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RESEARCH ARTICLE

Debunking myths about "allergy" to radiocontrast media in an academic institution

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Abstract

Purpose: Patients with "allergy" to iodine and shellfish often do not obtain necessary radiologic procedures due to anxiety about potential radiocontrast media reactions. This study assesses the impact of an educational intervention to dispel these myths. *Methods:* The authors surveyed 252 internal medicine, emergency medicine, pediatrics, radiology, obstetrics/gynecology, and surgery health professionals before and after an educational intervention. Pre- and posttest responses were analyzed to assess the impact of the intervention on beliefs about radiocontrast media reactions and their perceived relationship to shellfish allergy and iodine "allergy." *Results:* The mean pre- and posttest correct response scores were 41% and 91%, respectively. The intervention had a greater impact on respondents' knowledge about iodine allergy than shellfish allergy, most likely due to the difference in baseline knowledge ($P < 0.005$). Emergency medicine garnered the highest pretest correct response score (54%). Internal medicine earned the lowest pretest score (30%). There was a significant difference between the highest and lowest scoring specialties on the pretest ($P = 0.037$). There was no statistically significant correlation with training levels. There was a considerable decrease in the percentage of respondents who would withhold radiologic studies from patients suspected of shellfish or iodine allergy. The percentage of respondents who would premedicate patients with antihistamines or steroids also decreased significantly. *Conclusion:* An educational intervention helps rectify misconceptions among health care professionals about radiocontrast media reactions and their perceived relationship to shellfish or iodine allergy.

Keywords:

Allergy, radiocontrast media, shellfish, iodine, anaphylaxis, educational intervention

History

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Introduction

Despite a lack of association between reactions to radiocontrast media (RCM) and shellfish allergy or iodine "allergy", prior studies demonstrate that misconceptions are prevalent, even at academic institutions [1]. However, the impact of an educational intervention to rectify misperceptions among health care professionals has yet to be studied. This is the first study to evaluate such an educational intervention.

One prevalent misconception among health care professionals is that shellfish or iodine allergy predispose patients to increased risk of reactions to RCM. Allergy to shellfish or iodine does not increase the risk of adverse reactions to RCM [2-6]. Patients with a history of atopy are considered to be at twice the risk for adverse reactions to RCM compared with the general population [2,7,8]. However, a patient with a history of allergy to milk or eggs is at a similar risk as a patient with a history of an allergy to shellfish; shellfish does not confer an increased risk compared to other foods. Furthermore, iodine, is essential for human life, is not an allergen, and is not responsible for the allergic response in reactions to shellfish [4,6]. The allergens in shellfish are proteins, such as tropomyosin [9]. Therefore, there is no link between iodine and allergy to shellfish, nor is there a link between iodine and adverse reactions to RCM. Allergic-like reactions to RCM are thought to be caused by the high osmolality of these solutions compared to blood [6]. Solutions that are hyperosmolar compared to blood cause vasodilation and increased capillary permeability, and can cause nephrotoxicity [6]. Vasodilation and increased capillary permeability may cause nonimmunologic reactions associated with RCM. Rare reports suggestive of immune-mediated reactions to RCM exist in the literature, but these are not the majority [10,11].

Millions of imaging studies using RCM are conducted each year, providing vital information for patient care [12]. Adverse reactions to RCM occur in 1.5% to 3.1% of studies using low-osmolality contrast media [7,13] and 5.0% to 12.7% using high-osmolality contrast media [2,7]. Serious, life-threatening reactions occur in an even smaller fraction,

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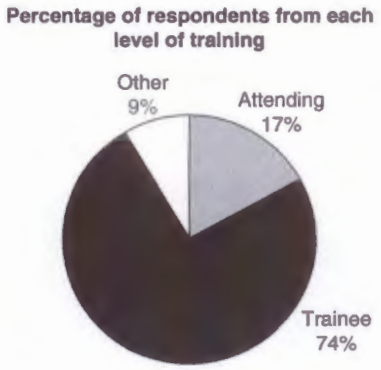

Figure 1. Respondents categorized by level of training. Trainees included medical students, residents, and fellows.

reported as 0.04% with low-osmolality and 0.22% with high-osmolality RCM [7]. In the United States from 1999 to 2001, 42 to 50 RCM-related deaths occurred per year, with RCM being a direct cause in only 7 to 9 of these deaths [14]. This finding is based on a study that examined causes of death listed on death certificates for the years 1999 to 2001. A diagnostic code was assigned to deaths attributable to RCM in 1999. Seven to 9 deaths each year listed RCM as the primary cause of death, whereas there were 42 to 40 "total mentions" of RCM as a possible contributing cause each year of the study. Of deaths attributed to RCM, renal failure and anaphylaxis were the 2 most commonly mentioned associated causes [14]. Although serious reactions and death are rare, it is imperative for physicians to understand the risk factors for adverse reactions to RCM.

Materials and methods

Survey instrument

A 17-question survey was developed based on a similar study that was limited to interventional cardiologists and radiologists [1]. The survey consisted of 2 demographic questions that solicited information about level of training (attending, fellow, resident, intern, medical student, physician assistant, other) and specialty (internal medicine, emergency medicine, pediatrics, obstetrics/gynecology, radiology, surgery, other). The level of training was simplified to include "attending," "trainee," and "other." Respondents indicated whether, in practice, they ask patients about their allergic history prior to administering radiocontrast media. Fourteen knowledge-based questions about iodine and shellfish followed. Responses were "yes/no" except for demographic information. The study was approved by the institutional review board and was conducted in 2012 to 2013. A cover letter was also distributed to explain the study, risks and benefits of participation, and to state that participation implied consent. Estimated completion time was 5 minutes.

Participant selection and collection of responses

The survey was administered before and after the educational intervention to individuals who were present at internal medicine, pediatrics, emergency medicine, surgery, obstetrics/gynecology, and radiology grand rounds. A total of 252 individuals attended the grand rounds; 171 complete pretests and 164 complete posttests were returned. Seven pretest respondents failed to complete the posttest or left the meetings early, and 81 individuals refused to participate or arrived too late to complete the pretest. We analyzed data from the 164 respondents who returned complete pre- and posttests.

Pretests were printed on white paper and posttests on blue paper to easily distinguish between them. Tests were numbered so that pre- and posttests from individual respondents could later be matched. Participants were given the cover letter, a pretest, and a sealed envelope containing a posttest. Participants were encouraged to complete the pretest prior to the educational intervention. After collecting the pretests, the 30-minute educational intervention began. Participants were given 5 to 10 minutes after the educational intervention to complete the posttest, which was then collected.

Participant demographics

Participants indicated their current level of medical training: attending, fellow, resident, intern, medical student, physician's assistant, or other. Participants also indicated their "field" or "specialty." Figure 1 depicts the percentages of respondents who represented each training level. Figure 2 depicts the percentages of respondents from each specialty.

Educational intervention

The educational intervention consisted of a 30-minute lecture on anaphylaxis. The educational intervention provided respondents with updated knowledge about anaphylaxis diagnosis and management. The content was designed to give participants a broad working knowledge of anaphylaxis, not simply focused on anaphylaxis to radiocontrast media. Five slides were specifically designed to elucidate the lack of relationship among shellfish, iodine, RCM, and anaphylaxis.

Data analysis

We analyzed data using SPSS version 21.0 (2012 release, IBM SPSS Statistics for Windows, IBM Corp., Armonk, NY), with the exception of Fisher exact tests and the Mantel-

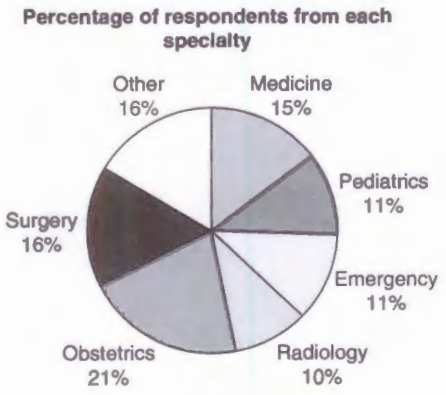

Figure 2. Respondents categorized by specialty.

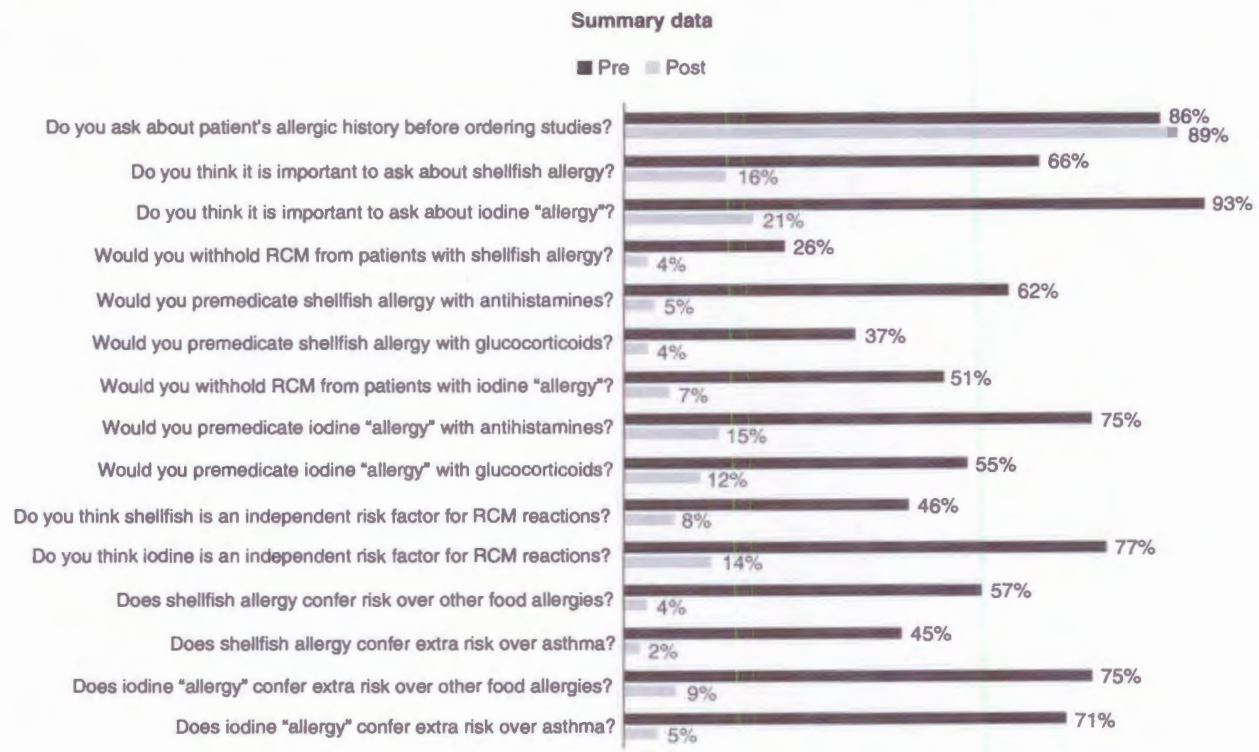

Figure 3. Percentage correct on pretest and posttest responses for each survey question. Survey questions were simplified for display purposes.

Haenszel technique, which were performed using MStat 5.5.3 (MStat, University of Wisconsin).

Fisher exact tests were performed to assess differences in the proportion of correct versus incorrect answers for each question. The Mantel-Haenszel technique was used to assess whether, overall, the percent of correct answers changed from pretest to posttest. This test was performed with a 1-sided P value, with the hypothesis that the proportion of wrong answers would be higher before the educational intervention than after.

One-way ANOVAs tested the effect of training level and specialty on pre- and post-scores, scores on shellfish- and iodine-related questions, and the overall change in score. Dependent variables were normally distributed, as assessed by the Shapiro–Wilk test ($P > 0.05$) for each ANOVA performed. Homogeneity of variances was assessed by Levene's test. The Kruskal–Wallis test was used to assess whether there were significant differences in scores among individual specialties or levels of training. Paired t tests were used to assess whether individual scores before and after the intervention were significantly different, and if respondents learned more about iodine or shellfish as they relate to radiocontrast media reactions.

Results

Summary of data

Figure 3 provides summary data of the percentage of correct responses to each survey question. It demonstrates that respondents changed their opinions on whether or not it is important to ask patients about a history of shellfish or iodine allergy prior to ordering studies that require RCM. Respondents also demonstrated knowledge gains regarding whether shellfish or iodine allergies are independent risk factors for such reactions, which they are not.

The percentage of respondents who would premedicate shellfish-allergic patients with either antihistamines or corticosteroids prior to administering RCM decreased 10-fold. Similarly, the percentage of respondents who would premedicate iodine-allergic patients with either antihistamines or corticosteroids prior to administering RCM decreased as well. Beliefs about iodine allergy appear to be more ingrained than about shellfish allergy, as on the posttest, respondents remained 3 times more likely to premedicate iodine-allergic patients with either corticosteroids or antihistamines than to premedicate shellfish-allergic patients. Nonetheless, the percentage of respondents who would premedicate for either shellfish or iodine allergy decreased significantly from pre- to posttests.

Figure 3 also demonstrates that respondents were less likely to withhold necessary radiologic procedures from patients reporting shellfish or iodine allergy.

Overall impact of the intervention

The mean pretest correct response score was 40.54%, whereas the mean posttest correct response score was 91.4%. There was a significant difference in pre- and post-scores, indicating that respondents gained substantial knowledge about allergy to iodine and shellfish as they relate to RCM ($P < 0.005$). The intervention had a greater impact on respondents' underlying assumptions about iodine than about

Figure 4. Pretest and posttest correct response scores by level of training. Posttest scores were higher for all levels of training.

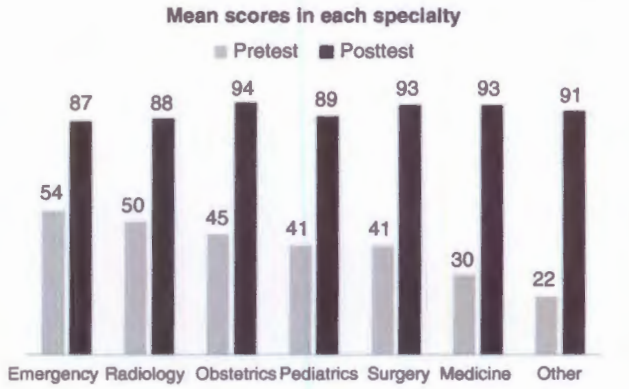

Figure 5. Mean pretest and posttest correct response scores in each specialty.

shellfish, as measured by the score change on iodine versus shellfish questions. There was a significant difference in the score change on iodine questions compared to shellfish questions ($P = 0.001$). One reason may be that the baseline level of knowledge about shellfish was higher than that about iodine. The mean correct response score on iodine questions prior to the intervention was 28.9%, whereas the mean correct response score on shellfish questions prior to the intervention was 51.6%, a significant difference ($P < 0.001$).

There was a significant difference in the proportion of correct versus incorrect responses before and after the intervention for each content question. The percent of wrong answers was indeed higher before the intervention than after ($P < 0.005$).

Effect of level of training

Attendings, trainees, and others (including nurses and physician assistants) all performed poorly on the survey prior to the intervention; mean pretest correct response scores were < 42% overall for all training levels. Average pretest correct response score for attendings was 39.7%, trainees 41.8%, and other respondents 29.6%, as shown in Figure 4. Level of training did not significantly impact pretest score ($P = 0.298$). Pretest performance was equally poor on shellfish- and iodine-related questions, with no significant difference based on level of training ($P = 0.051$ for shellfish, $P = 0.89$ for iodine). All levels of training gained significant knowledge after the lecture. Mean posttest correct response scores ranged from 90% to 92% for all levels of training after the lecture, compared with < 42% prior to intervention. Level of training did not affect the posttest score ($P = 0.86$) or overall score change ($P = 0.38$).

Effect of specialty

Respondent categories included internal medicine, emergency medicine, pediatrics, radiology, obstetrics/gynecology, surgery, and other. Emergency medicine garnered the highest pretest correct response score (54%) , as shown in Figure 5. Internal medicine earned the lowest pretest correct response score (30%). There was a significant difference between the highest and lowest correct response scoring specialties on the pretest ($P = 0.04$). Internal medicine physicians did learn the most from the intervention, with a score change of 62.5%. As expected, this was significantly different from the highest correct response scoring specialty on the pretest, emergency medicine, with a score change of only 32.7% ($P = 0.01$). Posttest correct response score was not significantly different among specialties. In other words, specialties that scored poorly on the pretest learned the most, and posttest correct response scores were uniformly good (> 87%) among all specialties. Specialty did not have a significant impact on iodine questions versus shellfish questions.

Discussion

This study demonstrates a significant impact of an educational intervention on health care professionals' beliefs regarding the relationship among shellfish allergy, iodine allergy, and RCM reactions. Health care professionals across 6 specialties and all levels of training held profound misconceptions regarding the use of RCM in patients with shellfish or iodine allergy. The percentage of respondents who would withhold RCM from these patients decreased significantly after the intervention. Arguably, these questions may not have a "correct" answer, because factors such as institutional protocols may influence clinician behavior regardless of their underlying knowledge and beliefs.

Respondents also gained considerable knowledge on each question analyzed individually and on the test as a whole. Respondents who benefited from the intervention may therefore be more comfortable ordering appropriate imaging studies for their patients who report shellfish or iodine allergy and may avoid the use of superfluous premedication in the future.

A true reaction to RCM carries a risk of recurrent reactions and thus requires premedication. In studies using high-osmolality contrast media, premedication with prednisone and diphenhydramine reduces reactions to 9% from 17% to 60%, based on historical data [15]. In studies using low-osmolality contrast media, RCM reactions occur in only 0.7% when premedication is utilized; 22% of patients with prior breakthrough reactions to RCM, defined as a reaction despite adequate premedication, will develop another reaction on repeat exposure [16]. The premedication regimen endorsed

by the American College of Radiology differs if the RCM study is elective or emergent. For elective studies, prednisone 50 mg by mouth at 13 hours, 7 hours, and 1 hour or methylprednisolone 32 mg by mouth at 12 hours and 2 hours before RCM administration is recommended. Diphenhydramine 50 mg intravenously, intramuscularly, or by mouth is usually also given 1 hour before RCM administration. For emergent studies, the recommended regimen is methylprednisolone 40 mg or hydrocortisone 200 mg intravenously every 4 hours until RCM administration plus diphenhydramine 50 mg intravenously 1 hour prior to administration [12]. These regimens are widely accepted and should be used in patients with a true previous reaction to RCM, not in those with a lone history of shellfish or iodine allergy.

Pervasive misconceptions about RCM reactions, shellfish allergy, and iodine allergy held by health care professionals bring about numerous consequences. First, patients with a history of shellfish or iodine allergy may experience unwarranted apprehension due to an implied increased risk for RCM reactions when they are inappropriately questioned. This psychological stress may trigger vasovagal events that could mimic anaphylaxis. Second, health care professionals are propagating misinformation by repeatedly asking unfounded questions about RCM reactions, shellfish allergy, and iodine allergy. Among hospitalized patients in Spain, only 3 of 15 reported reactions to RCM were confirmed after an in-depth study, including a thorough history and review of previous medical records [17]. This suggests that anxiety and delays in treatment could be prevented if health care professionals asked the correct questions. Third, the monetary repercussions of these misconceptions must be considered. In the aforementioned study from Spain, misdiagnosis of drug hypersensitivity, including RCM reactions, resulted in a 4-fold increase in overall cost [17]. The financial implications of unnecessary premedication, the delays prior to RCM administration, and the utilization of alternate imaging studies are likely substantial, but no studies have yet examined this issue to our knowledge. Finally, there are obvious consequences to the quality of patient care. Delaying a necessary RCM study, or failing to order the study altogether, in a patient who is not actually at increased risk for adverse events is irresponsible medical practice and should be avoided.

There are several limitations of this study. The majority of respondents (75%) were trainees, which may reflect the fact that grand rounds are mandatory for trainees. This should not significantly alter results, as the average overall scores were very similar for trainees (41.8%) and attendings (39.7%), with trainees performing marginally better. The grand rounds milieu permitted access to respondents with a wide range of prior knowledge, because respondents did not self-select to participate based on personal interest in the topic of anaphylaxis. The survey was based upon a previously published informal survey [1]. Neither this study nor the survey upon which it was based was validated. It is unknown whether the educational intervention will translate into behavioral change. Based on knowledge gained from the intervention, respondents may or may not be more likely to order appropriate imaging studies in patients who report shellfish or iodine allergy. There is also no guarantee that the knowledge will be retained long-term.

Conclusion

As evidenced in this study, education can correct misconceptions among health care professionals about RCM reactions and their perceived relationship to shellfish allergy and iodine "allergy." If health care professionals are educated about the true relationship among shellfish allergy, iodine "allergy," and radiocontrast media, then they are more likely to order appropriate radiologic tests, to avoid unnecessary delays, and refrain from ordering premedication protocols in patients who report such allergies. This could lead to decreased costs and improved quality of care.

Acknowledegments

Neetu Talreja, MD, participated in this work while she was a fellow in the Division of Allergy and Immunology, Department of Internal Medicine, University of South Florida Morsani College of Medicine and James A. Haley Veterans' Affairs Hospital, Tampa, Florida.

Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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