Asynchronous Interactive E-Learning in Diagnosis of Pediatric Elbow X-ray Pathology - A Pilot Study

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INTRODUCTION:

Medical education is experiencing a paradigm shift from lecture-based to more interactive teaching sessions. Use of online learning, particularly after the COVID-19 pandemic, is more frequent. Radiology is often mentioned as a specialty particularly suited to online education. In fact, in recent years, the majority of the medical teaching institutions throughout Europe were reportedly using e-learning extensively in radiology teaching and training. There are centers which use online quizzes as a competency standard for reading pediatric musculoskeletal radiographs in emergency medicine physicians. Studies show interactive online learning improves medical student learning during radiology rotations e-learners might perform better than traditional lecture learners. These findings extend to orthopaedic surgery as well, where blended (combined e-learning and lecture-based learning) proved to be more effective in knowledge and skill acquisition compared to lecture-based learning alone. This pilot study examines use of a web-based interactive e-learning application designed to evaluate and improve diagnostic accuracy of pediatric elbow x-rays in orthopaedic learners.

METHODS: Senior medical students on an orthopaedic surgery sub-internship (MS4) and junior orthopaedic residents (PGY1 and PGY2) participated in the study ("learners"). A web-based interactive application (XrayVis.com) tested a learner's ability to correctly diagnose pediatric elbow x-rays. In these modules, each learner completed two 20-question quizzes two months apart. The quiz shows two x-ray sets, one of which is abnormal. Learners 1) select the abnormal set (N/ABN) and 2) pick a diagnosis for the abnormal X-ray set (Dx) resulting in two scores from 0 to 20 for each quiz. The application contains over 1000 de-identified normal and abnormal elbow X-ray sets, with diagnoses determined both by board-certified pediatric orthopaedic surgeons and board-certified pediatric radiologists. The application provides immediate user audiovisual feedback for each question, as well as user-specific links to online learning based on questions missed at the end of testing. Data are stored on a secure, encrypted cloud-based server with data access limited by authenticated user permissions. Statistical analyses featured three main components: a one-way ANOVA examined quiz scores by learner year-in-training to identify potential differences in quiz scores to determine if quiz scores improved over time; a one-way ANOVA analyzed quiz scores by most common diagnoses to determine if quiz performance varied by different diagnosis.

RESULTS:

A total of 28 learners participated (MS4: 8, PGY1: 12, PGY2: 8) and collectively viewed 1864 x-ray sets. Most common xray diagnoses shown in the quizzes included: normal (n=932), supracondylar humerus fracture (n=334), lateral condyle fracture (n=161), radial neck fracture (n=142), olecranon fracture (n=69), and combined olecranon / radial neck fracture (n=68). ANOVA showed significant differences in scores by year-in-training (MS4: 14; PGY1: 16; PGY2: 18; p=0.03 for A/ABN and 8, 11, 12; p=0.05 for Dx). At two months from initial quiz completion, there was significant improvement upon repeat testing (16 to 18 for N/ABN and 11 to 13 for Dx, p=0.05 for both). For the most common pathologic x-ray diagnoses shown in the quiz, supracondylar humerus fracture was correctly diagnosed 76% of the time; lateral condyle fracture 71%; olecranon 71%; radial neck fracture 38%; combined radial neck / olecranon fracture 35%. ANOVA test showed significant differences in quiz performance by diagnosis (p < 0.001). There was not adequate statistical power to determine if quiz performance by diagnosis was different among different learner year-in-training. DISCUSSION AND CONCLUSION:

This pilot study shows that a web-based interactive application stratified learners according to year in training and demonstrated improvement in learner scores over time. It also highlighted commonly missed diagnoses among learners. This application may be used to identify musculoskeletal diagnoses which are more difficult for learners, potentially focusing educational efforts towards these diagnoses. The data does not show if the increase in learner diagnostic accuracy over time is a result of the online learning links provided to the learners, as we did not characterize all educational activities that occurred between the two quizzes. Future directions include increasing the number of x-ray sets with less common diagnoses into the data set, measuring whether the suggested online learning links were actually viewed by learners, and then examining potential relations between score improvement and use of suggested online learning modules.