

# **Audit on non-invasive ventilation (NIV) in acute hypercapnic respiratory failure along with an introduction of proforma for acute NIV prescription**

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## **Abstract**

Hypercapnic respiratory failure is a cause of significant morbidity. It occurs in 20% of patients who are admitted with exacerbation of chronic obstructive pulmonary disease. Non-Invasive-Ventilation (NIV) is a mandatory treatment modality for them. The timely and accurate commencement along with the appropriate maintenance and weaning of NIV is crucial. In this audit cohort, most of the acute-NIV standards were not met as per the British Thoracic Society recommendations. Late detection, poor knowledge of acute NIV-Protocol, and maintenance of NIV has led to these suboptimal standards of the cohort. Therefore, we have suggested an NIV-Proforma to overcome them expecting a good outcome.

## **Background**

Acute Type II Respiratory Failure (A-T2RF) or Acute Hypercapnic Respiratory Failure (AHRF) is a common occurrence of chronic respiratory conditions, especially in chronic obstructive pulmonary disease (COPD), obesity hypoventilation syndrome (OHS) and neuromuscular diseases with respiratory muscle involvement.<sup>1</sup>

Measuring either the arterial or capillary blood gas (ABG or CBG) is a simple, bedside, key investigation in suspected respiratory failure patients. Oxygen titration to 88-92% range and repeat blood-gas assessment will indicate the necessity of acute-Non-Invasive Ventilation (NIV). It is the mainstay of treatment of AHRF and the British Thoracic Society (BTS) has laid down the specific guidelines and recommendations.<sup>2,3</sup>

We carried out the acute-NIV audit in the National Hospital for Respiratory Diseases (NHRD), Welisara to look for adherence to the BTS standards published

in 2018.<sup>4</sup> Furthermore, using a proforma for NIV prescription has evidence in the literature for improving the quality of NIV care and we introduce an NIV-proforma to be used when the acute-NIV is prescribed for AHRF.<sup>5</sup>

## **Method**


The audit proposal was approved by the respiratory consultants in NHRD and permission was granted by the Director of NHRD. The standards (Table 1) were made as per BTS recommendations, and the details were gathered respectively from the patient records who were given acute NIV during the months of March and April 2021. All patients who were newly started on acute NIV (for AHRF) in the respiratory wards or tuberculosis high-dependency-unit (HDU) were included and data were gathered using an interviewer-administered questionnaire based on their documentation. The patients on whom the NIV started in the intensive care unit (ICU) were excluded. No patient had NIV started on the emergency treatment unit (ETU). Data were entered in Microsoft Excel for the analysis.

## **Results**

Out of the total 15 patients, 66.6% were male and the median age of the cohort was 69 years. All the patients had AHRF secondary to COPD and none of them required NIV due to OHS or neuromuscular diseases. The first standard of having an ABG/CBG with indicated pH and PaCO<sub>2</sub> criteria was met in all the cases. However, there were suboptimal levels of adherence to other standards. Delays in doing the blood-gas and delays in commencing the NIV were largely due to the delayed diagnosis/suspicion of AHRF. Each standard that we assessed is tabulated below (Table 1) along with the results of the cohort's

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degree of compliance. Flapping-tremor (66.7%) and confusion (40%) had been commonly documented as clinical features at the time of blood gas assessment and palmar erythema and bounding pulse had been rarely documented. Lack of a place to commence NIV or difficulties in finding the equipment has led to delays in 20% of cases and late diagnosis had led to delays in starting NIV in 27% of cases. Intensive-care-unit transfer has happened in 3 (20%) cases and another 3 patients were transferred to high dependency unit for NIV. One-third of patients had passed away. Among the discharged patients, none of them had been organized for a follow-up blood gas, which is crucial in the management of chronic type-2 respiratory failure.

## Discussion

The acute NIV protocol which should elaborate on indications/contraindications, commencement, and maintenance was not clearly known to the junior doctors. The clinical suspicion of potential AHRF, timely blood gas analysis, and appropriate escalation to the seniors are crucial points for appropriate NIV therapy.

Literature suggests that using a proforma for acute NIV enhances the maintenance of standards.<sup>5</sup> We postulated an NIV proforma with the purpose of reducing the gaps between the practice and the standards.<sup>5</sup> This proforma is illustrated in figures 1 and 2 elaborating the assessment, commencement, and the weaning down plan for the NIV, based on BTS recommendations. Therefore, utilizing the proforma should enhance the standards of NIV prescription and maintenance. The precise documentation, timing of blood gas analysis, and appropriate escalation to the senior would necessarily be optimized. Furthermore, the dissemination of the knowledge on NIV among the doctors and nurses is mandatory and we conducted health education sessions in our unit. Establishing a separate NIV bay with trained staff should be the ultimate goal for acute NIV care and may require manpower with financial support, which can overcome the delay of the NIV therapy due to lack of space and equipment.<sup>1,5</sup> These interventions once established should need re-audit to verify the standards are achieved with success.

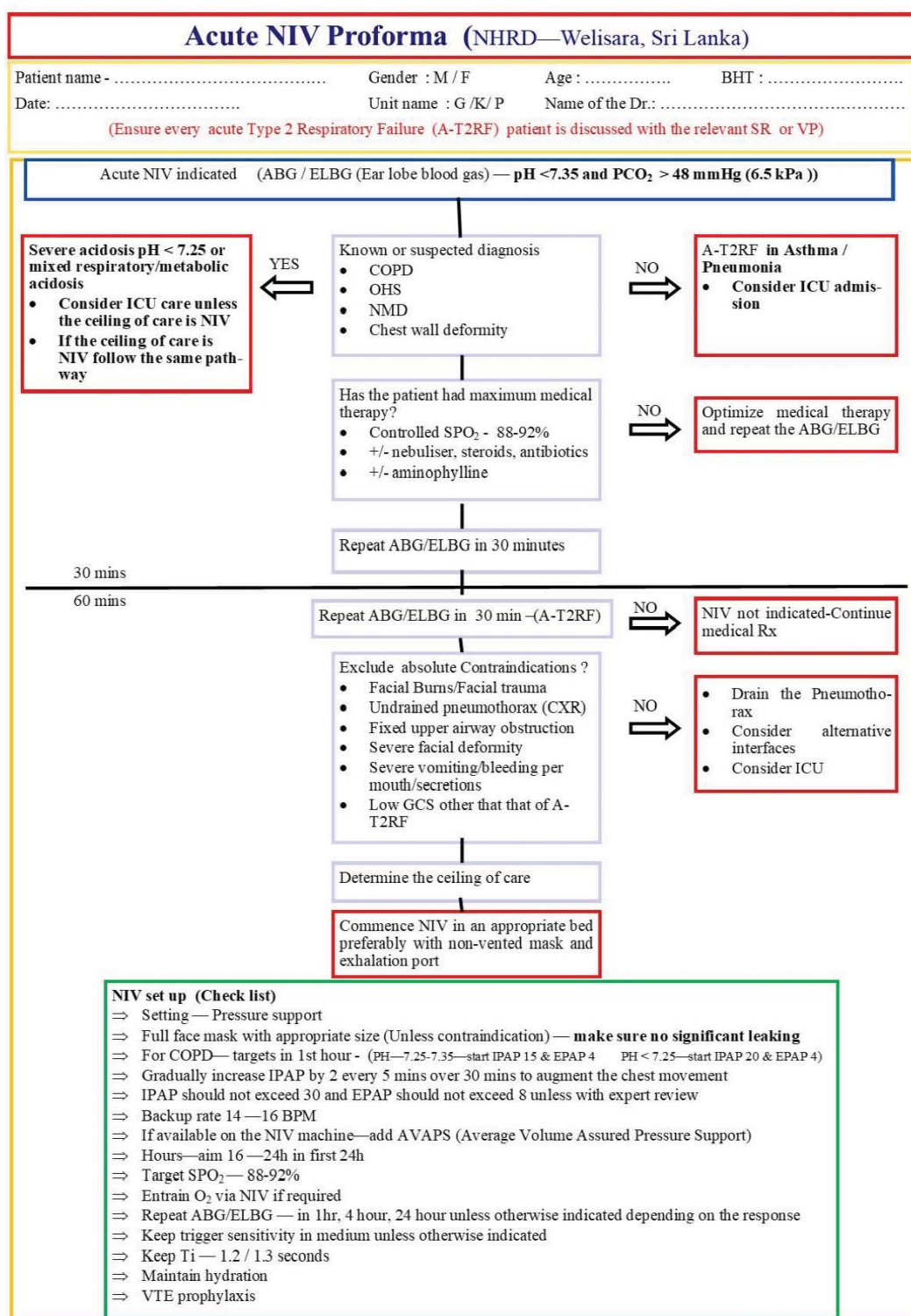
**Table 1. Illustrate the results of the audit as per the compliance rate**

Standard	Compliance (%)
<b>Standard 1</b> All patients need to have either capillary or arterial blood gas prior to starting on NIV. Venous blood gas is not acceptable.	100% (15/15)
<b>Standard 2</b> Oxygen to be delivered to target range (88-92%) in the Pre-NIV decision phase (Mentioned the target range in the initial phase of the ward)	40.0% (6/15) 7/15-Not documented
<b>Standard 3</b> All patients should have a documented escalation plan before starting treatment with acute NIV.	46.7% (7/15) 8/15-Not documented
<b>Standard 4</b> Patients who meet evidence-based criteria for acute NIV should start NIV within 60 min of the blood gas result associated with the clinical decision to provide NIV	66.7% (10/15)
<b>Standard 5</b> Clinical progress should be reviewed by a healthcare professional with appropriate training and competence within 4 hours of starting NIV (Senior Registrar or Consultant in Respiratory Medicine)	80% (12/15)
<b>Standard 6</b> All patients treated with acute NIV should have blood gas analysis performed within 2 hours of starting acute NIV.	80% (12/15)
<b>Standard 7</b> Failure of these blood gas measurements to improve should trigger a specialist healthcare professional review within 30 min.	83.3% (5/6) ABG improvement Failed in 6 patients
<b>Standard 8</b> Every patient on Acute NIV(COPD) should have a discharge blood gas and if hypercapnic should be followed up in the clinic in 4 weeks (10 patients were discharged alive after NIV)	70% (7/10) – Discharge ABG 0% (0/10) – Follow-up ABG

Compliance ≥95%

Compliance 75%-94%

Compliance ≤74%



Compiled according to the Acute NIV BTS guideline 2016 as an Audit Project of Dr. Harshana Bandara (SR—Respiratory) in 2022

**Figure 1. Suggested acute-NIV proforma (Page 1) – elaborating the indications and the NIV commencement flowchart.**

Abbreviations in the image

ABG – Arterial blood gas, ELBG – Ear lobe blood gas, A-T2RF – Acute-type II respiratory failure, PCO<sub>2</sub> – Partial pressure of CO<sub>2</sub>, OHS – Obesity hypoventilation syndrome, NMD – Neuromuscular disease, ICU – Intensive care unit, SPO<sub>2</sub> – Pulse oximetry, CXR – Chest X-ray, GCS – Glasgow coma scale, IPAP – Inspiratory positive airway pressure, EPAP – Expiratory positive airway pressure, AVAPS – Average volume assured pressure support, Ti – Inspiratory time, VTE – Venous thromboembolism

### NIV Prescription and Monitoring in A-T2RF

Date									
Time									
IPAP									
EPAP									
Ti									
BPM									
FiO <sub>2</sub>									
SPO <sub>2</sub>									
Machine alarm									
Leak report									
Pressure areas									
pH									
PCO <sub>2</sub>									
PO <sub>2</sub>									
HCO <sub>3</sub>									
BE									
Signature									

**NIV Weaning Plan**

Weaning can be done with abrupt weaning if an NIV dedicated setting. However, step down weaning would be more safer and more convenient for the staff as mentioned below.

**Step 01—Establish the stability on ventilator**  
**Patient must meet the following criteria for 24 hours prior to commencing wean**

- pH > 7.35
- PCO<sub>2</sub> < 60 mmHg
- FiO<sub>2</sub> < 4 L or 28% venturi
- Normal RR (within range for the patient)

Document the need for ABG/ELBG in medical notes

**Step 02—Increase breaks in ventilation**  
**Aim for**

- 2 × 4 hours daytime breaks from ventilation
- 8 hours of ventilation overnight
- Repeat ELBG/ABG at 0600 on the following morning

**Ensure :**  
pH > 7.35      FiO<sub>2</sub> < 4 L or 28%  
PCO<sub>2</sub> < 60 mmHg      Normal RR

**Step 03—Increase breaks in ventilation**  
**Aim for**

- 3 × 4 hours daytime breaks from ventilation
- 8 hours of ventilation overnight
- Repeat ELBG/ABG at 0600 on the following morning

**Ensure :**  
pH > 7.35      FiO<sub>2</sub> < 4 L or 28%  
PCO<sub>2</sub> < 60 mmHg      Normal RR

**Step 04—Increase breaks in ventilation**  
**Aim for**

- Whole daytime break from ventilation
- 8 hours of ventilation overnight
- Repeat ELBG/ABG at 0600 on the following morning

**Ensure :**  
pH > 7.35      FiO<sub>2</sub> < 4 L or 28%  
PCO<sub>2</sub> < 60 mmHg      Normal RR

**Step 05—Discontinue NIV**  
**Aim for**

- If patient clinically stable and acidosis resolved NIV can be discontinued
- Repeat ELBG/ABG at 0600 on the following morning

**Ensure :**  
pH > 7.35      FiO<sub>2</sub> < 4 L or 28%  
PCO<sub>2</sub> < 60 mmHg      Normal RR

Compiled according to the Acute NIV BTS guideline 2016 as an Audit Project of Dr. Harshana Bandara (SR—Respiratory) in 2022

**Figure 2. Suggested acute NIV proforma (Page 2) – elaborating maintenance of NIV and weaning down plan.**

Abbreviations in the image

ABG – Arterial blood gas, ELBG – Ear lobe blood gas, A-T2RF – Acute-type II respiratory failure, ICU – Intensive care unit, IPAP – Inspiratory positive airway pressure, EPAP – Expiratory positive airway pressure, BPM – Breaths per minute, Ti – Inspiratory time, VTE – Venous thromboembolism SPO<sub>2</sub> – Pulse oximetry, FiO<sub>2</sub> – Fraction of oxygen, PCO<sub>2</sub> – Partial pressure of CO<sub>2</sub>, PO<sub>2</sub> – Partial pressure of O<sub>2</sub>, HCO<sub>3</sub> – Bicarbonate, BE – Base excess, RR – Respiratory rate

## Conclusion

Acute-NIV is one of the mainstays of the management of AHRF and it should be started timely, correctly, and maintained appropriately for a better outcome. Moreover, the delays, mistakes, and document deficits should be overcome for a better outcome for the patients. In addition to the establishment of a dedicated acute NIV bay, adherence to a prescription proforma would maintain the preferred standards.

## Author declarations

### Ethical approval and consent to participate

Approval from the Director of Welisara Hospital was granted for the audit. Ethical approval was not considered as this is an audit.

### Competing interests

All the authors declare no competing interests.

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### Author contributions

HB conceptualized the project and all authors contributed equally to conduct the project. The

proforma was initially created by HB and the other authors modified and approved the final version. HB drafted the manuscript, and the other authors approved the final version.

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