

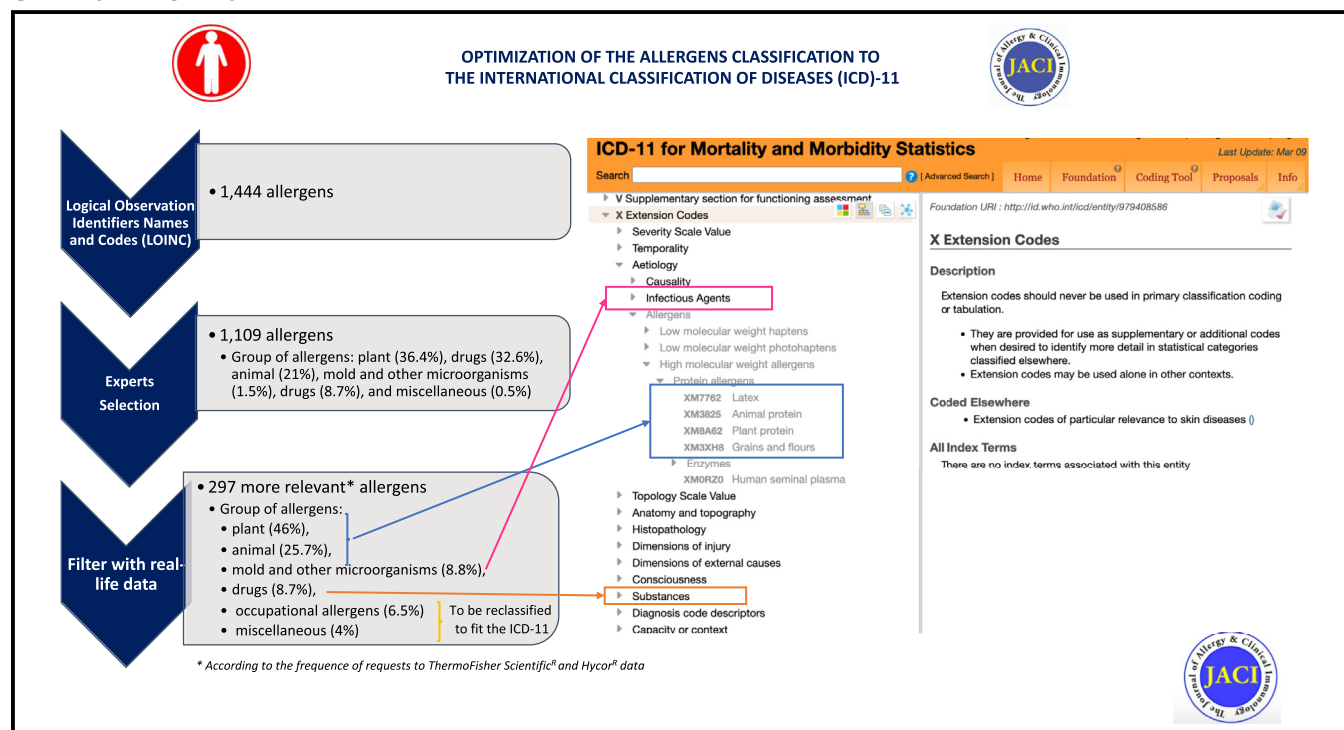
Optimization of the allergen classification of the International Classification Of Diseases, 11th Revision (ICD-11)



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GRAPHICAL ABSTRACT



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Background: Accurate diagnosis of triggers or causative allergens is essential for appropriate risk assessment, providing correct advice to patients with allergy and their caregivers and personalized treatment. However, allergens have never been represented in the World Health Organization *International Classification of Diseases* (ICD).

Objective: In this article, we present the process of selection of allergens to better fit the ICD, 11th Revision (ICD-11) structure and the outcomes of this process.

Methods: The Logical Observation Identifiers Names and Codes database, containing 1444 allergens, was used as the basis for the selection process. Two independent experts were responsible for the first selection of the allergens according to specific technical criteria. The second step of the selection process was based on real-life relevance of the allergens according to the frequency of requests regarding each of them.

Results: We selected 1109 allergens (76.8%) from all 1444 present in the Logical Observation Identifiers Names and Codes database, with considerable agreement between experts (Cohen $\kappa = 8.6$). After assessment of real-life data, 297 additional relevant allergens worldwide were selected and grouped as plants (36.4%), drugs (32.6%), animal proteins (21%), mold and other microorganisms (1.5%), occupational allergens (0.4%), and miscellaneous allergens (0.5%).

Conclusion: The stepwise approach allowed us to select the most relevant allergens in practice, which is the first step to building a classification of allergens for the WHO ICD-11. Aligned with the achievement in the construction of the pioneer section addressed to the allergic and hypersensitivity conditions in the ICD-11, the introduction of a classification for allergens can be considered timely and much needed in clinical practice. (J Allergy Clin Immunol 2023;151:1655-9.)

Key words: Allergy, allergens, classification, coding, epidemiology, hypersensitivity, International Classification of Diseases, World Health Organization

CURRENT STATUS OF CLASSIFICATION OF ALLERGENS IN THE ICD

The need for a classification of allergens in the ICD-11

Allergic and hypersensitivity conditions are common, and their prevalence and complexity are increasing worldwide. Accurate diagnosis of triggers or causative allergens is essential to assess risk appropriately, providing correct advice to patients with allergy and their caregivers and to tailor personalized treatment.

Progress in the field of identifying potential causes of allergies started in 1869 with demonstration of the fact that pollen could be the apparent trigger of hay fever,¹ and it continued throughout the 1900s with the establishment of allergen immunotherapy using whole allergen extracts as a treatment in routine practice by the 1970,² when only a few allergens had been characterized. During the past several years, many allergens that cause allergic and hypersensitivity conditions in humans have been isolated through a wide variety of sources and methodologies.³ The result has enhanced allergy diagnosis with the implementation of molecular allergy, including utilization of recombinant allergens. This process has helped in better understanding and management of

Abbreviations used

ICD: *International Classification of Diseases*

ICD-10: *International Classification of Diseases, 10th Revision*

ICD-11: *International Classification of Diseases, 11th Revision*

LOINC: Logical Observation Identifiers Names and Codes

WHO: World Health Organization

WHO CC: WHO Collaborating Centre

allergic diseases, including basic and clinical research, allergen product standardization, allergy diagnosis, and development of novel therapeutic approaches.⁴

Consistent efforts have been made by the World Health Organization (WHO) and the International Union of Immunological Societies to harmonize nomenclature of allergens,^{4,5} but systematic data collection and dissemination of statistics on diagnosis-based morbidity does not exist. The lack of accurate information related to allergens has a negative impact on public health policy development and investments such as public reimbursement for specific treatments, adrenaline autoinjectors, and relevant environmental changes. This limitation is due in part to the lack of representation of allergens in international classifications, such as the *International Classification of Diseases* (ICD). Currently, most countries have been using the ICD, 10th Revision (ICD-10) (or adaptations) for morbidity and mortality statistics. Although the ICD is generally reviewed by the WHO periodically, allergens have never been represented in this international system.

An example of negative outcome owing to the lack of allergen representativeness

Peanut allergy is a prevalent and persistent food allergy,^{6,7} and it has been reported as being the main cause of severe and fatal anaphylaxis in children.⁸ However, most of the current data are based on reports and specialty registries. Peanut and the majority of allergens have never been represented in the ICD,⁹ leading to lack of morbidity and mortality statistics, which prevents establishment of preventive policies and reimbursement of specific treatments such as peanut immunotherapy. Because allergens have never been well represented in the ICD framework, there is a lack of accurate and comparable epidemiologic data in official health statistics, which prevents appropriate investments and care of patients experiencing allergies.

The ICD-11: Current status

Under development since 2007, the ICD-11 is intended not only to rectify deficiencies in ICD-10 and to incorporate changes driven by scientific information advances but also to take advantage of the revolution in electronic data handling since publication of the ICD-10 a quarter of a century ago.¹⁰ The ICD-11 is regarded as a suite of classifications that is based on a detailed and comprehensive polyhierarchical web-like “foundation,” in which any single disease entity may be represented in multiple locations.^{10,11} The ICD-11 enables diagnoses to be linked to a range of parameters by the addition of 1 or more “extensions” classified under the Extension Codes chapter of the ICD-11 in a process termed *postcoordination*. The WHO has been promoting this classification strategy in which a stem entity

(eg, anaphylaxis) can be more fully defined by linking it to a range of different value sets, including severity, anatomic location, and causal agent. The ICD-11 was released in June 2018 and presented and approved by the World Health Assembly in May 2019.¹² Although under global implementation, the online framework accepts inputs after validation by the World Health Organization–Family of International Classifications network.

Active since 2012, the ALLERGY in ICD initiative, led by 2 of the authors of this article (L.K.T. and P.D.), succeeded in construction of the pioneer section Allergic and Hypersensitivity Conditions in the ICD-11^{13–18} and changes in the WHO mortality coding rules by including these conditions as possible underlying causes of death in official death certificates.^{16,18} Currently, the Montpellier WHO Collaborating Centre (WHO CC) for Classification Scientific Support¹⁹ (directed by L.K.T. and P.D.) is working together with the French WHO CCs,¹⁹ represented by the Digital Health Science (Agence Numérique en Santé) in preparation of the allergen classification to be proposed to the ICD-11.

In this article, we present the process of selection of allergens to better fit the ICD-11 structure and the outcomes of this process. We also demonstrate how the group of allergens will be mapped in the ICD framework.

METHODS

Optimization of allergen classification to the ICD-11

Terminology. Because the ICD is a realistic global, cross-cultural, multiaxial classification system to be used widely by allergists, nonallergists, and nonphysicians, an allergen has been defined as any substance (antigen), eaten, inhaled, or exposed to the skin, that is recognized by the immune system and causes an allergic reaction, such as rhinitis, asthma, food and drug hypersensitivity, skin reactions, and anaphylaxis. For this purpose, terminology and semantics were based on sources (and not on molecules). However, if the ICD-11 WHO governance extends the proposed classification of allergens to molecular allergens, a mapping will be developed to align with the WHO/International Union of Immunological Societies platform at a later time.

Allergen selection process. The Logical Observation Identifiers Names and Codes (LOINC) database,²⁰ containing 1444 allergens categorized by taxonomy and containing 136 recombinants, was used as the basis for the selection process. The LOINC was established in 1999 to facilitate discussions regarding the public use code system for exchanging laboratory and clinical observations between computer systems; it comprises more than 100,000 registered users worldwide. The LOINC database was chosen because it applies universal code names and identifiers to medical terminology related to electronic health records.

In the first step of the process, 2 independent experts were responsible for selection of the allergens according to (1) relevance in clinical practice, (2) prevalence, (3) need for simplification for nonallergists, and (4) number of the terms needed to fit the ICD-11 framework (letters and numbers). At this stage, it has been agreed that the selection should be as exhaustive as possible to avoid losing relevant allergens and that recombinants would be proposed as inclusions according to their clinical relevance. The 2 professionals were selected because of their expertise in allergy and classification and coding, as well as because they did not have any conflict of interest related to the purpose of this selection.

The second step of the selection process was based on real-life relevance of allergens; it involved using the list of frequency of allergens requested of a supplier of scientific instrumentation, reagents, and consumables, as well as software services (ThermoFisher Scientific).²¹ In this step, only the frequency of requests was considered, regardless of the results of tests. To avoid selection bias, a further step entailing using the frequencies of allergens for which requests were submitted to another supplier, Hycor, was applied.²² At this stage, rather than considering the ranking of allergens by request frequency, we used

the presence or absence of a given allergen in the report (ie, whether the allergen was on the list) (Fig 1).

RESULTS

Outcomes of the selection process

As a result of the first step of the process, we selected 1109 allergens (76.8%) from all 1444 present in the LOINC database, with considerable agreement between the 2 experts (Cohen $\kappa = 8.6$). In all cases of disagreement, the decisions were made by open discussion. Most of categories excluded were mixed allergens (eg, Food Allergen Mix 13 [carrot + white bean + peas + potato]), which is not meaningful for an international classification. At this stage, 511 allergens (46.0%) were categorized as plant allergens, 285 (25.7%) were categorized as animal allergens, 98 (8.8%) as mold and other microorganisms, 97 (8.7%) as drugs, 73 (6.5%) as occupational allergens, and 45 (4.0%) as miscellaneous allergens (a category for substances that can fit >1 of the previous categories [eg, wheat dust]).

After reviewing the full list of allergens and their frequencies according to ThermoFisher Scientific, we were able to add the 297 most relevant allergens worldwide (see Table E1 in the Online Repository at www.jacionline.org). These allergens are grouped as 108 plants (36.4%), 97 drugs (32.6%), 62 animal substances (21.0%), 17 molds and other microorganisms (1.5%), 5 occupational allergens (0.4%), and 6 miscellaneous allergens (0.5%). We were able to confirm these results by the Hycor list of allergen requests (Fig 1).

Contact allergens (low-molecular-weight haptens and photo-haptens) have been previously implemented in the ICD-11 mortality and morbidity statistics platform in collaboration with the WHO dermatology experts and were not covered in this project.

DISCUSSION

Although the new section of allergic and hypersensitivity conditions in the ICD-11 has been implemented,^{14,15} after previous validation by leadership of multiple allergy specialty organizations and the WHO ICD experts, the construction of a classification for allergens has appeared to be essential to allow more accurate data related to these conditions. Following international specialty validation of the new section of allergic and hypersensitivity conditions in the ICD-11, it became apparent that a more precise classification of allergens is needed to improve accuracy of the data. This is the first attempt to build up a classification of allergens for the WHO ICD-11. The procedures used allowed us to have a selection based on the clinical practice of the allergy community worldwide and to better fit the ICD-11 framework. Moreover, integrating the LOINC as part of the background for development of the Allergens section within the extension chapter establishes a natural cross talk between the ICD-11 and LOINC terminology. This connection should facilitate integrated use of these 2 complementary terminologies.

Fitting the allergens classification to the ICD-11

For the first time, the entity “allergen” has been implemented in the ICD²³ as a subheading of the section Etiology of the Extension Codes chapter. The prior Allergen section is distributed in 3

OPTIMIZATION OF THE ALLERGENS CLASSIFICATION TO THE INTERNATIONAL CLASSIFICATION OF DISEASES (ICD)-11

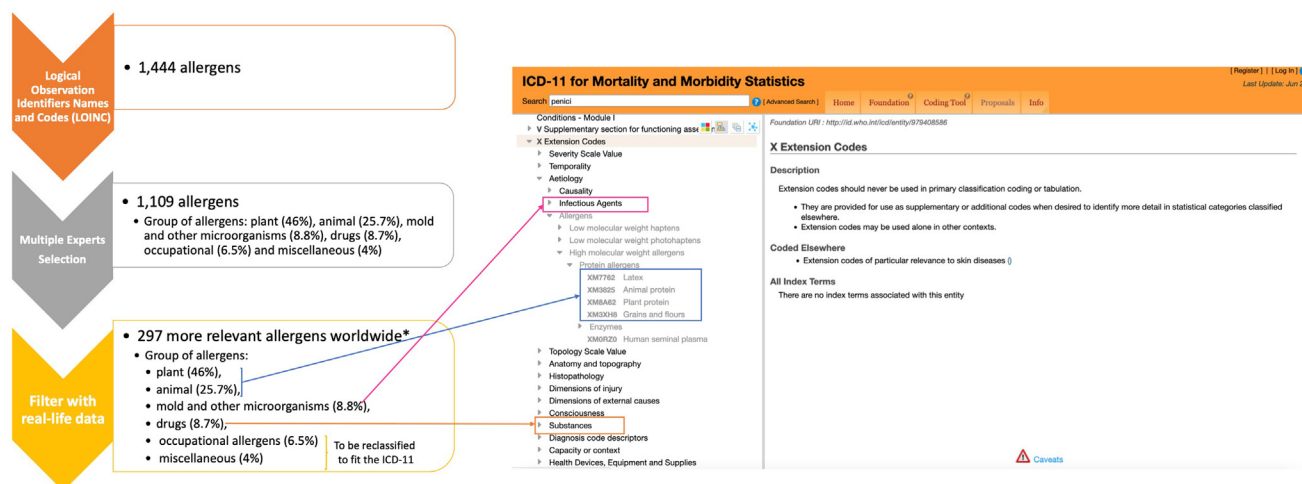


FIG 1. Generic schematic of the selection process for the allergen classification and tentative mapping in the ICD-11.

main categories: low-molecular-weight haptens, low-molecular-weight photohaptens, and high-molecular-weight allergens. Most of the allergens selected will be proposed as being part of the last category. Because infectious agents, including molds and other microorganisms and drugs, are already well classified in the ICD-11 framework, no additions to these allergen groups will be proposed. As forthcoming steps of this initiative, we will further proceed with the mapping between this list and the ICD-11 framework and proceed with the proposal submissions of allergens grouped as plant, animal, occupational, and miscellaneous (Fig 1). Once implemented as extension codes, all of the terms will be able to be linked to provide more detail to each allergic and hypersensitivity condition.

Critical view of the optimization process

The online version of the ICD-11²³ permits inputs according to proven needs. Presently, major changes in the framework of the ICD-11 are unlikely to be accepted. However, the allergens' classification will cover an open, remaining gap of the ICD-11, and the work is acknowledged by the WHO ICD governance. Although this work presents technical aspects of classification and coding, by publishing it we intend to introduce and simplify the complex concepts with the aim of making them more familiar to the allergic community of ICD end users.

The outcomes of this selection process are intended to represent the most frequent allergens worldwide, but we are aware that geographic variations can have an effect on these rates. This is why a validation will be performed.

The present results are crucial for the possibility of constructing the new section for allergens in the ICD-11. Although we are aware that additional work is required to have this allergen classification implemented and validated in the ICD-11, our efforts to have allergic and hypersensitivity conditions updated and well classified in the ICD-11 will have an important impact on the visibility of our specialty.

Conclusion: Forthcoming steps for classification of allergens

This project is the collaboration of 2 French WHO CCs to propose enhancements to the ICD-11. The construction of the classification for allergens for the ICD-11 has a stepwise approach. Because the more relevant allergens have been selected, 2 main projects will follow: (1) implementation of minor allergens and recombinants, probably as inclusions, and (2) preparation of the content of proposals for each allergen to fit the WHO ICD-11 work plan on implementation and carry the online submissions. Each proposal has to follow the WHO ICD content model (Table 1) to be acceptable for internal revision by the World Health Organization-Family of International Classifications network. Because the classification is not a single list of allergens, hierarchic construction is required. The ICD-11 follows a multi-hierarchic framework, and single changes can have considerable impact on the clinical applicability, mortality and morbidity statistics, and reimbursement. Therefore, all of the proposals will have to fit well with clinical use and technical and epidemiologic purposes.

The classification of allergens should be a standard for scientific comparability and for facilitating communication among all those who are interested in allergy. The classification of allergens should undergo validation by coding experts and end users through a Delphi or crowdsourcing technique with the mission of producing an international classification for global use that is up to the contemporary challenges of its suitability for use in electronic health records.

The construction and introduction of an ICD-11 allergen classification for allergic and hypersensitivity conditions is timely and needed for health data sharing. More accurate, comprehensive, and comparable epidemiologic data will provide a much better global picture of causes of these conditions and will support improvements to the management of allergic disorders worldwide.

TABLE I. The ICD-11 content model

1. Content title 1.1 Fully specific name	8. Temporal properties 8.1 Age of occurrence and occurrence frequency 8.2 Development course/stage
2. Classification properties 2.1 Parent 2.2 Type 2.3 Use and linearization	9. Severity of subtype properties
3. Textual definition(s)	10. Functioning properties 10.1 Impact on activities 10.2 Contextual factors 10.3 Body function
4. Terms 4.1 Base index terms 4.2 Inclusion terms 4.3 Exclusion terms	11. Specific conditions properties 11.1 Biologic sex 11.2 Life cycle properties
5. Body structure description 5.1 Body system 5.2 Body part(s) 5.3 Histopathology	12. Treatment properties
6. Manifestation properties 6.1 Signs and symptoms 6.2 Investigation findings	13. Diagnostic criteria
7. Causal properties 7.1 Etiology type 7.2 Causal properties Agents 7.3 Causal properties – mechanisms 7.4 Genomic linkage/Risk factors	14. External causes

Any category in the ICD is represented by title of entity: Name of disease, disorder, or syndrome.

We would very much like to thank the medical-scientific boards of ThermoFisher Scientific and Hycor for data sharing, which allowed us to have real-life data regarding the request of allergens worldwide.

Clinical implication: The process of selection of the most relevant allergens in practice, which is the first step in building a classification of allergens for the ICD-11, has been presented.

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TABLE E1. List of selected allergens for the ICD-11

Allergen name	Allergen display name
Fish	Fish
<i>Gadus morhua</i>	Codfish (<i>Gadus morhua</i>)
<i>Cancer pagurus</i>	Crab (<i>Cancer pagurus</i>)
<i>Homarus gammarus</i>	Lobster (<i>Homarus gammarus</i>)
<i>Salmo salar</i>	Salmon (<i>Salmo salar</i>)
<i>Pandalus borealis</i>	Shrimp (<i>Pandalus borealis</i>)
<i>Thunnus albacares</i>	Tuna (<i>Thunnus albacares</i>)
Chicken	Chicken
Chicken feather	Chicken feather
Cockatiel droppings	Cockatiel droppings
Cockatiel feather	Cockatiel feather
Cockatiel serum	Cockatiel serum
Egg white	Egg white
Egg, whole	Whole egg
Egg yolk	Egg yolk
Goose feather	Goose feather
<i>Periplaneta americana</i>	American cockroach (<i>Periplaneta americana</i>)
<i>Blomia tropicalis</i>	<i>Blomia tropicalis</i>
<i>Blatella germanica</i>	Cockroach (<i>Blatella germanica</i>)
<i>Dermatophagoides farinae</i>	American house dust mite (<i>Dermatophagoides farinae</i>)
<i>Dermatophagoides pteronyssinus</i>	<i>Dermatophagoides pteronyssinus</i>
<i>Solenopsis geminata</i>	Fire ant
<i>Apis mellifera</i>	Honey bee (<i>Apis mellifera</i>)
Hornet venom	Hornet venom
Mite dust	Mite dust
<i>Aedes communis</i>	Mosquito (<i>Aedes communis</i>)
<i>Culex pipiens</i>	Mosquito (<i>Culex pipiens</i>)
Moth	Moth
<i>Polistes</i> spp	Paper wasp (<i>Polistes</i> spp)
Wasp venom	Wasp venom
<i>Dolichovespula arenaria</i>	Yellow hornet (<i>Dolichovespula arenaria</i>)
<i>Vespula</i> spp	Yellow jacket (<i>Vespula</i> spp)
Cat dander	Cat dander
Cochineal extract	Cochineal extract
Beef	Beef
Cow dander	Cow dander
Dog dander	Dog dander
Dog epithelium	Dog epithelium
Hamster epithelium	Hamster epithelium
Horse dander	Horse dander
Cheese, cheddar-type	Cheese, cheddar-type
Cow's milk	Cow's milk
Milk	Milk
Mouse epithelium	Mouse epithelium
Mouse urine proteins	Mouse urine proteins
Rabbit epithelium	Rabbit epithelium
Pork	Pork
<i>Mytilus edulis</i>	Blue mussel (<i>Mytilus edulis</i>)
<i>Ostrea edulis</i>	Oyster (<i>Ostrea edulis</i>)
<i>Pecten</i> spp	Scallop (<i>Pecten</i> spp)
Amoxicillin	Amoxicillin
Ampicillin	Ampicillin
Benzylpenicilloyl-polylysine	Benzylpenicilloyl-polylysine
Penicillin G	Penicillin G
Penicillin V	Penicillin V
House dust	House dust
Wheat dust	Wheat dust
<i>Alternaria alternata</i>	<i>Alternaria alternata</i>
<i>Anisakis</i>	<i>Anisakis</i>

(Continued)

TABLE E1. (Continued)

Allergen name	Allergen display name
<i>Aspergillus fumigatus</i>	<i>Aspergillus fumigatus</i>
<i>Aspergillus niger</i>	<i>Aspergillus niger</i>
<i>Candida albicans</i>	<i>Candida albicans</i>
<i>Candida</i> sp	<i>Candida</i> sp
<i>Cladosporium herbarum</i>	<i>Cladosporium herbarum</i>
<i>Epicoccum purpurascens</i>	<i>Epicoccum purpurascens</i>
<i>Fusarium</i> sp	<i>Fusarium</i> sp
<i>Malassezia</i> sp	<i>Malassezia</i> sp
<i>Mucor racemosus</i>	<i>Mucor racemosus</i>
<i>Penicillium notatum</i>	<i>Penicillium notatum</i>
<i>Penicillium</i> sp	<i>Penicillium</i> sp
<i>Phoma</i> sp	<i>Phoma</i> sp
<i>Stemphylium botryosum</i>	<i>Stemphylium botryosum</i>
<i>Fagus grandifolia</i> wood dust	American beech (<i>Fagus grandifolia</i>) wood dust
<i>Fraxinus excelsior</i> wood dust	European ash (<i>Fraxinus excelsior</i>) wood dust
Latex	Latex
Oak wood dust	Oak wood dust
<i>Malus sylvestris</i>	Apple (<i>Malus sylvestris</i>)
<i>Musa</i> spp	Banana (<i>Musa</i> spp)
<i>Vitis vinifera</i>	Grape (<i>Vitis vinifera</i>)
<i>Actinidia chinensis</i>	Kiwifruit (<i>Actinidia chinensis</i>)
<i>Mangifera indica</i>	Mango (<i>Mangifera indica</i>)
<i>Cucumis melo</i> spp	Melon (<i>Cucumis melo</i> spp)
<i>Olea europaea</i>	Olive
Olive	Olive
<i>Citrus sinensis</i>	Orange (<i>Citrus sinensis</i>)
<i>Prunus persica</i>	Peach (<i>Prunus persica</i>)
<i>Pyrus communis</i>	Pear (<i>Pyrus communis</i>)
<i>Ananas comosus</i>	Pineapple (<i>Ananas comosus</i>)
<i>Fragaria vesca</i>	Strawberry (<i>Fragaria vesca</i>)
<i>Paspalum notatum</i>	Bahia grass (<i>Paspalum notatum</i>)
<i>Hordeum vulgare</i>	Barley (<i>Hordeum vulgare</i>)
<i>Cynodon dactylon</i>	Bermuda grass (<i>Cynodon dactylon</i>)
<i>Fagopyrum esculentum</i>	Buckwheat (<i>Fagopyrum esculentum</i>)
<i>Zea mays</i>	Corn (<i>Zea mays</i>)
Gluten	Gluten
<i>Humulus japonicus</i>	Japanese hop (<i>Humulus japonicus</i>)
<i>Sorghum halepense</i>	Johnson grass (<i>Sorghum halepense</i>)
<i>Poa pratensis</i>	Kentucky blue grass (<i>Poa pratensis</i>)
<i>Avena sativa</i>	Oat (<i>Avena sativa</i>)
<i>Lolium perenne</i>	Perennial rye grass (<i>Lolium perenne</i>)
<i>Oryza sativa</i>	Rice (<i>Oryza sativa</i>)
<i>Secale cereale</i>	Rye (<i>Secale cereale</i>)
<i>Secale cereale</i> pollen	Cultivated rye (<i>Secale cereale</i> pollen)
<i>Distichlis spicata</i>	Salt grass (<i>Distichlis spicata</i>)
<i>Anthoxanthum odoratum</i>	Sweet Vernal grass (<i>Anthoxanthum odoratum</i>)
<i>Phleum pratense</i>	Timothy (<i>Phleum pratense</i>)
<i>Persea americana</i>	Avocado (<i>Persea americana</i>)
<i>Saccharomyces cerevisiae</i>	Baker's yeast (<i>Saccharomyces cerevisiae</i>)
<i>Daucus carota</i>	Carrot (<i>Daucus carota</i>)
<i>Apium graveolens</i>	Celery (<i>Apium graveolens</i>)
<i>Dactylis glomerata</i>	Cocksfoot (<i>Dactylis glomerata</i>)
<i>Theobroma cacao</i>	Cocoa (<i>Theobroma cacao</i>)
Pigweed common	Common pigweed
<i>Ambrosia elatior</i>	Common ragweed (<i>Ambrosia elatior</i>)
<i>Plantago lanceolata</i>	English plantain (<i>Plantago lanceolata</i>)
<i>Allium sativum</i>	Garlic (<i>Allium sativum</i>)

(Continued)

TABLE E1. (Continued)

Allergen name	Allergen display name
<i>Ambrosia trifida</i>	Giant Ragweed (<i>Ambrosia trifida</i>)
<i>Chenopodium album</i>	Goosefoot (<i>Chenopodium album</i>)
<i>Lens esculenta</i>	Lentils (<i>Lens esculenta</i>)
<i>Lactuca sativa</i>	Lettuce (<i>Lactuca sativa</i>)
<i>Artemisia vulgaris</i>	Mugwort (<i>Artemisia vulgaris</i>)
Mustard	Mustard
<i>Urtica dioica</i>	Nettle (<i>Urtica dioica</i>)
<i>Allium cepa</i>	Onion (<i>Allium cepa</i>)
<i>Pisum sativum</i>	Pea (<i>Pisum sativum</i>)
<i>Solanum tuberosum</i>	Potato (<i>Solanum tuberosum</i>)
Pigweed rough	Rough pigweed
<i>Rumex acetosella</i>	Sheep sorrel (<i>Rumex acetosella</i>)
<i>Glycine max</i>	Soybean (<i>Glycine max</i>)
<i>Lycopersicon lycopersicum</i>	Tomato (<i>Lycopersicon lycopersicum</i>)
Wall pellitory	Wall pellitory
<i>Ambrosia psilostachya</i>	Western ragweed (<i>Ambrosia psilostachya</i>)
Bean, white	White bean
<i>Artemisia absinthium</i>	Wormwood (<i>Artemisia absinthium</i>)
<i>Prunus dulcis</i>	Almond (<i>Prunus dulcis</i>)
<i>Fagus grandifolia</i>	American beech (<i>Fagus grandifolia</i>)
<i>Cupressus arizonica</i>	Arizona cypress (<i>Cupressus arizonica</i>)
<i>Bertholletia excelsa</i>	Brazil nut (<i>Bertholletia excelsa</i>)
<i>Anacardium occidentale</i>	Cashew nut (<i>Anacardium occidentale</i>)
<i>Ulmus crassifolia</i>	Cedar elm (<i>Ulmus crassifolia</i>)
<i>Acer macrophyllum</i>	Coastal maple (<i>Acer macrophyllum</i>)
<i>Cocos nucifera</i>	Coconut (<i>Cocos nucifera</i>)
<i>Populus deltoides</i>	Cottonwood (<i>Populus deltoides</i>)
<i>Juglans regia</i> pollen	English walnut pollen (<i>Juglans regia</i> pollen)
<i>Alnus incana</i>	Grey alder (<i>Alnus incana</i>)
<i>Corylus avellana</i>	Hazelnut (<i>Corylus avellana</i>)
<i>Cupressus sempervirens</i>	Italian cypress (<i>Cupressus sempervirens</i>)
<i>Cryptomeria japonica</i>	Japanese cedar (<i>Cryptomeria japonica</i>)
<i>Chamaecyparis obtusa</i>	Japanese cypress
<i>Macadamia</i> spp	Macadamia (<i>Macadamia</i> spp)
<i>Prosopis juliflora</i>	Mesquite (<i>Prosopis juliflora</i>)
<i>Juniperus sabinoideis</i>	Mountain juniper (<i>Juniperus sabinoideis</i>)
<i>Broussonetia papyrifera</i>	Paper mulberry (<i>Broussonetia papyrifera</i>)
<i>Arachis hypogaea</i>	Peanut (<i>Arachis hypogaea</i>)
<i>Carya illinoensis</i> nut	Pecan or hickory nut (<i>Carya illinoensis</i> nut)
<i>Carya illinoensis</i> tree	Pecan or hickory tree (<i>Carya illinoensis</i> tree)
<i>Pinus edulis</i>	Pine nut (<i>Pinus edulis</i>)
<i>Pistacia vera</i>	Pistachio (<i>Pistacia vera</i>)
<i>Acer rubrum</i>	Red maple (<i>Acer rubrum</i>)
<i>Morus rubra</i>	Red mulberry (<i>Morus rubra</i>)
<i>Sesamum indicum</i>	Sesame seed (<i>Sesamum indicum</i>)
<i>Betula verrucosa</i>	Silver birch (<i>Betula verrucosa</i>)
<i>Juglans</i> spp	Walnut (<i>Juglans</i> spp)
<i>Acacia longifolia</i>	Wattle (<i>Acacia longifolia</i>)
<i>Pinus monticola</i>	Western white pine (<i>Pinus monticola</i>)
<i>Fraxinus americana</i>	White ash (<i>Fraxinus americana</i>)
<i>Betula populifolia</i>	White birch (<i>Betula populifolia</i>)
<i>Carya tomentosa</i>	White hickory (<i>Carya tomentosa</i>)
<i>Morus alba</i>	White mulberry (<i>Morus alba</i>)
<i>Salix caprea</i>	Willow (<i>Salix caprea</i>)

(Continued)

TABLE E1. (Continued)

Allergen name	Allergen display name
<i>Agrostis stolonifera</i>	Red top grass (<i>Agrostis stolonifera</i>)
<i>Todarodes pacificus</i>	Pacific squid (<i>Todarodes pacificus</i>)
Guinea pig epithelium	Guinea pig epithelium
Cheese, mold-type	Cheese, mold-type
Cefaclor	Cefaclor
<i>Octopus vulgaris</i>	Octopus (<i>Octopus vulgaris</i>)
<i>Citrus limon</i>	Lemon (<i>Citrus limon</i>)
<i>Dolichovespula maculata</i>	Whitefaced hornet (<i>Dolichovespula maculata</i>)
<i>Helianthus annuus</i> seed	Sunflower (<i>Helianthus annuus</i>) seed
<i>Cicer arietinus</i>	Chick pea (<i>Cicer arietinus</i>)
<i>Oncorhynchus mykiss</i>	Trout (<i>Oncorhynchus mykiss</i>)
Duck feather	Duck feather
<i>Liquidambar styraciflua</i>	Sweet gum (<i>Liquidambar styraciflua</i>)
<i>Curvularia lunata</i>	<i>Curvularia lunata</i>
<i>Eucalyptus</i> spp	Gum tree (<i>Eucalyptus</i> spp)
<i>Ascaris</i> sp	<i>Ascaris</i> sp
<i>Hippoglossus hippoglossus</i>	Halibut (<i>Hippoglossus hippoglossus</i>)
Firebush, Mexican	Mexican firebush
Goat's milk	Goat's milk
<i>Prunus avium</i>	Cherry (<i>Prunus avium</i>)
Sardine	Sardine
<i>Capsicum annuum</i>	Paprika (<i>Capsicum annuum</i>)
<i>Apis mellifera</i>	Honey bee (<i>Apis mellifera</i>)
<i>Brassica oleracea</i> var <i>capitata</i>	Cabbage (<i>Brassica oleracea</i> var <i>capitata</i>)
<i>Citrus paradisis</i>	Grapefruit (<i>Citrus paradisis</i>)
<i>Piper nigrum</i>	Black Pepper (<i>Piper nigrum</i>)
Bean green	Green bean
<i>Spinacia oleracea</i>	Spinach (<i>Spinacia oleracea</i>)
5-Aminosalicylate	5-Aminosalicylate
Acetaminophen	Acetaminophen
Acetylcysteine	Acetylcysteine
Acetylsalicylate	Acetylsalicylate
Alcuronium	Alcuronium
Ambroxol	Ambroxol
Ammonium persulfate	Ammonium persulfate
Articaine	Articaine
Atracurium	Atracurium
Atropine	Atropine
Azithromycin	Azithromycin
Benzocaine	Benzocaine
Gelatin, bovine	Bovine gelatin
Bromhexine	Bromhexine
Bupivacaine	Bupivacaine
Cefamandole	Cefamandole
Cefazolin	Cefazolin
Cefoxitin	Cefoxitin
Ceftriaxone	Ceftriaxone
Cefuroxime	Cefuroxime
Cephalexin	Cephalexin
Cephalosporin	Cephalosporin
Cephalosporin C	Cephalosporin C
Cetuximab	Cetuximab
Chlorhexidine	Chlorhexidine
Chymopapain	Chymopapain
Ciprofloxacin	Ciprofloxacin
Clarithromycin	Clarithromycin
Clavulanate	Clavulanate
Clindamycin	Clindamycin
<i>Clostridium tetani</i> toxoid	<i>Clostridium tetani</i> toxoid
Cloxacillin	Cloxacillin

(Continued)

TABLE E1. (Continued)

Allergen name	Allergen display name
Codeine	Codeine
Corticotropin	Corticotropin
Dexamethasone	Dexamethasone
Diatrizoate	Diatrizoate
Diclofenac	Diclofenac
Dipyrrone	Dipyrrone
Doxycycline	Doxycycline
Droperidol	Droperidol
Erythromycin	Erythromycin
Erythrosine B	Erythrosine B
Fosfomycin	Fosfomycin
Gelatin	Gelatin
Gentamicin	Gentamicin
Glutamate	Glutamate
Heparin	Heparin
Ibuprofen	Ibuprofen
Indomethacin	Indomethacin
Insulin, bovine	Insulin, bovine
Insulin, human	Insulin, human
Insulin, porcine	Insulin, porcine
Lactose	Lactose
Levothyroxine	Levothyroxine
Lidocaine	Lidocaine
Lysine acetylsalicylate	Lysine acetylsalicylate
Mefenamate	Mefenamate
Mepivacaine	Mepivacaine
Methylene blue	Methylene blue
Metronidazole	Metronidazole
Mivacurium	Mivacurium
Naproxen	Naproxen
Neomycin	Neomycin
Novocaine	Novocaine
Pancuronium	Pancuronium
Paraphenylenediamine	Paraphenylenediamine
Penicillamine	Penicillamine
Phenylbutazone	Phenylbutazone
Pholcodine	Pholcodine
Piroxicam	Piroxicam
Gelatin, porcine	Porcine gelatin
Propofol	Propofol
Propyphenazone	Propyphenazone
Protamine	Protamine
Pyrazole	Pyrazole
Rocuronium	Rocuronium
Sodium benzoate	Sodium benzoate
Spiramycin	Spiramycin
Succinylcholine	Succinylcholine
Sulfadiazine	Sulfadiazine
Sulfalazine	Sulfalazine
Sulfamedradoxole	Sulfamedradoxole
Sulfamethoxazole	Sulfamethoxazole
Sulfisoxazole	Sulfisoxazole
Sulphonamide	Sulphonamide
Tartrazine	Tartrazine
Tetracycline	Tetracycline
Thiopental	Thiopental
Tobramycin	Tobramycin
Trimethoprim	Trimethoprim
Vecuronium	Vecuronium