

# Impact of case-based radiology education on first-year medical students knowledge, perceptions, and interests in the field of radiology

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## CASE STUDY

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## ABSTRACT

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Medical training institutions utilize a variety of approaches to present specialty educational material such as radiology. Typically, this material is introduced during the latter years of medical school and includes interactive modules, individual contexts, and case-based learning. This is a quasi-experimental study designed to evaluate the effectiveness of case-based radiology education presented to first-year medical students. Pre- and post-surveys were administered to measure changes in knowledge, perceptions of, and career interest in radiology. The results suggest that the use of case-based learning may improve medical students' perceived knowledge of radiology and perceived importance of radiologists in the patient care process.

### Key Words

Case-based, medical students, radiology, education

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### Implications for Practice:

#### 1. What is known about this subject?

Case-based modules adapt and execute the ideals behind problem-based learning; designed to facilitate group discussion, while integrating pre-existing knowledge and

incorporating new ideas.

#### 2. What new information is offered in this case study?

Medical education may be enhanced by integrating case-based curricula early in medical students' careers.

#### 3. What are the implications for research, policy, or practice?

With adequate follow-up and persistent educational reinforcement, the benefits to medical education realized in this study could be further expanded.

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## Background

Medical education is a complex discipline that has undergone rapid evolution in recent years. Training institutions have responded with changes in curricula and educational approaches, shifting their emphasis from didactic teaching to interactive, case-based learning.<sup>1–5</sup> Case-based (or problem-based) modules have often been implemented as interactive e-learning courses to evaluate medical students' knowledge and perceptions of educational material, although these techniques have not specifically been applied to education in the field of radiology.<sup>6,7</sup> In particular, it is important to establish a successful radiology curriculum during the early stages of medical training in ways that are well received by students, not only to nurture the future physician's medical knowledge, but also to foster a better understanding of the importance of radiology's role in patient care. However, there is little current literature exploring how case-based radiology teaching affects first-year medical students' knowledge and opinions about the field of radiology.<sup>8–10</sup>

Therefore, the goal of this study is to evaluate how the introduction of dedicated radiology case-based learning modules affected first-year medical students' 1) perceived knowledge of radiology, 2) perception of radiology's role in patient care, and 3) interest in a career in diagnostic radiology.

## Case details

This quasi-experimental study utilized pre- and post-surveys to evaluate the implementation of a new radiology case-based module curriculum for first-year medical students during the spring of 2015. The modules either replaced pre-existing radiology lectures or were new additions to the current curriculum. Attendance was mandatory for all first-year students. Those who attended the lectures were eligible to complete the pre- and post-surveys online. An institutional review board (IRB) research waiver was obtained prior to administration of the surveys since the surveys were evaluating a new curriculum and medical students' response was voluntary.

The new case-based radiology curriculum consisted of three modules focusing on cardiopulmonary, gastrointestinal, and genitourinary/reproductive imaging. Each organ system-based module was presented in a fifty-five minute session to groups of first-year medical students of less than twenty-five participants per session. During each interactive session, staff radiologists discussed a series of three clinical cases that directly mapped to the disease states covered in the students' current training modules. Final diagnoses covered a wide range of medical conditions, including infectious, traumatic, and neoplastic processes. All cases incorporated the multiple diagnostic imaging tests necessary for the correct diagnosis and management of the patient's condition. Cases were presented via PowerPoint (Figure 1) and followed a step-by-step approach that addressed the patient's history and physical findings, laboratory work-up, and other pertinent non-imaging information for the case.

With the facilitation of the radiologist, students generated differential diagnoses for each unique case and selected which imaging exams they would obtain. The radiologist offered suggestions to the students regarding the appropriateness of their choices, taking into consideration patient safety, American College of Radiology (ACR) Appropriateness Criteria, and exam cost.<sup>11</sup> Each case concluded with a short discussion about the clinical disease process, followed by a series of three-to-five multiple choice questions relative to the material to improve student retention of concepts covered in the module.

Prior to attending the first radiology case-based lectures, brief pre-surveys were distributed via email to first-year medical students enrolled in the class. Post-surveys were emailed to students who attended the case-based radiology curriculum. The pre- and post-survey questions primarily measured medical students' 1) perceived knowledge of

radiology, 2) perception of radiology's role in patient care, and 3) interest in a career in diagnostic radiology. Both surveys measured the same concepts on a five-point Likert scale, ranging from 'very knowledgeable' to 'not knowledgeable,' 'very important' to 'not important,' and 'very interested' to 'not interested,' depending on the question. Additional background questions were obtained regarding the students' previous radiology experiences.

Participant characteristics and survey responses were summarized using basic descriptive statistics (mean and standard deviation for continuous variables and count and percentage for categorical variables), and the Wilcoxon signed-rank test was used to evaluate change between the pre- and post-surveys. Statistical analyses were performed using SAS 9.4 software (SAS Institute, Inc., Cary, NC) and statistical significance was determined using p-values <0.05.

## Discussion

A total of 45 first-year medical students completed both the pre- and post-surveys, with a mean age of 24.2 years (SD±2.9) and an even gender split. The majority of students (93 per cent) had no previous radiology work history, while only half (47 per cent) had previously spoken with a radiologist to learn about a career in radiology (Table 1).

Survey results demonstrated that after participating in the case-based radiology curriculum, students' perceived knowledge of radiology significantly improved, with 44 per cent (n=20) of students classifying themselves as 'not knowledgeable' prior to the course and only 4 per cent indicating the same category after the course ( $p<0.001$ ). The percentage of students ranking themselves as 'knowledgeable' about radiology increased from 11 per cent to 33 per cent ( $p<0.001$ ; Figure 2). Although many students already acknowledged the importance of radiology to future patient care prior to the new course, the perception among medical students increased from 53 per cent to 73 per cent of participants classifying radiology as 'very important' to patient care ( $p=0.06$ ).

Conversely, students' overall interest in radiology as a career did not significantly change ( $p=0.12$ ) with 11 per cent reporting 'very interested' in radiology on the pre-survey and 13 per cent reporting the same response on the post-survey. However, students who indicated they were 'not interested' in a career in radiology decreased from 31 per cent to 16 per cent from the pre- and post-surveys, respectively. When separated by gender, there were no significant differences between survey results for male and female medical students ( $p=0.53$ ) (Figure 3).

Establishing the best method to introduce specialty practices, such as radiology, to medical students is an important educational issue that does not have an easy answer. Multiple factors influence students' desire to pursue a career in radiology and their selection of residency program. Previous studies have been conducted in order to analyse changes in curricula and educational approaches. Specifically, case-based (or problem-based) and e-learning courses have been implemented to evaluate medical students' knowledge and perceptions of educational material, although these techniques have not specifically been applied to education in the field of radiology.<sup>1,6–9</sup> This study suggests that the use of a case-based learning curriculum not only improved first-year medical students' perceived foundational knowledge of the field of radiology, but also the awareness of the critical role radiologists play in the broader patient care process. Even though half of the students viewed radiology as 'very important' to patient care prior to the new curriculum, the proportion of participants who felt this way after the lectures significantly increased. Therefore, these results suggest that these case-based modules may have reinforced how integral radiology is in the patient care process.

Despite the positive influence the new curriculum had on perceptions of the importance of radiology, first-year medical students did not demonstrate a significant change regarding pursuing radiology as a career after the lectures. This finding suggests that the course may have objectively presented the teaching concepts and did not introduce persuasion bias, which may have influenced students' perceptions of radiology positively. Therefore, this new case-based educational method may be viewed as an objective approach to teaching critical clinical radiology concepts, without serving as a 'recruiting' tactic for the radiology specialty.<sup>12–15</sup>

This study is not without limitations. First, the total number of students who completed the surveys may not be sufficient to generalize results to all medical schools. Second, perceived knowledge of the field could have been falsely elevated, as the surveys were conducted as early as two weeks after completion of the last case-based module. Long-term follow-up, including students' comfort with interpreting imaging exams, as well as additional multiple choice questions, may better evaluate the true effectiveness of the course.

## Conclusion

In summary, the results of this survey indicate that a case-based curriculum may have reinforced the value of

radiology in the patient care process and increased first-year medical students' perceived knowledge of the field, without stimulating a long-term interest in pursuing radiology as a career. As a result, medical education may be enhanced by integrating case-based curricula early in medical students' careers. Perhaps, with adequate follow-up and persistent educational reinforcement, the benefits to medical education realized in this study could be further expanded.

Additionally, the gender of the applicant is often taken into account, and program directors may strategically target female applicants in order to close the gender gap in the field of radiology. This study, however, suggests that deliberate attempts to close the gender gap may be unnecessary if equivalent early interest in the field of radiology can be sustained through the later years of medical school training.<sup>16</sup>

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## PEER REVIEW

Not commissioned. Externally peer reviewed.

## CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

## FUNDING

None

## PATIENT CONSENT

The authors, Aaron Rohr; Jacqueline Hill, Suzanne Hunt, Lucas Meek, Ryan Ash, Shelby Fishback, Kirk Miller, declare that:

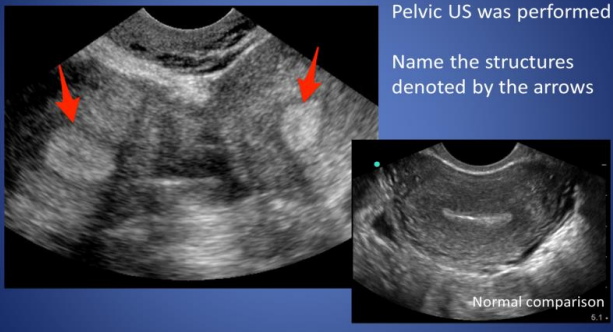
1. They have obtained written, informed consent for the publication of the details relating to the patient(s) in this report.
2. All possible steps have been taken to safeguard the identity of the patient(s).
3. This submission is compliant with the requirements of local research ethics committees.

**Figure 1: A series of PowerPoint slides extracted from chosen case-based modules of the new radiology curriculum for first-year medical students demonstrating: A) patient presentation, B) example radiologic findings, C) process of ordering appropriate examinations per accepted guidelines, and D) multiple choice questions regarding subject material**

### History of Present Illness

Laura is a 27 year old female who is unable to become pregnant. She has been married to her husband, Chris, for four years and they want to start a family. They have been trying to get pregnant for over 2 years. She presents to her primary care physician for her initial workup for infertility.

Back to our patient...



Pelvic US was performed  
Name the structures denoted by the arrows

**Clinical Condition:** Suspected Lower Urinary Tract Trauma  
**Variant 3:** Blunt perineal trauma in the male (straddle injury).

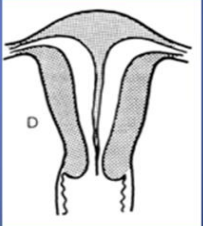
Radiologic Procedure	Rating	Comments	RRL*
X-ray retrograde urethrography	9		☆☆☆
X-ray pelvis	3	This procedure can be combined with retrograde urethrography.	☆☆
CT pelvis with contrast	7		☆☆☆
CT pelvis without and with contrast	3	This procedure adds radiation without increased diagnostic improvement beyond CT with contrast for trauma.	☆☆☆☆
CT pelvis without contrast	1	This procedure is not sufficient to diagnose urethral or bladder injury. It may detect free fluid or fracture.	☆☆☆

ACR Appropriateness Criteria®

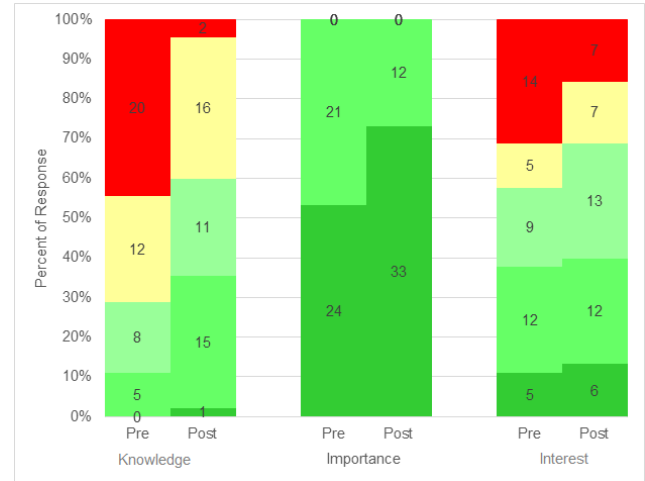
### Questions

Which of the following Mullerian duct anomalies has the worst obstetrical outcomes?

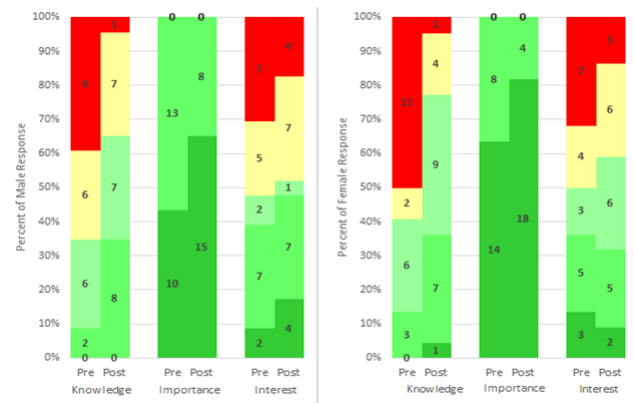
- A. Uterine didelphys
- B. Bicornuate uterus
- C. Septate uterus**
- D. Arcuate uterus



**Figure 2: Frequency and percentage of responses for pre- and post-surveys in the three domains of interest. Colour reflects response (green = positive, red = negative, yellow = neutral)**



**Figure 3: Frequency and percentage of responses for pre- and post-surveys for males (left) and females (right). Colour reflects response (green = positive, red = negative, yellow = neutral)**



**Table 1: Survey Participant Characteristics (n=45)**

Characteristic	n	%
Age, mean (SD)	24.2	2.9
Gender		
Male	23	51
Female	22	49
Radiology Work History		
Yes	3	7
No	42	93
Spoken to Radiologist about Career		
Yes	21	47
No	24	53

