Original Article

Nutrition Therapy in Patients Requiring Noninvasive Ventilation in the Intensive Care Unit: Feasibility, Tolerance, and Complications

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Abstract

Background: Patients requiring noninvasive ventilation (NIV) in the intensive care unit (ICU) are likely to have a high prevalence of malnutrition. Nutrition provision in these patients is of utmost importance; however, data on its feasibility, tolerance, and complications are largely unavailable. **Objective:** The objective of the study was to assess the prevalence of malnutrition in patients requiring NIV in the ICU and to analyze feasibility, tolerance, and complications of nutrition therapy in this population. **Methods:** This was a prospective, observational study of consecutive patients requiring NIV admitted to the multidisciplinary ICU of a tertiary care, teaching hospital between April 2017 and November 2017. Baseline nutrition status was assessed using subjective global assessment (SGA). Nutrition requirement calculation and prescription were standardized. All included patients were monitored for pattern of nutrition provision, adequacy of delivery tolerance, and complications. Relevant outcomes such as intubation rates, ICU length of stay (LOS), and mortality were also noted. **Results:** A total of 34 patients were included in the study. Seventy-six percent of patients (26 out of 34 patients) were malnourished as determined by SGA. The mean Acute Physiology, Age and Chronic Health Evaluation II score was 15.1 ± 6.9. The average time for feed initiation was 12.4 h, and the most common reason for the delay (in 43%) was an impending intubation. The mean percentages of calorie and protein requirement that was delivered by day 3 were 67.2% and 48.3%, respectively. Thirteen patients (38.2%) required continuous nasogastric (NG) feeding, while the others could be fed orally. In 14 patients (41.1%), we were able to achieve 80% or more of target calorie requirement by day 3, and among these patients, the mean percentage of target protein intake that could be achieved was 66.6% by day 3. Feed intolerance was observed only in three patients. One patient had an inadvertent dislodgement of NG tube. Six patients (17.6%) required intubation and three (8.8%) died. Mean ICU LOS was 5.6 ± 3.9 days. **Conclusion:** Patients requiring NIV in the ICU have a high prevalence of malnourishment. Protocol-driven nutrition delivery is feasible in this population and is well tolerated.

Keywords: Intensive care unit, malnourishment, noninvasive ventilation, nutrition, outcomes

Introduction

Noninvasive ventilation (NIV) as a means of assisted mechanical ventilation (MV) is becoming increasingly popular given the benefits of avoiding endotracheal intubation and therefore its complications.[1] While traditionally NIV is indicated for exacerbation of chronic obstructive pulmonary disease (COPD), cardiogenic pulmonary edema, and immunocompromised patients with hypoxemic respiratory failure and palliative therapy, the scope of application seems to be increasing.[2] It is possible that in the coming years, the spectrum of indications could extend further. Therefore, a thorough knowledge about the predictors of NIV success and the provision of optimal supportive care is paramount to improve outcomes in this population. One such predictor could be the patient's baseline nutritional status and adequacy and tolerance of nutrition therapy while on NIV.[2]

While there is a considerable body of evidence available on the nutritional management of patients receiving MV, there is

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a significant paucity of data concerning nutrition in patients managed with NIV.[2,3] Any of the conventional indications for NIV could be potentially associated with a state of baseline malnutrition.[4] This could be expected to worsen during acute de-compensation from the disease, further adding to the burden of illness. In addition to the disease state, the use of NIV itself could pose unique challenges to nutrition therapy, further exacerbating the magnitude of malnutrition. This is likely to adversely impact both the success of NIV therapy and the disease outcome. Many questions remain unanswered as to the prevalence of malnutrition in this group of patients, the ideal mode, goals, feasibility, risks involved, and complications of nutrition therapy.

While enteral feeding remains the route of choice in the intensive care unit (ICU) for various reasons, there are several limitations to implementing the same in patients receiving NIV.[5] Patients may be unable to remain off NIV for a sufficient period of time to allow adequate food intake or may feel too short of breath or may become hypoxemic while eating. While nasogastric (NG) feeding may be used to overcome this, it is not free of problems. NG feeding could be associated with adverse effects such as nosocomial sinusitis, tracheobronchial aspiration of gastric contents, and mask leak with decreased NIV efficiency.[6,7] In addition, the perceived risk of gastric inflation with NIV and aspiration of feeds deters clinicians from early initiation of enteral nutrition (EN). Further to this, there are no recommendations guiding us toward nutritional support specific to patients receiving NIV. The accurate evaluation of malnutrition and provision of adequate nutritional support, therefore, remains a major challenge in patients requiring NIV.

The present study was therefore intended to assess our own cohort of patients in the ICU requiring NIV for the prevalence of malnutrition and to study feasibility of nutrition therapy, tolerance, and any related complications. We additionally sought to look into our performance in terms of adequacy of nutrition delivery.

Methods

This was a prospective, observational study conducted in the 24-bed multidisciplinary ICU of our tertiary care, teaching hospital between April 2017 and November 2017. All consecutive adult patients who were initiated on NIV within 24 h from the time of admission to ICU and subsequently required NIV for 3 or more consecutive days were enrolled in the study. Initiation, titration, and termination of NIV were at the discretion of the treating clinician. Patients in whom NIV was used for a postoperative or postextubation period, for neuromuscular disease, or for those with treatment limitation decision within 24 h of admission were excluded from the study.

Data pertaining to demographics, indication for NIV, the severity of illness - Acute Physiology, Age and Chronic Health Evaluation II (APACHE II) score, and baseline nutrition status using subjective global assessment (SGA)[8] were collected.

Descriptive statistics was used for analysis and to report results. Student's *t*-test was used to compute *P* value for continuous variables and Z score test was used for proportions. Two-tailed *P* values were analyzed.

Assessment of nutritional requirements and its prescription were based on standard operating protocols of the ICU according to which an initial screening was done by a clinical dietitian using SGA. The subsequent prescription of nutrition was done by the treating intensivist together with the dietitian to meet the daily recommended requirements of calories and protein. The practice of provision of nutrition was standardised and in accordance with the ESPEN/ASPEN guidelines for critially ill patients. Factors mentioned below were emphasized: Initiation of EN within 24-48 h in critically ill patients who are unable to maintain volitional intake, efforts to provide >80% of estimated or calculated goal energy and protein within 48–72 h, and calorie requirement of 25–30 kcal/kg/day with protein 1.2–2.0 g/kg actual body weight per day.[9,10] A follow-up on prescription versus delivery was done on a scheduled manner by the dietitian.

All included patients were monitored for pattern of nutrition provision. The route of EN was classified as NG, nasojejunal (NJ), or oral. NG and NJ feeding in our ICU were by default continuous, controlled infusions. The required rate of feeding (ml/h) and daily volume allowance were specified by the treating intensivist, and the composition of enteral formula feeds would be adjusted to achieve targeted calorie and protein delivery by the dietitian. Caloric density of feed was titrated between 0.8 and 1.1 Kcal/ml to meet with the requirement. In patients who were allowed oral feeds, intake was intermittent and NIV was disconnected during those brief periods of time.

Nutrition adequacy was analyzed by estimating the requirement, the prescription, and the actual delivery of calories and proteins to the patients on days 1 and 3. Details pertaining to the time delay in initiation of feeds and any interruptions were documented.

Feed tolerance was assessed by following up for events such as vomiting, diarrhea, or clinical evidence of aspiration. Events such as NG tube block/misplacement and inadvertent displacement were noted. Gastric residual volume (GRV) was monitored every 6 hourly as a part of institutional policy. Relevant outcomes such as intubation rates, ICU length of stay (LOS), and mortality in this cohort were documented. This study was not designed to look into other potential outcomes such as new-onset infection, new organ failure, or loss of lean body mass.

Results

During the study period of 8 months, 631 patients were admitted to the ICU. Among them, 72 consecutive patients requiring NIV on ICU admission were screened for inclusion to the study [Figure 1]. Only 34 (47.2%) patients satisfied the inclusion/exclusion criteria and were included for subsequent follow-up and analysis.

The baseline characteristics of the study population are presented in Table 1. SGA in the study population was suggestive of mild/moderate malnourishment in 76% (26 out of 34 patients).

All patients were initiated on enteral feeds. The average time to feed initiation was 12.4 ± 13.4 h, and the most common reason for delay (43%) was an impending intubation. Thirteen patients (38.2%) required continuous NG feeding, while the others could be fed orally with intermittent discontinuation of NIV. No patient required the placement of NJ tube. In 14 patients (41.1%), we were able to achieve 80% or more of target calorie requirement by day 3 [Table 2a], and among these patients, the mean percentage of target protein achieved was 66.6% (day 3). The percentage of target calorie and protein requirement that was achieved in all by day 3 was 67.2% and 48.3%, respectively.

Six patients out of 34 (17.6%) required intubation and three (8.8%) died. Mean ICU LOS was 5.6 ± 3.9 days. Feed intolerance was observed only in three patients (8.8%). This was manifested as diarrhea in two (5.8%) and increased gastric residual volume (GRV) (>500 ml) in one patient (2.9%). Only one patient had inadvertent dislodgement of NG tube during care process and this was immediately replaced.

There was no statistically significant difference in intubation rates, ICU LOS, or mortality between the groups of patients wherein we achieved 80% of target calorie goal or not by day 3 [Table 2b].

Discussion

Although nutritional support is well recognized as an essential component of management of the critically ill patient, the optimal timing and goals remain debated.[11,12] There is growing evidence to suggest a favorable impact on survival with optimal nutrition therapy.[13,14] Further to this, malnutrition has been shown to be independently associated with poor clinical outcomes in the ICU.[15] Malnutrition has been identified as a cause for disease as well as a consequence, resulting from inflammation associated with acute or chronic disease. It has been variably reported to occur in 30%–50% of hospitalized patients. Inflammation has been associated with malnutrition and hence with compromised immune status, infection, and increased ICU and hospital LOS.[16] Our study reveals a very high prevalence of mild/moderate malnutrition (76%) in this specific population. This high prevalence is likely attributed to the fact that more than 50% of the included patients had a chronic disease component (COPD/heart failure) and an

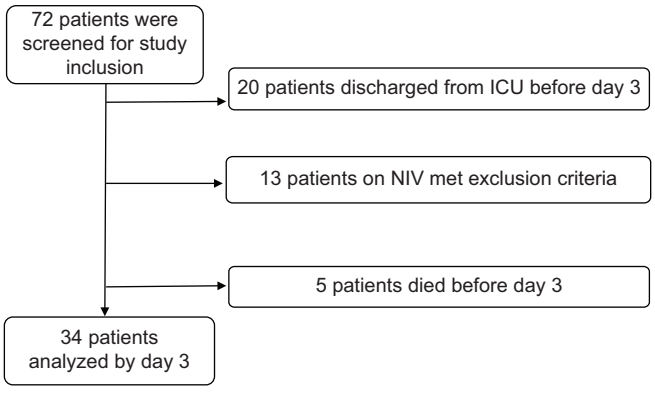

Figure 1: Patient screening and inclusion

Table 1: Baseline characteristics

Variables	Values, *n* (%)
Number of patients (*n*)	34
Age (years), mean±SD	62.5±15.8
Gender	
Male	16 (47.1)
Female	18 (52.9)
APACHE II score (mean±SD)	15.1±6.9
SGA	
Well nourished	8 (23.5)
Moderately malnourished	25 (73.5)
Severely malnourished	1 (2.9)
Weight (kg), mean±SD	69.4±15.7
Indications for NIV	
Acute exacerbation of COPD	11 (32.4)
Mild acute hypoxemic respiratory failure	9 (26.5)
Cardiogenic pulmonary edema	8 (23.5)
Immunocompromised host with respiratory failure	5 (14.7)
Others	1 (2.9)
Feeds	
Nasogastric	13 (38.2)
Oral feeds	21 (61.8)
Time to feed initiation (h), mean±SD	12.4±13.4
Intubation	6 (17.6)
LOS (days), mean±SD	5.6±3.9
Mortality	3 (8.8)

SD: Standard deviation, APACHE II: Acute Physiology, Age and Chronic Health Evaluation II, SGA: Subjective global assessment, NIV: Noninvasive ventilation, COPD: Chronic obstructive pulmonary disease, LOS: Length of stay

Table 2a: Baseline characteristics between groups where 80% calorie target by day 3 was achieved and not

Variables	>80%	<80%	*P*
Number of patients (*n*)	14	20	
Age (years), mean±SD	64.6±13.4	61.1±17.5	0.52
Gender (*n*)			
Male	7	9	0.77
Female	7	11	
APACHE II score, mean±SD	14.6±8.4	15.5±5.9	0.73
SGA (*n*)			
Well nourished	4	4	0.56
Moderately malnourished	10	16	
Feeds (*n*)			
Nasogastric	5	8	0.80
Oral feeds	9	12	
Time to feed initiation (h), mean±SD	8±4.2	15.6±16.7	0.23

SD: Standard deviation, APACHE II: Acute physiology, age and chronic health evaluation II, SGA: Subjective global assessment

Table 2b: Impact of achieving 80% calorie goal by day 3 on outcomes

Variables	>80%	<80%	*P*
Number of patients (*n*)	14	20	
Intubation (*n*)	2	4	0.66
Death (*n*)	1	2	0.77
Length of ICU stay (days), mean±SD	5.2±1.3	6.0±4.9	0.59

SD: Standard deviation, ICU: Intensive care unit

additional 14% had a baseline immunocompromised state. While SGA may not be the ideal tool for nutritional screening and is not without limitations, it continues to be commonly used at the bedside in view of ease and reasonable validity.[17]

Our nutrition therapy practices were based on the recent ESPEN/ASPEN guidelines.[10,11] There is growing evidence to show that very low-calorie intake (less than 50% of goal) may lead to severe calorie debt, empty the energy reserves, reduce lean body mass, and increase infectious complications.[18,19] Recently, the analysis of a large database including 1171 patients using indirect calorimetry data confirmed that both under and overfeeding were deleterious and that the optimal target appeared to be between 70% and 100% of measured energy expenditure.[20] Therefore, we sought to assess our proportion of patients in whom we were able to achieve 80% of caloric goal by day 3. This goal was achieved in 14 out of 35 patients (41.1%) on day 3. The mean protein goal achieved in this group on day 3 was 66.6%. The lag in protein delivery is explained by the inherent difficulty in meeting protein requirements despite supplementation when a calorie goal-driven scientific feeding protocol is used and volume restriction imposed. Intubation rates, ICU LOS, and mortality were similar between patients whether 80% of calorie goal by day 3 was achieved or not. This comparison was not intended *a priori* and also lacked power. This therefore, is only viewed as hypothesis generating and not as a strong observation.

Kogo *et al*. observed in a retrospective study that EN was associated with more airway complications in subjects receiving NIV for acute respiratory failure than in those receiving nutrition by other routes.[21] In our study group, patients were followed up for vomiting, aspiration pneumonia, and significant mask leakage, amounting to decreased NIV efficiency, and only three patients had intolerance to feeds manifesting as high gastric residual volume (GRV) ($n = 1$) and diarrhea ($n = 2$). None of them developed clinically relevant aspiration. Leak resulting from the presence of NG tube did not amount to clinically significant lack of efficiency of NIV.

We can conceive that physicians are more likely to promote NIV efficiency rather than nutrition during the first 2 days of NIV. In fact, Bendavid *et al*. showed in a large prevalence study of nutrition practice in intensive care that enteral feeding was prescribed to only 10% of the patients on the first day. This number increased to more than 40% of patients after 5 days.[22] In our study population, we were able to initiate feeds in all patients with an average time to feed initiation of 9 h. This was possible because of our robust ICU policy for feed initiation. In most instances (43%), a delay to feed initiation was attributed to an impending intubation. However, postoperative patients requiring NIV were not included in this study. This could have partly been responsible for the low rates of intolerance found in our study.

In addition to the timing of initiation, the route of delivery is also viewed as an important determinant of the effect of nutritional.[23,24] Recent studies have shown that EN should be preferred in critically ill patients.[25,26] We observed that all our patients could be fed enterally either through the NG or oral route.

One of the problems with EN could be gastric insufflation and high residual gastric volume (GRV) which increases the risk of aspiration, bacterial colonization, and Ventilator Associated Pneumonia (VAP).[27,28] To evaluate the effect of NIV on GRV, we continued to monitor the same every 6 h as part of our study. We discouraged withholding EN for GRV <500 ml in the absence of signs of intolerance. Only in patients with GRV >500 ml or other signs of feed intolerance, interventions such as feed interruption or prokinetic agents were initiated. Only one of our patients had a high GRV of greater than 500 ml requiring feed cessation for an hour and the use of prokinetic agent. There were however no clinical consequences.

In this study, we observed 34 consecutive patients requiring NIV. The majority had mild or moderate malnutrition. Enteral feeding was possible in all patients and was well tolerated. It was possible to achieve 80% or more of target calorie by day 3 in 40% of our patients. Whether this could be associated with an outcome benefit remains to be evaluated in a larger study. We did not look into other potential outcomes such as infectious complications, new organ failure, and loss of lean body mass. The small size of the observed cohort precludes us from making a dogmatic conclusion regarding impact on outcomes.

To our knowledge, this observational study is a first of its kind assessing the prevalence of malnutrition in ICU patients requiring NIV. We also report the pattern and practice of feeding in these patients. The major limitations of this study are the small cohort size, single-centered nature, and that it did not include postsurgical patients. Although a baseline severity of illness (APACHE II score) was provided, we did not report real-time dynamics of physiological variables which could have a potential impact on feeding patterns and outcomes. Furthermore, this study did not look into additional important outcomes such as new infections, new organ failure, and loss of lean body mass. Despite these limitations, our study provides proof to the high prevalence of malnutrition in patients requiring NIV in the ICU and also establishes the feasibility and tolerance of nutrition therapy in this cohort. We recommend the need for a large prospective observational study or a large data reference analysis to reinforce our findings in this patient population.

Conclusion

Patients requiring NIV in the ICU have a high prevalence of malnourishment. Nutrition therapy is feasible in this population and is well tolerated.

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Conflicts of interest

There are no conflicts of interest.

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