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Hospital monitoring, setting and training for home non invasive ventilation

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ABSTRACT: ***Hospital monitoring, setting and training for home non invasive ventilation. D. Fiorenza, M. Vitacca, E. Clini.***

Although in recent years guidelines have been published in order to define indications, applications and delivery of long-term home non invasive mechanical ventilation (HNMV), there is lack of information with regards to in-hospital assessment, planning and training to initiate and prescribe it.

Discontinuation and lack of compliance versus HNMV may affect the follow-up of these patients adding a costly burden for care.

The present review proposes an operative flow chart for optimisation of HNMV prescription from initial patient's selection to post discharge follow up including;

1. **assessment of the correct choice of ventilator, interfaces, ventilation setting**
2. **Timing for different physiological monitoring (arterial gases, mechanics, sleep)**
3. **Timing for clinical evaluation, machine adaptation, carer training and long term follow-up.**

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In recent years, guidelines were published to define indications, applications and delivery of long-term mechanical ventilation (MV) [1, 2].

Non-invasive positive pressure ventilation (NPPV) has been increasingly used in the management of chronic respiratory insufficiency resulting from neuromuscular and restrictive chest wall diseases [3] and, also in chronic obstructive pulmonary disease (COPD) [4] with controversial results.

Side-effects due to the interface may impact the follow-up of these patients in 20-50% of cases [5-7] and they account for an important problem when dealing with discontinuation and lack of compliance. Nonetheless, the selection of patients [2], mode of ventilation [8], types of ventilator [9], ventilator setting [10, 11] and apparatus needed for MV [12-14] have claimed to account for these conflicting results.

There is a lack of information regarding in-hospital assessment and the plans to initiate and prescribe NPPV. The present review proposes an operative flow chart for optimisation of home NPPV prescription which has been used since 2001 in two Italian rehabilitative centres.

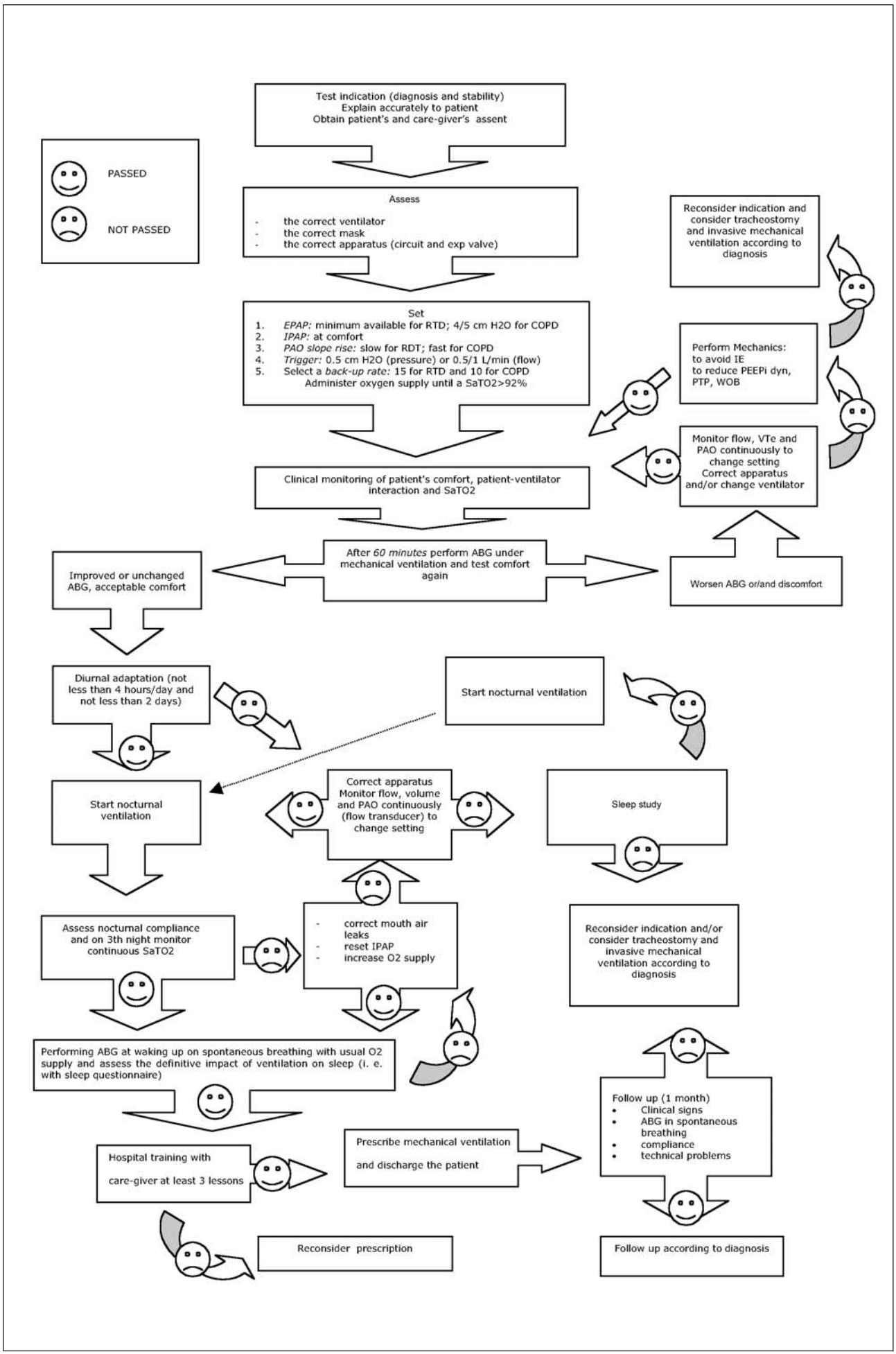
As stressed in recent guidelines [2] the physician needs to strictly test the correct indication for NPPV in terms of correct diagnosis (neuromuscular disorders or chest wall deformities rather than COPD) and in terms of patient's stability (see figure 1). Patient's stability refers to general conditions, to respiratory status in absence of any factor associated with exacerbation, and to the psycho-social ability to cope with a long-term MV [2] programme. In particular, stability in COPD patients, has been defined as an arterial pH > 7.35 and absence of acute exacerbations in the four weeks preceding recruitment [4]. At the same time, another key point is to accurately explain the in-hospital training and home NPPV programs to the patient and care-giver(s) in terms of;

a) expected results
b) outcome
c) necessity of program adherence and
d) strict long term follow up [2].

The second step of the ideal training process (figure 1) requires the careful choice of: 1) ventilator, 2) mask, 3) apparatus (in terms of circuit and expiratory valve) 4) mode of MV and 5) setting up of MV.

Home NPPV is often prescribed after in-hospital practice sessions have been performed with the commercial ventilators available at the moment (often a single one), which may be not necessarily the same one used by the patient at home. This limits the possibility to select the best ventilator "tailored" for the patient. Although the large majority of the so-called "home care" ventilators can offer performances similar to those of the traditional and more expensive "ICU" ventilators [10, 15], it has been demonstrated that, at least in bench studies, each ventilator may perform differently [16-18]. One study has compared patients' compliance in the commonly prescribed commercial ventilators [8]: however, no specific comparisons on the physiological effects among these ventilators have been reported yet.

In our laboratory we undertook a study [19] to compare patient-ventilator interaction and patient comfort with five different commercial bi-level pressure home ventilators, all set on the basis of the maximal tolerated Inspiratory Positive Airway Pressure (IPAP). These ventilators were delivered


Test indication (diagnosis and stability)
Explain accurately to patient
Obtain patient's and care-giver's assent
PASSED
NOT PASSED
Assess
- the correct ventilator
- the correct mask
- the correct apparatus (circuit and exp valve)
Reconsider indication and consider tracheostomy and invasive mechanical ventilation according to diagnosis
Set
1. EPAP: minimum available for RTD; 4/5 cm H2O for COPD
2. IPAP: at comfort
3. PAO slope rise: slow for RDT; fast for COPD
4. Trigger: 0.5 cm H2O (pressure) or 0.5/1 L/min (flow)
5. Select a back-up rate: 15 for RTD and 10 for COPD
Administer oxygen supply until a SaTO2>92%
Perform Mechanics:
to avoid IE
to reduce PEEPi dyn, PTP, WOB
Monitor flow, VTe and PAO continuously to change setting
Correct apparatus and/or change ventilator
Clinical monitoring of patient's comfort, patient-ventilator interaction and SaTO2
After 60 minutes perform ABG under mechanical ventilation and test comfort again
Improved or unchanged ABG, acceptable comfort
Worsen ABG or/and discomfort
Diurnal adaptation (not less than 4 hours/day and not less than 2 days)
Start nocturnal ventilation
Start nocturnal ventilation
Correct apparatus Monitor flow, volume and PAO continuously (flow transducer) to change setting
Sleep study
Assess nocturnal compliance and on 3th night monitor continuous SaTO2
- correct mouth air leaks
- reset IPAP
- increase O2 supply
Reconsider indication and/or consider tracheostomy and invasive mechanical ventilation according to diagnosis
Performing ABG at waking up on spontaneous breathing with usual O2 supply and assess the definitive impact of ventilation on sleep (i. e. with sleep questionnaire)
Follow up (1 month)
• Clinical signs
• ABG in spontaneous breathing
• compliance
• technical problems
Hospital training with
care-giver at least 3 lessons
Prescribe mechanical ventilation
and discharge the patient
Reconsider prescription
Follow up according to diagnosis

to 28 obstructed or restricted patients with chronic ventilatory failure; we concluded that (despite a great inter-subject variability in comfort) all these ventilators are well tolerated, and produce similar physiological effects thus fulfilling the aims of mechanical ventilation [2]. These findings suggest that, in order to make informed decision when prescribing a ventilator for NPPV to the individual patient, it is necessary to understand how the ventilator tested actually performs in that patient, and how it is accepted by the patient him/her self. For that reason the choice of ventilator for home NPPV should be made after comparing different ventilators which are suitable to the individual patient.

Serious attention is also necessary to test different masks in order to minimize leaks and side effects and also to obtain the best comfort. Nevertheless, poor literature is available in this specific field: Navalesi and colleagues [12] demonstrated that during application of NPPV the best comfort is found with the use of nasal masks, whereas the best improvements in minute ventilation and $PaCO_2$ are obtained using the facial mask.

The use of an appropriate exhalation device for home ventilatory assistance to avoid significant CO_2 re-breathing is mandatory. Controversies remain if this goal may be obtained only with an appropriate exhalation device (such as the "plateau" expiratory valve) without compromising the delivered pressures and tidal volume [13] or also with the traditional exhalation valve [14] Recent work [2] shows that the majority of authors use pressure assisted modalities rather than volume controlled ones; in particular, the pressure support modality has been demonstrated to be the most comfortable method to chronically ventilate COPD patients with respiratory failure [4, 8].

In clinical practice, home NPPV for COPD patients is prescribed as Nasal Pressure Support Ventilation (NPSV), and it is set to achieve a decrease in $PaCO_2$ and an optimal patient's compliance ("usual setting"). However, targeting the setting to these objects gives no information on the respiratory muscle unloading and the intrinsic positive end expiratory pressure (PEEPi) counterbalancing ("physiological setting"). The application of extrinsic positive end expiratory pressure (PEEPe) in these patients has been shown to be the best to unload the diaphragm with an adequate titration [i.e. 80-90% of intrinsic dynamic positive end-expiratory pressure (PEEPi dyn)], whilst an incorrect setting (for example in the case of over assistance) may lead to further increase hyperinflation [20]. The "usual setting" and the "physiological setting" might have different implications in clinical practice as demonstrated in a recent study performed on stable COPD patients with chronic hypercapnia [11]. This study supports the notion that NPSV set either at patient's comfort or tailored to the physiological measurements provides similar improvement in arterial blood gases (ABG) and unloading of the respiratory muscles. However, the physiological setting of inspiratory assistance and PEEPe (with the need to use an invasive evaluation of lung mechanics and respiratory muscles function) may result in a reduction of inspiratory ineffective efforts, which relate to the patient-ventilator dissynchrony [11]. Figure 1 shows in details the modality of the settings more used in literature.

Figure 1 also indicates that clinical monitoring of patient's comfort, patient-ventilator interaction and arterial saturation ($SatO_2$) is necessary from the beginning of MV [2]. In particular, ABG to test the effect of the ventilation, the assessment of patient comfort and the appearance of any technical problems (leaks, high pressure limit) are recommended 60 minutes after MV application [2]. At this stage patient's co-operation, rather than immediate clinical results, is the main aim.

Two different results are possible in the patient under evaluation (see figure 1): arterial blood gases (ABG) improvement or ABG unchanged/worsening:

1. If ABG is worsened and MV discomfort appears, then there is the possibility to change apparatus (see above) and/or to add flow, volume and airway pressure by continuous monitoring (by means of a flow transducer); these changes may therefore help physician to optimise setting and to improve the patient's compliance [11]. Only in selected situations [11] evaluation of lung mechanics (by means of oesophageal balloon) may substantially lead to improve the patient-ventilator interaction, to avoid ineffective efforts, to physiologically reduce intrinsic PEEP (PEEPi dyn) and work of breathing (WOB).
2. If an acceptable level of patient comfort with a good response in terms of ABG is found, diurnal adaptation to MV can start. The recommended protocol of application is targeted to reach no less than four hours per day and no less than two consecutive days of positive adaptation [2]. Thereafter, nocturnal ventilation may be tested: the assessment of nocturnal compliance and $SatO_2$ monitoring at the 3rd consecutive night is usually performed. ABG on spontaneous breathing with usual O_2 supply at waking up is assessed to evaluate the definitive impact of MV during sleep. Questionnaires on sleep quality can also be administered. Only in selected situations a full-night polysomnography might be useful to assess apnoeas, snoring or arousals and possibly, to normalise them after proper setting.

Only when both diurnal and nocturnal adaptations are acceptable, can in-hospital training for the patient and the carer be proposed [2]. The training consists of at least 6 lessons (by medical doctors and nurses) lasting 30 to 45 minutes to illustrate the use of mask, circuit, comfort flaps, ventilator and cleaning procedures. Finally, it is also essential to test the ability of the care-giver and family members to collaborate with the home MV programme.

Only at this step can a definitive prescription of MV be assured to complete the discharge planning. A strict follow-up including clinical signs (i. e. gastric inflation, coughing, etc.), mask and/or ventilator discomfort and technical problems (i. e. leaks) needs also to be planned.

In conclusion, the prescription of home NPPV is a hard task for doctors and it represents a kind of challenge for a multidisciplinary team consisting not only of the doctor himself, the nurse, the respiratory therapist, the psychologist, but also of the patient's family and care-giver. Acceptance and motivation to co-operate are essential and should be proportional to the patient's dependency.

The main goals of NPPV are to control symptoms linked to nocturnal hypo-ventilation, to improve the patient's quality of life and to reduce morbidity and, (possibly) mortality in a cost-effective way. In-hospital assessment and planning are necessary to initiate NPPV. A documented diagnosis and indications, an adequate setting and the patient's compliance are essential for prescription. The follow-up monitoring is also essential to confirm prescription each year; moreover, a re-evaluation about the correct indication for NPPV and/or alternative indication for tracheotomy and change to invasive MV may be considered at this stage .

The process to properly assess and plan home MV is the correct way to improve and stabilize lung function, to increase the quality of life and to prevent acute episodes of hypercapnia which are often fatal recurrences in these kind of patients with advanced respiratory disease.

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