



Patient-Centered, Case-Based Education in Radiology: an Interactive Module Following a Patient Through Their Disease Course from an Imaging Perspective

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Abstract

During typical radiology resident conferences, faculty presents images of a disease at a single juncture followed by relevant teaching points; however, the current generation of learners poses unique challenges given different learning preferences. We thus sought to demonstrate the benefits of a novel interactive case-based learning method following a patient through their disease. Twenty-four trainees completed an interactive glioblastoma module along with pre- and post-surveys. Findings revealed a significant increase of average scores for all knowledge-based questions and confidence levels related to glioblastoma and its treatment. Response was overwhelmingly positive with most considering this teaching method superior to traditional conferences.

Keywords Interactive · Radiology · Education · Modules

Introduction

Despite advances in educational theory [1], many radiologists still use traditional lectures to teach residents. This involves presenting images of a disease at a single moment followed by the diagnosis and relevant teaching points. However, as each generation possesses different characteristics and learning preferences, radiologists must adopt new approaches for effective teaching. The current millennial generation of learners poses unique challenges to educators who may not share the same life outlooks or experiences with technology.

Having utilized technology since a young age, millennials are able to quickly find information and tend to expect immediate answers, leading to a relatively short attention span [2]. Additionally, they often prioritize creativity and technology in the workplace. Effective teachers thus integrate technology into active learning experiences to best facilitate learning [3]. Flipped classrooms, simulations, and question banks are several of the newer teaching methods

used to enhance the traditional lecture model [4]. While there is literature evaluating electronic radiology modules [4, 5], to our knowledge, there are no radiology modules that use a narrative approach following a patient through their disease course. In this paper, we thus sought to determine whether a novel interactive module following a disease through time would be beneficial to the radiologist's teaching repertoire.

Activity

To develop the module, radiology faculty at our institution searched for patients with glioblastoma imaging through PACS (picture archiving and communication systems) and electronic health records. They identified a candidate patient with a clinical course highlighting two key teaching objectives: multiple treatment options and an array of treatment-related complications. Creation of the module itself only required basic PowerPoint skills such as inserting images, using the hyperlink function, and customizing action buttons. Google Surveys was used to administer pre- and post-module questions. All in all, the course took approximately four hours to generate.

The module began with a patient complaining of headache. Trainees were subsequently guided through glioblastoma-related

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concepts including initial diagnosis, differential diagnoses, management, genetic markers, chemotherapies, Response Assessment in Neuro-Oncology (RANO) criteria, true progression, pseudoprogression, pseudoresponse, and radiation necrosis. To advance, participants needed to correctly answer multiple embedded questions and evaluate patient images. Commentary explaining the reasoning behind question answers and pertinent imaging findings were included. Additionally, pre- and post-surveys were administered immediately before and after completion of the module. The pre- and post-surveys as well as slides from the teaching module are included in the supplementary material (Online Resource 1: Pre and Post-Survey Questions, Online Resource 2: Module Slides).

After institutional board approval, we distributed pre-surveys, post-surveys, and teaching modules to be taken during the hour allotted for neuroradiology resident conference. All who were present that day participated and consisted of 24 trainees (7 first-year radiology residents, 5 s-year radiology residents, 5 third-year radiology residents, 4 fourth-year radiology residents, and 3 fourth-year medical students). The pre-test consisted of six knowledge-based multiple-choice questions as well as five subjective questions assessing confidence-level related to glioblastoma and its treatment. In addition to the eleven questions featured on the pre-test, the post-test included two perception-based questions asking how this teaching method compares to typical case conferences and if more teaching modules using this method would be preferred. Responses were presented as multiple-choice options: “overall better,” “some pros and cons but overall no difference,” and “overall worse” for the former and “yes” or “no” for the latter. Moreover, participants were given the option to provide feedback and comments in a free-text section on the post-survey. An attending was available if any questions arose, but their presence was not required to complete the modules.

Pre- and post-module test scores and confidence levels were represented by mean values and analyzed via unpaired *t*-tests. Calculated two-tailed *p*-values were evaluated at a 0.05 alpha level of significance.

Results

The results demonstrated statistically significant improvement between pre- and post-module examinations. For example, the average scores for the six knowledge-based questions on the pre-survey were 31% and 87% on the post-survey with a *p*-value of < 0.0001. The average score for the five confidence level questions significantly increased from 3.9/10 on the pre-survey to 6.4/10 on the post-survey (Table 1). With respect to perception questions, most trainees considered this teaching method superior to typical radiology case conferences (21 of 24, 88%) and would prefer more teaching modules covering other diseases (23 of 24, 96%). Additionally, 11 of 24 (46%) trainees gave feedback in the free-text space with overwhelmingly positive responses (Table 2).

Discussion

The aim of this project was to determine whether implementing a new narrative, case-based electronic teaching module on glioblastoma would enhance radiology education. Our study showed that this learning method was both effective and well-received. Specifically, survey data demonstrated a significant, positive impact on immediate knowledge retention of glioblastoma and improvement of confidence on post-module tests. Feedback from trainees was positive with participants preferring this modality over conventional case conferences or as an adjunct to conventional conferences.

Given the ease, feasibility, and effectiveness of instituting this narrative case-based learning module, we foresee widespread utilization of this teaching method. The versatility of the interactive module allowed trainees to chronologically evaluate disease progression. Interspersed commentary and questions allowed for instant application, furthering retention as noted on post-test questions. Moreover, the lack of required direct supervision allowed trainees to learn at their leisure. We believe this approach could easily be applied to other complex, progressive diseases and plan to implement

Table 1 Responses to confidence-related questions on a 10-point scale

Questions	Mean		Significance (<i>p</i> ≤ 0.05)
	Pre-survey	Post-survey	
How comfortable are you interpreting a follow-up scan on a patient with glioblastoma?	4.0	6.1	0.0022
How comfortable are you explaining what to look for on immediate post-op MRI after glioblastoma resection?	4.0	6.5	0.0005
How comfortable are you explaining what pseudoprogression is?	3.8	6.1	0.0002
How comfortable are you explaining what pseudoresponse is?	3.5	6.7	0.0001
How comfortable are you explaining how perfusion imaging is used in the imaging of glioblastoma?	4.5	6.4	0.0157

Table 2 Feedback from trainees

Positive feedback [year of training]	Constructive feedback [year of training]
I really enjoyed this and much prefer it over normal lectures. [R1]	Immediate post teaching retention may be great, but wondering on longer term retention on these topics. [R3]
I think this method of learning is awesome. It is much better to have material one can interact with and consume at one’s own pace. Even the act of thinking about the question and clicking through an answer seems to help solidify the concepts. The quiz/survey on either end helps cement concepts. Overall I would love to see as much as this sort of content as possible - although it does seem like a lot of work to create from your end. [R2]	There’s definitely value to both. It would be great to mix these in every once in a while if possible. Or to do this, then a few cases that highlight the potential differences in findings on cases like this. Like pull up some true progression and pseudoprogession cases (maybe that’s what we’re about to do). [R2]
I think having the case laid out chronologically with commentary on what to look for/how the disease progresses is great. Also having the criteria immediately available and then applying is definitely more effective. Probably could be effectively translated to other pathologies (MS, chronic osteo?) Overall solid. [R1]	
Very useful. Would love more training tools like this one. [MS3]	
Beats active learning for sure. [MS4]	
While this type of module might not work for all conditions, I found this quite helpful for glioblastoma, and I’m sure there are a lot of other complex/chronic conditions that it would work well for, too! Very well-organized. [R2]	
I found this really helpful. Thanks! [R1]	
Like it. [R4]	
This was a superb learning module. Not only do I feel more comfortable with GBM and the associated pathologies covered, I feel like I have a solid foundation to build on. This was excellent. I definitely learned and retained a lot more information than a typical case conference with unknown cases - I think because following one patient and being guided really helped consolidate the information. [R1]	

MS4 fourth-year medical student, R1 first-year radiology resident, R2 second-year radiology resident, R3 third-year radiology resident, R4 fourth-year radiology resident

this learning delivery style more frequently at our institution. For instance, at the time of this article’s writing, modules on carotid stenosis, head/neck cancer, and multiple sclerosis are in progress.

There are several limitations to this study. One limitation was the small sample due to ease of assembling trainees in one place. Analysis of variability in response due to knowledge base was therefore ineffective given low-statistical power when dividing participants into groups based on level of training. Similarly, as this was implemented at a single site, external generalizability may be limited. There is potential for response bias, as surveyed trainees were aware of the faculty who created the learning. Another limitation was that we only evaluated participants’ reactions to the learning process and immediate post-module knowledge (i.e., Levels 1 and 2 of the Kirkpatrick Four-Level Evaluation Model) [6]. Based on the positive results of this initial study, a larger database of modules is currently being produced with a plan to test Kirkpatrick Level 3 (behavior change resulted from the learning process) by implementing a 6-month knowledge retention test. In addition, this future study will test Kirkpatrick Level 4 (tangible results of the learning process)

by having radiology residents dictate the same glioblastoma case before and after completing the module. Reports will subsequently be rated using criteria derived specifically from the module.

Conclusion

Our study demonstrates that using interactive modules in a narrative case structure adds value to radiology education and could be complementary to traditional teaching methods. Having included clinical decision-making and medical knowledge into the context of imaging benefits both medical students and radiology residents in understanding the larger picture of patient experience. Data from trainees show a significant level of improved immediate knowledge retention and significantly increased confidence regarding glioblastoma and its management. Furthermore, the module was well-received and surveys indicate a desire for additional modules using this method. In the future, this new, effective, and feasible interactive case-based teaching could

be expanded to address additional disease processes and be implemented at other institutions.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s40670-021-01441-5>.

Data Availability Derived data supporting study findings are available within this article and supplementary materials. Raw data is available from the corresponding author on request.

Declarations

Ethics Approval Reviewed by the Institutional Review Board and considered exempt as the research involved normal educational practices.

Informed Consent NA.

Competing Interests The authors declare no competing interests.

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