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# Medical Student Usage of the American College of Radiology Appropriateness Criteria

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**Rationale and Objectives:** Educating medical students on appropriate imaging utilization has been increasingly recognized as important for patient care. The American College of Radiology Appropriateness Criteria (ACR-AC) is designed to support evidence-based imaging examination selection. We sought to assess whether medical students order imaging studies independently, what resources they use for guidance, and whether they use the ACR-AC in clinical practice. A secondary aim was to determine whether increasing familiarity with the ACR-AC could impact student usage.

**Materials and Methods:** We surveyed third year medical students at a single institution on their imaging practices, familiarity with the ACR-AC, and preferences among available resources to guide proper examination selection. The survey was performed in person before a lecture. We also designed a brief intervention to improve familiarity with the ACR-AC and then reassessed students to determine any effect on utilization.

**Results:** The response rate for the initial survey was 103 of 109 (94%) and the response rate for the second survey was 99 of 109 (91%). Our initial survey found students initiated imaging orders independently (74 of 100, 74.8%) and consulted resources to assist in examination selection (50 of 74, 67.6%). Students expressed a preference for non-ACR-AC resources, notably UptoDate via its online mobile application. Few students (8 of 71, 11.3%) were familiar with the ACR-AC. After an intervention to increase familiarity with the ACR-AC, student awareness of the ACR-AC increased to 61 of 74 (82.4%). However, usage among those familiar with the resource remained low, 13 of 61 (21.3%) versus 3 of 8 (37.5%).

**Conclusions:** Use of the ACR-AC was low among third year medical students. After increasing students' familiarity with the ACR-AC, their usage in a clinical setting did not increase. The largest barrier to use may be the lack of a quick, easy to use online mobile application-based interface.

**Key Words:** Medical student; education; radiology; ACR appropriateness criteria.

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Medical imaging is a critical and growing component of modern medical diagnosis and practice. Over the past 4 decades, advances in diagnostic imaging have contributed greatly to patient care, improving our ability to detect disease, guide procedures, and deliver treatments (1). Most medical specialties now regularly use medical imaging, which has led to a substantial increase in the number of diagnostic imaging examinations performed in recent years (2,3). It is estimated that imaging services have grown at about twice the rate of other health care technologies over the past decade (4).

The increased use of medical imaging comprised examinations that are beneficial to patients' welfare and examinations that could be considered inappropriate to use (4). Several publications have documented that as many as 25%–50% of advanced imaging studies fail to improve patient welfare and may be unnecessary (4–7). This not only contributes to escalating health care costs in the United States (4,8,9) but also exposes patients to unnecessary risks including radiation, contrast-related complications (7,10–14), and unnecessary interventions for incidentalomas (15).

Among a number of factors that contribute to imaging overutilization, physician knowledge gaps regarding imaging safety and appropriateness play an important role (4,16). Studies have shown that referring physicians sometimes lack expertise in determining which tests are most appropriate. For example, Lehnert and Bree (17) found that 26% of computed tomography or magnetic resonance imaging scans performed by primary care physicians were for inappropriate indications. A separate survey of medical house staff found that less than 50% of respondents were able to correctly answer half

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the questions regarding appropriate imaging test choice for specific clinical situations (18). In addition, a number of studies have demonstrated that referring physicians and physician trainees, regardless of specialty, lack knowledge of radiation doses and safety (19–24).

Thus, educating physicians on appropriate imaging utilization and imaging safety has been increasingly recognized as important for patient care and health care cost containment (25–29). Targeted education campaigns have been promoted by a number of medical organizations, including the “Choosing Wisely” and “Image Gently” campaigns (30,31). Efforts have also included the development of electronic order entry systems with integrated clinical decision support systems (16,32). Others have developed free access resources that aim to help physicians select imaging modalities that are safer and more appropriate for their patients. The American College of Radiology (ACR) has developed one of these comprehensive imaging decision support resources called the ACR Appropriateness Criteria (ACR-AC). This free, online, evidence-based, peer-reviewed resource is designed to help referring physicians choose the best imaging examination for more than 200 commonly encountered clinical scenarios (33). It provides an appropriateness rating of each imaging option and most importantly attempts to introduce radiologist knowledge into the decision algorithm before the examination being ordered. Specifically, each potential test is described with a discussion of both its pros and cons including any associated radiation risk and a pertinent literature review regarding each option.

Despite the availability of versions of the ACR-AC since 1993, awareness and utilization of this resource by nonradiologists remains low (1,26,34). For instance, a survey by Bautista et al. (27) found that 1.7% of residents and 3.0% of attending referring physicians reported using the ACR-AC as one of their top three resources for selecting the best imaging technique. Another survey found that 81% of interns across a wide representation of referring specialties had never heard of or used the ACR-AC (35). Unsurprisingly, awareness of this resource is also low among medical students. As most current medical students will become future referring physicians, it is of particular importance that education efforts are directed toward this group. A study by Dillon et al. (29) found that 96% of senior medical students at one institution were not aware of the ACR-AC. A survey of students at multiple US medical schools by Prezzia et al. (28) found that 77% had never heard of the ACR-AC.

The purpose of this study was to assess whether medical students at our institution order imaging studies independently, what resources they use to help in decision making, and whether those familiar with the ACR-AC use the resource in clinical practice. A secondary aim was to determine whether increasing familiarity with the ACR-AC could impact student usage. To our understanding, this is the first study to evaluate medical student use of the ACR-AC within a clinical setting.

## MATERIALS AND METHODS

This study was confirmed as exempt-status by our institutional review board.

### *Survey Design and Administration*

A survey was created to assess awareness and use of the ACR-AC as well as imaging practices and preferences among third year medical students. The 11-question survey was created by a team of three authors and then reviewed and edited by two faculty members with extensive experience in educational survey design. The survey comprised questions using a 5-point Likert Scale, yes or no, multiple choice, and free response formats; the survey questions are presented in Tables 1–3.

The survey was distributed on paper, in person to 109 third year medical students (of a class of 150) who were in attendance for a radiology lecture in October 2014, during which the ACR-AC were not discussed. The lecture was part of a weeklong course that occurred midway in third year, between core rotations. The survey was distributed by a member of the third year medical student class who was among the study authors. Surveys were collected anonymously, and students did not indicate their name or identifying information. Participation was optional.

### *Increasing Student Familiarity with the ACR-AC*

At our institution, radiology is taught in an integrated longitudinal fashion over the first 2 years (30 hours). During the third year, students have four radiology lectures that occur in between clinical clerkships that focus on skills for wards. However, the ACR-AC is not currently incorporated into the radiology curriculum until the fourth year, when most medical school class take a 4-week elective focused on appropriate imaging examination selection (100 hours). To introduce third year medical students to the ACR-AC, a lecture describing the purpose, utility, and benefits of the resource was given immediately after the collection of the preintervention survey. The lecture material was presented by two third year medical students (who were study authors) and a radiology faculty member using a PowerPoint presentation. The tutorial also included a live demonstration on how to access and navigate this resource using “right lower quadrant pain” as a clinical vignette. To remind students about this resource, and for those not in attendance, a follow-up e-mail was sent 1 week later to all third year medical students that included the lecture slides and instructions on how to use the ACR-AC. Students were also provided an electronic PowerPoint module on their online course platform as reference material.

### *Follow-up Survey Design and Administration*

A 13-question postintervention survey was designed to evaluate whether this brief intervention had any impact on student use of the ACR-AC and on various imaging

**TABLE 1. Third Year Medical Student Responses to “Yes/No,” “Multiple Choice,” and Likert-Scale Survey Questions**

Question	Answer Choices	Preintervention Responses, n (%)	Postintervention Responses	P Value
Have you ever placed an order for an imaging exam (including orders which needed to be co-signed) before?	Yes	70 (68)	74 (74.8)	.35
	No	33 (32)	25 (25.2)	
How often do you initiate ordering an imaging study on your own (as opposed to being told that ordering an imaging study is needed)?	5 Always	0 (0)	0 (0)	.025
	4 Often	4 (5.6)	7 (9.5)	
	3 Sometimes	18 (25.4)	31 (41.9)	
	2 Rarely	34 (47.9)	31 (41.9)	
	1 Never	15 (21.15)	5 (6.8)	
Do you typically consult any resource in deciding what study to order?	Yes	46 (64.8)	50 (67.6)	.72
	No	25 (35.2)	24 (32.4)	
If so, which resource do you primarily use?	UpToDate	42 (*)	55 (*)	.001
	Medscape	4 (*)	3 (*)	
	ACR-AC	6 (*)	6 (*)	
	Google	11 (*)	7 (*)	
	Access Medicine	1 (*)	0 (*)	
	Other	15 (*)	2 (*)	
Have you ever heard of the ACR Appropriateness Criteria?	Yes	8 (11.3)	61 (82.4)	<.001
	No	63 (88.7)	13 (17.6)	
If you have heard of it have you ever used the ACR Appropriateness Criteria in deciding what to order?	Yes	3 (37.5)	13 (21.3)	.37
	No	5 (62.5)	48 (78.7)	
Did learning about the ACR Appropriateness Criteria change how you approach ordering imaging studies? <sup>†</sup>	Yes	N/A	12 (20.1)	N/A
	No		46 (79.3)	
If you have heard of the ACR Appropriateness Criteria, how likely are you to use it in your future practice? <sup>†</sup>	5 Very likely	N/A	18 (23.1)	N/A
	4 Likely		28 (35.9)	
	3 Possibly		29 (37.2)	
	2 Unlikely		2 (2.6)	
	1 Not at all		1 (1.3)	
How often do you have input on what imaging study is ordered in collaboration with the team?	5 Always	5 (4.9)	9 (9.1)	.24
	4 Often	14 (13.7)	19 (19.2)	
	3 Sometimes	37 (36.3)	41 (41.4)	
	2 Rarely	40 (39.2)	27 (27.3)	
	1 Never	6 (5.9)	3 (3.0)	
When orders are placed for an imaging study, how strong is your understanding of the rationale for the choice of imaging (ie, CT vs. MRI vs. US)?	5 Very strong	2 (1.9)	4 (4.0)	.38
	4 Strong	27 (26.2)	32 (32.3)	
	3 Moderate	65 (63.1)	59 (59.6)	
	2 Low	9 (8.7)	4 (4.0)	
	1 None	0 (0)	0 (0)	
If a resource were designed to help you learn about and select appropriate radiology studies, what format would you prefer?	Mobile application	66 (*)	69 (*)	.68
	Book	4 (*)	8 (*)	
	Internet site	43 (*)	36 (*)	
	Electronic medical record based	19 (*)	19 (*)	
	Other	2 (*)	1 (*)	

ACR-AC, American College of Radiology Appropriateness Criteria; CT, computed tomography; MRI, magnetic resonance imaging; N/A, not applicable; US, ultrasound.

\*Percentage could not be calculated as some respondents chose more than one answer option.

<sup>†</sup>Questions included only on postintervention survey.

**TABLE 2. Responses to the Free Text Question: "Why Do You Prefer This Resource?" Coded Categories for Those Respondents Choosing the Most Common Option: UptoDate**

Coded Responses for Students Choosing UptoDate as Preferred Resource	Number of Respondents
Easy to use	17
Habit/familiarity	10
Trust/reliability	7
Availability of other information (medical management, and so forth)	7
Used by other members of the team	4
Links to literature	4
Organization/format	3
Fast/efficient	2
Comprehensive	2
Other	1
Total responses	57*

\*Percentages of total not calculated as some students chose multiple options.

behaviors. The postsurvey was administered 6 months after the intervention and presurvey and at the end of the students' third year. The preintervention and postintervention surveys were nearly identical. Two additional questions were added to the postintervention survey. These are marked with an dagger in Table 1.

The postintervention survey was administered using the same methodology to 110 of 150 students in attendance at a radiology lecture. Given slight variations in attendance to specific lectures, the groups of 109 and 110 surveyed students (which comprised approximately 73% of the medical school class each) had substantial overlap, although were not exactly the same cohort. To maintain anonymity and survey feasibility, responses were not collected in a paired fashion.

### Data Coding

The survey included two free text questions. A single radiologist analyzed all free text responses for common themes and coded each individual comment by theme.

### Statistical Analyses

Data were summarized with the absolute number and percentage selecting each answer choice. To statistically compare answers to questions asked on both the preintervention and postintervention surveys, the Fisher's exact test was used. Differences were considered statistically significant with a  $P$  value < .05.

## RESULTS

The response rate for the initial survey was 103 of 109 (94%), and the response rate for the second survey was 99 of 110 (90%). The survey responses for yes or no, multiple choice, and Likert Scale questions are reported in Table 1.

**TABLE 3. Coded and Categorized Responses to the Free Text Question: "If You Have Heard of the ACR Appropriateness Criteria but Have Not Used it in Practice, Why Not?"**

Coded Responses	Number of Respondents
Forgot	21
Attending/resident decided what to order	7
Habits/familiarity	6
Did not need resource	4
Accessibility/usability	3
Did not place order	3
Other	3
Not used by team	2
Total responses	47*

\*Percentages of total not calculated as some students chose multiple options.

Most students reported initiating imaging examination orders independently (74 of 100, 74.8%) and consulting resources (50 of 74, 67.6%), but they expressed a strong preference for non-ACR-AC resources, most notably UptoDate (<http://www.uptodate.com>) via its online mobile application interface. In a free text question, students were asked, "Why do you prefer this resource?" Responses (UptoDate,  $n = 42$  for survey 1 and  $n = 55$  for survey 2) were coded into 10 different categories and are presented in Table 2. Most respondents cited ease of use and familiarity as the leading reasons. Students expressed a strong preference for an imaging examination selection resource to be formatted as a mobile application.

Perceived awareness of the ACR-AC resource increased from 8 of 71 (11.3%) to 61 of 74 (82.4%) 6 months after the lecture and tutorial. Although more students used the resource, given that more were familiar with it (13 after the intervention compared to 3 on the preintervention survey), the proportion of students choosing to use it remained low, only 13 of 61 (21.3%) versus 3 of 8 (37.5%) preintervention.

Students were asked, "If you have heard of the ACR-AC but have not used it in practice, why not?" Free text responses were coded into eight different categories and are presented in Table 3. Most respondents simply said they "forgot" about it during relevant moments, deferred to the opinions of the resident or attending, or used more familiar resources.

## DISCUSSION

Similar to previous authors (28,29), we found that most third year medical students at our institution had not heard of the ACR-AC. Most students who consulted a reference when choosing an imaging study used UptoDate. After performing a simple introduction to increase familiarity with the ACR-AC, awareness of the resource markedly improved (from 11.3% to 82.4%,  $P < .001$ ). However, use of the resource among those who were aware of it did not increase, 21.3% after the intervention compared with 37.5% initially.

The students' preference for UptoDate was true both before and after the intervention, and in fact, use of UptoDate

significantly increased ( $P = .001$ ) later in their clerkship year despite increased familiarity with the ARC-AC. This may be due to the students simply becoming more seasoned during their additional 6 months experience on wards, and thus becoming more familiar with the common practices and resources of their supervising residents and student colleagues. The most common reason students provided for their reliance on UptoDate was its ease of use ( $n = 17$ ), including its online application-based format. Habit and familiarity ( $n = 10$ ) was also a commonly cited reason for use of the resource, as was trust ( $n = 7$ ), and the fact that it was used by other team members ( $n = 4$ ).

Given that more attention has been placed on proper utilization and reducing risks from imaging, there has been a renewed focus among medical educators on improving the radiology education trainees receive in medical school (1). There is a growing trend toward abandoning curricula that focus almost entirely on imaging interpretation skills in favor of those that emphasize imaging appropriateness and safety (1,3,28,29,36,37). This concept was underscored by a recent national survey of Radiology Department Chairs and Medical School Deans, who called for the development and incorporation of resources that emphasize imaging safety, appropriateness, and utilization into medical school curricula, including the ACR-AC (1). Another argument for including this type of content within medical training is the idea that instilling good imaging practices early in training is more effective than correcting already formed habits (1,28). Ideally, if medical students can be taught to use appropriate imaging practices (such as use of the ACR-AC), they will be more likely to use these practices throughout their careers (7). Ultimately, this may help improve patient care and reduce costs by reducing unnecessary imaging.

Although such education efforts focusing on appropriate examination selection are increasingly targeting medical students in an attempt to effect their future practice patterns, many assume that medical students do not actually order imaging studies themselves. We found that most third year medical students at our institution do place orders for imaging studies (75%), and of those that do, most (93.2%) have initiated requesting studies on their own without consulting other members of their team. Therefore, targeting education efforts toward these students is not just for the benefit of their future imaging habits, but for their current practices as well.

Our study suggests that increasing awareness of the ACR-AC is not enough to increase use of the resource among medical students. Should increasing utilization of the ACR-AC be a goal, as suggested by some authors and radiology organizations (1), greater efforts beyond simply publicizing the resource will likely be required. Based on our institutional experience, it seems unlikely that the resource will be used preferentially in the future practice of these students unless it is presented in an easy to use, easy to access, searchable, online mobile application-based format (the most desired feature reported by students,  $n = 69$ ). Or secondarily, unless its use is guaranteed by incorporation into an Electronic Health

Record-based decision support program such as "ACR Select" (38), an idea that also held appeal to the students ( $n = 19$ ). Other authors have also suggested that the format could be more "user friendly" and suggested that numeric rankings for many possible imaging tests could be replaced by more concise recommendations or flow charts (39).

In addition, expansion of traditional education efforts would also likely be useful. More comprehensive integration of ACR-AC-based materials into medical school curricula, could certainly have a more substantial effect on use of the resource than the single lecture-based introduction in our study. Efforts are currently underway by the Alliance of Medical Student Educators in Radiology to create sharable, discrete resources (educational blocks) that will include an expanded focus on appropriate imaging examination utilization and patient safety.

There are additional factors that may contribute to underuse of the ACR-AC beyond those which were elucidated in our study. Some authors have suggested that the ACR-AC are not adequately "evidence-based," relying heavily on expert opinion in some cases (39). It is possible that such opinions affect use among referring clinicians, but this was not specifically addressed by the medical students in our study population.

Although our students did not report increased use of the ACR-AC over this study period, most (59%) said they would likely or very likely use the resource in their future practice. It is likely that to some extent, the medical student's subordinate role on the clinical team may have impaired introduction of the ACR-AC as a new tool, when most more complex imaging decisions were likely made by supervising physicians. Even when imaging appropriateness resources were consulted, the students would likely defer to their residents or attendings preferred sources, an occurrence that was reported by some students. If any attempts at increasing familiarity with the ARC-AC are to have substantial effect on medical students' imaging habits, supervising residents and faculty would likely need to be targeted, as well.

Our study has several additional limitations. First, it represents the experience at a single institution only. Second, the student surveys were collected anonymously and as such responses on the initial and follow-up surveys were not linked, thereby mildly hindering sensitivity for detecting differences. In addition, our introduction to the ACR-AC was short, comprised a single lecture and a reminder e-mail to the entire class. It is possible that a more sustained intervention would yield more pronounced findings. We also relied on self-reporting to estimate usage of the ACR-AC resource, as we had no mechanism to track direct accessing of the ACR-AC content. The second survey was also administered 6 months after the lecture introduction to the ACR-AC. Given our reliance on self-reporting, it is possible that perceived usage might have been higher if the second survey occurred earlier. However, we hoped to give the students adequate occasion to use the resource during their core clerkships. Finally, we did not directly assess whether imaging appropriateness improved among students who used the resource or whether there

was any difference in imaging appropriateness between students who used the ACR-AC compared to other resources.

In summary, we found that use of the ACR-AC was low among third year medical students, despite the fact that they did order imaging studies independently and often used a resource to assist in appropriate examination selection. Furthermore, use remained low even after increasing familiarity with the resource. This underutilization is concerning for the immediate impact on their patients but also is significant for the lost opportunity for radiologists to influence imaging practices shown to be inefficient currently. The largest barrier to improved utilization amongst this medical student population appears to be the lack of a quick, easy-to-use online mobile application-based interface. Packaging of the ACR-AC in such a format might substantially increase its appeal and practicality to the next generation of digitally savvy physicians. Incorporation of the imaging AC into electronic order entry decision support software was less desired, but was also thought to represent an improvement over the current format. In addition, more comprehensive integration of ACR-AC-based learning materials into medical school curricula, might have a more pronounced effect on student usage of the resource. These improvements could have a large effect on future physician ordering practices and improvement of rational, safe, and cost-effective use of medical imaging.

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