A Video and Case-Based Transport Curriculum for Neonatal-Perinatal Medicine Trainees Using a Flipped Classroom Methodology

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Abstract

Introduction: Neonatal-perinatal medicine (NPM) providers actively manage medical transports. However, there is wide variation in transport education among fellowship programs. Using the flipped classroom methodology, we developed a video and case-based transport education curriculum. Methods: A national needs assessment identified safety, communication skills, and physiology as the most important aspects of transport management. Three 10-minute video modules and two 20-minute case-based discussions were developed to address this content. Using the flipped classroom format, seven NPM fellows from all three postgraduate years of training took part in the curriculum by individually viewing each video followed by participation in group case-based discussions. Cognitive and affective outcomes were assessed using a knowledge and attitude pretest, individual video module posttests, and a postcurriculum follow-up survey. Results: NPM fellows showed significant improvements in transport knowledge and reported increased confidence in their ability to perform important transport roles. Case discussions were adaptable to learners who had different levels of training and had variable transport experience. Case discussions were successfully executed both in person and by video telecommunications during the 2020 COVID-19 pandemic. Discussion: This transport curriculum addressed a national education gap in NPM fellowship training. Using the flipped classroom methodology, cognitive and affective objectives were achieved by improving knowledge and confidence in transport skills among NPM learners. The video and case-based formats were easily implemented, applicable to multiple types of learners, and adaptable to different environments.

Keywords
Transport Medicine, Neonatology, Neonatal-Perinatal Medicine, Physiology, Communication Skills, Online/Distance Learning

Educational Objectives

By the end of this activity, learners will be able to:

1. Report increased confidence in their ability to accept a transport referral call.
2. Report increased confidence in their ability to provide transport referral providers with patient management recommendations.
3. Report increased confidence in their ability to medically manage a transport by phone.
4. Analyze how patient physiology is affected by medical air transports.
5. Describe how communication skills affect safe transport practices.
6. Discuss how external factors such as weather, local expertise, and resources can affect decisions regarding safe patient retrieval.

Introduction

Over 68,000 neonatal transports occur annually.1 Practicing neonatologists participate in this process as the referring provider, the accepting provider, and/or the medical control physician in order to provide safe and efficient transfers of critically ill newborns or premature babies between hospitals.1-4 Medical control physicians direct the clinical management of transported patients either in-person or by telecommunications. Neonates that require transfer to a tertiary care facility have higher rates of mortality and morbidity during their hospitalization.5-8 Their unique physiology and small size create transport challenges which require knowledge of prematurity, specialized equipment, and experienced personnel for safe
transport. The 2013 consensus statement by the American Academy of Pediatrics Section on Transport Medicine stated that transport medicine and medical control training is, “an essential part of neonatology, pediatric critical care, and pediatric emergency medicine fellowship training.” Competency in transport physiology is also an American Board of Pediatrics subspecialty content specification. After graduating from a neonatal-perinatal medicine (NPM) fellowship program, neonatologists are expected to have the necessary skills to direct the safe transport of this high-risk population.

Despite this expectation, there are limited data regarding the current state or content of NPM fellowship transport training. To our knowledge, there are no previously published educational materials available within MedEdPORTAL or other NPM fellowship resources that address this issue. Using the educational framework described by Kern et al., we began by first identifying this problem (Kern et al. Step 1), and then performed a specific assessment. We performed a national needs assessment by developing an anonymous web-based questionnaire that was distributed to the Organization of Neonatal-Perinatal Training Program Directors (ONTPD) listserv (Kern et al. Step 2). ONTPD represents all 96 accredited NPM training programs in the United States and Canada. Fifty-four percent of NPM program and associate program directors responded to the questionnaire. Due to the anonymity of the survey, more than one person from the same program may have responded, thus the data represented the opinions of each program or associate program director rather than an individual fellowship program. Of respondents, 78% of respondents strongly agreed that neonatal transport is an important aspect of NPM fellowship training. Despite this, approximately 20% of respondents reported that their program had no formal transport educational program or requirement. There was also a wide variation in individual skills and requirements for participation in the transport process among NPM fellowship programs. In contrast to the current state of NPM fellow education across the country, there are rigid transport education and maintenance of certification requirements for other neonatal transport providers including nurses, respiratory therapists, ambulance drivers, and emergency medical technicians. With this knowledge, it was determined that a need for a national NPM fellow transport curriculum exists.

Because of this national gap in NPM training, our aim was to create a multimodal NPM transport educational curriculum that was readily available, adaptable to individual learners, and applicable to different environments. We developed a video and case-based NPM transport curriculum that focused on transport safety, communication, and physiology. Curriculum content was based on the American Board of Pediatrics subspecialty content specifications regarding transport physiology and the results of our national needs assessment. Based on the results of the needs assessment, the three most important competencies (i.e., those with the highest percent of extremely important or very important responses) a NPM trainee should acquire are: patient referral/intake (100%), medical management of patients by telephone (98%), and transport physiology (90%). The ability to accomplish these tasks safely and efficiently is dependent on a solid foundation of transport safety knowledge and communication, thus these were also included in the development of the curriculum.

Following the needs assessment, curriculum learning objectives were designed to address cognitive and affective learning skills (Kern et al. Step 3). Cognitive objectives focused on knowledge acquisition of transport safety, communication techniques, and physiology. Finally, affective objectives centered on positively impacting the learner’s confidence in their future ability to act in different transports roles.

To achieve this range of objectives in a graduate medical training program as well as accomplish our aim to develop a widely applicable, adaptable, and sustainable curriculum for distribution to a wide range of learners and teaching environments, the principles of andragogy were to be taken into consideration. According to Malcolm Knowles there are six traits of adult learners. Adults are internally motivated, self-directed, and problem oriented. Their learning is impacted by personal experience, and the relevance of information is based on personal need and practicality. For these reasons, we decided to utilize a flipped classroom methodology for this curriculum. The flipped classroom is a methodology in which trainees learn when individually motivated at their own pace. Classroom time uses active learning methods for knowledge application, thus reinforcing knowledge that was gained independently. Facilitators are able to gauge the learners’ base knowledge and tailor classroom time to the learners’ needs. We determined that using short videos followed by small-group case-based discussions was the ideal flipped classroom format to achieve the stated objectives and aims of the curriculum (Kern et al. Step 4). These modalities are easily disseminated to a wider audience. They are also adaptable to different environments by enabling programs to utilize the videos and discussions that are appropriate for individual learners and variable clinical practices. Because the content was based on evidence-based...
communication techniques and human physiology, the curriculum is sustainable for long-term use.

Methods

Educational Modalities

We developed a precurriculum transport knowledge pretest assessment (Appendix A), and three 10-minute video modules with individual learning objectives and associated posttests. Content addressed: (1) transport basics and safety, (2) transport communication, and (3) transport physiology (Appendices B-D).

Utilizing Vyond (GoAnimate Inc.), a web-based video creation platform, the videos were animated, then the voiceover was recorded and edited. Local transport medicine experts edited the videos for content prior to publishing and distributing to learners. The videos were designed to be viewed individually or as a complete curriculum depending on individual NPM program learning needs.

Two case-based discussions with individual learning objectives primarily focusing on content from video 2 on transport communications (although relevant to all three videos) were also developed (Appendices E and F). Both cases were based on frequently encountered real-world clinical situations in NPM transport medicine and ranged from simple to complex. Cases and facilitator guides were edited for content, rationality, and accuracy by local NPM faculty. These cases are modifiable to allow individual programs to integrate local clinical practices.

From our experience during implementation, each discussion took approximately 20 minutes to complete, depending on learner participation.

Learners

This curriculum was developed for NPM fellows at the University of Michigan. Currently our program enrolls a total of eight NPM fellows. Seven NPM fellows were eligible for participation and completed the curriculum. One fellow was ineligible to participate because she was an author and was directly involved in the curriculum’s development and implementation. At our institution, NPM fellows participate in the neonatal patient transport process after they completed the first 6 months of their 3-year fellowship and were determined to be clinically competent by NPM Clinical Competency Committee. At our institution, this means they demonstrated competency for independent practice in intubation, umbilical line placement, and chest tube placement. During the second year of fellowship, the learners participated in a clinical rotation during which they were the primary transport provider. This role consisted of accepting transport referral calls and participating in patient retrievals either by ground or air medical transport. Although many of our learners had previous transport experience and were at various stages of NPM training when they participated in the evaluation of this curriculum, no prerequisite transport knowledge or experience was required to participate in this curriculum.

Facilitator

A senior NPM fellow facilitated this curriculum. The intended facilitator for implementation of this curriculum can be an NPM attending physician, or senior NPM fellow, or senior transport-trained advanced practice provider. To initiate the curriculum, the facilitator began by distributing the pretest to the learners. Upon completion, the facilitator provided access to the videos and associated posttests, that were completed asynchronously. Following completion of the video modules and posttests, the facilitator organized and led the small case-based discussions using the facilitator’s guide. Groups may be organized based on availability, transport experience, or level of training. The facilitator should be familiar with the content of the transport communication video (Appendix C). Although answers to posed questions in the case discussion were provided in the facilitator’s guide, knowledge of the video can facilitate discussion.

Implementation

This curriculum evaluation study was deemed exempt by the Michigan Medicine Institutional Review Board. This curriculum was implemented at specific time periods based on transport responsibilities for each postgraduate year of training (PGY 4-6) between October 2019-April 2020 (Kern et al. Step 5). These periods included: prior to participating in patient retrievals during the first year (PGY 4), before attending a transport rotation scheduled during the fall of the second year (PGY 5), and during a nonclinical month of the third year (PGY 6). To determine baseline transport knowledge, our learners were given access to the web-based questionnaire distributed through QualtricsXM 1 week prior to their scheduled transport responsibilities. After the questionnaire was completed, the educational videos were made available to learners through a shared NPM division computer drive. NPM fellows were instructed to asynchronously view all three videos and complete the associated posttest (Appendices G-I) made available through QualtricsXM. Total time for each fellow to view the three videos and complete the posttests was approximately 30 minutes. Upon completion of the videos and posttests, three different small groups consisting of two to three fellows and one facilitator participated in the case-based discussions using the flipped classroom methodology to assess and apply the knowledge and skills learned from the video modules. These synchronous in-person discussions lasted
approximately 20 minutes. Two of the discussions occurred via web-based video chat platforms during the COVID-19 pandemic. The facilitator guide included two cases and a script with suggested questions and answers to help prompt discussions amongst learners. A learner's guide was also developed to allow the learners to have the case information and questions available for viewing during the discussion. This activity enabled the learners to teach each other and work together to come to a conclusion as a group, utilizing knowledge obtained in the previously viewed videos. The composition of the discussion groups was designed to allow for individualized learning based on fellow comfort and transport experience with more than 1 year of training represented in each group. The discussions were an additional opportunity to evaluate learner knowledge acquisition, and encouraged the integration of local clinical practice variation. Based on local experience and feedback provided by learners, we recommend that fellows view the videos at the beginning of their fellowship, as well as prior to participating in the transport process. The postcurriculum questionnaire (Appendix J) was distributed to learners following completion of all curriculum activities. Responses were obtained within 2 months of completing the curriculum.

Technical Information
To access the videos in Appendices B, C, and D, learners double clicked on the MP4 file which opened and played the video with any video playing software, including Windows Media Player. The videos were intended to be played by the individual learner, which enabled them to view the videos at their own pace. The learners were able to pause and rewind the video as needed, using the video navigation buttons in the video player.

Outcome Measures
Learners were instructed to complete the 15-question, web-based transport pretest, distributed through QualtricsXM, prior to implementing the curriculum. Using multiple-choice questions, the pretest identified individual knowledge gaps. The assignment of individual videos may be modified based on individual knowledge base and pretest performance. Results may also be shared with learners depending on individual program preference. In order to accurately measure knowledge acquisition from the curriculum, we did not share pretest results with learners prior to completion of the curriculum. Posttests (Appendices G-I) consisting of four to five questions each addressing cognitive learning objectives were included for each video and were distributed through QualtricsXM. The posttests were used to assess individual knowledge acquisition and compared to corresponding questions in the pretest (Kern et al. Step 6). Learner confidence was also assessed using the transport pretest and postcurriculum survey. Trainees were asked to rate their confidence in their ability to perform specific transport skills using a 7-point Likert scale (0 = strongly disagree, 7 = strongly agree).

Statistical Analysis
All statistical analysis was completed using GraphPad Prism Version 8.0.0 (GraphPad Software, Inc.). Knowledge acquisition was assessed by comparing the median difference between pre- and posttest scores using the Wilcoxon matched-pairs signed-rank test. A value of $p < .05$ was considered significant. Evaluation of the individual videos and questions was completed by comparing the number of questions answered correctly pre- and postmodule using the Fisher's Exact test. A value of $p < .05$ was considered significant. Confidence was assessed by comparing the median difference between pre- and posttest scores after converting the Likert scale into a numerical scale, and comparing for differences using the Mann-Whitney U Test. Qualitative information was reviewed for common themes by two providers.

Results
Seven NPM fellows representing all three postgraduate years of fellowship training (PGY 4-6) participated in the curriculum. All participants completed the curriculum, which included viewing the videos and participating in the case-based discussions. Each fellow also completed the pretransport test, the posttest for each video and the postcurriculum feedback survey.

Pre- and posttest results are shown in Figure 1. Overall, total test scores significantly improved after viewing the video modules ($p = .015$). Although we were inadequately powered to assess statistical significance for categorical variables, the percentage
of learners who accurately answered two important transport physiology questions also increased. These concepts addressed the change in the fraction of inhaled oxygen required during air medical transport (57% increase) and gas expansion during air medical transport (14% increase).

In addition to cognitive knowledge, confidence in the learner’s ability to perform all three transport skills used in various provider roles significantly improved after watching the videos (accept referral calls, \( p = .007 \); give recommendations, \( p = .015 \); and manage retrieval by phone, \( p = .002 \); Figure 2). The majority of learners also reported that the videos were extremely effective in teaching transport basics and safety (71%), the importance of communication during transport (86%), and transport physiology (86%).

Qualitative feedback regarding how to improve the transport curriculum included the addition of active learning activities such as simulations and more cases. One learner expressed that the curriculum should be distributed to “all providers going on transport,” and another recommended having “fellows complete this during orientation and perhaps once a year every year.”

**Discussion**

We developed a video and cased-based NPM transport curriculum using the framework developed by Kern et al.\(^{11}\) to address a national educational gap in NPM fellowship training. Specifically, we developed a curriculum addressing education in transport safety, communication skills, and physiology, as determined by a national needs assessment. We found that this combination of videos and case-based discussions using a flipped classroom methodology improved knowledge acquisition and confidence in performance of transport skills among NPM learners at different levels of training.

This curriculum is applicable to learners at all levels of NPM training who have varying transport and clinical neonatology experience. All participating learners showed improvement in their pre- versus posttest knowledge acquisition regardless of their previous experience. All learners, independent of level of training, also reported increased confidence in their transport skills. Because of its basic knowledge content and independent video format, the curriculum potentially has the capability to be used by all members of the transport team including other health providers such as advanced practice providers, nurses, and emergency medical technicians. Transport safety, communication, and physiology are a necessary knowledge base for any participant in neonatal transport, not only physicians.\(^{1,9,11-15}\)

During the implementation of this curriculum we were also able to confirm its adaptability. During the COVID-19 pandemic we were able to complete our evaluation of the curriculum without difficulty. Because the videos were remotely accessible, learners were able to view them from home according to their own schedule. Two of the small-group case-based discussions occurred virtually. Learners reported that the case discussions helped them learn about the transport logistics specific to our institution, thus improving their confidence in our institution’s transport process. This was very effective for those learners who had not participated in the transport process prior to curriculum implementation. Upon completion of the curriculum, they felt better prepared to take on transport management roles. The

![Figure 2.](image-url)

Figure 2. Learner-reported median confidence on a 7-point Likert scale (0 = strongly disagree, 7 = strongly agree) before and after completion of the video modules and case discussions (\( N = 7 \)).
ability to personalize the curriculum to individual NPM program processes while maintaining standard educational content required for all NPM trainees is a strength of this curriculum’s format.

One limitation of our evaluation was that a small number of learners participated in the curriculum, which limited statistical power for categorical outcomes and impacted the analysis of our results. However, our program is an average-sized NPM fellowship program and is representative of NPM programs that collectively train small groups of learners representing all postgraduate years with variable transport experience.23 Including additional NPM learners from other fellowship programs in future evaluations is an important consideration. We also designed and evaluated the curriculum incorporating all three videos as a complete set. However, the videos were intentionally created so they could be utilized independently. Although our evaluation showed that learner knowledge improved with each video, we cannot determine if learner confidence can be gained through utilization of only one or two of the videos versus utilizing the complete set. Finally, our curriculum did not include the assessment of transport skills in a simulated or real-world environment. This is an important aspect of applied learning and for development of competency in a clinical skill which should be considered.16 However, because of its adaptability, this curriculum could easily be combined with a transport simulation or direct observation exercise to enhance overall learning.

Neonatal transport is a time-sensitive and critical service provided to a high-risk patient population. The ability to facilitate this activity in a safe and reliable way is imperative. NPM fellows are expected to be competent in managing neonatal transports upon graduation. The ability to successfully participate in neonatal transport provider roles requires a baseline knowledge of general transport safety, the importance of clear communication during transport, and a knowledge of how physical gas laws affect patient physiology. We believe this readily available, easily implemented, and adaptable transport curriculum will fulfill this known educational gap in NPM education.

Appendices

A. Transport Physiology Pretest.docx
B. Transport Basics Video.mp4
C. Transport Communication Video.mp4
D. Transport Physiology Video.mp4
E. Group Case Discussions Facilitator Guide.docx

F. Group Case Discussions Learner Guide.docx
G. Transport Basics Posttest.docx
H. Transport Communication Posttest.docx
I. Transport Physiology Posttest.docx
J. Postcurriculum Questionnaire.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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Ethical Approval
The University of Michigan Institutional Review Board approved this study.

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