

Original article

Influence of a multidisciplinary paediatric allergy clinic on parental knowledge and rate of subsequent allergic reactions

Background: Studies have demonstrated that families of children with food allergy have significant deficiencies in their knowledge of how to avoid allergen exposure and how to manage allergic reactions. This study aims to assess the impact of a multidisciplinary paediatric allergy clinic consultation on parental knowledge of food allergy and to determine the rate of subsequent allergic reactions.

Methods: Sixty-two subjects (<17 years) referred with food allergy were prospectively enrolled. Parental knowledge was assessed by questionnaire and EpiPen trainer. Families saw a paediatric allergist, clinical nurse specialist and dietician. Knowledge was reassessed after 3 months and rate of allergic reactions after 1 year.

Results: After one visit to the paediatric allergy clinic, there was a significant improvement in parental knowledge of allergen avoidance (26.9%, $P < 0.001$), managing allergic reactions (185.4%, $P < 0.0001$) and EpiPen usage (83.3%, $P < 0.001$). Additionally, there was a significant reduction in allergic reactions ($P < 0.001$). Children with egg, milk or multiple food allergies were more likely to suffer subsequent reactions.

Conclusions: A single visit to a multidisciplinary allergy clinic considerably improves families' abilities to manage allergic reactions to foods with an accompanying reduction in allergic reactions. Young children with egg, milk or multiple food allergies were at greatest risk of further reactions.

S. Kapoor, G. Roberts, Y. Bynoe, M. Gaughan, P. Habibi, G. Lack

Paediatric Allergy and Clinical Immunology,
St Mary's Hospital, London, UK

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Graham Roberts
Paediatric Allergy and Clinical Immunology
Ground Floor Salton House
St Mary's Hospital
Praed Street
London
W2 1NY, UK

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There has been a considerable increase in the apparent prevalence of food allergy in recent years (1). Food allergy is a very disabling problem as families have to alter their lifestyle and live in fear of life-threatening anaphylaxis (2, 3). One study shows greater impairment in quality of life in children with food allergies, compared with children with rheumatological diseases (4). Despite this, very few children and teenagers in the UK are referred to a paediatric allergy clinic for assessment and management (2, 5). Training packages for management of food allergy have been published (6, 7) but parents still have significant deficiencies in their knowledge (8, 9).

Patients with food allergy, and their parents, need a broad training to arm them with the knowledge necessary to live with their allergy (6). This should include (i) information about dietary avoidance, (ii) recognition of an allergic reaction, (iii) management of reactions including the administration of epinephrine, and (iv) control of coexisting asthma (7). Particular focus was placed on asthma control given the evidence to suggest that co-existent asthma is associated with severe allergic reactions

(3, 10). We aimed to provide this education in a multidisciplinary paediatric allergy clinic consisting of paediatric allergists, clinical nurse specialists and dietitians. Using a pragmatic approach, we have examined the effectiveness of a consultation within this busy clinic in terms of its impact on parental knowledge of food allergy and the rate of subsequent allergic reactions.

Methods

Subjects

Children aged <17 years referred to the allergy clinic at St Mary's Hospital with food allergy were prospectively enrolled into the study. The study was approved by the local research ethics committee. Informed consent was obtained from each family.

Clinical assessment by paediatric allergist

Subjects were assessed either by a consultant paediatric allergist or a specialist in training. Food allergy was diagnosed on the basis of the

clinical history of typical immediate hypersensitivity symptoms and signs occurring within an hour of exposure (11) in addition to positive specific IgE (Pharmacia Cap, Uppsala, Sweden; >0.7 kU/l) or skin-prick testing (ALK-Abello, Horsholm, Denmark; weal ≥ 3 mm). Where the diagnosis was unclear, food challenges were performed. The severity of reactions was defined using a grading system from mild to severe (12). The diagnosis of asthma was based on clinical history and examination, lung function parameters (masterscreen; Jaeger, Wuerzburg, Germany) and reversibility with inhaled bronchodilators (13).

Management

An individualized anaphylaxis management plan was prepared for each subject. A self-injectable epinephrine device (EpiPen) was prescribed if there was (i) previous severe anaphylactic reaction (cardio-respiratory problems) or (ii) mild reaction with coexisting asthma. Where appropriate, asthma management was optimized. The anaphylaxis management plan was sent to the general practitioner (GP) and school/nursery. Parents were advised to keep a treatment plan and a medication pack (anti-histamine, bronchodilator and EpiPen, as appropriate) at school. Liaison was also established with the local community paediatric team who provided training for school and nursery staff.

Education by a clinical nurse specialist

A clinical nurse specialist educated the family as to how to use the anaphylaxis management plan. The education emphasized on (i) the recognition of an allergic reaction, (ii) when to use antihistamines, bronchodilators or an EpiPen, (iii) when to call an ambulance, and (iv) how to use an EpiPen using a trainer device. Education was also given on how to use an asthma self-management plan.

Dietetic assessment

A specialist paediatric dietician gave advice regarding food allergen avoidance. The problems of cross-contamination and cross-reactivity within food groups and indirect exposure were highlighted. The education was reinforced with written material.

Evaluation

Prior to attending the allergy clinic, parents completed a standardized questionnaire. This assessed their knowledge of (i) how to avoid the allergen (five questions); (ii) whether they had and understood an anaphylaxis management plan (two questions); and (iii) their understanding of how to manage allergic reactions (five questions). Families were also asked how many allergic reactions to food their child had suffered in the previous year. Parents, and the child if old enough, were asked to demonstrate how they would administer an EpiPen using a trainer device. Three steps were identified as being critical for effective EpiPen administration: removal of the grey safety cap, selecting the appropriate site, and pressing the EpiPen down until it 'clicks'.

At review in clinic 3 months later, the families filled in the same questionnaire and demonstrated how they would administer an EpiPen. The same parent was asked to complete the questionnaire. The questionnaire was sent to parents who were unable to attend and they were asked how they would administer EpiPen over the telephone. A further review was undertaken 1 year after the initial assessment to document the number of allergic reactions during that period.

An allergic reaction was defined as the presence of immediate hypersensitivity symptoms or signs (e.g. urticaria, angioedema, wheeze or rhinoconjunctivitis) within an hour of exposure to the food in a previously healthy child. Proven allergy was defined according to one of three criteria: a serum specific IgE (14, 15) or skin-prick weal size (16, 17) above the appropriate 95% positive predictive value or a positive food challenge with objective signs of immediate hypersensitivity.

Analysis and statistics

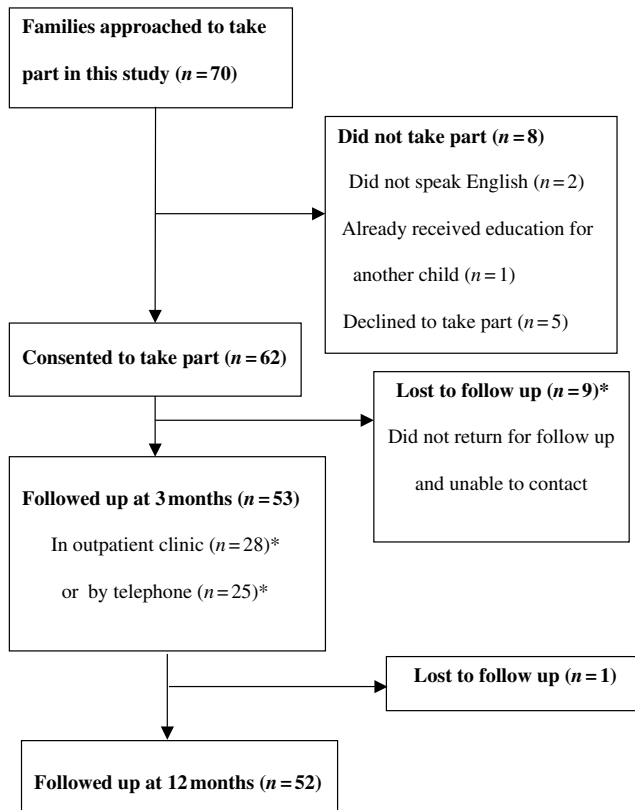
The study questionnaire was piloted with 16 families. They were asked to fill in the questionnaire twice with an interval of 4 h. Analysis indicated that the questionnaire was reliable with Kappa scores of 0.427, 0.786 and 0.620 for knowledge of overall management, which foods to avoid and practical management, respectively. To ensure the validity of the questionnaire, it was completed by two consultants and two specialist fellows within the allergy clinic. For the couple of questions where there was disagreement, a consensus answer was reached. Knowledge of allergen avoidance and managing allergic reactions is presented as a percentage of maximal score. Knowledge of how to use an EpiPen is presented as the number of families able to identify all the critical steps. The data from the subjects referred from primary and secondary care was compared using unpaired *t*-test or unmatched Wilcoxon rank sum test as appropriate. The data from the initial and follow-up visits was compared using a paired *t*-test or Wilcoxon matched-pair, sign-ranked test as appropriate. Proportions were compared using a chi-squared analysis. A sample size calculation suggested that at least 43 subjects needed to be enrolled to be able to detect a 20% change in knowledge given 90% power and a 5% level of significance. Stata 6 was used for all statistical tests.

Results

Subjects

Seventy new patients with food allergy were seen during the study period (February to June 2000), eight were not included in the study for reasons listed in Fig. 1. Forty-nine (79.0%) subjects had proven food allergy on the basis of their specific IgE result, skin-prick weal diameter or a positive food challenge. Only two were proven to have food allergy on the basis of a food challenge. Primary care, GPs practicing in the community referred 39 patients. Eighteen other patients were referred by secondary care, general paediatricians based in hospitals. There was no difference in the complexity of referrals between primary and secondary care. The referrer's diagnosis was accurate in only 20 (34.5%). For 31 (53.4%) referrals, the referrer had not identified all the foods allergens that subjects needed to avoid. For a further seven (12.1%) subjects, either the wrong food allergens had been identified or no food allergens were identified. The characteristics of the 62 subjects who enrolled in the study are listed in Table 1.

Fifty-three subjects (85.5%) were followed up after 3 months, 25 were unable to return to clinic but were reviewed by questionnaire and telephone interview (Fig. 1). There were no significant differences in the



*There was no significant difference in terms of age, sex, asthma, ethnicity, baseline knowledge or severity of reactions between these groups

Figure 1. Subjects.

results for subjects followed up by these two different means. The remaining nine subjects failed to respond to the reminder of the questionnaire.

Baseline evaluation

Knowledge of how to avoid food allergens. Parents had a poor knowledge of which foods they should avoid and how to avoid them (Table 2). There was no difference between primary and secondary care referrals.

Understanding of managing allergic reactions. The parents of only 27 (43.5%) children had been told and claimed to understand how to manage their child's reactions. This was reflected in their unsatisfactory understanding of anaphylaxis management as evaluated by questionnaire (Table 3). More children referred from secondary care had received advice and overall their knowledge was significantly better than those referred from primary care. Nonetheless significant deficiencies remained in many knowledge areas in both groups. Only 26 (55.3%) children with severe reactions or co-existing asthma had been prescribed a self-injectable epinephrine device (9/27 primary care; 14/15 secondary care referrals). Only 11 (40.7%) of the asthmatic patients had been

prescribed an EpiPen. Seventeen asthmatics always had their bronchodilators available but only three knew they should use it with an allergic reaction.

Knowledge of how to use an EpiPen. Of the families who had received an EpiPen, only 17 families (60.7%) had received a demonstration on how to use it. Only 13 parents (50%) were able to identify all the three critical steps. There was no significant difference in those referred from primary and secondary care.

Rate of allergic reactions. Subjects had a median of one reaction (interquartile range 0–3) during the year that they were waiting to be seen in the outpatient clinic. There was no significant difference between subjects referred from primary and secondary care (Table 4).

Effectiveness of education in the allergy clinic

Knowledge of how to avoid food allergens. After receiving education in the allergy clinic, there was a highly significant increase ($P < 0.001$) in the family's knowledge of how to avoid the allergen (Table 5). Significant improvements were seen in both the knowledge of which foods should be avoided and how to avoid them (data not shown). A similar improvement was seen for families referred from both primary and secondary care (Table 5).

Family's understanding of managing allergic reactions. There was a dramatic improvement (185.4%) in parental knowledge of how to manage allergic reactions ($P < 0.0001$) (Table 5). An improvement was seen in families referred from both primary and secondary care (Table 5). After education in the allergy clinic, all the asthmatics always had their bronchodilators available.

Knowledge of how to use an EpiPen. After education, 22 families (95.7%) with an EpiPen prescribed for their child could identify all the three critical steps. This represents a 83.3% improvement (95% CI 41.1–125.6%) in the family's level of knowledge (Table 5). Similar improvements were seen for families referred from both primary and secondary care (Table 5).

Allergic reactions. In the year after education in the paediatric allergy clinic, children had a median of 0 reactions (interquartile range 0–1.2). This is a significant reduction in reactions after education in the paediatric allergy clinic ($p < 0.001$) (Table 4). Comparable reductions were seen in subjects referred from both primary and secondary care. A further subgroup analysis of the reaction rate data was undertaken in two subgroups: (i) children with proven food allergy ($n = 49$) and (ii) subjects with proven nut or peanut allergy ($n = 45$). The rate of reactions in the children with proven food allergy showed a similar reduction from a median of 1 per year at baseline to 0 after the consultation ($P < 0.005$).

Table 1. Subject characteristics

	Subjects			
	All (<i>n</i> = 62)	Primary care referrals (<i>n</i> = 39)	Secondary care referrals (<i>n</i> = 18)	Referral from other sources (<i>n</i> = 5)
Male	36 (58)	26 (66.7)	9 (50.0)	1 (20.0)
Age (years)	6.1 (0.5–15.3)	5.8 (0.5–14.8)	6.0 (1.2–15.3)	8.5 (4.0–14.6)
Asthma	27 (43.5)	13 (33.3)	10 (55.6)	4 (80.0)
EpiPen appropriately prescribed by referrer	26 (41.9)	9 (23.1)***	14 (77.8)***	3 (60.0)
Weal diameter in mm (SE)	7.9 (0.5)	7.9 (0.7)	8.0 (1.1)	7.0 (2.3)
Specific IgE in kU/l (SE)	40.0 (9.2)	31.8 (12.0)	54.4 (17.1)	50.0 (7.1)
Clinical diagnosis				
Peanut	38 (61.3)	21 (53.8)	14 (77.8)	3 (60.0)
Tree nut	34 (54.8)	20 (51.3)	10 (55.6)	4 (80.0)
Milk allergy	12 (19.4)	8 (20.5)	2 (11.1)	2 (40.0)
Egg allergy	21 (33.9)	11 (28.2)	6 (33.3)	4 (80.0)
Fish allergy	8 (12.9)	7 (17.9)*	0 (0)*	1 (20.0)
Allergy to other food	18 (29)	8 (20.5)	5 (27.8)	3 (60.0)
Multiple food allergies	29 (46.8)	14 (35.9)	11 (61.1)	4 (80)
Proven food allergy	49 (79.0)	31 (79.5)	15 (83.3)	3 (60.0)
Severity of reactions (19)				
Mild (localized)	15 (24.2)	9 (23.1)	6 (33.3%)	0 (0.0)
Mild (generalized)	21 (33.9)	16 (41.0)	3 (16.7)	2 (40.0)
Mild (gastrointestinal or rhinoconjunctivitis)	3 (4.8)	0 (0.0)	2 (11.1)	1 (20.0)
Moderate	10 (30.7)	13 (33.3)	4 (22.2)	2 (40.0)
Severe	4 (6.5)	1 (2.6)	3 (16.7)	0 (0.0)

* $P < 0.05$; *** $P < 0.001$ for comparison of subjects referred from primary and secondary care (Student's *t*-test or chi-squared test). Many subjects were allergic to more than one food. Clinical diagnosis of food allergy was made on the basis of the clinical history of typical immediate hypersensitivity signs in addition to positive specific IgE (>0.7 kU/l) or skin-prick testing (≥ 3 mm). Proven food allergy was defined by one of the following criteria: (i) serum-specific IgE or skin-prick weal diameter was above the 95% predictive value for clinical allergy or (ii) positive food challenge (two positive challenges of the four open food challenges undertaken). Primary care refers to general practitioners practising in the community; secondary care refers to paediatric specialists practising in hospitals. Other sources of referral were community nurses, health visitors and teachers.

Values in parentheses are percentages.

Table 2. Family's knowledge of how to avoid food allergens at baseline

Knowledge area	Questionnaire results for each knowledge area (percentage of maximum score)		
	All subjects (<i>n</i> = 62)	Subjects referred from primary care (<i>n</i> = 39)	Subjects referred from secondary care (<i>n</i> = 18)
Which foods to avoid	39.8	42.7	25.5
How to avoid indirect allergen contact	65.3	57.7	75.0
What to do if your child is offered some food which might contain the allergen	96.8	100	88.9
What their child can safely do at a party	58.1	56.4	50.0
What their child should do at school lunch time	50.0	41.9	53.7
Overall knowledge of food allergen avoidance	53.7	53.4	46.0

* $P < 0.05$ for comparison of subjects referred from primary and secondary care (Student's *t*-test or Wilcoxon rank sum test depending on normality of the data). Negative marking was used when assessing the family's questionnaires (see methods). For the overall knowledge of food allergen avoidance, knowledge of which foods to avoid has four times the weight of the other areas reflecting its relative importance.

A similar significant reduction was also seen in this subgroup with proven persistent peanut or tree nut allergy (Table 4).

The children who did and did not experience a further allergic reaction during the follow-up period were similar in terms of age, gender and co-existent asthma. The reactors were however more likely to be allergic to either milk or egg (chi-squared test, $P = 0.001$). They were also on average allergic to twice as many foods (3.1 vs 1.6 foods, $P < 0.0001$, unpaired *t*-test). There was a highly

significant relationship between the number of individual food allergies and the number of subsequent reactions in the year following consultation: children with only one food allergy suffered only 0.2 reactions per year compared to 0.7 for those with two and 3.4 reactions per year for those with three or more food allergies (ANOVA; $P < 0.001$). Putting this into clinical terms, children allergic to more than one food made up 56% of the subjects but experienced 93% of the reactions during follow-up.

Table 3. Family's understanding of managing allergic reactions at baseline

Knowledge areas	Questionnaire results for each knowledge area (percentage of maximum score)		
	All subjects (<i>n</i> = 62)	Subjects referred from primary care (<i>n</i> = 39)	Subjects referred from secondary care (<i>n</i> = 18)
Received and claimed to understand advice as to how to manage allergic reactions	43.5	30.8	66.7*
Carry an antihistamine and know when to use it?	25.0	16.7	36.1*
Carry a bronchodilator and know when to use it during an allergic reaction†	31.5	15.4	50.0*
Have an EpiPen at school and understand when to use it‡	25.0	10.0	30.0
When to call an ambulance	31.4	25.6	44.4
Family's overall understanding of managing allergic reactions§	22.5	15.2	38.2***

* $P < 0.05$, *** $P < 0.001$ for comparison of subjects referred from primary and secondary care (Student's *t*-test or Wilcoxon rank sum test depending on normality of the data).

† If diagnosed with asthma; ‡ if prescribed an EpiPen; § overall understanding is the average of the five knowledge areas. Negative marking was used when assessing the family's questionnaires (see methods).

Table 4. Rate of allergic reactions 1 year before and after consultation in allergy clinic

	Subjects	Year before initial assessment	Year after initial assessment	<i>P</i> -value*
Number of subjects reacting	All	39 (75.0%)	20 (38.5%)	0.012
Frequent reactors (>2 reactions)	All	21 (40.4%)	11 (21.2%)	0.016
Rate of reactions (per year)	All	1 (0, 3)	0 (0, 1.2)	<0.001
	Primary care	2 (0, 3)	0 (0, 1)	<0.001
	Secondary care	1 (0, 2)	0 (0, 1.2)	<0.001
	Proven food allergy	1 (0, 3)	0 (0, 1.8)	0.005
	Proven nut or peanut allergy	1 (0, 2)	0 (0, 1.8)	0.001

* The change in reactions are tested by chi-squared test (proportions) or Wilcoxon signed ranked test (rate of reaction). Proven food allergy are subjects with skin-prick weals or serum specific IgE above the 95% predictive value or a positive food challenge. Only the families where data was available from both the initial and final assessment are included in this analysis (*n* = 52). Rates of reaction presented as medians (interquartile ranges).

Table 5. The effectiveness of education in a multidisciplinary allergy clinic

Knowledge area (number included in analysis)	Subjects (%)	Initial visit (%)	Follow-up visit (%)	Improvement in knowledge (%)	<i>P</i> -value*
Summary of family's knowledge of how to avoid food allergen exposure (<i>n</i> = 53)	All	55.4	70.3	26.9	<0.001
	Primary care	56.3	72.0	27.9	0.028
	Secondary care	47.6	64.5	35.5	0.087
Family's overall understanding of managing allergic reactions (<i>n</i> = 53)	All	20.6	58.8	185.4	<0.0001
	Primary care	13.1	57.6	340.0	<0.0001
	Secondary care	34.1	60.2	76.5	<0.001
Critical steps of EpiPen administration (<i>n</i> = 23)	All	52.2	95.7	83.3	<0.001
	Primary care	28.6	85.7	200.0	<0.01
	Secondary care	61.5	100.0	62.6	<0.01

* Comparison between initial and follow-up knowledge using Student's *t*-test or Wilcoxon signed ranked test as appropriate. Negative marking was used when assessing the family's questionnaires (see methods). Only the families where data was available from both the initial and subsequent assessment are included in this analysis (*n* = 53). Only the 23 subjects prescribed an EpiPen at both the initial and subsequent assessments are included in the EpiPen analysis.

Discussion

In this paper we demonstrate that families referred to a paediatric allergy clinic, from primary or secondary care, have a poor knowledge of allergen avoidance and managing allergic reactions. This is perhaps not surprising given a low diagnostic accuracy rate of referrers. With only one attendance in clinic, there is a large and significant improvement in the family's knowledge of

food avoidance (26.9%), managing allergic reactions (185.4%) and using an EpiPen (83.3%). This was associated with a reduction in the rate of allergic reactions during a year of follow-up. Similar levels of improvement were seen in patients referred from primary or secondary care. Also, for the first time, we have demonstrated that young children with egg, milk or multiple food allergy most at risk for further allergic reactions.

As with previous studies, we have demonstrated that families have a poor understanding of how and when to use an EpiPen (8, 9, 18). This perhaps not surprising when less than two-thirds could remember receiving a demonstration of how to use one. These results are concerning and reflect the fundamental problem that many GPs and paediatricians do not know how to use an EpiPen (8, 19).

During the 9–12 month wait for a consultation in the allergy clinic, subjects had an unacceptably high rate of allergic reactions, despite having being seen by their GP or paediatrician. With multidisciplinary education in clinic, there was a large reduction in reactions during the following year. A similar improvement occurred whether the patients had previously seen a GP or a paediatrician. This is the first time that an educational intervention has been shown to reduce the rate of reactions. Potentially this decrease may have resulted from children outgrowing milk and egg allergy as the children presenting to our clinic are relatively older than might be expected from the natural history of food allergy (11). This is an unlikely explanation as the vast majority had a peanut or tree nut allergy, which persists for years (10), and a similarly large reduction in reactions was seen in subjects allergic only to peanut and tree nuts.

Over a third of the children had a further allergic reaction in the year following their initial clinic visit. This is higher than the 15% rate that Ewan et al. report using a similar educational package (7) but lower than the 50% rate reported by other authors (10). This may reflect the younger age group seen in our clinic or a higher initial rate of reactions at presentation. This younger age group is likely to suffer from egg and milk allergy which are responsible for a disproportionate number of subsequent reactions. As a hypothesis generating exercise we looked at factors associated with continuing allergic reactions. Most of the subsequent reactions were experienced by subjects with milk or egg allergy and those with multiple food allergies. Whether or not this represents a high-risk group of children needs to be the focus of a further study.

The study we have undertaken does have a number of limitations. A control group was not included as it was felt to be unethical to withhold specialist education from families. The multidisciplinary clinic team were aware that the study was being undertaken. However, the provision of education in clinic was not changed because of the study and a questionnaire completed by study families were used as the study endpoint to minimize the potential for bias. Although not all children had challenge-proven food allergy, nearly 80% of the subjects had specific IgE or skin-prick testing above the 95% positive predictive values for clinical allergy (14–17). The primary outcome of interest in this study was the effectiveness of

education in the context of a specialist paediatric allergy clinic. In order for our findings to have broad clinical relevance, we looked at all children with suspected food allergy in our clinic and did not confine our analyses to a more selective challenge-proven subgroup. However, a reduction in allergic reactions was seen in both the entire cohort and the subgroup with proven peanut or tree nut allergy. It might be argued that additional medical evaluations will improve parental knowledge and any benefit to patients being seen in the allergy clinic was due to this effect. Our data argues against this as subjects referred from both primary and secondary care had poor baseline knowledge and achieved comparable improvements after a consultation in the allergy clinic. Although our study design is potentially susceptible to follow-up bias, this should be minimal given the high follow-up rate (85%) that was achieved. It is possible that the benefits achieved in this study were not entirely due to the multidisciplinary evaluation but may have resulted to some extent from other agencies. All children's families were given information about the Anaphylaxis Campaign, and they may have obtained subsequent information through the campaign's resources. The high rate of EpiPen availability at school is at least in part attributable to the liaison established with school nurses and community paediatricians.

Food allergy is a significant paediatric problem causing considerable disruption to a family's life and parental anxiety because of the concern about further reactions. If families are to understand both how to avoid the food allergen and how to manage allergic reactions, a multidisciplinary educational approach is required within the context of a paediatric allergy clinic. We have shown that such an approach is able to improve the knowledge of families referred from both primary and secondary care, even in a busy clinic. This is paralleled by a highly significant decline in the rate of allergic reactions after education. There is still room for improvement, particularly in the high-risk group of young children with egg, milk or multiple food allergy. This may be achieved by refining the education process or directing further education at the high-risk children.

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