

# Neurally adjusted ventilation assist in weaning difficulty: First case report from India

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## Abstract

Invasive mechanical ventilation is an integral component in the management of critically ill patients. In certain situations, liberation from mechanical ventilation becomes difficult resulting in prolonged ventilation. Patient-ventilator dyssynchrony is a frequently encountered reason for difficult weaning. Neurally adjusted ventilatory assist (NAVA) is a novel mode of ventilation that utilizes the electrical activity of diaphragm to pick up respiratory signals and delivers assistance in proportion to the ventilatory requirement of a patient. It may, therefore, be associated with a better patient-ventilator synchrony thereby facilitating weaning. Herein, we report the first case from India describing the use of NAVA in successfully weaning a patient with difficult weaning.

**Keywords:** Mechanical ventilation, neurally adjusted ventilatory assist, neurally adjusted ventilatory assist, weaning failure

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## Introduction

Patient-ventilator dyssynchrony is a common cause of weaning failure.<sup>[1]</sup> It is defined as mismatch between the ventilator delivered breath and neural respiratory effort of the patient.<sup>[2]</sup> Patient-ventilator dyssynchrony leads to an extra burden on the respiratory system and is associated with an increase in the patient morbidity.<sup>[3]</sup> The most effective way to overcome this mismatch would be to connect ventilator either to the brain of the patient or as close to it as possible. Neurally adjusted ventilatory assist (NAVA) is a novel mode, which is based on neural respiratory output.<sup>[4]</sup> NAVA utilizes the electrical activity of diaphragm (EAdi) to assist the patients' breathing. Evidence suggests that NAVA may have a role in weaning difficulty, by reducing patient-ventilator dyssynchrony.<sup>[5]</sup> Herein, we report the first case from India describing the use of NAVA in successfully weaning a patient with difficult weaning who was intubated for the management of acute respiratory failure due to scrub typhus.

## Case Report

A 55-year-old female, a known case of ulcerative colitis, was admitted with fever and acute onset breathlessness of 5-day duration. She denied any history of loose stools, melena, jaundice, hemoptysis, and chest pain. On admission, she was tachypneic (respiratory rate of 50/min) and had an arterial oxygen saturation of 81% on FiO<sub>2</sub> of 0.6. Chest radiograph demonstrated bilateral infiltrates. Auscultation revealed inspiratory crackles in bilateral basal areas. Investigations showed thrombocytopenia, neutrophilic leukocytosis, and transaminitis. Serology for scrub typhus (IgM) was positive; a diagnosis of scrub typhus with acute respiratory distress syndrome (ARDS) was made.

She was ventilated using ARDSNet protocol.<sup>[6]</sup> After 3 days of mechanical ventilation, she was given a 30-min

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spontaneous breathing trial (SBT). However, she failed three SBTs on three consecutive days and was labeled as a case of difficult weaning. She had good cough reflex, and there was no muscle weakness. Serum potassium, magnesium, phosphorus, and thyroid function tests were normal [Table 1]. The flow-time waveform revealed several failed efforts (ineffective triggering). Thus, patient-ventilator dyssynchrony was considered as the likely reason for difficult weaning.

After several failed attempts at weaning using the pressure support mode (PSV), we decided to wean her using the NAVA® (Servo-i universal with NAVA, Maquet Critical Care, Solna, Sweden) for facilitating weaning. A special type of feeding tube (16F diameter, 125 cm in length; Maquet Critical Care, Solna, Sweden) mounted with nine electrode rings at its distal end at intervals of 16 mm, starting from 120 mm from the tip, was inserted through the nasal cavity. The catheter was then gently advanced through the nasal route. The position of the catheter was then verified by a special tool implemented in the ventilator. It displays an EAdi curve and four raw leads that are not filtered for the electrocardiogram (ECG) activity. The position of the electrodes in relation to the heart and diaphragm was estimated by evaluating different leads for presence/absence of p-wave and QRS complex. During the placement, the catheter was pulled out in steps of 1 cm. EAdi signal and electrical activity from raw leads were recorded at each step using special software (NAVA tracker, Maquet Critical Care, Solna, Sweden) for offline analysis until ECG signals disappeared.

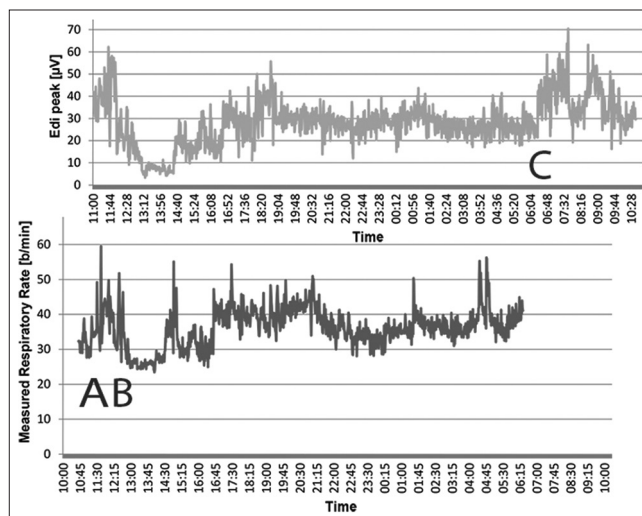
EAdi signal was used to adjust NAVA level (NAVA<sub>L</sub>) such that the estimated pressure curve overlapped with the pressure delivery curve.<sup>[7]</sup> To do so, an initial NAVA<sub>L</sub> of 2.5 was required. Immediately after doing so, the EAdi peak, as well as the respiratory rate, showed a marked decline [Figure 1]. Over the next 48 h, the EAdi gradually reduced, and the NAVA<sub>L</sub> was correspondingly reduced in steps of 0.2 while monitoring EAdi and patient comfort. The patient was successfully extubated after 2 days and continues to do well on follow-up.

## Discussion

The index case highlights patient-ventilator dyssynchrony as an important cause of difficult weaning and its successful management using NAVA. To the best of our knowledge, this is the first report from India that describes the use of NAVA in the successful weaning of a difficult-to-wean patient from ventilatory support.

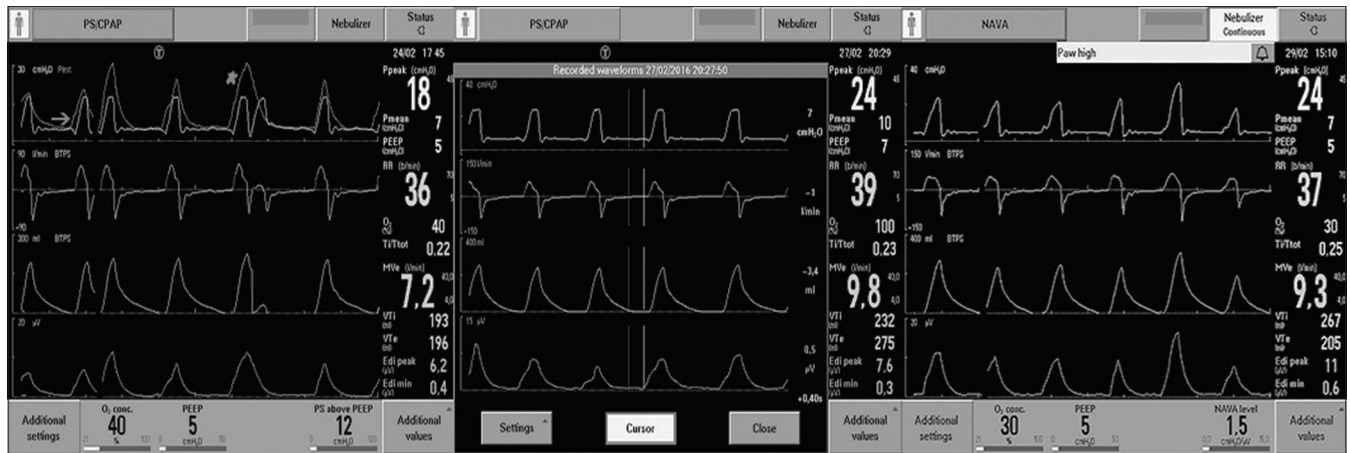
**Table 1: Hematological, biochemical, microbiological, ventilator, and other parameters of the patient at the time of weaning**

Investigations	Value
Hemoglobin (g/dL)	10.8
Total Leucocyte count (cells/ $\mu$ L)	11,000
Platelet count (cells/ $\mu$ L)	200,000
Urea (mg/dl)	32
Creatinine (mg/dl)	0.49
Total bilirubin (mg/dl)	0.5
Aspartate transaminase (U/L)	64.5
Alanine transaminase (U/L)	42.9
Alkaline phosphatase (U/L)	84.4
Sodium (mmol/L)	135
Potassium (mmol/L)	3.86
Chloride (mmol/L)	99
Magnesium (mg/dL)	2.23
Phosphorus (mg/dL)	4.0
Urine routine	Normal
Blood culture	Sterile
Endotracheal tube aspirate culture	Sterile
Ventilator parameters	
Mode	Pressure support ventilation
Pressure support, in cm of H <sub>2</sub> O	12
Positive end expiratory pressure, in cm of H <sub>2</sub> O	5
Tidal volume, in mL	320
Respiratory rate, breaths/min	18



**Figure 1:** Twenty-four-hour trend of electrical activity of diaphragm peak and respiratory rate on day 1 to day 2 of neurally adjusted ventilator assist ventilation. (A) Electrical activity of diaphragm signal tracing during pressure support ventilation at baseline showing high electrical activity of diaphragm (60  $\mu$ V) and high respiratory rate (60/min) suggestive of increased requirement of assistance and patient-ventilator-dyssynchrony; (B) there is an immediate decline in electrical activity of diaphragm peak and respiratory rate after patient is ventilated with the neurally adjusted ventilator assist mode, at a neurally adjusted ventilatory assist level 2.5; (C) electrical activity of diaphragm signal tracing during spontaneous breathing trial on the following day demonstrating an immediate surge in the electrical activity of the diaphragm suggestive of an increased ventilatory requirement. Respiratory rate is not plotted as the patient is off ventilator

Difficult weaning is defined as a condition in which the patient fails initial weaning and requires up to three



**Figure 2:** Patient-ventilator dyssynchrony identified at the initiation of the neurally adjusted ventilator assist mode. Right panel: There was trigger dyssynchrony (arrow) and auto triggering (asterisk) during pressure support ventilation whereas the electrical activity of diaphragm signal tracing did not reveal diaphragmatic contraction (lowest tracing); central panel: There is trigger delay as highlighted by a delay in the initiation of a ventilator delivered breath when compared to electrical activity of diaphragm signal tracing (lowest tracing); left panel: Ventilation during neurally adjusted ventilator assist mode demonstrating better patient-ventilator synchrony and inter-breath variation in the airway pressure in proportion to electrical activity of diaphragm at same neurally adjusted ventilatory assist level

SBT or 7 days from the first SBT to achieve successful liberation from the ventilator.<sup>[8]</sup> About one-third of the patients are difficult-to-wean from mechanical ventilation.<sup>[9]</sup> Unresolved underlying disease, electrolyte imbalance, neuromuscular weakness, delirium, cardiac dysfunction, and poor nutrition result in difficult weaning.<sup>[9]</sup> In the index case, none of the aforementioned conditions were present, and patient-ventilator dyssynchrony was identified as a reason for weaning difficulty. Patient-ventilator dyssynchrony is present in approximately 25% of patients ventilated with PSV mode and is associated with prolonged duration of mechanical ventilation.<sup>[3]</sup>

NAVA is a novel approach to mechanical ventilation that is based on neural respiratory output.<sup>[4]</sup> The EAdi (expressed in microvolts) is multiplied by a user-controlled gain factor, the  $NAVA_L$ . The airway pressure applied by the ventilator depends on the magnitude of both EAdi and the  $NAVA_L$ . For a given  $NAVA_L$ , the airway pressure varies breath-by-breath in proportion to EAdi, also seen in the index case [Figure 2]. NAVA may be superior to PSV as it reduces dyssynchrony in intubated and spontaneously breathing patients.<sup>[10]</sup> In the index case attempts to wean the patient using the PSV were unsuccessful despite resolution of the underlying illness and no neurological deficit or weakness. On initiating the NAVA mode, trigger dyssynchrony, auto trigger were identified that resulted in discomfort to the patient [Figure 2]. NAVA by virtue of its triggering mechanism picks up the neural impulse much early in the path and thus minimizes the triggering delay, as seen in the index case [Figure 2]. This leads to a better synchrony between the patient and the ventilator thereby minimizing patient discomfort and

agitation.<sup>[4]</sup> The use of EAdi to guide pressure support also helps in avoiding ventilator-induced diaphragmatic dysfunction.<sup>[4]</sup> In the index case, the initial  $NAVA_L$  was set according to the EAdi signal and was reduced gradually that resulted in successful weaning.

## Conclusion

Patient-ventilator dyssynchrony is an important cause of difficult weaning. Use of newer modes such as NAVA may enable successful weaning by a facilitating better patient-ventilator interaction.

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## Conflicts of interest

There are no conflicts of interest.

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