

A clinical and immunological study of allergy to hen's egg white

I. A clinical study of egg allergy

T. LANGE LAND

*Department of Dermatology and Children's Asthma and Allergy Institute
Voksentsoppen, University Hospital, Rikshospitalet, Oslo, Norway*

(Received 16 February 1982; accepted for publication 11 May 1982)

Summary

Various clinical features of eighty-four atopic patients, with clinical hypersensitivity to egg and positive RAST to egg white, were studied. Some of the clinical data were compared with data from a control group of atopic patients without egg allergy. Atopic diseases and certain food allergies in the families of the egg-allergic patients and atopic controls were also studied. This was done in order to investigate the extent to which differences between the egg allergy group and the atopic control group were reflected in their respective families.

Introduction

Egg white is a food that frequently causes hypersensitivity in atopic children. Ratner and Untracht (1952) reported an incidence of clinical hypersensitivity to egg white in 5.6% of 500 atopic children. In the same study the frequency of positive skin reactions to egg white was 20.4% (Ratner & Untracht, 1952). A high frequency of positive skin tests to egg white in various populations of atopic patients have also been reported by others (Freedman & Sellars, 1959; Miller & Campbell, 1950; Sedlis & Prose, 1966). In more recent studies, there seems to be a better correlation between positive skin tests to egg white and clinical hypersensitivity to this food (Aas, 1978; Bock *et al.*, 1978), probably due to improvements in skin testing techniques and the test material. This indicates that numerous positive reactions reported in previous works may have been non-specific and/or not significant.

Positive skin reactions to egg white have been reported to be particularly frequent in children with atopic dermatitis (Epstein & Pelecek, 1951; Freedman & Sellars, 1959; Miller & Campbell, 1950; Sedlis & Prose, 1966). The clinical significance of these skin reactions has been a subject for debate (Hill, 1955; Jadassohn, 1957; Schur, Hyde & Wypych, 1974).

Correspondence: Dr Tor Langeland, Department of Dermatology and Children's Asthma and Allergy Institute Voksentsoppen, University Hospital, Rikshospitalet, Oslo 1, Norway.

The aim of the present work is to study various clinical aspects of egg allergy, and to identify clinical material for immunological studies of allergy to hen's egg white.

Materials

Egg allergic patients and atopic controls

Eighty-four patients, aged 1–15 years, were studied. All patients were admitted to either the Children Department's Allergy Unit, or to the Children's Asthma and Allergy Institute, Voksentoppen, Rikshospitalet, for examination and/or treatment of various symptoms of immediate allergy. All patients had serum IgE antibodies to egg white as measured by radioallergosorbent test (RAST), with titres corresponding to RAST class 2 or more. Patients with obvious tolerance to egg were excluded, whereas those with a doubtful history of egg intolerance were included if the sum of the RAST class, and result of skin prick test (SPT) to egg white, was more than 4.

To compare with the clinical aspects of the egg allergy group, a control group consisting of seventy-two atopic patients was established. All the patients in this group had been admitted to the Children Department's Allergy Unit or to Voksentoppen and had both asthma and atopic dermatitis, or at least one immediate type allergy, based on a combination of data obtained from the case history, SPT and/or RAST. This group were RAST=0 to egg white with a history of tolerance to egg. If the history was doubtful with respect to egg tolerance, the patient was included in the control group when SPT to egg white was only 1+ or absent. The patients in the control group were sex and age matched with the egg allergy group at the first consultation.

Two sub-groups were established, one in the egg allergy group, and one in the atopic control group, each consisting of twenty-two individuals. These groups were matched as described above, and in addition, with respect to total IgE levels, the mean values being 745 U/ml in the former and 730 U/ml in the latter sub-group.

Test materials

RAST kits were obtained from Pharmacia, Sweden, as were the allergosorbents with egg white, cow's milk and cod fish.

Reagents for paper radioimmunosorbent test (PRIST) were those available in PRIST kits, delivered from Pharmacia.

Allergen preparations for SPT were as follows: (1) undiluted raw egg white; (2) skimmed cow's milk, undiluted, and diluted ten-fold in physiological saline; and (3) crude cod fish allergen extract 1:1000 (w/v) from Allergologisk Laboratorium, Denmark.

Venous blood was stored at -20°C until analysed.

Methods

PRIST

Total IgE levels in sera from egg-allergic patients and atopic controls were determined by PRIST. The assay was performed according to the instructions of the manufacturer.

Diagnosis of food allergy

The allergy diagnosis was in all cases based on the history, SPT, RAST and in some cases elimination and provocation tests in the diet.

The history was obtained by means of a detailed questionnaire, followed by an interview by an experienced physician. The different clinical manifestations of egg allergy and the age when symptoms of egg allergy were first observed, were recorded.

SPT was carried out as described by Frostad *et al.* (1977). The results were recorded according to the Scandinavian Allergy Reference System, using histamine-HCl 1 mg/ml as the positive + + + (3) reference (Aas & Belin, 1972). Reactions of + + (2) or more were considered positive.

RAST was performed according to the instructions given by the manufacturer, and the results were expressed in RAST classes according to general practice.

Food challenges were carried out as open tests as described by Aas (1978). Challenges were not performed unless it was considered safe and necessary for the diagnosis.

Diagnosis of atopic dermatitis, bronchial asthma and allergic rhinitis

Criteria for the diagnosis of atopic dermatitis were those given by Hanifin & Rajka (1980). The basis for the gradation of the severity of atopic dermatitis were three parameters, namely extension of dermatitis, course and intensity, the latter evaluated

Table 1. Grading of the severity of atopic dermatitis

<i>Extension:</i>	
<i>Infantile phase:</i>	
Less than 20% of the skin involved	1
20–50% of the skin involved	2
More than 50% of the skin involved	3
<i>Childhood and adult phase:</i>	
Not more than two predilectional areas involved (less than approx. 40 cm ²)	1
Involvement evaluated to be more than score 1, less than score 3	2
Dermatitis including and extending beyond the predilectional areas	3
<i>Course:</i>	
More than 3 months of remissions during a year	1
Remissions less than 3 months during a year	2
Continuous course	3
<i>Intensity:</i>	
Mild itch, only exceptionally disturbing night's sleep	1
Itch evaluated to be more than score 1, less than score 3	2
Severe itch, usually disturbing night's sleep	3
Score summation: 3–4 = Mild	
5–7 = Moderate	
8–9 = Severe	

as pruritus. The grading was in each case based upon observations and during a 1-year period. Adequate therapy was provided and included topical steroid preparations and antihistamines, if needed. The score system was as shown in Table 1.

Diagnosis and gradation of the severity of bronchial asthma were performed according to Aas (1981), using a scale from 1 to 5, grade 5 being the most severe form of the disease.

The diagnosis of allergic rhinitis was in all cases based upon a combination of a history of periodic rhinitis and SPT with or without RAST to the allergens incriminated.

Duration of breast-feeding period and age for introduction of egg into the diet

In the egg allergy group and in the atopic control group information was collected by means of separate questionnaires recording the duration of the breast-feeding period, and the age when egg was first introduced into the child's diet. Information was obtained from sixty-five patients in the egg-allergy group and forty-two atopic controls.

Incidence of atopic diseases and food allergies (egg, cow's milk, fish) in the families of the egg-allergic patients and atopic controls

Family disposition with respect to atopic diseases (atopic dermatitis, bronchial asthma, allergic rhinitis) and allergy to egg, milk and fish were compared in the group of egg-allergic patients with atopic controls. For this purpose, information about these diseases and allergies were obtained from parents and siblings of the egg-allergic patients and atopic controls. The information was obtained by use of a mailed questionnaire, answered by each family member (or parents). In some cases, where the information was considered inconclusive, the history was completed by a telephone interview.

Evaluation of the information was carried out by a physician, and each relative was given a score for each of the three diagnosis and each of the three food allergies in this manner: Obvious disease/allergy = 2; probable disease/allergy = 1; doubtful or no disease/allergy = 0.

Table 2. Comparison of scores obtained by personal interviews (telephone) and questionnaires in thirty relatives

	Telephone	Questionnaire
Atopic dermatitis	11	12
Bronchial asthma	10	10
Allergic rhinitis	23	20
Egg allergy	6	5
Milk allergy	1	0
Fish allergy	1	1

Score: Obvious disease/allergy: 2

Probable disease/allergy: 1

Doubtful/non-allergy: 0

Two hundred and twenty-one relatives of patients in the egg-allergy group were included in this part of the study, whereas the number of relatives of controls answering the questions was 164. Relatives not available for interview were excluded.

The reliability of the result based upon the questionnaires was investigated 4 months later. The author then interviewed thirty parents by telephone, with regard to the same subjects. These parents were randomly selected among parents with positive score (1–2) for at least one of the atopic diseases or food allergies in the first evaluation. The conclusions drawn from these interviews were compared with the previous conclusions about atopic diseases and the three food allergies in question in these relatives. The scores obtained in these different ways are compared in Table 2.

Statistical analysis

For parameters recorded on graded scales, a two-sided Wilcoxon rank-sum test, with correction for ties, was used. The statistical significance of differences between frequencies was evaluated by means of a Fisher–Irwin test. For each analysis a significance level of 5% has been used.

Results

Total IgE levels

The total IgE levels were significantly higher in the egg-allergy group than in the atopic control group ($P < 0.001$) (Table 3): The mean values for those egg-allergic patients and controls with IgE levels within the range 100–1000 U were 506 U and 334 U respectively.

Table 3. Total IgE level

	<i>n</i>	< 100	100–1000	> 1000
Egg-allergic patients	82	9(11%)	33(40%)	40(49%)
Atopic controls	56	26(46%)	22(39%)	8(15%)

$P < 0.001$

Symptoms of egg allergy

The various symptoms provoked by egg ingestion are presented in Table 4. Itching and exacerbation of atopic dermatitis were the most common manifestation of egg allergy (48%). Urticaria was observed in connection with exacerbation of the dermatitis in nine patients. Asthma and rhino-conjunctivitis occurred as reactions to egg ingestion as well as inhalation of egg products (Table 4). The reactions due to inhalation of egg products occurred mostly in the kitchen when various foods were prepared with egg.

Age at onset of egg allergy

This information was obtained from sixty-three patients. Thirty-six of these reacted with various immediate type reactions on the very first occasion they ate egg or egg products. In these cases the reactions were all observed during the first year of life.

Table 4. Symptoms of egg allergy (84 patients)

<i>Reaction to egg ingestion:</i>		
Itching/exacerbation of atopic dermatitis	40	(48%)
Bronchial asthma	22	(26%)
Urticaria	22	(26%)
Vomiting	21	(25%)
Angio-oedema	12	(14%)
Rhinitis/conjunctivitis	8	(14%)
Laryngeal oedema	2	(2%)
<i>Reaction to inhalation of egg products (14 patients [17%]):</i>		
Bronchial asthma	9	
Rhinitis/conjunctivitis	7	

Twelve patients were advised to avoid egg before it was introduced, based upon positive skin tests and/or RAST results during the first year of life. In these cases the diagnosis was confirmed by later exposure to egg in most cases accidentally.

Fifteen patients ate egg in periods varying from 2 months to 12 years until the diagnosis of egg allergy was confirmed. This period was less than 1 year in eight patients and more than 3 years in three patients.

Allergies to cow's milk and fish, and atopic diseases in the egg-allergy group and in the atopic control group

The degree of allergy to cow's milk and fish were significantly higher in the egg-allergy group than in the main control group ($P < 0.001$) (Tables 5 and 6).

Table 5. Allergy to cow's milk

	<i>n</i>	No	Doubt	Yes
Egg-allergic patients	84	53(63%)	17(20%)	14(17%)
Atopic controls	72	68(94.5%)	3(4%)	1(1.5%)

$P < 0.001$

Table 6. Allergy to fish

	<i>n</i>	No	Doubt	Yes
Egg-allergic patients	84	55(65%)	15(18%)	14(17%)
Atopic controls	72	64(89%)	6(8%)	2(3%)

$P < 0.001$

Table 7. Degree of atopic dermatitis

	<i>n</i>	None	Mild	Moderate	Severe
Egg-allergic patients	84	7(8%)	19(23%)	18(22%)	40(47%)
Atopic controls	72	39(54%)	17(24%)	9(12%)	7(10%)

 $P < 0.001$ **Table 8.** Degree of bronchial asthma

	<i>n</i>	None	Grade				
			I	II	III	IV	V
Egg-allergic patients	84	11(13%)	5(6%)	11(13%)	22(26%)	33(39%)	2(3%)
Atopic controls	72	13(18%)	7(10%)	13(18%)	22(31%)	15(20%)	2(3%)

 $P = 0.03$ **Table 9.** Incidence of allergic rhinitis

	<i>n</i>	Yes	No
Egg-allergic patients	84	64(76%)	20(24%)
Atopic controls	72	35(49%)	37(51%)

 $P < 0.001$

In the egg-allergy group, 84% of the patients had both atopic dermatitis and bronchial asthma, whereas the corresponding percentage in the atopic control group was 32% ($P < 0.001$).

The degree of atopic dermatitis was significantly higher in the egg allergy group than in the main control group ($P < 0.001$) (Table 7).

The degree of bronchial asthma was also significantly higher in the egg-allergy group than in the main control group ($P = 0.03$) (Table 8.).

The frequency of allergic rhinitis was significantly higher in the egg allergy group than in the main control group ($P < 0.001$) (Table 9). The allergic rhinitis in both groups was, in most cases, due to allergies to various pollens and animals.

Only small differences were observed between the two sub-groups, considering the grade of allergy to fish, atopic dermatitis and frequency of allergic rhinitis. There was still a tendency to a higher degree of allergy to milk in the egg-allergic subgroup,

although this difference was not statistically significant ($P=0.1$). With respect to bronchial asthma, the difference between the subgroups was comparable with that found between the two main groups ($P=0.04$).

Duration of breast-feeding period and age for introduction of egg in the diet

In the egg allergy group the duration of the breast-feeding period varied from 2 weeks to 21 months. Three of the egg allergic patients were not breast-fed at all, whereas five patients received breast-milk for more than 18 months. The mean duration of the breast-feeding period was 24 weeks. Excluding the five patients with more than 18 months of breast-feeding, the mean duration of the breast-feeding period was 17 weeks.

In the control group the breast-feeding period lasted from 2 weeks to 10 months. Three patients within this group were not breast-fed at all. The mean duration of the breast-feeding period was 13 weeks.

The mean age at the introduction of egg into the diet was 9 months in the egg-allergy group and 7 months in the control group.

Incidence of atopic diseases and food allergies (egg, cow's milk, fish) in the families of the egg allergic patients and atopic controls

There was a significantly higher frequency of atopic dermatitis in the families of atopic controls ($P=0.03$) (Table 10). This difference could not be related to any particular group of relatives. Differences between the families of the two groups in incidence of bronchial asthma and allergic rhinitis were not statistically significant.

Considering each food allergy separately, there were no statistically significant differences between the families of the two groups (Table 11). When the three food allergies were considered together, it was found that thirty (14%) relatives of the egg-allergic patients had at least one 'probable allergy', whereas the corresponding

Table 10. Incidence of atopic dermatitis, bronchial asthma and allergic rhinitis in the families of egg-allergic patients and controls

	Total (n)	Atopic dermatitis		Bronchial asthma		Allergic rhinitis	
		Score	n	Score	n	Score	n
Relatives of egg-allergic patients	221	2	38	2	27	2	33
		1	22	1	9	1	18
		0	161	0	185	0	170
Relatives of atopic controls	164	2	14	2	16	2	26
		1	19	1	11	1	2
		0	131	0	137	0	136
P values		0.03		>0.05		>0.05	

Number of relatives in different score groups (0, 1 and 2) were registrated for each atopic disease.

Score: Obvious disease 2
 Probable disease 1
 Doubtful/none disease 0

Table 11. Incidence of allergy to egg, cow's milk and fish in the families of egg-allergic patients and atopic controls

	Total (n)	Egg white		Cow's milk		Fish	
		Score	n	Score	n	Score	n
Relatives of egg-allergic patients	221	2	8	2	3	2	5
		1	11	1	6	1	9
		0	202	0	212	0	207
Relatives of atopic controls	164	2	5	2	1	2	3
		1	3	1	3	1	1
		0	156	0	160	0	160
P values		> 0.05		> 0.05		> 0.05	

Number of relatives in different score groups (0, 1 and 2) were registered for each food item.

Score: Obvious allergy: 2
Probable allergy: 1
Doubtful/non-allergy: 0

number of the families of the controls was eleven (7%). This difference is statistically significant ($P=0.03$).

Discussion

The selection of patients on the basis of egg allergy or not in this atopic population, resulted in two groups of patients who were widely different in most parameters considered. The egg-allergic patients were more severely affected by atopic diseases and suffered from more allergies than did the atopic controls. This finding is in accordance with previous studies in this field (Schur *et al.*, 1974; Buffum & Settipane, 1966).

The egg-allergy group had a significantly higher frequency of allergies to fish and milk than the control group indicating that the susceptibility to the development of food allergies applies to food in general, rather than to one particular food item. The higher frequency of allergic rhinitis in the egg-allergy group was an expression of the higher frequency of allergies to other agents than food, such as pollen and animal dander. This indicates that the high tendency to develop allergies in the egg-allergy group was not restricted to food alone, but included other allergens as well. Furthermore, the egg-allergy group had a higher total IgE level than did the control group, this difference being very pronounced.

These findings lead to the conclusion that egg allergy is associated with a tendency to high total IgE synthesis and liability to develop multiple allergies. Thus, according to immunological definitions of the atopy concept (Pepys, 1975), the egg allergy group was found to have more atopic signs than the control group. A possible explanation for this may be that the predisposition to develop egg allergy may be more dependent upon a general high IgE synthesis than upon specific responsiveness to egg white proteins, perhaps determined by the immune-responsive genes (Marsh *et al.*, 1977). The results of the study of the sub-groups supports this hypothesis, demonstrating that most differences between the egg-allergic patients and controls disappeared when the groups

were matched with respect to total IgE levels. Though, the difference in severity of asthma was still present and unexplained.

It follows that egg allergy may be an indicator of a high degree of atopy, and therefore a bad prognostic sign for atopic disease (Buffum & Settupane, 1966). Egg allergy may be useful in this respect as it usually starts early, often in the first year in life. Furthermore, the diagnostic precision by means of proper SPT and RAST is reasonably good (Aas, 1978; Bock *et al.*, 1978). However prospective studies of unselected atopic patients will be required in order to determine the reliability of this particular allergy as a prognostic factor in atopic diseases.

The association found in this study, between atopic dermatitis and immediate type allergies and elevated total IgE levels, is in accordance with previous studies (Berg & Johansson, 1969; Juhlin *et al.*, 1969). However, controversy exists with regard to the significance of food allergies in atopic dermatitis. One reason may be selection using different criteria. In our patients the association between egg allergy and atopic dermatitis was striking. The finding of itching and exacerbation of the dermatitis as the most frequent symptom of egg ingestion, strongly suggests the importance of egg allergy as an aggravating factor for the dermatitis in many of these patients, where adequate elimination was not performed. Of course, this does not permit conclusions as to the aetiological significance of this allergy for the atopic dermatitis in these patients. The immediate type reaction is complex, comprising release of numerous mediators (Austen, Wasserman & Goetzel, 1976). Some of these mediators seem to be able to initiate a late phase in the immediate-type allergic reaction (Solley *et al.*, 1976). The significance of this phenomenon in atopic dermatitis is not clear.

Food allergies were more frequent in the families of the egg allergic patients than in the families of the controls. No particular food item, not even egg, was found to be more responsible for this than any other. It seems reasonable to conclude that this difference is a reflection of the higher degree of atopy in the egg-allergy group than in the control group. The higher frequency of atopic dermatitis in the families of the egg allergic patients than in the families of the controls, is consistent with the association between immediate allergies and atopic dermatitis as described before (Juhlin *et al.*, 1969).

Twin studies have revealed that environmental factors may be of considerable importance in the development of atopic diseases and allergies (Lubs, 1972). Special attention has been given to the prophylactic effect of prolonged breast-feeding and the delayed introduction of certain food known to frequently cause hypersensitivity in atopic children. Therefore, the duration of the breast-feeding period and the age at the first introduction of egg into the diet, were recorded to see if the presence of egg allergy could be referred to these factors. The egg-allergy group was the one which has the longest period of breast-feeding, probably because mothers of egg allergic children were more exposed to advice on the benefits of breast-feeding in delaying atopic manifestations appearing in many of these children within the first months of life.

This may also be the explanation for the delayed introduction of egg into the diet in the egg-allergy group as compared with the control group. Thus in this study, the sensitization to egg white could not be related to short duration of the breast-feeding period or to early introduction of this food into the diet.

More than half of the patients with egg allergy reacted with allergic symptoms on the very first occasion they ate egg or egg products. This must be due to previous, un-noticed exposition to egg white protein. Previous studies indicate that egg white

proteins ingested by the mother are able to pass to the breast-milk (Donnally, 1930). Possibly, egg white proteins ingested by the pregnant women may also be able to pass into the circulation of the foetus. Neither can the possibility of sensitization by egg white proteins in environmental dust be excluded. Thus, there are several possibilities for exposure to egg antigens, without eating egg.

Conclusions

We conclude that egg white may provoke various symptoms in hypersensitive individuals, of which itching and exacerbation of atopic dermatitis was found to be most frequent, and may act as an allergen by inhalation as well as by ingestion. Egg allergy was found to be associated with high IgE level, which can explain the association between egg allergy and severe atopic diseases and multiple allergies. The egg allergy was not reflected in the families of the egg-allergic patients, whereas the high degree of atopy was, through a higher frequency of food allergies and atopic dermatitis than in the families of the atopic control group. Short duration of the breast-feeding period or early introduction of egg into the diet could not explain why the egg allergic patients became allergic to egg. Most of the allergies to egg white were developed previously to the introduction of egg into the diet.

Acknowledgments

Thanks are due to Kjell Aas who allowed me to perform this study at Voksentoppen, and for advice and valuable criticism of the manuscript. Georg Rajka is acknowledged for advice and fruitful discussions.

References

- AAS, K. (1981) Heterogeneity of bronchial asthma. *Allergy*, **36**, 3.
- AAS, K. (1978) The diagnosis of hypersensitivity to ingested foods. *Clinical Allergy*, **8**, 39.
- AAS, K. & BELIN, L. (1972) Standardization of diagnostic work in allergy. *Acta Allergologica*, **27**, 439.
- AUSTEN, K.F., WASSERMAN, S.I. & GOETZL, E.J. (1976) Mast cell-derived mediators: Structural and functional diversity and regulation of expression. In *Molecular and Biological Aspects of the Acute Allergic Reactions* (eds S.G.O. Johansson, K. Strandberg and B. Uvnäs) p. 293. Plenum Press, New York.
- BERG, T. & JOHANSSON, S.G.O. (1969) IgE concentrations in children with atopic dermatitis. *International Archives of Allergy and Applied Immunology*, **36**, 219.
- BOCK, S.A., LEE, W.-Y., REMIGIO, L.K. & MAY, C.D. (1978) Studies of hypersensitivity reactions to foods in infants and children. *Journal of Allergy and Clinical Immunology*, **62**, 327.
- BUFFUM, W.P. & SETTIPANE, G.A. (1966) Prognosis of asthma in childhood. *American Journal of Diseases of Children*, **112**, 214.
- DONNALLY, H.H. (1930) The question of the elimination of foreign protein (egg white) in woman's milk. *Journal of Immunology*, **19**, 15.
- EPSTEIN, S. & PALECEK, M. (1951) Studies in infantile eczema. *Annals of Allergy*, **9**, 421.
- FREEDMAN, S.S. & SELLERS, W. (1959) Food sensitivity. A study of 150 'allergic' children. *Journal of Allergy*, **30**, 42.
- FROSTAD, A.B., BOLLE, R., GRIMMER, Ø. & AAS, K. (1977) A new well-characterized purified allergen preparation from Timothy pollen. II Allergenic *in vivo* and *in vitro* properties. *International Archives of Allergy and Applied Immunology*, **55**, 35.
- HANIFIN, J.M. & RAJKA, G. (1980) Diagnostic features of atopic dermatitis. *Acta Dermatovenereologica*, **92** (Suppl.), 44.
- HILL, L.W. (1955) The treatment of eczema in infants and children. *Journal of Pediatrics*, **47**, 648.
- JADASSOHN, W. (1957) Contact dermatitis versus atopic eczema. *International Archives of Allergy*, **11**, 20.
- JUHLIN, L., JOHANSSON, S.G.O., BENNICHT, H., HOGMAN, C. & THYRESSON, N. (1969) Immunoglobulin E in dermatosis. *Archives of Dermatology*, **100**, 12.

- LUBS, M.-L. E. (1972) Emperic risk for counselling on families with allergies. *Journal of Pediatrics*, **80**, 26.
- MARSH, D.G., CHASE, G.A., GOODFRIEND, L. & BIAS, W.B. (1977) Mapping of postulated Ir gens within HLA by studies of allergic populations. *Monographs in Allergy*, **11**, 106.
- MILLER, H. & CAMPBELL, D.H. (1950) Skin test reactions to various chemical fractions of egg white and their possible significance. *Journal of Allergy*, **21**, 522.
- PEPYS, J. (1975) Atopy. Clinical aspects of immunology 3rd ed. (ed. P.G.H. Gell, R.R.A. Coombs and P.J. Lachmann) p. 877, Blackwell Scientific Publications, Oxford, London, Edinburgh, Melbourne.
- RATNER, B. & UNTRACHT, S. (1952) Egg allergy in children. *American Journal of Diseases of Children*, **83**, 309.
- SCHUR, S., HYDE, J.S. & WYPYCH, J.I. (1974) Egg white sensitivity and atopic eczema. *Journal of Allergy and Clinical Immunology*, **54**, 174.
- SEDLIS, E., PROSE, P.H. & HOLT, L.E. (1966) Infantile eczema. *Postgraduate Medical Journal*, **40**, 63.
- SOLLEY, C.O., GLEICH, G.J., JORDON, R.E. & SCHROETER, A.L. (1976) The late phase of the immediate wheal and flare skin reaction. *Journal of Clinical Investigation*, **58**, 408.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.