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Standardized Extubation and High Flow Nasal Cannula Training Program for Pediatric Critical Care Providers in Lima, Peru

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Abstract

Introduction: Acute lower respiratory tract infections are the top cause of nonneonatal mortality in children under 5 years of age. Since many resource-limited settings lack basic pediatric respiratory support modalities, introducing respiratory technology in these settings may improve survival. Unfortunately, data suggest that many interventions in these settings are not sustainable and that after several months, local staff are no longer comfortable using newly implemented technology. **Methods:** We aimed to create training modules for implementation of a standardized extubation process and high flow nasal cannula for physician and nurse providers at a tertiary care center in Lima, Peru. This training curriculum combined a didactic lecture with hands-on practicum and clinical case discussion over multiple sessions spanning a year. We created all materials in English and translated to Spanish for use. Participants completed evaluations after the training program to determine whether objectives were met. This training was intended for critical care providers but could be modified for other audiences. **Results:** A total of 76 providers (12 attending/fellow critical care physicians, 40 bedside nurses, eight pediatric residents, and 14 medical technicians) participated in this multiday training. Almost all (75, 99%) participants felt the objectives were clearly stated, and 70 (92%) felt objectives were met. **Discussion:** We have provided materials to help instructors set up and implement a standardized training curriculum with recommended timing and improvements based on feedback. The tools provided allow for adaptation depending on the instructors' primary objectives, language of audience (English or Spanish), and learners' level of training.

Keywords

High Flow Nasal Cannula, Extubation, Pediatric Critical Care, Spanish, Global Health, Resource-Limited Settings, Pediatric Pulmonology, Case-Based Learning, Clinical/Procedural Skills Training

Educational Objectives

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

1. Summarize the data supporting the use of an extubation readiness protocol and high flow nasal canula (HFNC) in pediatric respiratory failure.
2. Describe three complications associated with HFNC
3. Identify four indicators of a good response to HFNC.
4. Apply the protocols for HFNC implementation in clinical scenarios.
5. Classify respiratory distress in children as mild, moderate, or severe.
6. Demonstrate appropriate HFNC device setup.

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Introduction

Approximately 700,000 children under 5 years of age died from lower respiratory infections in 2015, and the vast majority of these deaths occurred in low- and middle-income countries.[1] This disparity is, in part, due to lack of availability of respiratory support and antibiotics for pneumonia. Even basic respiratory support modalities, such as oxygen, have been shown to save lives in resource-limited settings.[2] A subset of patients will progress to needing a higher level of support, such as invasive or noninvasive mechanical ventilation, to improve oxygenation and ventilation. However, these technologies are complex and require reliable oxygen and compressed air sources, highly trained bedside staff, access to device maintenance personnel, and a reliable supply chain for consumables. In many settings, providing

this level of respiratory support is not feasible.[3] Furthermore, prior attempts to introduce advanced respiratory support modalities in resource-limited settings have revealed limitations in both equipment maintenance and staff training.[4]

High flow nasal cannula (HFNC) is an alternative form of noninvasive respiratory support that is widely used for neonatal, pediatric, and adult respiratory failure.[5,6] Its basic nonocclusive interface eases the workload of bedside providers and makes its use in resource-limited settings promising. Given concerns for sustainability following initial HFNC implementation, our primary aim was to create a standardized HFNC curriculum for pediatric intensive care unit (PICU) providers.

Using practice guidelines from various institutions[7-9] and manufacturer recommendations,[10] we developed our curriculum to introduce best practices for standardizing extubation and initiating HFNC in young children with acute respiratory failure following extubation. Although our curriculum targeted Spanish-speaking pediatric critical care providers with minimal HFNC experience, it would be generalizable to all clinicians involved in the care of children with respiratory disease, including residents, respiratory therapists, and medical technicians in settings where HFNC is being introduced. Currently, there is only one other educational module in *MedEdPORTAL* related to HFNC, and it is embedded in a pediatric emergency medicine simulation curriculum.[11] Importantly, despite Spanish being the second most-common language spoken around the world, there are very few curricula available in Spanish through *MedEdPORTAL*, and none have been designed to train native Spanish-speakers in the introduction of new technology.[12]

Methods

We designed this curriculum to train PICU providers at Instituto Nacional de Salud del Niño (INSN) in Lima, Peru, in basic concepts and use of HFNC for use immediately prior to HFNC deployment. INSN is a large tertiary care facility in the Ministry of Health system serving as a referral center for children throughout Peru. The majority of patients admitted to the PICU with respiratory failure were on invasive mechanical ventilation. Therefore, we included best practices for extubation readiness and evaluation of postextubation respiratory failure.

The coauthors of this module bring extensive clinical expertise in the use of HFNC in hospitalized pediatric patients. Katie R. Nielsen, Rosario Becerra Velásquez, and José Tantaleán da Fieno are pediatric critical care physicians; Laura E. Ellington is a pediatric pulmonary fellow; and Gabriela Mallma Arrescurrenaga is a respiratory therapist in the PICU at INSN. Rosario Becerra Velásquez, José Tantaleán da Fieno, and Gabriela Mallma Arrescurrenaga are native Spanish speakers; Katie R. Nielsen is fluent in Spanish; and Laura E. Ellington is highly proficient.

Our learners had experience with the assessment of children with respiratory distress and were familiar with advanced respiratory care, including invasive and noninvasive mechanical ventilation. It is not necessary that learners be experts in these areas, but a basic knowledge of important concepts will facilitate learning. We followed the behaviorist learning theory, in which learners are guided toward appropriate answers by using positive and negative reinforcement, because it tends to be effective in teaching scientific concepts and skills.[13]

The curriculum consisted of three parts: (1) a didactic PowerPoint presentation that explained theoretical concepts of extubation readiness and HFNC, (2) a hands-on practical session involving the setup of the HFNC system, and (3) case-based scenarios for group discussion. We designed this curriculum to allow for refresher training at regular intervals by local support teams to reinforce key concepts. We began training with the 45-minute didactic presentation (Appendices A in Spanish and B in English). We divided learners into groups of fewer than 20 people to facilitate interactions between learners and teachers. After completing the didactic presentation, we divided learners into smaller groups (i.e., fewer than 10 people) and transitioned to a hands-on practicum to demonstrate the setup of the HFNC system. We designed the hands-on practicum for groups smaller than 10 people so that all learners could see the HFNC system, practice setup, and ask questions. We created a video in Spanish demonstrating the setup since no educational materials existed in Spanish from the manufacturer. Due to a lack of resources, the quality of the video is low, so we have made it optionally available (Appendix H). In the final portion of the curriculum, we facilitated case-based small-group discussions (Appendices C in Spanish and D in English) with videos of respiratory distress (Appendix E). We distributed copies of the HFNC protocols for learners to reference during these discussions. We projected videos of respiratory distress on a computer screen and/or projector and discussed key concepts in the recognition of respiratory distress and response to HFNC therapy. The initial training session took place twice daily for 5 days to ensure that all staff received the training during scheduled work hours. Refresher trainings took place 3 and 12 months after baseline training.

Finally, we measured the effectiveness of the activity through written evaluations (Appendices F in Spanish and G in English) and semistructured focus groups performed after the training

session. In the written surveys, we assessed the quality of the learning experience as it pertained to learning objectives, time allotted, participant comfort with HFNC, and overall satisfaction with the training. During focus groups, we asked participants to further elaborate on their overall satisfaction and to provide suggestions for improvement. We also collected pre- and posttest evaluations to evaluate knowledge acquisition, which will be reported elsewhere.

Adaptation in Different Settings

Each portion of this curriculum could be adapted for use at other sites. The didactic presentation could be used for large groups if a large conference room and projector were available, or the individual PowerPoint slides could be printed and provided in handout format for groups of fewer than 10 people if a computer and/or projector were unavailable. The section on extubation readiness can be excluded if not applicable to specific clinical settings. For the hands-on practical session, we used the Fisher & Paykel OptiFlow Junior HFNC system because it was available at INSN. However, the session could easily be adapted for other commercially available HFNC systems, such as Vapotherm and Hudson RCI Comfort Flo. If an HFNC system is not available, there are online resources in English that demonstrate appropriate device setup. For the case-based scenarios, facilitators could show videos on smartphones if a projector is not available, but we would recommend smaller group sizes if this approach is undertaken. Regardless of the clinical setting, it is important to consider specific cultural or local language differences prior to implementation and training. Therefore, these materials can be readily adapted based on local context.

Results

A total of 76 learners participated in the initial training session, including 12 PICU-trained physicians (attending or fellow), eight pediatric residents, 40 registered nurses, one respiratory therapist, and 14 medical technicians. Demographics of the learners can be found in Table 1.

Almost all participants felt the objectives were clearly stated ($n = 75$, 99%), and 70 (92%) felt objectives were met (Table 2). Approximately 90% of participants rated time in each section as just right, and 52 (68%) rated the session quality as above average or excellent. The proportion of participants claiming a level of comfort of comfortable or very comfortable increased from 68% to 89%, with the greatest increase noted in the very comfortable group. Results on knowledge acquisition and information retention of our training program will be reported elsewhere.

Table 1. Demographics of Participants ($N = 76$)

Factor	Posttraining Assessment: No. (%)
Provider role:	
ICU-trained physician (fellow or attending)	12 (16)
Pediatric resident	8 (11)
Registered nurse	40 (53)
Respiratory therapist	1 (1)
Medical technician	14 (18)
Years of ICU experience:	
1-10 years	44 (58)
>10 years	30 (39)
Years as health care provider:	
1-10 years	29 (38)
>10 years	45 (59)
Experience with high flow nasal cannula:	
Used >5 times	3 (4)
Used ≤5 times	5 (7)
Never used	66 (87)

Discussion

We developed an HFNC curriculum in both English and Spanish for use by PICU providers of different skill levels at a tertiary care PICU in Lima, Peru. It was well received by learners and rated as a positive learning experience. To our knowledge, this curriculum is the first in *MedEdPORTAL* originally targeted for non-English speakers in a resource-limited setting. While developed specifically for providers in the PICU at INSN, this

Table 2. High Flow Nasal Cannula (HFNC) Training Assessment ($N = 76$)

Factor	Posttraining Assessment: No. (%)
Objectives clearly stated at the beginning of the session	75 (99)
Objectives met	70 (92)
Rate the time spent on the didactic session:	
Too long	2 (3)
Just right	68 (89)
Too short	5 (7)
Rate the time spent on the practical skills session:	
Just right	66 (87)
Too short	6 (8)
Rate your level of comfort with HFNC before the training session:	
Very comfortable	11 (14)
Comfortable	41 (54)
Neutral	19 (25)
Uncomfortable	3 (4)
Very uncomfortable	0 (0)
Rate your level of comfort with HFNC after the training session:	
Very comfortable	24 (32)
Comfortable	44 (58)
Neutral	5 (7)
Uncomfortable	0 (0)
Rate the overall quality of the training session:	
Excellent	8 (11)
Above average	44 (58)
Average	22 (29)
Below average	2 (3)

curriculum can be adapted to educate providers on HFNC and provide a framework for HFNC implementation in a variety of settings. Our curriculum is strengthened by a multipronged approach including a didactic lecture-based section with evaluation, a hands-on section with equipment, and case-based discussion for application of concepts.

There are multiple opportunities to improve the educational session. The overwhelming feedback received was to modify our approach to include more time for case-based discussion and hands-on practice with equipment. Although we incorporated case-based small-group discussions into the curriculum, the videos of respiratory distress did not include sound, somewhat limiting the information conveyed to learners. This topic would lend itself well to a simulation approach, and we recommend this for future work. To ensure sustainability after the initial training session has been completed, we recommend identifying local collaborators and other support to continue education as a train-the-trainer program. While we provided all training materials to the local PICU for refresher training, providers have limited time for self-study and would therefore benefit more from ongoing, frequent structured educational opportunities before and during the initial implementation phase. In addition, the protocol included in our didactic session was developed using best-practice guidelines at the time of HFNC implementation along with local standards of care. To generalize use in other settings, some details of the protocol may need to be adapted based upon local guidelines of care.

Important considerations should be made to adapt this training program to local contexts depending on the learners' HFNC experience. For example, we recommend having multiple sessions based on provider role (i.e., nurses, physicians, advanced practice providers) to encourage more discussion with reduced power dynamics. Performing a pretraining assessment of learners' experience with HFNC would be helpful to determine which content may need particular emphasis. Asking learners to repeat back important concepts from the session would also be helpful to gauge participants' understanding of the material and identify content that may need to be reviewed. Learners with more HFNC experience could also benefit from a review of basic concepts in the didactic slide set but might not need a detailed review of assessing respiratory distress in children.

Our project has several limitations. First, we did not align our evaluation approach with the educational objectives. Our intent was to determine whether learners met the educational objectives by interactive discussion during all components of the curriculum—didactic lecture, hands-on practical session, and case-based small-group discussion. Unfortunately, we did not incorporate a formal evaluation of these objectives and included only a posttest evaluation of the training program itself. The incorporation of an evaluation that assesses educational objectives would strengthen this project. In addition, our posttest evaluation did not use a standardized scale, such as a Likert scale, making interpretation of data more challenging. To improve our evaluation system, one might consider adapting the posttest evaluation to a Likert scale and including a formalized assessment of knowledge and skills acquisition and retention over time. A major goal of our project was to create a sustainable curriculum for ongoing improvement and future use by the local institution. Although we evaluated knowledge retention over time, these data will be presented elsewhere, which limits the ability to determine the sustainability of this project. To better evaluate effectiveness and sustainability, future programs could consider performing direct observation of HFNC use with patient care or during a simulation and providing direct feedback to providers. Our module does not include an English version of a video demonstrating HFNC setup, but these resources can be accessed via the manufacturer.[14]

Additionally, the poor sound and image quality of the Spanish version of the video that we created may be challenging for some to follow, so we have made it an optional part of this resource. We encourage facilitators to demonstrate HFNC setup as part of the workshop, either by using available videos or by arranging a live presentation. Finally, our curriculum does not include aspects of equipment-management errors related to HFNC. Certainly, this information is valuable, and others could consider adding case-based scenarios for discussion with learners.

Our experience with this project has illustrated the scarcity of resources for medical education in Spanish and other non-English languages, especially targeting trainees in resource-limited settings. Future directions for training development, therefore, will focus on expanding on additional tools in Spanish. We believe this curriculum fills a need for the evaluation of respiratory distress and implementation of advanced respiratory support modalities in the form of HFNC in resource-limited settings.

Appendices

A. Training in Spanish.pptx

B. Training in English.pptx

C. Clinical Cases in Spanish.docx

D. Clinical Cases in English.docx

E. Respiratory Distress Videos.mp4

F. Posttraining Assessment in Spanish.docx

G. Posttraining Assessment in English.docx

H. Training Video in Spanish.mp4

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

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Disclosures

None to report.

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Ethical Approval

The institutional review boards at the Seattle Children's Hospital and the Comité de Ética at Instituto Nacional de Salud del Niño approved this study.

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