

CHALLENGING ADVERSE REACTIONS IN CHILDREN WITH FOOD ALLERGIES

Gillian Waring and David Levy argue that offering skin and oral food tests provides more accurate diagnoses

Summary

The Department of Health (2006) has highlighted that food allergy is increasing in prevalence. In response, Tameside General Hospital in Greater Manchester has developed a dedicated children's allergy service. By using skin tests, followed by oral consumption of a particular food, the clinic is able to establish allergies and prevent future adverse reactions. This article summarises the findings of an audit of food challenges that were undertaken at the clinic.

Keywords

Allergy, anaphylactic shock, asthma, skin and skin disorders

BETWEEN APRIL 2002 and April 2007, 141 food challenge procedures were performed in the children's outpatient department at Tameside General Hospital in Greater Manchester. The department provides a safe, child- and family-friendly environment. The members of the multidisciplinary team involved in the assessment and management of the child's care include a paediatrician with a special interest in food allergy, children's outpatient nursing and medical staff, a play specialist, dietician and dermatologist.

A food challenge may be undertaken for any of the following reasons: to detect a specific food which causes immediate allergic symptoms, to eliminate a food as the potential cause of symptoms

and therefore avoid unjustified dietary restrictions (Niggemann *et al* 1994, 1999) or to discover whether a child has grown out of the allergy. Following a strict protocol, food challenges are performed in a safe environment supported by prompt access to expert paediatric nursing and medical intervention if a child develops a reaction to the food being challenged. The service also provides families with information on symptoms suggestive of an allergic reaction, on diet and on how to safely manage the condition at home and at school.

This article provides a brief overview of food allergy and reports on the food challenges held at Tameside General Hospital children's unit between 2002 and 2007. Food challenge procedures and outcomes (quantifying the number of positive and negative food challenges for each food type) are summarised in Table 1.

Background

Food allergy is believed to occur in 2-3 per cent of the paediatric population (Spergel *et al* 2004). A Review of Services for Allergy (Department of Health (DH) 2006) suggests that approximately 6 per cent of children less than three years old may be affected.

Food allergy is increasing in prevalence and at a faster rate than other allergies (DH 2006). Although there are many theories, the literature in general suggests that this increase in prevalence may be a result of improvements in screening and diagnosis (Rancé *et al* 1999), and a combination of genuine

Opposite page: Gillian Waring (right) and staff nurse Clair Armitt prepare a child for a food allergy test



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increases and improved identification and recording (Simpson *et al* 2008). Environmental and genetic factors have also been suggested as causes (House of Lords 2007).

In developing a paediatric allergy service it is important to realise that food allergy cannot be taken in isolation. Allergic disorders commonly co-exist, several occurring in the same individual (Royal College of Physicians (RCP) 2003). This co-existence of food allergy, eczema, allergic rhinitis, asthma and anaphylaxis is thought to be increasing (Simpson *et al* 2008); the management of asthma is intimately linked to the management of the food allergies.

The British Paediatric Surveillance Unit instituted a prospective survey of fatal and severe food allergy in children (Macdougall *et al* 2002), and found eight deaths from 1990 to 2000; half of these were identified from death certificates. Almost all the children who died or nearly died from food allergy also had asthma (Macdougall *et al* 2002). It is therefore vital that a paediatric allergy clinic not only functions in an appropriate setting for families but also has professionals who work closely with each other and across primary, secondary and tertiary care. The health department emphasised that children should be seen by health professionals trained in the care of children, in a child-friendly environment (RCP 2003).

Diagnosis

An accurate diagnosis is key to treating an allergic condition adequately, and much depends on eliciting an accurate patient history (House of Lords 2007). This can be supplemented with a range of investigations to help support or inform the preliminary diagnosis, including skin prick testing, laboratory assessment of serum such as levels of immunoglobulin E (IgE) antibodies and food challenges. The results of these investigations are meaningless in isolation and should be interpreted in context (House of Lords 2007). Negative skin prick tests are more useful in excluding food allergies than positive skin prick tests are in diagnosing them, as sensitisation can occur without clinical allergy (RCP 2003). Tests for specific IgE antibodies to foods are useful but should stimulate further investigations (RCP 2003). Several large studies have determined laboratory parameters (skin tests, IgE concentrations) with excellent predictive values for diagnosing

current clinical reactivity or tolerance, although oral food challenges are necessary for a definitive diagnosis (Sicherer 2002, Niggemann *et al* 2005).

Most children will lose their food allergy over time but there is no laboratory parameter that can accurately predict when clinical tolerance will develop. Therefore repeated, controlled oral food challenges are the investigation of choice (Niggemann *et al* 2005). These have been described as the cornerstone for diagnosis of food allergy and quick-onset reactions to foods, and a fundamental tool in management (Rancé and Dutau 1997, Sicherer 1999, Caffarelli and Petroccione 2001).

In open food challenges, the child, parents and health professionals are aware of the food being challenged (Torr 2002). In a double-blind, placebo-controlled food challenge, the test food is concealed and neither the subject nor test supervisor know which is the adulterated dish (RCP 2003); such challenges are very time consuming but remain the gold standard for diagnosis of adverse food reactions (RCP 2003).

Food challenge procedure

The evidence-based food challenge protocol used (Table 1) was written by David Levy, consultant paediatrician at Tameside, who has a special interest in atopy and food allergy.

On the day of the challenge, the children first undergo a clinical assessment to ensure they are well, have not taken an antihistamine in the past seven days and have not had any accidental exposure to the food type since the initial consultation with the paediatrician. Any history of a recent reaction indicates that the child is still allergic and therefore the challenge should not proceed; the child should have been free of symptoms for the previous six months.

For each of the food challenges performed, the food type is rubbed onto one part of the child's back and gauze only is rubbed onto another part of the back. A positive result would comprise an urticarial skin reaction on the part of the back in contact with the food type, with no reaction on the part of the back rubbed by gauze only. This would rule out a false positive result due to dermatographism, that is, the production by gentle stroking of wheals on the skin resembling urticaria (Brooker 1996).

Severe reactions begin and progress rapidly, and early recognition and treatment are mandatory (RCP 2003). Because of the potential to cause severe anaphylactic reactions, food challenging is performed in the children's outpatient department, which directly adjoins the children's ward, with emergency medication and equipment immediately

Table 1 The food/milk challenge protocol

Solid food challenge in incremental stages	Timing between stages
Skin test	20 minutes
Stage 1: Touch to lower oral mucosa	30 minutes
Stage 2: Ingest pin-head amount	30 minutes
Stage 3: Ingest ¼ grain of rice amount	30 minutes
Stage 4: Ingest 1 grain of rice amount	15 minutes
Stage 5: Ingest pea-sized amount	15 minutes
Stage 6: Ingest teaspoon-sized amount	15 minutes
Stage 7: Ingest tablespoon-sized amount	15 minutes (followed by two hours observation period)
Milk challenge in incremental stages	Timing between stages
Skin test	20 minutes
Stage 1: Drop to lower oral mucosa	30 minutes
Stage 2: Ingest 1ml	30 minutes
Stage 3: Ingest 5ml	30 minutes
Stage 4: Ingest 10ml	30 minutes
Stage 5: Ingest 20ml	30 minutes
Stage 6: Full milk feed (dependent on the age of the child, a full feed consists of approximately 200ml)	Two hours of observation

available. The medication is prescribed in advance, in accordance with the child's weight, and includes antihistamines, adrenaline (epinephrine), corticosteroids and inhaled beta-agonists.

All the healthcare professionals involved in the challenges are familiar with the Advanced Life Support Group (ALSG) anaphylaxis protocol, are trained to manage anaphylaxis and attend regular paediatric life support (PLS) training. Baseline observations recorded include blood pressure, heart rate, respirations, temperature and capillary refill time, and are repeated at each stage of the food challenge. Food allergy usually manifests as immediate systemic reaction (type 1 hypersensitivity). Clinical anaphylactic symptoms range from angioedema, urticarial rash (Figure 1), eczema, wheezing, stridor, rhinitis and vomiting to collapse (Caffarelli and Petroccione 2001).

If any such signs or symptoms occur the procedure is immediately stopped, and the child is treated appropriately and observed. The child is deemed allergic to the food type and avoidance information is reiterated.

Results

Between April 2002 and 2007, 141 food challenge procedures were performed, approximately the same number in each year. The age of children ranged between 11 months and 15 years. Although any

food protein can trigger an allergic response, a small group of foods account for the majority of reactions; these include milk, egg, wheat, soya, peanut, fish and shellfish (Rancé and Dutau 1997, Sicherer 1999, RCP 2003). This is supported by the food types referred by a paediatrician for challenge at Tameside, among which egg, milk and nuts were the most prominent (Table 2).

Researchers and clinicians have used a variety of challenge regimens with some success. Some methods have included screening challenges which,

Figure 1 Child with urticaria

Table 2 Food types challenged and results shown as positive, negative or inconclusive

Food challenged	Positive	Negative	Inconclusive	Total tested
Egg	40	12	4	56
Milk	20	7	1	28
Nuts	14	5	1	20
Salmon	6	0	0	6
Cod	4	0	1	5
Peas	3	1	0	4
Tuna	1	4	0	5
Prawn	1	1	0	2
Bengali fish	2	0	0	2
Trout	1	0	0	1
Sardine	1	0	0	1
Haddock	1	0	0	1
Kiwi	1	0	0	1
Sesame oil	0	1	0	1
Potato	0	1	0	1
Orange	0	1	0	1
Strawberry	0	1	0	1
Coconut	0	1	0	1
Banana	0	1	0	1
Baked beans	1	0	0	1
Chick peas	0	1	0	1
Tomato	0	1	0	1
Total	96	38	7	141

Table 3 Positive oral food challenge in four children

Reaction	Food	Stage (Table 1)	Treatment
Urticarial rash on cheeks	Cow's milk	Stage 3	Oral antihistamine
Vomited once	Egg	Two-hour observation period	None
Swollen lips	Mixed nuts	Two-hour observation period	Oral antihistamine and oral prednisolone
Pallor, vomiting, urticarial rash with surrounding erythema	Prawn	Two-hour observation period	Oral antihistamine

if negative, are followed by an oral food challenge (Sicherer 1999).

During the period studied at Tameside, 92 (65 per cent) of the food challenges performed produced a positive skin test. All the affected children received oral antihistamine and were

observed in the department for a further hour until their symptoms subsided before discharge home. The diagnosis was made of allergy to the challenge food and a follow-up appointment was arranged for the atopy clinic. By this method, food allergy may be over-diagnosed because some children may have

a positive skin reaction but no symptoms following oral consumption. However, it is felt that this is the safer option.

The 49 (35 per cent) children who had a negative skin test underwent the oral part of the food challenge, which involved receiving the food orally in gradually increasing amounts over a set period of time. Of these, 38 completed the food challenge and were negative, four had a positive reaction to oral consumption and seven were deemed inconclusive. Researchers have used a variety of challenge regimens (Sicherer 1999) with different dosages. The timing between incremental doses varies between 15 and 45 minutes, as most children will react in these time periods (Torr 2002).

It is suggested (Niggemann *et al* 1994) that after six to seven intermediate doses (Metcalf and Sampson 1990, Torr 2002) the final dose should consist of the 'average daily dose' of this food for the age of the child. Once they have completed the food challenge, children remain in the department for a further two hours of observation.

Symptoms usually occur in five to ten minutes of exposure to the food allergen and can certainly be noted within two hours (Hourihane 2000). The nurse performing the food challenges remains present with the child throughout the procedure. Four (3 per cent) of the children reacted to the oral food challenges (Table 3), and of these, three displayed a positive reaction during the two hours' observation and the fourth at stage 3 (Table 3) of the milk challenge. Three of the children received oral antihistamine, one of whom also required oral prednisolone. The fourth child, who vomited following ingestion of egg, did not require any medication.

All children were discharged on the day of the challenge, with verbal and written advice to the families on the management of symptoms suggestive of an allergic reaction. Dietary and food avoidance advice is offered where appropriate. A criticism is that, if people hold strong beliefs about adverse reaction to a certain food type, they are likely to react subjectively to that food during an open challenge (Metcalf and Sampson 1990). However, none of the challenges were considered falsely positive as none was terminated by subjective report alone. All displayed objective positive responses such as vomiting, urticaria and swollen eyes.

Although it is not uncommon for children to refuse to ingest the challenge food (Sicherer 1999), only seven (5 per cent) challenges were discontinued because of child refusal. The success of food challenges depends on the preparation undertaken with the child and family. Sicherer (1999) advises the participation of the play leader at all stages

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of the food challenge. The play team are involved throughout, including in the preparation of the child.

Following a food challenge, all families are offered follow up by the consultant paediatrician. Successful exclusion of identified dietary allergens requires extensive education regarding the interpretation of ingredient labels of commercial food products and an appreciation of issues of cross contact in settings such as restaurants. Attention is also given to potential dietary insufficiencies resulting from exclusions (Mofidi 2003).

The follow-up appointment allows the arrangement of subsequent food challenges, which are often the only means to determine whether the allergy has been outgrown (Sicherer 1999). All children are re-assessed regularly.

The follow up of children demonstrated that the 38 (27 per cent) who had a negative challenge, did not have a reaction at home following the introduction of the challenged food, thus demonstrating there were no false negatives. This supports previous research suggesting that the size of the final dose should be high enough to diagnose correctly and also to ensure that the child will not react to larger amounts of the food at a later date (Torr 2002). The results show that 38 (27 per cent) children were identified as not having an allergy to a particular food. This means it was unnecessary to restrict their diet, which would have a positive impact on their lives (Table 4).

Discussion

User feedback, to establish how satisfied children and their families were with service provision, was gathered during the first 12 months of the food challenge clinics. Families were given a questionnaire at the end of the challenge and were asked to hand it in at reception on their way out. The questionnaires were anonymous. All the families undergoing

Table 4 Overall results of the food challenge (n=141)

Challenges	Results
Positive skin tests	92 (65 per cent)
Underwent oral challenge	49 (35 per cent)
No reaction to oral challenge	38 (27 per cent)
Positive reaction to oral challenge	4 (3 per cent)
Inconclusive challenges	7 (5 per cent)

a food challenge during 2002/03 completed a questionnaire on the day of the investigation (100 per cent response rate). The information on the questionnaires included:

- Appropriateness of information given to the family before and following the food challenges.
- Difficulties with the food challenge.
- Changes the family would recommend.
- Reactions the child may have had and the treatment given.
- Any other comments.

Later evaluation demonstrated positive responses. The treatment during the procedure was described as excellent and caring. The families were pleased with the close observation of their child throughout the procedure. All found the information provided clear and helpful. Families also commented on the benefit of a relaxed, child-friendly environment, with large numbers of age-appropriate activities available.

Conclusion

The food challenge clinics held at Tameside General Hospital children's outpatient department appear beneficial for children with symptoms suggestive of food allergy, as they provide a definitive negative or positive result. An allergic child's dietary needs can be clearly established to prevent future adverse reactions. The food challenge protocol appears to enable the safe and reliable diagnosis of food allergy among children, allowing suspected associations to be either confirmed or disregarded. The initial skin test, followed by the oral challenge in timed increasing doses, maintains a low risk for systemic reactions. It may be that food allergy is being over-diagnosed on the basis of skin tests, as some children may have skin symptoms but no symptoms following oral consumption. It is intended that this area will be addressed and may result in future changes to the protocol.

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