Original Publication

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Acute Neuromuscular Respiratory Weakness Due to Acute Inflammatory Demyelinating Polyneuropathy (AIDP): A Simulation Scenario for Neurology Providers

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

Abstract

Introduction: Acute neuromuscular respiratory failure is a source of morbidity and mortality in neurological diseases, including acute inflammatory demyelinating polyneuropathy (AIDP), also known as Guillain-Barré syndrome. It is important for health care providers to recognize this condition and provide early ventilatory support. In this simulation, learners must assess and treat a standardized patient with acute respiratory complications related to AIDP. **Methods**: This is a single-session simulation that can be run in a standard simulation center using a live standardized patient. The simulation scenario is followed by a facilitated debriefing session. Details about the simulation scenario, critical action checklist, environment preparation, actors/roles, and debriefing session are outlined. **Results:** A total of 14 neurology residents participated in this simulation. A postsimulation survey revealed that participants thought the simulation achieved its stated objectives, was useful, and would impact their future practice. **Discussion:** We designed this simulation to assess a learner's ability to identify acute neuromuscular respiratory weakness in a patient with AIDP and initiate treatment with ventilatory support. This simulation can easily be incorporated into an existing curriculum for neurology residents or for trainees in other specialties.

Keywords

Simulation, Standardized Patient, Respiratory Insufficiency, Neurology, Guillain-Barré Syndrome, Acute Inflammatory Demyelinating Polyneuropathy, Respiratory Paralysis, Neuromuscular Diseases

Educational Objectives

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

1. Recognize acute inflammatory demyelinating polyneuropathy (AIDP) based on history and physical exam findings.
2. Recognize acute neuromuscular respiratory failure, a complication of AIDP.
3. Manage acute respiratory failure by initiating ventilatory support.

Introduction

Acute neuromuscular respiratory failure is a complication of neuromuscular conditions for which early intervention can reduce morbidity and mortality.[1] Recognition and management of acute neuromuscular disorders are required milestones in neurology residency training programs,[2] as well as being essential skills that neurology providers should be able to demonstrate with competence.

Respiratory insufficiency due to neuromuscular disease is unique and differs from other types of respiratory failure. Namely, it is characterized by ventilatory failure that manifests as hypercapnia (so-called type 2 respiratory failure or pump failure) and must be distinguished from hypoxic respiratory failure associated with intrinsic lung disease (type 1 respiratory failure).[3] The mainstay of treatment for neuromuscular respiratory failure is ventilation, as opposed to oxygenation; both noninvasive and invasive positive pressure can be considered.[1,4] On bedside pulmonary function tests, forced vital capacity (FVC) less than 20 mL/kg, maximum inspiratory pressure less than 30 cm H_2O, and maximum expiratory pressure less than 40 cm H_2O are associated with progression to respiratory failure, so it is useful to

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obtain serial measurements.[5] Other signs and symptoms of neuromuscular respiratory failure include changes in vital signs (i.e., tachycardia, tachypnea), breathlessness, staccato speech, use of accessory breathing muscles, orthopnea, paradoxical breathing, and weakness (particularly in neck and bulbar regions).[1,4]

One challenge to treating neuromuscular respiratory weakness is its association with a broad range of complex neurological conditions; thus, providers must be proficient in recognizing neuromuscular diseases based on clinical history and exam. Acute inflammatory demyelinating polyneuropathy (AIDP), also known as Guillain-Barré syndrome, is a prototypic neuromuscular disorder in which approximately 25% of patients develop respiratory failure. This condition is characterized by subacute ascending numbness, paresthesias, flaccid weakness, and areflexia. Diaphragmatic failure can occur suddenly, so it is important for clinicians to recognize the diagnosis and initiate early ventilator support.[5,6]

Acute neuromuscular respiratory failure is a treatable but potentially life-threating condition, and specialized knowledge of neuromuscular diseases and hypercapnic respiratory failure is required to be able to accurately identify and manage this condition. For these reasons, we deemed it important to assess the ability of neurology residents to confront acute neuromuscular respiratory failure in a simulated environment. Simulation is a well-established educational tool in neurology,[7,8] particularly for learning acute care and management skills.[9] In reviewing the literature, including a thorough search of *MedEdPORTAL,* we found numerous publications related to simulations for neurological emergencies[10-17] and acute respiratory failure,[18-27] but we did not find curricula pertaining to respiratory failure due to neuromuscular disease. We created this simulation to address this gap in the medical education literature. In this simulation, the learner must manage a standardized patient with acute respiratory failure due to AIDP by recognizing the diagnosis and initiating rapid treatment. This exercise is primarily directed towards residents and fellows and likely is not appropriate for a medical student level of training.

Methods

The simulation scenario, environment preparation, list of actors/roles, standardized patient details, critical action checklist, and debriefing plan were fully outlined (Appendices A, B, D-G). The pertinent labs and imaging were available on PowerPoint slides and were displayed when the learners requested them (Appendix C). The learners completed the simulation in groups of three or four. The total duration of the simulation was 40 minutes. The simulation scenario ran for 20 minutes and was observed by faculty who completed a critical action checklist; this was followed by a 20-minute debriefing session led by the observing faculty.

Brief Summary of Learner Actions During the Case
The learners initially got very little information, only that the patient had transferred from an outside hospital with a chief complaint of weakness. The learners were expected to obtain pertinent history from the patient, including the time course of progressive ascending weakness and numbness for the past week and more recent progression of bulbar and respiratory symptoms. The learners were also expected to perform a focused neurological exam including checking strength, sensation, and deep tendon reflexes (the confederate registered nurse [RN] was able to verbally convey the finding of areflexia since this was difficult to simulate). Learners needed to perform exam maneuvers that were high yield for assessing neuromuscular respiratory strength (e.g., neck strength, breath counting). Pulmonary function tests, including FVC and negative inspiratory force, were given by the RN when the learners inquired. Over the course of the simulation, the patient developed progressive respiratory decline, including worsening tachypnea and tachycardia, hypercapnia and respiratory acidosis on blood gas, and eventually hypoxia and obtundation. The learners were expected to recognize these signs and symptoms of acute neuromuscular respiratory failure due to AIDP and initiate urgent treatment with ventilator support. Bi-level noninvasive ventilation may have been tried initially, but eventually, the learners needed to escalate to endotracheal intubation and invasive mechanical ventilation. The case ended when the learners gave a

sign-out to the intensive care unit (ICU) fellow prior to transferring the patient to the ICU. See Appendix A for further simulation details.

Actors, Roles, and Standardized Patient

An operator controlled the change in vital signs following the flow described in the case. Two faculty debriefers, who had clinical expertise in the field, observed the learners and completed the critical action checklist. A live actor/standardized patient played the role of the patient, and another actor played the combined roles of the confederate RN and respiratory therapist. The standardized patient was recruited by the Hennepin Healthcare Simulation Center and was trained by simulation center staff and the writers of the case per details outlined in Appendices F and G.

Equipment and Environment

The case was run in a high-fidelity simulation room that mimicked a medical/surgical hospital room. Environmental preparation and equipment are outlined in Appendix A. The simulation software (LLEAP v6.1, Laerdal Medical, Stavanger, Norway) was programmed with the initial set of vitals described in the case file. Briefly, the room was equipped with hospital bed, pulse oximeter, blood pressure cuff, vital sign display, intravenous line and pole, 1-L normal saline bag, high-flow oxygen mask, and bi-level noninvasive ventilation. The learners were instructed to bring their own stethoscope and reflex hammer. Finally, labs and imaging findings were displayed on a monitor per learner request. See Appendix B for more logistical details.

Assessment and Debriefing

The learners were assessed based on the critical action checklist by two faculty observers for the purpose of formative assessment. The critical action checklist (Appendix D) was developed by three subject matter experts who discussed the progression and ideal management of the case and was peer-reviewed by simulation- and education-trained physicians. After the simulation, the learners, confederates, and faculty observers gathered in a separate room for debriefing. The debriefing sessions were run in the typical three-phase structure (reactions phase, analysis phase, and summary phase) and facilitated using the "debriefing with good judgment" approach.[28-30] A brief summary of this approach is provided in Appendix E, along with specific debriefing questions.

Results

The simulation scenario was run with a group of neurology residents ($n = 14$). After the session, 71% of participants ($n = 10$) completed a postsession evaluation survey. Ninety percent of survey respondents agreed or strongly agreed when asked if the simulation met the intended learner outcomes of (1) recognizing AIDP based on history and physical exam findings and (2) managing complications of acute respiratory failure in an AIDP patient. The remainder of the survey questions outlined in the Table revealed largely positive evaluations, reflecting that the learners found the simulation and debriefing sessions to have high utility and value.

Table. Simulation Survey Results ($n = 10$)

Survey Question	Average Score[a]
The simulation met its stated objectives for learners to:	
1. Recognize AIDP based on history and physical exam findings.	4.4
2. Manage complication of acute respiratory failure in an AIDP patient.	4.5
The simulation was useful.	4.5
The simulation will have an impact on my future practice.	4.4
The debriefing session promoted reflection and team discussion.	4.7

Abbreviation: AIDP, acute inflammatory demyelinating polyneuropathy.
[a]Five-point Likert scale (1 = *strongly disagree,* 5 = *strongly agree*).

Discussion

We created this simulation to allow neurology residents an opportunity to recognize and manage acute neuromuscular respiratory failure in a safe environment. This is an important skill that all neurologists

should possess, yet we could not find specific curricula pertaining to this topic in the literature. Feedback from learners about the educational value and utility of the simulation and debriefing session was largely positive.

One lesson learned while implementing this case was the importance of providing prereading about the topic. Neuromuscular respiratory failure is a complex topic, and we noted that learners who had less experience with it were less likely to perform items on the critical action checklist effectively. Thus, in the future, we recommend assigning prereading about neuromuscular respiratory failure to the learners before the simulation; consideration can be given to Rabinstein's review.[1] Another challenge was to address the individual educational needs of learners at different levels of training. In this simulation, each group comprised neurology residents ranging from PGY 1 to PGY 4; thus, we worried that the simulation objectives and content would not be appropriate for every individual learner. We addressed this by assigning prereading,[1] as previously mentioned, to equalize baseline knowledge about the topic. Another approach could be to split the learners up into groups of similar training level, and the debriefing session for each group could address learning issues specific to that group's level. Another challenge that we observed in the debriefing sessions was variation in the debriefing approach taken by facilitators. We intended for the sessions to be conducted with the "debriefing with good judgment" approach, but there was variable adherence to this approach, and at times, the discussions went off script. Therefore, in the future, we recommend training or faculty development for all the facilitators, confederates, and simulated patients in this area to elevate the level of discussion and standardize the debriefing approach. If formal simulation debriefing courses are not available, then review of evidence-based debriefing materials could be required for facilitators prior to running the simulation.[28-31]

This case can easily be replicated at other institutions using minimal resources. The equipment and logistical details are fairly simple, and thus, the case could be executed at a standard health care simulation center. While this simulation was written for neurology residents, it could be utilized for trainees (i.e., residents and fellows) in other disciplines, including internal medicine, emergency medicine, critical care, neurocritical care, anesthesiology, and pulmonology. Furthermore, although this activity was originally intended as formative assessment, it could certainly be used for summative assessment as well. One limitation is that the simulation experience was evaluated mainly with learner perception and we did not assess behavior change. Another limitation is the low sample size, but we were limited by the size of our residency program. While having more participants would have been ideal, we still feel that there is sufficient evidence to demonstrate efficacy and to support sharing the simulation with others.

Overall, we feel this simulation case can be an effective resource for teaching medical trainees to recognize and manage acute neuromuscular respiratory failure.

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Disclosures
None to report.

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