

Educational Series

Egg allergy

Kemp AS. Egg allergy.
Pediatr Allergy Immunol 2007; 18: 696–702.
© 2007 The Author
Journal compilation © 2007 Blackwell Munksgaard

Egg allergy is one of the most common food allergies in infants and young children. The great majority is not life-threatening and management involves exclusion of egg from the diet and regular review with the expectation that the majority of children will outgrow the allergy by school age. Judgment is required as to when the dietary elimination of egg is no longer required. This decision may be helped by demonstrating loss of sensitivity by skin prick or specific IgE testing and in some cases a supervised food challenge. Particular issues in management arise with more severe, potentially life-threatening reactions, with immunization with vaccines prepared in eggs, with the diagnosis of egg hypersensitivity as a cause of delayed exacerbations of eczema which can be non-IgE mediated, and in deciding whether a child can be allowed to ingest small amounts of cooked egg through egg-containing foods while continuing to avoid raw egg or larger amounts of whole egg. Cases which illustrate these issues are presented.

Andrew S. Kemp^{1,2}

¹Department of Allergy and Immunology, The Children's Hospital at Westmead, Sydney Australia,
²Discipline of Paediatrics and Child Health, Clinical School, University of Sydney, Sydney, Australia

Key words: anaphylaxis; egg hypersensitivity; egg white; egg yolk; urticaria; vaccination

Andrew Kemp, Department of Allergy and Immunology, The Children's Hospital, Westmead, Sydney, NSW 2145, Australia
Tel.: +61 2 98453416
Fax: +61 2 98453421
E-mail: Andrewk5@chw.edu.au

Accepted 9 October 2007

Case 1

Egg allergy and immunization

A 12-month-old girl is referred with presumed egg allergy. At the age of 3 months, some raw egg touched her face and she developed localized urticaria and eyelid angioedema which settled spontaneously. At the age of 3.5 months, she developed contact urticaria on the cheek following being kissed by her mother after the mother ate an omelette. She has never knowingly ingested egg. There were no other systemic manifestations or respiratory difficulties associated with these two reactions. Immediate hypersensitivity skin prick tests (SPT) showed 10-mm wheals to egg white and egg yolk and were negative to cow's milk, wheat, and banana. She is now due her MMR vaccination and her mother wonders whether she should have this, as the package insert says it is contraindicated in egg allergy?

Discussion

Transient low levels of IgE antibodies against egg proteins often occur in healthy infants without

any symptoms (1). The prevalence of IgE-mediated reactions to egg in a population-based study of 2-yr olds was 1.6% (2). Egg-allergic reactions commonly are first observed in the second 6 months of life and the most common symptoms are cutaneous with erythema and urticaria occurring in 90% of children with a median age at presentation of 10 months (3). Symptoms usually occur within 30 min or less of egg contact but may be delayed for 1–2 h in a minority of cases (3). Contact urticaria following application of egg protein to the skin is a common finding (4). The application of raw egg may sometimes be followed by systemic symptoms of erythema/urticaria outside the application area. Gastrointestinal symptoms, abdominal discomfort, and vomiting occur in 40–50% of cases following ingestion of egg. The vomiting is often repetitive. The occurrence of gastrointestinal symptoms would not be expected in this case as there has been no ingestion of egg.

Reactions does not uncommonly occur on first known ingestion or skin contact with egg (5). In one study of 107 infants with atopic dermatitis and no known egg ingestion, 67% had evidence of IgE sensitivity to egg and positive reactions to

an oral food challenge (6). Sensitization may theoretically occur either by transplacental transfer of egg allergen (7) or through breast milk (8). Egg allergen can be detected in breast milk after maternal egg ingestion. There is no evidence that egg avoidance in pregnancy decreases sensitization in the infant (9).

Vaccine manufacturers have listed egg allergy as a contraindication to measles immunization. However, measles vaccines are produced in a culture of chick embryo fibroblasts. In the past, MMR vaccine for children with egg allergy has been controversial; however, now it is agreed that MMR vaccine is not contraindicated in egg allergy and that vaccine skin testing is not required. An Australian study gave 410 egg-allergic children MMR vaccine and only four children had minor reactions that did not require any intervention (10). Recent evidence suggests that allergic reactions to MMR vaccines have been caused by sensitization to gelatin (11).

In contrast to MMR vaccines, influenza vaccines are grown in eggs and anaphylaxis has been reported. The ovalbumin content of different influenza vaccines may vary (12). Thus, caution is indicated when considering whether an egg-allergic child should be given influenza vaccine. In 1976 in USA, there were 11 episodes of non-fatal anaphylaxis in 48 million doses (13). Fatal anaphylaxis has also been documented in an egg-allergic child following influenza immunization (14). It is generally recommended that a history of a severe life-threatening reaction (anaphylaxis) to egg is a contraindication to influenza immunization.

Concerning influenza immunization, The American Academy of Paediatrics in the Red Book recommends that less severe reactions to egg are not a contraindication to immunization and children can be immunized with the influenza vaccine without skin testing (15). Concerning more severe reactions, it provides somewhat inconclusive advice. It states that children with a 'severe anaphylactic reaction' to egg protein should generally not receive influenza vaccines, but also states that skin testing can be performed on children with a severe anaphylactic reaction to egg. The Red Book describes a protocol of a SPT with a 1:10 diluted vaccine followed by a 1:100 vaccine intradermal test and states that if negative, the vaccine can be given as a single dose and if positive, recommends a 5-dose protocol every 15–20 min (15). Others have utilized a 1:10 dilution of the vaccine for intradermal skin testing (16).

A somewhat different approach has been published by James et al. who performed a SPT

only with undiluted vaccine containing less than 1.2 µg/ml egg protein (17). Only 5% of egg-allergic subjects were positive on SPT with undiluted vaccine. The study included 83 children, however, only 27 children had a history of a severe allergic reaction to egg (17). For all the egg-allergic subjects a 2-dose injection protocol (1/10, followed 30 min later by 9/10 dose) was used without any adverse effects.

One authority, The Jaffe Food Allergy Institute, suggests if there is a previous history of a life-threatening reaction (generalized hives, drop in blood pressure, or upper or lower airway symptoms after eating egg) and it is considered that influenza immunization is warranted then both SPT and intradermal testing may be performed (http://www.mssm.edu/jaffe_food_allergy/pdf/influenza_vaccination.pdf). Following testing consideration may be given to gradual administration over five injections. In this situation, referral to a consultant allergist would be strongly indicated, particularly if it is decided to administer the vaccine in children with a positive skin test.

For the practitioner, an issue which must be weighed up in each egg-allergic child is do the potential benefits of influenza immunization outweigh the risks of a life-threatening reaction to the influenza vaccine? In the majority of children with non-anaphylactic reactions to egg in whom influenza vaccination is indicated, it seems reasonable to perform a SPT with the undiluted influenza vaccine and give the vaccine as a 2-dose protocol in those who do not react.

Case 2

Egg allergy: should adrenaline be prescribed?

A 23-month-old boy is referred because his doctor wants to know whether he should have an EpiPen[®] (E. Merck, Darmstadt, Germany). At 9 months of age, following a one-fourth teaspoon of cooked egg, he developed facial erythema, lip swelling, a hoarse cry, and possibly some respiratory distress which resolved spontaneously over a couple of hours. He did not receive medical attention. At 13 months of age, following a one-fourth teaspoon of whole cooked egg, he had a similar reaction with a hoarse cry. He has not reacted to other foods and has not been exposed to peanut products. SPT were positive to egg yolk 7 mm and egg white 8 mm.

Discussion

In addition to the cutaneous symptoms, this case had some respiratory symptoms. Respiratory

symptoms occur in a minority of cases; one specialist center recorded respiratory symptoms in 12% of egg-allergic children (3). Symptoms of cough, hoarse voice or cry, wheeze, and stridor indicate involvement of the respiratory tract. In the present case, the history of a hoarse cry in association with the cutaneous features of an acute allergic reaction to egg suggests some laryngeal involvement. Fatality from egg anaphylaxis is very uncommon (18); however, involvement of the respiratory tract indicates a potentially more severe reaction, and authorities and consensus guidelines have suggested that airway involvement is an indication for prescribing an adrenaline auto-injector in food-allergic children (19, 20). In this case, he was prescribed an EpiPen® junior and provided with a written anaphylaxis action plan because he has had voice changes indicating laryngeal edema. His weight was 14 kg which fits into guidelines for provision of self-injectable adrenaline which have suggested that children of > 10 kg can be prescribed an adrenaline auto-injector which has a fixed dose of 0.15 mg of adrenaline (20).

Skin prick test and Specific IgE are sensitive indicators that a child has food-specific IgE. A strongly positive SPT to egg (wheal > 7 mm) was found to be strongly predictive of a reaction on formal food challenge (21). Quantitative levels of IgE have been determined for egg allergy which can identify patients who have a >95% probability of reacting to an egg challenge reaction to egg (22). However, this varies with age and quite different cutoff levels have been proposed in children less than 2 yr (23). Unfortunately, SPT or Specific IgE test are not particularly helpful in predicting the severity of a clinical reaction which is what the clinician would like to know when considering whether to prescribe an adrenaline auto-injector. It has been suggested that there are several additional factors that might be considered in this decision (24). These are: age over 5, as most deaths have occurred in school age children or teenagers, a history of asthma requiring preventer medication, peanut or tree nut sensitivity, reactions induced by traces or small amounts of allergen, and a strongly positive SPT. The presence of asthma is considered to increase the risk of death (19, 25) or a severe reaction (26). However, this conclusion is derived predominantly from older subjects with peanut and tree nut anaphylaxis. Whether a similar consideration applies to infants and toddlers with egg allergy is unclear, and in the present case there was no history of asthma. However, it would seem reasonable that

asthma of sufficient severity to require preventer medication be considered a factor which may favor the provision of an adrenaline auto-injector.

The prescription of an adrenaline auto-injector alone is not a satisfactory response to the risk of food anaphylaxis. This is highlighted by the Australian evidence that only 29% of adrenaline auto-injectors prescribed were used appropriately in a subsequent anaphylactic reaction (27). Instruction in the auto-injector administration and provision of a clear and simple anaphylaxis action plan is just as important as the provision of the device itself. Surveys of parents of food-allergic children indicate that where, when, and how to give the adrenaline auto-injector is a core parental information need (28). In the UK, 69% of parents were found to have problems using the adrenaline auto-injector. A South Australian study found that even in children who had been prescribed an adrenaline auto-injector at an allergy clinic, in 71% of subsequent severe reactions the parents failed to use the device appropriately (27) highlighting the critical importance of appropriate parental instruction.

Case 3

Growing out of egg allergy

An infant was breastfed until 6 months of age. At 6 months, the first time she was given egg (in custard) she ingested about four teaspoons, then 10 min later vomited once and developed generalized erythema, eyelid edema, and an urticarial rash which involved her face and trunk. The rash persisted for about 1 h, then gradually resolved. There was no respiratory distress. SPT at 8 months showed a 6-mm wheal to egg white and 5-mm wheal to egg yolk. She was advised to avoid egg. At 10 months, she was inadvertently given a further three teaspoons of egg-containing custard and developed facial and mild eyelid edema swelling plus some urticarial lesions on her trunk. She was advised to continue egg avoidance. On review, at 18 months, her skin tests to egg yolk and egg white were negative. She now tolerated all forms of egg in her diet.

Discussion

Egg allergy generally remits by school age in contrast to peanut allergy which usually persists into older childhood and adult life. Approximately, two-third of egg-allergic children outgrows their allergy by 5 yr of age (3). About 20% of children will outgrow their egg allergy in the

first 12 months following the diagnosis, as in the present case, and another 20% persist for 6 yr or more (29). The resolution of a positive egg SPT is a good indicator of the acquisition of tolerance in previously egg-sensitive children. The median time from appearance of first symptoms to tolerance is 35 months (29). Smaller SPT wheal size, lower specific IgE antibody levels, and clinical reactions restricted to the skin without other systemic features are positive prognostic factors for the development tolerance (29). It has been postulated that once tolerance is established regular intake of egg may help to maintain this state (30). As tolerance acquisition occurs at a rate of 20% per year in the first 5 yr of life, it is reasonable to review egg-sensitive children with repeat SPT on a yearly basis.

Case 4

Tolerates cooked but not uncooked egg

A boy had excluded egg from his diet from 6 months of age following an urticarial reaction. At 3 yr, SPT showed 7 mm to egg yolk and 9 mm to egg white. He was advised to continue egg avoidance. At age 4, he gave a history that after touching some mayonnaise (which contains egg yolk and white) into his eye, he had eyelid and conjunctival edema and his SPT (10 mm to egg yolk and 12 mm to egg white) remained positive. At age 6, he had never knowingly eaten cooked egg in cakes or other foods. He has not had any other food reactions. His mother wanted to know whether he could have cakes containing cooked egg provided this was under her supervision. His skin test remained positive (egg yolk 5 mm white 9 mm). On an in-hospital challenge, he tolerated one-third of an egg cooked in cake. He subsequently underwent a whole egg challenge with lightly cooked egg. Fifteen minutes following one-eighth teaspoon, he developed minimal swelling of his lower lip and complained of some itchiness in his throat. The symptoms settled spontaneously.

Discussion

Reaction to raw or lightly cooked egg but tolerance of more extensively cooked egg-containing foods is a common finding. In one case series, three-fourth of egg-allergic children had previously tolerated cooked egg yolk (3). Egg allergens may be altered by heat and acidity. There is a differential effect of heat on egg allergens with heating reducing the allergenicity of ovomucoid and ovalbumin, but not affecting

that of lysozyme (31). The reduction in allergenicity by heat provides an explanation for those children with who react to uncooked but not cooked egg (32). It is important to be aware that children who tolerate cooked egg might still react to uncooked egg proteins and therefore any exposure should only be to well cooked egg if the child has not been demonstrated to tolerate uncooked egg. Although there is, on occasions, some immunological cross-reactivity between hens' egg proteins and egg proteins from other birds (duck, turkey, and quail), egg-allergic children can usually tolerate eggs of other birds. Similarly, there is no need for egg-sensitive children to avoid chicken and those very rare children who are allergic to chicken often tolerate hens' eggs (33).

An issue to be considered is whether the continued exposure to cooked egg at levels below that which induces symptoms increases the IgE level or delays the acquisition of tolerance in egg-allergic individuals? In a pre- and post-natal study of food allergen avoidance, Zeiger et al. found that egg sensitization was not related to exposure in the first 2 yr of life. Furthermore, the rate of acquisition of sensitivity and subsequent tolerance induction was similar in the control and study groups despite approximately 80% of the control group and only 20% of the avoidance group being exposed to egg by 12 months of age (34). In children with egg allergy who were desensitized with graded increasing oral exposure to egg allergen, egg-specific IgE was observed to decrease rather than increase over 24 months (35). Once tolerance is established either naturally or by oral tolerance induction with graded exposure to foods, continued allergen exposure favors the maintenance of tolerance rather than re-sensitization (30, 36). Thus, there is no good evidence that exposure to egg allergens delays the acquisition of tolerance.

Case 5

Eczema and egg allergy

A male infant developed atopic dermatitis at 4 months of age while being fully breastfed. SPT at 5 months of age showed negative reactions to cow's milk, wheat, pea, yeast, soy, sesame, potato and rice, a 5-mm wheal to egg white, a 3-mm wheal to egg yolk and 4-mm wheal to peanut. Institution of more aggressive topical treatment plus removal of egg and peanut from the maternal diet improved the dermatitis substantially. At 8 months, he commenced a cow's milk-based infant formula without any obvious

exacerbation of the dermatitis. He had also introduced a range of solids particularly vegetables, fruits, and rice without exacerbation of the dermatitis. Following inadvertent exposure to cooked egg in noodles, he developed some contact facial urticaria without a more generalized reaction. Continued avoidance of egg and nut products was advised.

Discussion

Immunoglobulin E sensitization to egg is common in children with atopic dermatitis and is associated with persistence of the dermatitis (37). Some children with atopic dermatitis have a delayed reaction causing a worsening of their dermatitis about 24 h after exposure to egg (38). These delayed reactions are generally not IgE mediated and may be mediated by T-cell sensitization (39), resulting in exacerbation of the dermatitis (40). There are currently no routine skin or blood tests which are useful in the diagnosis of these delayed reactions. In experimental situations, epicutaneous application of egg allergens may lead to the development of a local eczematous reaction (41). These observations suggest that patch testing with egg allergens may offer the possibility of further clarifying the diagnosis of these delayed reactions. However, this form of testing, while having a high degree of specificity (approximately 95%), has a low degree of sensitivity (approximately 10%) (42).

Food allergens such as egg and peanut can be detected in breast milk (8, 43). Ovalbumin was detected in the breast milk of lactating women up to 8 h after ingestion of egg (8). A dose-response correlation was indicated. It has been difficult to formally establish whether eczema can be exacerbated by food allergens in breast milk; however, many allergists consider this to be the case from clinical experience. Hattevig et al. observed less atopic dermatitis in the first 6 months of age in breastfed infants whose mothers avoided cow's milk and egg ingestion (44). One small double-blind trial reported an inconclusive response of breastfed infants with atopic eczema when their mothers avoided consumption of cow's milk and egg, and the authors concluded 'most breastfed babies with eczema do not respond to maternal dietary manipulation' (45).

Reference

- HATTEVIG G, KJELLMAN B, JOHANSSON SG, BJORKSTEN B. Clinical symptoms and IgE responses to common food proteins in atopic and healthy children. *Clin Allergy* 1984; 14: 551–9.
- EGGESBO M, BOTTEN G, HALVORSEN R, MAGNUS P. The prevalence of allergy to egg: a population-based study in young children. *Allergy* 2001; 56: 403–11.
- BOYANO MT, GARCIA-ARA C, DIAZ-PENA JM, MUNOZ FM, GARCIA SG, ESTEBAN MM. Validity of specific IgE antibodies in children with egg allergy. *Clin Exp Allergy* 2001; 31: 1464–9.
- HANSEN TK, HOST A, BINDSLEV-JENSEN C. An evaluation of the diagnostic value of different skin tests with egg in clinically egg-allergic children having atopic dermatitis. *Pediatr Allergy Immunol* 2004; 15: 428–34.
- DE BOISSIEU D, DUPONT C. Natural course of sensitization to hen's egg in children not previously exposed to egg ingestion. *Allerg Immunol* 2006; 38: 113–7.
- MONTI G, MURATORE MC, PELTRAN A, et al. High incidence of adverse reactions to egg challenge on first known exposure in young atopic dermatitis children: predictive value of skin prick test and radioallergosorbent test to egg proteins. *Clin Exp Allergy* 2002; 32: 1515–9.
- VANCE GH, GRIMSHAW KE, BRIGGS R, et al. Serum ovalbumin-specific immunoglobulin G responses during pregnancy reflect maternal intake of dietary egg and relate to the development of allergy in early infancy. *Clin Exp Allergy* 2004; 34: 1855–61.
- PALMER DJ, GOLD MS, MAKRIDES M. Effect of cooked and raw egg consumption on ovalbumin content of human milk: a randomized, double-blind, cross-over trial. *Clin Exp Allergy* 2005; 35: 173–8.
- FALTH-MAGNUSSON K, KJELLMAN NI. Allergy prevention by maternal elimination diet during late pregnancy – a 5-year follow-up of a randomized study. *J Allergy Clin Immunol* 1992; 89: 709–13.
- AICKIN R, HILL D, KEMP A. Measles immunisation in children with allergy to egg. *BMJ* 1994; 309: 223–5.
- POOL V, BRAUN MM, KELSO JM, et al. Prevalence of anti-gelatin IgE antibodies in people with anaphylaxis after measles–mumps rubella vaccine in the United States. *Pediatrics* 2002; 110: e71.
- KURSTEINER O, MOSER C, LAZAR H, DURRER P. Inflexal V – the influenza vaccine with the lowest ovalbumin content. *Vaccine* 2006; 24: 6632–5.
- RETAILLIAU HF, CURTIS AC, STORR G, CAESAR G, EDDINS DL, HATTWICK MA. Illness after influenza vaccination reported through a nationwide surveillance system, 1976–1977. *Am J Epidemiol* 1980; 111: 270–8.
- BIERMAN CW, SHAPIRO GG, PIERSON WE, TAYLOR JW, FOY HM, FOX JP. Safety of influenza vaccination in allergic children. *J Infect Dis* 1977; 136 (Suppl.): S652–5.
- AMERICAN ACADEMY OF PEDIATRICS. Hypersensitivity to vaccine components. In: PICKERING LK, BAKER CJ, LONG SS, McMILLAN JA, eds. *Red Book: 2006 Report of the Committee on Infectious Diseases*, 27th edn Elk Grove Village, IL: American Academy of Pediatrics, 2006: 46–8.
- SUGAI K, SHIGA A, OKADA K, et al. Dermal testing of vaccines for children at high risk of allergies. *Vaccine* 2007; 25: 3454–63.
- JAMES JM, ZEIGER RS, LESTER MR, et al. Safe administration of influenza vaccine to patients with egg allergy. *J Pediatr* 1998; 133: 624–8.
- ALLEN CW, CAMPBELL DE, KEMP AS. Egg allergy: are all childhood food allergies the same? *J Paediatr Child Health* 2007; 43: 214–8.

19. BOCK SA, MUNOZ-FURLONG A, SAMPSON HA. Fatalities due to anaphylactic reactions to foods. *J Allergy Clin Immunol* 2001; 107: 191–3.
20. SICHERER SH, SIMONS FE. Self-injectable epinephrine for first-aid management of anaphylaxis. *Pediatrics* 2007; 119: 638–46.
21. SPORIK R, HILL DJ, HOSKING CS. Specificity of allergen skin testing in predicting positive open food challenges to milk, egg and peanut in children. *Clin Exp Allergy* 2000; 30: 1540–6.
22. SAMPSON HA. Utility of food-specific IgE concentrations in predicting symptomatic food allergy. *J Allergy Clin Immunol* 2001; 107: 891–6.
23. CELIK-BILGILI S, MEHL A, VERSTEGE A, et al. The predictive value of specific immunoglobulin E levels in serum for the outcome of oral food challenges. *Clin Exp Allergy* 2005; 35: 268–73.
24. KEMP AS. EpiPen epidemic: suggestions for rational prescribing in childhood food allergy. *J Paediatr Child Health* 2003; 39: 372–5.
25. MACDOUGALL CF, CANT AJ, COLVER AF. How dangerous is food allergy in childhood? The incidence of severe and fatal allergic reactions across the UK and Ireland. *Arch Dis Child* 2002; 86: 236–9.
26. SICHERER SH, FURLONG TJ, MUNOZ-FURLONG A, BURKS AW, SAMPSON HA. A voluntary registry for peanut and tree nut allergy: characteristics of the first 5149 registrants. *J Allergy Clin Immunol* 2001; 108: 128–32.
27. GOLD MS, SAINSBURY R. First aid anaphylaxis management in children who were prescribed an epinephrine autoinjector device (EpiPen). *J Allergy Clin Immunol* 2000; 106: 171–6.
28. HU W, GRBICH C, KEMP A. Parental food allergy information needs: a qualitative study. *Arch Dis Child* 2007; 92: 771–5.
29. BOYANO-MARTINEZ T, GARCIA-ARA C, DIAZ-PENA JM, MARTIN-ESTEBAN M. Prediction of tolerance on the basis of quantification of egg white-specific IgE antibodies in children with egg allergy. *J Allergy Clin Immunol* 2002; 110: 304–9.
30. ROLINCK-WERNINGHAUS C, STADEN U, MEHL A, HAMELMANN E, BEYER K, NIGGEMANN B. Specific oral tolerance induction with food in children: transient or persistent effect on food allergy? *Allergy* 2005; 60: 1320–2.
31. MINE Y, ZHANG JW. Comparative studies on antigenicity and allergenicity of native and denatured egg white proteins. *J Agric Food Chem* 2002; 50: 2679–83.
32. ROMEIRA AM, PIRES G, GASPAR A, AREDE C, MORAIS-ALMEIDA M, ROSADO-PINTO J. Egg allergy – to be or not to be boiled. *Allergy* 2003; 58: 533–4.
33. CAHEN YD, FRITSCH R, WUTHRICH B. Food allergy with monovalent sensitivity to poultry meat. *Clin Exp Allergy* 1998; 28: 1026–30.
34. ZEIGER RS, HELLER S, MELLON MH, et al. Effect of combined maternal and infant food-allergen avoidance on development of atopy in early infancy: a randomized study. *J Allergy Clin Immunol* 1989; 84: 72–89.
35. BUCHANAN AD, GREEN TD, JONES SM, et al. Egg oral immunotherapy in nonanaphylactic children with egg allergy. *J Allergy Clin Immunol* 2007; 119: 199–205.
36. FLEISCHER DM, CONOVER-WALKER MK, CHRISTIE L, BURKS AW, WOOD RA. The natural progression of peanut allergy: resolution and the possibility of recurrence. *J Allergy Clin Immunol* 2003; 112: 183–9.
37. WOLKERSTORFER A, WAHN U, KJELLMAN NI, DIEPGEN TL, DE LONGUEVILLE M, ORANJE AP. Natural course of sensitization to cow's milk and hen's egg in childhood atopic dermatitis: ETAC study group. *Clin Exp Allergy* 2002; 32: 70–3.
38. BREUER K, HERATIZADEH A, WULF A, et al. Late eczematous reactions to food in children with atopic dermatitis. *Clin Exp Allergy* 2004; 34: 817–24.
39. HOLEN E, ELSAYED S. Specific T cell lines for ovalbumin, ovomucoid, lysozyme and two OA synthetic epitopes, generated from egg allergic patients' PBMC. *Clin Exp Allergy* 1996; 26: 1080–8.
40. NIGGEMANN B, SIELAFF B, BEYER K, BINDER C, WAHN U. Outcome of double-blind, placebo-controlled food challenge tests in 107 children with atopic dermatitis. *Clin Exp Allergy* 1999; 29: 91–6.
41. DARSOW U, LAIFAOU J, KERSCHENLOHR K, et al. The prevalence of positive reactions in the atopy patch test with aeroallergens and food allergens in subjects with atopic eczema: a European multicenter study. *Allergy* 2004; 59: 1318–25.
42. HEINE RG, VERSTEGE A, MEHL A, STADEN U, ROLINCK-WERNINGHAUS C, NIGGEMANN B. Proposal for a standardized interpretation of the atopy patch test in children with atopic dermatitis and suspected food allergy. *Pediatr Allergy Immunol* 2006; 17: 213–7.
43. CANT A, MARSDEN RA, KILSHAW PJ. Egg and cows' milk hypersensitivity in exclusively breast fed infants with eczema, and detection of egg protein in breast milk. *Br Med J (Clin Res Ed)* 1985; 291: 932–5.
44. HATTEVIG G, KJELLMAN B, SIGURS N, BJORKSTEN B, KJELLMAN NI. Effect of maternal avoidance of eggs, cow's milk and fish during lactation upon allergic manifestations in infants. *Clin Exp Allergy* 1989; 19: 27–32.
45. CANT AJ, BAILES JA, MARSDEN RA, HEWITT D. Effect of maternal dietary exclusion on breast fed infants with eczema: two controlled studies. *Br Med J (Clin Res Ed)* 1986; 293: 231–3.

Multiple Choice Questions

Question 1. Which vaccine(s) is/are prepared in hens' eggs and should be given with caution to egg-allergic children?

- A. Hepatitis b
- B. Influenza
- C. MMR
- D. Polio
- E. Varicella

Question 2. Which of the following symptom(s) following egg exposure indicates that an egg-allergic child should be provided with an EpiPen?

- A. Abdominal pain
- B. Eyelid angioedema
- C. Facial urticaria
- D. Stridor
- E. Vomiting

Question 3. Concerning the interpretation of a Skin Prick Test (SPT) to egg allergens, which of the following is/ are true?

- A. A positive test to egg yolk is a better predictor of an allergic reaction than a positive test to egg white.
- B. The size of the SPT provides an accurate assessment of the likelihood of anaphylaxis.

Kemp

- C. The larger the SPT the more likely the child is to have a clinical reaction if exposed to egg.
- D. A negative SPT means the child will not get any type of reaction if exposed to egg.
- E. All children with a SPT wheal of > 5 mm should avoid egg.

Question 4. Concerning the measurement of egg allergen-specific IgE in the serum by a Specific IgE test, which of the following is/are correct?

- A. If the child is on antihistamines the test may be falsely negative.

- B. The test is a more accurate indicator of clinical sensitization than the skin test.
- C. Cutoff levels have been proposed above which 95% of subjects will react.
- D. Once a Specific IgE test has become positive it will remain positive for life.
- E. If positive in early childhood the IgE antibodies may have been acquired from the mother by placental transport.

Correct responses to the questions: 1 – B, 2 – D, 3 – C, 4 – C.