

Current Status of Residency Training of Allergic-like Adverse Events to Contrast Media

Jonelle M. Petscavage, MD, MPH, Angelisa M. Paladin, MD, Carolyn L. Wang, MD, Jennifer Gail Schopp, MD, Michael L. Richardson, MD, William H. Bush Jr.

Rationale and Objectives: Acute allergic-like adverse reactions to contrast media are rare but life-threatening events. Residents may complete training without ever managing such an event. Surveys have shown practicing radiologists to incorrectly dose and administer medications for treatment. Thus, contrast education may be deficient or inconsistent. The purpose of this study was to assess the current status of contrast reaction education in US radiology residency programs and the methods used to test residents' knowledge.

Materials and Methods: A 10-question anonymous survey on residency education methods and testing pertaining to allergic-like adverse events to contrast media was distributed through the Association of Program Directors in Radiology to program directors of US diagnostic radiology residency programs. The past 4 years of the American College of Radiology in-service examination were reviewed to assess the number of contrast reaction questions.

Results: Fifty-one programs responded to the Association of Program Directors in Radiology survey. Forty-nine percent of programs train with one lecture per year, 29.4% train with two lectures, and 16% train with three or more lectures. Only 44% include role-playing training during the lectures. Eighteen percent of programs are incorporating simulation training. Fewer than 50% of programs formally test residents' knowledge, and there were no questions on the 2007 to 2010 American College of Radiology in-service examinations.

Conclusions: Resident education for contrast reaction management is primarily performed with annual lectures. Only 18% of programs are using simulation training, and <50% are testing residents' knowledge or skills. These findings suggest that education may need revision to incorporate simulation or other means of psychomotor learning.

Key Words: Resident education; contrast media; simulation training.

©AUR, 2012

Methods of educating radiology residents have evolved over the past decade. There has been an increase in the implementation of small-group sessions, simulation training, and Web-based models (1). This educational trend has occurred in part because of required compliance with the Accreditation Council for Graduate Medical Education's six domains of clinical competence: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice (2). The Accreditation Council for Graduate Medical Education recommends the use of the educational method of high-fidelity simulation as one way of incorporating these domains (3).

Intuitively, simulation training and other types of psychomotor learning would be more applicable than lectures for

learning procedural radiology skills and handling medication administration, such as when managing allergic-like reactions to iodinated contrast media and gadolinium-based contrast agents. Hands-on training may be the only opportunity to apply didactic material, because of the rarity of allergic-like reactions to iodinated contrast media, estimated at a incidence of only 0.05% to 3.1% (4–7). Moderate or severe reactions are even less common, accounting for only 0.04% to 0.08% of all adverse events (4–8). Thus, a resident may complete a 4-year residency program without ever encountering an allergic-like adverse event to iodinated or gadolinium-based contrast media. This may explain the alarming results of several recent surveys.

Lightfoot et al (9) showed in a survey of radiologists that only 41% provided acceptable medication doses and routes of administration, 17% administered overdoses, and 89% did not know what was required in an emergency contrast box. Another report showed that 47% of residents and attending radiologists incorrectly answered knowledge-based and skills-based questions on adverse events to iodinated contrast media (10). Initial studies of high-fidelity simulation training showed that only 26% of residents identified that clinically significant contrast media reactions were occurring, only

Acad Radiol 2012; 19:252–255

From Penn State Hershey Medical Center, 500 University Drive, Hershey, PA 17033 (J.M.P.); and the University of Washington (A.M.P., C.L.W., J.G.S., M.L.R., W.H.B.). Received July 14, 2011; accepted October 20, 2011. Address correspondence to: J.M.P. e-mail: jpetscavage@hmc.psu.edu

©AUR, 2012

doi:10.1016/j.acra.2011.10.020

TABLE 1. Survey Questions Sent Through the Association of Program Directors in Radiology

1. Each year, how many lectures do your residents receive on contrast reactions?
2. Do the lectures ever include practice scenarios/role playing?
3. Do the lectures ever include hands on learning of what the different drugs look like and how to administer them?
4. Do the residents receive special contrast reaction training during their CPR, Basic Life Support, and/or Advanced Life Support courses?
5. Do your residents get Simulation Training (with interactive mannequins) to learn about contrast reactions?
6. If yes, how long has your residency been using simulation?
7. If yes, how many simulation sessions do you hold per year?
8. How do you test residents on their knowledge of contrast reactions? Please mark all that apply.
9. Do you use computer-based programs to teach residents about contrast reactions?
10. If yes, how long has your residency been using computer programs?

CPR, cardiopulmonary resuscitation.

54% appropriately ordered epinephrine doses with chart aid, and only 68% called code teams in a timely manner (11,12).

Thus, there is concern over the methods currently used for educating and testing radiology residents on this subject. The purpose of this study was to assess the current methods of education and testing of allergic-like reactions to contrast media in US residency programs and determine if there is an evolution in educational methods in this subject area. A second objective was to provide this information to radiology residency programs to allow them to gauge if they are on par with others in terms of contrast media curricula and testing.

MATERIALS AND METHODS

A 10-question survey was created to ask residency program directors how they are educating and testing residents (Table 1). The invitation to complete the survey specifically asked for feedback on resident, not fellowship-level, contrast training to ensure only one response per academic institution. The survey included questions about resident lecture, simulation training, Web-based training, and testing methods. The survey was created using SurveyMonkey (<http://www.surveymonkey.com>), a free online survey and questionnaire tool. An invitation to participate in the survey was sent through the Association of Program Directors in Radiology with assurance that the results would be anonymously collected and analyzed. The survey was administered over a 2-month period in June and July 2010. The study received institutional review board exemption.

To further assess testing methods, the last 4 years of the American College of Radiology's in-service examination (2007–2010) were reviewed to calculate the number of questions addressing contrast media and allergic-like events.

RESULTS

Fifty-one program directors answered the survey, for a response rate of 32%. The majority of programs that responded are using lectures for their educational curricula,

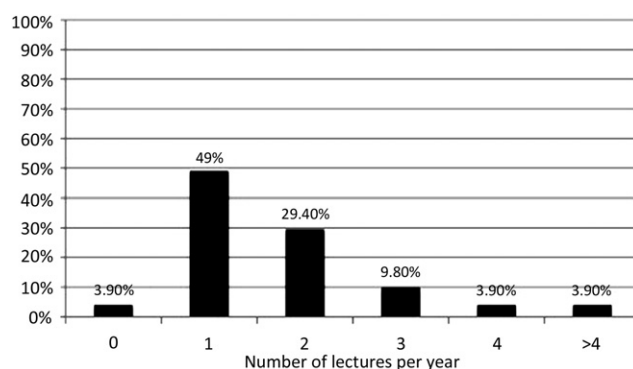


Figure 1. Number of lectures per year given on allergic-like adverse events to contrast media and percentage of programs on y axis.

with 49% giving one lecture per year, 29% giving two lectures per year, and 10% giving three lectures per year (Fig 1). Fewer than half of programs (44% and 39%, respectively) are including role-playing scenarios or hands-on training in the lecture format (Fig 2). Only 18% are using simulation training, 90% of which hold one session per year. Approximately 30% have been running simulation for 2 years, 30% for >2 years, and 40% for <2 years. Only six sites are using computer-based training, all of which have been doing so for >2 years. Thirty percent of institutions are including education on contrast media in their advanced cardiac life support or basic life support training sessions.

In terms of testing, almost half of residency programs (49%) are not testing residents at all on allergic-like reactions to contrast media. Twenty-two percent are using written testing, 20% oral testing, and 14% simulation testing (Fig 3). There were no questions on the past four American College of Radiology in-service examinations about nonrenal allergic-like reactions to contrast media.

DISCUSSION

This survey shows that resident education on allergic-like reactions to contrast media is still primarily performed using didactic lecture. Although some sites are including hands-on training or role-playing during lecture, >50% are not.

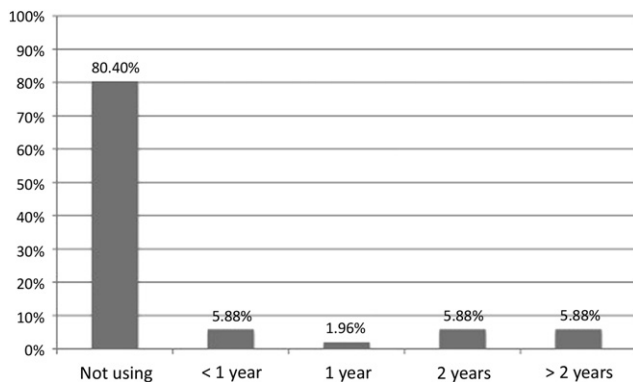


Figure 2. Percentage of programs using simulation training on y axis and length of use of simulation training on x axis.

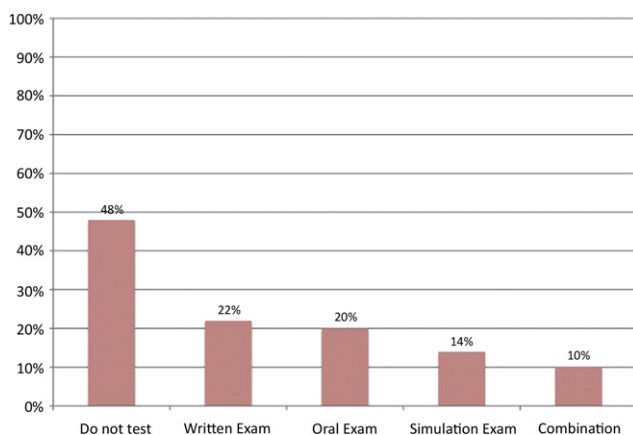


Figure 3. Summary of distribution of testing methods of allergic-like adverse events to contrast media.

Additionally, only 18% have introduced simulation training, and only 12% are using Web-based training modules. Two recent studies by Tofil et al (13) and Tubbs et al (14) showed statistically increased mean test scores after simulation training. Both studies also showed statistically improved subjective ratings of resident confidence and knowledge after simulation education. Another study by Wang et al (15) showed that residents' skills, not just multiple-choice test scores of knowledge, also improved after simulation training.

One reason that the majority of sites may not be using simulation training is the increased expenses. It is estimated that annual training per resident costs \$204 (16), compared to <\$5 for lecture. However, low-fidelity simulation mannequins are a less costly possibility that still allows hands-on training and testing. Additionally, this type of education requires greater faculty time and resident time away from clinical services. Alternatively, Web-based simulation can be performed on a more repetitive yet cheaper basis than simulation education. A Web-based program could include time limits on choosing a medication dose and route of administration and interactive question trees on the basis of residents' answers. Immediate feedback could be provided and comparison scores generated against peers. Schwid et al (17) showed statistically

higher scores on examinations in participants receiving computer simulation for advanced cardiac life support compared to standard textbook education methods.

It seems that not only the types of education but testing of residents' knowledge is insufficient, as nearly half of programs are not examining their residents. This survey result is important, because it can be easily addressed by incorporating a simulation scenario test, oral quiz, or written test within the genitourinary resident rotation. Additionally, the American College of Radiology's in-service examination does not address allergic-like reactions. The American Board of Radiology's oral examination may include a question in the genitourinary section about allergic-like contrast management, although again, this is merely knowledge memorization rather than application and performance in a real-life scenario. Additionally, there are no continuing medical education programs that offer hands-on training or simulation testing on the subject.

Ultimately, our results indicate that previous surveys showing poor radiologist knowledge and skill sets on allergic-like adverse events to iodinated contrast media and gadolinium-based contrast agents may be due not only to the infrequency of adverse events during training but also to the lack of realistic and standardized training and testing. Instead, most programs are primarily using lecture rather than psychomotor educational techniques. Changes need to be made at the national and institutional levels to increase residents' education and skills to improve patient safety.

REFERENCES

1. Towbin AJ, Paterson BE, Chang PJ. A computer-based radiology simulator as a learning tool to help prepare first-year residents for being on call. *Acad Radiol* 2007; 14:1271-1283.
2. Accreditation Council for Graduate Medical Education. Common program requirements: general competencies. Available at: <http://www.acgme.org/outcome/comp/GeneralCompetenciesStandards21307.pdf>. Accessed April 16, 2011.
3. Accreditation Council for Graduate Medical Education. Toolbox of assessment methods. Chicago: Accreditation Council for Graduate Medical Education, 1999.
4. Cochran ST, Bomyea K, Sayre JW. Trends in adverse events after IV administration of contrast media. *AJR Am J Roentgenol* 2001; 176: 1385-1388.
5. Palmer FJ. The RACR survey of intravenous contrast media reactions: final report. *Australas Radiol* 1988; 32:426-428.
6. Velasco Martin A, Perez Gonzalez E, Cortejoso Hernandez F. Monitoring of adverse reactions to iodinated contrast media in in-patients and out-patients. *Farm Clin* 1996; 13:596-609.
7. Wang CW, Cohan RH, Ellis JH, et al. Frequency, outcome, and appropriateness of treatment of nonionic iodinated contrast media reactions. *AJR Am J Roentgenol* 2008; 191:409-415.
8. Katayama H, Yamaguchi K, Kozuka T, et al. Adverse reactions to ionic and nonionic contrast media: a report from the Japanese Committee on the Safety of Contrast Media. *Radiology* 1990; 175:621-628.
9. Lightfoot CB, Abraham RJ, Mammen T, et al. Survey of radiologists' knowledge regarding the management of severe contrast material induced allergic reactions. *Radiology* 2009; 25:691-696.
10. Bartlett MJ, Bynevelt M. Acute contrast reaction management by radiologists: a local audit study. *Australas Radiol* 2003; 47:363-367.
11. Krupinski EA, Patel B, Berger W, et al. Assessing radiology resident preparedness to manage IV contrast media reactions using simulation technology. *Stud Health Technol Inform* 2009; 142:139-141.

12. Gaca AM, Frush D, Hohenhaus S, et al. Enhancing pediatric safety: using simulation to assess radiology resident preparedness for anaphylaxis from intravenous contrast media. *Radiology* 2007; 245: 236–244.
13. Tofil NM, Lee White M, Grant M, et al. Severe contrast reaction emergencies high-fidelity simulation training for radiology residents and technologists in a children's hospital. *Acad Radiol* 2010; 17: 934–940.
14. Tubbs RJ, Murphy B, Mainiero MB, et al. High-fidelity medical simulation as an assessment tool for radiology residents' acute contrast reaction management skills. *J Am Coll Radiol* 2009; 6:582–587.
15. Wang C, Schopp J, Petscavage J, et al. Prospective randomized comparison of standard didactic lecture versus high fidelity simulation for radiology resident contrast reaction management training. *AJR Am J Roentgenol* 2011; 196:1288–1295.
16. Petscavage JM, Wang CL, Schopp JG, et al. Cost analysis and feasibility of high-fidelity simulation based radiology contrast reaction curriculum. *Acad Radiol* 2011; 18:107–112.
17. Schwid HA, Rooke AG, Ross BK, et al. Use of a computerized advanced cardiac life support simulator improves retention of advanced cardiac life support guidelines better than a textbook review. *Crit Care Med* 1999; 27:821–824.