ORIGINAL ARTICLE

TEACHING PHYSICS TO RADIOLOGY RESIDENTS: INITIAL OUTCOMES OF INTERACTIVE LECTURE BASED APPROACH WITH IMMEDIATE SUMMATIVE EVALUATION

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ABSTRACT

OBJECTIVE: We present a new educational approach to teaching physics to radiology residents. The hypothesis is that consecutive 3 to 4 day interactive physics lectures followed immediately by a summative written evaluation will facilitate greater retention of core physics concepts. We present initial outcome of this new technique. **MATERIALS AND METHODS:** The study was conducted in department of Radiology, Shifa International Hospital, Islamabad, Pakistan between January 2012 to January 2014. Modified curriculum was developed with two major changes: replacing didactic lectures with interactive format and changing to curriculum of short modules followed immediately by a written exam. Lectures were based on interactive group discussions with facilitating medical physicist. **RESULTS:** Average percentage physics test scores of residents in tests taken before and after trial of new curriculum showed 25% improvement. Post-trial survey demonstrated 54% respondents (n=7) thought that new interactive lecture based approach with immediate summative evaluation was extremely effective and 38% (n=5) thought of it as moderately effective . When asked whether the newly tried physics curriculum seems a better option to meeting both academic and professional needs, 61% (n=8) strongly agree while another 7% (n=1) agree . 46% percent of respondents (n=6) disagree , while 15% (n=2) of residents strongly disagree . When asked to directly compare the two curricula in terms of implementation, 85% (n=11) of residents thought that the new curriculum is much better. **CONCLUSION:** Compared with prior didactic lecture based approach with quarterly exam, the change to interactive approach with immediate evaluation has provided better results.
Keywords: Physics, radiology residents, interactive lecture approach

Introduction

Role of physics in medicine was increasingly and slowly felt over a long period of time with an interesting history dating back to the late eighteenth century.[1] However introduction of physics curricula and compulsory examination about knowledge of basic physics principles in medical field of Radiology is relatively recent. Getting hold on basics of radiological physics is essential to master imaging technologies so that they are used in an efficient, safe and cost effective manner. Radiology certification authorities around the globe have made physics a compulsory part of radiology curriculum.[2] Although many studies have been published in the west[3-10] about methods of teaching physics to radiology residents, no such

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study has yet been published in Pakistan.

Teaching physics to radiology residents in an effective way is a major challenge as most residents perceive physics as boring and irrelevant or simply as a hurdle to be crossed and forgotten. Like most training programs, our institution has had a didactic curriculum taught by a medical physicist in a traditional lecture format followed by an end of the year written physics exam. The exam results and resident feedback suggested that a change was needed as the exam scores and the resident satisfaction and interest levels were sub-optimal. On reviewing literature, we found outstanding articles on teaching of physics to radiology residents by Dr William R Hendee, editor of Medical Physics,[3,4,5,6] who has urged radiology academic institutions to change the role of medical physicists from sage on the stage to guide on the side . Another approach suggested in literature is to integrate different methods to impart physics education with increased clinical emphasis and increased participation of residents.[7] Article by Shankar et al suggested good initial outcomes in their shift from didactic lectures by a medical physicist to a resident-led physics curriculum format with integration of the RSNA(Radiological society of North America)/ and AAPM (American Association of Physicists in medicine) physics modules.[8]

Consequently, our department developed a trial of a newer interactive approach with immediate written evaluation that has replaced the traditional didactic lecture structure used in previous years in our department. Previously two physics didactic lectures were delivered fortnightly by a medical physicist followed by an end of the year written exam. A change in teaching schedule was made with 3 to 4 physics lectures on consecutive days. Residents were given the topics to be covered prior to the lectures and lectures were given in an interactive format with residents participating in the discussion rather than only listening to the lecture. This was followed by a prompt summative written evaluation at the end of these lectures.

We undertook this endeavor with the goal of establishing better understanding and facilitating greater retention of core physics concepts in order to improve performances in in-service and external training exams. We present both the trail of this newer technique and the initial results with the purpose of evaluating the early outcomes of these changes in our physics curriculum.

Material & Methods

Ethical Approval: Ethical approval of the study was obtained from the Institutional Review Board (IRB No 379-228-2014).

Analysis: Pre and post trial tests were marked from a total of 30 marks. Average test scores and their standard deviation was calculated. Five residents out of 13 were present in both tests and their pre and post test performance was separately calculated and plotted on graph. Student t test was applied and p value was calculated using windows Excel version 2007. P value of less than 0.05 was considered significant. Surveys and comparative analysis were approved by the Institutional Review Board.

Introduction of new curriculum: The study was conducted in department of Radiology, Shifa International Hospital, Islamabad, Pakistan between January 2012 to January 2014.

A questionnaire (Appendix I) was designed to obtain feedback from residents regarding their opinions about the current curriculum and didactic teaching methodology. Options in the questionnaire included strongly agree, agree, do not know, disagree and strongly disagree. For purpose of statistical analysis two groups were made; agree and strongly agree were placed in one group and disagree and strongly disagree were placed in the second group. Do not know category was not considered. Based on this feedback, a new and modified teaching curriculum was developed for teaching physics in our radiology department which basically comprised of two changes. First was to replace the didactic approach of lecture delivery by an interactive approach. The second change was to replace the previous teaching schedule of fortnightly lectures with quarterly written physics exam. In its place we started a curriculum of short modules comprising consecutive three to four day interactive lectures followed immediately by a written exam. These changes were tried by joint efforts of senior faculty radiologist and medical physicist in our department after approval from residency program director and post graduate medical education depart-

ment. Each of these lectures comprised of small group discussion in an interactive manner with medical physicist acting as facilitator and audience comprising all residents in the residency program. An open discussion forum was allowed for continuous interaction between facilitator and participants. A compulsory in-training exam was taken at the end of these short modules. After introduction of this new curriculum a post-trial survey was conducted to obtain feedback from all the participants. (Appendix II).

Quantitative and qualitative measurement of outcome: Average test scores improved from 19/30(63%) with standard deviation of 3.8 to 26.5/30 (88%) with standard deviation of 2.6. Five residents out of 13 were present in both pre and post trial tests and their performance pre and post test was separately calculated and plotted on graph (Fig. 1). All of them showed improvement in test scores with improvement in average test scores from 21/30(70%) to 27.4/30 (91%). On applying student t test the improvement is statictically significant (p value= 0.0007).

Response rate of 100% (n=13) was obtained for both pre- and post- trial surveys. The post-trial survey demonstrated that 46% (n=6) of respondents disagree , while another 15% (n=2) of residents strongly disagree with the opinion that the previous didactic approach to teaching physics should be continued (Fig. 1). When asked to directly compare the two curricula in terms of implementation, 85% (n=11) of residents thought that the new curriculum should be implemented in the future and replace the previous one, while 15 % (n=2) opted for the purely didactic method to continue (Fig. 2). In terms of resident perception about the new approach to teaching physics, 54% (n=7) respondents thought that the new interactive lecture approach with immediate summative evaluation was extremely effective and 38% (n=5) thought of it as moderately effective (Fig. 3). When asked whether the newly implemented physics curriculum seems a better option to meeting both academic and professional needs of the residents, 61% (n=8) strongly agree to its continuation while another 7% (n=1) agree with the suggestion (Fig. 4).

PRE-TRIAL QUESTIONNAIRE

Regarding radiological physics curriculum and teaching, please select a single option from the following:

	Strongly Agree	Agree	Do not know	Disagree	Strongly Disagree
Do you think physics should be included I teaching curriculum of radiology residency	☐	☐	☐	☐	☐
Do you think your working knowledge of physics is helpful in tackling daily professional problems (daily call/work related)	☐	☐	☐	☐	☐
Do you think you have adequate knowledge of physics to cover exam syllabus without the support or assistance from a physics teaching program	☐	☐	☐	☐	☐
Do you think that the and teaching methodology of didactic lectures with annual exams is preparing you optimally for your exams	☐	☐	☐	☐	☐

Appendix I

POST-TRIAL QUESTIONNAIRE

Regarding radiological physics curriculum and teaching, please select a single option from the following:

	Strongly Agree	Agree	Do not know	Disagree	Strongly Disagree
Do you want the previous radiologic physics curriculum comprising of twice a month lecture with annual exams to be reimplemented.	☐	☐	☐	☐	☐
Do you think that the new interactive lecture methodology is a better option for meeting your requirements of gaining knowledge of Physics for academic and professional purposes	☐	☐	☐	☐	☐
Do you think a resident led approach can yield better outcomes than a physicist led session	☐	☐	☐	☐	☐
How do you rate the current interactive session teaching with immediate summative evaluation as compared to previous lecture based approach	☐ Extremely effective ☐ Moderately effective ☐ No significant change ☐ Less useful				
Which of the following physics teaching programs would you like to be implemented in the future	☐ Didactic lecture with annual exam ☐ Interactive lecture with immediate summative evaluation				

Appendix II

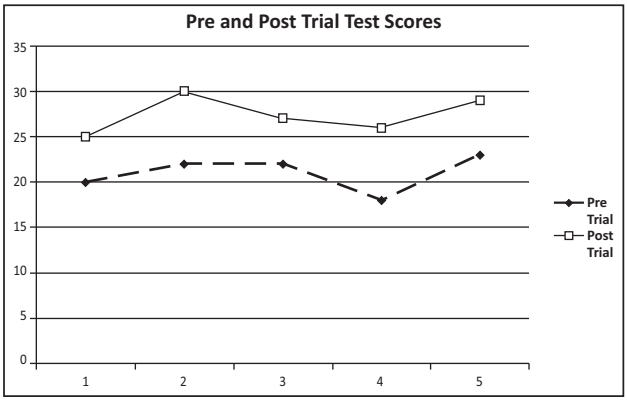

Figure 1: Pre and post trial test score.

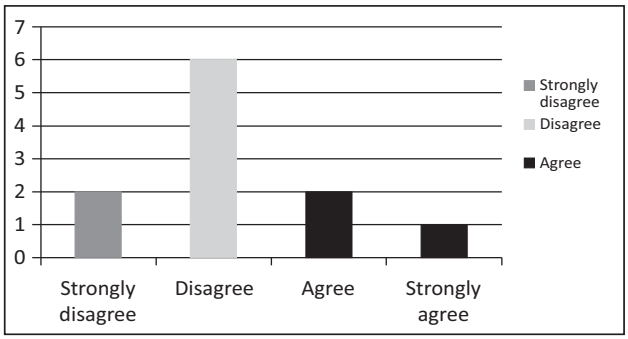

Figure 2: Response of residents in survey to question Do you think that teaching methodology of didactic lectures with annual exam is preparing you optimally for your exams

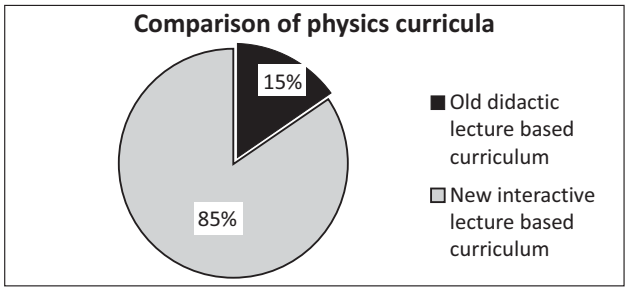

Figure 3: Pie chart of number of residents responding to question Which one of the following physics teaching curriculum would you be like to be implemented in the future- didactic lecture with annual exam or interactive lecture with immediate summative evaluation

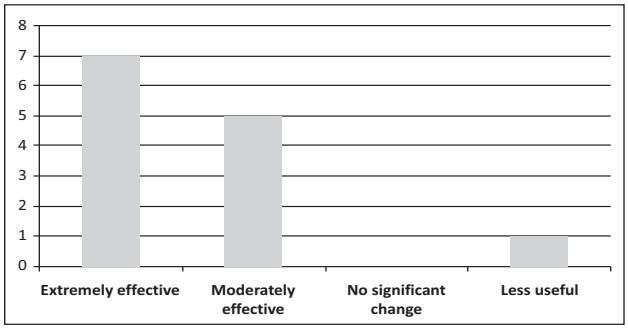

Figure 4: Graph of resident response to question about their perception of impact of new curriculum

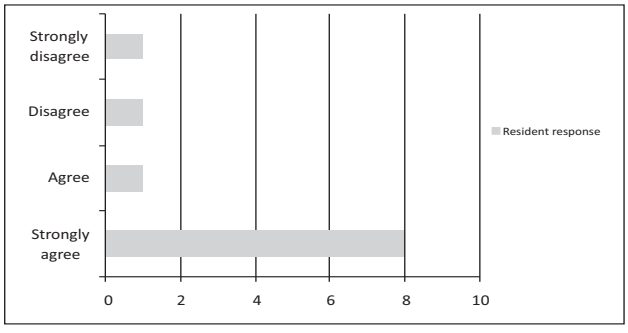

Figure 5: Chart depicting response of residents to question regarding their opinion about new interactive lecture based physics curriculum as a better option to meet requirements of radiologic physics education

Discussion

Early Observations: Imparting core physics principles to future radiologists has historically been a challenging process with mixed or suboptimal results. Reasons sometimes associated include lack of identifiable relationship between the syllabus and clinical radiology, complex instruction, lack of proper or interesting delivery of material, boredom or monotony with a primary goal of undertaking of a distant examination. The previous method of teaching at our institution, of fortnightly lectures with distant examination, left the residents feeling without a sense of continuity to core topics. The lack of active resident involvement and zeal or reinforcement of syllabus through this method proved to be less productive. The sense of preparedness for examination was also suboptimal.

The trial of a fresh approach of a series of lectures with active resident involvement followed immediately thereafter by a short written exam yielded encouraging results. The novel method was met with resident enthusiasm, and there was an appreciation for the focused interactive approach with reinforcement. Residents felt more at ease with the topics and felt better able to recall important learnt facts. Pre-reading allowed for heightened involvement of the residents. The short temporal association of lectures with immediate evaluation bolstered a sense of focus and interest, with improved recall of topics examined, as shown in improved in-house examination results. While clinically related diagnostic radiology is undoubtedly the primary focus, there is a compelling need to integrate a structured physics curriculum that is both beneficial and relevant for Diagnostic Radiology trainees. Hendee WR has rightly commented that efforts involving many professional organizations are under way to resolve the paradox of expanding complexity of radiological imaging contrasted with the declining emphasis on physics in radiology residency programs. These efforts should help to reestablish physics education as a core value in radiology residency programs.[9]

Potential Limitations: We recognize that this effort is only an initial step towards meeting radiology physics educational goals. The data given is based upon feedback from a single institute and long term feasibility of this approach is yet to be assessed, which

is a limitation of our study. Also the sample size is small. The need to continue to study this altered curriculum for its shortcomings and allow it to evolve accordingly is undoubtedly evident. The effect on long-term recall of important facts and topics may be the next step in assessment and a short revision course of core concepts may be required at a later stage for reinforcement.

As the complexity of the physics curriculum progresses it is yet to be seen how our method works. For example concepts related to conventional radiography maybe relatively easier to grasp while more challenging topics such as advanced MR physics can pose a problem especially if dealt with in too much haste. The ability of residents to keep up pace with such involving topics may require a more thorough pre-read, or additional allotted lecture time. We feel that the guidance of a medical physicist will be key when such complex core topics arise, and their role cannot be entirely excluded. That also brings to light that a solely resident -driven approach as suggested by Shanker et al,[8] may not be viable in such instances, perhaps underscoring how a combined didactic and interactive approach may be necessary. That said, we must not understate the importance of resident involvement and integration into the process that are vital to the success of any method. Merits of the residenteled approach include bolstered individual interest, learning through teaching, responsibility, group cooperation and it deters boredom. We feel that continued resident and faculty input and feedback are critical to the sustainability and envisioned benefit of this endeavor and its results. The assessment of such may be considered in the future.

Going Forward: We would like to continue this method of focused interactive teaching with immediate assessment in the future. The scope of the syllabus feels demanding at times and breaking the knowledge mass down into modules with intermittent serial lectures is a helpful step. Clinical radiology facultie s input for clinically related radiology physics applications might help gear residents to understand the clinical relevance of this approach going forward. Molding and evolving the structure of our curriculum as the syllabus broadens may be required and the creative capacity of all involved may be a driving force. A comparative trial or integration of the resident led-approach as described by Shankar et al may add another dimension to our efforts.

Another avenue to be explored may be the integration of a web based modular educational endeavor as incorporated by the RSNA and AAPM. This method has many positive attributes such as quality and uniformity improvement of physics education, residents can choose their own rate and time of study, the physicist will be able to change from being a lecturer to a mentor for difficult material and it frees physicists and residents from unsatisfactory lectures that are difficult to attend.[3,9,10] Perhaps in the future we can supplement our current format with these enriching, focused, goal oriented learning packets.

The radiology resident of today has an entirely different and expanding scope of information to learn and master. There is a requirement for the knowledge base to grow in a horizontal (involving more imaging technologies with a variety and frequency of applications) and vertical direction (increased level of sophistication of the applications based on health and disease at cellular, molecular, and genetic levels).[2,7] Given these challenges the physics curriculum should be taught in as easy and intuitive fashion as possible. Optimistically substantial progress is being made on a global level, as the universal need for a budding radiologist to understand the basis of producing quality images, their interpretation, developing safe protocols is being appreciated. Collaboration with other radiology training programs for possible expansion of similar programs and sharing the results may help clarify our combined path forward.

Conclusion

Compared to our prior didactic lecture-based physics curriculum with an quarterly exam, the transition to an interactive lecture-based approach with immediate evaluation on a quarterly basis has provided better results and been well received by radiology residents in the initial analysis.

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Conflict of Interest: None

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