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Original Article

Outcome of NIV in Critical Care Setting: Experience from a Tertiary Care Center

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Abstract:

NIV is a method of ventilatory support which is delivered to the patient without using an invasive airway. For the last two decades it is increasingly used as an accepted method of mechanical ventilatory support as it is proved to have many positive outcomes as it can prevent invasive ventilation & its complication. In a tertiary care hospital of Bangladesh we are using this method in all patients meeting the NIV criteria & not having absolute contraindication irrespective of diagnosis. Our study aimed to access the out come of the NIV trial using our local resource & to compare it with others. This is an ongoing prospective study and till this report data from 82 patients were analyzed here of which 50% patient ended with positive outcome & 50% ended as negative outcome. As the result of this method varies significantly by diagnosis & severity of disease we are generating specific recommendations according to the likely outcome according to the diagnosis.

Key Word: *Non Invasive Ventilation, BiPAP, Critical Care*

Introduction:

Noninvasive ventilation (NIV) refers to the administration of ventilatory support without using an invasive artificial airway (endotracheal tube or tracheostomy tube). The use of noninvasive ventilation has markedly increased over the past two decades as it has been proved to be aan efficient method for selective conditions and by which invasive mechanical ventilation can be avoided along with its complications. NIV has already proven to have beneficial effects like reducing complications (like VAP, ventilator dependency), reducing hospital stay and cost. Noninvasive ventilation has now become an integral tool in the management of both acute and chronic respiratory failure, in both the home setting and in the critical care unit. Noninvasive ventilation has been used as a replacement for invasive ventilation, but its flexibility also allows it to be a valuable complement in patient management.

At the ICU concerned our team is doing an observational study to draw do periodic assessment & to draw some conclusions to generate some specific recommendations from the observations regarding NIV.

Methods of delivery:

Delivering positive airway pressure through a mask (which is primarily discussed in this text) has become the predominant method of providing noninvasive ventilatory support. It reduces respiratory rate, increase in tidal volume, decrease in dyspnea by reducing transdiaphragmatic pressures, work of breathing and improvement in oxygenation with a reduction in hypercapnia.

Ventilatory support can bewas delivered through a variety of interfaces (mouth piece, nasal msak, full-face mask, or helmet mask), using a variety of ventilatory modes (eg, volume ventilation, pressure support, bi-level positive airway pressure proportional-assist ventilation, continuous positive airway pressure etc.) with either ventilators dedicated to noninvasive ventilation (NIV) or those capable of providing support through an endotracheal tube or mask.

Negative-pressure ventilators provide ventilatory support using a device that encases the thoracic cage starting

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from the neck, and devices range from a whole-body tank to a cuirass shell. The general principal is the same with a vacuum device, which lowers the pressure surrounding the thorax, creating subatmospheric pressure and thereby passively expanding the chest wall with diaphragmatic descent, all leading to lung inflation. Exhalation occurs with passive recoil of the chest wall (which is not discussed here).

Patient interfaces:

In its simplest terms, noninvasive ventilation differs from invasive ventilation by the interface between the patient and the ventilator. Invasive ventilatory support is provided via either an endotracheal tube or tracheostomy tube. Noninvasive ventilatory support uses a variety of interfaces, and these have continued to evolve with modifications based on patient comfort and efficacy.

Nasal masks and orofacial masks were the earliest interfaces, with subsequent development and use of full face masks, mouthpieces, nasal pillows, and helmets. Nasal masks and orofacial masks are still the most commonly used interfaces. Orofacial masks are used almost twice as frequently as nasal masks. Both have advantages and disadvantages in the application of noninvasive ventilation.

Proper fitting of the mask or other interface is one of theanother key component to successful noninvasive ventilation. The mask or interface may be held in place (without straps applied) by the patient or therapist to familiarize the patient with the mask and ventilator. Typically, the smallest mask providing a proper fit is the most effective. Straps hold the mask in place, with care to minimize excess pressure on the face or nose. Leaks are the bane of all of the interfaces, but excess pressure applied with the straps increases the risk of pressure necrosis and skin breakdown. Straps should be tight enough to prevent leaks, but with enough slack to allow passage of 1 or 2 fingers between the face and the straps.

While orofacial masks and nasal masks are the most commonly used interfaces, other patient ventilator interfaces through which noninvasive ventilation can be applied include mouthpieces, nasal pillows, total face masks, and even a helmet device, which encompasses the entire head.

In patients with a higher severity of illness, the orofacial mask and total face mask appear to result in comparable outcomes.

Orofacial masks (general advantages)

- Best suited for less cooperative patients
- Better in patients with a higher severity of illness
- Better for patients with mouth-breathing or pursed-lips breathing
- Better in edentulous patients
- Generally more effective ventilation

Orofacial masks (cautions, disadvantages)

- Claustrophobic
- Hinder speaking and coughing
- Risk of aspiration with emesis

Nasal masks (general advantages)

- Best suited for more cooperative patients
- Better in patients with a lower severity of illness
- Not claustrophobic
- Allows speaking, drinking, coughing, and secretion clearance
- Less aspiration risk with emesis
- Generally better tolerated

Nasal masks (cautions, disadvantages)

- More leaks possible (eg, mouth-breathing or edentulous patients)
- Effectiveness limited in patients with nasal deformities or blocked nasal passages

Ventilators:

Early noninvasive ventilatory support was applied using either large bedside critical care volume ventilators or smaller volume or pressure specialty ventilators devoted to noninvasive ventilation. While the critical care ventilators had more options, they were also less tolerant of leaks. The specialty ventilators hMany critical care ventilators currently in use also have a noninvasive ventilation option, either as part of the original device or available as an upgrade option. The ideal device is dependent on a number of factors, including familiarity by staff and available options. The differences between the bedside critical care ventilator and specialty noninvasive ventilator continue to diminish as differences related to ventilator options, range of support, and leak tolerance are corrected in both devicesad fewer options and range, but they were more leak tolerant.

Modes of ventilation

Bilevel positive airway pressure (BiPAP) is the most common mode of support and requires provision of inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP). The difference between IPAP and EPAP is a reflection of the amount of pressure support ventilation provided to the patient, and EPAP is synonymous with positive end-expiratory pressure (PEEP).

All of our patients who got NIV support in our ICU was given support by BiPAP mode.

Predictors of successful noninvasive ventilation
It was judged both clinically & by ABG parameters, trials of noninvasive ventilation are usually 1-2 hours in length and are useful to determine if a patient can be treated with noninvasive ventilation .But all pts who got attached with NIV interface was included in our study irrespective of its time length. Extended trials without significant improvement are not recommended & was not given as because this only delays intubation and mechanical ventilation .ventilation & adding extra risk related to these.

Predictors of Success:
- Decrease in $PaCO_2$ greater than 8 mm Hg
- Improvement in pH greater than 0.06
- Correction of respiratory acidosis

Predictors of failure
- Severity of illness
- Acidosis (pH < 7.25)
- Hypercapnia (>80 and pH < 7.25)
- Acute Physiology and Chronic Health Evaluation II (APACHE II) score higher than 20
- level of consciousness
- Neurologic score (>4 = Sstuporous, arousal only after vigorous stimulation; inconsistently follows commands.)
- Encephalopathy score (>3 = Mmajor confusion, daytime sleepiness or agitation.)
- Glasgow Coma Scale score lower than 8
- Failure of improvement with 12-24 hours of noninvasive ventilation

Late failures (>48 h after initiation of noninvasive ventilation)
- Admission predictors of failure
- Lower functional status (Activity score < 2 = Ddyspnea on light activity)
- Initial acidosis (pH d" 7.22)
- Hospital complications (pneumonia, shock, coma)

Study design & case definition:
A comprehensive form was designed which included pts particular, diagnosis, history, ABG results, immediate response & the outcome. The form was filled up by the respiratory therapist group with the direct supervision of ICU physician (primarily mid level).. **Positive outcome** was defined to the pts who were improved (discharged from ICU care) without requiring intubation & M/V support & **negative outcome** was defined as the pt requiring intubation & M/V support for further management.

Study populations:
All pts admitted to SHL ICU who meets the criteria for NIV & who do not have absolute contraindications. Pts having relative contraindications were judged clinically where expert advice was taken in account.

Patient inclusion criteria:
Clinical parameters:
- Patient cooperation (an essential component that excludes agitated, belligerent, or comatose patients)
- Dyspnea (moderate to severe, but short of respiratory failure)
- Tachypnea (>24 breaths/min)
- Increased work of breathing (accessory muscle use, pursed-lips breathing)

Blood gas parameters:
- Hypercapnic respiratory acidosis (pH range 7.10-7.35)
- Hypoxemia (PaO_2/FIO_2 < 200 mm Hg, best in rapidly reversible causes of hypoxemia)

Contraindication
Absolute Contraindications:
- Coma
- Cardiac arrest
- Respiratory arrest
- Any condition requiring immediate intubation

Other contraindications (rare exceptions)
- Cardiac instability
- Shock and need for pressor support
- Ventricular dysrhythmias
- Complicated acute myocardial infarction
- GI bleeding - Intractable emesis and/or uncontrollable bleeding
- Inability to protect airway
- Impaired cough or swallowing
- Poor clearance of secretions
- Depressed sensorium and lethargy
- Status epilepticus
- Potential for upper airway obstruction
- Extensive head and neck tumors
- Any other tumor with extrinsic airway compression
- Angioedema or anaphylaxis causing airway compromise

Study result & discussion:
Data from total 82(n) pts were taken in account as we got clear reliable data from diagnosis, NIV criteria, initial ABG, F/U parameters & the outcome.

From those 41 pts were ended with positive outcome & rest 41 pt were ended as negative outcome (needed ETT intubation). A total 50 % of all pts irrespective of diagnosis were ended with positive outcome.

Data from pts:

Diagnosis	Population (n)	Positive outcome	Negative outcome	%Positive outcome	%Negative outcome
CKD with pulmonary oedema.	16	12	4	75%	25%
Acute LVF	15	13	2	86.66%	13.33%
Acute LVF associated with active ischemia	6	2	4	33.33%	66.66%
Acute exacerbation of COPD	6	6	NIL	100%	NIL
Community Acquired Pneumonia	16	1	15	6.25%	93.75%
Bronchial Asthma	4	2	2	50%	50%
Sepsis with MOF	4	NIL	4	NIL	100%
Post Extubation (1GBS, 1 OPC poisoning, 1 Bronchiactesis)	3	3	NIL	100%	NIL
ALI due to acute pancreatitis	2	2	NIL	100%	NIL
ILD	1	NIL	1	NIL	100%
Bronchogenic Ca	4	NIL	4	NIL	100%
OSA	1	NIL	1	NIL	100%
Acute Abdomen (PGCHV, Intestinal obstruction, Ca pancreas)	4	NIL	4	NIL	100%

According to the difference of diagnosis the results were as follows

Better out come

- **CKD with pulmonary oedema:** The outcome was good, 12 out of 16 patients, ended with positive outcome (75%). As thsesthese pts main cause of respiratory distress wereis due to fluid overload whicsh was corrected in a very short time by haemo dialysis & pt no longer needed ett endotracheal intubation.
- **Acute exacerbation of COPD:** It was 100% successful (6 out of 6). And it was applied to wide range of PH & PCO_2 variations.
- **Acute LVF:** Acute cardiogenicCardiogenic pulmonary oedema has over all success rate15 out of 21(71.42%), but those pts having ough has ongoing ischemia (relative contraindication) hadhas increased failure rate (only 2 succeded out of 6). But those pts who diddoes not have active ischemia hadas a better outcome (13 out of 15).
- **Acute exacerbation of Bronchial Asthma:** Our 1st pt had Br asthma & it was a successful case but our over all success rate is 50% (2 out of 4).
- **Post Extubation:** So far our success rate was 100% (3 out of 3).
- **ALI due to acute pancreatitis:** Had 100% success rate (n=2).

Poor out come

- **Community Acquired Pneumonia:** Its out come was poor (1 out of 16) irrespective of clinical of ABG parameter.
- **Sepsis with MOF:** It had 100% failure rate (n=4).
- **Acute Abdomen (PGCHV, Intestinal obstruction, Ca pancreas):** Had 0% success rate.
- **Bronchogenic Ca:** Had 0% success rate**.**

Discussion:

Noninvasive Ventilation in COPD

The largest review concluded that noninvasive ventilation decreased the intubation rate by 28% (95% confidence interval [CI], 15-40%), in-hospital mortality rate by 10% (95% CI, 5-15%), and absolute reduction in length of stay by 4.57 days (95% CI, 2.30-6.38 d).[1]In another review, greater improvement in respiratory acidosis, hypercapnia, and tachypnea was noted after 1 hour on noninvasive ventilation, along with fewer complications related to intubation.[2] Experience in a case-control study suggests a reduction in nosocomial pneumonia from 22% to 8%, with fewer days in the ICU and lower mortality (26% down to >4%) in those treated with noninvasive ventilation as opposed to those who received endotracheal intubation.[3,4]

In case of our study NIV trial in Acute exacerbation of COPD was 100% successful (6 out of 6). And it was applied to wide range of PH & PCO_2 variations.

Noninvasive Ventilation in Cardiogenic Pulmonary Edema

Meta-analyses do suggest a benefit with CPAP, with a risk reduction in intubation of 60% (RR, 0.40; 95% CI, 0.27-0.58) and a decrease in mortality rate of 47% (RR, 0.53; 95% CI, 0.35-0.81). Noninvasive ventilation has also

demonstrated a risk reduction in intubation rates of 52% (RR, 0.48; 95% CI, 0.34-0.76), but not for mortality rates. No differences were noted when comparing CPAP and noninvasive ventilation.[5]

In our study Acute cardiogenic pulmonary oedema has over all success rata 15 out of 21(71.42%), but thouse who had ongoing ischemia (relative contraindication) had increased failure rate (only 2 succeded out of 6). But those pts who did not have active ischemia has a better outcome (13 out of 15).

Noninvasive Ventilation After Extubation

A systematic review and meta-analyses of noninvasive ventilation and weaning in slightly more than 500 patients (mostly COPD patients) found that the use of noninvasive ventilation reduced mortality rates by 45% (RR, 0.55; 95% CI, 0.38-0.79), ventilator-associated pneumonia rates by 71% (RR, 0.29; 95% CI, 0.19-0.45), weighted duration of ICU stay by 6.27 days (95% CI, 8.77-3.78 d), and hospital days by 7.19 days (10.8-3.58 d) compared with a conventional weaning approach. The duration of endotracheal intubation was reduced by 7.81 days (95% CI, 11.3-4.31 d), as was the need for tracheostomy. However, reintubation rates were not decreased.[6]

Post Extubation: So far our success rate was 100% (3 out of 3).

Do-not-intubate status (advanced disease or terminal malignancy)[7]

Benefit in dyspnea relief for patients with terminal malignancy [8]

Although NIV trial in these patients had 100% failure rate but this method may be applied to relieve acute respiratory distress for some time.

Conclusion:

At this stage of our study we can make the following recommendation from our data.

1. All pts with COPD exacerbation & CKD with pulmonary edema (due to fluid overload) should routinely be offered NIV support & those pts are likely to end up with good out come.
2. CAP, Severe sepsis Acute cardiogenic pulmonary oedema with active ischemia Acute abdomen (Any cause) may not be offered NIV support routinely as they likely to end up with invasive ventilation even if they look healthier then that of other diagnosis both clinically& by ABG parameter.
3. We need to have more data or should have to go for Meta analysis for the other diseases like Br Asthma.

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