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Reading Room Electives: Say Goodbye to the “Radi-Holiday”

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Reading room electives are among the most challenging curricula to develop for medical student educators. Students tend to have few responsibilities and poorly defined learning objectives. The authors review the components of a successful reading room elective. The important components include a thorough orientation, written goals and expectations, attendance and feedback systems, objective mid-elective and end-of-elective evaluations, and an end-of-elective debriefing session. Many educational activities, tools, and assessments are available and should be considered to supplement the curriculum. Radiology electives must break free of the “radi-holiday” stereotype and adopt increased responsibilities and expectations, similar to rigorous clinical subinternships.

Key Words: Reading room electives, medical students, curriculum, teaching

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AN EDUCATIONAL CHALLENGE

Reading room electives present a significant challenge for medical student educators. The most difficult obstacle is that the primary activity is typically passive shadowing. Other clinical medical school electives, particularly those in the senior year, involve direct patient care and well-defined clinical responsibilities.

Three main reasons seem responsible for the passive nature of reading room electives. First, the practice of radiology is highly specialized. It is difficult to identify entry-level tasks suitable for medical students. Additionally, the sporadic nature of student enrollment in some reading rooms prevents the consistent assignment of these tasks to students. The use of specialized computer hardware and software with personalized login requirements further complicates the matter. Second, radiology training is generally not considered “essential” for graduation from medical school [1]. Students are expected to learn accurate assessment of the heart and lungs with a stethoscope but not with a chest x-ray. Some authors have proposed more exposure to radiology education early in medical school [2,3], which would likely help establish more defined expectations. As it stands now, many schools lack a universal set of radiology learning objectives to guide reading room and other electives. Finally, the shiftlike rotation of attending radiologists, fellows, and residents, even

from day to day, can limit the ownership supervising instructors have of students’ learning.

There are additional reasons why some radiology rotations have remained relatively unstructured. More flexible, easier rotations are often fun and relaxed, thereby attracting more students or students who would otherwise not sign up for the elective. More flexible rotations also sometimes allow students to be away for residency interviews, which can be very desirable during senior year. Radiology electives at many institutions have earned the name “radi-holiday” because of their easy or unstructured nature.

Reading room electives can be popular and educational while also being rigorous. To overcome the challenges listed above, these electives must have a detailed structure similar to other clinically oriented electives. A multitude of activities and responsibilities should be assigned. The era of radi-holiday electives [4] should pass; such electives do not reflect the busy, modern practice of radiology, and they are a disservice to students’ education. Herein, we describe the key components of a successful elective, including a suggested chest radiology curriculum using widely available resources. We have instituted these recommendations at a medical school with an enrollment of 600 students and an affiliation with a large tertiary care hospital; approximately 30 students enroll in reading room electives per year.

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THE NECESSARY COMPONENTS

An Attending Radiologist Responsible for the Student(s) and Support From the Full Section

Students appreciate having a single individual responsible for their education while on a given elective. Often, it

is that same person who is responsible for the administrative tasks of the course, such as submitting grades. This single designated individual may be the course director or, in larger departments, a section representative (eg, a designated faculty member from the abdominal imaging section). In the latter case, there should be regular face-to-face meetings between all faculty members who participate in medical student education. The structure and expectations of a reading room elective should be standardized across all sections. Everyone on service should have a common understanding of the elective's activities and expectations. Residents often play an informal role in students' reading room experiences, but residents particularly interested in teaching [5] may be given more formal roles. Of note, residents should never take the place of an attending radiologist in being ultimately responsible for students.

First-day One-on-One Orientation With an Attending Radiologist

Bewilderment on the first day of an elective is uncomfortable for students. Before the start of the elective, a departmental coordinator or the course director should e-mail a welcome note with specific instructions for the first day. The designated attending radiologist or course director should meet with the student at an assigned start time. Orientation should include an introduction to the people in the reading room, including those who will rotate in later on. The structure of the elective, goals and expectations, resources, and methods of assessment should all be discussed. Required activities should be explained in detail. If possible, the information imparted should also be provided in written (or digital) form for later reference. In particular, it is essential that the orientation, expectations, and learning objectives be written and verbally communicated, with sufficient time for questions and clarification.

Written Orientation, Expectations, and Learning Objectives

An orientation guide should be provided. This may be edited over time to include answers to frequently asked questions. The list of detailed written expectations should include the attendance policy, time to show up, proper attire, and so on. An outline for a written orientation guide with course expectations is provided in Table 1.

Next, there should be a complete, well-crafted set of learning objectives. There is a complex science behind writing learning objectives, which is well described elsewhere [6-10]. If a course does not have a set of defined learning objectives already in use, the Alliance of Medical Student Educators in Radiology website (http://www.aur.org/Affiliated_Societies/AMSER/amser_curriculum.cfm) provides a list of suggested objectives that can be used by course directors in a variety of different types of radiology electives and educational settings. The

Table 1. Outline for the written "orientation and expectations" document given to students enrolled in reading room electives

Enthusiastic welcome
Orientation to people in the section and to the reading room
Expectations for attendance
<ul style="list-style-type: none"> ● Adhere to medical school attendance policies ● Know expected arrival and leaving times ● Request an excused absence ● Record attendance
Proper attire
Orientation to computers and clinical applications
<ul style="list-style-type: none"> ● How to obtain login information ● How to use the PACS ● How to use the non-PACS computers in the reading room, including computers with internet access ● How to access the internet with a personal laptop ● How to find patient histories with the clinical applications
Course website
<ul style="list-style-type: none"> ● Access the course website ● Orientation to the type of information and resources available on the site (eg, course documents, required reading)
Assignments
<ul style="list-style-type: none"> ● Assignments listed with due dates and detailed descriptions ● Note that each assignment is linked to one or more learning objective
Providing feedback
<ul style="list-style-type: none"> ● Tips for giving helpful feedback as a student ● Formal end-of-elective feedback from the student
Assessments
<ul style="list-style-type: none"> ● The contribution of each assignment to the student's assessment ● Mid-elective assessment of the student ● End-of-elective assessment of the student ● Orientation to the written assessment provided to the medical school
Last-day debriefing
<ul style="list-style-type: none"> ● Student assessment discussed and feedback solicited
The future and advising
<ul style="list-style-type: none"> ● Requesting a letter of recommendation ● Keeping in touch ● Calling if we can help at any time

Note: The full version is made available to students on the course website and is discussed verbally on the first day of the elective.

alliance also provides online resources on writing learning objectives so that these can be customized to any particular program. An example set of learning objectives from our chest radiology reading room elective is provided in Table 2.

After the learning objectives, the required activities of the elective should be described in detail, including how to access the necessary resources, due dates, and so on. Finally, each educational activity should be linked to specific learning objectives. The mid-elective and end-of-elective feedback and assessment plans should also be covered in this document as well as discussed verbally.

Table 2. Example learning objectives from the chest radiology reading room elective

<p>General radiology learning objectives: after completing the elective, the student should be able to</p> <ul style="list-style-type: none"> ● Describe the procedure for ordering a radiologic examination ● Summarize the categories of critical information that must be included on an imaging examination requisition ● Understand the role of radiologists in multidisciplinary conferences ● Explain typical workflow and educational practices in the reading room environment ● Collect relevant histories and medical data from appropriate sources to assist in patient diagnosis ● Design an imaging-based case presentation using necessary technology ● Examine the current radiologic literature for potential evidence-based improvements in patient care <p>Subspecialty-specific learning objectives: after completing the elective in thoracic imaging, the student should be able to</p> <ul style="list-style-type: none"> ● Use a systematic search pattern for interpreting chest x-rays (CXRs) ● Recognize normal anatomic structures of the chest on imaging examinations and become familiar with the range of normal appearances ● Identify the different CXR views and describe when they are helpful, as well as the limitations of each ● List different types of pathologies that can produce an “opacity” on CXR ● Recognize a pleural effusion on CXR on supine, upright, and decubitus films ● Describe signs of pneumothorax on CXR ● Differentiate between pulmonary vascular congestion, interstitial pulmonary edema, and alveolar edema on CXR ● Discuss the criteria for diagnosis of cardiomegaly on CXR ● Compare the conspicuity of chest “masses” on CXR and CT ● Recognize the correct positioning of feeding tubes, venous lines, and endotracheal tubes on CXR and likewise recognize incorrect positioning ● List several clinical scenarios in which imaging of the chest can be used to guide procedures ● Construct the appropriate imaging algorithm for common diagnostic scenarios, including suspected pneumonia, suspected pulmonary embolism, solitary pulmonary nodule, lung cancer staging, screening for metastasis, and suspected aortic dissection
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A Reliable Attendance Record

Attendance cannot be optional. Professional conduct necessitates daily attendance, arriving on time, and leaving only after a prespecified time or other end point is reached (such as after the last readout of the day). We do a disservice to radiology’s reputation when we allow electives to be overly lax. Our electives should reflect the fast-paced practice of modern radiology. The expectations for attendance must be made clear at the orientation and should be included in the written expectations. Additionally, all radiology faculty members, fellows, and residents should be aware of the expectations regarding medical student attendance.

We have found an online attendance system to be helpful. Students are asked to document their own attendance and their excused absences. The system reinforces our expectations for attendance, and to our knowledge, no one has falsely reported attendance.

An Anonymous Feedback System

Student feedback about the course is essential. Not only is it required of formal educational activities, but feedback allows course improvement. Anonymity (and, more important, confidence in the anonymity) is required to receive honest feedback. This presents a logistic challenge given the small number of students on service in this type of elective. Some systems, such as E*Value (<http://www.e-value.net>), allow feedback to be hidden until a sufficient number of responses are available for aggregation. This resource and others cited in the text are listed in Table 3. Anonymity can also be secured by asking a

department staff member uninvolved with medical student education to tally the responses, or course directors can simply refrain from accessing feedback until multiple responses have been registered. Completing a final course evaluation should be listed with the other required activities of the course.

The feedback form (online or paper) should include a numeric assessment of the course as a whole, specific course components, and all relevant faculty members. There can be specific questions as to the educational contribution of residents, fellows, and others in the reading room. Free-text sections are essential for receiving comments not otherwise covered and to obtain valuable input. Asking about the best part, the worst part, and the most improvable aspect of the elective can be a valuable trio of questions.

Objective Mid-Elective and End-of-Elective Evaluations

Medical schools universally require end-of-elective evaluations. Evaluations from reading room electives are often lacking, limited by relatively few assessment methods and subjectivity. Incorporating additional activities, tasks, and methods, such as those listed in the next section, can dramatically expand the methods of assessment. Evaluations may be made more objective by assessing specific domains of competency. The commonly used domains in medical student assessment mirror those developed by the ACGME for resident assessment [11]. These include medical knowledge, patient care, professionalism, communication and interpersonal skills, prac-

Table 3. Online resources listed in the text

National medical student curriculum in radiology
<ul style="list-style-type: none"> • Alliance of Medical Student Educators in Radiology (http://www.aur.org/Affiliated_Societies/AMSER/amser_curriculum.cfm)
Online feedback and evaluation system
<ul style="list-style-type: none"> • E*Value (http://www.e-value.net)
Accreditation agencies
<ul style="list-style-type: none"> • ACGME (http://www.acgme.org): this organization accredits graduate medical education and has pioneered the use of 6 competency domains in evaluating trainees • Liaison Committee on Medical Education (http://www.lcme.org): this national authority accredits programs leading to the MD degree and establishes standards for medical student education
Course website platform
<ul style="list-style-type: none"> • Moodle (http://www.moodle.org)
Online “case-of-the-day” websites
<ul style="list-style-type: none"> • ACR’s Case in Point (http://3s.acr.org/CIP/) • AuntMinnie.com’s Case of the Day (http://www.auntminnie.com)
Online testing software for medical students in radiology courses
<ul style="list-style-type: none"> • Radiology ExamWeb (http://radiology.examweb.com)
Radiology educator organizations
<ul style="list-style-type: none"> • Alliance of Medical Student Educators in Radiology (http://www.aur.org/Affiliated_Societies/amser/index.cfm) • Alliance of Clinician-Educators in Radiology (http://www.aur.org/Affiliated_Societies/acer/) • Association of University Radiologists (http://www.aur.org)

tice-based learning and improvement, and systems-based practice [12]. Nearly all domains except for direct patient care (as it is classically defined) can be assessed in a reading room-based elective.

The Liaison Committee on Medical Education specifically states that medical students should be assessed and provided formal feedback early enough during each clerkship to allow sufficient time for improvement or remediation [13]. Simply put, mid-elective feedback and evaluation are expected. Feedback should be derived from the assessment methods available by mid-elective, including any assignments due early in the elective. The depth of the mid-elective assessment will likely be variable among institutions.

The end-of-elective, and possibly the mid-elective, evaluation should be assembled with input from all section faculty members. Feedback should be aggregated ideally at a face-to-face meeting, for example, during a monthly section meeting. The course director (or designated section representative) can guide the discussion, addressing each domain of competency separately. Input from fellows, residents, and possibly other members of the health care team should also be considered, consistent with the principles of 360° evaluations [14]. The emphasis placed on self-assessment is increasing in medical education; an opportunity for students to reflect should also be provided at both feedback sessions.

Last-day One-on-One Debriefing Session With an Attending Radiologist

A last-day debriefing session should be scheduled. The student can provide verbal feedback, if desired. Feedback about the student’s performance should also be discussed. This conversation should not replace the full, objective, written evaluation provided to the medical school, nor should it replace the formal anonymous feed-

back provided by the student about the course. End-of-elective logistics may also be addressed at this meeting, such as returning identification badges for visiting students and so on.

Optional: A Website or Other Repository for Resources

Course websites are quite common in medical student education. Often, medical schools adopt a common platform for use in all of their courses, for example, the Moodle (<http://www.moodle.org>) platform. A course website can be used to post course documents, including goals and expectations, attendance records, and by providing a mechanism for feedback. Course assignments can be described and uploaded to the course website. We also use our site to record student evaluations, visible only to instructors, such that all information pertaining to students is housed in one place.

Alternatively, a dedicated reading room computer, or folder on a computer, could serve some of these purposes, including as a repository of course documents and a central storage site for completed assignments.

SUPPLEMENTAL EDUCATIONAL ACTIVITIES

Shadowing alone provides only a single avenue for student learning and allows very little opportunity for student assessment. In an ideal world, students could act as apprentices, much like residents, actually doing some of the work of a radiologist. Given the steep learning curve, the reliance on specialized software, and other logistics, a residency-like apprenticeship is largely not possible. Varied educational activities should therefore be used. Such supplemental activities can often help students accomplish standardized course learning objectives, more so than the somewhat random learning

inherent to observing daily cases. Activities representing a variety of teaching methods and those offering a deep and broad assessment of students' performance are preferred. Below is a list of activities that may be considered, at the discretion of the institution and course director.

Gathering Histories and Looking Up Relevant Literature

Observing readouts need not be purely passive. At our institution, students complete the appropriate training and are granted access to medical records and the PACS. Students search the PACS work lists for cases to be read that day and gather the pertinent medical histories of the patients. At readout, students supplement the histories provided by the requisitions and the residents. If additional history is needed beyond what was discovered from a student's initial query (eg, the exact time of a course of radiation treatment), the student can seek out this additional information during the readout. Even if looking up medical histories does not yield additional useful information, the limited information found can provide a context for students as they listen to the readout. During readout, students can also look up information to address questions raised (eg, What proportion of patients with pulmonary tuberculosis also have tracheal tuberculosis?). We have found that active participation in readout can easily occupy approximately 5 hours of the students' day.

One-on-One Teaching With an Attending Radiologist

One-on-one time with attending physicians is becoming increasingly rare in medical education. Prolonged teaching sessions in the reading room are generally not possible. Short sessions, however, can be incorporated easily and can prove very valuable. Every subspecialty has radiologic skills that would be suitable for medical student mastery. In chest radiology, for example, students can learn to identify commonly placed lines and tubes. In bone radiology, students can learn to identify common fractures. In all sections, basic anatomy through the eyes of imaging can also be reviewed. We often structure these one-on-one sessions after the student is given time to review a set of images, either from a teaching file or from the clinical work list. These sessions can be as short as 15 minutes and are generally well liked by students.

The multiple-day one-on-one format allows these sessions to be tailored to students' learning speeds and styles. It is interesting to note that, we have found these sessions immensely helpful for student assessment. The speed of learning and students' engagement vary widely, allowing some students to clearly shine. These sessions could culminate in an end-of-elective oral examination, if desired.

Example. In the chest radiology elective, students independently review chest x-ray cases for 60 minutes as the

first activity of the day. They are taught how to identify and access the cases that are being read that morning, and they are initially asked to identify lines and tubes on each film and nothing else. If there are no lines and tubes, they simply state so. After 60 minutes of reviewing, they go over their list of cases for approximately 15 minutes with an attending radiologist. Once identifying basic lines and tubes becomes familiar, students are asked to look for additional findings related to the lines and tubes (eg, look for pneumothorax in patients with chest tubes, identify the location of peripherally inserted central catheter tips and endotracheal tube tips). Once that is mastered, they are asked to examine the comparison along with the current film to assess for changes in the lines and tubes. Subsequently, multiple additional layers are added, as time permits and dependent upon the students' speed. They can be asked to describe pulmonary opacities, give differential diagnoses, assess the cardiomeastinal silhouette, and so on.

Reviewing Online Teaching Modules and Preselected Articles

A reading curriculum should be established with the expectation that a base level of radiology knowledge will be mastered. In its simplest form, this can include a collection of articles made available on the course website or on a computer in the reading room. Questions from the readings can be included on an end-of-elective examination, if desired. Alternatively, the articles can be informally or formally discussed between students and a designated attending radiologist or fellow. If available, online teaching modules can be interactive and well targeted to each student's level. Various external radiology educational websites are available; for example, in pediatrics, an impressive set of modules are available from the Cleveland Clinic Children's Hospital [15]. Reviewing myriad sites available in each of the radiology subfields is beyond the scope of this article. Although external sites may supplement a home institution's deficiencies, caution should be taken to not overly rely on external sites, as it may result in faculty members' taking less ownership of student learning.

Example. In the chest radiology elective, students are asked to read approximately 10 articles. A subset is listed here:

- "Interpreting a Radiograph of the Chest" [16];
- "Interpreting the Chest Radiograph" [17];
- "Lateral Chest Radiograph: A Systematic Approach" [18];
- "Lung Cancer Staging Essentials: The New TNM Staging System and Potential Imaging Pitfalls" [19];
- "Signs in Thoracic Imaging" [20];
- "Spectrum of Blunt Chest Injuries" [21]; and
- "Viral Pneumonias in Adults: Radiologic and Pathologic Findings" [22].

Additionally, students are asked to review all the cases listed at these two sites:

- University of California, San Francisco: Practical Pathology of Chest Disease—Case Studies (<http://pathhsw5m54.ucsf.edu/introduction.html>); and
- McGill University: Radiologic Pathologic Correlation in Chest Disease (<http://sprojects.mmi.mcgill.ca/radpath/molson3/default2.htm>).

Giving a Didactic Presentation

Students often give formal presentations during clinical clerkships. Similarly, while on a radiology elective, students may present interesting cases observed during their reading room elective, including the provided history, key images, a discussion of the interpretation, and the relevant clinical follow-up. Alternatively, students may choose topics appropriate for their levels and relevant to their future fields (for students entering nonradiology fields). We encourage very short presentations so students may hone effective, concise presentation techniques and also not lose the interest of the audience (usually the residents, fellows, and attending radiologists on service). On the chest radiology service, for example, the two most recent presentations have focused on the radiologic manifestations of sarcoidosis and the CT angiographic findings of aortic dissection.

Presenting at a Journal Club

A student may be the main or assistant discussant during a section journal club. Care should be taken to assign an appropriate-level article if a student is the main discussant. Assessing the medical literature can be daunting for students, and faculty members should ensure that the environment is sufficiently supportive and not overly intimidating.

Example. The following recent article in *Radiology* would be appropriate for a student to present as the main journal club discussant: “Internal Growth of Nonsolid Lung Nodules: Radiologic-Pathologic Correlation” [23]. The discussion of this article would be of value to the residents and fellows on service as well.

Attending Conferences

Medical students may benefit most from attending interdisciplinary conferences, such as tumor boards, which can highlight radiology’s pivotal role in clinical decision making. Didactic lectures primarily intended for radiology residents or fellows, though, tend to be too advanced and usually are much less beneficial. If there are enough medical students rotating through the elective, dedicated didactic lectures may be an efficient way to teach basic radiology principles; these lectures may be given by residents, fellows, or faculty members.

Example. We do not hold dedicated conferences for students on the chest service. They are, however, asked

to go to relevant resident conferences given by chest faculty members (approximately 3 per month), and they attend weekly tumor boards and interstitial lung disease conferences.

Preparing a Research Abstract or Case Report

Participation in research and publications will likely be variable among institutions and sections and will depend on the other electives offered at the institution. Some reading room electives require participation in a case-report write-up and submission to a journal or an online case-of-the-day website (such as the ACR’s Case in Point [<http://3s.acr.org/CIP/>] or AuntMinnie.com’s Case of the Day [<http://www.auntminnie.com>]). The RSNA has a heavily advertised case-of-the-day program at its annual meeting.

At some institutions, radiology reading room electives can involve completion of a full project and the creation of a manuscript. To achieve this goal, dedicated research time is often needed, sometimes up to 50% or more of a student’s time. The successful participation of students in radiology research is beyond the scope of this article but has been discussed in the radiology literature [24].

Taking an End-of-Elective Test

Examinations are a tried and true method of assessment. Often maligned by students, examinations provide a powerful motivator in the correct context. Unfortunately, secure, valid, relevant examinations are difficult to create. With greater attention being paid to the structure of test questions, creating examinations from scratch may prove daunting, particularly for electives taken by relatively few students.

Radiology ExamWeb (<http://radiology.examweb.com>) is a grant-supported, free online resource with an extensive question bank and superb testing software. The tests are secure and customizable, and instructors have access to detailed performance reports. Radiology ExamWeb is supported by the Alliance of Medical Student Educators in Radiology (http://www.aur.org/Affiliated_Societies/AMSER/AMSER_Radiology_ExamWeb.cfm). With the provided question bank, even if highly customized, tests created in ExamWeb may not directly reflect the material learned in a given course; nonetheless, this is an excellent resource. Other formats for end-of-elective tests may also be considered [25].

An oral examination may also be incorporated into the course; although the oral testing format is prone to biases [14], it may be suitable in some circumstances.

Of note, all of the components of the elective can result in test questions, including assigned reading and one-on-one teaching sessions.

Example. We often assemble tests of approximately 40 questions. We ask the section assistant to assemble the test, print it out, administer the test, and grade it. An example of a question is as follows: Which technique is

most sensitive for small pleural effusions? (A) An upright frontal radiograph, (B) a supine frontal radiograph, (C) a lateral radiograph, or (D) a lateral decubitus radiograph (the correct answer).

TAKE-HOME POINTS

- Reading room electives are common in radiology departments, though they often lack the involvement and rigor of other medical school electives.
- Rigorous electives are possible in the reading room setting. Such electives are educational, and they better represent the modern practice of radiology.
- The essential components of a successful elective include well-defined expectations and learning objectives, active participation in varied educational activities, and objective methods of evaluation.

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