Teaching Radiology to Medical Students—There Is a Need for Change to Better Prepare Students for Clinical Practice

Brian M. Moloney, MB, MCh, Christine E. McCarthy, MB, MRCP, Dara Byrne, MB, MMedEd, Terri P. McVeigh, MB, MRCS, Michael J. Kerin, MCh, FRCSI, Peter A. McCarthy, FRCPI, FFRRCSI

Rationale and Objectives: Deriving maximum benefit from radiology rotations in medical schools is challenging. Lack of education on appropriate imaging renders students feeling unprepared. This study compares the ability of undergraduate medical students to identify appropriate radiological investigations, both at the beginning and end of their final year of education, to those of residents in their first year of clinical practice.

Materials and Methods: Twelve scenarios were extracted from the American College of Radiology's Appropriateness Criteria (ACR-AC) and a questionnaire was generated. One topic was selected from each of the 10 sections in the diagnostic section and two from the interventional section. The questionnaire was distributed to three groups. Group A was composed of medical students at the beginning of final year. Group B was composed of medical students at the end of final year. Group C was composed of residents at the end of their first year of clinical practice. Radiology residents were surveyed to assess familiarity with the ACR-AC among trainees in Ireland.

Results: The total cohort included 160 participants. Group C ($n = 35$) performed significantly better than group A ($n = 72$) and group B ($n = 53$). There was no statistical difference in the mean scores achieved by group A and group B. Sixteen (73%) of 22 radiology trainees were familiar with the ACR-AC.

Conclusions: A minimal improvement in the knowledge of medical students in requesting radiological investigations over the course of the final medical year, yet a significant impact of a relatively short period of "on-the-job" learning in the clinical setting, was indicated. Emphasis on education on appropriateness may offer an improvement in the utilization of radiology services and improve patient care.

Key Words: Medical students; Appropriateness Criteria; radiology curriculum; preparedness for practice.

INTRODUCTION

Radiological investigations are important diagnostic tools in the evaluation of patients. Although the interpretation and reporting of radiological investigations are a core clinical activity for radiologists, an awareness of the utility, limitations, and risks associated with different imaging modalities is important for all doctors. Recent technological advances in computed tomography (CT), ultrasonography, and magnetic resonance imaging have greatly increased the number of requests for these investigations by doctors (1). A combination of expeditious imaging processing and greater diagnostic information from the imaging modalities has rendered diagnostic imaging more attractive (2). The majority of specialties increasingly request medical imaging, and this has seen an upsurge in diagnostic imaging examinations performed in recent years (3,4).

With access to multiple imaging modalities becoming more commonplace, the reliance by healthcare providers on imaging has intensified significantly (5,6). Imaging services are estimated to have grown at twice the rate of other healthcare technologies over the last decade (7). Rise in the use of imaging in patient care means that, although imaging is being used to positively impact patient welfare in most circumstances, it is also being used inappropriately. The selection of the most appropriate radiological investigation is a combination of multiple competencies: the interpretation of the clinical presentation, due regard for available evidence and best practice, cost-effectiveness, limitations, and risk-benefit analysis. Deficiencies

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From the Department of Radiology, Galway University Hospital, Saolta University Health Care Group, Galway, Ireland (B.M.M., D.B., P.A.MC.); School of Medicine, Clinical Science Institute, National University of Ireland, Galway, Costello Road, Galway, Ireland H91 YR71 (B.M.M., C.E.MC., D.B., T.P.MV., M.J.K., P.A.MC.). Received July 19, 2016; revised September 30, 2016; accepted October 6, 2016. **Address correspondence to:** B.M.M. e-mail: Brian.m.moloney@nuigalway.ie

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in the knowledge of the requesting doctor may contribute to inappropriate imaging, leading to subsequent image overutilization (7,8). Furthermore, inappropriate scanning may lead to identification of incidental findings unrelated to the patient's clinical presentation, may expose the patient to unnecessary risk, or may falsely reassure the patient or the clinician. Educational efforts by medical organizations have attempted to address this, and the need for improvement has been reiterated for a number of years (2,9,10).

In medical school, the teaching of radiology is often limited to image interpretation and the recognition of abnormal findings. Delivering the type of radiology teaching that promotes critical thinking and decision making around the requesting of radiological investigations is challenging. Radiology is often taught as a distinct course, and may not be integrated into clinical rotations. Obtaining maximum educational benefit from radiology rotations in medical school has historically been considered difficult (11).

The dynamic nature of the discipline of radiology can rapidly render teaching methods outdated, with the radiology curriculum ever-expanding. There is a need for a continued audit and revision of the curriculum in order to ensure its proper role (12). Due to continuous change, comprehensive international standards of educational practices in undergraduate radiology remain undefined, calling for recommendations for an innovative curriculum and the production of suggested frameworks (13,14). The absence of a unified syllabus can result in redundant teaching, gaps in knowledge, and lack of continuity in the curriculum (15). In many medical schools, self-directed teaching is strongly encouraged, resulting in the rotation being seen as merely an opportunity for a "radi-holiday" (16). Internationally, the move toward competency-based frameworks, such as entrustable professional activities in postgraduate radiology, is helping to define what is expected of a radiology trainee, and a similar framework may be applicable in undergraduate teaching (17).

The combination of a lack of education on the appropriate indications for various radiological investigations and a radiology curriculum that is in a continuous state of flux leaves medical students feeling unprepared for work as a junior resident, when a large proportion of their time will be spent requesting such investigations (18–20). In the "Your Training Counts" report from the Medical Council in Ireland (2015), only 53% of residents in their first postgraduate year reported that their previous medical education had prepared them for the job of a resident, whereas 64% reported that the lack of preparedness was a medium-sized or serious problem (21).

In 1993, the American College of Radiology (ACR) developed the ACR Appropriateness Criteria (ACR-AC). Regularly updated, the ACR-AC offers both physicians and medical students an online resource to assist with identifying appropriate imaging needs. It embodies the best, current, evidence-based, peer-reviewed guidelines designed to assist in identifying appropriate diagnostic imaging selection, radiotherapy protocols, and image-guided interventional procedures. The ACR-AC has previously been praised for its comprehensive coverage of modalities and is a valuable resource for teaching evidence-based imaging to medical students (9). Despite being identified as a valuable learning source, knowledge and utilization of the ACR-AC among doctors and medical students remain negligible. Of 126 physicians who completed a questionnaire investigating the use of the ACR-AC, 1.59% (two physicians) claimed to use the ACR-AC as the first source when selecting the best imaging technique for their patients (2). Similar to a questionnaire study of 259 medical students, 96% (223 students) had no prior knowledge of the ACR-AC (9). This current study sought to evaluate and compare the ability of final year medical students to identify appropriate radiological investigations, as predetermined by the ACR-AC, both at the beginning and end of their final year in medical school, to those of residents in their first year of clinical practice.

MATERIALS AND METHODS

In keeping with the guidelines produced by the Intern Network Executive, ethical approval was sought and granted from the principal hospital site attached to the intern training network from which the first year residents were recruited into the study. This was a large teaching hospital in the West of Ireland. Of note, in Ireland, the first year of residency is termed "internship" and the residents are termed "interns."

Questionnaire Design and Administration

The ACR-AC was accessed through the ACR website. A single topic was selected at random from each of the 10 sections in the diagnostic section. These sections included breast, cardiac, gastrointestinal, musculoskeletal, neurologic, pediatric, thoracic, urologic, vascular, and gynecology. Two topics were selected from the interventional section. In total, 12 topics were chosen, as outlined in Figure 1. As there are a number of different topics in each section (eg, breast, 6; cardiac, 12; gastrointestinal, 15, etc), a topic was determined using a random number generator (Random.org, Dublin, Ireland). The same method was applied to the interventional radiology section and two questions were selected randomly from this section. The electronic multiple choice questionnaire, which is composed of 12 questions based on these topics, was designed and disseminated using surveymonkey.com (Table 1).

The questionnaire was distributed to three study cohorts by e-mail. A link to the online questionnaire was included in each e-mail, and a reminder e-mail was distributed after 2 weeks. The first cohort (group A) was composed of medical students at the beginning of their final year in medical school who had not yet completed a formal clinical radiology module in their undergraduate programs. The second cohort (group B) was composed of a second group of medical students at the end of their final year who had completed a radiology module. Both student groups were recruited via e-mail from