Abstract

Introduction: Children with neuromuscular disabilities (NMD) receive care in a wide variety of clinical settings. Residents lack training to develop physical examination skills for evaluating patients with NMD. We devised a curriculum to teach residents how to examine patients with NMD using a systematic and simplified approach.

Methods: Creation of this resource was a response to a survey of final-year residents that revealed the need for education focused on developing physical examination skills. The curriculum has four components—multimedia PowerPoint with embedded video, knowledge assessment, clinical exam (CEX) assessment, and module feedback—and was completed by 37 residents over an 8-month period from January to September 2016. We utilized knowledge assessment, direct clinical skills observation using the CEX, and module-feedback responses as part of the evaluation.

Results: All 37 residents completed the curriculum, with an overall knowledge score of greater than 80%. Residents demonstrated most of the desired patient care behaviors on the CEX assessment and provided positive feedback on the quality, usefulness, and applicability of the module, in addition to requesting more curricula to develop their physical examination skills.

Discussion: The CEX assessment provided a unique opportunity for faculty feedback on residents’ physical exam performance. After completing the module, residents achieved high scores in most areas of the standardized CEX and were able to conduct the NMD physical exam in a sensitive manner. The assessment highlighted the need to improve residents’ skills of detecting abnormal clinical findings and communicating with the patient during the physical exam.

Keywords
Curriculum, Physical Examination, Pediatric Residents, Neurodisability

Educational Objectives

By the end of this session, learners should be able to:
1. Demonstrate a systematic and sensitive approach to examining patients with neuromuscular disabilities as assessed by clinical exam assessment.
2. Identify at least four commonly seen physical abnormalities in patients with neuromuscular disabilities.
3. Apply the four domains of physical examination in a patient with neuromuscular disabilities during the clinical exam assessment.

Introduction

Physical examination is an essential component of the medical decision-making that guides establishing a diagnosis. Recent evidence suggests that skills in performing a physical exam are declining among physicians trained at U.S.-based medical schools. Children with neuromuscular disabilities (NMD) are a vulnerable cohort of patients who often are nonverbal, sometimes are immobile with intellectual disability and multisystem involvement, and rely on an astute physician to perform a thorough physical exam to detect clinical abnormalities. Inadequate physical exams are preventable sources of medical errors, leading to missed diagnoses with cost implications and even mortality. Previous studies reported in the literature have highlighted the need for improved teaching of the musculoskeletal examination.

Opportunities for faculty feedback focused on improving residents’ physical examination skills are sparse.
Online methods that reinforce face-to-face instruction with a blended curriculum have proven to be effective in encouraging deeper learning and improved accuracy of the physical exam. With advances in technology, online video-based instruction is perceived to be more authentic and illustrative, allowing for better retention of knowledge content, and can be particularly effective when used prior to bedside teaching, utilizing the flipped classroom approach. A needs assessment of graduating residents at Nationwide Children’s Hospital highlighted the need for better teaching of physical examination skills. Our findings were similar to those reported by Grant, Macnab, and Wambera and Begets, Begets, Resaca, Gabhart, and Blankenburg on pediatric residents’ lack of confidence regarding examination of patients with neurological disabilities. We developed this curriculum to address the gap in physical exam skills training during residency. The curriculum is aimed at pediatric residents and primary care providers who care for patients with NMD in both inpatient and outpatient settings.

Utilizing Kolb’s experiential learning cycle, the curriculum addresses the following phases of learning:

1. The PowerPoint presentation and knowledge assessment provide concrete experience by engaging residents in a learning activity.
2. The clinical exam (CEX) assessment allows for reflective observation on the learning activity by faculty and residents and for abstract conceptualization by teaching skills through experience, with direct faculty feedback.
3. Ongoing implementation of these learned skills enables active experimentation by allowing residents to try out the new skills learned.
4. The module allows residents to provide feedback on the overall quality and usefulness of the module and to improve future curricula.

To our knowledge, this is the first educational intervention that incorporates online learning to meet the specific goal of improving physical exam skills for evaluating patients with NMD, as well as using a modified NMD CEX assessment to reinforce learning. The CEX assessment is a 15- to 20-minute direct observation of a trainee-patient interaction by a faculty member, who offers constructive feedback to the trainee; it has been shown to have higher fidelity for assessment of physical examination. The crucial components of the physical examination criteria were matched with the essential skills required in examining a patient with NMD to formulate the NMD CEX. The NMD CEX utilizes an actual patient encounter and the judgment of a skilled clinical educator to provide feedback on the trainee’s examination technique and communication with the patient. For the purposes of this resource, we used a CEX assessment that details physical examination parameters, which are pertinent to the examination of a child with NMD.

There is a paucity of curricula validated by content experts for performing examinations of patients with NMD, although several are available online. Previously published curricula on complex care address different aspects of caring for patients with NMD but not the vital aspect of the physical examination. This resource was developed with the primary aim of improving residents’ physical examination skills. It utilizes a blended curriculum featuring an asynchronous online learning module with assessment prior to clinical rotation and bedside teaching and follows a flipped classroom approach.

Methods

Implementation of Module

We delivered the module as a didactic lecture utilizing the flipped classroom approach. Learners were encouraged to utilize the educational module (Appendix A or B), using the tip sheet (Appendix C) to navigate through the PowerPoint. After completing the module, participants were directed to answer the knowledge assessment questions (Appendix D). Further bedside teaching reiterated knowledge outlined.
in the module during the residents’ clinical rotation. Residents underwent an assessment with the CEX (Appendix E), which assessed learned skills in an actual clinical encounter with a patient. After completing the assessment, learners provided feedback on the curriculum using a survey (Appendix F).

Personnel
We advised the instructors to familiarize themselves with the module prior to teaching in order to ensure best utilization and reinforcement of the skills taught in the module. There were no specified knowledge prerequisites for the learners, and the instructors familiarized themselves with examining patients with NMD and with using the NMD CEX to provide effective feedback and instruction. CEX assessment was performed by one faculty instructor with a participant learner during an actual clinic encounter with a patient.

Physical Exam Module
We presented the physical exam module as a PowerPoint lecture with an embedded video demonstrating the systematic examination of a child with NMD (dyskinetic cerebral palsy). The physical examination had a simplified head-to-toe approach, with close attention given to commonly seen abnormalities in patients with NMD (e.g., joint contractures and joint deformities measured with a decrease in popliteal angle, explanation of types of hypertonia and ankle deformities). Learners were directed to pertinent journal articles via links in the presentation. The module with audio narration (Appendix A) was used for asynchronous learning in conjunction with the knowledge test. Residents were instructed to view the module early in their rotations to optimize learning and enable application of concepts taught in the module to real-life clinical encounters.

Knowledge Assessment
The knowledge assessment was aligned with the learning objectives and consisted of 10 multiple-choice questions presented in pediatric board–style format and addressing the knowledge content of the module. Residents completed the assessment after watching the video. The assessment was created by us and piloted with a group of residents, faculty, and chief residents who provided feedback that was incorporated prior to implementation. Residents viewed the video and completed the knowledge assessment in our institution’s learning management system.

CEX Skills Assessment
The CEX skills assessment was performed by a faculty member in the inpatient or outpatient setting. The resident examined a patient during a real-life clinic encounter. The NMD CEX addressed the educational content, as well as communication and professional behavior, in the following four aspects during the examination of the patient:

1. Ability to perform a structured physical exam in a sensitive manner.
2. Accuracy in detecting abnormal clinical signs.
3. Ability to adapt the exam to meet the needs of the patient.
4. Ability to communicate with the patient during the clinical encounter.

The CEX was developed by incorporating the essential parameters of physical examination skills as outlined in the formative mini-CEX rating form. Faculty instructors were advised about the teaching physician, and the resident obtained permission from the patient/parents prior to performing the CEX assessment. The teaching physician observed the resident performing the examination and interviewing the patient. The CEX assessment form was completed outside the patient room in discussion with the resident as part of the formative assessment. The assessment was part of the educational portfolio of the resident performing the examination.
Learner Survey
The survey questions were designed to elicit feedback on the quality of the module and to direct future curricula. The responses to the survey questions were rated on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

Results
All 37 residents who were assigned the module completed it with a knowledge score greater than 80%. Residents scored more than 80% in all domains of the CEX, with their best scores being in the ability to conduct the examination in a sensitive manner (94%). Lower scores (80%-87%) were recorded for detecting abnormal signs, communicating during the physical exam, and modifying the examination to the needs of the patient. That residents scored better in some domains than others is likely explained by the fact that the module more explicitly covered examination of a patient with a specific type of neurodisability and was not comprehensive enough to demonstrate skills for adapting the examination to the particular needs of other patients. Not all types of patients with neurodisability were captured in the module, and having additional curricula may help better demonstrate the spectrum of commonly seen clinical abnormalities. The module-feedback responses were graded on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), with ratings of 3.8 for satisfaction with the module, 4.0 for changing the way residents would interact with patients, and 4.1 for confidence applying learned principles to clinical practice. Qualitative feedback from residents showed they wanted more curricula of this nature for further training. Comments related to improvement on specific topics are provided below.

Additional Content
- “Showing more examples of physical exam findings with pictures or videos of patients.”
- “More diagrams explaining where contractures occur and differentiating types of hypertonia would be helpful.”
- “Include more videos of various findings (or provide links to YouTube videos). Maybe provide one slide with examples of how management varies with the different exam findings.”
- “More information about specific exam findings . . . More specific exam techniques. I felt that this was such a basic module that really nothing was new information compared to what I already know after completing medical school.”

Improve Methodology
- “I would have preferred a reading resource to refer to for the questions, and more time to answer the questions. I also think it would be more beneficial to do a hands-on exam to learn, rather than watch a video and take a quiz.”
- “Video of exam too quick, would be better if a little slower. Also, a PDF of an exam checklist would be helpful to practice in clinic.”

Adding Additional Knowledge Assessment Questions
- “A few more practice questions throughout the module. Patient and family comments about the things that are helpful for their/their child’s exam.”
- “Linking to an article is not particularly useful. It would have been more useful to demonstrate step-by-step how to perform physical exam components (for us visual learners) instead of forcing learners to read through a moderately dense article.”

Discussion
Several studies indicate the need for improvement in residents' education in managing patients with NMD.\textsuperscript{12,19} We developed a curriculum to examine pediatric patients with NMD and found this tool to be effective in addressing a gap in training to improve residents' physical exam skills. Advances in neonatal
care have led to increasing numbers of survivors with NMD, who often have complex medical needs. Having a basic framework to systematically examine these patients simplifies the exam and minimizes the potential to omit pertinent findings. The physical exam module demonstrates this framework in order to help simplify an otherwise challenging exam, alleviate residents' anxiety, and improve acquisition of knowledge by highlighting commonly seen clinical findings in these patients. Our curriculum provides foundational physical examination skills that can be applied directly to clinical practice.20

During the CEX assessment, the residents demonstrated their ability to perform a structured clinical exam on a child with NMD. The assessment highlighted the need to improve detection of abnormal clinical signs and communication with the patient. This improvement can be achieved with repeated practice and ongoing efforts by the faculty and residents. Trainees, who are taught a wide range of clinical features across many cases, acquire a rich clinical memory of physical signs.21

The module itself is not comprehensive and provides only foundational training for the physical exam. This curriculum complements, but cannot be a substitute for, bedside teaching of physical exam skills. Residents demonstrated desired patient care behaviors across all domains on the CEX. We found it beneficial to do these assessments in real-patient encounters, rather than with a standardized patient, to allow for better detection of abnormal clinical findings. Performing the CEX assessment in the inpatient setting, for example, following ward rounds, allowed for more time for feedback than in an outpatient setting, due to time constraints with clinic appointments.

Although this module discusses the basic framework to approach examination of a child with neurodisability, it is only the starting point to better addressing the educational needs of learners who care for this patient population. By design, the module highlights important basic aspects of the physical examination that are frequently overlooked or omitted during the examination of the child with NMD, such as remembering to speak to a nonverbal child or stepping back to perform a thorough inspection before performing examination maneuvers. For some learners, this content may be very basic, but for others, it can prove to be rewarding.

We received feedback from residents requesting additional diagrams and schematic representations of contractures and checklists to simplify examination in these patients. We are developing curricula that will help standardize examination of these patients across specialties (physical medicine and rehabilitation, orthopedics, and pediatrics) to help with referrals from primary providers to specialties. This effort will address some of the concerns of previous learner groups. In addition, we want to implement the module in more than one hospital site and with various learner groups (medical students, residents, fellows) to help establish general effectiveness. Also, future curricula will allow learners to view examples of examination techniques by utilizing slow-motion videos that can be repeated and reviewed, ideally improving the quality of instruction through use of better videos.

Limitations
The patient in our video has dyskinetic cerebral palsy and normal intellectual ability and communicates with an augmentative communication device. This patient is not reflective of the whole spectrum of patients with NMD. Including a few more examinations of patients with different needs would more accurately represent the challenges and spectrum of this patient population. Scheduling residents for assessment in addition to the clinical work that needed to be completed at the end of rounds was sometimes challenging. Another challenging aspect was ensuring that residents completed the different components of the curriculum. They were sent reminders through email prompts to finish the assessments.

Although the CEX is a standardized tool, in our study we were not able to perform numerous assessments of a single resident by several assessors and, therefore, could not calculate interrater bias or reliability for
the method. We were unable to reassess residents for retention of knowledge and skills via a repeat assessment later in the year of training.

In the feedback survey, the residents provided comments on the curriculum's usability, its quality, and their ability to apply learned skills to clinical practice. The residents requested that more details on specific signs (e.g., abnormal movements, cranial suture abnormalities, and other commonly seen physical examination findings) be presented. These suggestions are very good and will be incorporated into the next version of this educational study. We plan to continue to develop a curriculum that further augments the foundation provided by this module. Such online modules have the advantage of scalability to reach multiple learners and can also be improved over time based on learner feedback.

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