

Comparison between MAGIC LITE®- and CAP®-system: two automated specific IgE antibody assays

J. KLEINE-TEBBE, M. EICKHOLT, M. GÄTJEN, T. BRUNNÉE,
A. O'CONNOR and G. KUNKEL

Department of Clinical Immunology and Asthma OPD, University Hospital Rudolf Virchow, Free University Berlin, Berlin, Germany

Summary

The MAGIC LITE system, a newly developed immunochemiluminometric assay for specific and total IgE antibody using paramagnetic particles coupled with standardized allergens as solid phase, was compared to the CAP system, a recently introduced immunoassay based on a cellulose polymer encased in a capsule. A total of 357 serum samples of patients with suspected inhalant allergies and a positive skin prick test (SPT) to common allergens (birch, timothy-grass, mugwort, cat dander, *Dermatophagoides pteronyssinus*, Alternaria) were investigated. Fifty SPT negative subjects served as controls (total number of tests in each assay = 1600). Both assays were highly precise (overall intra-assay and inter-assay coefficients of variation were 2.9% and 4.5% in MAGIC LITE, 4.7% and 5.5% in CAP) and showed excellent linearity (mean r^2 of eightfold log₂ serum dilutions were 99.7% and 99.3% in MAGIC LITE and CAP). Good correlations were found between the absolute specific IgE antibody values detected by both methods (correlation coefficient r : birch 0.86, grass 0.93, mugwort 0.96, cat 0.91, *D. pteronyssinus* 0.73, Alternaria 0.90). Excellent specificity ($\geq 98\%$) occurred in both assays and with all allergens, and sensitivity was related to the allergen (MAGIC LITE/CAP): birch 91%/89%, grass 83%/90%, mugwort 50%/69%, cat 83%/83%, *D. pteronyssinus* 72%/78%, Alternaria 75%/81%. Our results indicate that both *in vitro* tests are useful tools for the detection of specific IgE antibody.

Clinical and Experimental Allergy, Vol. 22, pages 475–484. Submitted 21 May 1991; revised 23 October 1991; accepted 28 October 1991.

Introduction

The determination of specific serum IgE antibody represents the most important *in vitro* method for the diagnosis of IgE mediated hypersensitivity. Over the past two decades the RAST became the standard technique for the measurement of allergen specific IgE antibody [1]. However, the sensitivity of the RAST was limited by the solid phase used (simple paper discs of cellulose) and did neither allow an efficient automation nor a software based data management [2]. Recently two immunoassays for the detection of allergen specific IgE antibody were introduced, the CAP system (Pharmacia Diagnostics, Uppsala, Sweden) and the MAGIC LITE system (ALK Laboratories, Hørsholm, Denmark). Both systems pro-

vided increased sensitivity, specificity and efficiency together with high precision and linearity [3–9]. The allergens used in both methods are coupled as standardized extracts to the solid phases, since the quality of solid-phase immunoassays is largely dependent on the quality of allergens [10,11]. The solid phase used in the CAP can bind three times more protein than a paper disc used for the Pharmacia-RAST [3], while the IgE antibody binding capacity of the allergen coupled solid phase of MAGIC LITE is at least four times higher than a commercial paper disc [5]. No interference with non-specific IgE antibody up to 20 000 IU/ml was observed, and crossreactivity with other immunoglobulins was less than one per million and one per two million for MAGIC LITE and CAP, respectively [3,5]. Both assays are rapid (CAP: 4 hr, MAGIC LITE: 2 hr) and accurate, using small volumes of undiluted serum samples (CAP: 50 μ l, MAGIC LITE: 25 μ l) [3,5]. Considering SPT as the 'true diagnosis', the same

Correspondence: Professor Dr G. Kunkel, Universitätsklinikum Rudolf Virchow, Abteilung für klinische Immunologie und Asthma-Poliklinik, Augustenburger Platz 1, 1000 Berlin 65, Germany.

sensitivity, specificity and efficiency for MAGIC LITE and RAST were found for 10 inhalant allergens [7]. In addition to highly significant correlations between CAP and RAST ($r: 0.87-0.99$), the sensitivity and specificity of CAP with regard to SPT with standardized inhalant allergens were even better than those found using the RAST. Therefore, it has been concluded that CAP is a superior system to RAST for measuring IgE antibodies [4,9]. MAGIC LITE was compared to the CAP assay using 357 serum samples for the detection of specific IgE antibodies to six common inhalant allergens of northern and western Europe to determine which test system might produce results of increased clinical relevance. The diagnosis of allergy was determined by two approaches dependent on the allergen specificity. In the case of birch, timothy and cat, an allergy was defined by a positive clinical history plus a concordantly positive SPT. In the case of mugwort, *Alternaria* and house dust mite, where clinical history is less definitive, a positive SPT was used as the sole criterion for the presence of allergic disease.

Methods and materials

Both assays for the determination of specific IgE antibody, MAGIC LITE and CAP, consist of immunoassay reagents, partial automation and information management software, using MS-DOS compatible IBM computers. Undiluted sera were assayed in duplicate in a blinded fashion for IgE antibodies against the suspected allergen(s).

Methods

MAGIC LITE is a rapid immunochemiluminometric assay for the detection of specific IgE antibody. The allergens are covalently bound to paramagnetic particles [12], which allows their separation without centrifugation and the reaction with the specific IgE antibody in serum. In brief, the allergen solid phase (250 μ l) is washed, and 25 μ l of either the test serum, the standards or the control serum are added and the mixture is incubated at room temperature (approximately 20°C) for 30 min. After another washing procedure, a specific anti-human IgE monoclonal antibody labelled with acridinium ester as the chemiluminescent compound [13] is added and incubated at room temperature, then washed two times. Demineralized water is added and the light reactions of the samples are detected in a chemiluminometer (Ciba Corning, Germany) by automatic addition of an oxidating reagent (H_2O_2) and determination of photoemission at 426 nm [14]. The assay uses a two point adjustment based on an extended standard curve [14,15], is equilibrated against a Timothy Grass Reference serum, and

Table 1. Absolute values of specific IgE antibody, detected by MAGIC LITE and CAP, and their transformation into class levels according to the instructions of the manufacturers.

MAGIC LITE		CAP	
[SU/ml]	Class	[kU _A /l]	Class
<1.43	0	<0.35	0
1.44-4.0	1	0.36-0.7	1
4.01-20.0	2	0.71-3.5	2
20.01-100.0	3	3.51-17.5	3
100.01-300.0	4	17.51-50.0	4
>300.0	5	50.10-100.0	5
		>100.0	6

SU/ml: standardized units of specific IgE/ml. kU_A/l: kilo units of allergen specific IgE/l.

measures specific IgE antibody in concentrations from 1.43 to 800 standardized units per millilitre (SU/ml) and allergy classes from 0 to 5 (Table 1).

CAP, a recently developed immunoassay for the detection of allergen specific IgE antibody, uses cyanogenbromide-activated cellulose derivatives as the solid phase encased in a capsule (ImmunoCAP). The fluoroimmunoassay version was used. Test sera (50 μ l) and standards are incubated at room temperature with the ImmunoCAP for 30 min before being washed. For the determination of allergen-bound IgE antibody, specific combinations of polyclonal and monoclonal anti-IgE (Fc specific) antibodies labelled with beta-galactosidase are added. After a second incubation of 150 min, the ImmunoCAP is washed and the substrate, 4-methylumbelliferyl-beta-D-galactoside, is added. After 10 min, the reaction is stopped and the fluorescence detected in a fluorometer (FluoroCount Pharmacia, Sweden). The assay can also be performed as a radioimmunoassay. The standard curve is equilibrated against the WHO standard for total IgE antibody and measures specific IgE antibody in concentrations from 0.35 to 100 kilo units_A per millilitre (kU_A/ml) and allergen classes from 0 to 6 (Table 1).

Allergens

The efficiency of immunoassays for the detection of specific IgE antibody is highly dependent on the allergens used, which have to be recognized only by specific IgE antibody avoiding binding to non-allergen specific IgE antibodies. Due to the large number of different allergens it is possible to use, a clinical study investigating every IgE antibody specificity seemed impractical. Thus, the follow-

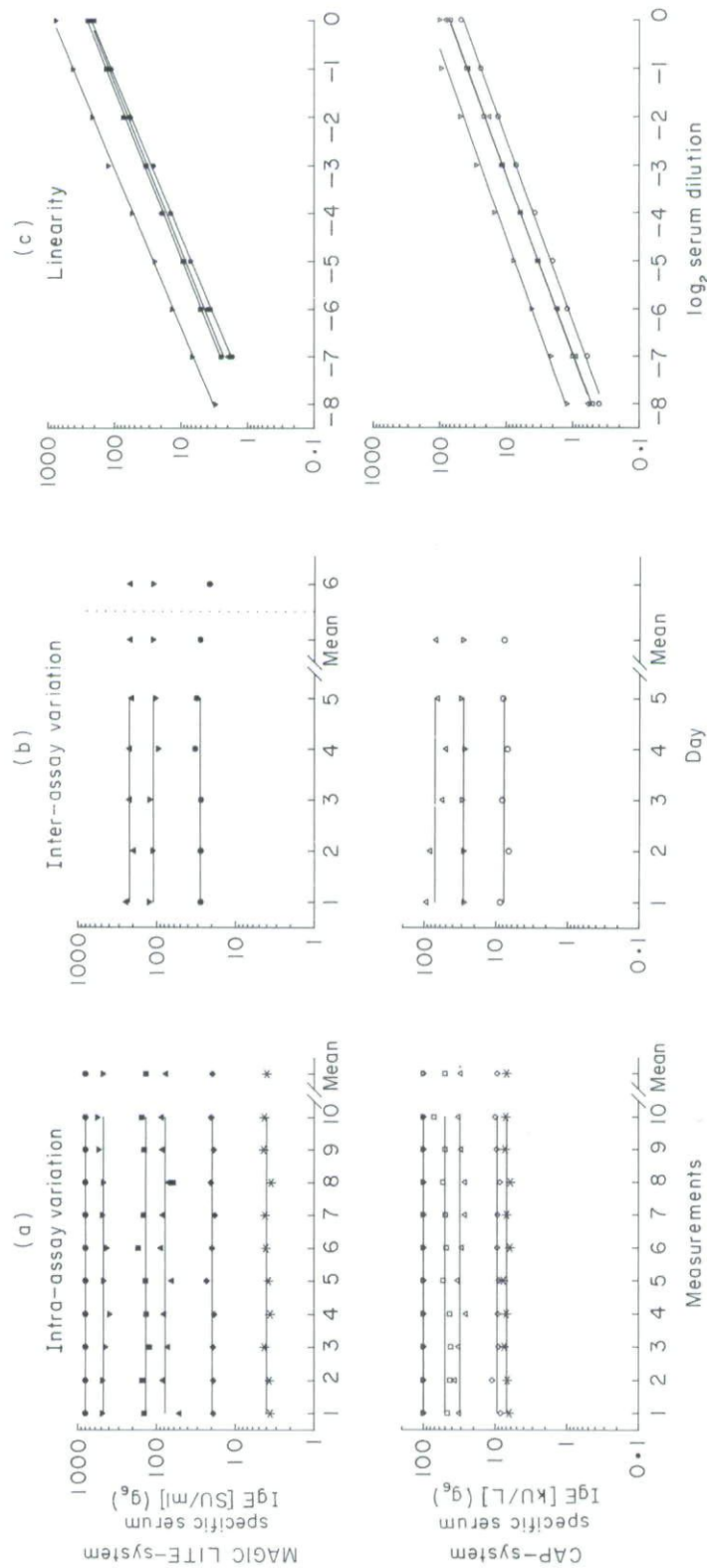


Fig. 1. (a) Intra-assay variation examined by 10 times determination of timothy grass-specific serum IgE antibody in six sera. The horizontal lines represent the mean value of 10 determinations. (b) Inter-assay variation examined by single assay runs of timothy grass-specific serum IgE antibody in three sera. The horizontal lines represent the mean value of five determinations. The value of specific IgE antibody detected by MAGIC LITE on day no. 6 was obtained with a new batch of the fluid allergen. (c) Linearity shown by timothy grass-specific IgE antibody levels in four sera with eight log₂-dilutions.

Table 2. (a) Intra-assay coefficients of variation (IACV) were calculated by determinations of six sera per allergen 10 times in the same assay run. (b) Inter-assay coefficients of variation (IECV) were detected by single determinations of three sera per allergen in five different assay runs. (c) Linearity is expressed as the average of the squared linear correlation coefficient (r^2) after determination of four sera plus eight log₂-dilutions per allergen. (d) Specific IgE antibody levels were expressed in classes according to the instructions of the manufacturer (Table 1), concordance between classes (k) was calculated for each allergen.

	(a) Intra-assay precision		(b) Inter-assay precision		(c) Linearity		(d) Class concordance (ML versus C)		
	ML (IACV [%])	C (IACV [%])	ML (IECV [%])	C (IECV [%])	ML (r^2 [%])	C (r^2 [%])	<i>n</i>	<i>k</i>	<i>P</i>
Birch	2.3	3.9	2.8	4.3	99.7	99.8	78	0.61	<0.001
Timothy grass	3.0	2.3	2.1	4.5	99.8	99.6	78	0.74	<0.001
Cat dander	3.0	3.4	11.8	7.2	99.9	99.5	71	0.81	<0.001
<i>D. pteronyssinus</i>	2.6	7.5	2.1	4.3	99.7	99.7	58	0.47	<0.001
Alternaria	2.8	5.6	5.1	7.3	99.0	97.7	36	0.47	<0.001
Mugwort	3.6	5.6	3.2	5.6	99.8	99.7	36	0.62	<0.001

ML, MAGIC LITE. C, CAP.

n, number of samples.

ing representative allergens of major importance were chosen for the comparison of both immunoassays:

Birch (t_3)—*Betula verrucosa*

Timothy grass (g_6)—*Phleum pratense*

Mugwort (w_6)—*Artemisia vulgaris*

Alternaria (m_6)—*Alternaria tenuis*

Cat (c_1)—*Felis domestica*

House dust mite (d_1)—*Dermatophagoides pteronyssinus*

Samples

Three hundred and fifty-seven serum samples from patients with suspected inhalant allergies ($n=285$, 120 females, 165 males, age 11–54 years, mean, 28 years) and a positive SPT to one or several common allergens were evaluated. Fifty SPT-negative subjects (21 females, 29 males, age 15–62 years, mean, 31 years) served as controls. Each serum sample of 5 ml was divided into 0.5 ml portions and stored at -20°C until specific IgE antibody determination.

Diagnosis of allergy

The characterization of patients and the diagnosis of allergy were based on case history and SPT. All patients had respiratory symptoms and suffered from rhinitis and/or asthma. Skin prick tests were performed with glycerinated extracts purchased from Allergopharma (Reinbek,

Germany) and ALK* (Hørsholm, Denmark) including a histamine solution (1 mg/ml) and physiological saline as positive and negative controls, respectively. The inhalant seasonal and perennial allergens prevalent in northern and western Europe were tested: birch, timothy grass, mugwortpollen, cat*, dog*, horse-dander*, two house dust mite species, *D. pteronyssinus* and *D. farinae*, and Alternaria*. None of the patients had taken medications which might interfere with SPT results [17]. Skin tests with the allergen extracts listed above were done in all patients included in the study. They were considered to be positive when the weal size induced by the allergen was at least $>100\%$ of the weal size induced by the histamine positive control.

Study design

To compare both immunoassays with respect to assay precision, assay linearity, and concordance as well as sensitivity, specificity and efficiency with relationship to the clinical diagnosis, every serum sample was assessed for allergen specific IgE antibodies using both assays in parallel. All data were analysed following log transformation.

Intra-assay and inter-assay variation. After determination of six sera per allergen 10 times in the same assay run, single coefficients of variation were calculated using the formula, $100 \times \text{s.d. divided by the mean}$, and summarized

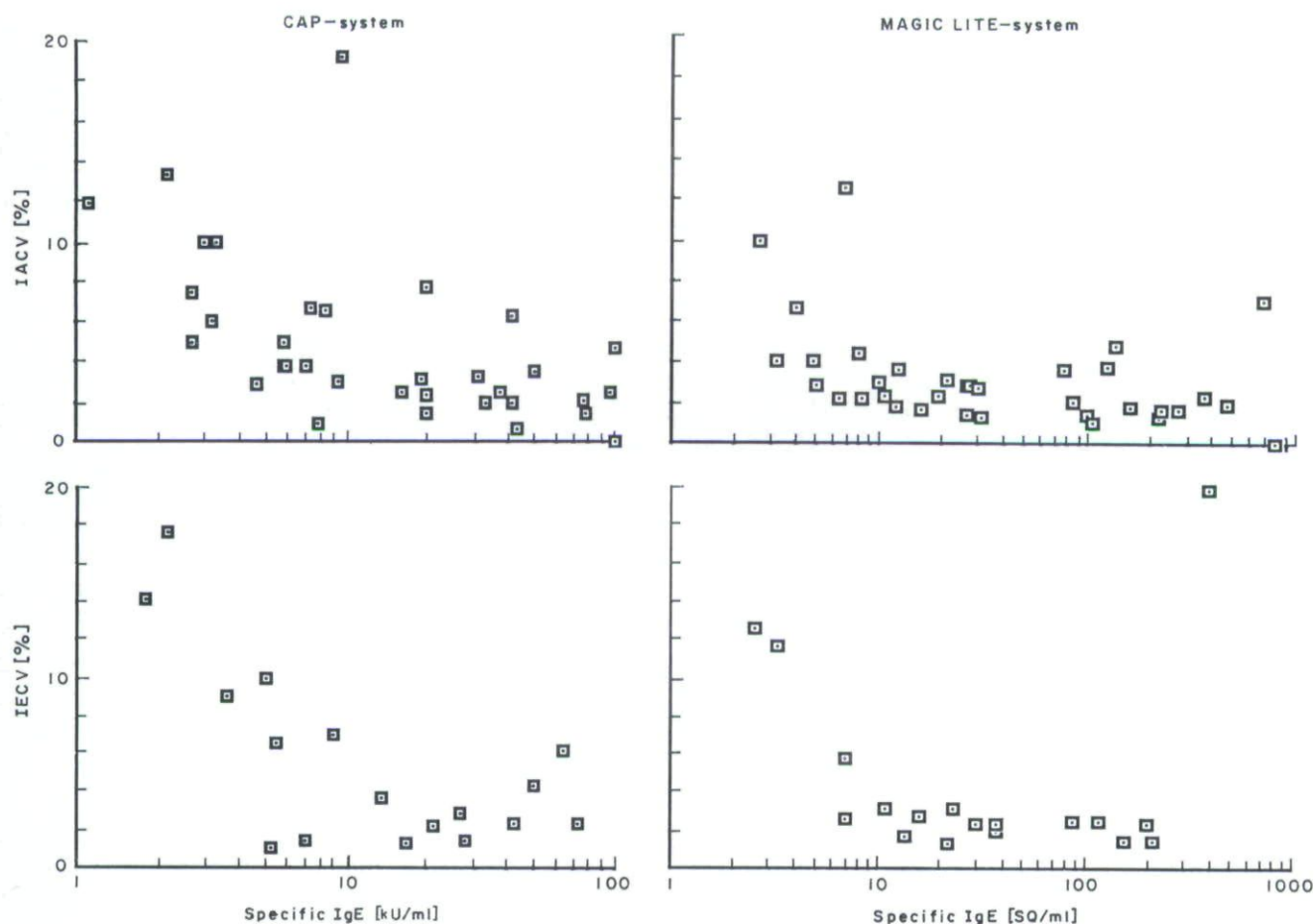


Fig. 2. Precision profile of two immunoassays, the CAP- and the MAGIC LITE-system, for the detection of specific IgE antibodies. IACVs and IECVs (coefficients of intra- and inter-assay variation) were depicted in relationship to the mean of the specific IgE antibody levels.

to obtain one intra-assay coefficient (IACV) per serum. The mean IACV for each allergen was calculated.

Single determinations of three sera per allergen in five different assay runs and their average were used to determine coefficients of variation. After summarizing these data to obtain one coefficient per serum sample, the mean inter-assay coefficient of variation (IECV) for each allergen was calculated. To demonstrate, in how far the variation depends on the height of the specific IgE antibody levels, precision profiles were depicted for both tests [18].

Linearity. Serial 1:2-dilutions were prepared using four sera per allergen using commercial serum diluter (Pharmacia, Sweden). After determination of these eight log₂-dilutions, linear regression analysis was used to calculate the correlation coefficient (r); linearity is given by the mean of the squared correlation coefficients (r^2).

Correlations of the absolute specific IgE antibody levels.

The absolute values of allergen specific IgE antibodies were measured in duplicate and expressed in SU/ml (MAGIC LITE) or kU_A/l (CAP) according to the instructions of the manufacturer. The mean values were correlated by regression analysis. In addition to the correlation coefficient for each allergen, the slope of each regression line was calculated. The negative results in both assays and levels out of range in one or both assays were excluded from the regression analyses to avoid fixed correlations.

Concordance of specific IgE antibody classes.

The absolute IgE antibody levels were also expressed as classes based on the instructions of the manufacturer (Table 1), because these results are usually given as classes in the practice of clinical allergy. CAP classes 5 and 6 were treated as one class in order to have the same number of classes for both

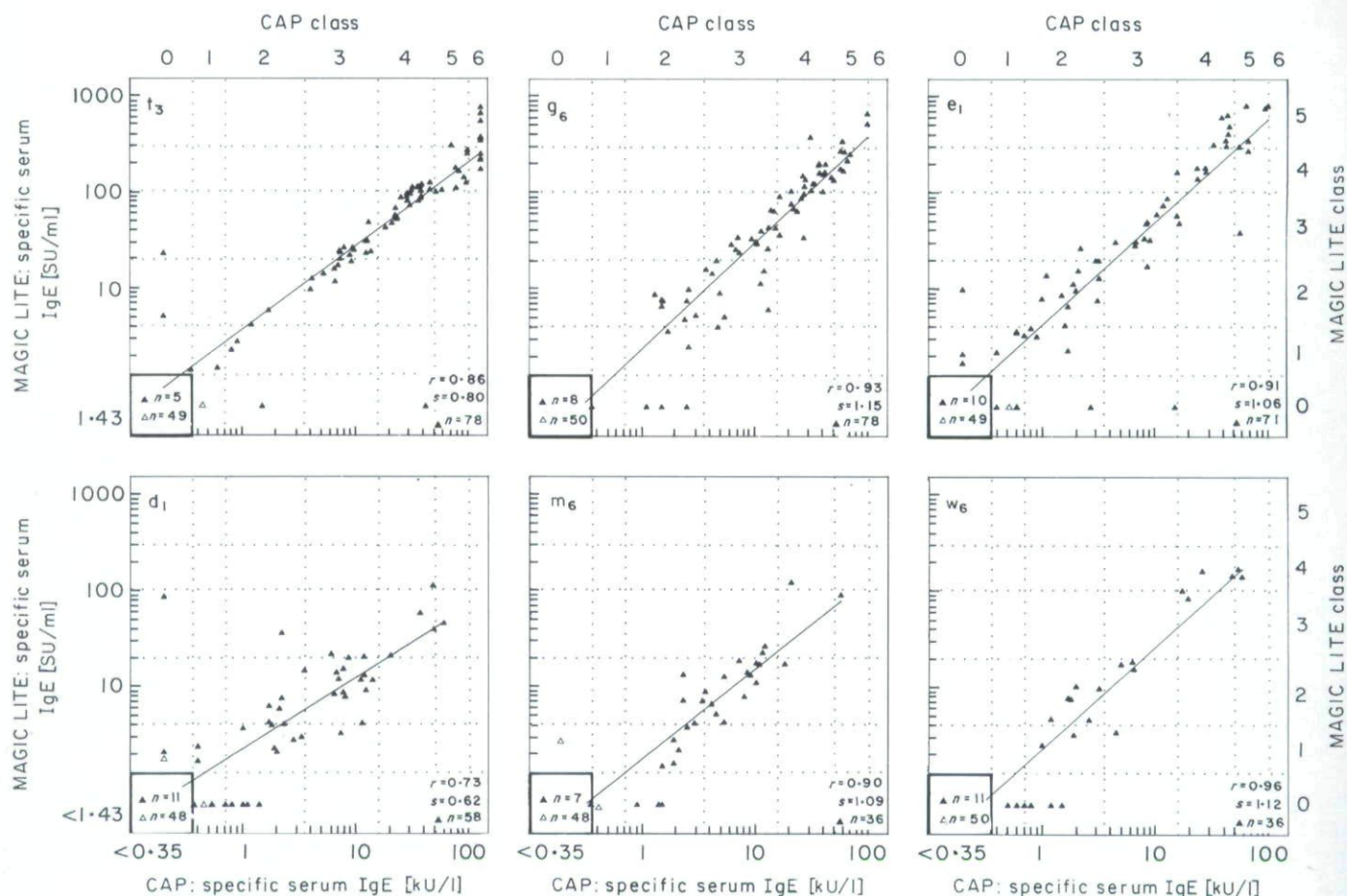


Fig. 3. Linear regression analysis between the absolute specific IgE antibody levels obtained by MAGIC LITE (y-axis) and CAP (x-axis) following log transformation. Correlation coefficient: r . Slope of the regression line: s . Number of patients: n . The small squares in the lower left corner include all specific antibodies values below the sensitivity levels of both immunoassays (MAGIC LITE cut-off 1.43 SU/ml, CAP cut-off 0.35 kU_A/ml), which are considered to be negative. The negative results in both assays and levels out of range in one or both assays were excluded from the calculation to avoid fixed correlations. Dotted lines show the limits of the scoring system, which are based on a transformation of SU/ml and kU_A/l into classes created by each manufacturer (see Table 1). Allergens: t_3 birch, g_6 timothy grass, e_1 cat, d_1 house dust mite *D. pteronyssinus*, m_6 Alternaria, w_6 mugwort. In t_3 , g_6 , and e_1 the closed triangles represent serum samples from patients with a positive case history plus concordant SPT; in d_1 , m_6 , and w_6 they represent samples of SPT-positive subjects. The open triangles represent serum samples from individuals with a negative case history and a negative SPT.

immunoassays. The class levels of both tests were listed in 5×5 tables and used for the calculation of kappa by a test of concordance.

Sensitivity and specificity. To calculate the sensitivity, specificity and efficiency of both immunoassays [19] in birch pollen-, grass pollen- and cat dander-allergy, only serum samples of patients with either a definite clinical history to the given allergen plus concordant positive SPTs (allergic group) or from subjects with no history to the given allergen plus negative SPTs (non-allergic group) were analysed. For mugwort pollen, Alternaria and *D. pteronyssinus*, in which the case history was not as clear as

for the allergens above, serum samples of patients with a positive SPT to these allergens (allergic group) and subjects without any allergic symptoms plus negative SPTs (non-allergic group) were investigated. CAP and MAGIC LITE classes were used to discriminate between positive (class ≥ 1) and negative (class = 0) results.

Results

Intra-assay variation

Intra-assay precision is expressed using coefficients of variation based on the determination of six sera per

Table 3. Comparison of MAGIC LITE and CAP results with the clinical diagnosis of allergy, based on case history plus concordant SPT. H, Case history. S, SPT. E, presence of specific IgE. Based on these data sensitivity, specificity and efficiency—related to each allergen—were calculated.

Allergen	HS+E+	HS+E-	HS-E+	HS-E-	Sens. (%)	Spec. (%)	Effic. (%)
<i>MAGIC LITE</i>							
Birch	71	7	0	50	91	100	95
Timothy grass	65	13	0	50	83	100	90
Cat dander	59	12	0	50	83	100	90
<i>CAP</i>							
Birch	69	9	1	49	89	98	93
Timothy grass	70	8	0	50	90	100	94
Cat dander	59	12	1	49	83	98	89

Table 4. Relation of MAGIC LITE and CAP results to the SPT results. S, SPT. E, presence of specific IgE. For estimation of sensitivity, specificity and efficiency, SPT was considered to represent the 'true diagnosis'.

Allergen	S+E+	S+E-	S-E+	S-E-	Sens. (%)	Spec. (%)	Effic. (%)
<i>MAGIC LITE</i>							
<i>D. pteronyssinus</i>	42	16	1	49	72	98	84
Alternaria	27	9	1	49	75	98	86
Mugwort	18	18	0	50	50	100	73
<i>CAP</i>							
<i>D. pteronyssinus</i>	45	13	1	49	78	98	87
Alterarnia	29	7	1	49	81	98	89
Mugwort	25	11	0	50	69	100	83

allergen 10 times. The raw data for grass pollen allergy are shown in Fig. 1a. The mean IACVs for all of the allergens are depicted in Table 2a. As the absolute values for the standard deviations were related to the size of the mean, the precision profile in Fig. 2 demonstrates higher IACVs, determined with samples of low IgE antibody concentrations in both assays.

Inter-assay variation

The precision of the assays on different days of determination was investigated using three sera per allergen on five different days (for grass pollen see Fig. 1b). The overall IECVs for every allergen are shown in Table 2b. Coefficients of variation for specific IgE antibody measurements with MAGIC LITE using a new batch of allergens

did not exceed 10%. The precision profile in Fig. 2 shows that lower IgE antibody levels were related to a higher IECV.

Linearity

Linearity of both assays was calculated by the determination of four sera with eight log₂-dilutions per allergen (data for grass pollen see Fig. 1c). After linear regression analysis of the serum dilutions, the average of the squared linear correlation coefficient (r^2) is given in Table 2c for each allergen.

Linear correlations

Negative results in both immunoassays, obtained by investigation of the non-allergic control sera, and positive

results which are out of range in one of the immunoassays, were excluded from the regression analysis, to avoid fixed correlations. After linear regression analysis of the absolute specific IgE antibody levels, the correlation coefficient and the slope of the regression line were calculated (Figs 2 and 3).

Concordance of class levels. The absolute values of specific IgE antibody were also expressed in classes which were used for the calculation of concordance between both diagnostic tests. The coefficients of concordance, kappa, are depicted in Table 2d. For cat allergy, both immunoassays showed excellent concordance ($\text{kappa} > 0.81$). Very good concordance ($\text{kappa} > 0.61$) was found for birch, timothy grass and mugwort pollen. For the allergens of house dust mite and *Alternaria*, a good concordance ($\text{kappa} > 0.41$) was found between both immunoassays.

Sensitivity and specificity. Based on the clinical findings (case history and SPT results) the number of positive and negative results of both immunoassays were determined (Tables 3 and 4) and were used for the calculation of sensitivity, specificity and efficiency. Excellent specificity ($> 98\%$) was found for all allergens investigated. A very good sensitivity ($> 83\%$) was found in both immunoassays using birch pollen, timothy grass pollen and cat dander. The other allergens showed good sensitivity ($> 70\%$) except for mugwort pollen, in which the MAGIC LITE results reached a sensitivity of only 50%.

Discussion

MAGIC LITE and CAP are immunoassays of very high precision: no IACVs or IECVs exceeded 10% with the exception of cat allergen using MAGIC LITE. Furthermore, most of the coefficients of variation, determined with middle and high IgE antibody levels, were below 5%, which underscores the high reproducibility of specific IgE antibody determination by both test systems. IACVs and IECVs for MAGIC LITE were found to be 7.5% and 8.9% in a former study [6]; no results were given with regard to CAP. Nevertheless, the high precision of both assays is shown by the present IACV and IECV data. Excellent linearity was found using serially diluted serum samples. After linear regression analysis of diluted allergen specific IgE antibody, the r^2 values were greater than 99%, except for *Alternaria* (97.7%) detected with CAP. Similar results were found with dilution recoveries between 90 and 110% using MAGIC LITE [5].

Strong correlations were found between CAP and MAGIC LITE for detection of specific IgE antibodies to birch pollen, timothy grass pollen and cat dander, which

might be a result of using the same allergen source (Allergon, Sweden). Also, the concordance between these specific IgE antibody determinations expressed as classes was excellent for cat dander and very good for birch and timothy grass pollen. A weaker correlation between CAP and MAGIC LITE was found for *D. pteronyssinus* specific IgE antibody. In nine of 58 serum samples, MAGIC LITE gave negative results in contrast to CAP, while in three cases CAP values were negative compared to MAGIC LITE. The lower class concordance (0.41) suggests that the discrepancies might be due to different preparations of the allergen used in the immunoassays. Similar findings occurred with *Alternaria* and mugwort allergy: negative IgE antibody levels as well as lower IgE classes were found more often using MAGIC LITE, instead of rather good correlations, which were obtained by comparing the absolute specific IgE antibody levels towards both allergens. A recent study investigated whether the low amounts of circulating specific IgE antibody measured by CAP, but not confirmed by SPT, might be a result of technical errors. The authors stated that the CAP results were indeed specific and agreed with the case history of hypersensitivity [9]. Discussion of the discrepancies in class concordance is difficult because the classification of specific IgE antibody levels requires the creation of arbitrary limits by the manufacturer of the test system. CAP classes between 0 and 4 are based on RAST classes [3], which were also based on arbitrary cut-off levels known as Phadebas-RAST-Units per millilitre. An international standardization for the detection of allergen specific IgE antibodies has not yet been developed. However, the manufacturer of the CAP-system uses kU_A/l for quantifying specific IgE antibodies, because the standard curve of their assay is calibrated against the WHO standard for total IgE antibody [3]. Different affinities of specific IgE antibody for the coupled allergen raise the question of whether allergen specific IgE antibody levels can be reported in units similar to the international standardization used for total IgE antibody values.

For birch, timothy grass pollen and cat dander, good correlations were found between the specific IgE antibody levels obtained by both immunoassays and the clinical diagnosis, based on the history plus concordant SPT to the specific allergen, providing information which appears to be as accurate as provocation tests [20]. While rather high sensitivities with only marginal differences between both assays were detectable for these allergens, the excellent specificity might be due to our study design, which included only sera from non-allergic subjects with no positive SPT reactions as negative controls. Low total IgE antibody levels will occur in this group, avoiding interference by non-specific IgE antibody in both assays,

which might occur if sera from allergic individuals with elevated total serum IgE antibody levels were used. However, no interference in the assay 'CAP' by elevated total serum IgE antibody levels has been observed [3-5]. Similar and somewhat better results for both CAP and MAGIC LITE with regard to assay sensitivity were found in comparison to RAST [4,9], when SPT was considered as the true diagnosis [6]. The values for sensitivity calculated in some of these studies were based on a small number of positive serum samples [4,6,8,9], limiting clear cut conclusions about the quality of an *in vitro* assay. Unfortunately, results from other studies comparing MAGIC LITE and CAP are not available. Besides an excellent specificity for *D. pteronyssinus* and *Alternaria*, a good and quite comparable sensitivity was calculated for both immunoassays. The poor sensitivity in detecting mugwort specific IgE antibody especially with MAGIC LITE may be due to the fact that different allergen preparations were used for the *in vitro* tests and the SPT. Similar discrepancies were also found for olive pollen in another study [4], that might be due to different allergen sources and differences in their quality, i.e. the composition of individual allergens.

In addition to the fact that the size of the weal taken as positive will determine the incidence of positive SPT reactions, these test results are not invariably equated with clinical relevant allergy. A study including provocation tests would give a more accurate diagnosis for 'clinical allergy' and would help in the evaluation and interpretation of a positive *in vitro* test result [8]. In cases of sensitization to *D. pteronyssinus*, *Alternaria* and mugwort indicated by SPT, there may be a number of atopic subjects who have no evidence of the clinical allergy in question at the time of investigation, emphasizing the importance of the history in the interpretation of any test for specific IgE antibody.

Both test systems, MAGIC LITE and CAP, offer advantages of speed, efficiency and automation over older solid phase systems for IgE antibody measurement. Since excellent precision, linearity, and good concordance between the *in vitro* results were found for the allergens studied, both assays appear to have many advantages over former methods for the detection of allergen specific IgE antibodies.

Acknowledgments

We gratefully acknowledge Mrs Elke Kirchhof and Mrs Marianne Sladek for technical assistance and Dr Anne Kagey-Sobotka and Dr Robert Hamilton for editorial assistance.

References

- 1 Schröder H, Kober A, Yman L. New developments in specific IgE antibody measurement—Phadezym RAST. *Allergol Immunopathol* 1981; (suppl 9):46-50.
- 2 Bernstein IL. Proceedings on the task force on guidelines for standardizing old and new technologies used for the diagnosis and treatment of allergic diseases. *J Allergy Clin Immunol* 1988; 82(suppl 3):499-504.
- 3 Axen R, Drevin H, Kober A, Yman L. A new laboratory diagnostic system applied to allergy testing. In: Johansson SGO, ed. Proceedings of a clinical workshop: IgE antibodies and the Pharmacia CAP system in allergy diagnosis. Uppsala, Sweden: Pharmacia Publication, 1988:3-5.
- 4 Bousquet J, Chanez P, Chanal I, Michel FB. Comparison between RAST and Pharmacia CAP system: a new automated specific IgE assay. *J Allergy Clin Immunol* 1990; 85:1039-43.
- 5 Johansen N, Andersson MW, Rohde H. Magic Lite SQ specific IgE assay system. In: Danish Society of Allergology, ed. Proceedings of the 17th Nordic Congress of Allergology. Arhus, Denmark, 1990:157.
- 6 Jacobsen L, Johansen N, Rohde H, Lynch M, Comerci C, Tugendhaft N. Evaluation of the Magic Lite SQ specific IgE assay system. *Clin Chemistry* 1990; 36:1189 (abstract).
- 7 Heinig JG, Engel T, Johansen N, Jacobsen L. Comparison between Magic Lite, Phadebas RAST and SPT in patients suspected to suffer from allergic rhinitis and/or asthma. In: Danish Society of Allergology, ed. Proceedings of the 17th Nordic Congress of Allergology. Arhus, Denmark, 1990:156.
- 8 Ewan PW, Coote D. Evaluation of a capsulated hydrophilic carrier polymer (the ImmunoCAP) for measurement of specific IgE antibodies. *Allergy* 1990; 45:22-9.
- 9 Leimgruber A, Mosimann B, Claeys M, Seppey M, Jaccard Y, Aubert V, Peitrequin R, Nisoli MP, Pécoud A. Clinical evaluation of a new in-vitro assay for specific IgE, the immuno CAP system. *Clin Exp Allergy* 1991; 21:127-31.
- 10 Berg T, Johansson SGO. In vitro diagnosis of atopic allergy. V. The value of repeated testing using several batches of the allergen extract. *Int Arch Allergy Appl Immunol* 1976; 51:471-8.
- 11 Schröder H. RAST-based techniques for allergen assay. In: Brede HD, Goings H, eds. Proceedings of the First Paul Ehrlich Seminar on Regulatory Control and Standardization of allergenic extracts. Stuttgart: Fisher Verlag, 1980:139-44.
- 12 Hersh LS, Yaverbaum S. Magnetic solid phase-radioimmunoassay. *Clin Chem Acta* 1975; 63:69-72.
- 13 Weeks I, Beheshti L, McCapra F, Campbell AK, Woodhead JS. Acridinium esters as high-specific activity labels in immunoassays. *Clin Chem* 1983; 29:1474-9.
- 14 Whitehead TP, Kricka LJ, Carter JN, Thorpe GHG. Analytical luminescence: its potential in the clinical laboratory. *Clin Chem* 1979; 25:1531-46.
- 15 Johansen N, Gjesing B, Lynch MJ. Comparison of two-point adjustment and a full 10-point standardization on the

- Magic Lite SQ specific IgE system. *Scan J Clin Lab Invest* 1991; 50(suppl 202):211.
- 16 Lynch MJ. Extended standard curve stability on the CCD Magic Lite immunoassay system using a two-point adjustment. *J Biolumin Chemilumin* 1989; 4:615-9.
- 17 Bousquet J. In vivo methods for the study of allergy: skin tests, techniques, and interpretation. In: Middleton E Jr, Ellis EF, Reed CE, Adkinson NF Jr, Yunginger JW, eds. *Allergy: principles and practice*, 3rd edn. St Louis: CV Mosby, 1988:419-36.
- 18 Ekin RP. The precision profile and its use in RIA assessment and design. *J Clin Immunoassay* 1981; 4:33-44.
- 19 Galen RS, Gambino SR. *Beyond normality: the predictive value and efficiency of medical diagnoses*. New York: John Wiley, 1975.
- 20 Eriksson NE, Ahlstedt S, Belin L. Diagnosis of reaginic allergy with house dust, animal dander and pollen allergens in adult patients. I. A comparison between RAST, skin tests and provocation tests. *Int Arch Allergy Appl Immunol* 1976; 52:335-46.

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.