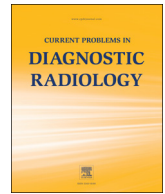




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## Interactive Learning Module Improves Resident Knowledge of Risks of Ionizing Radiation Exposure From Medical Imaging



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Physician awareness of the risks of ionizing radiation exposure related to medical imaging is poor. Effective educational interventions informing physicians of such risk, especially in emergency medicine (EM), are lacking. The SIEVERT (Suboptimal Ionizing Radiation Exposure Education – A Void in Emergency Medicine Residency Training) learning module was designed to improve provider knowledge of the risks of radiation exposure from medical imaging and comfort in communicating these risks to patients. The 1-hour module consists of introductory lecture, interactive discussion, and role-playing scenarios. In this pilot study, we assessed the educational effect using unmatched, anonymous preintervention and postintervention questionnaires that assessed fund of knowledge, participant self-reported imaging ordering practices in several clinical scenarios, and trainee comfort level in discussing radiation risks with patients. All 25 EM resident participants completed the preintervention questionnaire, and 22 completed the postintervention questionnaire within 4 hours after participation. Correct responses on the 14-question learning assessment increased from 6.32 (standard deviation = 2.36) preintervention to 12.23 (standard deviation = 1.85) post-intervention. Overall, 24% of residents were comfortable with discussing the risks of ionizing radiation exposure with patients preintervention, whereas 41% felt comfortable postintervention. Participants ordered fewer computed tomography scans in 2 of the 4 clinical scenarios after attending the educational intervention. There was improvement in EM residents' knowledge regarding the risks of ionizing radiation exposure from medical imaging, and increased participant self-reported comfort levels in the discussion of these risks with patients after the 1-hour SIEVERT learning module.

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### Introduction

In the last quarter century, the advent of advanced imaging modalities has led to a 6-fold increase in ionizing radiation exposure to patients.<sup>1,2</sup> This is mainly owing to an increased use of computed tomography (CT), which accounts for up to 70% of medical ionizing radiation exposure.<sup>3</sup> It has been estimated that up to 2% of cancers diagnosed annually could be attributable to CTs performed in the United States in 2007.<sup>3,4</sup>

Current physician awareness of radiation risks from medical imaging remains poor.<sup>5–17</sup> Proven, effective interventions to educate physicians regarding risks of radiation from medical imaging, especially in the field of emergency medicine (EM), are lacking.

The objectives of this pilot study were to design and implement an interactive, clinically oriented learning module that identifies the radiation risks of medical imaging for EM residents and assess improvement in knowledge and comfort level when discussing the risks with patients using preintervention and postintervention questionnaires.

We hypothesized that the learning intervention would improve learner knowledge of the risks of radiation exposure from medical

imaging and reduce the likelihood that trainees would order CT in clinical scenarios without a clear indication. Furthermore, we hypothesized that participants would become more comfortable discussing the risks with patients postintervention.

### Methods

This pilot study was conducted at a single urban academic institution with approximately 130,000 annual emergency department (ED) visits that hosts a postgraduate year (PGY) 1–4 EM training program. In total, 25 EM residents participated in the educational intervention during a standing weekly educational conference. The study was deemed exempt by our institutional review board.

### SIEVERT (Suboptimal Ionizing Radiation Exposure Education – A Void in Emergency Medicine Residency Training) Learning Module

The 1-hour module consisted of 3 segments: a 10-minute introductory lecture; a 25-minute facilitated, interactive small-group discussion; and a 25-minute role-playing exercise.

The introductory lecture covered several key topics, including the rise of radiation exposure from medical imaging, the

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carcinogenic effects of ionizing radiation, the units of measurement of radiation exposure, and radiation doses associated with common imaging tests ordered in the ED. This was supplemented by an introduction to the American College of Radiology Appropriateness Criteria (ACR-AC),<sup>18</sup> and suggestions for having discussions with patients regarding the risks of radiation from imaging.

The second segment (Appendix A) was a 25-minute guided, interactive, small-group discussion with participants working in groups of 2–3. Each group was given 4 clinical scenarios in which there were no accepted guidelines governing the appropriate use of medical imaging. Participants were encouraged to deliberate the optimal imaging decision. These “indeterminate” patient imaging scenarios allowed participants to assimilate and apply concepts that were presented during the introductory lecture.

The third segment (Appendix B) was a 25-minute role-playing exercise. Participants in groups of 2–3 were assigned to play the roles of the physician, the patient, or family member and given character descriptions specific to their role. The general trajectory of the conversation was laid out. Specific details of the conversation were intentionally left vague to better simulate real patient-provider interactions. The exercise allowed participants the opportunity to discuss the risks of radiation exposure from medical imaging from various perspectives. Participants alternated roles as from case to case for 4 scenarios.

### Study Questionnaire

#### Survey Demographics

Demographic data, including level of training, self-reported familiarity with ACR-AC, and frequency of discussion of the risks of radiation from imaging with patients in clinical practice (part 1 of Appendix C), were collected from all participants.

#### Learning Assessment Instrument

Identical preintervention and postintervention multiple choice questions derived from material introduced in the lecture then reinforced through discussion and role-playing were used to assess participant understanding of radiation risks from medical imaging (14 questions) (part 2 of Appendix C). All responses were anonymous, with no identifiers and completed voluntarily.

#### Survey Instrument

Self-reported imaging ordering practices were assessed using the same 4 “indeterminate” patient imaging scenarios from the learning module. Participants were asked to rate their level of comfort in discussion of radiation risks with patients preintervention and postintervention using a 5-point Likert scale (part 3 of Appendix C).

### Development and Validation

The SIEVERT educational module was developed in observance of the tenets of adult learning theory.<sup>19</sup> Specifically, it was created under the assumption that our adult learners are relevancy oriented, are practical, and learn best through active participation in an informal setting.<sup>20</sup> In turn, we minimized the length of the lecture portion to maximize time for interactive discussion and role-playing exercise. We especially designed the discussion scenarios and role-playing cases to promote open dialogue among learners. The “indeterminate” patient imaging scenarios were carefully developed as to avoid a “gold standard” answer because in our experience, residents generally do adhere to evidence-based decision rules like NEXUS<sup>21</sup> and Canadian Head CT Rules<sup>22</sup> when available and applicable. But imaging ordering practices vary widely in most patient presentations for which no

evidence-based guidelines and decision rules exist. And it is in these exact scenarios where education interventions can have the greatest potential to reduce unnecessary imaging. An iterative process was used to generate the “indeterminate” patient imaging scenarios, role-playing cases, learning assessment and survey instrument; all of which were piloted with 2 EM and 1 radiology faculty with expertise in medical education and imaging utilization.

### Statistical Analysis

Frequencies and percentages, along with mean and standard deviation were calculated in aggregate and by PGY class. Self-reported CT ordering practices were assessed by calculating frequencies and percentages for each of the 4 “indeterminate” patient imaging scenario questions. Level of comfort in discussing the risk of imaging procedures with patients was assessed using a 5-point Likert scale: “very uncomfortable, uncomfortable, neither comfortable nor uncomfortable, comfortable, and very comfortable.” Statistical analysis was conducted with SAS 9.3 (SAS Institute, Inc., Cary, NC).

### Results

A convenience sample of 25 EM residents (6 PGY-1, 5 PGY-2, 6 PGY-3, and 8 PGY-4) who attended a scheduled, weekly educational conference participated in the training. All completed the voluntary preintervention questionnaire immediately before and 22 completed the postintervention questionnaire within 4 hours after participation in SIEVERT (2 PGY-1 and 1 PGY-3 left before the postintervention assessment due to duty-hour work restrictions or other commitments). There were no incomplete questionnaires.

For the 14-question learning assessment, the mean score pretest was 6.32 (range: 1–12); and posttest was 12.23 (range: 6–14). The mean score increased similarly for all PGY levels (Fig 1).

Residents were less likely to order CT in 2 of 4 “indeterminate” patient imaging scenarios postintervention (52% vs 36% in scenario 2: first-time seizure; and 40% vs 5% in scenario 3: atraumatic headache, Appendix A). The decision to order CT in scenario 1 (first-time renal colic) and scenario 4 (suspected diverticulitis) showed no appreciable change postintervention (Fig 2).

Most residents (84%) indicated that they were not familiar at all with the ACR-AC before participation. This was consistent across all PGY levels (Table).

Before participation, 72% of residents reported that they discussed the risks of radiation from imaging with patients “sometimes,” “often,” or “always.” Overall, 24% of residents were comfortable discussing radiation risks with patients at baseline,

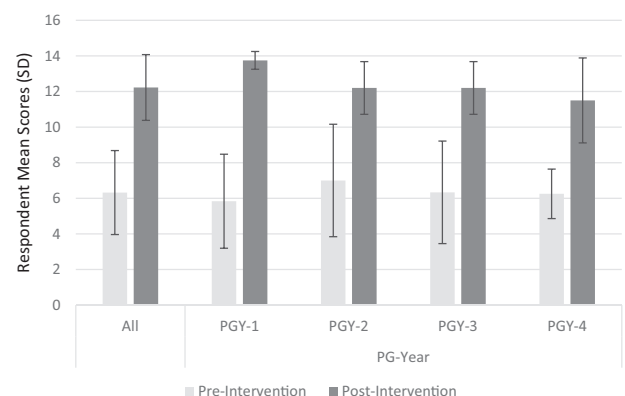


FIG 1. Preintervention and postintervention learning assessment mean scores and standard deviations out of a possible 14 questions.

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