

ORIGINAL ARTICLE

A World Allergy Organization International Survey on Diagnostic Procedures and Therapies in Drug Allergy/Hypersensitivity

Bernard Yu-Hor Thong, MBBS, MRCP (UK), FRCP (Edin),¹ Rita Mirakian, MD,²
Mariana Castells, MD, PhD,³ Werner Pichler, MD,⁴ Antonino Romano, MD,⁵
Patrizia Bonadonna, MD,⁶ Deleanu Diana, MD,⁷ Marek Kowalski, MD,⁸ Anahi Yanez, MD,⁹
Ramon Lleonart, MD,¹⁰ Mario Sanchez-Borges, MD,¹¹ and Pascal Demoly, MD¹²

Objective: To study the diagnostic and treatment modalities used in drug allergy/hypersensitivity among members of the World Allergy Organization (WAO).

Methods: A questionnaire comprising 39 questions was circulated electronically to member societies, associate member societies, and regional and affiliate organizations of WAO between June 29, 2009, and August 9, 2009.

Results: Eighty-two responses were received. Skin testing was used by 74.7%, with only 71.4% having access to penicillin skin test reagents. In vitro-specific IgE tests were used by 67.4%, and basophil activation test was used by 54.4%. Lymphocyte transformation tests were used by 36.8% and patch tests by 54.7%. Drug provocation tests were used by 68.4%, the most common indication being to exclude hypersensitivity where history/symptoms were not suggestive of drug hypersensitivity/allergy (76.9%). Rapid desensitization for chemotherapy, antibiotics, or biologic agents was used by 69.6%. Systemic corticosteroid was used in the treatment of Stevens–Johnson syndrome by 72.3%, and high-dose intravenous immunoglobulins in toxic epidermal necrolysis by 50.8%. Human leukocyte antigen screening before prescription of abacavir was used by 92.9% and before prescription of carbamazepine by 21.4%.

Conclusions: Results of this survey form a useful framework for developing educational and training needs and for improving access to drug allergy diagnostic and treatment modalities across WAO member societies.

Key Words: desensitization, drug allergy, hypersensitivity, skin tests

(*WAO Journal* 2011; 4:257–270)

Drug allergy/hypersensitivity¹ is a common problem seen by general and subspecialty adult and pediatric outpatient clinics,² inpatient wards,³ and emergency department.⁴ Among specialists, patients with drug allergy/hypersensitivity may present to an allergologist,⁵ dermatologist, or other organ-based specialist depending on the type, extent, and severity^{6–9} of clinical manifestations. Although guidelines for the diagnosis, evaluation, and treatment of drug allergy/hypersensitivity have been available for more than a decade, clinical practice is heterogeneous across the world and indeed even within districts/regions in the same country. This may be influenced by different origins of undergraduate and postgraduate allergological training (dermatology, pulmonology, or allergy/immunology^{10,11}), type of allergological practice (private, government practice, clinical or research-based institution), funding mechanisms, accessibility to various types of diagnostic tests, availability of basic versus tertiary practice infrastructure/laboratory equipment, and many other factors.¹²

OBJECTIVE

The objective of this survey was to study the diagnostic and treatment modalities used in drug allergy/hypersensitivity among members of the World Allergy Organization (WAO), with the results forming the framework for developing the educational and training needs and for improving access to drug allergy diagnostic and treatment modalities across WAO member societies. The specific aims of this survey were

1. To increase the global awareness on the requirement of specialized/dedicated allergy clinics/centers for drug allergy testing and management;

From the ¹Department of Rheumatology, Allergy and Immunology, Tan Tock Seng Hospital, Singapore; ²Cambridge University, NHS Foundation Trust, Allergy Clinic, Cambridge, United Kingdom; ³Division of Rheumatology, Allergy and Immunology, Department of Medicine, Brigham and Women's Hospital, Boston, MA; ⁴Division of Allergology, Department of Rheumatology and Allergology/Clinical Immunology, Inselspital, University of Bern, Bern, Switzerland; ⁵Allergy Unit, Complesso Integrato Columbus, Rome and IRCCS Oasi Maria S.S., Troina, Italy; ⁶Allergy Unit, Azienda Ospedaliera Universitaria Integrata of Verona, Verona, Italy; ⁷Department of Allergy, University of Medicine and Pharmacy Iuliu Hatieganu, Cluj-Napoca, Romania; ⁸Department of Clinical Immunology, Rheumatology, Allergology, Medical University of Lodz, Lodz, Poland; ⁹Servicio de Alergia e Inmunología Clínica, Hospital Aeronáutico Central, Buenos Aires, Argentina; ¹⁰Allergy Unit, Hospital Universitari Bellvitge Feixa Llarga sn l'Hospitalet, Barcelona, Spain; ¹¹Clinica El Avila, Caracas, Venezuela; ¹²Clinical Department of Allergology, Arnaud de Villeneuve Hospital, University Hospital of Montpellier, Montpellier, France.

The authors have no funding or conflicts of interest to disclose.

Correspondence to: Bernard Yu-Hor Thong, MBBS, MRCP (UK), FRCP (Edin), Department of Rheumatology, Allergy and Immunology, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, Singapore 308433. Telephone: +65-6357 7822. Fax: +65-6357 2686. E-mail: bernard_thong@tsh.com.sg.

Copyright © 2011 by World Allergy Organization

2. To lay foundations toward a globally standardized clinical practice of drug allergy management;
3. To train allergists in performing diagnostic tests;
4. To facilitate exchanges of knowledge and collaborations among allergy centers in different countries.

METHODS

The questionnaire was initiated and circulated to members of the WAO Drug Allergy Special Committee for evaluation in January 2009. The questions covered both diagnostic and therapeutic practices in drug allergy/hypersensitivity. The final questionnaire comprised a total of 39 questions, which was approved by the entire committee (Appendix 1).

The questionnaire was then converted into a Web-based questionnaire by the WAO Secretariat and sent electronically to 77 regional and national member societies of WAO. If representatives of member societies were unable to complete the specific questions on diagnostic tests and therapies available in their own country/region, they were asked to recommend the questionnaire to centers that would be able to respond to the questions. All respondents were given 6 weeks (June 29, 2009 to August 9, 2009) to reply. The responses were then collated by the WAO Secretariat, and the numbers and percentages of respondents for each question were collated.

RESULTS

There were a total of 82 responses comprising respondents from WAO member societies (95%), associate member societies (3.7%), regional organizations (3.7%), and affiliate organizations (1.1%). There were 13 additional responses from individuals who were recommended by the WAO member society representative who was not able to complete the specific questions on diagnostic tests and therapies available in the country/region. The geographical origin of all respondents was Europe (49.1%), Asia Pacific (26.4%), Latin America (15.1%), North America (5.7%), and Africa/Middle East (3.7%).

Among all responders, 95.3% and 55.6% responded that dedicated allergy clinics and dermatology clinics, respectively, in their country conducted evaluations for drug allergy/hypersensitivity. Among responders, 61.8% practiced in countries/regions where there were drug allergy centers/clinics dedicated to adult care, and 64.7% practiced where such centers dedicated to pediatric care were available.

The most widely used clinical practice guideline was the American Academy of Allergy Asthma and Immunology/American College of Allergy, Asthma and Immunology (AAAAI/ACAAI) 2008 Practice Parameter Update: Allergy diagnostic testing¹³ (59.7%), followed by the European Academy of Allergy Asthma and Clinical Immunology (EAACI) guidelines on provocation tests for aspirin and other drugs^{14,15} (41.6%). The remaining guidelines used^{16–26} are summarized in Table 1.

For immediate reactions, skin testing was used by 74.7%, with the majority (67.6%) using this for both clinical care and research. Only 71.4% had access to penicillin skin test reagents, where the commercial Diater product (Diater Laboratories, Madrid, Spain) for penicilloyl polylysine and minor determinant mix was used by 49.1% and in-house reagents by 26.3%. Drugs that were commonly skin tested were penicillins (87.5%), cephalosporins (77.8%), local anesthetic agents (75.0%), general anesthetic agents (61.1%), and non-beta-lactam antibiotics (50.0%) (Table 2). Drugs for skin testing were prepared by the allergist in 65.3%, nurse practitioner/specialist in 34.7%, and pharmacist in 27.8%. Among some respondents, there was more than 1 practitioner who could prepare the drugs for skin testing. Negative skin tests were followed by a drug provocation test (DPT) in only 56.2% of cases.

In vitro-specific IgE tests were used by 67.4% of respondents. The tests commercially available were the immunoCAP-fluorescent enzyme immunoassay (CAP-FEIA) (previously Pharmacia now called Phadia, Uppsala, Sweden) in 80.6%, radioallergosorbent test (RAST) in 56.5%, flow cytometric cellular allergen stimulation test (Buhlmann Labs, Switzerland) in 25.8%, cellular allergen stimulation test enzyme-linked immunosorbent assay (CAST-ELISA) (Buhlmann Labs) in 24.2%, and flow cytometry-2-cellular allergen stimulation test (Flow-2-CAST) (Buhlmann Labs) in 14.5% (Table 3). In-house assays most commonly used were radioallergosorbent test (48.6%) and radioimmunoassays (22.9%). The most commonly tested drugs were penicillins (93.7%), cephalosporins (61.9%), general anesthetic agents (36.5%), and nonsteroidal anti-inflammatory drugs (NSAID) (27.0%). Other tests available to respondents included serum total tryptase in 75.0% and basophil activation test in 54.4%.

For nonimmediate reactions, lymphocyte transformation tests (LTTs) were used by 36.8% of respondents, the majority for both clinical care and research (48.6%) but more for research (37.1%) than for clinical care (14.3%) alone. Where available, in-house LTT was used by 52.9%, sent to another facility in the same region/country by 32.4%, and sent out of the region/country by 14.7%. The drugs most commonly tested using LTT were beta-lactam antibiotics (77.8%), non-beta-lactam antibiotics (58.3%), and NSAID/selective cyclooxygenase inhibitors (36.1%). The other drugs commonly tested are listed in Table 4. The types of nonimmediate reactions most commonly tested using LTT were drug-induced hypersensitivity syndrome (DIHS) (65.6%), Stevens-Johnson syndrome (SJS) (65.6%), maculopapular exanthema (46.9%), acute generalized exanthematous pustulosis (AGEP) (46.9%), and toxic epidermal necrolysis (TEN) (46.9%). The other types of nonimmediate reactions commonly tested using LTT are shown in Table 5.

Patch tests were used for both clinical care and research (59.6%) but more for clinical care (30.8%) than for research (9.6%) alone. Commercialized form of the drug was used by 55.3%, the pure substance by 21.3%, and both by the remaining 23.4%. The most common dilutions were 1% (34.2%) and 5% (31.6%), with majority using petrolatum (90.0%). Drugs used for patch testing were obtained commercially by 55.3%, prepared in-house by 34.0%, and obtained

TABLE 1. Commonly Used Clinical Guidelines

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Total (n = 77)
AAAAI/ACAAI 2008 Practice Parameter Update: Allergy diagnostic testing ¹³	14 (18.2)	16 (19.5)	6 (7.8)	7 (9.1)	3 (3.9)	46 (59.7)
EAAACI/GA2LEN 2007: Aspirin provocation tests for aspirin hypersensitivity ¹⁴	20 (26.0)	3 (3.9)	2 (2.6)	5 (6.5)	2 (2.6)	32 (41.6)
ENDA 2003 Guidelines: DPTs ¹⁵	21 (27.3)	6 (7.8)	1 (1.3)	3 (3.9)	1 (1.3)	32 (41.6)
ENDA 2006: Statement on penicillin skin testing ¹⁷	17 (22.1)	4 (5.2)	1 (1.3)	4 (5.2)	2 (2.6)	28 (36.4)
ENDA 2004 Guidelines: Non-immediate allergic reactions to beta-lactam antibiotics ¹⁸	19 (24.7)	4 (5.2)	1 (1.3)	3 (3.9)	1 (1.3)	28 (36.4)
ENDA 2003 Guidelines: Immediate allergic reactions to beta-lactam antibiotics ¹⁹	18 (23.4)	4 (5.2)	1 (1.3)	3 (3.9)	1 (1.3)	27 (35.1)
BSACI 2009 Guidelines: Management of drug allergy ¹⁶	12 (15.6)	11 (14.3)	0 (0.0)	2 (2.6)	1 (1.3)	26 (33.8)
ENDA 2005 Guidelines: Management of hypersensitivity to iodinated contrast media ²⁰	18 (23.4)	2 (2.6)	1 (1.3)	3 (3.9)	1 (1.3)	25 (32.5)
AAAAI/ACAAI 1999 Practice Parameter: Drug hypersensitivity ²¹	6 (7.8)	9 (11.7)	3 (3.9)	4 (5.2)	3 (3.9)	25 (32.5)
AAAAI/ACAAI 2006 Practice Parameter: Contact dermatitis ²²	10 (13.0)	3 (3.9)	4 (5.2)	4 (5.2)	1 (1.3)	22 (28.6)
SFAR/ENDA 2005 Guidelines: Reducing the risk of anaphylaxis during anaesthesia ²³	13 (16.9)	4 (5.2)	1 (1.3)	2 (2.6)	1 (1.3)	21 (27.3)
European Society of Contact Dermatitis 2001 Guidelines for the study of skin testing in investigating CADR ²⁴	13 (16.9)	3 (3.9)	2 (2.6)	1 (1.3)	1 (1.3)	20 (26.0)
International Contact Dermatitis Research Group (ICDRG) 1970: Criteria for patch test reading ²⁵	5 (6.5)	5 (6.5)	3 (3.9)	3 (3.9)	1 (1.3)	17 (22.1)
BSACI 2003 Guidelines: Suspected anaphylactic reactions associated with anaesthesia ²⁶	4 (5.2)	5 (6.5)	0 (0.0)	1 (1.3)	0 (0.0)	10 (13.0)

Percentage represents percentage of all 77 respondents who answered this question.

from both sources in the remaining 10.7%. In addition to the parent drug, 53.3% also tested components other than the parent drug including preservative (44.4%), coloring (37.8%), and excipient (28.9%). Patch test reading was done, and read at 20 minutes by 4.2%, 48 hours by 47.9%, 96 hours by 10.4%, and on day 7 (if days 2 and 4 are negative) by 37.5%. Photopatch tests were done by only 46.5% of respondents. Drugs most commonly used for patch testing were beta-lactam antibiotics (83.3%), non-beta-lactam antibiotics (64.6%), and corticosteroids (60.4). The drugs commonly patch tested are shown in Table 6. Patch tests were most commonly used in the diagnosis of maculopapular exanthema (66.0%), DIHS (63.8%), fixed drug eruption (61.7%), and AGEP (55.3%).

The other types of nonimmediate reactions for which patch tests were commonly used are shown in Table 7.

DPTs were used by 68.4% with the most common indication being to exclude hypersensitivity where the history was not suggestive or the symptoms not specific for drug hypersensitivity/allergy (76.9%). It was used for definitive diagnosis where history was suggestive but allergological tests were negative, nonconclusive or not available by 67.7%; to exclude cross-reactivity of related drugs in proven hypersensitivity (eg, cephalosporin in a penicillin allergic individual) by 63.1%; and to provide safe pharmacologically/structurally nonrelated drugs in proven hypersensitivity (eg, beta-lactams) by 60.0%. This is summarized in Table 8.

TABLE 2. Drugs Commonly Skin Tested

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 72), n (%)
Penicillins	26 (36.1)	15 (20.8)	6 (8.3)	8 (11.1)	6 (8.3)	2 (2.6)	63 (87.5)
Cephalosporins	25 (34.7)	14 (19.4)	6 (8.3)	7 (9.7)	2 (2.6)	2 (2.6)	56 (77.8)
Local anesthetic agents	28 (38.9)	8 (11.1)	7 (9.7)	7 (9.7)	2 (2.6)	2 (2.6)	54 (75.0)
General anesthetic agents	25 (34.7)	4 (5.6)	4 (5.6)	7 (9.7)	2 (2.6)	2 (2.6)	44 (61.1)
Non-beta lactam antibiotics	21 (29.2)	6 (8.3)	3 (4.2)	4 (5.6)	1 (1.4)	1 (1.4)	36 (50.0)
Non-steroidal anti-inflammatory drugs	15 (20.8)	6 (8.3)	2 (2.6)	4 (5.6)	1 (1.4)	1 (1.4)	29 (40.3)

Percentage represents percentage of all 72 respondents who answered this question.

TABLE 3. Commercially Available In Vitro-Specific IgE Tests

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 62), n (%)
CAP-FEIA	25 (40.3)	9 (14.5)	6 (9.7)	3 (4.8)	4 (6.5)	3 (4.8)	50 (80.6)
RAST	18 (29.0)	3 (4.8)	4 (6.5)	3 (4.8)	4 (6.5)	3 (4.8)	35 (56.5)
CAST-ELISA	10 (16.1)	1 (1.6)	0 (0.0)	2 (3.2)	2 (3.2)	1 (1.6)	16 (25.8)
FLOW-CAST	11 (17.7)	1 (1.6)	1 (1.6)	0 (0.0)	0 (0.0)	2 (3.2)	15 (24.2)
FLOW-2-CAST	8 (11.1)	0 (0.0)	1 (1.6)	0 (0.0)	2 (3.2)	2 (3.2)	9 (14.5)

Percentage represents percentage of all 72 respondents who answered this question.

CAP-FEIA, immunoCAP fluorescent enzyme immunoassay; CAST-ELISA, cellular allergen stimulation test enzyme-linked immunosorbent assay; FLOW-CAST, flow cytometry cellular allergen stimulation test; FLOW-2-CAST: flow cytometry-2-cellular allergen stimulation test; RAST, radio allergosorbent test.

Preparation of drugs for challenges was performed by the doctor (62.1%), pharmacist (39.4%), and nurse practitioner (25.8%), respectively. Challenges used were most commonly open challenges (75.4%), followed by single-blind placebo-controlled (44.6%), or double-blind placebo-controlled (24.6%). Oral challenges were more commonly used compared with parenteral challenges. Among oral challenges, the most commonly used formulations were tablet (80%), capsule (73.8%), or syrup (61.5%). Among parenteral challenges, subcutaneous challenges (49.2%) were more commonly done compared with intravenous (27.7%) and intramuscular (21.5%) routes.

In the survey on therapies for drug allergy, rapid desensitizations for the treatment of IgE-mediated and non-IgE-mediated anaphylactic reactions to chemotherapy, antibiotics, or biologic agents, such as monoclonal antibodies, were used by 69.6% of respondents. Systemic corticosteroids were used by 72.3% for the treatment of SJS and/or systemic manifestations of TEN, high-dose intravenous immunoglobulins for TEN by 50.8%, and other immunosuppressive drugs by 9.2% (most commonly cyclosporine). Comanagement with an intensive care/high-dependency/burns unit was commonly practiced by 67.7% of respondents, whereas comanagement with an ophthalmologist (49.2%), daily pain assessment and management (36.9%), and the use of the Severity of Illness Score for TEN for prognostication during the first 24 hours (29.2%) were less frequently practiced.

Human leukocyte antigen (HLA) testing for specific drugs associated with severe cutaneous adverse reactions (SCAR) before prescription was reported by 14 respondents (17.1%). Of these, 92.9% of respondents from the American,

Australasian, Austrian, Azerbaijan, Chilean, Columbian, Dutch, French, and Swiss societies screened for HLA-B*5701 in white ancestry before the prescription of abacavir. There were 21.4% of respondents from the Australasian, Chinese, and Dutch societies who screened for HLA-B*1502 in Han Chinese or people with Asian ancestry before the prescription of carbamazepine. None of the respondents screened for HLA-B*5801 before the prescription of allopurinol in Han Chinese.

DISCUSSION

There was a good response rate for this survey, reflecting significant interest in the diagnosis and management of drug allergy/hypersensitivity among WAO member organizations. Most regions used existing guidelines and practice parameters from their own (where available) and those from other international allergy/immunology member groups and regional organizations.

There were more respondents who did not have dedicated pediatric drug allergy services in their region compared with adult drug allergy clinics. First, this could be due to children with drug allergy/hypersensitivity being usually seen within general pediatric or general pediatric allergy clinics, in contrast to adult internal medicine/specialty services, which tend to be more subspecialized. Second, most clinical and research groups in pediatric allergology tend to focus more on pediatric asthma, eczema, rhinitis, food allergy, and anaphylaxis rather than drug allergy/hypersensitivity²⁷⁻³¹.

TABLE 4. Drugs Commonly Tested Using LTT

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 36), n (%)
Antibiotics (beta-lactams)	19 (52.8)	3 (8.3)	3 (8.3)	1 (2.8)	1 (2.8)	1 (2.8)	28 (77.8)
Antibiotics (Non beta-lactams)	14 (38.9)	2 (5.6)	3 (8.3)	1 (2.8)	1 (2.8)	0 (0.0)	21 (58.3)
NSAIDs and Selective Cox-2 inhibitors	11 (30.6)	1 (2.8)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	13 (36.1)
Anti-epileptics	11 (30.6)	0 (0.0)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	12 (33.3)
Anti-tuberculous drugs	8 (22.2)	1 (2.8)	0 (0.0)	1 (2.8)	1 (2.8)	0 (0.0)	11 (30.6)
Pyrazolones	8 (22.2)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	2 (5.6)	11 (30.6)
Local anesthetic agents	8 (22.2)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.8)	10 (27.8)
Neuromuscular blockers	6 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (5.6)	8 (22.2)

Percentage represents percentage of all 36 respondents who answered this question.

TABLE 5. Types of Nonimmediate Reactions Commonly Tested Using LTT

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 32), n (%)
DIHS	16 (50.0)	1 (3.1)	1 (3.1)	2 (6.3)	1 (3.1)	0 (0.0)	21 (65.6)
SJS	14 (43.8)	1 (3.1)	2 (6.3)	0 (0.0)	0 (0.0)	4 (12.5)	21 (65.6)
Maculopapular exanthema	11 (34.3)	1 (3.1)	2 (6.3)	0 (0.0)	0 (0.0)	1 (3.1)	15 (46.9)
AGEP	14 (43.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.1)	15 (46.9)
TEN	11 (34.3)	1 (3.1)	1 (3.1)	0 (0.0)	0 (0.0)	2 (6.3)	15 (46.9)
Fixed drug eruption	7 (21.9)	2 (6.3)	1 (3.1)	1 (3.1)	1 (3.1)	1 (3.1)	13 (40.6)
Immunobullous eruptions	9 (28.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.1)	10 (31.3)
Vasculitis	6 (18.8)	1 (3.1)	0 (0.0)	1 (3.1)	1 (3.1)	0 (0.0)	9 (28.1)
Hepatitis	4 (12.5)	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (15.6)
Blood dyscracias	2 (6.3)	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (9.4)
Interstitial nephritis	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.1)

Percentage represents percentage of all 32 respondents who answered this question.

Third, children present, in general, with less complex drug-related allergies than adults because they do not tend to take many drugs at the same time. Although the principles of when and how to evaluate children with suspected drug allergy is no different from adults,^{32,33} pragmatically, testing in children is mainly recommended if no alternative drug is available and there is an absolute requirement for that specific drug to be administered. There are logistic constraints as intradermal testing and DPTs may be difficult to perform on children, especially the very young. Even if drug allergy is documented in childhood, full retesting is often necessary once the adult age is reached. This pragmatic approach has not, however, reached unanimous consensus among allergists.

Skin tests (74.7%) and in vitro blood tests (67.4%) were commonly used in the diagnosis of immediate reaction, with beta-lactam antibiotics and anesthetic agents being the most commonly tested. However, only 70% of respondents had access to penicillin skin test reagents. Benzylpenicilloyl-polylysine, a major penicillin skin test reagent commercially known in the United States as, was not commercially available after September 2003. Hollister-Stier, the sole producer of PrePen in the United States, was directed by the Food and Drug Administration to cease its production in 2003 because of the lack of a dedicated penicillin manufacturing facility and hence quality concerns. A product

containing major and minor determinants (Allergopen) was available on the European market until 2004, then it was also withdrawn by Merck worldwide.¹⁷ Thus, major and minor penicillin determinants produced commercially by Diater S.A. (Madrid, Spain) were used in several European and Asian countries with comparable performance characteristics compared with PrePen and Allergopharma kit.³⁴⁻³⁷ In September 2009, ALK-Abelló and AllerQuest, LLC announced the return of PrePen to the United States and the international market. With this, penicillin skin testing is likely to become more widely available among WAO member societies again.

Although intradermal tests (IDTs) are used in the diagnosis of immediate reactions,¹³ the delayed IDT reading usually at 24 hours and 72 hours is useful in the diagnosis of nonimmediate reactions³⁸ and has been recommended in guidelines on the evaluation of drug allergy,¹⁶ for instance, for nonimmediate reactions to beta-lactam antibiotics.¹⁸ However, this survey did not look specifically at the number of sites that carried out delayed IDT readings.

For nonimmediate reactions, patch tests were used more commonly (54.7%) compared with LTT (36.8%). The use of patch tests and LTT is more common in Europe compared with other regions of the world. A positive patch test or LTT is useful, but a negative test cannot exclude drug allergy/hypersensitivity. Patch tests preparations are not well

TABLE 6. Drugs Commonly Tested Using Patch Tests

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 48), n (%)
Antibiotics (beta-lactams)	22 (45.8)	6 (12.5)	4 (8.3)	6 (12.5)	3 (6.3)	1 (2.1)	40 (83.3)
Antibiotics (non-beta-lactams)	19 (39.6)	1 (2.1)	4 (8.3)	5 (10.4)	2 (4.2)	0 (0.0)	31 (64.6)
Corticosteroids	20 (41.7)	3 (6.3)	2 (4.2)	3 (6.3)	1 (2.1)	0 (0.0)	29 (60.4)
Anti-epileptics	19 (39.6)	1 (2.1)	2 (4.2)	5 (10.4)	0 (0.0)	1 (2.1)	28 (58.3)
Cotrimoxazole	16 (33.3)	1 (2.1)	2 (4.2)	3 (6.3)	0 (0.0)	0 (0.0)	22 (45.8)
NSAIDs and Selective Cox-2 inhibitors	13 (27.1)	3 (6.3)	2 (4.2)	3 (6.3)	1 (2.1)	1 (2.1)	21 (43.8)
Anti-tuberculous drugs	12 (25.0)	1 (2.1)	1 (2.1)	2 (4.2)	0 (0.0)	1 (2.1)	17 (35.4)
Radiocontrast media	13 (27.1)	1 (2.1)	1 (2.1)	1 (2.1)	0 (0.0)	0 (0.0)	16 (33.3)
Acyclovir	11 (22.9)	0 (0.0)	1 (2.1)	2 (4.2)	0 (0.0)	0 (0.0)	14 (29.2)

Percentage represents percentage of all 48 respondents who answered this question.

TABLE 7. Types of Nonimmediate Reactions Commonly Tested Using Patch Tests

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 47), n (%)
Maculopapular exanthema	18 (38.3)	2 (4.3)	4 (8.5)	5 (10.6)	1 (2.1)	1 (2.1)	31 (66.0)
Drug induced hypersensitivity syndrome (DIHS)	14 (29.8)	6 (12.8)	3 (6.4)	4 (8.5)	2 (4.3)	1 (2.1)	30 (63.8)
Fixed drug eruption	14 (29.8)	3 (6.4)	2 (4.3)	4 (8.5)	4 (8.5)	2 (4.3)	29 (61.7)
AGEP	15 (31.9)	3 (6.4)	4 (8.5)	3 (6.4)	0 (0.0)	1 (2.1)	26 (55.3)
Stevens–Johnson syndrome	13 (27.7)	2 (4.3)	0 (0.0)	4 (8.5)	2 (4.3)	1 (2.1)	22 (46.8)
TEN	8 (17.0)	1 (2.1)	0 (0.0)	3 (6.4)	1 (2.1)	1 (2.1)	14 (29.8)
Immunobullous eruptions	8 (17.0)	1 (2.1)	0 (0.0)	2 (4.3)	0 (0.0)	1 (2.1)	12 (25.5)
Vasculitis	7 (14.9)	1 (2.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (17.0)
Blood dyscrasias	1 (2.1)	1 (2.1)	0 (0.0)	1 (2.1)	0 (0.0)	0 (0.0)	3 (6.4)

Percentage represents percentage of all 47 respondents who answered this question.

standardized across all drugs, seem to be useful only in certain types of drug eruptions (eg, exanthema, eczema, and AGEP) but not others (eg, TEN), and are useful only with certain drugs.^{38,39} The same is true for LTT, which has been found to be useful in exanthema, AGEP, bullous exanthema, drug rash with eosinophilia and systemic symptoms, and only for certain drugs. Many of the respondents, mainly from Europe, used patch tests and LTT in diagnosing the putative drug for severe reactions (SJS, TEN, DIHS). The many disadvantages for LTT including the requirement for sterile cell cultures, long time required to run the test, use of radioactivity, and expensive equipment limit its use to specialized tertiary clinical and research centers.⁴⁰

DPTs were used by 68.4% of respondents with the most common indication being to exclude hypersensitivity where the history was not suggestive or the symptoms not specific for drug hypersensitivity/allergy (76.9%). DPT is generally safe when properly carried out under supervision and with constant, careful patient assessment⁴¹ both in adults⁴² and in children.⁴³ It is most commonly used in the definitive diagnosis of beta-lactam (penicillin or cephalosporin) allergy,^{44–46} or demonstration of tolerance to alternative NSAIDs—weak

COX-1 inhibitors (paracetamol) and/or preferential (meloxicam) or highly selective COX-2 inhibitors (etoricoxib, parecoxib)—in patients with NSAID/aspirin exacerbated respiratory disease, urticaria/angioedema, or NSAID intolerance.^{47–51}

Definitive treatment of drug allergy includes avoidance of the drug in question, patient education on prevention, knowledge of potentially cross-reacting drugs, and giving patients some form of medic alert identification or notification. The survey looked at 2 specific treatment modalities: drug desensitization and management of SCAR (SJS/TEN/DIHS).

Rapid desensitizations, carried out by 69.6% of respondents, has been described for the treatment of IgE-mediated and non-IgE-mediated anaphylactic reactions to chemotherapy, antibiotics, or biologic agents, such as monoclonal antibodies,^{52–54} and to high-dose aspirin in aspirin exacerbated respiratory disease⁵⁵ and low-dose aspirin (desensitization rechallenge) in patients with coronary artery disease requiring percutaneous coronary intervention.^{56–58}

The management of SJS/TEN⁵⁹ was variable across different respondents, among whom 72.3% used systemic corticosteroids in SJS and/or systemic manifestations of TEN, 50.8% used high-dose intravenous immunoglobulin

TABLE 8. Indications for DPTs

	Europe, n (%)	Asia Pacific, n (%)	North America, n (%)	Latin America, n (%)	Africa Middle East, n (%)	Region Not Specified, n (%)	Total (n = 65), n (%)
Exclude hypersensitivity (non-suggestive history/non-specific symptoms)	25 (38.5)	10 (15.4)	4 (6.2)	4 (6.2)	2 (3.1)	5 (7.7)	50 (76.9)
Definitive diagnosis in suggestive history with negative, non-conclusive or non-available allergological tests	22 (33.8)	9 (13.8)	4 (6.2)	5 (7.7)	4 (6.2)	0 (0.0)	44 (67.7)
Exclude cross-reactivity of related drugs in proven hypersensitivity (e.g. cephalosporin in a penicillin allergic individual)	22 (33.8)	8 (12.3)	4 (6.2)	3 (4.6)	2 (3.1)	2 (3.1)	41 (63.1)
Provide safe pharmacologically/structurally non-related drugs in proven hypersensitivity (e.g. beta-lactams)	21 (32.3)	5 (7.7)	5 (7.7)	3 (4.6)	2 (3.1)	3 (4.6)	39 (60.0)

Percentage represents percentage of all 65 respondents who answered this question.

for TEN and 9.2% used other immunosuppressive drugs including cyclosporine. More than two thirds would consider comanaging TEN patients with an intensivist/ burns unit^{60,61}; this may have been limited by the availability of such tertiary specialty care in certain regions. Only 49.2% considered comanagement with an ophthalmologist, suggesting that a greater awareness of the ocular complications of SCAR and the need for aggressive ocular immunomodulatory therapy may be needed.⁶²

HLA screening⁶³ has been shown to be useful in preventing SCAR before the prescription of abacavir in whites,⁶⁴ carbamazepine in Han Chinese or individuals of Asian ancestry,⁶⁵ and allopurinol in Han Chinese.⁶⁶ Only 17.1% of respondents had access to HLA screening for drugs at high risk of causing SCAR, with the majority (92.9%) screening for HLA B*5701 before prescribing abacavir, and 21.4% screening for HLA B*1502 before prescribing carbamazepine in Asians. This may have been due to lack of availability of rapid HLA screening kits in certain parts of Asia, or differences in local pharmacovigilance requirements.⁶⁷

There were several limitations to this survey, which was highlighted by respondents. First, within large countries/regions, the president/chair of the WAO affiliated society may not have had ample opportunity to run the survey through all members from different states/districts within the 6-week consultation period, especially where practices may be heterogeneous and in large countries/regions. Second, interest and expertise in dealing with drug allergies also varied within different countries/regions, as certain types of drug allergies were looked after by organ-based specialists rather than allergologists, for example, patients with SJS were looked after by dermatologists in certain regions. In this context, the survey may have inevitably been slightly skewed toward obtaining/ receiving the results from the most dedicated centers with specific research interests. For example, the use of basophil activation test or LTT as diagnostic tools may not be as common in clinical practice as it appears from the audit's results. Third, there were clinical practices in certain regions, which were not covered by the questions used in the survey (eg, delayed IDT readings for nonimmediate reactions).

Although this survey has shown the types of tests available and practiced in various parts of the world, this need not necessarily mean that the tests are uniformly useful. For instance, patch tests, although carried out in many European centers for nonimmediate reactions, are drug-specific and reaction-specific and thus are more useful where certain types of nonimmediate reactions predominate. The use of standardized nomenclature, patient profiles, harmonization of test procedures, measurements, and outcome measures are crucial in improving the diagnostic modalities presently used in evaluating drug hypersensitivity/ allergy, findings similarly reflected in the Drug Ambassador Project carried out by the European Network for Drug Allergy.⁶⁸

CONCLUSIONS

This survey shows that even though well-established international guidelines are available for the diagnosis and management of drug allergy, practices vary across the different

regions of the world due to differences in allergology training, practice setups, funding mechanisms, and resource limitations. Nonetheless, the results of this survey will help facilitate multicenter networking in education, practice, and resource development in drug allergy/hypersensitivity. It is our hope that the results of this survey will, through WAO, facilitate clinical, educational, and research collaboration among the different allergy centers with an interest in drug allergy/hypersensitivity.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of Karen Henley and Kate Kirchner from the WAO Secretariat for coordinating and collating the results of this survey. They also acknowledge the following members from the WAO member societies who participated in this survey: A. B. Singh, Amir Hamzah Abdul Latiff, Andreas J. Bircher, Beatrice M. Bilò, Carlos Serrano, Catherine Orci-Darier, Chng Hiok Hee, Clifford Tepper, David A. Khan, David Gislason, Deleanu Diana, Dominic Mallon, Panadda, Eric Macy, Eris Mesonjesi, Esther Moreno Rodilla, Estrella Asayag, Greg Sharon, Gulfem Elif Celik, Heru Sundaru, Hiroo Yokozeki, Zenro, Ikezawa, Igor Kaidashev, Ingrid Terreehorst, Jaime Alberto Guggiari, Doutreleau, Jan, Jan de Monchy, Jean-Francois Nicolas, Jorge Oswaldo Castro, Jovilia M. Abong, Juan JoseYepes Nunez, Jung-Won Park, Kamal Maurice Hanna, Kazi Saifuddin Bennoor, Kevin J. Kelly, Kristof Nekam, Ledit R. F. Arduoso, Luigi Fontana, Luis Felipe Chiaverini Ensina, Margit Zeher, Maria Antonieta Guzman, Maria Jose Torres Jaen, Marisol Montano, Medunitsyna Ekaterina, Menachem Rottem, Mihaela Zidarn, M. T. Guin-nepain, Paolo Campi, Paul C. Potter, Paula Kauppi, Peter Schmid-Grendelmeier, Petr Panzner, Pierre Gumowski, Piotr Kuna, Raymond Mullins, Richard Warrington, Ruby For-onda, Sanna Poikonen, Sonomjamts Munkhbayarlakh, Stefan Wöhrl, Stephen R Durham, Suwat Benjaponpitak, Tahira Panahova, Thomas Werfel, Torgeir Storaas, Vojislav Djuric, Yehia El-Gamal, and Yin Jia.

REFERENCES

- Johansson SG, Bieber T, Dahl R, Friedmann PS, Lanier BQ, et al. Revised nomenclature for allergy for global use: report of the Nomenclature Review Committee of the World Allergy Organization, October 2003. *J Allergy Clin Immunol.* 2004;113:832–836.
- Dietrich JJ, Quinn JM, England RW. Reasons for outpatient consultation in allergy/immunology. *Allergy Asthma Proc.* 2009;30:69–74.
- England RW, Ho TC, Napoli DC, Quinn JM. Inpatient consultation of allergy/immunology in a tertiary care setting. *Ann Allergy Asthma Immunol.* 2003;90:393–397.
- Dantonio C, Galimberti M, Barbone B, Calamari M, Airoidi G, et al. Suspected acute allergic reactions: analysis of admissions to the Emergency Department of the AOU Maggiore della Carità Hospital in Novara from 2003 to 2007. *Eur Ann Allergy Clin Immunol.* 2008;40:122–129.
- Dietrich JJ, Quinn JM, England RW. Reasons for outpatient consultation in allergy/immunology. *Allergy Asthma Proc.* 2009;30:69–74.
- Bastuji-Garin S, Rzany B, Stern RS, Shear NH, Naldi L, Roujeau JC. Clinical classification of cases of toxic epidermal necrolysis, Stevens-Johnson syndrome, and erythema multiforme. *Arch Dermatol.* 1993;129:92–96.
- Rzany B, Hering O, Mockenhaupt M, Schröder W, Goertler E, Ring J, Schöpf E. Histopathological and epidemiological characteristics of patients with erythema exudativum multiforme major, Stevens-Johnson syndrome and toxic epidermal necrolysis. *Br J Dermatol.* 1996;135:6–11.

8. Halevy S. Acute generalized exanthematous pustulosis. *Curr Opin Allergy Clin Immunol.* 2009;9:322–328.
9. Sampson HA, Muñoz-Furlong A, Campbell RL, Adkinson NF Jr, Bock SA, et al. Second symposium on the definition and management of anaphylaxis: summary report—second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium. *J Allergy Clin Immunol.* 2006;117:391–397.
10. Warner JO, Kaliner MA, Crisci CD, Del Giacco S, Frew AJ, et al. World Allergy Organization Specialty and Training Council. Allergy practice worldwide: a report by the World Allergy Organization Specialty and Training Council. *Int Arch Allergy Immunol.* 2006;139:166–174.
11. Potter PC, Warner JO, Pawankar R, Kaliner MA, Giacco SD, Rosenwasser L, on behalf of the WAO Specialty and Training Council Recommendations for Competency in Allergy Training for Undergraduates Qualifying as Medical Practitioners. A Position Paper of the World Allergy Organization. *WAO J.* 2009;2:150–154.
12. American Academy of Allergy, Asthma and Immunology. Consultation and referral guidelines citing the evidence: how the allergist-immunologist can help. *J Allergy Clin Immunol.* 2006;117(2 suppl Consultation): S495–S523.
13. Bernstein IL, Li JT, Bernstein DI, Hamilton R, Spector SL, et al. American Academy of Allergy, Asthma and Immunology; American College of Allergy, Asthma and Immunology. Allergy diagnostic testing: an updated practice parameter. *Ann Allergy Asthma Immunol.* 2008;100(3 suppl. 3):S1–S148.
14. Nizankowska-Mogilnicka E, Bochenek G, Mastalerz L, Swierczyńska M, Picado C, et al. EAACI/GA2LEN guideline: aspirin provocation tests for diagnosis of aspirin hypersensitivity. *Allergy.* 2007;62:1111–1118.
15. Aberer W, Bircher A, Romano A, Blanca M, Campi P, et al. European Network for Drug Allergy (ENDA); EAACI Interest Group on Drug Hypersensitivity. Drug provocation testing in the diagnosis of drug hypersensitivity reactions: general considerations. *Allergy.* 2003;58:854–863.
16. Mirakian R, Ewan PW, Durham SR, Youlten LJ, Dugué P, et al. BSACI. BSACI guidelines for the management of drug allergy. *Clin Exp Allergy.* 2009;39:43–61.
17. Torres MJ, Blanca M. European Network for Drug Allergy (ENDA); EAACI Interest Group on Drug Hypersensitivity. Importance of skin testing with major and minor determinants of benzylpenicillin in the diagnosis of allergy to betalactams. Statement from the European Network for Drug Allergy concerning AllergoPen withdrawal. *Allergy.* 2006;61:910–911.
18. Romano A, Blanca M, Torres MJ, Bircher A, et al. EAACI. Diagnosis of non-immediate reactions to beta-lactam antibiotics. *Allergy.* 2004;59:1153–1160.
19. Torres MJ, Blanca M, Fernandez J, Romano A, Weck A, et al. ENDA; EAACI Interest Group on Drug Hypersensitivity. Diagnosis of immediate allergic reactions to beta-lactam antibiotics. *Allergy.* 2003;58:961–972.
20. Brockow K, Christiansen C, Kanny G, Clément O, Barbaud A, et al. ENDA; EAACI Interest Group on Drug Hypersensitivity. Management of hypersensitivity reactions to iodinated contrast media. *Allergy.* 2005;60:150–158.
21. Executive summary of disease management of drug hypersensitivity: a practice parameter. Joint Task Force on Practice Parameters, the American Academy of Allergy, Asthma and Immunology, the American Academy of Allergy, Asthma and Immunology, and the Joint Council of Allergy, Asthma and Immunology. *Ann Allergy Asthma Immunol.* 1999;83(6 pt 3):665–700.
22. American Academy of Allergy, Asthma and Immunology; American College of Allergy, Asthma and Immunology. Contact dermatitis: a practice parameter. *Ann Allergy Asthma Immunol.* 2006;97(3 suppl 2):S1–38.
23. Mertes PM, Laxenaire MC, Lienhart A, Aberer W, Ring J, Pichler WJ, Demoly P. Working Group for the SFAR; ENDA; EAACI Interest Group on Drug Hypersensitivity. Reducing the risk of anaphylaxis during anaesthesia: guidelines for clinical practice. *J Investig Allergol Clin Immunol.* 2005;15:91–101.
24. Barbaud A, Gonçalo M, Bruynzeel D, Bircher A. European Society of Contact Dermatitis. Guidelines for performing skin tests with drugs in the investigation of cutaneous adverse drug reactions. *Contact Dermatitis.* 2001;45:321–328.
25. Wilkinson DS, Fregert S, Magnusson B, Bandmann HJ, Calnan CD, et al. Terminology of contact dermatitis. *Acta Dermato-Venereologica.* 1970;50:287–292.
26. Harper NJ, Dixon T, Dugué P, Edgar DM, Fay A, et al. Working Party of the Association of Anaesthetists of Great Britain and Ireland. Suspected anaphylactic reactions associated with anaesthesia. *Anaesthesia.* 2009;64:199–211.
27. Sturkenboom M, Nicolosi A, Cantarutti L, Mannino S, Picelli G, Scamarcia A, Giaquinto C. NSAIDs Paediatric Research Group. Incidence of mucocutaneous reactions in children treated with niflumic acid, other nonsteroidal antiinflammatory drugs, or nonopioid analgesics. *Pediatrics.* 2005;116:e26–e33.
28. Rebelo Gomes E, Fonseca J, Araujo L, Demoly P. Drug allergy claims in children: from self-reporting to confirmed diagnosis. *Clin Exp Allergy.* 2008;38:191–198.
29. Ponvert C, Weilenmann C, Wassenberg J, Walecki P, Bourgeois ML, de Blic J, Scheinmann P. Allergy to betalactam antibiotics in children: a prospective follow-up study in retreated children after negative responses in skin and challenge tests. *Allergy.* 2007;62:42–46.
30. Kidon MI, Liew WK, Chiang WC, Lim SH, Goh A, Tang JP, Chay OM. Hypersensitivity to paracetamol in Asian children with early onset of nonsteroidal anti-inflammatory drug allergy. *Int Arch Allergy Immunol.* 2007;144:51–56.
31. Tan VA, Gerez IF, Van Bever HP. Prevalence of drug allergy in Singaporean children. *Singapore Med J.* 2009;50:1158–1161.
32. Caubet JC, Kaiser L, Lemaître B, Fellay B, Gervais A, Eigenmann PA. The role of penicillin in benign skin rashes in childhood: a prospective study based on drug rechallenge. *J Allergy Clin Immunol.* 2011;127:218–222.
33. Ponvert C, Perrin Y, Bados-Albiero A, Le Bourgeois M, Karila C, et al. Allergy to betalactam antibiotics in children: results of a 20-year study based on clinical history, skin and challenge tests. *Pediatr Allergy Immunol.* 2011;22:411–418.
34. Matheu V, Pérez-Rodríguez E, Sánchez-Machin I, de la Torre F, García-Robaina JC. Major and minor determinants are high-performance skin tests in beta-lactam allergy diagnosis. *J Allergy Clin Immunol.* 2005;116:1167–1168.
35. Bousquet PJ, Co-Minh HB, Arnoux B, Daures JP, Demoly P. Importance of minor determinants and benzylpenicilloyl poly-L-lysine skin testing in the diagnosis of beta-lactam allergy. *J Allergy Clin Immunol.* 2005;115:1314–1316.
36. Matheu V, Pérez E, González R, Poza P, de la Torre F, Sánchez-Machin I, García-Robaina JC. Assessment of a new brand of determinants for skin testing in a large group of patients with suspected beta-lactam allergy. *J Investig Allergol Clin Immunol.* 2007;17:257–260.
37. Romano A, Viola M, Bousquet PJ, Gaeta F, Valluzzi R, Caruso C, Demoly P. A comparison of the performance of two penicillin reagent kits in the diagnosis of beta-lactam hypersensitivity. *Allergy.* 2007;62:53–58.
38. Barbaud A. Skin testing in delayed reactions to drugs. *Immunol Allergy Clin North Am.* 2009;29:517–535.
39. Friedmann PS, Arden-Jones M. Patch testing in drug allergy. *Cur Op Allergy Clin Immunol.* 2010;10:291–296.
40. Lochmatter P, Zawodniak A, Pichler WJ. In vitro tests in drug hypersensitivity diagnosis. *Immunol Allergy Clin North Am.* 2009;29:537–554.
41. Aberer W, Kränke B. Provocation tests in drug hypersensitivity. *Immunol Allergy Clin North Am.* 2009;29:567–584.
42. Messaad D, Sahla H, Benahmed S, Godard P, Bousquet J, Demoly P. Drug provocation tests in patients with a history suggesting an immediate drug hypersensitivity reaction. *Ann Intern Med.* 2004;140:1001–1006.
43. Blanca-López N, Zapatero L, Alonso E, Torres MJ, Fuentes V, Martínez-Molero MI, Blanca M. Skin testing and drug provocation in the diagnosis of nonimmediate reactions to aminopenicillins in children. *Allergy.* 2009;64:229–233.
44. Bousquet PJ, Pipet A, Bousquet-Rouanet L, Demoly P. Oral challenges are needed in the diagnosis of beta-lactam hypersensitivity. *Clin Exp Allergy.* 2008;38:185–190.
45. Torres MJ, Mayorga C, Leyva L, Guzman AE, Cornejo-García JA, Juárez C, Blanca M. Controlled administration of penicillin to patients with a positive history but negative skin and specific serum IgE tests. *Clin Exp Allergy.* 2002;32:270–276.

46. Caimmi S, Galéra C, Bousquet-Rouanet L, Arnoux B, Demoly P, Bousquet PJ. Safety of cefuroxime as an alternative in patients with a proven hypersensitivity to penicillins: a DAHD Cohort Survey. *Int Arch Allergy Immunol.* 2010;153:53–60.
47. Bavbek S, Dursun AB, Dursun E, Eryilmaz A, Misirligil Z. Safety of meloxicam in aspirin-hypersensitive patients with asthma and/or nasal polyps. A challenge-proven study. *Int Arch Allergy Immunol.* 2007;142:64–69.
48. El Miedany Y, Youssef S, Ahmed I, El Gaafary M. Safety of etoricoxib, a specific cyclooxygenase-2 inhibitor, in asthmatic patients with aspirin-exacerbated respiratory disease. *Ann Allergy Asthma Immunol.* 2006;97:105–109.
49. Celik G, Erkekol FO, Bavbek S, Dursun B, Misirligil Z. Long-term use and tolerability of cyclooxygenase-2 inhibitors in patients with analgesic intolerance. *Ann Allergy Asthma Immunol.* 2005;95:33–37.
50. Sánchez-Borges M, Caballero-Fonseca F, Capriles-Hulett A. Safety of etoricoxib, a new cyclooxygenase 2 inhibitor, in patients with nonsteroidal anti-inflammatory drug-induced urticaria and angioedema. *Ann Allergy Asthma Immunol.* 2005;95:154–158.
51. Muratore L, Ventura M, Calogiuri G, Calcagnile F, Quarta E, Muratore M, Ferrannini A. Tolerance to etoricoxib in 37 patients with urticaria and angioedema induced by nonsteroidal anti-inflammatory drugs. *Ann Allergy Asthma Immunol.* 2007;98:168–171.
52. Castells M. Rapid desensitization for hypersensitivity reactions to medications. *Immunol Allergy Clin North Am.* 2009;29:585–606.
53. Cernadas JR, Brockow K, Romano A, Aberer W, Torres MJ, et al. European Network of Drug Allergy and the EAACI Interest Group on Drug Hypersensitivity. General considerations on rapid desensitization for drug hypersensitivity—a consensus statement. *Allergy.* 2010;65:1357–1366.
54. Joint Task Force on Practice Parameters; American Academy of Allergy, Asthma and Immunology; American College of Allergy, Asthma and Immunology; Joint Council of Allergy, Asthma and Immunology. Drug allergy: an updated practice parameter. *Ann Allergy Asthma Immunol.* 2010;105:259–273.
55. Macy E, Bernstein JA, Castells MC, Gawchik SM, Lee TH, et al. Aspirin Desensitization Joint Task Force. Aspirin challenge and desensitization for aspirin-exacerbated respiratory disease: a practice paper. *Ann Allergy Asthma Immunol.* 2007;98:172–174.
56. Wong JT, Nagy CS, Krinzman SJ, Maclean JA, Bloch KJ. Rapid oral challenge-desensitization for patients with aspirin-related urticaria-angioedema. *J Allergy Clin Immunol.* 2000;105:997–1001.
57. Silberman S, Neukirch-Stoop C, Steg PG. Rapid desensitization procedure for patients with aspirin hypersensitivity undergoing coronary stenting. *Am J Cardiol.* 2005;95:509–510.
58. Rossini R, Angiolillo DJ, Musumeci G, Scuri P, Invernizzi P, Bass TA, Mihalscik L, Gavazzi A. Aspirin desensitization in patients undergoing percutaneous coronary interventions with stent implantation. *Am J Cardiol.* 2008;101:786–789.
59. French LE. Toxic epidermal necrolysis and Stevens Johnson syndrome: our current understanding. *Allergol Int.* 2006;55:9–16.
60. Wolf R, Davidovici B. Severe cutaneous adverse drug reactions: who should treat, where and how: Facts and controversies. *Clin Dermatol.* 2010;28:344–348.
61. Gerull R, Nelle M, Schaible T. Toxic epidermal necrolysis and Stevens-Johnson syndrome: a review. *Crit Care Med.* 2011;39:1521–1532.
62. Yip LW, Thong BY, Lim J, Tan AW, Wong HB, Handa S, Heng WJ. Ocular manifestations and complications of Stevens-Johnson syndrome and toxic epidermal necrolysis: an Asian series. *Allergy.* 2007;62:527–531.
63. Kim SH, Ye YM, Palikhe NS, Kim JE, Park HS. Genetic and ethnic risk factors associated with drug hypersensitivity. *Curr Opin Allergy Clin Immunol.* 2010;10:280–290.
64. Mallal S, Phillips E, Carosi G, Molina JM, Workman C, et al. PREDICT-1 Study Team. HLA-B*5701 screening for hypersensitivity to abacavir. *N Engl J Med.* 2008;358:568–579.
65. Hung SI, Chung WH, Jee SH, Chen WC, Chang YT, et al. Genetic susceptibility to carbamazepine-induced cutaneous adverse drug reactions. *Pharmacogenet Genomics.* 2006;16:297–306.
66. Hung SI, Chung WH, Liou LB, Chu CC, Lin M, et al. HLA-B*5801 allele as a genetic marker for severe cutaneous adverse reactions caused by allopurinol. *Proc Natl Acad Sci U S A.* 2005;102:4134–4139.
67. Fernando SL, Broadfoot AJ. Prevention of severe cutaneous adverse drug reactions: the emerging value of pharmacogenetic screening. *CMAJ.* 2010;182:476–480.
68. Gomes ER, Pichler WJ, Demoly P, Aberer W, Frew AJ, DeWeck A, and the EAACI Interest Group on Drug Hypersensitivity. The Drug Ambassador Project. The diversity of diagnostic procedures for drug allergy around Europe. *Allergy Clin Immunol.* 2005;17:9–18.

Annex A

**WORLD ALLERGY ORGANIZATION
SURVEY ON DRUG ALLERGY DIAGNOSTIC PROCEDURES 2009**

Thank you for spending some time to fill in this questionnaire. The objective of this is to survey the types of allergological tests available worldwide for the diagnosis of drug allergy/hypersensitivity. It is our hope that the results of this survey will through WAO facilitate collaboration and education among the different allergy centres with an interest in managing patients and undertaking research in drug allergy/hypersensitivity. Please check all answers that apply.

Questions 1-7 are applicable to all member societies of WAO.

Questions 8-42 are specific questions. If member societies are unable to complete this part of the questionnaire, please fill in the name, centre, e-mail of the centres in your country (Question 8).

Name of Society:

1	WAO Member Status	Member Society	<input type="checkbox"/>
		Associate Member Society	<input type="checkbox"/>
		Regional Organization	<input type="checkbox"/>
		Affiliate Organization	<input type="checkbox"/>
2	Do the Allergy Clinics in your country carry out evaluation for drug hypersensitivity/allergy?	Yes	<input type="checkbox"/>
		No	<input type="checkbox"/>
3	Do the Dermatology Clinics in your country carry out evaluation for drug hypersensitivity/allergy?	Yes	<input type="checkbox"/>
		No	<input type="checkbox"/>
4	If they do, which of the following guidelines are used?		
	International Contact Dermatitis Research Group (ICDRG) 1970: Criteria for patch test reading		<input type="checkbox"/>
	AAAAI/ACAAI 1999 Practice Parameter: Drug hypersensitivity		<input type="checkbox"/>
	European Society of Contact Dermatitis 2001 Guidelines for the study of skin testing in investigating CADR		<input type="checkbox"/>
	BSACI 2003 Guidelines: Suspected anaphylactic reactions associated with anaesthesia		<input type="checkbox"/>
	ENDA 2003 Guidelines: Immediate allergic reactions to beta-lactam antibiotics		<input type="checkbox"/>
	ENDA 2003 Guidelines: Drug provocation tests		<input type="checkbox"/>
	ENDA 2004 Guidelines: Non-Immediate allergic reactions to beta-lactam antibiotics		<input type="checkbox"/>
	ENDA 2005 Guidelines: Management of hypersensitivity to iodinated contrast media		<input type="checkbox"/>
	SFAR/ENDA 2005 Guidelines: Reducing the risk of anaphylaxis during anaesthesia		<input type="checkbox"/>
	ENDA 2006: Statement on penicillin skin testing		<input type="checkbox"/>
	AAAAI/ACAAI 2006 Practice Parameter: Contact dermatitis		<input type="checkbox"/>
	EAACI/GA2LEN 2007: Aspirin provocation tests for aspirin hypersensitivity		<input type="checkbox"/>
	AAAAI/ACAAI 2008 Practice Parameter Update: Allergy diagnostic testing		<input type="checkbox"/>
	BSACI 2009 Guidelines: Management of drug allergy		<input type="checkbox"/>
5	Are there adult drug allergy centres/clinics in your country?	Yes: please specify the number:	<input type="checkbox"/>
		No	<input type="checkbox"/>
6	Are there paediatric drug allergy centres/clinics in your country?	Yes: please specify the number:	<input type="checkbox"/>
		No	<input type="checkbox"/>
7	Which of the following tests for drug allergy/hypersensitivity are available in your country?	Skin prick and intradermal test → go to section (A)	<input type="checkbox"/>
		Specific IgE in-vitro tests → go to section (B)	<input type="checkbox"/>
		Other tests for immediate reactions → go to section (C)	<input type="checkbox"/>
		Lymphocyte transformation test → go to section (D)	<input type="checkbox"/>
		Patch testing → go to section (E)	<input type="checkbox"/>
		Drug provocation tests → go to section (F)	<input type="checkbox"/>

(A) SKIN TESTING

8	Is skin testing used in the clinical or research setting?	Clinical Research Both clinical and research	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
9	Do you have access to penicillin skin test reagents?	Yes No	<input type="checkbox"/> <input type="checkbox"/>
10	From where do you obtain your skin test reagent for penicilloyl polylysine (PPL)?	In-house Diater® Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
11	From where do you obtain your skin test reagent for minor determinant mix (MDM)?	In-house Diater® Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
12	Which drugs are commonly skin tested in your country?	Penicillins Cephalosporins Non-beta lactam antibiotics General anaesthetic agents Local anaesthetic agents NSAIDs Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
13	Who prepares the drugs for skin testing?	Allergist Pharmacist Nurse clinician/specialist Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
14	Are negative skin tests followed by a drug provocation test in all instances?	Yes No	<input type="checkbox"/> <input type="checkbox"/>

(B) SPECIFIC IgE IN-VITRO TESTS

15	Are these used in the clinical or research setting?	Clinical Research Both clinical and research	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
16	Are in-house or commercial assays available for these tests?	In-house Commercial Both Neither	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
17	Which commercial tests are available in your country?	CAP-FEIA (Pharmacia®) RAST (Radioallergosorbent test®) FLOW-CAST (Buhlmann Labs®) FLOW-2-CAST (Buhlmann Labs®) CAST-ELISA (Buhlmann Labs®) Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
18	Which in-house methods are used in your country?	RAST (Radioallergosorbent tests) RIA (Radioimmunoassay) Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
19	Which drugs are commonly tested using these in-vitro methods?	Penicillins Cephalosporins General anaesthetic agents NSAIDs Others – specify:	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

(C) OTHER TESTS FOR IMMEDIATE REACTIONS

20	Is serum total tryptase available in your country?	Yes	<input type="checkbox"/>
		No	<input type="checkbox"/>
21	Is the basophil activation test (BAT) available in your country?	Yes	<input type="checkbox"/>
		No	<input type="checkbox"/>

(D) LYMPHOCYTE TRANSFORMATION TESTS (LTT)

22	Is LTT used in the clinical or research setting?	Clinical	<input type="checkbox"/>
		Research	<input type="checkbox"/>
		Both clinical and research	<input type="checkbox"/>
23	Where are these tests done?	In-house	<input type="checkbox"/>
		Sent to another facility in the same region/country	<input type="checkbox"/>
		Sent to another facility out of the region/country	<input type="checkbox"/>
24	What drugs are commonly tested using LTT in your country?	Antibiotics (betalactams)	<input type="checkbox"/>
		Antibiotics (non-beta lactams)	<input type="checkbox"/>
		Anti-epileptics	<input type="checkbox"/>
		ACE inhibitors	<input type="checkbox"/>
		Anti-tuberculous drugs	<input type="checkbox"/>
		Diuretics	<input type="checkbox"/>
		NSAIDs & selective COX-2 inhibitors	<input type="checkbox"/>
		Pyrazolones	<input type="checkbox"/>
		Local anaesthetic agents	<input type="checkbox"/>
		HMG-CoA reductase inhibitors	<input type="checkbox"/>
		Opioids	<input type="checkbox"/>
		Neuromuscular blockers	<input type="checkbox"/>
25	For what types of delayed reactions are LTT commonly used for diagnosis?	Others - specify:	<input type="checkbox"/>
		Acute generalized exanthematous pustolosis (AGEP)	<input type="checkbox"/>
		Blood dyscracias (cytopaenias)	<input type="checkbox"/>
		Drug induced hypersensitivity syndrome (DIHS)	<input type="checkbox"/>
		Fixed drug eruption (FDE)	<input type="checkbox"/>
		Hepatitis	<input type="checkbox"/>
		Immunobullous eruptions	<input type="checkbox"/>
		Interstitial nephritis	<input type="checkbox"/>
		Maculopapular exanthems (MPE)	<input type="checkbox"/>
		Stevens Johnson syndrome	<input type="checkbox"/>
		Toxic epidermal necrolysis	<input type="checkbox"/>
		Vasculitis	<input type="checkbox"/>
		Others – specify:	<input type="checkbox"/>

(E) PATCH TESTS

26	Is this used in the clinical or research setting?	Clinical	<input type="checkbox"/>
		Research	<input type="checkbox"/>
		Both clinical and research	<input type="checkbox"/>
27	What formulation of the drug is used for testing?	Pure substance	<input type="checkbox"/>
		Commercialized form of the drug	<input type="checkbox"/>
		Others – specify:	<input type="checkbox"/>

28	What dilutions of the drug are used	0.1%	<input type="checkbox"/>
		1%	<input type="checkbox"/>
		5%	<input type="checkbox"/>
		10%	<input type="checkbox"/>
29	What vehicle is used?	Petrolatum	<input type="checkbox"/>
		Water	<input type="checkbox"/>
		Alcohol	<input type="checkbox"/>
30	How do you obtain the drugs for patch testing?	In-house	<input type="checkbox"/>
		Commercial - specify:	<input type="checkbox"/>
		Others - specify:	<input type="checkbox"/>
31	Which of the following are also tested?	Preservative	<input type="checkbox"/>
		Colouring	<input type="checkbox"/>
		Excipient	<input type="checkbox"/>
		None of the above	<input type="checkbox"/>
32	When is the patch test reading done?	20 minutes	<input type="checkbox"/>
		48 h (Day 2)	<input type="checkbox"/>
		96 h (Day 4)	<input type="checkbox"/>
		Day 7 if Day 2,4 negative	<input type="checkbox"/>
33	Is photo patch testing done?	Yes	<input type="checkbox"/>
		No	<input type="checkbox"/>
34	What drugs have you used for patch testing?	Antibiotics (betalactams)	<input type="checkbox"/>
		Antibiotics (non-beta lactams)	<input type="checkbox"/>
		Anti-epileptics	<input type="checkbox"/>
		Anti-tuberculous drugs	<input type="checkbox"/>
		Aciclovir, valaciclovir	<input type="checkbox"/>
		Corticosteroids	<input type="checkbox"/>
		NSAIDs & selective COX-2 inhibitors	<input type="checkbox"/>
		Cotrimoxazole	<input type="checkbox"/>
		Diltiazem	<input type="checkbox"/>
		Hydroxyzine	<input type="checkbox"/>
		Heparin derivatives	<input type="checkbox"/>
		Pseudoephedrine	<input type="checkbox"/>
		Radiocontrast media	<input type="checkbox"/>
Tetrazepam	<input type="checkbox"/>		
Others - specify:	<input type="checkbox"/>		
35	For what types of delayed reactions have you used patch testing to help in diagnosis?	Acute generalized exanthematous pustolosis (AGEP)	<input type="checkbox"/>
		Blood dyscracias (cytopaenias)	<input type="checkbox"/>
		Drug induced hypersensitivity syndrome (DIHS)	<input type="checkbox"/>
		Fixed drug eruption (FDE)	<input type="checkbox"/>
		Hepatitis	<input type="checkbox"/>
		Immunobullous eruptions	<input type="checkbox"/>
		Interstitial nephritis	<input type="checkbox"/>
		Maculopapular exanthems (MPE)	<input type="checkbox"/>
		Stevens Johnson syndrome	<input type="checkbox"/>
		Toxic epidermal necrolysis	<input type="checkbox"/>
		Vasculitis	<input type="checkbox"/>
		Others – specify:	<input type="checkbox"/>

(F) DRUG PROVOCATION TESTS

36	What are the main indications for drug provocation tests in your centre/country ?	
	Exclude hypersensitivity (non-suggestive history/non-specific symptoms)	<input type="checkbox"/>
	Provide safe pharmacologically/structurally non-related drugs in proven hypersensitivity (e.g. betalactams)	<input type="checkbox"/>
	Exclude cross-reactivity of related drugs in proven hypersensitivity (e.g. cephalosporin in a penicillin allergic)	<input type="checkbox"/>
	Definitive diagnosis in suggestive history with negative, non-conclusive or non- available allergological tests	<input type="checkbox"/>
	Others - specify:	<input type="checkbox"/>
37	Who prepares the drug used for challenge?	
	Pharmacist	<input type="checkbox"/>
	Nurse clinician	<input type="checkbox"/>
	Doctor	<input type="checkbox"/>
	Others – specify:	<input type="checkbox"/>
38	What are the types of challenges used?	
	Open challenge	<input type="checkbox"/>
	Single blind placebo control	<input type="checkbox"/>
	Double blind placebo control	<input type="checkbox"/>
	Others - specify	<input type="checkbox"/>
39	What are the common routes of administration used?	
	Oral (tablet)	<input type="checkbox"/>
	Oral (capsule)	<input type="checkbox"/>
	Oral (syrup)	<input type="checkbox"/>
	Intramuscular	<input type="checkbox"/>
	Subcutaneous	<input type="checkbox"/>
	Intravenous	<input type="checkbox"/>

(G) OTHER COMMENTS