Check for updates



# Positivity rates of in vitro inhalant/respiratory and food allergy tests in the northern midwestern United States

Michael S. Benninger, MD; Thomas Daly, MD; Kevin Graffmiller, MD


## Abstract

*Rates of allergy-test positivity vary by country and by regions within countries. Several studies have looked at allergy test results to determine the most common allergens. Many of these studies have been based on surveys or on studies of small numbers of tests. Positivity rates for allergy tests are poorly defined in the northern midwestern region of the United States. We conducted a study to identify the rates of positive allergy tests for both inhalant/respiratory allergens and food allergens in the upper Midwest. We extracted from our laboratory database the results of all test samples sent for one of eight allergen panels that had been analyzed between Sept. 1, 2014, and Sept. 1, 2015. All testing was performed at The Cleveland Clinic with the Phadia ImmunoCAP system. The percentage of positive tests, the distribution of the most frequently positive tests, and the class of in vitro responses were identified. A total of 148,628 test results for 63 different allergens were identified. Of the 125,190 tests for inhalant/respiratory allergens, the most frequently positive were dog dander (24% of tests), cat dander (23%), dust mites (23% for both* Dermatophagoides pteronyssinus *and* Dermatophagoides farinae), *and June grass (21%). Of the 23,438 food tests, the most frequently positive test results were for milk (18%), peanut (17%), wheat (16%), and egg white (15%). Most of the results fell into classes 1 through 3, although there was still a notable number of very high responses (class 5 and 6). These findings suggest that there is wide variability in the positivity of in vitro allergy tests and that the likelihood of a positive result in screening panels can be estimated. Evaluating such rates will help identify the most and least common allergens and will help to cost-effectively refine allergy screening panels.*


From the Head and Neck Institute (Dr. Benninger and Dr. Graffmiller) and the Pathology and Laboratory Medicine Institute (Dr. Daly), The Cleveland Clinic, Cleveland, Ohio.

Corresponding author: Michael S. Benninger, MD, Head and Neck Institute, The Cleveland Clinic, 9500 Euclid Ave., A-71, Cleveland, OH 44139. Email: benninm@ccf.org

Previous presentation: The information in this article has been edited for publication and updated as necessary from its original form as a podium presentation at the 26th Congress of the European Rhinologic Society in conjunction with the 35th Congress of the International Society of Infection and Allergy in the Nose and the 17th Congress of the International Rhinologic Society; July 3-7, 2016; Stockholm.

## Introduction

Allergic disease is a highly prevalent condition with several clinical manifestations, including allergic rhinitis and sinusitis, allergic dermatologic disorders, allergic conjunctivitis, asthma, and food sensitivities. It is difficult to identify its true prevalence because diagnoses may not be confirmed, studies may be looking at only one of the allergic diseases, and many studies rely on survey responses. When looking at allergic rhinitis, for example, its reported prevalence ranges from 10 to 30% in adults and is as high as 40% in children.[1] There is also evidence that the prevalence of allergies may be increasing, particularly in Western countries.[2]

The diagnosis of allergic disease is based on a classic history with confirmation by allergy testing or response to treatment. Allergy testing can be performed either through skin testing or in vitro (blood) testing for specific IgE directed against potential allergens.[3] Recent clinical guidelines for the management of allergic rhinitis developed by the American Academy of Otolaryngology–Head and Neck Surgery state, "Clinicians should perform and interpret, or refer to a clinician who can perform and interpret, specific IgE (skin or blood) allergy testing for patients with a clinical diagnosis of AR who do not respond to empiric treatment, or when the diagnosis is uncertain, or when knowledge of the specific causative allergen is needed to target therapy."[3]

Allergy testing, be it skin or blood testing, can be expensive and is associated with some minor morbidity. Test positivity rates may vary depending on the level of suspicion of the ordering provider, the prevalence of a specific allergy in a given location, and the type of clinical practice. Individual allergens can be pursued on the basis of specific symptoms, or broad panels can be performed to screen for any allergen positivity.

In an attempt to refine a cost-effective allergy test panel, Bousquet et al looked at large numbers of skin allergy tests to identify which were highly positive and to determine the size of the panel that might be necessary to identify most of the positive allergens.[4] They tested approximately 3,000 patients and found that roughly two-thirds were sensitized to at least one allergen, and they identified eight allergens (grass pollen, *Dermatophagoides pteronyssinus,* birch pollen, cat dander, *Artemisia,* olive pollen, *Blatella,* and *Alternaria)* that allowed them to detect more than 95% of sensitized patients.

Their study overlapped several European countries, which suggested that there were some differences among them.[4] Despite the differences, only 13 allergens were needed to identify all sensitized patients.

Although there have been studies that evaluated the prevalence of food allergies,[5] not many have looked at positivity rates of allergy testing for foods. Moreover, there has been a lack of good studies looking at large numbers of in vitro allergy tests to identify the frequency of positive tests or differences among specific allergens.

We conducted this study to identify positive rates of in vitro allergy testing (both inhalant/respiratory and food) in a reference laboratory in the northern Midwest region of the United States.

## Patients and methods

We searched our automated database to identify the results of specimen testing for any of eight large allergen panels offered at The Cleveland Clinic. These included a mixture of results from patients seen at Cleveland Clinic sites throughout northeast Ohio, as well as results sent to us by reference laboratory clients who were primarily located in the upper Midwest (northern Ohio, northern Illinois, and southern Wisconsin).

**Table 1. Positivity rates for 48 inhalant/respiratory allergens**

| Allergen | Tests, n | Pos, n (%) | Allergen | Tests, n | Pos, n (%) |
|---|---|---|---|---|---|
| *Alternaria tenuis* | 5,508 | 884 (16) | Johnson grass | 1,188 | 155 (13) |
| Australian pine | 147 | 4 (3) | June grass | 2,580 | 543 (21) |
| Bahia grass | 147 | 21 (14) | Lamb's quarters | 2,570 | 240 (9) |
| Bermuda grass | 4,124 | 582 (14) | Marsh elder | 2,916 | 338 (12) |
| Birch tree | 1,632 | 195 (12) | Mountain juniper | 3,072 | 293 (10) |
| Box elder | 4,369 | 747 (17) | Mouse epithelium | 2,936 | 172 (6) |
| Cat dander | 5,516 | 1,285 (23) | *Mucor racemosus* | 3,081 | 124 (4) |
| *Cladosporium herbarum* | 5,511 | 387 (7) | Oak tree | 5,493 | 710 (13) |
| Cocklebur | 149 | 13 (9) | Orchard grass | 147 | 25 (17) |
| Cockroach | 4,123 | 461 (11) | *Penicillium notatum* | 4,372 | 244 (6) |
| Common ragweed | 5,488 | 944 (17) | Pigweed | 3,328 | 307 (9) |
| Cottonwood tree | 3,077 | 418 (14) | Rabbit epithelium | 147 | 5 (3) |
| *Dermatophagoides farinae* | 5,518 | 1,286 (23) | Redtop grass | 147 | 25 (17) |
| *Dermatophagoides pteronyssinus* | 4,126 | 932 (23) | Russian thistle | 2,918 | 344 (12) |
| Dog dander | 5,516 | 1,325 (24) | Sheep sorrel | 411 | 26 (6) |
| Elm tree | 4,103 | 539 (13) | Sweet vernal grass | 147 | 24 (16) |
| English plantain | 1,021 | 97 (10) | Sycamore tree | 3,343 | 368 (11) |
| *Epicoccum purpurascens* | 147 | 8 (5) | Timothy grass | 4,738 | 828 (17) |
| Feather mix | 147 | 2 (1) | Walnut tree | 4,117 | 581 (14) |
| Giant ragweed | 148 | 16 (11) | White ash tree | 3,076 | 510 (17) |
| Goldenrod | 149 | 7 (5) | White mulberry tree | 2,921 | 112 (4) |
| *Helminthosporium halodes* | 146 | 7 (5) | White pine | 147 | 2 (1) |
| Hickory/pecan tree | 4,116 | 449 (11) | Willow tree | 147 | 9 (6) |
| Horse dander | 147 | 10 (7) | | | |
| House dust (Hollister-Stier) | 1,026 | 299 (29) | | | |

**Product demonstrations daily**
AAO-HNSF booth #2833

# New Orion Rotary Chair for Micromedical VisualEyes™



Rotational testing is the **gold standard** for bilateral weaknesses identified in caloric and vHIT testing

## The future of balance is here!

Rotary Chair functionality and easy-to-use USB goggles with the most precise eye tracking available are two of the great features of the VisualEyes™software.

The comprehensive rotary chair test battery with customizable protocols includes Sinusoidal Harmonic Acceleration (SHA), Step Test, VOR Suppression and Visual VOR.

Micromedical VisualEyes™ 515/525 is an investment that will grow with your clinic, using a platform that can meet your changing needs into the future.

**Find out more at**
micromedical.com
interacoustics.com

**Micromedical**
by Interacoustics

Touch activated software

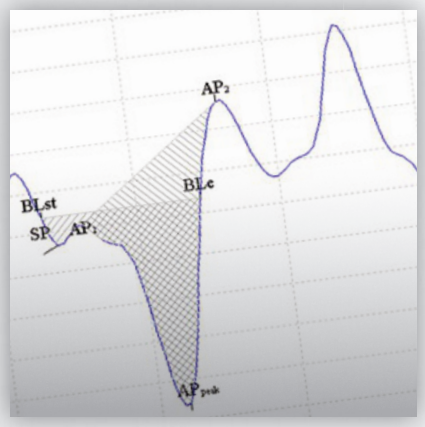


Interacoustics

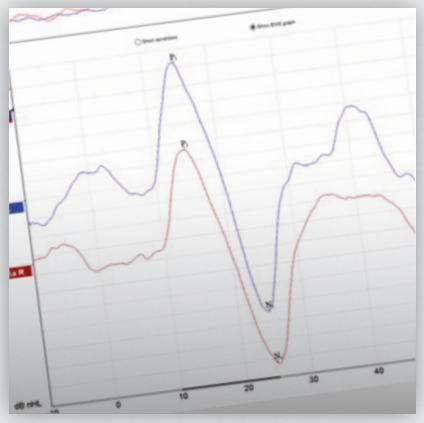
# Eclipse Vestibular Solution



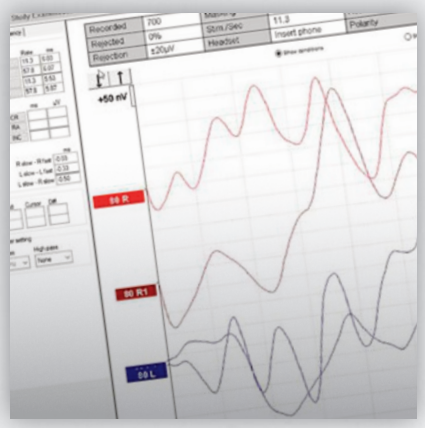
See us at AAO-HNSF booth #2833




*Unique ECochG Area Ratio Calculation implementation*



*VEMP recording with responses scaled according to muscle tonus during recording*



*Auditory evoked neurological recording*



*The VEMP monitor assists the patient in maintaining adequate muscle contraction during testing*



- **Vestibular Evoked Myogenic Potentials (cVEMP and oVEMP)**
- **Electrocochleography (ECochG)**
- **Neuro Rate Study**

## Ideal for:

- Neurological balance centers
- Rehab balance centers
- ENT practices

Interacoustics

**ABR/OAE** | **Balance Assessment** | Fitting Systems | Middle Ear Analyzers | Audiometers

**Interacoustics** is a world leading diagnostic solutions provider in the fields of hearing and balance assessment. Since 1967 we have designed and manufactured our innovative diagnostic solutions for the world of audiology with a constant focus on providing our customers with quality, dependable products.

Interacoustics USA 10393 West 70th Street Eden Prairie, MN 55344 T +1-800 947 6334 info@interacoustics-us.com

These samples had been analyzed between Sept. 1, 2014, and Sept. 1, 2015.

All specific IgE testing was performed at The Cleveland Clinic with the Phadia ImmunoCAP system (Thermo Fisher Scientific; Uppsala, Sweden) in accordance with manufacturer-specified protocols. The prevalence of each allergen was calculated as the number of positive results of any class (using a lower cutoff of 0.35 kU/L) divided by the total number of times an allergen was assayed across all panels.

Institutional Review Board approval for the study protocol was obtained, and no patient identifiers were included in the study.

**Table 2. Most common positive inhalant/respiratory allergens**

| Allergen | Tests, n | Positive, n (%) |
|---|---|---|
| Dog dander | 5,516 | 1,325 (24) |
| Cat dander | 5,516 | 1,285 (23) |
| Dust mites *(Dermatophagoides farinae)* | 5,518 | 1,286 (23) |
| June grass | 2,580 | 543 (21) |
| Common ragweed | 5,488 | 944 (17) |
| Timothy grass | 4,738 | 828 (17) |
| *Alternaria tenuis* | 5,508 | 884 (16) |
| Oak tree | 5,493 | 710 (13) |
| Cockroach | 4,123 | 461 (11) |

## Results

A total of 148,628 individual results for 63 different allergens were generated during the study period. A large majority were from respiratory/inhalant panels.

***Respiratory/inhalant allergies.*** The frequency of positive reactions to the inhalant allergens ranged as high as 29%; 30 antigens had positivity rates of at least 10% (table 1). The most commonly found inhalant antigens were dog dander (24%), cat dander (23%), dust mites (23%), and June grass (21%) (table 2).

***Food allergies.*** Two food panels yielded 23,438 individual tests for 14 allergens. The positivity rate for these allergens ranged as high as 18%, with 6 allergens that exceeded 10%. The most common positive allergen tests were for milk (18%), peanut (17%), wheat (16%), and egg white (15%) (table 3).

***Allergy class.*** The distribution of class results was similar across most antigens, with most falling into the class 1 to class 3 range (figure 1). However, a notable number of very high responses (class 5 and 6) were seen for most allergens. Dog dander, cat dander, dust mites, and peanut had the greatest class 4 and 5 responses (figure 2).

## Discussion

Identifying the prevalence of allergies is difficult because (1) allergic disorders are fairly common, (2) many patients self-treat and are therefore not identified in the healthcare system or literature, and (3) patients are often diagnosed with an allergy without confirmation by objective testing. In addition, particularly with allergic rhinitis, there is a notable overlap with allergic rhinitis and nonallergic rhinitis, and there is a growing number of reports indicating that there are patients who may have a local allergic response in the nose (local allergic rhinitis) who do not have positive results on either skin or in vitro testing.[6] Many of the prevalence studies have relied on surveys, again without objective confirmation.

Allergy testing is routinely performed to confirm a diagnosis, to detect specific allergies, to identify areas for prevention and avoidance, to direct pharmacotherapy, and to identify antigens for immunotherapy. Although there is debate about the effectiveness of skin testing vis-à-vis blood testing for identifying allergies, both are good screening methods, and they have been used interchangeably in guidelines.[3]

A few well-done prevalence studies have been performed. The National Health and Nutrition Examination Survey (NHANES) prospectively evaluated patients in the United States by skin testing to identify the prevalence of allergic disease and specific allergens. NHANES II[7] evaluated patients aged 6 to 74 years from 1976 through 1980, and NHANES III[8] looked at patients aged 6 to 59 from 1988 through 1994.

NHANES III investigators looked at 10 inhalant allergies and the rate of skin-test positivity. They found that

**Table 3. Most common food allergen positivity rates**

| Food | Tests, n | Positive, n (%) |
|---|---|---|
| Milk | 2,217 | 396 (18) |
| Peanut | 2,220 | 388 (17) |
| Wheat | 2,213 | 348 (16) |
| Egg white | 2,218 | 330 (15) |
| Soybean | 2,219 | 242 (11) |
| Corn | 2,215 | 242 (11) |
| Shrimp | 2,218 | 210 (9) |
| Clam | 1,273 | 56 (4) |
| Codfish | 1,270 | 43 (3) |

# ACCLARENT AERA®

## *Eustachian Tube Balloon Dilation System*

GO TO THE SOURCE.



**Visit us at AAO-HNSF Booth #2223**

The only balloon dilation system*specifically designed to address persistent Eustachian tube dysfunction at its source.

OpenMyEars.com | Acclarent.com

*In the U.S. only.

ACCLARENT AERA® is intended for use by physicians who are trained on Acclarent technology. Eustachian tube balloon dilation has associated risks, including tissue and mucosal trauma, infection, or possible carotid artery injury. Prior to use, it is important to read the Instructions for Use and to understand the contraindications, warnings, and precautions associated with these devices. The safety of the device as used under local anesthesia has not been evaluated.

Caution: Federal (US) law restricts the sale, distribution or use of these devices to, by or on the order of a physician. Third party trademarks used herein are trademarks of their respective owners. This site is intended for visitors from the United States and published by Acclarent, Inc., which is solely responsible for its contents.

©2017 Acclarent, Inc. All rights reserved. 061003-170803

Acclarent®
PART OF THE Johnson&Johnson FAMILY OF COMPANIES

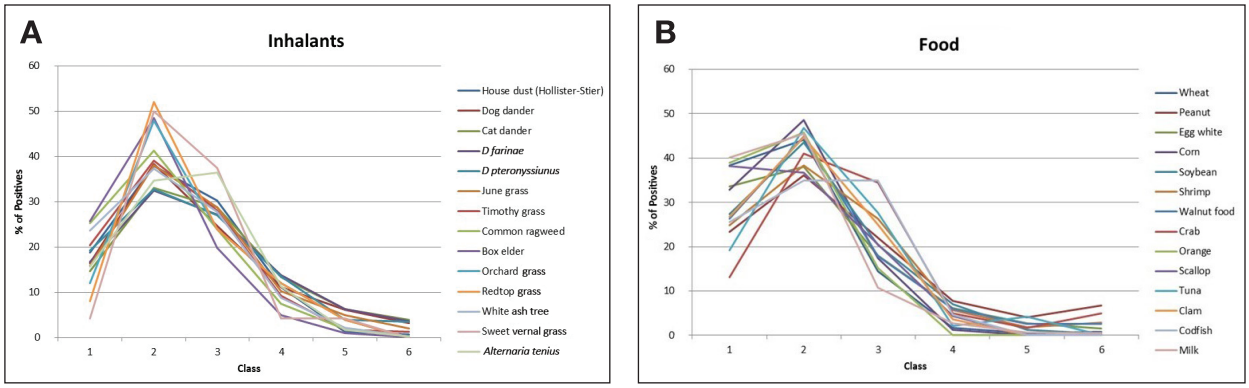



*Figure 1. Graphs show the in vitro class response for the most common inhalant/respiratory allergens (**A**) and food allergens (**B**).*

dust mites were the most frequently positive allergen (27.5% of tests), followed by perennial rye grass (26.9%), short ragweed (26.2%), cockroach (26.1%), Bermuda grass (18.1%), and cat dander (17%). Study participants were positive for at least one indoor allergen 43% of the time and to one outdoor allergen 40% of the time. Some 15% of patients were test-positive for only one allergen, with 4.3% being cockroach and 4.2% being dust mites.[8]

These figures represented a dramatic increase in positivity over the rates found during NHANES II, which had been conducted only a few years earlier. In NHANES II, only 20% of participants were positive for one allergen—7.6% for an indoor allergen, and 17.7% for an outdoor allergen. Positivity rates were 6.2% for house dust mites and 2.3% for both cat and dog dander, while rates were 10.2% for rye grass, 10.1% for ragweed, and 4.4% for Bermuda grass.[7]

It is difficult at times to correlate the true prevalence of allergic disease with positive test results. In most cases, patients are sent for testing with only a suspicion of allergic disease, and a positive test result does not necessarily mean that positivity rates are consistent with the presence of true allergic disease. However, surveys of positive allergen rates do serve to help identify the most common allergens, and they may correlate with the severity of associated diseases such as allergic rhinitis and asthma.

Quest Diagnostics Health Trends investigators analyzed test results from more than 2 million patient encounters over a 4-year period, and they found that the overall allergen-sensitization rate increased by 5.8% during the course of the 4-year study period.[9] The greatest increases were seen in positive test results for ragweed (15%) and molds (12%).[9]

Their study also found wide variability in testing results throughout the United States.[9] For example, ragweed positivity was only 11% in Miami and San Francisco but 29% in Phoenix. Mold positivity was 7% in Seattle and 20% in both Riverside, Calif., and San Bernardino, Calif. The ranking of the five cities with the highest rates by categories of allergen showed that Baltimore was worst for foods, Phoenix for ragweed, Dallas for molds, Miami for dust mites, and Denver for animals.

In addition, there was very little overlap among the top five cities in relationship to the five major allergies, with Boston appearing three times and Las Vegas and Dallas twice among the 25 worst cities for allergies.[9] A broad distribution of positive rates was also seen with foods. These data illustrate the importance of identifying possible allergens that are relevant to the local environment and determining which screening tests and panels are sensitive to the allergies that are common within that geographic area.

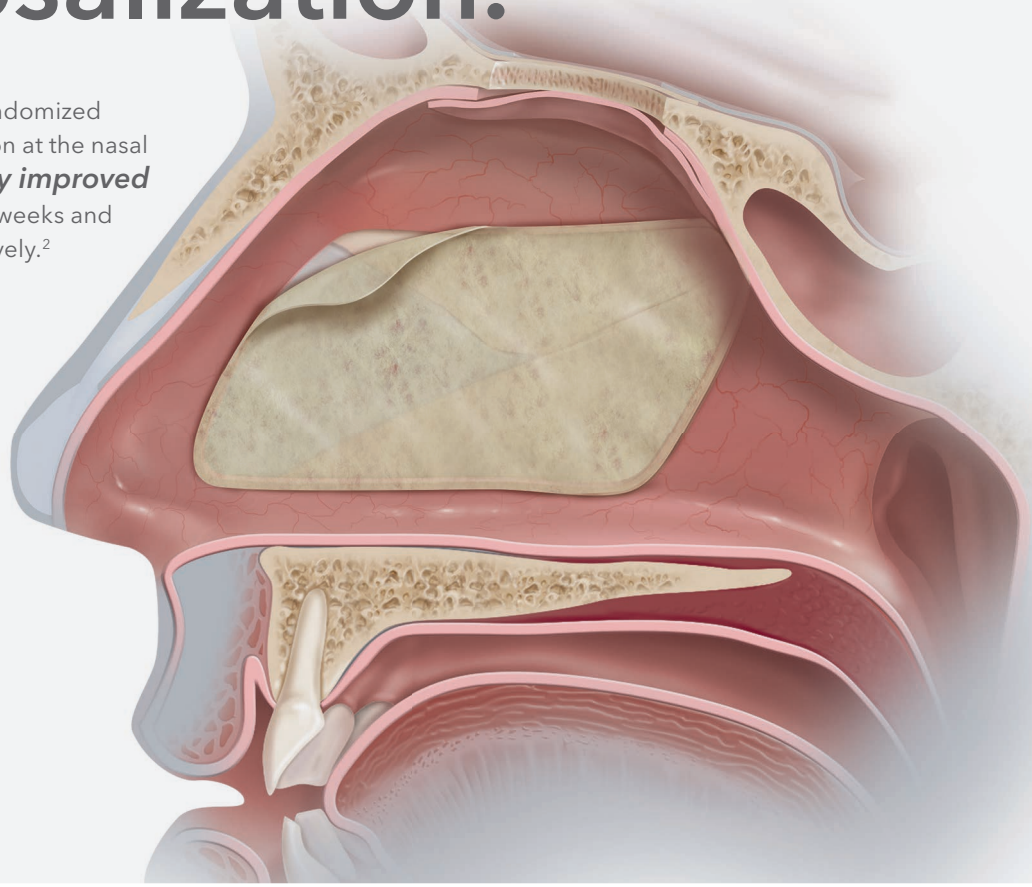
Our study represents one of the largest evaluations of screening allergy tests ever reported within a specific region, with 125,190 potential inhalant/respiratory allergens and 23,438 individual food tests. Although there are differences between our study and others regarding both the frequency of positive tests and the most common positive tests, there are some similarities, as well. Dog dander (24%), cat dander (23%), dust mites (23% for both *D farinae* and *D pteronyssinus),* and June grass (21%) were the most common inhalant/respiratory allergens in our study, while milk (18%), peanut (17%), wheat (16%), and egg white (15%) were the most commonly positive food allergens. These results are for the most part similar to those reported in other studies, including in the NHANES III study and the Quest Diagnostics Health Trends report, although there are some differences with regard to specific allergens.[7,8,10] The in vitro class responses we found are also similar to those in the Quest study.[9]

On the other hand, our positivity rates were notably lower than those identified in the GA$^2$LEN III study.[4] Of note, cockroach positivity was relatively low (11%) in our study; indeed, it was less than half of that seen in other studies.[8] This might be a bit surprising given

RESTORE PATIENT TISSUE[1]

# *Promote* remucosalization.[2]

In a multicenter, prospective, randomized controlled study remucosalization at the nasal septum donor site ***significantly improved*** early and overall by 10.03% at 2 weeks and 8.13% across 12 weeks, respectively.[2]



Biodesign®
SINONASAL REPAIR GRAFT

## Contact us

at cookohns@cookmedical.com.


1. Ambro BT, Zimmerman J, Rosenthal M, Pribitkin EA, Nasal septal perforation repair with porcine small intestinal submucosa. *Arch Facial Plast Surg*. 2003;5(6):528-529.
2. Nayak JV, Rathor A, Grayson JW, et al. Porcine small intestine submucosal grafts improve remucosalization and progenitor cell recruitment to sites of upper airway tissue remodeling. *Int Forum Allergy Rhinol*. 2018;00:1–7.


**Biodesign® Sinonasal Repair Graft**

**INTENDED USE:** The Biodesign® Sinonasal Repair Graft is intended to separate tissue or structures compromised by surgical trauma, help control minimal bleeding, and act as an adjunct to aid in the natural healing process. The device is indicated for use where an open wound dressing material is required in the nasal and/or sinus cavities following nasal and/or sinus surgery where separation of tissues or structures is desired. The device is supplied sterile and is intended for one-time use. Rx ONLY This symbol means the following: **CAUTION: Federal (U.S.A.) law restricts this device to sale by or on the order of a physician.** SINONASAL REPAIR GRAFT This symbol means the following: Sinonasal Repair Graft. This product is intended for use by trained medical professionals.

**CONTRAINDICATIONS:** This graft is derived from a porcine source and should not be used in patients with known sensitivity to porcine material.

**PRECAUTIONS:** This device is designed for single use only. Attempts to reprocess, resterilize, and/or reuse may lead to device failure and/or transmission of disease. • **Do not resterilize.** Discard all open and unused portions of the graft. • The graft is sterile if the package is dry, unopened and undamaged. Do not use if the package seal is broken. • Discard graft if mishandling has caused possible damage or contamination, or if the graft is past its expiration date. • The graft should not be applied until excessive exudate, bleeding, acute swelling, and infection is controlled. • Ensure that all layers of the graft are secured during fixation.

**POTENTIAL COMPLICATIONS:** The complications listed below are possible with the use of surgical graft materials in nasal/sinus surgery. If any of these conditions occur, the graft should be removed if possible. However, if graft removal is not possible due to graft incorporation, then appropriate care should be given to treat the complication. • Infection/Toxic Shock Syndrome • Acute or chronic inflammation (initial application of surgical graft materials may be associated with transient, mild, localized inflammation) • Allergic reaction • Excessive redness, pain, swelling, or blistering • Septal perforation recurrence

**See instructions for use for full product information.**

AB_FP0089-01_REV2

COOK® MEDICAL cookmedical.com

© COOK 06/2018 OHNS-D42808-EN-F

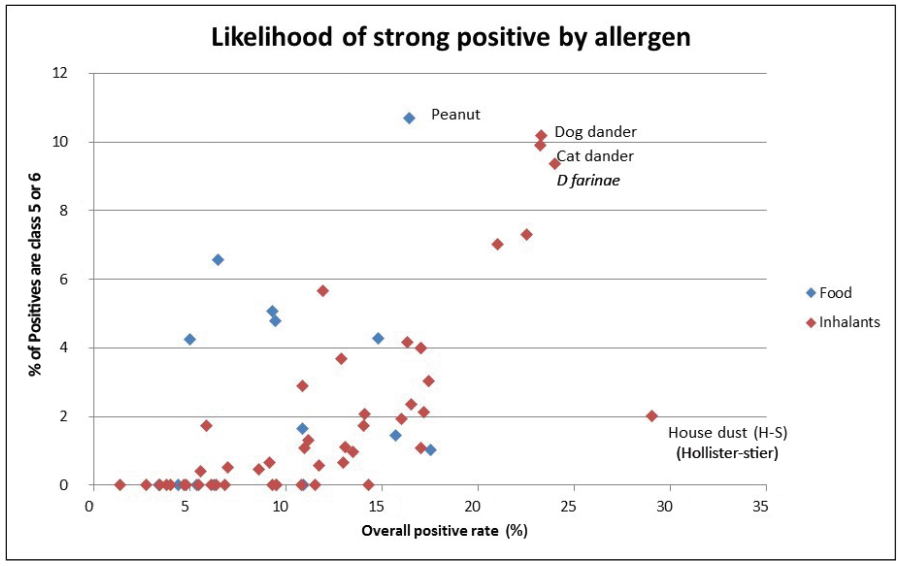



*Figure 2. Scatter plot illustrates the likelihood of a strong positive class response by allergen. The greatest class 4 and 5 responses are seen with dog dander, cat dander, dust mites* (D farinae)*, and peanut.*

the many large industrial cities located in the upper Midwest and the large underprivileged populations in the inner cities.

One of the conclusions of the GA²LEN III study was that, depending on the specific country, as few as 8 to 13 allergens were all that were needed to identify all sensitized subjects.[4] This might allow for refinement of screening allergy test batteries in a way that would be more cost-efficient than current methods.

Although treatment paradigms differ between Europe and the United States, and multiantigen immunotherapy in the United States may result in a desire to identify more positive allergens, there is some cost benefit in trying to reduce the panel size for allergy tests. Our study did not identify a huge opportunity for reducing the size of testing panels since 30 of the inhalant/respiratory allergy tests were positive in at least 10% of tests, although known cross-reactivity among certain allergens, such as grasses, might allow for some reduction in the size of the panels. However, some of the allergens tested yielded very low positivity rates; for example, rates for feather mix and white pine were 1%, rabbit epithelium was 3%, and 18 allergens yielded rates of less than 10%. This suggests that inclusion of these antigens in large panels may not be helpful unless there are specific suggested triggers that might justify them.

Evaluating the prevalence of food allergies is a bit more challenging than doing so for inhalant allergies. Some persons experience reactions to foods that may not be allergic. According to Sampson, "Food intolerances *(nonallergic food hypersensitivities)* are adverse responses caused by some unique physiologic characteristic of the host, such as metabolic disorders (e.g., lactase deficiency). Food hypersensitivities/allergies are adverse immunologic reactions that might be due to IgE- or non-IgE–mediated immune mechanisms."[5]

Food allergies also vary according to age. While the prevalence of inhalant allergies increases with age, the prevalence of food allergies decreases, so positivity rates of food allergy screening tests would be expected to be much higher in children than in adults.[11] While food allergy positivity rates may be well above 25 to 30% in small children, these rates drop to less than that by the later teenage years.[11] IgE sensitization drops over time for milk and egg in particular.[5] Screening panels for foods, particularly those panels that are performed with in vitro testing, tend to be relatively small, and therefore the opportunity to reduce their size would seem to be limited, other than panels for fish perhaps.

The limitations of our study are related to the inability to correlate our findings with specific symptoms or diagnoses. This study was not a random survey of the population but rather an analysis of ordered tests. We assume that the tests were ordered because patients exhibited symptoms, physical findings, or diagnoses suggestive of allergic disease and therefore some unidentified clinical correlate was involved. It would be likely then that in most patients, positive allergy test results were associated with a clinical allergy.

A potential controversy concerns whether skin tests or in vitro tests should be used for screening. It seems that blood testing is easier to perform in many patient populations, particularly in primary care and emergency department settings. The authors of the recent "International Consensus Statement on Allergy and Rhinology: Allergic Rhinitis" suggest that "Perhaps the strongest statement that can be made on behalf of tIgE [total IgE] is its ability to generally identify patients or populations with atopic or allergic disease."[6] They also wrote, "Based on the reviewed literature, sIgE [serum IgE] testing is an acceptable alternative to skin testing...."[6]

Other potential limitations of our study are related to the clinical usefulness of our data in patient care, even though the large number of tests we studied would be useful in identifying the most common potential allergens in patients with allergy-mediated diseases.

*Continued on page 322*

The patient also should be informed about symptoms of tumor recurrence and the need for close follow-up, especially during the first 2 years.

## References


1. Helliwell TR, Woolgar JA. Datasets for Histopathology Reports on Head and Neck Carcinomas and Salivary Neoplasms. 2nd ed. London: The Royal College of Pathologists; 2005.
2. Spiro RH, Guillamondegui O Jr., Paulino AF, Huvos AG. Pattern of invasion and margin assessment in patients with oral tongue cancer. Head Neck 1999;21(5):408-13.
3. Mistry RC, Qureshi SS, Kumaran C. Post-resection mucosal margin shrinkage in oral cancer: Quantification and significance. J Surg Oncol 2005;91(2):131-3.
4. Johnson RE, Sigman JD, Funk GF, et al. Quantification of surgical margin shrinkage in the oral cavity. Head Neck 1997;19(4):281-6.
5. McMahon JD, Devine JC, Hetherington J, et al. Involved surgical margins in oral and oropharyngeal carcinoma—an anatomical problem? Br J Oral Maxillofac Surg 2011;49(3):172-5.
6. Wong LS, McMahon J, Devine J, et al. Influence of close resection margins on local recurrence and disease-specific survival in oral and oropharyngeal carcinoma. Br J Oral Maxillofac Surg 2012;50(2):102-8.
7. Sutton DN, Brown JS, Rogers SN, et al. The prognostic implications of the surgical margin in oral squamous cell carcinoma. Int J Oral Maxillofac Surg 2003;32(1):30-4.
8. Brown JS, Shaw RJ, Bekiroglu F, Rogers SN. Systematic review of the current evidence in the use of postoperative radiotherapy for oral squamous cell carcinoma. Br J Maxillofac Surg 2012;50(6):481-9.
9. Brown JS, Blackburn TK, Woolgar JA, et al. A comparison of outcomes for patients with oral squamous cell carcinoma at intermediate risk of recurrence treated by surgery alone or with post-operative radiotherapy. Oral Oncol 2007;43(8):764-73.
10. Bekiroglu F, Ghazali N, Laycock R, et al. Adjuvant radiotherapy and health-related quality of life of patients at intermediate risk of recurrence following primary surgery for oral squamous cell carcinoma. Oral Oncol 2011;47(10):967-73.
11. Lawaetz M, Homøe P. Risk factors for and consequences of inadequate surgical margins in oral squamous cell carcinoma. Oral Surg Oral Med Oral Pathol Oral Radiol 2014;188(6):642-6.
12. Binahmed A, Nason RW, Abdoh AA. The clinical significance of the positive surgical margin in oral cancer. Oral Oncol 2007;43(8):780-4.
13. Ch'ng S, Corbutt-Burns S, Stanton N, et al. Close margin alone does not warrant postoperative adjuvant radiotherapy in oral squamous cell carcinoma. Cancer 2013;119(13):2427-37.
14. Blackburn TK, Bakhtawar S, Brown JS, et al. A questionnaire survey of current UK practice for adjuvant radiotherapy following surgery for oral and oropharyngeal squamous cell carcinoma. Oral Oncol 2007;43(2):143-9.
15. Rogers SN, Brown JS, Woolgar JA, et al. Survival following primary surgery for oral cancer. Oral Oncol 2009;45(3):201-11.




*Continued from page 304*

Although the reference laboratory we used is in the upper Midwest region of the United States, the large number of allergens and the significant overlap among regions might make seasonal data applicable to most regions throughout the United States and the perennial allergens applicable more broadly.

In conclusion, wide variability in positive in vitro allergy tests exists, and the likelihood of a positive result in screening panels can be estimated. The most common positive antigens in our study were dog dander (24%), cat dander (23%), dust mites (23% each for *D farinae* and *D pteronyssinus*), and June grass (21%). The most common positive food allergen tests were for milk (18%), peanut (17%), wheat (16%), and egg white (15%). The positivity rates for shellfish ranged from 4 to 9%, and the rates for fish were low (3 to 5%). Evaluating these rates will help further identify the most and least common allergens, and there is potential to use the results to identify opportunities to cost-effectively refine allergy screening panels.

## References


1. McCrory DC, Williams JW, Dolor RJ, et al. Management of allergic rhinitis in the working-age population. Evid Rep Technol Assess (Summ) 2003;(67):1-4.
2. Andersson M. Emerging treatments for allergic rhinitis. Expert Opin Emerg Drugs 2003;8(1):63-9.
3. Seidman MD, Gurgel RK, Lin SY, et al; Guideline Otolaryngology Development Group, AAO–HNSF. Clinical Practice Guideline: Allergic Rhinitis. Otolaryngol Head Neck Surg 2015;152:(1 Suppl):S1-43.
4. Bousquet PJ, Burbach G, Heinzerling LM, et al. GA$^2$LEN skin test study III: Minimum battery of test inhalant allergens needed in epidemiological studies in patients. Allergy 2009;64(11):1656-62.
5. Sampson HA. Update on food allergy. J Allergy Clin Immunol 2004;113(5):805-19; quiz 820.
6. Wise SK, Lin SY, Toskala E, et al. International Consensus Statement on Allergy and Rhinology: Allergic Rhinitis. Int Forum Allergy Rhinol 2018;8(2):108-352.
7. Gergen PJ, Turkeltaub PC, Kovar MG. The prevalence of allergic skin test reactivity to eight common aeroallergens in the U.S. population: Results from the second National Health and Nutrition Examination Survey. J Allergy Clin Immunol 1987;80(5):669-79.
8. Arbes SJ Jr., Gergen PJ, Elliott L, Zeldin DC. Prevalence of positive skin test responses to 10 common allergens in the US population: Results from the third National Health and Nutrition Examination Survey. J Allergy Clin Immunol 2005;116(2):377-83.
9. Kaufman HW, Odeh MA, Bost WH, Ragothaman P. Allergies across America. Health Trends Allergy Report 2010. www.QuestDiagnostics.com/HealthTrends, 1-40.
10. Kay AB. Allergy and allergic diseases. First of two parts. N Engl J Med 2001;344(1):30-7.
11. Osborne NJ, Koplin JJ, Martin PE, et al; HealthNuts Investigators. Prevalence of challenge-proven IgE-mediated food allergy using population-based sampling and predetermined challenge criteria in infants. J Allergy Clin Immunol 2011;127(3):668-76.e1-2.