Respiratory Diseases of Pregnancy

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Case Presentation

A 26 year-old gravida 3 para 2 with no known prior medical history presents at 34 weeks gestation to the emergency room with shortness of breath that worsened in the last 24 h. She had been sick for the last week and had been to her primary care provider who treated her symptomatically. Vital signs are remarkable for an oxygen saturation of 88 % on room air and tachycardia. On exam she appears to be tachypneic, using accessory muscles of respiration. Coarse breath sounds are heard on auscultation. She has mild pedal edema. A rapid flu test comes back positive. Chest X-ray shows diffuse interstitial infiltrates (Fig. 89.1). She is admitted to the intensive care unit and started on supplemental oxygen and oseltamivir. A blood gas obtained an hour after admission shows a PCO_2 of 40 and a PaO_2 of 70 on an FIO_2 of 100 %.

Question What is her diagnosis?

Answer ARDS associated with Influenza pneumonia.

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Question What will you do next?

Answer Intubate the patient with precautions for possible difficulty airway and initiate mechanical ventilation. Initiate empiric antibacterial therapy along with neuraminidase inhibitors.

Principles of Management

Physiologic Respiratory Changes Seen in Pregnancy

Dyspnea on exertion is a common complaint reported by gravid patients as the pregnancy progresses. The etiology is the increase in oxygen

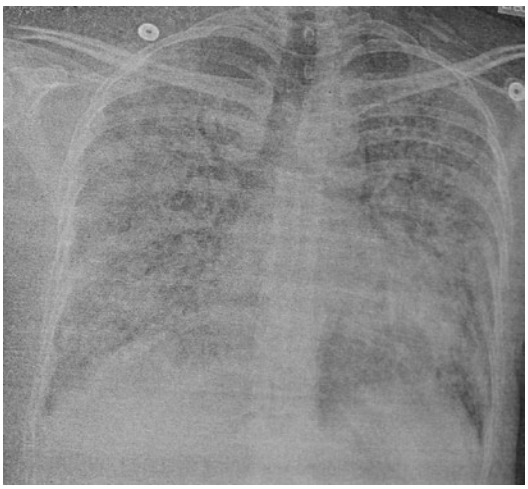

Fig. 89.1 Patient's chest x-ray

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consumption by almost 20 %. However, the body compensates for this by increasing both respiratory rate and tidal volume, thereby increasing minute ventilation [1, 2]. These changes make the partial pressure of oxygen slightly higher than normal on a blood gas, and would range from 100 to 110 mmHg. The partial pressure of carbon dioxide would be lower than normal for a non-pregnant patient and ranges from 27 to 32 mmHg [3]. Low pulmonary reserves that arise from reductions in functional residual capacity and increased oxygen consumption make pregnant women develop hypoxemia more rapidly [4].

Differential Diagnosis of Pulmonary Conditions in Pregnancy

Conditions Unique to Pregnancy

Pulmonary edema

- Pre-eclampsia related
- Tocolytic induced pulmonary edema
- Peripartum cardiomyopathy
- Ovarian hyper stimulation syndrome
- Mendelson syndrome
- Amniotic emboli

Conditions not Unique to Pregnancy

Exacerbation of underlying pulmonary conditions

- Asthma
- Obstructive sleep apnea

Pulmonary infections

Pulmonary emboli

ARDS secondary to trauma, burns, sepsis

Pulmonary Edema

Pulmonary edema can be broadly classified as cardiogenic or non-cardiogenic. Cardiac output increases very early on and is the highest in the post-partum period. Plasma volume expands due to sodium and water retention, thereby increasing preload, but afterload reduces due to vasodilation systemically [5]. The most common causes of non-cardiogenic acute pulmonary edema in pregnancy are the use of tocolytic agents, fluid overload, preeclampsia, sepsis, trauma or following aspiration of gastric contents [6, 7].

Pre-eclampsia associated pulmonary edema – Pulmonary edema is a frequently encountered complication in patients with pre-eclampsia with most cases occurring after delivery. Initial management involves lowering the blood pressure urgently especially in patients who have severe elevations of blood pressure that persists longer than 15 min. Once pulmonary edema occurs, parenteral therapy is more effective, and nitroglycerine is the agent of choice as recommended by The European Society of Cardiology [8]. Diuretics should be instituted to promote pre load reduction recognizing that the preeclamptic patient may have complex fluid balance needs due to low oncotic pressure. When necessary, noninvasive ventilation is recommended, in patients with increased work of breathing or hypoxemia as it is known to improve these parameters and can decrease the need for invasive mechanical ventilation by [9].

Tocolytic induced pulmonary edema is relatively uncommon [10]. Tocolytics such as ritodrine and terbutaline are beta agonists that increase heart rate and stroke volume but cause peripheral vasodilation and decrease blood pressure. Management involves firstly stopping the tocolytic therapy and treating pulmonary edema with diuretics. These patients tend to recover well and reported mortality is low [11].

Peripartum cardiomyopathy – These patients usually have no known prior heart disease and present with congestive heart failure typically in the last month of pregnancy and up to 5 months post-partum. Unfortunately, the mortality can be as high as 20–50 % [12, 13].

Ovarian hyperstimulation syndrome (*OHSS*) is another uncommon cause of pulmonary edema with a prevalence of 1–10 %. Mechanisms are not entirely clear but involve increased vascular permeability. Treatment is supportive care [14].

Aspiration – Certain factors such as an incompetent lower esophageal sphincter coupled with a decrease in stomach motility can increase the risk for aspiration. One must have a high index of suspicion as not all events are witnessed. Treatment is usually supportive [15].

Airway Disease

Asthma is seen very frequently with prevalence in pregnancy ranging from 1 to 8 % [16]. Certain factors easily obtained by a good history can help you understand who is at increased risk of complications from asthma, these being history of exacerbations, intubations, and recent steroid use. Most exacerbations are characterized by cough, wheezing, and dyspnea. The National Asthma Education and Prevention (NAEP) group recommends obtaining a baseline peak expiratory flow in order to guide further management. If the patient is approaching less than half of what their baseline is, then treatment with supplemental oxygen to correct hypoxemia and bronchodilators such as a beta-agonist and anticholinergic agents are to be given. A target oxygen saturation above 90 % with consideration for invasive mechanical ventilation in those who are in impending respiratory failure. A partial pressure of carbon dioxide within the normal range of 36–40 on an arterial blood gas can be a early sign of imment respiratory failure in the gravid patient. Intravenous steroids also have to be instituted. Care should be taken during mechanical ventilation to avoid a short expiratory time that can cause auto peep [16]. Intravenous magnesium sulfate may be beneficial in acute severe asthma in addition to bronchodilators especially in patients with coexistent hypertension or preterm uterine contractions [16, 17].

Large airway obstruction mostly arises due to a difficult intubation and the incidence is anywhere between 0.4 and 5.5 %. Intubation may be difficult during pregnancy and the peripartum period due to upper airway edema, pharyngeal mucosal friability and diminished airway caliber, especially late in pregnancy. The gravid patient especially third trimester, should be considered a difficult airway patient with high risk of aspiration and decreased oxygen reserve. Other causes of airway obstruction such as tumors, hematoma and laryngeal edema are rarely encountered [18, 19].

Obstructive Sleep Apnea in Pregnancy

Increased upper airway resistance may occur in pregnancy as a result of pharyngeal edema and increased pharyngeal tone could potentially worsen OSA in pregnant women. Incidence of OSA is estimated to be between 8.4 % in the first trimester and 19.7 % in the third trimester [20]. Maternal risks include increased morbidity from conditions that have been associated with OSA and underlying obesity such as preeclampsia, eclampsia, gestational hypertension, cardiomyopathy and gestational diabetes [21]. These patients are at higher risk for hypoxemia during labor, and continuous monitoring is necessary. CPAP therapy remains the first line of therapy and women are instructed to bring in their device when they come during labor.

Pulmonary Infections in Pregnancy

Viral Pneumonia

Varicella and influenza are the most common pathogens associated with viral pneumonia in pregnancy [22].

Estimated mortality rate amongst the H1N1 pandemic ranged from 12.5 to 42.1 % [23]. The risk of hospitalization is highest in the third trimester. Mortality related to influenza is mostly due to secondary bacterial pneumonia, although the 2009 H1N1 pandemic differed in this aspect with more patients dying primarily from the effects of H1N1 virus. The most commonly implicated pathogens are *S. pneumonia* and *Staphylococcus aureus* followed by *H.* influenza and it is reasonable to start empiric antibacterial agents at the time of presentation [24].

Bacterial Pneumonia

Streptococcus pneumonia followed by *Hemophilus Influenza* are the most commonly encountered agents [22]. Some of the risk factors for pneumonia in pregnancy include anemia, asthma, antepartum corticosteroids given to enhance fetal lung maturity, and the use of tocolytic agents to induce labor [25].

Oxygen supplementation is necessary with a goal of keeping the partial pressure of oxygen above 70 mmHg. The penicillins, cephalosporins, and macrolides are considered safe to use in pregnancy [22]. A history of contact with farm animals should raise suspicion for Q fever and therapy with macrolides is preferred [26].

Neuromuscular Diseases and Central Causes

Central causes of respiratory failure such as drugs, tumors, hemorrhage, and infection should be treated for in a similar manner as the general population with treatment of the underlying cause and mechanical ventilation if necessary. Conditions such as kyphoscoliosis may precipitate hypercapnic respiratory failure in pregnancy [27]. These patients should be closely monitored with arterial blood gasses, vital capacity and maximal and minimal inspiratory pressures [28].

Magnesium sulfate which is used as a tocolytic and to prevent seizures in pre-eclampsia can cause respiratory depression at levels greater than 12, and respiratory arrest at levels of 16–18.

Careful monitoring of magnesium sulfate dosing and infusion rates and monitoring maternal deep tendon reflexes and urine output with serum magnesium levels with precise infusion rates is necessary.

Pneumothorax in Pregnancy

Pneumothorax may occur because of hyperemesis, pushing efforts in labor, underlying lung disease, and without obvious precipitating cause [29]. Hamman's syndrome of intrapartum subcutaneous emphysema, pneumomediastinum, or pneumothorax results from the forceful "pushing" efforts during labor and about 200 cases have been reported worldwide before [30]. The clinical presentation is usually chest pain with breathlessness and presence of crackles or 'Hamman's sign 'in the left lateral decubitus position in systole. Most cases resolve spontaneously, but emergent chest tube placement might be required in some cases.

Pulmonary Embolism in Pregnancy

Embolic events rank among the major causes of maternal mortality in modern obstetrics. Risk factors include venous stasis, advanced age, sepsis, obesity and cesarean section. Hypoxemia is common. With massive embolism, circulatory failure is more prominent. Diagnosis is made by compression ultrasonography and if negative they will need perfusion study. If the diagnosis of PE is strongly considered, then treatment with unfractionated heparin should be started immediately unless a high risk or contraindication is present for the use of any anticoagulants.

Unfractionated heparin and low-molecular weight heparin are safe to use during pregnancy because they do not cross the placenta. TPA has also been used during pregnancy although there are no controlled trials [31, 32].

Cystic Fibrosis

Cystic fibrosis is the most common congenital pulmonary disease encountered during pregnancy. It is a restrictive and obstructive disorder, with a predisposition to infection. Bronchodilators and chest physiotherapy should be recommended, and chest infections should be treated aggressively [33].

Evidence Contour

The critically ill pregnant patient requires a multidisciplinary approach and early inclusion of obstetrical expertise is paramount in managing these patients especially in the third trimester.

Ventilation Strategies in the Pregnant Patient

Challenges

Pregnant women have hypocapnia due to hyperventilation at baseline. Thus, the arterial carbon dioxide tension ($PaCO_2$) tends to be lower in a pregnant woman, and a normal $PaCO_2$ is a sign of impending respiratory failure. Intubation may be difficult during pregnancy and the peripartum period due to upper airway edema and diminished airway caliber, especially late in pregnancy.

Goals of Ventilation

The goal is to rest the fatigued respiratory muscles while providing 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.

Non-invasive Ventilation

A trial of NIV can be instituted early on in patients with pulmonary edema. Favorable outcomes have been reported in case reports and series [34].

Mechanical Ventilation

Low tidal ventilation strategy is recommended [35]. PEEP improves oxygenation and should be used to provide a $PaO_2 > 65$ mmHg while administering the least FiO_2. The target $PaCO_2$ is 30–32 mmHg since this is the normal level during pregnancy. Marked respiratory alkalosis should be avoided because it may decrease uterine blood flow. Maternal permissive hypercapnia may also be deleterious to the fetus because of resultant fetal respiratory acidosis although this mode of ventilation has been used safely in pregnant women in small trials.

Propofol remains the first choice for sedation in these patients and if paralytics are clinically of cisatracurium would be the preferred agent [36].

Extra Corporeal Membrane Oxygenation (ECMO)

This technique has been used a rescue therapy for refractory ARDS with reported maternal and fetal survival rates between 80% and 70%, respectively [37, 38]. Most of the published literature is from the 2009 H1N1 influenza pandemic. Early institution with careful patient selection and judicial management of anticoagulation might improve successful outcomes [38, 39].

Prone Ventilation

Use of prone positioning in the third trimester has not been widely studied however case reports have appeared in the literature with apparently acceptable results. As in other severe ARDS patients, proning requires careful attention to inadvertent decannulation of lines or extubation. The pressure points especially eyes need to be protected and no hyperextension of joints. There needs to be adequate room for the abdomen to expand passively. This can be achieved by the use of appropriately sized bolsters at chest and hip level to help elevate the patient above the mattress. This also allows for anterior displacement of uterus off of the inferior vena cava which is necessary for adequate venous return after 20 weeks gestation. Close monitoring of mother and fetus including continuous fetal cardiotocography should be in place if fetus of viable age [40, 41].

Delivery

Delivery of the fetus can improve the maternal condition in several obstetrical disease states. In ARDS, it appears perhaps to improve oxygenation and management of the mother but does not definitively improve maternal survival [35, 42].

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