Comparisons of Medical Student Knowledge Regarding Life-Threatening CT Images Before and After Clinical Experience

Barbara Nguyen, M.D.1, Brady Werth, M.D.1, Nicholas Brewer, M.D.1,2, Jeanette G. Ward, MSCR1, R. Joseph Nold, M.D.1,2, James M. Haan, M.D.1,2
1University of Kansas School of Medicine-Wichita, Department of Surgery
2Via Christi Hospital Saint Francis, Wichita, KS
3Chandler Regional Medical Center, Chandler, AZ

ABSTRACT

Introduction. Currently, no national standard exists for educating medical students regarding radiography or formal research indicating the level of improvement regarding computed tomography (CT) interpretation of medical students during clinical rotations.

Methods. Students were evaluated based on their response to twenty-two open-ended questions regarding diagnosis and treatment of eleven de-identified CT images of life-threatening injuries. The number of incorrect answers was compared with correct or partially correct answers between students starting third-year clinical rotations and those starting their fourth year.

Results. Survey results were collected from 65 of 65 (100%) beginning third-year students and 9 of 60 (15%) beginning fourth-year students. Students in their fourth-year had less incorrect answers compared to third-year students, with five questions reflecting a statistically significant reduction in incorrect responses. The image with the least incorrect for both groups was epidural hemorrhage, 33.9% and 18.5% incorrect for third-year students for diagnosis and treatment, respectively, and 11.1% and 0% incorrect for fourth-year students. Outside of this image, the range of incorrect answers for third-year students was 75.4% to 100% and 44.4% to 100% for fourth-year students.

Conclusion. Baseline CT knowledge of medical students, regardless of clinical experience, indicated a strong deficit, as more students were incorrect than correct for the majority of CT images. KS J Med 2017;10(3):55-58.

INTRODUCTION

Currently, there are no national standards for educating medical students regarding radiography interpretation in the trauma population. Radiology clinical rotations were required in only a quarter of U.S. medical schools as recently as 2009 to 2010.1 Among U.S. medical students surveyed, over three-fourths planned to take a radiology elective before residency.2 The majority of these students believed radiology changes patient care or was as important as a physical exam.2 In addition, general surgery pro-
Table 1. Life-threatening computed tomography injury and treatment images.

| Injury Type                          | Treatment                                      |
|--------------------------------------|------------------------------------------------|
| Head                                 | **Epidural hematoma (EDH)** Operative intervention or drainage |
|                                      | **Subdural hematoma (SDH)** Medical management |
|                                      | **Intraparenchymal hemorrhage (IPH)** Medical management |
| Chest, Abdomen and Pelvis            | **Pulmonary contusion and pneumothorax** Chest tube |
|                                      | **Grade III liver laceration** Observation in the intensive care unit |
|                                      | **Grade III liver laceration** Observation in the intensive care unit |
|                                      | **Grade IV splenic injury** Embolization or operative intervention |
|                                      | **Grade IV renal injury** Embolization or operative intervention |
|                                      | **Pelvic fracture** Operative intervention or sacroiliac screw |
|                                      | **Small bowel thickening** Serial exam or operative intervention |
|                                      | **Right colon mesenteric injury** Serial exam or operative intervention |

Survey forms were de-identified when scored and were reviewed separately and scored by two trauma surgeons. One point was assigned for a correct response, half a point for a partially correct response, or zero points for an incorrect response. Each student’s scores were averaged for each of the 22 questions. Both groups were compared by total points for each image, and proportion of incorrect responses was calculated by group. Differences in proportions were calculated.

Due to sample size, focus on the error reduction comparison was viewed through proportional differences, assessing statistical significance with a 95% confidence interval, corrected for continuity. Confidence intervals of 95% were calculated, of which those intervals, including zero, were considered statistically insignificant. Bonferroni correction indicated one out of 18 comparisons, given this confidence interval. Analyses were conducted using SPSS release 19.0 (IBM Corp, Somers, New York). The study was approved by the Institutional Review Board of Via Christi Hospitals, Wichita, Inc.

RESULTS

Survey results were collected from 65 of 65 (100%) MS3s and 9 of 60 (15%) MS4s (N=74). Overall, MS4s performed better than MS3s, with fewer incorrect responses on 20 of 22 questions (Figures 1 and 2). Two exceptions were noted: diagnosis of a grade IV renal injury (96.9% incorrect for MS3s and 100% incorrect for MS4s) and treatment of a grade III liver laceration (95.4% incorrect for MS3s and 100% incorrect for MS4s). Neither were statistically significant (95% CI: 7.2 to 1.1% and -9.7 to 0.49%, respectively).

Percentage of incorrect responses ranges from 18.5% to 100% for MS3s and from 0.0% to 100% for MS4s. The image with the least incorrect responses by both groups was epidural hemorrhage, 33.9% and 18.5% incorrect by MS3s for diagnosis and treatment, respectively, and 11.1% and 0% for MS4s. Excluding epidural hemorrhage, the range of incorrect for MS3s was 75.4% to 100% and 44.4% to 100% for MS4s. The median percentage of incorrect responses for MS3s was 93.1% and 77.8% for MS4s. No MS3s were able to identify or propose a correct diagnoses or treatment for one of two grade III liver lacerations. No MS4s correctly diagnosed the grade IV renal injury and no MS4s correctly identified a treatment for one of two grade III liver lacerations.

Five of the twenty-two questions reflected a statistically significant reduction in incorrect responses between MS3s and MS4s. These included: diagnosis of subdural hemorrhage (85.2% incorrect MS3 versus 44.4% MS4, 95% CI: 8.2% to 75%); diagnosis of grade III liver laceration (100% MS3 versus 66.7% MS4, 95% CI: 2.5% to 64%); treatment of epidural hematoma (18.5% incorrect by MS3 versus all correct by MS4, 95% CI: 90% to 28%); treatment of small bowel thickening (98.5% MS3 versus 66.7% MS4, 95% CI: 0.85% to 63%); and treatment of right colon mesenteric injury (90.8% MS3 versus 55.6% MS4, 95% CI: 2.0% to 68%).
DISCUSSION

By comparing pre- and post-evaluations, several studies have demonstrated that medical students CT interpretation abilities improve with radiology-focused training.15-17 Sendra-Portero et al.15 and Scheiner et al.16 compared medical students of different years of study and assessed their abilities in interpreting radiology images before and after a radiology-specific training. Results indicated that medical students improved in interpreting radiographs after the training, regardless of year of study.15,16 Dawes et al.17 also found medical students to improve in interpreting radiographs after participating in a 26-week clinical training course. Results showed the proportion of correct answers improved from 8% pre-evaluation to 43% post-evaluation (p < 0.001). Our study had similar results; however, the improvement was only slightly better for fourth-year students.

Of the twenty-two possible answers, MS4s did better than MS3s in all but two, indicating some improvement in reading CT imaging. However, both groups had a high range of incorrect responses. A median value of 93.1% incorrect by MS3s indicated the baseline CT knowledge of medical students entering clinical rotations was extremely low. As such, it is not surprising that MS4s had a mild improvement. Other than diagnosis and treatment of epidural hemorrhage, MS3s scored greater than 75% incorrect on all other questions. Although the median value for MS4s at 77.8% incorrect was lower than MS3s, it indicated a majority of students incorrectly identifying and ultimately treating injuries seen on CT scans.

Both groups performed best in diagnosing and treating an epidural hematoma. As MS3s did best with this injury, it raises the question if prior didactic learning regarding head injuries may have better prepared the students. However, MS3s did not perform particularly better on the other head injuries when compared to MS4s. No particular trend was noted regarding percentage incorrect and body regions.

Most surgeons expect MS3s to have a baseline ability to read CT scans and MS4s are expected to be able to identify life-threatening images. Yet, this study showed a strong deficit in baseline CT knowledge amongst medical students. Despite the low number of MS4s, after a year of clinical rotations and overnight trauma calls, which included education on CT imaging, they did show some improvement in evaluating CT images. However, without a standard curriculum in radiology, it is difficult to conclude if this improvement is significant enough to warrant satisfactory expectations of a beginning fourth-year student. Still, for medical education purposes, clinical rotations appear to provide a benefit to students in education of CT imaging of life-threatening injuries.

Areas for potential study include improving or expanding upon the findings of the current study. Within the study, the benefits of viewing an entire CT scan may provide a more thorough investigation of student abilities. In addition, after completion of this study, a new radiology rotation was implemented. This new program may impact the current study results, therefore, a possible follow-up study may be beneficial.

Similar studies at other institutions may provide groundwork for average radiographic education, but without national standards or expectations, it would be difficult to conclude if an intervention is necessary. Future studies confirming these results might include comparison of students who had received imaging-specific education, building upon studies such as at Boston University School of Medicine.6 At the campus in this study, students are allowed to undergo a radiology elective in the fourth year. Comparisons between students who choose this elective with those who choose alternative electives may provide more solid results upon the benefits of imaging-specific education.

The most appropriate intervention from this study would be continued comparisons after clinical rotations with the addition of imaging-specific education. For our studies, pursuing a continued study of current MS3s at the end of their third-year would provide stronger conclusions on the effect of radiographic-specific education, as baseline CT knowledge already has been attained. Through this, more studies can be developed to achieve a thorough understanding of medical students’ radiographic knowledge, as well as how to improve their education and help them achieve optimal competency for residency and as physicians.

This study had several limitations. As this was a voluntary study with no compensation provided to participants, there were no expectations for subject participation numbers, although similar numbers were anticipated from both groups. However, due to the small number of fourth-year medical students, this group is not represented adequately. Further, the study tested students with one image slice of a CT scan as opposed to a complete CT scan set, a scenario unlikely in real life. Comparative slices on a CT scan may help the reader better analyze the severity and extent of the injury. Also, the patient’s clinical history could have assisted students in their evaluations. Finally, the findings may not be generalizable to other trauma centers since this study was conducted at a single center.

CONCLUSIONS

The high percentage of incorrect responses reflects a strong deficit in baseline CT knowledge amongst medical students, particularly in an environment with limited radiologic education. Outside of diagnosis and treatment of head injuries, most students from both groups answered diagnosis and treatment incorrectly for the majority of the scans. If more than half of students are expected to identify these images correctly, other interventions are necessary to ensure better radiographic education. This study argues that a re-evaluation of current standards for radiographic education of medical students is needed. In addition, the possibilities of how to implement this education should be considered, whether it is through utilization of radiologist involvement and/or curriculum-specific education.
REFERENCES

1. Poot JD, Hartman MS, Daffner RH. Understanding the US medical school requirements and medical students’ attitudes about radiology rotations. Acad Radiol 2012; 19(3):369-373. PMID: 22177282.

2. Prezza C, Vorona G, Greenspan R. Fourth-year medical student opinions and basic knowledge regarding the field of radiology. Acad Radiol 2013; 20(3):272-278. PMID: 23452471.

3. Chorney ET, Lewis PJ. Integrating a radiology curriculum into clinical clerkships using case oriented radiology education. J Am Coll Radiol 2011; 8(1):58-64. PMID: 21211766.

4. Kondo KL, Swerdlow M. Medical student radiology curriculum: What skills do residency program directors believe are essential for medical students to attain? Acad Radiol 2013; 20(3):263-271. PMID: 23452470.

5. Branstetter BF 4th, Faix LE, Humphrey AL, Schumann JB. Preclinical medical student training in radiology: The effect of early exposure. AJR Am J Roentgenol 2007; 188(1):W9-14. PMID: 17179333.

6. Luller RS, Zumwalt AC, Romney CA, Hoagland TM. Incorporating radiology into medical gross anatomy: Does the use of cadaver CT scans improve students’ academic performance in anatomy? Anat Sci Educ 2010; 3(2):56-63. PMID: 20213692.

7. Mirsadraee S, Mankad K, McCoubrie P, Roberts T, Kessel D. Radiology curriculum for undergraduate medical studies - A consensus survey. Clin Radiol 2012; 67(12):1155-1161. PMID: 22705185.

8. Linaker KL. Radiology undergraduate and resident curricula: A narrative review of the literature. J Chiropr Humanit 2015; 22(1):1-8. PMID: 26770172.

9. de Barros N, Rodrigues CJ, Rodrigues Jr AJ, de Negri Germano MA, Cerri GG. The value of teaching sectional anatomy to improve CT scan interpretation. Clin Anat 2001; 14(1):36-41. PMID: 1135396.

10. Murakami T, Tajika Y, Ueno H, et al. An integrated teaching method of gross anatomy and computed tomography radiology. Anat Sci Educ 2014; 7(6):438-449. PMID: 24443310.

11. Margolis SA, Nilsson KA, Reed RL. Performance in reading radiographs: Does level of education predict skill? J Contin Edu Health Prof 2003; 23(1):48-53. PMID: 12739259.

12. Taylor JA, Clopton P, Bosch E, Miller KA, Marcelis S. Interpretation of abnormal lumbosacral spine radiographs. A test comparing students, clinicians, radiology residents, and radiologists in medicine and chiropractic. Spine (Phila Pa 1976) 1995; 20(10):1147-1153; discussion 1154. PMID: 7638657.

13. Jeffrey DR, Goddard PR, Callaway MP, Greenwood R. Chest radiograph interpretation by medical students. Clin Radiol 2003; 58(6):478-481. PMID: 12788318.

14. Eisem LA, Berger JS, Hegde A, Schneider RF. Competency in chest radiography. A comparison of medical students, residents, and fellows. J Gen Intern Med 2006; 21(5):460-465. PMID: 16704388.

15. Sendra-Portero F, Toraó-Chaparro OE, Ruiz-Gomez MJ. Medical students’ skills in image interpretation before and after training: A comparison between 3rd-year and 6th-year students from two different curricula. Eur J Radiol 2012; 81(12):3931-3935. PMID: 22647422.

16. Scheiner JD, Noto RB, McCarten KM. Importance of radiology clerkships in teaching medical students life-threatening abnormalities on conventional chest radiographs. Acad Radiol 2002; 9(2):217-220. PMID: 11918377.

17. Dawes TJ, Vowler SL, Allen CM, Dixon AK. Training improves medical student performance in image interpretation. Br J Radiol 2004; 77(921):775-776. PMID: 15447965.

Keywords: x-ray computed tomography, medical students, knowledge, clinical clerkships