

Considerations for Mechanical Ventilation in the Critically Ill Obstetric Patient

Abstract

Mechanical ventilation is a type of respiratory support therapy frequently used in pregnant patients in intensive care or during the intraoperative period, and understanding the physiological and pathophysiological changes in the respiratory system that are caused during pregnancy and its complications is key to management. Strategic knowledge of mechanical ventilation is essential to limit damage and reduce maternal and fetal morbidity and mortality.

Keywords: Obstetrics; Mechanical ventilation; Prone position; Critical care

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Introduction

The incidence of critically ill obstetric patients admitted to Intensive Care Units (ICUs) ranges from 0.4% to 16%, with an estimated mortality of 5% of all admissions. Acute Respiratory Failure (ARF) is one of the main causes of admission to an ICU and entails severe maternal-fetal complications if not treated early and adequately. Obstetric patients with ARF exhibit unique characteristics and managing them poses a challenge due to the cardiorespiratory alterations inherent to pregnancy; clinicians must be familiar with these anatomical and physiological changes in order to make necessary adjustments in managing Mechanical Ventilation (MV). There are no concise recommendations relating to the programming of MV in this specific group of patients. Consequently, we extrapolate the recommendations of prospective studies and clinical practice guidelines adapted to the physiological changes in pregnant patients [1].

Physiological Changes in the Respiratory System during Pregnancy

During pregnancy, important changes appear in the nasal mucosa and the oropharynx. These include hyperemia, edema and plasma leakage in the stroma, glandular hyper secretion, and an increase in phagocytic activity. These changes are mainly mediated by estrogens; the increase in serum estradiol produces an increase in the tissue content of hyaluronic acid, which enhances tissue hydration, contributing to capillary congestion and hyperplasia and hyper secretion of the mucous glands. As a consequence of these changes, pregnant patients may present with an airway that

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is difficult to access [2]. Humoral changes cause an increase in the production of relaxin, a hormone that is secreted by the corpus luteum and the placenta and causes relaxation of the pelvic ligaments and inferior ribs. The subcostal angle of the thoracic cage widens from 68.5° to 103.5°, increasing the anteroposterior and transverse diameters by 5 cm to 7 cm in the lower thorax [1]. These changes appear early in pregnancy to accommodate the enlargement of the uterus and increased maternal weight, with a peak in the 37th week of gestation [3].

Uterine growth displaces the diaphragm up to 4 cm in late pregnancy, and the configuration of the chest wall normalizes 24 weeks postpartum. Ventilatory muscle strength, inspiratory pressure, and trans-diaphragmatic pressure do not show changes during pregnancy. However, diaphragmatic excursion increases 2 cm compared to non-pregnant patients, due to a greater zone of apposition in the rib cage [3].

The pregnant uterus causes a decrease in Functional Residual Capacity (FRC) and its components (residual volume and expiratory reserve volume) due to the elevation of the diaphragm and decreased abdominal downward traction. FRC decreases by approximately 20% to 30%, beginning in the sixth month, with an additional decrease of 25% in the supine position at the end of pregnancy. As a compensatory mechanism, an increase of 5% to 10% in inspiratory capacity is noted [3]. Routine spirometric measurements (forced expiratory volume in 1 second/forced vital capacity) are not significantly different from the values of non-pregnant patients; the stability in spirometry during pregnancy suggests no significant changes in flow resistance. **Table 1** and **Figure 1** describe the changes in spirometry and lung volumes in pregnancy [2-5]. McAuliffe et al. carried out a study in women with twin pregnancies and found no significant difference from a woman with a single pregnancy [6].

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Oxygen consumption increases by 20% to 40% in obstetric patients, resulting in a decrease in the maternal oxygen reserve, which contributes to susceptibility in stressful situations (e.g. by creating a potential for closure of the respiratory tracts and atelectasis). The alveolar-arterial gradient increases 26 mm Hg and Minute Volume (MV_{ol}) increases at the expense of tidal volume, without altering the respiratory rate. This increase in MV_{ol} results in a decrease in the Arterial Pressure of CO₂ (PaCO₂) during the third trimester of gestation, increasing the maternal-fetal oxygen gradient and facilitating gas exchange. Measurement

Table 1: Lung capacities and volumes during pregnancy [2-4].

| Lung capacities and volumes during pregnancy | | |
|--|---|--------------------------|
| Measurement | Definition | Changes during pregnancy |
| Respiratory Rate (RR) | Breaths per minute | No change |
| Vital Capacity (VC) | Maximum volume of air that can be forcefully exhaled after maximum inspiration (IC+ERV) | No change |
| Inspiratory Capacity (IC) | Maximum volume of air that can be inhaled from a normal expiration (VC-IRV) | 5%-10% increase |
| Tidal Volume (TV) | Inspired and expired air volume with normal breathing | 30%-40% increase |
| Inspiratory Reserve Volume (IRV) | Maximum volume of air that can be inspired at the end of a normal inspiration | No change |
| Functional Residual Capacity (FRC) | Volume of air contained in the lungs at the end of a normal expiration (ERV+RV) | 20% decrease |
| Expiratory Reserve Volume (ERV) | Maximum volume of air that can be exhaled from the end of a normal expiration | 15%-20% decrease |
| Residual Volume (RV) | Volume of air in the lungs after a maximum expiration | 20%-25% decrease |
| Total lung capacity | Total volume of air in the lungs after maximum inspiration (VC+RV) | 5% decrease |
| Dead space | Volume of ventilated air that does not participate in gas exchange. | Increase |
| Minute ventilation | The product of respiratory rate and tidal volume. | 45% increase |
| Alveolar ventilation | Total volume of fresh air entering the alveoli per minute. | 45% increase |
| Chest wall compliance | Relationship between the transmural pressure across the chest wall and chest cavity volume. | Decrease |

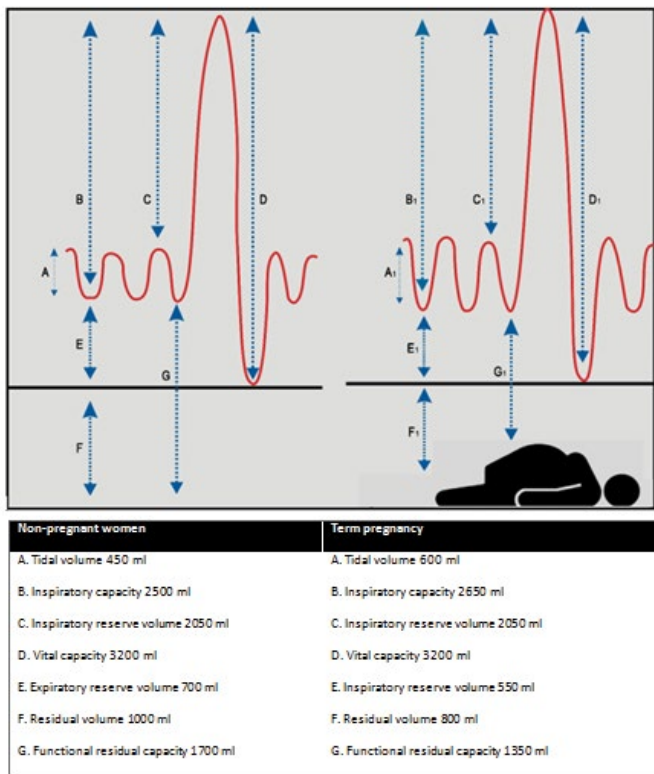


Figure 1: Changes in volumes and capacities in term pregnant women [5].

of arterial gases demonstrates a mild compensated respiratory alkalosis, with a decrease in PaCO₂ to between 28 mm Hg to 32 mm Hg and a decrease in serum bicarbonate (HCO₃) to between 18 mEq/L to 21 mEq/L (Table 2) [7].

Serum colloid osmotic pressure is reduced by 10% to 15%. The colloid osmotic pulmonary capillary wedge pressure gradient is reduced by about 30%, making pregnant women particularly susceptible to pulmonary edema. Pulmonary edema will be precipitated if there is an increase in cardiac preload (such as infusion of fluids), an increase in pulmonary capillary permeability (such as in pre-eclampsia), or both [8].

Table 2: Blood gas values in pregnant and non-pregnant women [7].

| Blood gas values | Non-pregnant | Trimester | | |
|--|--------------|-----------|------|------|
| | | 1° | 2° | 3° |
| Ph | 7.4 | 7.44 | 7.44 | 7.44 |
| PaO ₂ (mm Hg) | 100 | 107 | 105 | 103 |
| PaCO ₂ (mm Hg) | 40 | 30 | 30 | 30 |
| Serum bicarbonate (HCO ₃) (mmol/L) | 24 | 21 | 20 | 20 |

Indications for Mechanical Ventilation in Obstetric Patients

The indications for intubation and MV are similar to those for non-pregnant women. However, it should be remembered that the normal value of PaCO₂ is lower and that obstetric patients

have less tolerance to periods of apnea due to the increase in oxygen consumption and decrease in functional residual capacity, so rapid and elective intubation is recommended in case of ARF [9].

The objectives of oxygenation in all types of respiratory failure should be a maternal SaO₂ greater than 95% or a PaO₂ greater than 70 mm Hg, since the fetus does not tolerate hypoxemia or acidosis.

ARF that does not improve with conventional therapy is an indication for MV in pregnant patients; clinical data such as dyspnea, ventilatory fatigue, nasal flaring, cyanosis, or increased work of the ventilatory muscles are reliable indicators of urgent orotracheal intubation [10,11].

In the obstetric patient many factors may cause airway difficulty, and these can be classified as maternal, fetal, surgical, and situational. Maternal factors include the anatomical and physiological changes that occur during pregnancy; the mucosa of the airway is more edematous and vascularized, which causes changes in the Mallampati score and can lead to potential bleeding problems during intubation of the airway. For these reasons, smaller endotracheal tubes are recommended, and in addition, greater caution must be exercised due to the risk of bronchoaspiration [9].

Mechanical Ventilation in the Obstetric Patient

Achieving proper management of MV in pregnant patients in ICUs is essential, the goal being to rest the fatigued respiratory muscles while enabling suitable gas exchange. Respiratory muscle rest involves institution of invasive or noninvasive mechanical support and the ventilator must overcome pressures related to airway resistance and elastic properties of the lung to allow adequate ventilation and gas exchange. Based on pathophysiological mechanisms, epithelial and endothelial injury produces pulmonary edema that results in hypoxemia and an increase in airway resistance, but more notably a decrease in lung compliance that leads to excess respiratory muscle activity and eventually institution of ventilatory support [12].

Noninvasive Mechanical Ventilation

Noninvasive Ventilation (NIMV) is an effective means of ventilatory support that prevents intubation for the treatment of cardiogenic pulmonary edema; however, there is very little evidence in favor of this form of ventilation. However, NIMV should be viewed as an alternative form of ventilatory management and used with caution in obstetric patients and early in the treatment of hemodynamically stable patients. Maternal respiratory pattern and fetal heart rate should be monitored. A lack of clinical progress or improved oxygenation 30 to 45 minutes after initiation should prompt institution of Invasive Mechanical Ventilation (IMV) [12].

Contraindications for NIMV include respiratory arrest or unstable

cardiorespiratory status; uncooperative patients; inability to protect airway (impaired swallowing and cough); trauma or burns involving the face; facial, esophageal, or gastric surgery; apnea (poor respiratory drive); reduced consciousness; air leak syndrome; and gastrointestinal hemorrhage [13,14].

In NIMV, oxygen and positive pressure are delivered to the respiratory system through an interface, usually a face, nasal, naso-buccal or helmet mask [14,15]. Conditions like cardiogenic pulmonary edema (caused by severe pre-eclampsia or fluid overload) or hypercapnic respiratory failure due to asthma attacks improve with NIMV [15,16].

Invasive Mechanical Ventilation

There is no consensus regarding the programming of IMV in obstetric patients. However, there are certain considerations that must be taken into account to perform protective ventilation. Adjustments in the Fraction of Inspired Oxygen (FiO_2), Positive End-Expiratory Pressure (PEEP) and Tidal Volume (V_t) may be of utmost importance to avoid damage induced by the mechanical ventilator (VALI) and higher morbidity and mortality for the maternal-fetal binomial [17].

FiO_2 is the concentration of oxygen in relation to the ambient air: the minimum necessary to maintain a goal of arterial oxygen saturation (SaO_2) between 94% and 98% and Arterial Oxygen Pressure (PaO_2) that oscillates between 60 mm Hg and 100 mm Hg [17].

Although there are no specific studies in this regard for obstetric patients, in neurocritical patients (e.g.: post-arrest and cerebrovascular events), it has been shown that hypoxemia can contribute to ischemia and cerebral edema, and hyperoxemia to greater damage by oxygen free radicals. Therefore, a normoxemia strategy is recommended, especially in obstetric patients with complications from an acute neurological disease. Furthermore, this will seek to ensure an adequate supply of O_2 to the fetal-placental circulation [18,19].

Use of PEEP or CPAP (Continuous Positive Airway Pressure) in IMV, in spontaneous and NIMV modes, prevents alveolar collapse during expiration and serves to avoid cyclical atelectrauma. A PEEP level of 5 cm to 8 cm H_2O is recommended initially, although there is no consensus on an exact recommendation. As a result, it should be considered that patients in the 3rd trimester of pregnancy present a decrease in pulmonary compliance secondary to diaphragmatic apposition through the abdomen with the pregnant uterus, together with a decrease in functional residual capacity and residual volume [20].

Therefore, in a surgical event or acute respiratory or cardiac pathology, these patients could be at greater risk of atelectasis and/or pulmonary edema, which may require PEEP levels higher than 5 cm H_2O to improve oxygenation. In special circumstances, such as severe obstetric hemorrhage or high risk pulmonary thromboembolism, PEEP may be reduced or withdrawn until the shock is resolved [2].

V_t is directly related to mortality in the case of Acute Respiratory Distress Syndrome (ARDS). It should be taken into account that ARDS caused by SARS-CoV2 pneumonia is currently the most frequent cause of maternal death in the world, and therefore tidal volume must be programmed adequately [21]. In this case, it is necessary to measure the patient and determine her ideal or predicted weight according to the following formulae:

Ideal weight estimation formula in patients without ARDS (adapted from the World Health Organization):

- $Size (m)^2 \times 21.5$

Predicted weight formula for patients with ARDS:

- $[Size (cm) - 152.4] \times 0.91 + 45$

Subsequently, multiply the result by a number in the range of 6 to 10 ml/kg if the patient does not have ARDS (e.g. 55 kg of ideal weight \times 8 ml=440 ml of V_t to be programmed), and in the case of ARDS, the recommendation is to start with 6 ml and maintain parameters between 4 and 6 ml/kg of predicted weight to reduce lung injury (e.g.: 55 kg of predicted weight \times 6 ml=330 ml). This V_t can be programmed in Volume-Controlled Mode (VCV) [21,22]. The V_t can also be reached indirectly through the Pressure Support (PS), Inspiratory Pressure (PI), Spontaneous-Continuous Positive Airway Pressure/Pressure Support (CPAP-PS) or Pressure-Controlled (PCV) modes [22].

In VCV mode, the P_{plat} must be measured during an inspiratory pause (performed for 2-3 s, to allow a balance in airway pressures). P_{plat} is measured every 12 h in patients with confirmed or suspected ARDS, with a target of <25 to 30 cm H_2O [23]. When the P_{plat} is higher, V_t should be decreased until this target is achieved, with a lower limit of 4 ml/kg of predicted weight [24,25].

P_{plat} can only be measured in VCV and is determined by the total compliance of the respiratory system. A P_{plat} >25 to 30 cm H_2O is associated with higher mortality in patients with ARDS. Another parameter associated with mortality is Driving Pressure (DP), which depends on V_t and the Compliance of the Respiratory System (CRS), at levels above 12 cm to 16 cm H_2O . The DP formula is V_t/CRS and is obtained by subtracting PEEP from P_{plat} (P_{plat} -PEEP). In the case of DP >12 cm H_2O , the programmed V_t should be reduced. In moderate to severe ARDS, consider the prone position to optimize PEEP [24,25].

In the case of pressure modes, it is always recommended that the PS or PI value be \leq 12 to 15 cm H_2O to avoid lung injury. The PI adjustment depends mainly on lung compliance and also, if the patient is assisted, on his or her inspiratory effort; the greater the patient's inspiratory effort and lung compliance, the lower the pressure required to obtain the desired V_t . On the contrary, the lower the patient's inspiratory effort and the lower the compliance, the higher the pressure needs to be programmed to obtain the predetermined inspiratory volume (**Figure 2**) [21,22].

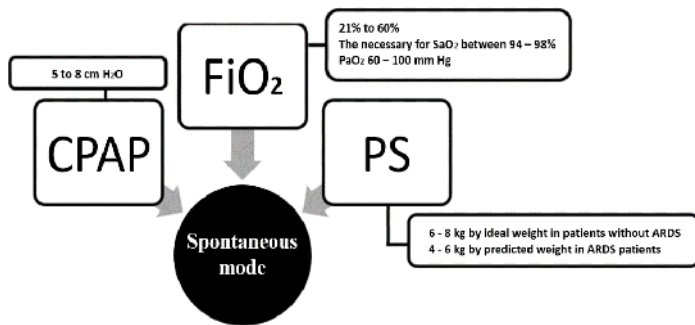


Figure 2: Mechanical ventilation programming in CPAP-PS mode.

IMV in Assisted Controlled Volume Ventilation

The Volume Controlled Ventilation (VCV) mode ensures the programmed V_t in this mode the P_{plat} and DP can be observed. Another advantage of this mode is that it ensures an almost exact Minute Volume (VMin), enabling greater control of $PaCO_2$, which is dependent on this parameter. In serious neurological conditions associated with pregnancy, such as intracranial hemorrhage, post-arrest syndrome, cerebral ischemia, severe cerebral venous thrombosis, etc., this ventilatory modality is recommended since abrupt changes in $PaCO_2$ could result in greater cerebral ischemia (in the case of hypocapnia) or greater cerebral edema and intracranial hypertension (in hypercapnia) (Figure 3) [22]. VCV can also be used in the event of an airway obstruction problem, such as an asthma attack or other bronchospasm, because a low Respiratory Rate (RR) setting, high inspiratory flow and low V_t could rapidly reduce air trapping and auto-PEEP. VMin must be programmed by adjusting the RR and V_t as necessary to maintain relative normocapnia for obstetric patients, that is, in a range of 28 mm Hg to 32 mm Hg [24,25].

Goals of MV in Obstetric Patients

Alveolar protection goals must be monitored to prevent damage induced by the mechanical ventilator. These goals include: [26]

- Peak inspiratory pressure ≤ 35 cm H_2O
- Plateau pressure ≤ 27 cm to 30 cm H_2O
- Driving pressure ≤ 12 cm H_2O

Arterial blood gas goals: [26,27]

- PaO_2 : : 60 mm Hg to 100 mm Hg, values outside these ranges are associated with higher mortality
- $PaCO_2$: Normocapnia in pregnancy is 28 mm Hg to 32 mm Hg (at sea level)
- SaO_2 : 94% to 98% in obstetric patients
- Peak Inspiratory Pressure (PIP)

PIP is the maximum pressure reached by the airway and is determined by V_t , Airway Resistance (R_{aw}) and lung compliance. PIP is the pressure that must be exerted by the volume of gas to overcome the resistance offered by the airways. An abrupt

elevation of the PIP suggests airflow obstruction caused by a bronchospasm, mucus plug, or orotracheal tube occlusion, although a PIP increase can also be caused by situations such as a pneumothorax or severe decrease in lung compliance. A PIP >35 cm H_2O is associated with barotrauma and pneumothorax [26,27].

Plateau Pressure

Pulmonary compliance in pregnant women is slightly decreased but does not cause complications when ventilating the patient. However, in cases of ARDS, compliance may decrease dramatically. P_{plat} can reach values between 25 cm and 30 cm H_2O and is one goal of MV, and should be limited if transpulmonary pressure cannot be monitored (esophageal balloon) [27].

Acute Respiratory Distress Syndrome in Pregnancy

ARDS is uncommon in pregnant patients. The causes of ARDS are associated with obstetric causes such as amniotic fluid embolism, pre-eclampsia, septic abortion and retained products of conception, or non obstetric causes that include sepsis, aspiration pneumonia, influenza pneumonia, blood transfusions, and trauma. An international group of leaders in the field of critical care medicine convened to develop a new definition of ARDS and developed the Berlin definition, which includes the following: onset occurring within 1 week of a known insult or worsening respiratory symptoms; bilateral infiltrates, lobar collapse, or nodules observed on chest radiograph or chest tomography; and radiographic opacities and pulmonary edema that produce respiratory failure not fully explained by cardiac failure or volume overload. The reason for the development of pulmonary edema in obstetric patients is likely diffuse endothelial injury secondary to the underlying infection leading to preterm labor, and not tocolytic use by itself, so excessive fluid administration should be avoided as it will worsen pulmonary edema. The final criterion is the deficit in oxygenation (Table 3) [12].

If pregnant patients with moderate or severe ARDS present with preterm labor and require the use of tocolytics, beta-agonists should be avoided since they increase the risk of acute pulmonary edema and cardiac demands. Another drug that contributes to increasing pulmonary capillary permeability is magnesium sulfate [12].

Table 3: Definition of acute respiratory distress syndrome.

| | The Berlin definition | Kigali modification |
|-----------------|---------------------------------|-----------------------------|
| Timing | <1 week | <1 week |
| Oxygenation | $PaO_2/FiO_2 <300$ mm Hg | $SaO_2/FiO_2 <315$ mm Hg |
| PEEP | >5 cm H_2O | No PEEP |
| Chest imaging | Chest Rx or Computed tomography | Chest Rx or Ultrasonography |
| Origin of edema | Heart failure excluded | Heart failure excluded |

Management seeks to identify and treat the cause while providing maternal supportive care and monitoring the fetus for signs of

distress that would prompt delivery. Managing the outcomes of pregnant patients with ARDS also requires good communication between the obstetrics team and critical care specialist and a fundamental understanding of MV support [12].

It is important to assess oxygenation in order to maintain a target SaO₂ of 94% to 98% to ensure correct maternal-fetal perfusion and avoid hyperoxemia (PaO₂ >120 mm Hg), which generates superoxide radicals, perpetuating the cytokine cascade [5].

Optimizing mechanical ventilation settings during the stabilization phase is the cornerstone of management. In cases of ARDS, the ventilation parameters and treatment should be reevaluated at least every 24 hours to employ lung-protective ventilator strategies: (1) Vt at 6 ml/kg of Predicted Body Weight (PBW), (2) Pplat <30 cm H₂O (using a 3-second end-inspiratory pause), (3) PEEP value >5 cm H₂O (high PEEP values are associated with a high risk of volutrauma and a decrease in preload and right ventricular afterload), and (4) DP <12 cm H₂O. Recruitment maneuvers should probably not be used routinely.

In patients who not reach a PaO₂/FIO₂ ratio <150 mm Hg with strategies, the prone position should be used combined with a neuromuscular blocking agent (Figure 3) [12,13].

perfusion relationship (Figure 4) [28,29].



Figure 4: Prone position strategy in the obstetric patient.

The prone position is associated with a lower concentration of Interleukins: IL-8, IL-6 and IL-1, reducing the inflammatory response at the lung level. It should be remembered that pregnancy is a pro-inflammatory state. The prone position results in a more even distribution of lung tension and leads to a better perfusion/ventilation ratio, increasing ventilation to the dorsal regions [29].

There is little literature on the prone position during pregnancy. However, data does exist from patients in the 2nd and 3rd trimesters of gestation with which the prone position was used, corroborating its functionality and showing respiratory improvement without fetal alterations [30].

In France, Vibert et al. report the case of a multiparous patient who was admitted to an ICU at 23 weeks' gestation with a diagnosis of respiratory failure secondary to SARS-CoV-2. As part of her treatment she was placed in the prone position for 2 hours a day. After this maneuver, her oxygen requirement decreased and clinical improvement was observed. IMV was withdrawn 15 days later. After 24 days of management, the patient was discharged home and continued her pregnancy [31].

In Mexico, Pozos et al. describe the case of a patient with 18 weeks of gestation diagnosed with ARDS secondary to bacterial sepsis. A prone position was used, achieving a reduction in ventilatory parameters until mechanical ventilation was withdrawn. She was discharged from the ICU without complications [32].

Samanta et al. reported the case of a 31-week-pregnant patient with severe respiratory failure due to influenza. High ventilatory parameters showed no improvement until protective ventilation was instituted in the prone position; pillows were used under the anterior thorax and pelvis to avoid uterine compression and ventilation in the prone position was alternated for 16 hours, achieving an improvement in oxygenation and a decrease in ventilatory parameters. After 5 days of protective ventilation in the prone position, she was discharged from the ICU with adequate fetal evaluation [33].

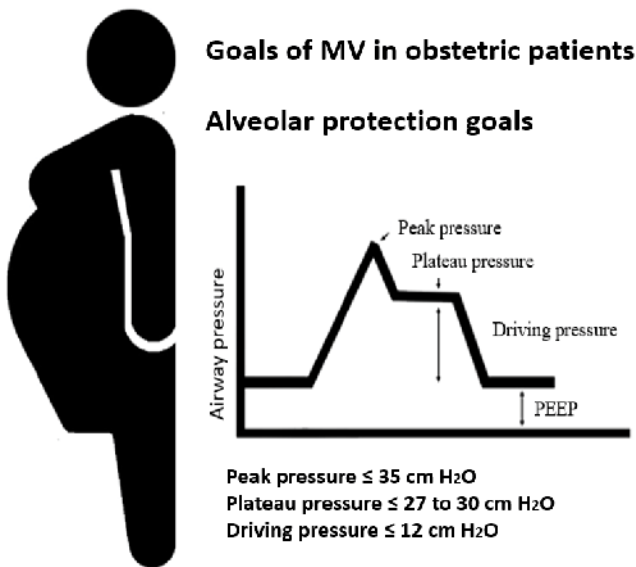


Figure 3: Ventilatory monitoring goals.

Prone Position Strategy in Pregnant Patients with ARDS

In 2013 the PROSEVA trial showed clear benefits from the prone position, which improved oxygenation and reduced mortality in patients with ARDS. Anatomically, the conical shape of the thoracic cavity causes compression of a greater proportion of the lung in the supine position; the posterior pulmonary segments are compressed by the heart, the abdominal viscera, and the increased weight of the lungs due to capillary leakage and edema. All this increases the dorsal pleural pressure, decreasing transpulmonary pressure and causing alterations in the ventilation-

The protective ventilation strategy in prone position for pregnant patients with severe ARDS should be carried out with specific care, including protection for the face and bony prominences, care of the endotracheal tube, and monitoring of the fetal cardiac rate, as well as gasometric control. The prone position has been little studied in pregnant patients, but is not a contraindication during pregnancy and has shown benefits in reducing mortality in severe ARDS. Medical teams must be trained to avoid complications and maintain fetal surveillance (Figure 5) [32].

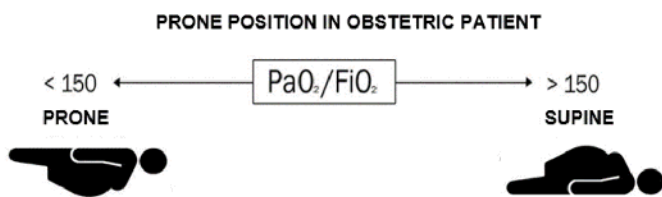


Figure 5: Prone position strategy in the obstetric patient.

Weaning in Obstetric Patients

There is no consensus or guideline for the withdrawal of MV in obstetric patients, so we recommend following the guidelines described for non-obstetric patients. The ATS (American Thoracic Society) recommends a systematic protocol for the withdrawal of mechanical ventilation in patients who have been ventilated for more than 24 hours. Patients should be removed from MV as soon as the cause for MV has resolved or if conditions have improved sufficiently for the patient to sustain spontaneous respiration without assistance [34].

The cuff leak test is a predictive method of post-extubation stridor due to laryngeal edema or a decrease in the cross-sectional area of the trachea. Obstetric patients present with general airway and laryngeal edema, which is why it is necessary to perform this test before extubation. The test consists in deflating the cuff and observing leakage in the volume-time curve. A difference in leak $>20\%$ or >110 ml with respect to that previously recorded by the ventilator is sufficient to tolerate extraction of the orotracheal

tube, whereas a leak $<20\%$ indicates tracheal or laryngeal edema that will require immediate treatment and subsequent reassessment (Figure 6). In order to decrease laryngeal edema, corticosteroids are recommended before the cuff leak test and as treatment in the event of post-extubation stridor [35].

A failed cuff leak test does not mean extubation should be delayed much longer; intravenous steroids should be started as soon as possible or 4 hours before intubation (usually methylprednisolone 20 mg every 12 hours, for 3 doses; the cuff leak test can be reassessed from the 2nd or 3rd dose and withdrawal from mechanical ventilation can be considered again) [34].



Figure 6: Mechanical ventilation in the critically ill obstetric patient.

Conclusion

Mechanical ventilation in critically ill obstetric patients has not been widely studied; pathophysiological changes must be considered in order to carry out protective and individualized ventilation for these patients.

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