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FRIDAY NIGHT VENTILATION: A SAFETY STARTING TOOL KIT FOR MECHANICALLY VENTILATED PATIENTS

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Friday night ventilation: a safety starting tool kit for mechanically ventilated patients

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ABSTRACT

We wish to report here a practical approach to an acute respiratory distress syndrome (ARDS) patient as devised by a group of intensivists with different expertise. The referral scenario is an intensive care unit of a Community Hospital with limited technology, where a young doctor, alone, must deal with this complicate syndrome during the night. The knowledge of pulse oximetry at room air and at 100% oxygen allows to estimate the PaO_2 and the cause of hypoxemia, shunt *vs.* VA/Q maldistribution. The ARDS severity (mild [$200<PaO_2/FiO_2\leq300$], moderate [$100<PaO_2/FiO_2\leq200$] and severe [$PaO_2/FiO_2\leq100$]) must be immediately assessed. Noninvasive ventilation should be attempted in mild ARDS only. Possible errors due to inappropriate premature intubation are preferable to a delayed intubation. In moderate and severe ARDS tracheal intubation associated with heavy sedation/muscle relaxation allows to fully characterize the patient. A tidal volume of 6 mL/kg predicted body weight is recommended, either in pressure or volume control ventilation. Tailoring tidal volume on residual functional capacity, however, is preferable. Plateau pressure greater than 30 cmH_2O is acceptable only if chest wall compliance is decreased. In this case maximal attention must be devoted to the hemodynamics. PEEP from 5 to 10, from 10 to 15 and greater than 15 cmH_2O should be set in mild, moderate and severe ARDS, respectively. Prone position should be applied in severe ARDS, if experience is available. In case of unchanged conditions or increased ARDS severity a referral center should be contacted. *(Minerva Anestesiol 2014;80:1-12)*

Key words: Positive-pressure respiration - Respiration, artificial - Functional residual capacity - Prone position.

In the new century, a series of therapeutical approaches have been proposed and tested in acute respiratory distress syndrome (ARDS),[1] starting with the National Institute of Health (NIH) low tidal volume ventilation;[2] some of them have been successful, as prone position [3-5]

TABLE I.—*Berlin definition of ARDS. With permission from the ARDS Definition Task Force.*[21]

	Acute respiratory distress syndrome		
Timing	Within 1 week of a known clinical insult or new/worsening respiratory symptoms		
Chest imaging [a]	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules		
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload; Need objective assessment (*e.g.*, echocardiography) to exclude hydrostatic edema if no risk factor present		
	Mild	Moderate	Severe
Oxygenation [b]	200 $<PaO_2/FiO_2 \leq 300$ with PEEP or CPAP ≥ 5 cmH_2O[c]	100 $<PaO_2/FiO_2 \leq 200$ with PEEP ≥ 5 cmH_2O	$PaO_2/FiO_2 \leq 100$ with PEEP ≥ 5 cmH_2O

ARDS: acute respiratory distress syndrome; PaO_2: partial pressure of arterial oxygen; FiO_2: fraction of inspired oxygen; PEEP: positive end-expiratory pressure; CPAP: continuous positive airway pressure: N/A not applicable. [a] Chest X-ray or CT scan. [b] If altitude higher than 1000 m, correction factor should be made as follows: PaO_2/FiO_2 x (barometric pressure/760). [c] This may be delivered non-invasively in the mild ARDS group.

and artificial lung support [6-9] in severe ARDS, some unsuccessful, as high frequency ventilation,[10, 11] and some still questionable and debated, as the use of higher Positive End Expiratory Pressure (PEEP) compared to lower PEEP.[12-18] At the same time, the mechanisms of ventilation induced lung injury, the primary risk of mechanical ventilation in ARDS, have been further investigated both in its physical and biological components.[19] Recently this bulk of knowledge has been embedded in the Berlin ARDS definition (Table I), which pragmatically classifies the degree of severity of the syndrome and, more important, suggests possible treatments scaled to the severity. It is not clear, however, within a certain degree of severity which criteria should guide the possible alternative treatment. As an example, in severe ARDS, should prone position and extracorporeal oxygenation be applied separately or in combination? And, more important, should these techniques be available in every hospital or concentrated in referral centers?

In 2013 in Frankfurt am Main (Germany) a group of intensivists with various levels of expertise discussed the possible treatments available today for ARDS patients, the sequence in which they should be applied, by whom, and where. The referring scenario was a small but busy ICU of a community hospital with limited technology, where a young doctor on duty on a Friday night, admits a patients with ARDS. We wish to report, thereafter, the results of our discussion aiming to provide some practical suggestions on how to approach an ARDS patient in a facility, where advanced technologies, as CT scan or artificial lung are not easily available. We focused on the early maneuvers necessary to keep the patient alive, reducing any potential harm, while waiting Saturday morning for further decisions (and some help!). We decided to call this approach "Friday night ventilation" to emphasize the worst working conditions of limited time, personnel and technology.

From Friday night to Saturday morning

10:00 PM - Patient arrival, observation of vital signs and first assessment

A rapid check of the vital signs (heart and respiratory rate, non-invasive blood pressure [NIBP], consciousness) is the first step (Figure 1). If the patient, as usually occurs, is not in desperate conditions, we believe that oxygen saturation by pulse-oximetry must be collected before any therapeutic intervention, such as oxygen supplementation, which may mask severity of the respiratory failure. Actually, the oxygen saturation, while breathing room air may give important insights on the oxygenation capability of the patient, unmasked by high inspired oxygen fraction. A saturation of ≈90%, at the knee of the oxygen saturation curve, usually corresponds to a PaO_2 around 60 mmHg, while P50 (saturation=50%) is around 25 mmHg. Assuming the linearity of the curve between 90 and 50% saturation, a decrease in saturation of 1% in this range roughly corresponds to about (60-25)/(90-50)≈0.875 mmHg decrease of PO_2 on the pressure scale. Therefore, it is clinically acceptable to consider that whatever decrease of 1 point of oxygen saturation roughly corresponds to 1 mmHg decrease below 60 mmHg, unless a severe circulatory impairment makes the

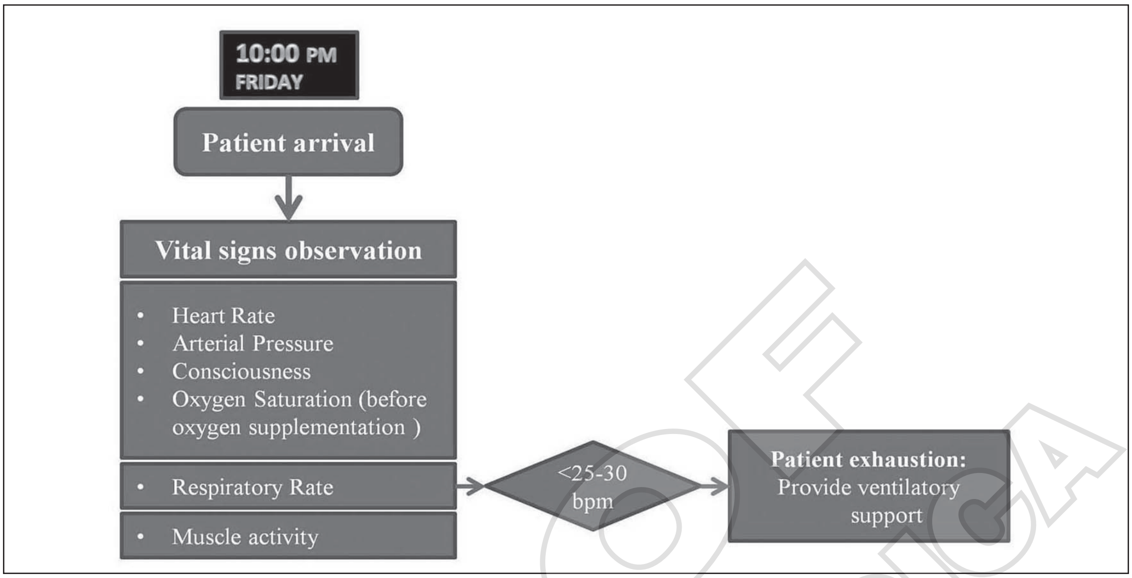

Figure 1.—Patient's arrival.

pulse oximetry reading questionable. Due to the shape of the oxygen saturation curve, whatever causes impairment of oxygen saturation below 90% may pose the patient at immediate risk. Knowing the oxygen saturation at room air and after oxygen supplementation will allow to make inference on the cause of hypoxemia (shunt or VA/Q maldistribution), as we will discuss later.

The measurement of respiratory rate, at this time point, is essential, although, surprisingly, seldom recorded in clinical practice. In a hypoxemic patient, let's say with an oxygen saturation below 90%, the respiratory rate should be elevated, *i.e.*, greater than 25-30 bpm, as the respiratory drive in a full-blown ARDS is greatly increased. A normal, or even lower than normal respiratory rate may indicate the exhaustion of the patient, due to the excessive work of breathing, or some impairment in the respiratory centers, and this dictates an immediate need for ventilatory support. The observation of the respiratory muscles activity may help to complete the first assessment.

10:05 PM - Oxygen supplementation and assisted ventilation

Before any other intervention, high flow oxygen should be provided. A FiO_2 close to 100% allows to roughly discriminate the true shunt from low VA/Q distribution (Figure 2). If the oxygen saturation, while breathing 100% oxygen, does not increase up to 96-98% or higher, this indicates a PaO_2 lower than 100 mmHg, which corresponds a shunt greater than 33% and allows to classify the patients, with high degree of probability, as having severe ARDS, being PaO_2/FiO_2 below 100. In contrast, if the oxygen saturation increases up to 96-98% or higher the patient will be likely present mild ARDS (PaO_2/FiO_2>100). To characterize the severity of ARDS in this way, a very high oxygen flow, at least for few minutes, is required, ideally in the range of estimated total ventilation of the patients (10 to 15 L/min) applied by non-rebreather mask. It must be remembered, in fact, that a patient with ARDS, before exhaustion, has vigorous spontaneous ventilation. Providing 1 or 2 liters of oxygen by nasal cannulas, in this condition, increases FiO_2 of only few points with esthetic more than a physiological impact. The maneuvers described above can be performed in few minutes. At this stage it is crucial to decide if the patient should be maintained just with oxygen and CPAP, if he must be treated with non-invasive mechanical ventilation, or must be immediately intubated.

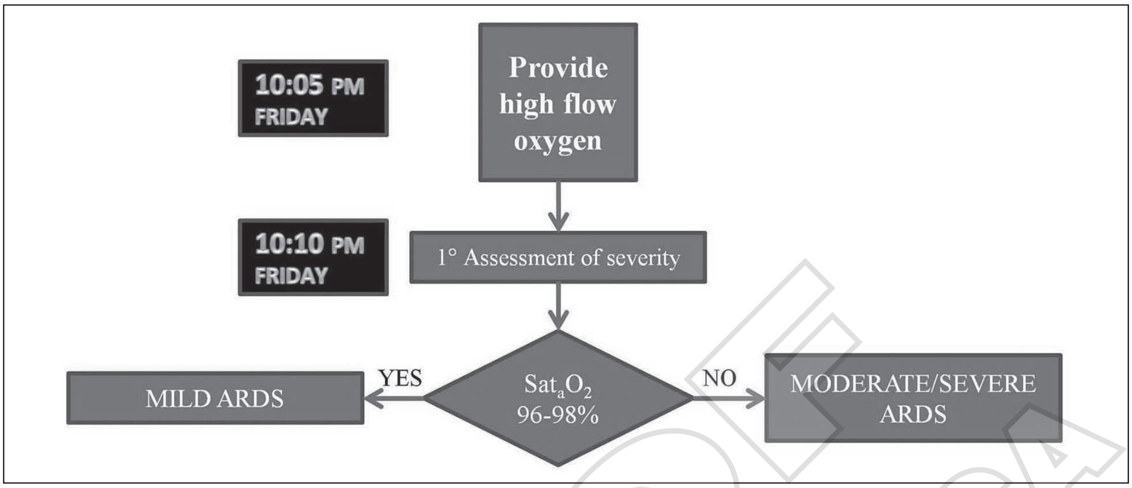

Figure 2.—Oxygen supplementation and assisted ventilation.

10:10 PM - CPAP and non-invasive ventilation

The continuous positive airway pressure (CPAP), by face mask or helmet, should be reserved to mild ARDS patients, in whom a rather short-term of support is expected (Figure 3). While on CPAP, with the patient in spontaneous breathing, the evolution must be observed carefully and the ventilation assessed by blood gases. If, for any reason, the ventilation decreases and the PCO_2 increases, the noninvasive respiratory support (*e.g.*, pressure support) must be considered. The role of noninvasive ventilation (CPAP and pressure support) in ARDS, however, is questionable and usually limited to few hours to overcome the acute phase. In fact, prolonged use of CPAP or non-invasive ventilation in these patients may increase the risk associated to a possible following intubation. In fact, with the patients with borderline oxygenation, the further lung collapse caused by the loss of muscle tone during the maneuvers associated with tracheal intubation may precipitate hypoxemia and the possible right ventricular dysfunction down to cardiac arrest. Early intubation should be performed, in our opinion, in patients with moderate and severe ARDS and in patients with

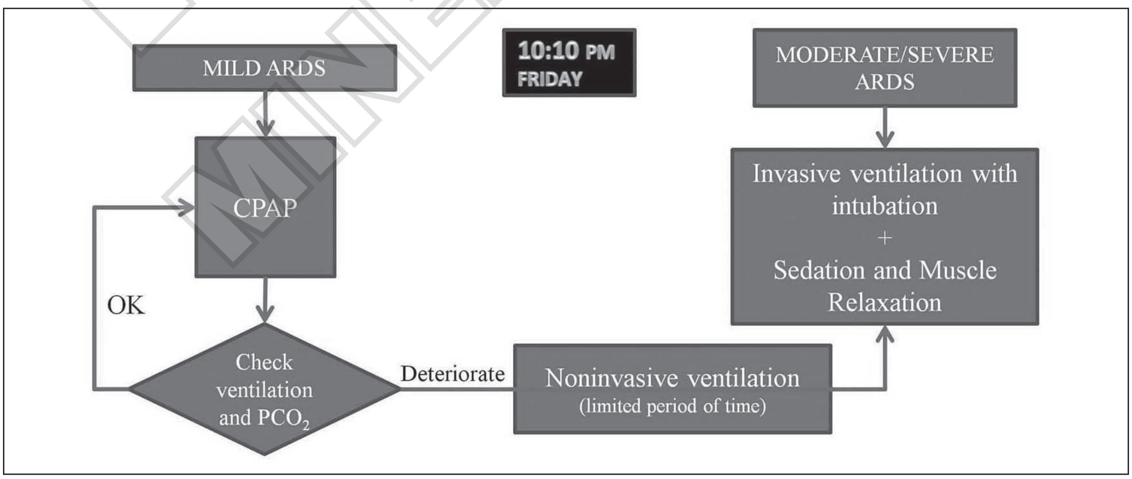

Figure 3.—CPAP and non-invasive ventilation.

CPAP or noninvasive ventilation in whom the ventilation decreases for muscle fatigue or the oxygenation deteriorates. In general (an exception might be patients with immunosuppression) we believe that in moderate and severe ARDS the invasive mechanical ventilation is mandatory during the early full blown phase. In fact, it assures a complete control of airways, pressures, FiO_2 and ventilation, as well as it allows a full characterization of the patient's pathophysiology. In case of doubt, on Friday night, we would suggest to intubate the patient promptly. However, we recommend that intubation is performed by personnel experienced in this technique. Otherwise help should be sought immediately. In fact, the consequence of possible errors due to inappropriate early intubation are less severe than the errors associated to a lack of intubation if needed. At this stage continuous treatment with neuromuscular blocking agents and appropriate sedation may be considered, due to its possible beneficial effects on final outcome at least during volume controlled assist control.[20] Arterial and central venous cannulations and X-rays (or CT if available) must be provided as they are essential for the therapy and full diagnosis, but they are lower priorities compared to the ventilatory assistance.

11:00 PM - Classifying ARDS severity

There is no need to emphasize that it is essential to diagnose the cause of ARDS since the beginning and the cure of the core disease must be immediately provided. As an example, in patients with ARDS of septic etiology (*i.e.*, pneumonia or other non-pulmonary infections), blood cultures followed by an appropriate broad-spectrum antibiotic therapy should be performed in the first hour of treatment, according to the international society of critical care guidelines.

When connecting the patient to the ventilator the doctor must choose the ventilatory mode, tidal volume, inspiratory oxygen fraction, PEEP, respiratory rate and inspiratory/expiratory ratio. The Berlin definition of ARDS [21] may guide the setting of some of these variables, therefore the patient severity must be accurately classified. The key variable of Berlin classification to scale the ARDS severity is the PaO_2/FiO_2 value. The PO_2 assessment, according to the definition, may be done at whatever FiO_2 and at whatever PEEP, equal or greater than 5 cmH_2O. However, it has been previously found that the PaO_2/FiO_2 more closely reflects the lung pathology, as measured by the CT scan, if it is assessed at a PEEP level standardized at 5 cmH_2O.[22] Five minutes of ventilation at a PEEP equal to 5 cmH_2O are sufficient to reach the equilibrium PaO_2/FiO_2,[23] allowing a better characterization of the ARDS severity. In addition it has been reported that physiological shunt and CT estimates of nonaerated lung can be estimated by the logarithm of PaO_2/FiO_2 measured during a short period of 100% oxygen ventilation in hemodynamically stabilized patients with systemic inflammation during the acute phase of disease.[24] If PaO_2/FiO_2 is higher than 100 mmHg, but assessed at PEEP higher than 5 cmH_2O, it may possibly mask the real ARDS severity. On Friday night, if the assessment of PaO_2/FiO_2 at 5 cmH_2O PEEP appears too complicated or unsafe, an initial assessment at PEEP 10 cmH_2O, I/E equal to 1:1 or 1:2, tidal volume 6 mL/kg ideal body weight (IBW), RR 15 bpm and FiO_2 from 0.6 to 0.8 is safe and the PaO_2/FiO_2 obtained reasonably reflects the ARDS severity. The use of recruitment maneuver before the assessment of PaO_2/FiO_2 may be indicated but, we believe, not mandatory at this stage.

When assessing the arterial PO_2/FiO_2 we recommend to contemporarily measure the central venous blood gases from the central venous catheter. This allows assessing the central venous oxygen saturation ($Sat_{cv}O_2$), the venous-arterial O_2 difference, the venous-arterial PCO_2 difference and lactatemia. $Sat_{cv}O_2$ values lower than 70%, ΔavO_2 greater than 4-5 mL/100cc, ΔPCO_2 greater than 5-6 mmHg, or arterial-venous oxygen saturation difference greater than 30% and blood lactate levels above 2 mmol/L all suggest an ongoing or impending hemodynamic problem, which must be carefully considered and monitored. The frequent assessment of urinary output may also help to evaluate the hemodynamic reaction to the mechanical ventilation.

11:30 PM - Setting the ventilator

At this time point the Friday night doctor should know at which ARDS severity subgroup

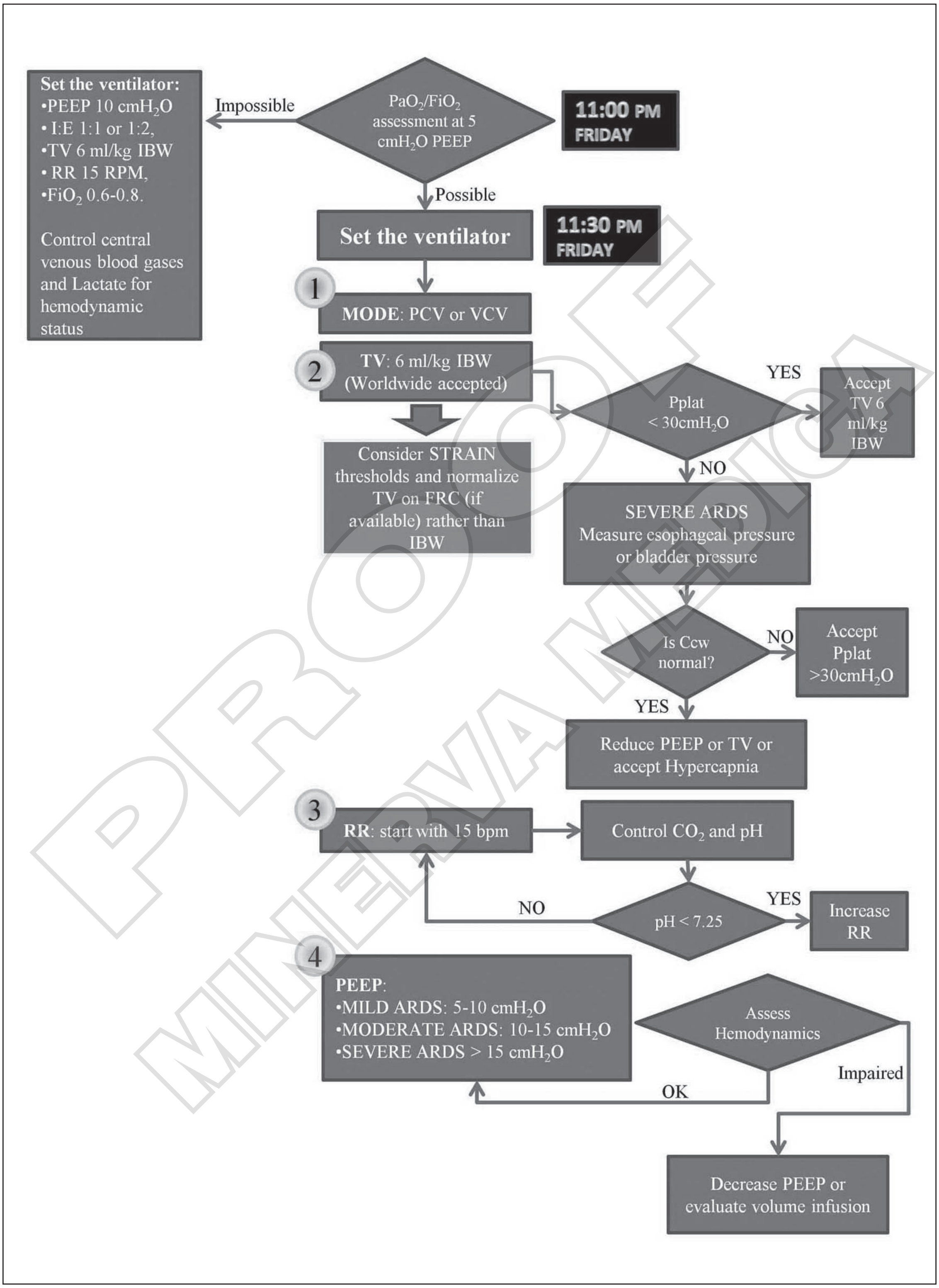

Figure 4.—Setting the ventilator.

the patient belongs, mild, moderate or severe, and the ventilator setting should be tuned accordingly (Figure 4).

Mode of ventilation

The mode of ventilation, *per se*, is indifferent, as pressure and volume are two faces of the same coin. It must always remembered, however, that, during pressure control ventilation a worsening of respiratory conditions leads to a decrease of tidal volume and hypoventilation, while, during volume control ventilation, it leads to an increase of inspiratory pressures (Peak and Plateau). As the risk of elevated pressures into the lung is likely greater than the risk of hypercapnia, we prefer to use the pressure control ventilation. However, both modes are absolutely acceptable as long as the tidal volumes and pressures are carefully monitored.

Tidal volume

Since the publication of the ARDSnet trial the 6 mL/kg IBW tidal volume ventilation has become the worldwide accepted standard, independently on the severity of the syndrome. In fact, the *post-hoc* analysis of the ARDSnet trial [1] clearly showed that even in the quartile of ARDS patients with better compliance (likely mild-moderate ARDS) the survival rate was significantly higher with 6 instead of 12 mL/kg IBW tidal volume ventilation.[25] Therefore, on Friday night ventilation, 6 mL/kg IBW ventilation should be the recommended setting, either during volume control or pressure control mode. Of note, for the reader convenience, ideal body weight can be computed using the following formulas:[26]

— in males ideal body weight = 50+0.91 * (height [cm] -152.4);

— in females ideal body weight = 45.5+0.91 * (height [cm] - 152.4);

Some caveats, however, must be pointed out. In mild and moderate ARDS, the 6 mL/kg IBW ventilation is likely associated with a Plateau pressure lower than 30 cmH_2O, as the respiratory system compliance is not excessively reduced. In contrast, in severe ARDS, where lung volumes ("baby lung" [27, 28]) and compliance are greatly reduced, 6 mL/kg IBW ventilation may result in regional hyperinflation and/or in a Plateau pressure greater than 30 cmH_2O. If the plateau pressure is greater than 30 cmH_2O, the possible contribution of chest wall compliance to the impaired mechanics of the respiratory system must be considered. If the patients are obese or pregnant or, for whatever reason, do have an increased intra-abdominal pressure,[29-31] plateau pressure greater than 30 cmH_2O is tolerable. In fact, a consistent fraction of the driving pressure, in these cases, is spent to expand the chest wall.[32] Unfortunately, the chest wall compliance cannot be estimated with sufficient degree of accuracy, even in obese patients or pregnant women. The measurement of esophageal pressure is necessary.[33, 34] If not available on Friday night, the bladder pressure, as surrogate of intra-abdominal pressure, should be measured [35] and an abdominal compartment syndrome should be considered. In all the cases in which the plateau pressure is higher than 30 cmH_2O due to the impaired chest wall elastance, a maximal attention should be devoted to the hemodynamics. In fact the pleural pressure, to which the heart and the great intrathoracic pressures are subjected, for a given driving pressure depend on the ratio between the chest wall elastance and the total elastance of the respiratory system.[32] Therefore, the greater is the chest wall elastance, the greater is the pleural pressure increase, which may deeply affect the hemodynamic status.[36] In this condition, volume infusion and/or vasoactive agents may be considered and their effect carefully monitored. Echocardiography is increasingly used as a tool to properly assess this problem.

If the chest wall elastance is normal and 6 mL/kg IBW tidal volume results in plateau pressure greater than 30 cmH_2O, the tidal volume (or PEEP) should be reduced. These maneuvers, unfortunately, may lead not only to hypoventilation, but also to a dramatic deterioration of oxygenation, due to the decrease of the mean airway pressure. On the Friday night ventilation, however, it is preferable to accept hypercapnia, may be increasing the respiratory rate, than to decrease PEEP, which, in these severe patients, should be set at high levels, as we will discuss below.

Although the tidal volume normalized to predicted body weight is the accepted standard, it must be remembered that this normalization has been introduced as a surrogate of the lung volume. The technology, implemented in some ventilators, allows to easily measure the lung volume. Therefore, the most rational choice should be to tailor the tidal volume not on the predicted body weight but on the actual lung volume available for ventilation. In fact, a 70-kg man with ARDS (6 mL/kg tidal volume being 420 mL) may have a baby lung volume of 300, 600 but also more than 1000 mL and still presenting the ARDS criteria. It is clear that the same tidal volume may result in completely different strain within the 3 conditions. No definite data are available on the threshold of strain allowed, although experimental data consistently showed that a tidal volume/FRC up to 1:1 (normally it should be 1:4) is still tolerable without harm.[37] Further studies are necessary, but the availability of lung volume, even now, may open interesting perspectives in tailoring a safe mechanical ventilation. Yet, it must be kept in mind that measurement of lung volume is performed by a nitrogen washout/washin technique that requires reduction of $FiO_2<1.0$. This reduction may pose patients with severe ARDS and marginal oxygenation at risk.

Respiratory rate

A frequency to start with may be around 15 bpm. This set is independent on the ARDS subgroup. Monitoring end-tidal CO_2 and taking blood gases after 15 minutes may indicate if the CO_2 clearance is sufficient. These 2 measurements, moreover, allow to estimate the alveolar dead space. Traditionally higher levels of PCO_2 are acceptable (permissive hypercapnia) until the pH remains at levels greater than 7.25-7.3.[38] In case of further decrease of pH, the respiratory rate should be increased, paying attention to the development of dynamic hyperinflation and intrinsic PEEP. Although the possible bicarbonate infusion to correct the pH during hypercapnia was part of the ARDSNet protocol,[2] we believe that this practice should be abandoned. During hypercapnia the buffer base is greatly increased and the bicarbonate infusion which, by the way increases the CO_2 content of the blood has modest effects on pH.[39] It is worth noting that PCO_2-pH problems are more likely to occur in patients with severe ARDS, which are characterized by greater dead space and VA/Q dishomogeneity. The use of artificial lung (not available in our scenario) is the logical solution to safely handle these ventilatory problems.[40, 41]

PEEP

Although all the trials on PEEP did not show clear benefits of higher or lower PEEP in the whole ARDS population,[12-14] the clinical experience and meta-analysis [17, 18] strongly suggest that the PEEP level should be in the range of 5 to 10 cmH_2O in mild ARDS, 10 to 15 cmH_2O in moderate and greater than 15 cmH_2O in severe ARDS. It must be noted, however, that these values refer to the early stage of ARDS (1 to 3-4 days). Data relative to the late phase of ARDS are scanty. When PEEP is set and any time it is changed, particularly if increased, the hemodynamic must be reassessed. The variations of central venous oxygen saturation or, more precisely, of the difference between arterial and venous saturation, provide insights on the hemodynamic variations. Whatever decrease of cardiac output should be indicated by a decrease of central venous oxygen saturation, being the arterial oxygen saturation constant or increased. The effects of decreased hemodynamics on arterial oxygenation cannot be ignored. They may be so important to justify the claim that sometimes the oxygenation increase due to PEEP is not due to the recruitment but fully justified by the decreased cardiac output with associated decrease of right-to-left shunt.[42] In case of hemodynamic deterioration, PEEP level should be decreased,[43] alternatively, if that level is really needed, volume infusion and vasoactive drugs should be provided, as described decades ago.[44]

PEEP is used for two main reasons of similar importance: to improve oxygenation and to prevent intra-tidal collapse and decollapse. The PEEP levels to reach acceptable oxygenation and to fully keep open the lung are not necessarily the same, as an adequate oxygenation may be obtained at PEEP levels lower than the ones necessary to keep the lung fully open.[45] Moreover, the importance of preventing the intratidal collapse and decollapse, for which higher levels of PEEP are required, is likely proportional to the amount of lung parenchyma which may undergo this phenomenon, *i.e.*, to the amount of recruitable lung.

Therefore, the assessment of recruitability should be the rationale underlying the PEEP selection. Several methods have been proposed to assess recruitability, as quantitative CT scan,[22] volume-pressure curve analysis [46] and automatic lung volume assessment at different pressures.[47] These methods are not easy to perform, unless automatically implemented. A promising method, which may more be easily applicable, is the lung echography.[48] We may also suggest the use of stethoscope. In patients with greater recruitability the paravertebral end-inspiratory crepitations are a common finding, reflecting the lung opening at end-inspiration.[49] If PEEP is sufficient to keep the lung fully open, this inspiratory rumors should disappear, as the intra-tidal opening-closing is abolished. However, on Friday night, the easiest way to estimate recruitability is the Berlin classification, as recruitability is almost nil in mild ARDS, intermediate in moderate ARDS and very high in severe ARDS.[50] Indeed, in mild ARDS, where the recruitability is very low, the use of higher PEEP with its associated side effect is unjustified and 5 to 10 of PEEP are sufficient to provide adequate oxygenation in absence of relevant opening and closing phenomenon. In contrast, in patients with severe ARDS, PEEP levels greater than 15 cmH_2O are necessary both, for providing sufficient oxygenation and to prevent the opening and closing of the recruitable tissue. In patients with moderate ARDS, the use of intermediate PEEP levels, between 10 and 15 cmH_2O, although unsupported by clinical studies, seems a reasonable solution.

1:30 AM - Monitoring ARDS course

One to two hours after setting mechanical ventilation the severity must be reassessed and the patients reevaluated (Figure 5). If the patient reaches or remains in mild or moderate categories, no further interventions on the respiratory system are necessary. In contrast, if the patient is still in severe ARDS, with PaO_2/FiO_2 remaining lower than 100/150 despite the high level of PEEP, prone position is indicated.[4, 51, 52] We believe that in the last 30 years sufficient data have been accumulated to clearly show that the use of prone position in severe ARDS may lead to outcome benefits.[53] If in the hospital in which the patient is actually admitted the prone position is used routinely, the maneuver should be applied immediately. However, a higher complication rate may occur in ICUs in which prone position has never been implemented. In this case, risks and benefits must be carefully weighted. Actually, the greatest immediate risk of proning is the possible extubation. If this happens in an intensive care where staff physicians have limited skills of intubation and advanced airways management, the consequences may be tragic. We may imagine, during the night, a patient with very low PaO_2/FiO_2, losing his endotracheal tube. FiO_2 will immediately plummet to 21% and a collapse may be expected as the airway pressures are lost. The time required to restore the airway control may be fatal for the patient. Therefore, we would recommend against practicing with prone position during the Friday night, but in favor during the day when a sufficient number of people is present and the cure of possible complications is immediately available. We rec-

Figure 5.—Monitoring ARDS course.

Figure 6.—Keep or transfer the patient.

ommend contacting an ARDS center as early as possible. Not only can a transfer be arranged as soon as possible if the patient's state does not improve but telephone counselling by an expert might help to optimize therapy.

8:00 AM - Patient transfer

A few hours of respiratory treatment, in general, are not sufficient to anticipate with a reliable degree of confidence what the patient's evolution will be (Figure 6). Once again the Berlin classification is useful to program the next steps. If the patient stays in mild or moderate ARDS status or, during the first hours, moves from a more severe to a less severe category, the treatment should continue for at least 24 to 48 hours, a time span which is usually sufficient to predict the final evolution of the syndrome. If the patient, however, is and remains in the severe ARDS subgroup or moves from a less severe to a more severe category, the closest referral center with more sophisticated diagnostic tools, such as CT scan, and treatments, such as prone position or extracorporeal support, should be contacted. Transferring the ARDS patient may also be considered if airway pressures remain high despite stabilization of oxygenation. Extracorporeal gas exchange may help to prevent VILI in these patients. It is worth emphasizing that severe ARDS, which is just a small fraction of the whole ARDS spectrum, may occur in a normal hospital only in very few cases/year, as 1 to 3. Therefore, it is logical that the severe ARDS patients are concentrated in referral centers, thus reaching a volume of activity sufficient to provide better outcome and to justify the use of sophisticated techniques, as the artificial lungs. Keep in mind that asking for help is not shameful, but a sign of intelligence.

Key messages

— Several therapeutical approaches have been proposed and tested in ARDS, with different results; some were successful (prone position and artificial lung support), some unsuccessful (high frequency ventilation), and some are still debated, (the use of higher Positive End Expiratory Pressure). The recently introduced Berlin definition of ARDS pragmatically classifies the degree of severity of the syndrome and, more important, suggests possible treatments scaled to the severity.

— The primary goal is the early treatment to keep the patient alive while inducing the lowest harm possible.

— Severe ARDS patients occur in a normal hospital only in very few cases/year, so they must be concentrated in referral centers with high volume of activity and experience in sophisticated techniques, as prone position or extracorporeal lung support.

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