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Deficits in allergy knowledge among physicians at academic medical centers

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ABSTRACT

Background: Allergic conditions have high prevalence in the general population. Misconceptions regarding the diagnosis and management of allergic disease among physicians can lead to suboptimal clinical care.

Objective: To determine the extent of allergy-related knowledge deficits among physicians.

Methods: Pediatric and internal medicine resident and attending physicians from 2 separate academic medical centers were asked to answer an anonymous electronic survey. Survey questions addressed 7 different allergy content areas.

Results: Four hundred eight physicians completed surveys (23.9% response rate). Respondents had few correct answers (mean $\pm$ SD 1.91 $\pm$ 1.43). Pediatric respondents had a larger number of correct answers compared with medicine-trained physicians ($P < .001$). No individual answered every survey question correctly, and 50 respondents (12.3%) had no correct answer. Three hundred seventy-eight respondents (92.6%) were unable to provide correct answers for at least 50% of survey questions. Level of residency training and prior rotation through an allergy and immunology elective correlated with a larger number of correct responses ($P < .01$). Only 1 survey question had an overall correct response rate higher than 50% ($n = 261$, 64%). Correct response rate was lower than 30% for 7 of the 9 possible questions.

Conclusion: There are significant knowledge deficits in many areas of allergy-related content among pediatric and internal medicine physicians and across all levels of training and specialty. Given the prevalence of allergic conditions, the potential implications of a negative impact on clinical care are staggering.

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Introduction

Allergic disorders, including allergic rhinitis, asthma, and hypersensitivity reactions to food and medication, are extremely common, affecting 20% to 30% of the world's population.^{1–5} The prevalence of allergic disease has increased in recent decades,^{6–11} prompting the World Allergy Organization to declare that “allergy must be regarded as a major healthcare problem.”¹² Most individuals with allergy are treated by primary care physicians and not by trained allergists or immunologists. Given the prevalence of allergic disease, it is not feasible or necessary for all patients to be evaluated by an allergist. This emphasizes the need for graduates of residency training programs, including those who enter primary care or medical subspecialties, to receive proper training and remain current with clinical guidelines for allergy and evidence-based management.

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As research and understanding of allergic processes evolve, prior recommendations and accepted practices might no longer be relevant or might have been incorrect in the first place. Primary care providers are not as likely to remain current in their understanding of the pathophysiology, evaluation, or treatment of allergic conditions, such as food allergy.¹³ Recent studies of primary care and emergency department physicians have demonstrated knowledge deficits and suboptimal treatment of anaphylaxis, the most serious and potentially life-threatening allergic condition.^{14–19}

The perpetuation of some non-allergy-related misconceptions by medical professionals has been highlighted in prior research.²⁰ However, there is a lack of studies evaluating the knowledge of common allergic conditions among medical providers. The primary objective of the present study was to identify allergy-related knowledge deficits among resident and attending physicians at academic medical centers.

Methods

A 9-question survey was developed by the investigational team at Nationwide Children's Hospital (Columbus, Ohio). The sources

used to develop topics and survey content included literature review, discussion with board-certified allergists on staff at Nationwide Children's Hospital and The Ohio State University regarding common misconceptions they encounter from referring physicians, and from the American Academy of Allergy, Asthma, and Immunology Web site regarding improper use of testing.²¹ Questions were developed to survey current knowledge regarding diagnostic testing and management of common allergic conditions. Content included safety of vaccine administration in individuals allergic to egg, relation between shellfish allergy and use of radiocontrast media, cross-reactivity of cephalosporin antibiotics in individuals allergic to penicillin, recommended age of introduction for common allergenic foods in children, reliability of skin prick testing in infants and toddlers, utility of serum-specific immunologic E (IgE) testing for food allergy, allergen-avoidance recommendations for dog dander, and recognition and treatment of anaphylaxis (eTable 1).

Questions were initially tested with a small group of board-certified allergists ($n = 4$) to determine validity, of which there was 96% agreement on all question answers. Then, surveys were administered to pediatric residents ($n = 15$) and attending physicians ($n = 31$) to determine readability and to solicit feedback. Edits were made to wording of questions and answer choices before distribution for data collection but content was not altered. Two separate survey versions were developed, 1 containing 6 questions for internal medicine physicians and 1 containing an additional 3 questions for pediatricians that pertained specifically to childhood allergies.

Surveys were distributed electronically in July, 2014 to 1,707 pediatric and internal medicine resident and attending physicians at 2 separate academic medical centers, excluding any allergists on staff. Eligible participants were identified and contacted through E-mail distribution lists, which included all active members of the house staff and medical staff. Participants received an E-mail invitation with a unique link to the questionnaire that prevented duplicate responses from individual accounts.

The survey remained accessible for 7 days, with a reminder notification sent 48 hours before survey close. No financial incentive was provided. The questions were administered in a multiple-choice format, with some questions that allowed for multiple responses per question. Response to every question was not mandated. Responses were automatically tabulated through the SurveyMonkey server (SurveyMonkey, Palo Alto, California) and exported to a spreadsheet for data cleaning, variable labeling, and statistical analysis. Data were collected and analyzed at the physician level for general descriptive trends by using frequency analysis. Inferential proportional comparisons were assessed by using the 2-sided Fisher exact test or 1-way analysis of variance at a prespecified α level of 0.05 for significance. This study was deemed exempt from review by the institutional review boards at Nationwide Children's Hospital and the University of Pittsburgh (Pittsburgh, Pennsylvania).

Results

Forty hundred eight physicians responded to the survey (a response rate of 23.9% for 1,707 invitees). The respondents consisted of pediatric residents ($n = 105$, 25.7%), internal medicine residents ($n = 96$, 23.5%), and internal medicine attending physicians ($n = 78$, 19.1%) at the 2 institutions and pediatric attending physicians ($n = 129$, 31.6%) at Nationwide Children's Hospital. For this study, participants who identified themselves as trained in internal medicine and pediatric medicine were included in the pediatric subgroup and they completed the 9-question survey. All respondent categories are reported as cumulative numbers from the 2 academic institutions. Among all resident respondents, 76

(36%) were in their first year of residency training. Most attending physicians ($n = 116$, 56%) reported completion of their residency training within 10 years of survey completion. Thirty-one residents (15.4%) and 68 attending physicians (32.9%) reported completion of an elective rotation in allergy and immunology during their residency training (Table 1). Sociodemographic characteristics, including sex, age, race, and ethnicity, were not collected from participants.

The percentage of total correct answers from all respondents was 24.7% (mean $\pm$ SD 1.91 ± 1.43). Pediatric respondents had a larger number of correct answers compared with internal medicine physicians ($P < .001$). Pediatric attending physicians answered 29% of questions correctly and had the largest mean number of correct answers per respondent (2.61 ± 1.59), followed by 25% correct answers from pediatric residents (2.25 ± 1.45), 20.3% correct answers from medicine attending physicians (1.22 ± 0.86), and 19.3% correct answers from medicine residents (1.16 ± 0.86). Overall, no respondent answered every survey question correctly, and 50 respondents (12.3%) had no correct answer, 36 (72%) of whom were internal medicine residents or attending physicians ($P < .001$). Three hundred seventy-eight respondents (92.6%) were unable to provide correct answers for at least 50% of survey questions (Table 2).

Among residents, the number of correct answers increased according to level of training ($P < .01$). Attending physicians who reported completion of their residency training within the past year had the largest percentage of correct answers (40%, $P = .15$). Attending physicians had a larger percentage of correct answers compared with residents (26.3% vs 23%, $P < .05$; Fig 1). There were no significant differences for number or percentage of correct answers between institutions.

Residents who completed an elective rotation in allergy and immunology had a larger percentage of correct answers (29.7%, 2.35 ± 1.28) compared with those who did not (21.8%, 1.63 ± 1.30 , $P < .01$). Likewise, attending physicians with prior allergy and immunology elective rotations had a larger percentage of correct answers (28.8%, 2.32 ± 1.81) compared with those who did not (26%, 1.93 ± 1.43 , $P = .26$).

Attending physician respondents were asked to select their primary area of clinical service from 5 different areas of practice, including medical subspecialty ($n = 91$), primary care ($n = 58$), emergency department ($n = 27$), hospitalist ($n = 21$), and intensive care ($n = 9$). Emergency medicine attending physicians had the largest percentage (32.9%) and largest number of mean correct

Table 1

Characteristics of survey respondents ($N = 408$) and prior experience with an allergy and immunology elective rotation

Respondent role	Pediatrics, n (%)	Internal medicine, n (%)	Reported prior A/I elective rotation, n (%)
Residents			
PGY-1	26 (24.8)	50 (52.1)	6 (7.9)
PGY-2	28 (26.7)	23 (24)	4 (7.8)
PGY-3	37 (35.2)	18 (18.8)	12 (21.8)
PGY-4	14 (13.3)	5 (5.2)	9 (47.4)
Total	105	96	31 (15.4)
Attending physicians (years since completion of residency)			
<1	7 (5.4)	4 (5.1)	5 (45.5)
1–5	37 (28.7)	18 (23)	21 (40)
6–10	33 (25.6)	17 (21.8)	22 (44)
>10	51 (39.5)	38 (48.7)	20 (22.5)
N/A	1 (0.8)	1 (1.3)	0
Total	129	78	68 (32.9)

Abbreviations: A/I, allergy and immunology; N/A, not available; PGY, postgraduate year.

Table 2
Overall performance

Survey question	Total (N = 408)	Pediatric residents (n = 106)	Pediatric attending physicians (n = 128)	Medicine residents (n = 96)	Medicine attending physicians (n = 78)	P value
Correct responses, mean (SD)	1.91 (1.43)	2.25 (1.45)	2.61 (1.59)	1.16 (0.86)	1.22 (0.85)	<.001 ^a
Performance distribution, n (%)						
0 correct	50 (12.3)	8 (7.6)	6 (4.7)	21 (21.9)	15 (19.2)	<.001 ^b
≤30% correct	351 (86)	87 (82)	100 (78.1)	92 (95.8)	72 (92.3)	<.001 ^b
≥50% correct	30 (7.4)	7 (6.6)	13 (10.2)	4 (4.2)	6 (7.7)	.38 ^b
All correct	0	0	0	0	0	

^aOne-way analysis of variance.^bFisher exact test of differences between total internal medicine respondents and total pediatric respondents.

answers per individual (2.96 ± 1.89) compared with physicians from all other areas of clinical practice (25.3% , 1.94 ± 1.76 , $P < .001$). However, emergency medicine attending physicians had a similar overall percentage (32.9% vs 32%) of correct answers compared with primary care physicians (2.51 ± 1.60). Compared with all other areas, primary care and emergency department attending physicians had the most correct answers ($P < .001$).

In regard to content, only 1 survey question (regarding recognition and treatment of anaphylaxis) had an overall correct response rate higher than 50% ($n = 261$, 64%). Fewer than 15% of all physicians correctly answered questions with content regarding contraindication of selected vaccines in patients with a history of egg allergy, relation of shellfish allergy with use of radiocontrast media, age at which skin prick testing becomes reliable, recommended age for introduction of allergenic foods, and cephalosporin cross-reactivity in individuals allergic to penicillin (Table 3).

Aggregate correct response rate from all physicians was lower than 30% for 7 of the 9 possible questions. Of the survey questions asked of pediatric and medicine physicians, pediatricians had a significantly larger number of correct answers for 4 of 6 questions ($P < .05$) concerning egg allergy and vaccines, radiocontrast media, dog dander, and anaphylaxis (Table 3).

Compared with residents, attending physicians were more likely to answer correctly that measles, mumps, and rubella vaccination was not contraindicated in a patient with egg allergy (86.5% vs 78.2% , $P < .05$). However, compared with attending physicians, residents were less likely to inquire about shellfish allergy before administration of radiocontrast media (31.7% vs 47.3% , $P < .01$). There were no differences between residents and attending

physicians for most answers, including incorrect answers that influenza vaccination is contraindicated in patients with egg allergy (66.8% vs 67.1%), inquiring about iodine allergy before radiocontrast media (81.7% vs 77.3%), and that food-specific IgE testing is a useful screening test (59.9% vs 64.7%).

Discussion

The present study identified significant knowledge deficits among physicians across all levels of training and experience in regard to common allergic conditions affecting the general population. To the authors' knowledge, this has not previously been reported in the medical literature.

During the past few years, efforts have been made to help medical professionals and patients make choices about their health care that are based on evidence, not duplicative, free from harm, and necessary.²² The underlying stimulus for this initiative was the recognition of overuse of unnecessary medical procedures and a desire to improve outcomes, including for the specialty of allergy and immunology.^{21,23} The debunking of all misconceptions and areas of content included in this survey would require a lengthy discussion and review. Some examples found in the literature include extensive data demonstrating safety of influenza vaccination in individuals allergic to egg,^{24–26} safety of cephalosporin antibiotics in patients who report a history of penicillin allergy,^{27,28} inappropriate use and interpretation of food-specific IgE testing,^{29,30} poor understanding of the recommended timing of introduction of allergenic foods to infants,^{31,32} and improper recommendations for dog allergen-avoidance measures.^{33,34}

However, it is helpful to illustrate details of 1 misconception from this survey, which has been propagated for 40 years.³⁵ Physicians frequently alter their decision making regarding the use of radiocontrast media in patients who report a history of shellfish allergy.^{36–38} This misconception most likely originated with a 1975 publication by Shehadi³⁵ who reported survey data collected from adult patients inquiring about any history of allergic reactions to foods and radiocontrast media. Interestingly, it has never been demonstrated that increased risk of allergic reaction occurs in patients with a history of IgE-mediated shellfish allergy.^{39–41}

Another striking misperception is that iodine is the allergen associated with shellfish allergy and serves as the common link with iodinated radiocontrast media. Iodine is not a recognized allergen or a cause of IgE-mediated food hypersensitivity reactions.³⁸ IgE-mediated hypersensitivity to shellfish is caused by allergens found in muscle proteins, such as tropomyosin, which has no relation with radiocontrast media.⁴¹

The authors identified this same misconception among physicians who answered the present survey. These findings demonstrate a significant deficit in medical knowledge and perpetuation of a misconception that has lasted for decades and is not supported by any evidence. To the authors' knowledge, the cost and risk of adverse effect from this misconception has not previously been reported, but is likely to be staggering.

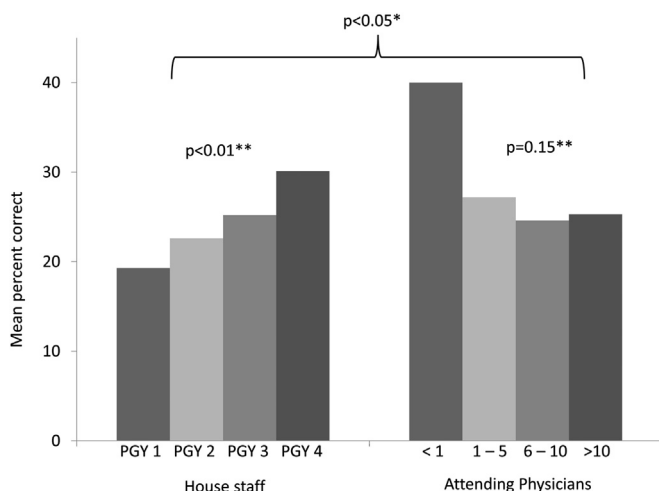


Figure 1. Percentage of correct responses by current level of training and years since completion of residency of house staff ($n = 201$) and attending physicians ($n = 205$). *Fisher exact test. **One-way analysis of variance. PGY, postgraduate year.

Table 3

Number of correct responses per survey question

Survey question	Total (N = 408), n (%)	Pediatric residents (n = 106), n (%)	Pediatric attending physicians (n = 128), n (%)	Medicine residents (n = 96), n (%)	Medicine attending physicians (n = 78), n (%)	P value ^a
Safety of vaccines and egg allergy	53 (13)	20 (19)	29 (23)	1 (1)	3 (4)	<.0001
Shellfish allergy and radiocontrast media	56 (14)	16 (15)	31 (24)	5 (5)	4 (5)	<.0001
Age for accuracy of skin prick testing ^b	19 (8)	6 (6)	13 (10)	N/A	N/A	.239
Age for food introduction ^b	28 (12)	14 (13)	14 (11)	N/A	N/A	.687
Penicillin cross-reactivity	57 (14)	15 (14)	22 (17)	11 (12)	9 (12)	.249
Utility of serum IgE testing for food allergy	90 (22)	27 (26)	32 (25)	20 (21)	11 (14)	.091
Dog dander avoidance	153 (37)	34 (32)	64 (50)	24 (25)	31 (40)	.039
Common childhood food allergens ^b	63 (27)	27 (26)	36 (28)	N/A	N/A	.769
Recognition and treatment of anaphylaxis	261 (64)	81 (76)	93 (72)	50 (52)	37 (47)	<.0001

Abbreviation: N/A, not available.

^aP values determined by the Fisher exact test comparison of total pediatric and total medicine respondents for questions distributed to all participants and comparison of residents with attending physicians for pediatric-only questions.^bDenotes survey question distributed only to pediatric physicians (n = 234).

There are several limitations to consider from this study. The content for the survey was based on previously identified knowledge deficits and expert opinion, but questions were not validated across different levels of physician experience or areas of clinical expertise. The overall response rate was 23.9%, which is similar to other studies that conducted electronic surveys of physicians to obtain data.^{42–44} Response bias could have been introduced owing to the electronic nature of the survey. Nonrespondents to the survey were more likely to be attending physicians (19.3% overall response rate), particularly from internal medicine (12.3% response rate). Pediatric residents had the largest percentage of completed surveys, with 39.6% of all surveys answered. Physicians surveyed in this study are associated with academic training institutions and might not be representative of the general population of health professionals.

Strengths of this study include the large number and diversity of respondents. Participants were from 2 separate academic centers that have large residency programs and associated allergy and immunology fellowship training programs. The attending physicians employed by academic centers have presumed teaching roles and likely increased involvement in scholarly activities such as journal clubs and didactic presentations. Thus, their responses could over-represent the knowledge of all practicing physicians, including those in private practice.

The present study was not designed to address the potential causes of knowledge deficits or misconceptions. A plausible contributing factor includes the perpetuation of previously held beliefs, since refuted by evidence-based medicine, over time through direct teaching of younger generations of physicians. Primary care and subspecialty physicians must care for a wide spectrum of patients and conditions. As such, they might be less likely to remain current with allergy-specific literature or published recommendations. Even with the publication and disbursement of disease-specific practice management guidelines by specialty boards,^{21,22} evidence has shown that adoption of these guidelines by general practitioners is slow and poor.^{45–48} Needless to say, physicians in training who learn incorrect or out-of-date information from their attending physicians are likely to adopt the same practice.

Future research should include validation of the present findings among physicians in other institutions and settings. Within post-graduate residency training programs, efforts can be devoted to promoting and ensuring access to clinical rotations in allergy and immunology. Board certification and maintenance of certification organizations could promote this content to practicing physicians, in addition to ongoing and more widespread use of existing content.²¹ Allergists themselves could provide succinct, evidence-based

literature to referring providers if they identify areas of clinical practice not consistent with current recommendations. Ideally, the identification and recognition of these knowledge deficits will begin to drive change on many levels.

There are significant knowledge deficits and misconceptions in many areas of allergy-related content among physicians across all levels of training and specialty. This can lead to unnecessary diagnostic evaluation, avoidance of appropriate therapeutic options owing to a misunderstanding of the risk of an allergic reaction, and increased cost of medical care through the use of more expensive, second-line treatment options. Ultimately, this can equate to sub-optimal care, decreased patient satisfaction, and increased morbidity. Addressing these knowledge deficits within residency training programs will not only improve the understanding of future generations of physicians but also directly affect patient care.

Supplementary Data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jana.2015.05.001>.

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eTable 1

Survey questionnaire

- 1 Which of the following immunizations are contraindicated in a patient with egg allergy? (Select all that apply.)
 - a Measles, mumps, rubella
 - b Influenza
 - c Rabies^a
 - d Yellow fever^a
 - e Varicella
- 2 Which of the following allergies are necessary to ask about before ordering an imaging study with radiocontrast media? (Select all that apply.)
 - a Iodine
 - b Shellfish
 - c Artificial dyes
 - d None of the above^a
- 3 At what age does skin prick testing for food or environmental allergens first become accurate and reliable? (Select 1.)
 - a 3 mo old^a
 - b 12 mo old
 - c 18 mo old
 - d 3 y old
- 4 For a child with no significant risk factors to develop allergy, at what age do you recommend peanut (butter) be introduced into the diet? (Select 1.)
 - a 6 mo old^a
 - b 12 mo old
 - c 2 y old
 - d 3 y old
- 5 Which of the following antibiotic classes are contraindicated in a patient with penicillin allergy? (Select all that apply.)
 - a First-generation cephalosporins^a
 - b Second-generation cephalosporins
 - c Third-generation cephalosporins
 - d Macrolides
 - e None of the above
- 6 Which of the following most accurately characterizes serum-specific IgE testing for foods? (Select all that apply.)
 - a It is a useful screening test to detect the presence of food allergy
 - b The negative predictive value is very high^a
 - c Any food with an elevated level should be avoided
 - d Certain medications might interfere with test results
- 7 Which of the following advice would you recommend to a patient who is allergic to dogs but wishes to have a dog in the home? (Select all that apply.)
 - a Short-haired dogs are hypoallergenic
 - b Dogs that shed less are hypoallergenic
 - c Certain breeds are hypoallergenic
 - d Cleaning the house regularly will effectively remove allergen
 - e None of the above^a
- 8 Which of the following are common causes of IgE-mediated allergic reactions in children ≤ 4 y of age? (Select all that apply.)
 - a Milk^a
 - b Artificial food coloring and dyes
 - c Strawberries
 - d Egg^a
 - e None of the above
- 9 Which of the following should be administered first to a patient who presents with immediate-onset generalized hives and vomiting after ingesting a known food allergen? (Select 1.)
 - a First-generation antihistamine (Benadryl)
 - b Prednisone
 - c Epinephrine^a
 - d H₂-histamine blocker (Zantac)

^aDenotes correct answer choice.