Chronic obstructive pulmonary disease pathways as a tool to improve appropriateness in Internal Medicine Departments

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ABSTRACT

In recent decades, in the medical field, criteria and methods of decision-making have radically changed, going from an environment dominated by opinions and knowledge transmitted from experts to a context of evidence-based medicine, that finds its practical realization in the drafting of guidelines (GL). However, GL have a poor implementation in the real world for several factors. In the field of chronic obstructive pulmonary disease (COPD), there are already many GL, international, national, regional and by specific scientific societies. This multiplicity, while it responds to the legitimate needs to respect the diversity of interpretation of the available scientific data, on the other hand, however, can be an element of confusion for physicians. In this varied scenery we have tried to create some new tools, easy and quick to use, in order to improve the local application of existing GL on COPD, by planning a limited number of pathways in the management of acute exacerbation of COPD, which focus on the fundamental diagnostic and therapeutic aspects, as a tool to improve appropriateness in Internal Medicine Departments. These pathways, reported on individual sheets, which can be distributed to medical personnel of wards/units involved in the care of patients with COPD (First Aid, Internal Medicine, Geriatrics, Pulmonology, Intensive Respiratory Care Unit, Resuscitation), are useful to support the physician in the decision-making process and help you to resolve any disputes.

Introduction

Criteria and methods of decision-making in the medical field have radically changed in recent decades: they changed from an environment dominated by opinions and knowledge transmitted from experts to a context of evidence based medicine (EBM). EBM finds its practical realization in the drafting of guidelines (GL), to support the decision-making processes in patient care.

Among the different definitions of the GL, published in the scientific literature,[1] the oldest and most widely quoted is the definition of the Institute of Medicine: as *systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances.*[2,3]

However, the publication of the GL has often poor practical impact in the concrete improvement of general clinical practice.[4-8]

Several factors prevent the implementation of GL in the real world: i) too much test (several pages) in relation to time available for physicians; ii) multiplicity of GL on the same subject by different organizations and scientific societies; iii) mode of presentation not always effective (a lot of text, small print); iv) high complexity of recommendations (with different levels of evidence and strength of recommendations); v) limited accessibility (publication in journals or sites are not always used to all).

In the field of chronic obstructive pulmonary disease (COPD), there are already many GL: at international level (GOLD 2014,[9] ACP-ACCP-ATS-ERS 2011[10]), at national level (USA ICSI 2013,[11] British NICE 2010,[12] Canadian CTS 2007,[13] Italian AGENAS 2009[14] and AIMAR-AIPO-SIMER-AGENAS-2011[15]), at regional level (Tuscany 2011[16]), in addition to some documents of Consensus Conferences, such as those developed by the Italian Federation of Associations of Hospital Doctors on Internal Medicine (FADOI) 2012.[17]

This multiplicity, while it responds to the legitimate needs to respect the diversity of interpretation of the available scientific data, on the other hand, however, can be an element of confusion for physicians.

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See online Appendix for Figures.

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In this varied scenery we have tried to create some new tools, easy and quick to use, in order to improve the local application of existing GL on COPD.

A useful Appendix is available online to summarize these new tools.

We used the model of the diagnostic-therapeutic protocol in order to obtain a link between GL and improvement of care quality, thus contributing to the achievement of the effectiveness and appropriateness objectives of the GL.[18,19]

So, we published[20] a *diagnostic-therapeutic protocol (PDT) for the internal medicine patients with acute exacerbation of chronic obstructive pulmonary disease: from the moment they arrive at the hospital until discharge*, to be applied in the Puglia region. This PDT has obtained the endorsement of FADOI Puglia, SIMI Puglia and Basilicata (Italian Society of Internal Medicine), SIGG Puglia and Basilicata (Italian Society of Gerontology and Geriatrics), SIGOT Appulo-Lucana (Italian Society of Geriatric Hospital and Territorial) and A.Re.S. Puglia (Regional Health Agency).[20]

From this PDT were extracted a limited number of pathways in the management of acute exacerbation of COPD (AECOPD), which focus on the fundamental diagnostic aspects that have to be assessed and monitored, on the information to be collected in a systematic, structured and continuous basis, on the procedures for the proper setting of the therapy, on the useful indicators to check the actual achievement of clinical objectives.

These pathways, reported on individual sheets, which can be distributed to medical personnel of wards/units involved in the care of patients with COPD (First Aid, Internal Medicine, Geriatrics, Pulmonology, Intensive Respiratory Care Unit, Resuscitation), are useful to support the physician in the decision-making process and help you to resolve any disputes.

Management of chronic obstructive pulmonary disease in Emergency Department

Figure 1 shows, in summary, the diagnostic algorithm to be implemented in the emergency room immediately after the arrival of the patient from the territory, to formulate the correct diagnosis and identify the most appropriate care setting for the individual clinical case. To do this we propose the use of the following three simple dichotomous clinical scores, to be applied progressively: i) observational sign and symptom index (OSSI) score: it helps to make the diagnosis of AECOPD, excluding alternative diagnoses, along with history and physical examination; ii) decisional observation objective rescue (DOOR) score: it contributes to the definition of the setting of care, *i.e.,* hospital or home; iii) WHERE score: in case of hospitalization, it directs the choice of the most appropriate department among the general wards (Internal Medicine or Geriatrics), the Semi-Intensive Respiratory Care Unit or Critical Area of Internal Medicine [where to implement non-invasive ventilation (NIV)] and the Intensive Care Unit [where to implement the invasive mechanical ventilation (IMV)].

When a patient with suspected AECOPD reaches the Emergency Department we suggest the following path (Figure 2). After the history and physical examination, some urgent laboratory and instrumental exams must be carried out: blood count, blood urea, creatinine, sodium, potassium, glucose, serum glutamic oxaloacetic transaminase, serum glutamic pyruvic transaminase, bilirubin, activated partial thromboplastin time, international normalized ratio, NT pro-BNP, D-dimer, serum albumin, arterial blood gas (ABG), electrocardiogram, chest X-ray. Then, in order to strengthen the diagnosis of AECOPD, we can use the *OSSI score*. The *OSSI score* provides three major items (increase in sputum, increase of dyspnea, purulent sputum) and six minor items (upper respiratory tract infection in the past 5 days; fever not from other known causes; increased cough; increased wheezing; heart rate (HR) >20% compared to baseline; respiratory rate (RR) >20% compared to baseline). If at least two major items of the OSSI score or one major + one minor exist, the diagnosis of AECOPD is confirmed; if not, alternative diagnoses should be considered. If the diagnosis is AECOPD, *DOOR score* helps to take a decision whether to treat patient at home or in hospital. The DOOR score provides 13 items: i) respiratory failure; ii) acidosis; iii) sudden and marked symptoms; iv) dyspnea at rest; v) significant comorbidities; vi) poor response to outpatient therapy; vii) important feeding problems; viii) important disorders of sleep; ix) worsening of pre-existing hypoxemia; x) worsening of pre-existing hypercapnia; xi) neuro-psychological impairment; xii) inappropriate home support; xiii) diagnostic doubt.

If there is none of these (minor acute exacerbation), the patient can be treated at home; if at least one of these occurs, the patient must be hospitalized.

In patients hospitalized, the *WHERE score* helps to identify the appropriate care setting.

It provides seven items: i) progressive dyspnea; ii) confused state or lethargy or coma; iii) PO_2<40 mmHg persistent/worsening with O_2 or NIV; iv) PCO_2>60 mmHg or worsening with O_2 or NIV; v) pH<7.35 with O_2 or NIV; vi) indication for invasive mechanical ventilation; vii) hemodynamic instability/need for vasopressors.

If there is none of these, the patient may be admitted to a general ward (Internal Medicine or Geriatrics); if at least one of these exists, the patient must be allocated in Semi-Intensive Respiratory Care Unit or Critical Area of Internal Medicine for NIV or in Intensive Care Unit for IMV (see below).

Appendix Figure 1 shows the algorithm to be applied to patients with AECOPD with *DOOR score*=zero (minor acute exacerbation), that can be managed at home by the general practitioner or in Short Intensive Observation in the Emergency Department. The algorithm provides several therapeutic steps, to be applied in succession, each followed by a clinical control at a distance of a few hours. The outcome may be the complete stabilization of the patient with the prescription of long-term treatment or, in case of lack of improvement, the hospitalization. This algorithm is also in line with the recommended approach by Respiratory Section of the Italian Society of General Medicine (SIMG).[21]

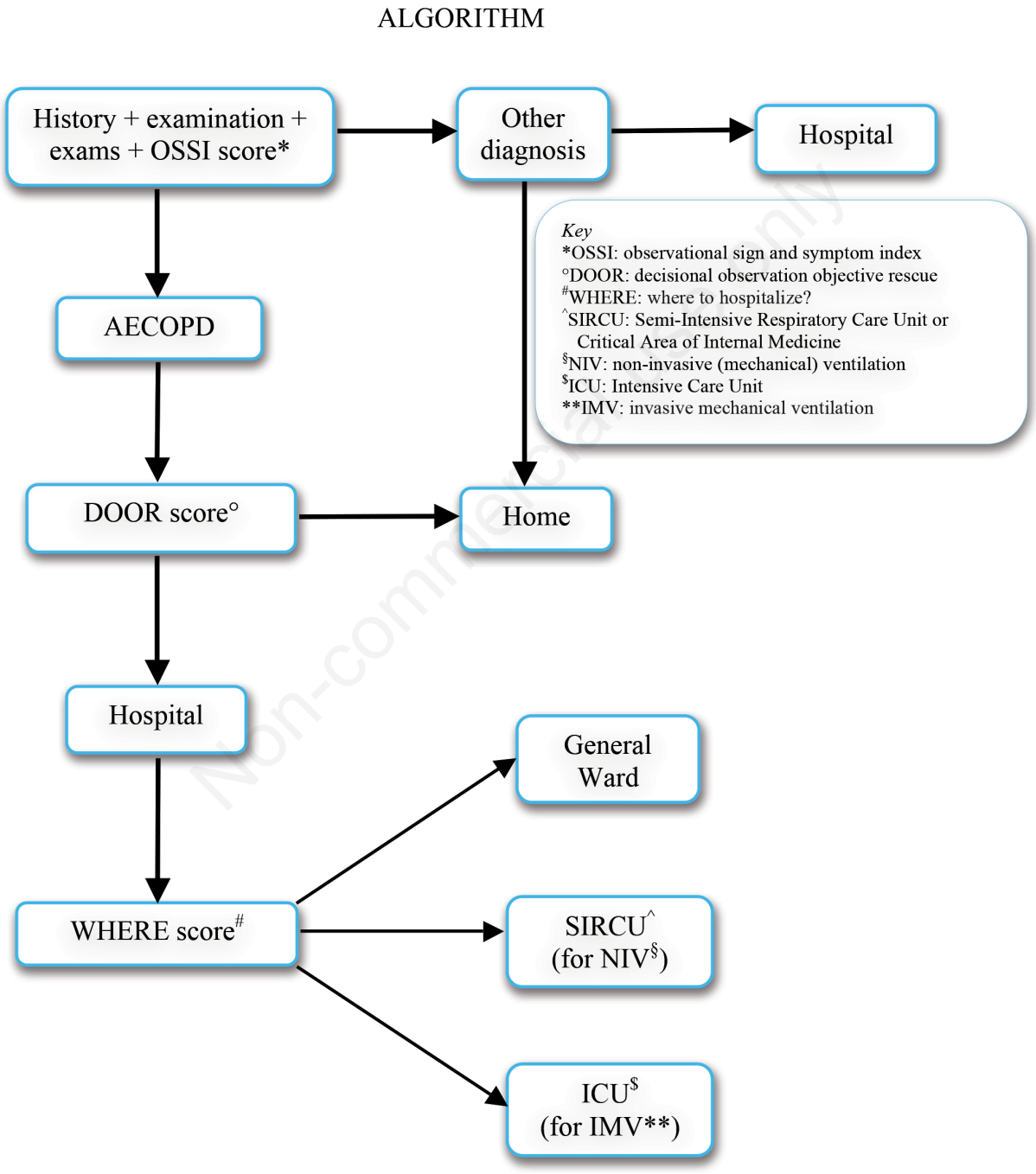

Figure 1. Algorithm of patients with suspected acute exacerbation of chronic obstructive pulmonary disease (AECOPD) in Emergency Department.

1. History + examination

2. Urgent exams: blood count, blood urea, creatinine, sodium, potassium, glucose, SGOT, SGPT, bilirubin, aPTT, INR, NT pro-BNP, D-dimer, serum albumin, arterial blood gas, EKG, chest X-ray

3. OSSI score

	Reference or fact
A	*Increase in sputum*
	Increase in dyspnea
	Purulent sputum
B	*Upper respiratory tract infection in the past 5 days*
	Fever not from other known cause
	Increased cough
	Increased wheezing
	HR>20% compared to baseline (if detectable)
	RR>20% compared to baseline (if detectable)

2-3 A or 1A+1B → AECOPD

If not AECOPD consider alternative diagnoses

1 (history + examination) + 2 (laboratory and instrumental exams) + 3 (OSSI score) = DIAGNOSIS

4. DOOR score (*to determine whether to admit or discharge home*)

Respiratory failure?
Acidosis?
Sudden and marked symptoms?
Dyspnea at rest?
Significant comorbidities?
Poor response to outpatient therapy?
Important feeding problems?
Important disorders of sleep?
Worsening of pre-existing hypoxemia?
Worsening of pre-existing hypercapnia?
Neuro-psychological impairment?
Inappropriate home support?
Diagnostic doubt?

None of these → Return home

At least one of these → Hospitalize

5. WHERE score (where to hospitalize?)

Progressive dyspnea?
Confused state or lethargy or coma?
PO_2<40 mmHg persistent/worsening with O_2 or NIV?
PCO_2>60 mmHg or worsening with O_2 or NIV?
pH<7.35 with O_2 or NIV?
Indication for invasive mechanical ventilation?
Hemodynamic instability/need for vasopressors?

None of these → General ward

At least one of these → Semi-Intensive Respiratory Care Unit or Critical Area of Internal Medicine* for NIV or ICU for IMV (**as local organization*)

Figure 2. Acute exacerbation of chronic obstructive pulmonary disease (AECOPD): patient management in the Emergency Department.

Management of chronic obstructive pulmonary disease in Internal Medicine Department

Appendix Figure 2 shows the therapy that should be established during hospitalization. It is the synthesis of the main guidelines on the management of AECOPD. But it needs some clarification. With regard to bronchodilator therapy, although there are no controlled studies, there is great consensus on the choice of short-acting bronchodilators, β2-agonist (SABA) and/or short acting muscarinic antagonists (SAMA).[9-17,22,23]

The administration of short-acting bronchodilators must be of intensive type, every 5-6 h, because their duration of action, in particular for SABA, is only 4-6 h.

For administration, can be used indifferently prebatched spray dispensers, so-called metered dose inhalers (MDI), with or without a spacer, and nebulizers.[24]

The use of the spacer allows, within certain limits, to reduce needs of the patient's cooperation in synchronizing the delivery of the spray dose inhaler with the inspiration and, therefore, makes possible the use of this device also in sparsely uncooperative patient, especially if it has the availability of spacer with mask. The nebulizers do not require cooperation from the patient and therefore are most often used. Should be favored the nebulisers by compressed air or electric; should be avoided, instead, the use of oxygen as propellant gas, because, as it will be explained later, in the moderate or severe exacerbations of COPD, the high-flow oxygen necessary for the nebulization of the drug (8-10 L/min), can cause worsening of hypercapnia.[25-27]

In common clinical practice, administration of short-acting bronchodilators every 5-6 h is easily accomplished during daylight hours, while it is more difficult during the night. And it is during the night that the physiological circadian oscillation of bronchial tone leads to increased bronchoconstriction, with worsening dyspnea[28,29]

Therefore, although there are no controlled clinical trials on this procedure, it is rational to associate the short-acting bronchodilator therapy in repeated doses during daylight hours (at 8 am, 2 pm, 8 pm or 7 am, 1 pm, 7 pm) with a single dose in the evening (at 11 pm) of an inhaled bronchodilator *long-acting*, associated or not with inhaled corticosteroid, through the use of MDI with spacer.

It should be noted, finally, that the early introduction of the use of MDI with spacer also ensures better training of the patient to use the device at home; training that is sometimes overlooked in the daily activities of wards.

The inhaled bronchodilator therapy for 7-10 days is always associated with systemic corticosteroid therapy, which has been shown to improve lung function [forced expiratory volume in the first second (FEV1)] and arterial hypoxemia,[30-33] reducing risk of early relapse, treatment failure, and length of hospital stay.[30,31,34]

Recently have been recommended shorter cycles of systemic corticosteroid therapy (5 days)[9] compared to traditional 7-14 days.[11-13]

The continuation of systemic steroid therapy beyond two weeks has not shown advantages on acute exacerbation.

Because of the unfavorable risk/benefit ratio, the long-term treatment with systemic steroids[9] must be avoided. The long-term corticosteroid therapy, when indicated, should be carried out with inhaled corticosteroids, always associated with inhaled bronchodilators.

With regard to antibiotic therapy exists evidence to support the antibiotic-therapy in exacerbations in which there is toning purulent sputum[35] or when mechanical ventilation is indicated.[36]

As regards the choice of antibiotics, it is useful to proceed to the classification of the individual patient in one of the three risk groups for therapeutic failure, unfavorable outcome and onset of resistance, as indicated in Table 1, which defines, for each group, the characteristics of the patient, the more likely bacterial etiology and then the antibiotics of choice for empirical therapy.[37]

Moreover, in the management of patients with AECOPD we propose a systematic evaluation of thromboembolic risk and of bleeding risk (Appendix Figure 3). For the thromboembolic risk we suggest a score of major reference, the Padua prediction score, that has been proposed and validated in an Italian study[38] and later also adopted by the American College of Chest Physicians (ACCP) guidelines for estimating the risk of venous thromboembolism in hospitalized medical patients[39]

For bleeding risk, we propose some warnings, reported in Appendix Figure 3B.

Oxygen therapy

Figure 3 summarizes the procedure of oxygen administration. Oxygen is a drug and, therefore, it is necessary to pay attention to its prescription, specifying the system of administration and dose, *i.e.,* the fraction of inspired oxygen (FiO_2); the correct determination of FiO_2 is essential to avoid the disadvantages of overdosing or underdosing.[40]

The dosage, which varies from case to case, should be adjusted based on arterial oxygen saturation to be achieved in the specific type of patient. While in hypoxemic-normocapnic patients the goal of oxygen therapy is a saturation of 94-98%, in hypoxemic and hypercapnic patients or at risk of hypercapnia, as the patients with COPD are often, the target saturation should be much lower, around 88-92%. Only in the case of persistently normal PCO_2, even in the course of oxygen, and in the absence of prior history of respiratory failure treated with pulmonary ventilation,

you will be able to tend to a saturation of 94-98%. The caution in the target oxygenation of these patients is due to the well known event that a higher dose of O_2 can promote hypercapnia up to respiratory acidosis, through different pathophysiological mechanisms: reduction of ventilatory drive, altered ventilation-perfusion ratio (V/Q), Haldane effect, higher density of oxygen than air.[25,27,41-43]

It follows that oxygen therapy in patients with COPD have to be controlled in FiO_2 and, in that sense, the best administration of oxygen is obtained with the Venturi masks,[22,25,27] following the steps indicated in Figure 3.

Venturi masks (ventimask) are systems with a high flow, consisting of a mask and a series of interchangeable valves of different color, each of them must be supplied with a specific minimum flow of oxygen from the centralized system (by 2 to 15 L/min), thus ensuring a specific FiO_2 (typically from 24% to 60%). On each colored valve are indicated the FiO_2 and the oxygen flow in L/min.

It should be emphasized that the flow of oxygen recommended for each valve is defined as the minimum flow. The increase of the oxygen flow, above the recommended level for each valve, will result in an increased suction of air into the system and therefore in an increased flow of oxygen-air mixture supplied to the patient, but the FiO_2 will always remain the same, as determined by the amplitude of the orifice of the fitting.[25,27]

The British Thoracic Society Guidelines[25] recommend that in patients with COPD and respiratory rate >30 breaths/min, the flow rate of oxygen, to be used for the specific FiO_2, should be increased by 50%, so as to determine, as specified above, an increase in the total gas flow provided to the patient, but always with the same FiO_2.

In some patients the ventimask may be poorly tolerated (claustrophobia); on these it should be replaced by a nasal cannula as soon as possible.

The nasal cannulas have some advantages: greater comfort, no claustrophobic feeling, allow the patient to eat, take medication and talk during use. However, they have important limitations: reduction in oxygena-

Table 1. Stratification of patients with acute exacerbation of chronic obstructive pulmonary disease into severity classes for the antibiotic treatment and the microorganism potentially involved in each group.

Group	Patients' features	Possible pathogenic	Treatment options
A Exacerbation mild or uncomplicated	Age≤65 years Exacerbations≤4/year FEV1>50% of predicted	*H. influenzae* *S. pneumoniae* *M. catarrhalis* *C. pneumoniae* *Virus*	Macrolides (azitro, claritro) Amoxicillin/clavulanate Oral cephalosporins* If allergy to these or failure: levofloxacin or moxifloxacin
B Exacerbation moderate-to-severe (no risk factors for *P. aeruginosa*)	Age>65 years FEV1 30-50 % of predicted Acute exacerbation>4/year Important comorbidities	Group A + *Enterobacteriaceae* *K. pneumoniae* *E. coli* *Proteus* *Enterobacter*	Amoxicillin/clavulanate Levofloxacin, moxifloxacin° Cefotaxime, ceftriaxone
C Exacerbation moderate-to-severe (with risk factors for *P. aeruginosa*)	Previous detection of *P. aeruginosa* FEV1<30% of predicted Chronic corticosteroid therapy Antibiotic therapy more than 4 times/year	Gruppo B + *P. aeruginosa*	Piperacillin/tazobactam or cefepime + Ciprofloxacin# or levofloxacin^ or aminoglycoside

Risk factors for *P. aeruginosa*:
- Severe impairment of lung function (FEV1<30% of predicted)
- Recent hospitalization
- No. exacerbations of COPD>3/year
- Corticosteroid therapy in the last 3 months
- Cycle of antibiotic therapy in the last 3 months
- Presence of bronchiectasis
- Previous isolation of *P. aeruginosa* (during exacerbation or less)

*Use high doses (*e.g.,* cefditoren 400 mg bid); °to be used only when antibiotics commonly recommended for the initial treatment are deemed inappropriate or have failed. In Italy is only available for oral; #to be evaluated based on local epidemiological; ^to be evaluated based on local epidemiology. The effective dose against *P. aeruginosa* is 750 mg (not for sale in Italy). FEV1, forced expiratory volume in the first second; COPD, chronic obstructive pulmonary disease.

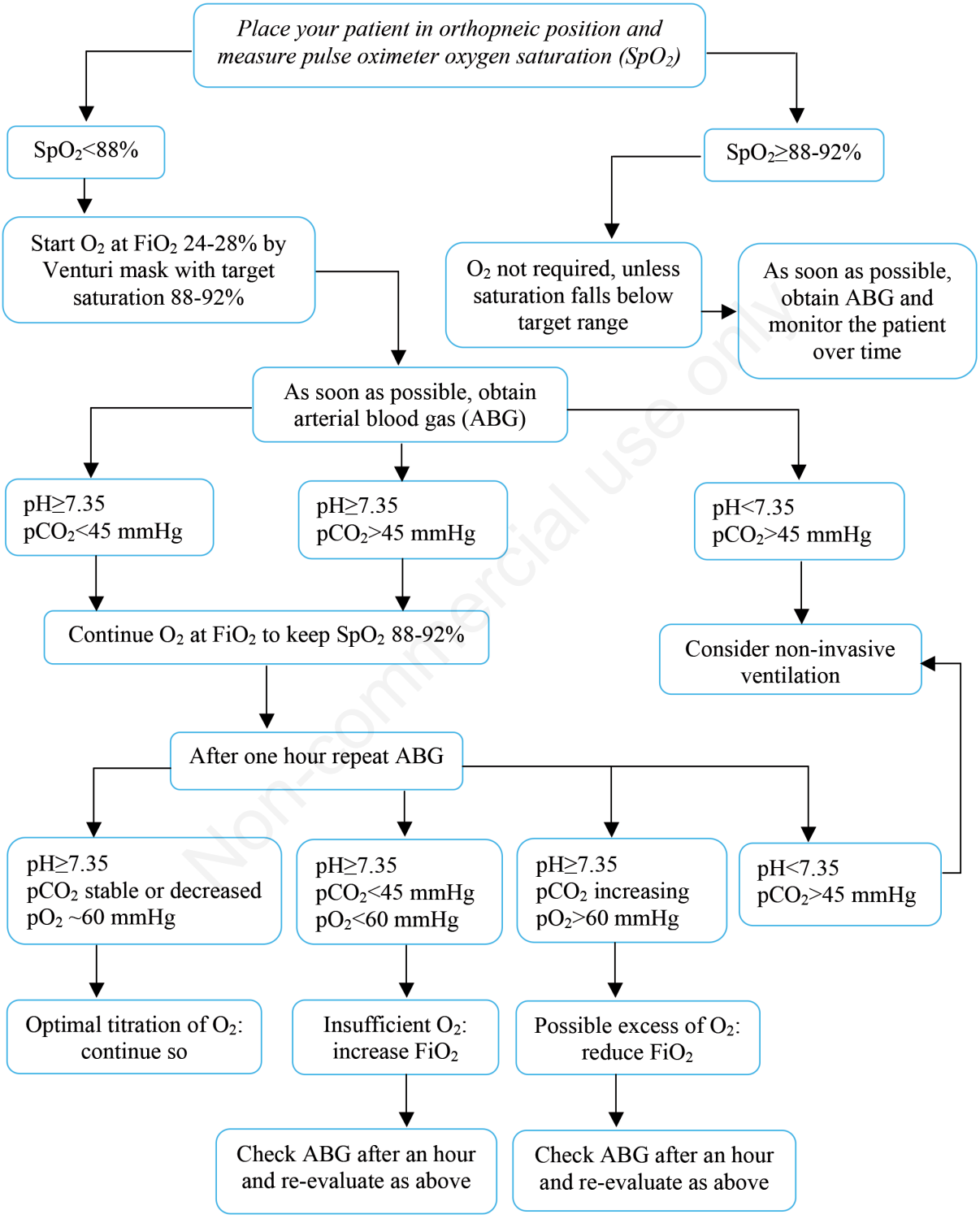

Figure 3. Oxygen therapy in patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) (patients at high risk of hypercapnia).

tion if the patient breathes mainly with the mouth, ineffectiveness in case of severe nasal congestion, but also less accuracy in the determination of FiO_2 compared to the Venturi mask.

The need to ensure a controlled oxygen therapy often clashes with the mode of execution of the aerosol therapy to administer the inhaled bronchodilators.[25-27]

In most wards, as well as in ambulances, the aerosol is carried out using oxygen at high flows as nebulizing gas (with FiO_2 up to 60%). This, as mentioned above, can favor the hypercapnic acidosis, which often appears quite early, even within 15 minutes from the beginning of the high flow of O_2. In cases where there is not any of the alternatives with respect to oxygen-nebulizers to administration of inhaled bronchodilators (use of electric nebulizers or compressed air nebulizers or metered-dose inhaler *MDI* with spacer), a useful tip is to use the aerosol up to a maximum of 6 min, time which usually ensures the administration of most of the dose of the drug while it limits to the maximum the risk of hypercapnia, which usually appears within 15 min.[25]

Non-invasive ventilation

Non-invasive ventilation (Figure 4) can be used in various forms of respiratory failure, and has proved to be particularly effective in the patient with respiratory failure from AECOPD, with the great advantage, compared to invasive ventilation, to avoid complications due to the process of endotracheal intubation (EI).[44-47]

Initially introduced and tested within the Intensive Care Units (ICUs), NIV was later also used outside the ICUs, in semi-intensive setting or even in the common wards, with consequent greater accessibility to a wider population of patients.[48-50]

The use of NIV outside the ICUs is the major advantage of this ventilatory technique, with the possibility of intervention at an early stage, for levels of respiratory acidosis mild or mild to moderate, for which there is no indication for invasive mechanical ventilation in ICU.

There are extensive experimental demonstrations in the literature of the great utility of NIV in patients with respiratory failure due to COPD, outside the ICUs in the ordinary wards of hospitalization, with rates of mortality and EI lower than the standard medical therapy alone, especially in cases with mild respiratory acidosis or mild-to-moderate treated early.[51-60]

From this experimental evidence derived the awareness that NIV can be used with safety and efficacy, even outside the ICUs, in areas adequately monitored in ordinary wards, with medical staff having necessary technical skills,[48,49,61-69] ensuring a success rates on average of up to 80-85% and reduction both in the mortality and in the length of hospital stay.[9]

The use of NIV compulsorily requires the adoption of a protocol regarding indications, absolute and relative contraindications, modes of ventilation, clinical-instrumental monitoring and weaning.

It is also desirable to provide an internal quality control, with one or more indicators, a reference standard, and by means of a collection of treated patients' data and their outcome. Finally do not forget the need to be clearly aware of your own limitations, how far you can push yourself and when to call instead the resuscitator.

The space available for this article does not allow you to analyze the physiopathological conditions of NIV and the many details of implementation of the different possible ventilation modes, for which reference should be made to the rich literature on the subject.[9,20,64-70]

NIV is a growing reality in the departments of Italian Internal Medicine. In our region, Puglia, the use of this technique is rapidly spreading in hospitals, albeit with different levels of organization and complexity, as shown in a recent survey carried out by the FADOI Puglia, the results of which are summarized in Table 2.

These data show that in approximately one-fifth (23.7%) of Internal Medicine Departments of Puglia, continuous positive airway pressure (CPAP) and NIV are technologies currently used in full autonomy; to these we will add 15.8% of Departments who currently use only the CPAP independently. Most departments (55.3%) often engage in these techniques, but they still

Table 2. Survey on the use of continuous positive airway pressure and non-invasive ventilation in Internal Medicine Departments of the Puglia region (year 2013).

Degree of adhesion to the survey	38 Internal Medicine Departments of Puglia (of 40 contacted) responded to the survey (95% adherence)	
Usage level	**No. departments**	**Rate (%)**
Use of CPAP and NIV in complete autonomy	9/38	23.7
Use of only CPAP in complete autonomy	6/38	15.8
Use of NIV and CPAP with the help of intensivists or pulmonologists	21/38	55.3
No use of NIV	8/38	21

CPAP, continuous positive airway pressure; NIV, non-invasive ventilation.

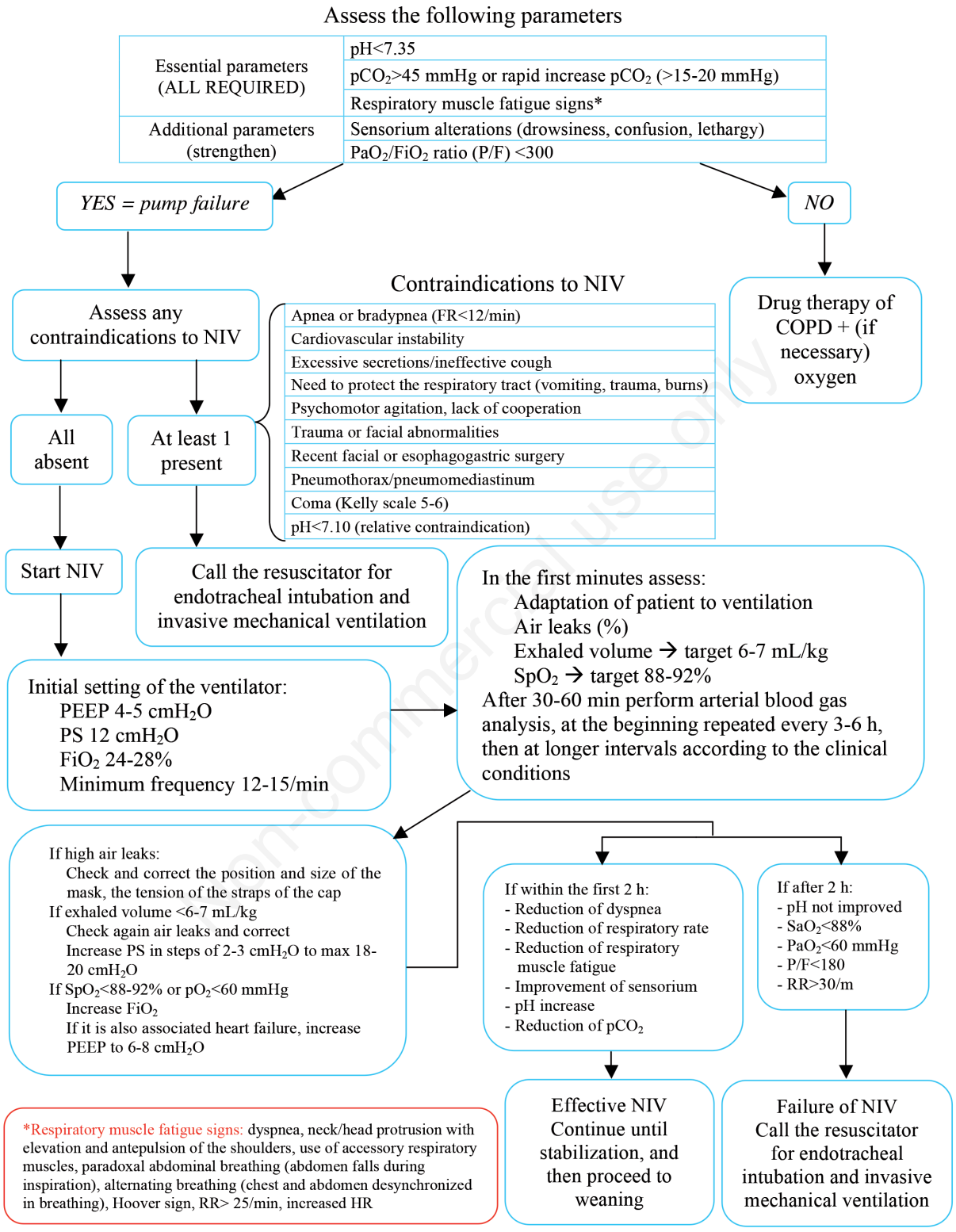

Figure 4. Patient with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) to be considered for non-invasive ventilation (NIV).

depend on the support or advice of intensivists or pulmonologists. Therefore, given the widespread interest in this technique from the internists, it is desirable that the Scientific Societies of Internal Medicine, primarily the FADOI, ensure a strong commitment to raising and training, aimed at fostering a greater and more widespread dissemination and indipendent management of NIV in almost all Internal Medicine Departments.

Figure 4 shows the precise indications to NIV: the most relevant is the reduction of the pH below 7.35, associated with hypercapnia, which is the typical expression of respiratory deficiency of the ventilatory pump (pump failure), due to respiratory muscle fatigue. It should be emphasized that, in patients with COPD, high values of PCO_2 with normal pH (>7.35) never represent an indication to NIV in acute phase (being usually an expression of a compensated chronic condition).

Of crucial importance is the choice of the right moment to start the NIV. In recent years the scenario of cases and timing of use of NIV have been detailed with greater precision and three different situations have been identified, on a scale of increasing severity in respiratory acidosis and depending on the specific therapeutic target of NIV:[67] i) when applied to patients with early respiratory acidosis, that is to say, with a pH between 7.34 and 7.30, the goal of NIV is to prevent the aggravation of respiratory failure: therapeutic intervention of choice in general wards; ii) when applied to patients with more critical clinical conditions and more advanced acidosis, *i.e.,* with a pH between 7.29 and 7.25, the purpose of NIV is to avoid EI; iii) when it is applied to much more severe patients with pH <7.25, NIV is used as an alternative to EI (for which there is already need) for a brief attempt to achieve improvements to ward off invasive ventilation in ICU.

The most used mode of NIV is pressure support ventilation (PSV), associated with a positive end-expiratory pressure (PEEP). In PSV mode, the ventilator provides a positive pressure of base, of low intensity (for example 5 cmH_2O), which is present during the expiratory phase (PEEP), to which, in the inspiratory phase, is added a further positive pressure of greater magnitude (*e.g.,* 15 cmH_2O), which supports the work of the inspiratory muscles (PS).

It is not the aim of this paper a detailed analysis of individual trials in the literature on the results obtained with the NIV in its various fields of application.

It may be useful, however, to those who intend to adopt it in their professional activity, highlighted, in a nutshell, the overall results that can be expected from it, according to all the studies already cited:

- rate of success of NIV from 65 to 80% (failure is defined as the death of the patient or the need of EI and invasive ventilation);
- in-hospital mortality ranges from 20 to 33%;
- in 15-28% of patients who have had an initial positive response to NIV, after more than 48 h, a worsening of respiratory failure may occur requiring EI: so-called *late NIV failure*;
- the factors that influence the percentages of success or failure of NIV are: i) the etiology of respiratory failure (best results in patients with COPD); ii) the extent of the initial alteration of pH (greater chance of success if >7.25); iii) the favorable response of the pH in the first 1-2 h of NIV; iv) the overall severity of the clinical picture of the patient, as indicated by APACHE score (greater chance of success if <20-29); v) comorbidities;
- the age does not seem to be a problematic factor for NIV: in very elderly patients the mortality was not significantly different compared to patients younger than 10;
- in patients for whom there is no consensus to EI or there is contraindication to EI, *do not intubate status*, treated with NIV, the short-term survival is 50%.

Hospital discharge and follow-up

There are optimal criteria that support the discharge: i) stable clinical improvement (for 12-24 h), documented by: reduction in cough, dyspnea, sputum, regression of fever, *etc.*; ii) stable improvement (for 12-24 h) of respiratory failure, scored using ABG, with PO_2>60 mmHg, P/F>300 and pH>7.35; iii) recovery of skills prior to admission (walking, eating, dressing, *etc.*); iv) certainty that the patient (or caregiver) has fully understood all about the use of medicines, and has acquired skills in the use of inhaler device and, if nedeed, of oxygen-therapy; v) certainty about the proper organization of home management and subsequent follow-up.

Before the patient is discharged, it is necessary to establish the combined assessment of severity of COPD after resolution of the exacerbation.

Appendix Figure 4 summarizes the steps for the combined assessment of the COPD severity, predicted from the recent GOLD guidelines,[9] following which it will be possible to set the long-term pharmacological therapy of stable COPD.

This approach provides mandatory integrated assessment of two key issues: i) the extent of the clinical symptoms (outside of exacerbations); ii) the risk of future exacerbations.

The symptomatology is measured using the COPD assessment test (CAT) questionnaire and/or the scale of the modified Medical Research Council (mMRC) dyspnea (Appendix Figure 4A): i) if the CAT score is <10 and/or the degree of dyspnea is <2 mMRC scale, the patient will be classified as *low symptom*; ii) if the CAT score is >10 and/or the degree of dyspnea is >2 mMRC scale, the patient will be classified as *high symptomatology*.

The risk of exacerbations is measured by reference, on the one hand, to the level of airflow obstruction measured by spirometry (GOLD level I to IV according to the percentage reduction in FEV1 of patient than normal), on the other hand to the number of exacerbations that occurred last year. The patient will be: i) *low risk of exacerbation* if he/she has a spirometric GOLD level I-II and has had a number of exacerbations in the last 12 months <2 without any hospitalization; ii) *high risk of exacerbation* if he/she has a spirometric GOLD level III-IV and/or has had a number of exacerbations in the last 12 months ≥2 *or* ≥1 leading to hospital admission.

On the basis of such information it will be possible to identify four different combined levels of severity, identified respectively with the capital letters A, B, C, D.

In those cases where there is an absolute impossibility to carry out the spirometric assessment before discharge, this must be programmed not later than 1-2 months, on the occasion of the 1st follow-up.

In patients who smoke, before discharge must be adequately assessed the extent of tobacco dependence and willingness to quit smoking.[71]

Appendix Figure 5 shows two short questionnaires that can be simply and quickly administered before discharge.

Depending on the outcome of this assessment you can program an adequate counseling and, if needed, medication, to help the patient to stop smoking.[72,73]

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