40.35		–
28	M	4	AAD	Egg	200	E, AP	nd	10.5	0.88		–
29	M	4	AAD	Egg	965	AP, Co, E, AO	nd	6	52.5	A	–
				Peanut	110	E, P	nd	8.5	>100		
30	F	5	AAD	¹ Peanut		nd	+ Grade 2	8	7.39		–
				² Milk		nd	+ Grade 2	6	11.20		
				³ Egg		nd	+ Grade 2	4	–		
31	F	8	A	Peanut	965	AP, lethargy	nd	4	32.2	A	–
32	M	7	A	Peanut		nd	Grade 3		>100	A	–
33	F	5	AD	Peanut		nd					+U
				Egg		nd	Grade 3	10	4.02		
34	F	17	CA	Lupine		nd	Grade 1		4.38	AS	–
35	F	10	AO	Peanut	265	V, R	nd	11	>100	AS	–
36	M	4	A	Peanut	965	C, ↓ PFR, R	nd	18	>100	A	–
37	M	15	A	Peanut	Handling peanut powder	W	Grade 3	9	41.10	A	–
38	M	6	A	Peanut	265	AP, Di, U	nd	8	>100	AS	–
39	F	6	AAD	Peanut	7110	AP, facial U		4	28		–
				Lysozyme	965	CA		18			
40	M	12	AAD	Peanut	65	V, A		7.5	>100	AS	–
41	F	17	A	Peanut	965	pP, V		6	>100	A	–
				Lupine	Handling lupine flour	Facial E, Co		8	8.55		
42	M	5	AAD	Peanut		nd	nd	4	6.23		
				Green peas		nd	nd	11	nd		–
				Egg	965	AP, V		11	4.27		
43	F	9	AO	Peanut	15	AP		5	7.9		–
44	F	8	AAD	Milk				13	>100		
				Egg				25	42	AS	–
				Peanut				4	15.3		

Table 1. (continued)

Subject no.	Sex	Age (years)	Symptoms	Food	CRD (mg or ml)	Symptoms induced by BPCFC	Labial challenge	Prick (mm)	RAST (kU/l)	At risk of	Further reaction
45	F	13	AAD	Wheat Gluten	10 000 3000	Generalized U		1.5 7	0.99 nd		–

CRD: cumulated reactive dose; BPCFC: (single- or double-) blind, placebo-controlled food challenge; GWT: glove wearing test; AS: anaphylactic shock; A: asthma; U: urticaria; AD: atopic dermatitis; AAD: asthma and atopic dermatitis; AO: angioedema; AP: abdominal pain; V: vomiting; Di: diarrhea; C: cough; W: wheezing; PFR: peak flow rate; pP: pharyngeal pruritis; E: erythema; Co: conjunctivitis; R: rhinitis.

* PCP not done.

The reactions took place at school in only 22% of cases, and at home in 78% of cases. The treatment required included epinephrine and emergency hospitalization (7.3%), a β -agonist (22%), drinkable drops of corticosteroid (2.5%), and an anti- H_1 drug (14.6%). No treatment was administered to children receiving daily treatment for asthma or taking anti- H_1 drugs (53.6% of cases).

The causes of the reactions remained unclear in 63% of cases, including the case of the anaphylactic shock in a child allergic to cashew nut and milk. Exactly 37% of cases were related to the inadvertent ingestion of food or of a hidden allergen. In four cases, the reaction followed the intake of a ready-cooked cake that had previously been well tolerated, due to a change in the recipe. A new food allergy occurred in 10% of the cases (chicken, beef, and artichoke).

The reasons for not establishing a PCP were diverse: two young students did not think it was necessary, parents were uncooperative (one case), there was no school doctor or the doctor declined to validate the plan (two cases), and the teachers declined to inject epinephrine if necessary (one case). Other difficulties were encountered: the impossibility of creating such a document in nursery schools and vacation day-care centers, and the refusal of one town council to accept an emergency kit in their vacation day-care center.

Discussion

The approach recommended by the French authorities includes written instructions giving information about the signs of allergic emergencies, and a protocol for personalized care giving details for the use of injectable epinephrine by the intramuscular route, corticosteroids by mouth, and β -agonists by inhalation. This protocol is drafted by the allergologist or the pediatrician. Then the request for the management plan is made by the family to the Public Health physician in charge of the school. The management plan is to be implemented by the school officials and countersigned by the physician and the parents. The personalized care protocol is attached.

This study is the first evaluation in France of the usefulness of these guidelines. The fact that reactions occurred in only 33% of the children who benefited from this emergency plan, whereas five out of six

children without a PCP presented reactions, is encouraging. The necessary cooperation of a large number of people was obtained, in certain cases through meetings between the allergist and the teaching staff.

However, it is remarkable that we could not predict accurately the possibility of allergic relapses. Could it be that our recommendations had introduced a bias, in the sense that the parents of such children had been more cautious than the other ones? Or is the risk of reactions really unpredictable?

Reactions concerned 48% of patients, as in previous studies (17–19). Only one severe reaction occurred, perhaps due to the rapid treatment given in the case of reactions occurring in children not benefiting from daily treatment. In another study, severe reactions were observed in 33% of children, two-thirds of whom did not benefit from this emergency plan (18). Reactions occurring at school represented only 22% of the cases, a finding which confirms the US experience (17), twice the rate observed in the Oxford area (UK) (19).

Most reactions occurred at home, sometimes due to a lack of parental surveillance. The irresponsibility of the food industries, which change the contents of their products without notification, has to be highlighted. Nonetheless, the fact that the cause remains unclear in 63% of cases is worrying.

The frequency of asthma attacks after inadvertent food intake is striking, anaphylactic shock being rather rare. Respiratory symptoms had been frequent during oral challenge tests, even after administration of a few milliliters of peanut oil, which contains less than 50 μ g of protein (27). A fall in the peak flow rate was observed in 15 children out of 33. Asthma was triggered in three nonasthmatic children: subjects 16, 18, and 23.

Serious acute asthma can follow the ingestion of a hidden allergen (30). Moreover, asthma could be caused by the conjunction of factors associated with ingestion, such as exercise, or inhalation of pollen in sensitized children (28). The frequency of acute food-induced asthma in the spectrum of allergic emergencies has been highlighted (11, 29). Asthma is the main cause of death due to food anaphylaxis (5, 31–33).

The addition of a rapid-action β -agonist and a space-inhaler to the emergency kit is advisable, since the effects of the inhalation of β -antagonists on average oxygen saturation and FEV are greater than those of epinephrine, and this therapy has fewer adverse effects (34). It is

also more acceptable to nonmedical personnel. Furthermore, epinephrine alone is not always sufficient in serious acute asthma (35).

Epinephrine is a well-established therapy (36–40). It is the only medication that is active against collapse (37, 40–43). It is noteworthy that the subjects who had lethal reactions to food had not received it (2, 3, 5, 33, 44). Nevertheless, epinephrine is used in only 3–33% of emergency cases (17, 19, 41). The intramuscular injection may be done by any person near the patient. We were faced with the refusal of a member of the teaching staff, and even of a school physician in two cases. The recent import of an autoinjector will help to overcome the reluctance of the staff members. It is certainly necessary to arrange meetings to inform and train the staff. Allergists may instruct school physicians in emergency care, and they, in turn, could train the teaching staff (34, 45, 46).

The indications for PCPs need to be clearly defined. The complexity of the procedure and the investment in time and manpower involved in establishing a PCP require careful consideration of the following conclusions of this document:

- 1) The frequency and the severity of peanut allergy have been well established (3, 5, 9, 47). Along with allergies to tree nuts, it is currently the most frequent indication for a PCP (20, 32, 47).
- 2) Previous history of serious reactions immediately after consumption of a food to which IgE-dependent sensitization has been recognized is an evident indication, whether it involves anaphylactic shock (rare in children), laryngeal angioedema, or serious acute asthma (nine patients in this study).
- 3) Moreover, severe idiopathic allergic reactions necessitate the prescription of an emergency kit (49). This disorder affects 5% of the children in the Oxford area who carry epinephrine with them (19).

- 4) It should be easy to reach agreement about the precautions needed when a clinical reaction occurs to a given food through inhalation of food particles, by a kiss, or during oral challenge tests with a dose inferior to 100 mg. This high level of clinical reactivity is observed in 10–20% of food-allergic children, according to the food (data not shown). These children are particularly at risk in case of the ingestion of a hidden allergen (4, 47–50).
- 5) Allergy of moderate intensity to fish, eggs, sesame, or nuts, accompanied by strong sensitization as detected by skin tests or by RAST, may indicate the need for a PCP, as both the risk of asthma and the anaphylactic risk are known for these foods.
- 6) All asthmatic children, especially if they presented asthma during the oral challenge to food, need a PCP.
- 7) The multiple food allergy syndrome entails a number of risks due to ingestion of hidden allergens (51, 52). For those allergic to peanut, the risk of unexpected cross-reactions with new ingredients must be emphasized, such as allergy to lupine, an ingredient in ordinary flour (30, 53). A PCP could thus be recommended.
- 8) Moreover, a PCP is sometimes solicited by parental anxiety (20). Unwarranted requests for PCPs could mean that the school staff pay insufficient attention to other children truly at risk. In such cases, a negative oral challenge reassures the parents.

The frequency of PCPs for food anaphylaxis in our school population was 1/5800, which was lower than the 1/1600 in Oxfordshire (19). This rate is bound to increase in years to come. This study emphasizes the need for a concerted effort in serious cases of food allergy, because subsequent allergic reactions remain common, in spite of the constant vigilance of adults caring for these children.

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