Chapter 2

Airway Management in the Pregnant Woman

Objectives

- Understand airway changes in the pregnant woman.
- Describe factors that cause airway difficulties in the pregnant woman.
- Outline interventions to manage airway difficulties.

Case Study

A 34-year-old woman, gravida 3, para 2 at 36 weeks' gestation, with a history of asthma presented to the emergency department with worsening shortness of breath and wheezing for the past 24 hours. She received three nebulizer treatments (albuterol-ipratropium), a dose of IV magnesium sulfate, and methylprednisolone and now has been admitted to the obstetrics floor.

On physical exam, she has respiratory distress and is unable to complete a full sentence. Her vital signs include: blood pressure, 117/63 mm Hg; pulse, 115 beats/min; respiratory rate, 28 breaths/min; temperature, 37.2°C (98.9°F) orally. Oxygen saturation is 94% on oxygen, 4 L/min via nasal cannula. Examination reveals decreased air movement with minimal wheezing and sinus tachycardia with regular rate and rhythm. No jugular venous distension or lower extremity edema is noted. Arterial blood gas results on oxygen include: pH 7.37; P_{CO_2}, 42 mm Hg; P_{O_2}, 74 mm Hg. After initiation of noninvasive positive pressure ventilation with a full face mask, arterial blood gas measurements are repeated: pH 7.34; P_{CO_2}, 48 mm Hg; P_{O_2}, 73 mm Hg.

– Should this patient be intubated?

– If so, what drugs would be appropriate to use?

I. INTRODUCTION

Although most pregnancies are uneventful, a minority of women require airway interventions, whether for general anesthesia or respiratory care. Pregnancy-related anatomic and physiologic changes in the airway may make securing the maternal airway difficult. Data suggest that up to 5.7% of intubations can be considered difficult and up to 0.4% fail. The rate of failed intubation in pregnant patients is 8 to 10 times higher than in nonpregnant patients. This leads to an average of one death per 90 failed intubations, a higher-than-usual iatrogenic maternal mortality rate caused by respiratory complications. Failed intubation also increases the risk of complications, such as hypoxemia or aspiration of gastric contents, leading to death. Preparation for airway management is essential and can help avoid maternal morbidity and mortality.

Appropriate airway management is fundamental to providing quality patient care and requires skill to reduce the risk of maternal and fetal complications. The primary objective in airway management is to maintain an open airway to facilitate adequate gas exchange. The anatomic and physiologic differences in pregnancy and the nature of both obstetric and critical care require expert knowledge to provide simultaneous care to both the mother and fetus.

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The rate of failed intubation in pregnant patients is 8 to 10 times higher than in nonpregnant patients.

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The importance of airway management in obstetrics is shown in studies of anesthesia-related maternal mortality. General anesthesia for cesarean delivery (the most common type of surgery during pregnancy) doubles or triples the risk of maternal death compared to regional anesthesia. Approximately 50% of these deaths are attributed to airway complications, such as aspiration, difficult intubation, insufficient ventilation, and respiratory failure. The risk of maternal death related to anesthesia is approximately 1000 times higher in low- and middle-income countries than in high-income countries (1.2 per 1000 and 1.2 per million, respectively). The presence of an experienced anesthesiologist is essential in a pregnant patient with a potentially difficult airway. Patients should receive continuous monitoring, and airway equipment should be readily available to establish an advanced airway. Advanced airway management during cardiopulmonary resuscitation should be performed by highly experienced personnel.

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Failed intubation is the most common cause of anesthesia–related maternal death during cesarean deliveries, followed by pulmonary aspiration.

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II. ANATOMY AND PHYSIOLOGY

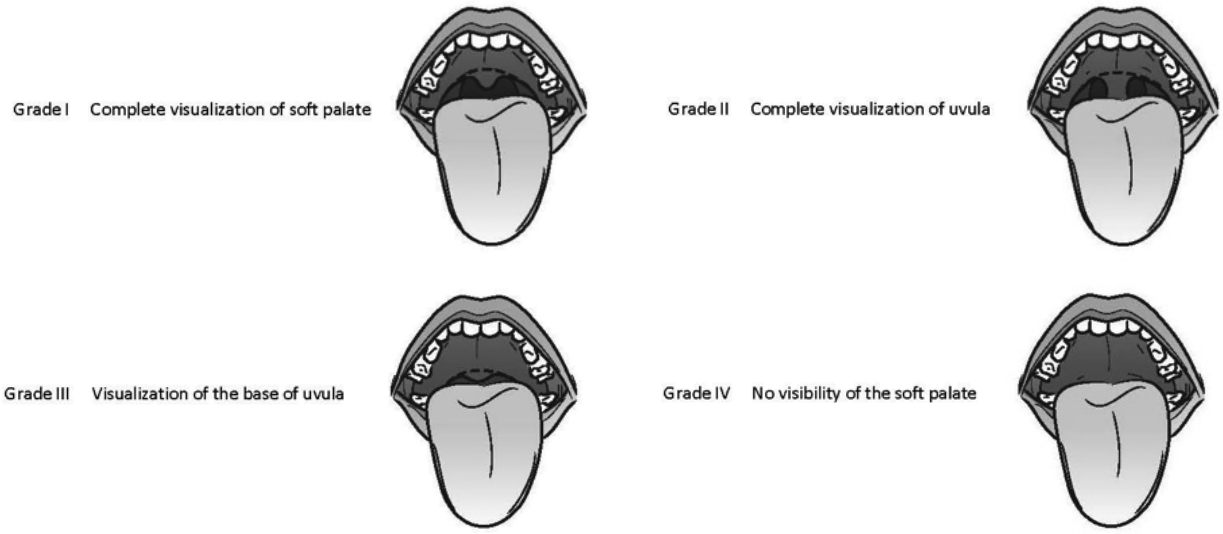
Maternal oxygen requirements in pregnancy increase due to an increased general metabolic demand (mostly by the fetus and placenta) and to increased work of breathing to keep up with the demand. Oxygen consumption increases by 20% and minute ventilation by 14%. The diaphragm is pushed up into the chest cavity as the uterus expands, resulting in a decrease in functional residual capacity, which is more pronounced in the supine position.

Anatomic changes that occur during pregnancy include pregnancy-induced generalized weight gain, an increase in breast size, fluid retention (particularly mucosal edema, leading to edema of the upper airway), and capillary engorgement, resulting in a more friable mucosa. An increase in the size of the abdomen raises the diaphragm and alters the normal anatomic alignment of the upper airway. Moreover, the enlarged breasts put pressure on the upper chest and neck, further distorting the airway anatomy and decreasing chest wall compliance. Some of these issues can be addressed with proper positioning.

The physiologic changes of pregnancy (decreased functional residual capacity, increased oxygen demand, decreased chest wall compliance) result in a decrease in oxygen reserve. During periods of hypoventilation or apnea, a pregnant patient desaturates more quickly than a nonpregnant woman. Additionally, pressure from the abdominal contents can compress the lungs and lead to small-airway closure when the patient is supine, leading to ventilation-perfusion mismatch, resulting in worsening hypoxemia.

Edema develops during pregnancy due to low serum protein levels and oncotic pressure, high estrogen levels, high blood volume, and high oxytocin levels (causing an antidiuretic effect and fluid retention). Aside from pregnancy-related weight gain, edema of the tongue, pharynx, vocal cords, arytenoids, and glottis may occur and may be worsened by an oxytocin infusion in labor, the Trendelenburg position, and/or Valsalva efforts in labor. Edema can be exacerbated by any upper respiratory tract infection and may cause airway obstruction during induction of anesthesia or resuscitation. Longitudinal changes over the course of pregnancy may worsen the Mallampati score (**Figure 2-1**); this is based on the calculation of the ratio between the base of the tongue and the oropharyngeal structures visualized with the tongue protruded. Because of airway edema and narrow glottis, a smaller size endotracheal tube is recommended (6-7 mm).

Figure 2-1. Mallampati scoring. Grade I, complete visualization of soft palate; grade II, complete visualization of uvula; grade III, visualization of base of uvula; grade IV, soft palate not visible.



Further respiratory and hemodynamic issues often arise when the pregnant patient is placed in a supine position, as she would commonly be positioned for intubation.

1. **Hemodynamic effects:** The supine position can lead to compression of the vena cava and reduced venous return to the heart. This can result in significant reduced cardiac output on both sides of the heart. Compression of the aorta can reduce uterine blood flow, leading to supine hypotensive syndrome and possibly causing syncope and bradycardia.

2. **Aspiration risk:** Reduced tone or anatomic distortion of the gastroesophageal sphincter and decreased gastrointestinal motility increase the risk of aspiration of gastric contents for all pregnant patients. The supine position tends to exacerbate the risk of regurgitation.

3. **Worsening of oxygenation:** All physiologic respiratory changes of pregnancy are exacerbated during supine positioning and can lead to significant desaturation and hypoxemia. Decreased venous return to the heart may result in low mixed venous oxygen saturation and an increase in alveolar-arterial oxygen difference.

III. EVALUATION OF THE AIRWAY

Anticipation and preparation for a potential problem are essential in the management of the obstetric airway. Despite a preparatory evaluation, the potential for airway problems may not be recognized before initiating intubation. Having a protocol to deal with difficult situations will lead to better outcomes. All pregnant patients who might be at risk for an operative delivery should be evaluated for airway management beforehand (**Table 2-1**). This will help the anesthesiologist to make anesthesia recommendations and have a management plan ready if needed. The risk factors highly predictive of difficult or failed intubation are a short neck (strongly associated with obesity), retracted mandible, and mandibular incisors that tend to protrude. Although facial edema and swelling of the tongue are predictive of laryngeal edema, neither is associated with difficulty in intubation. Nevertheless, more than three laryngoscopy attempts cause edema and injury to the oropharyngeal tissues, which can lead to a difficult intubation.

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Evaluate airway management for all pregnant patients who may be at risk for an operative delivery.

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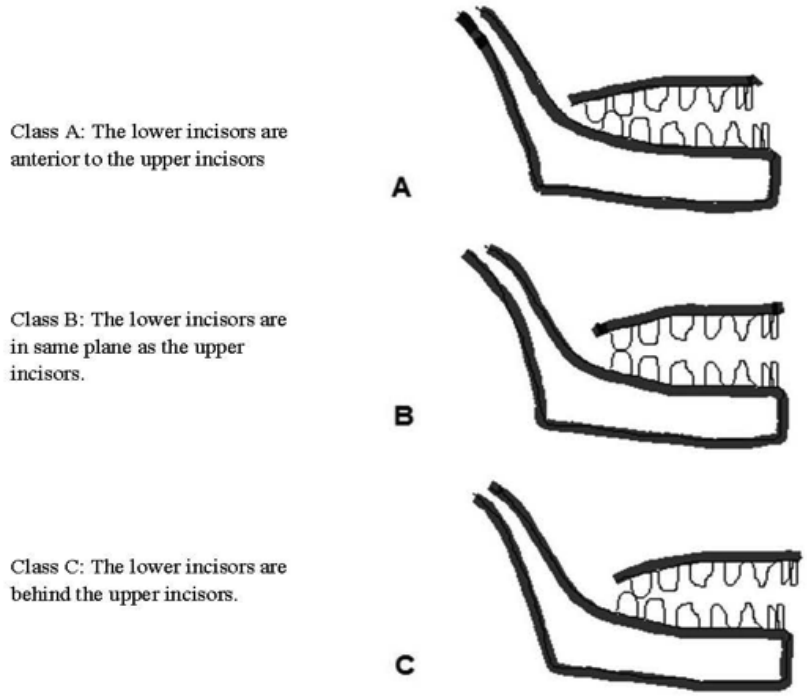
Table 2-1 Airway Assessment

Airway evaluation	Concerning observation
Length and thickness of neck	Short and thick
Mandibular incisors that tend to protrude	Retracted
Inter-incisor distance	<3 cm
Thyro-mental distance	<6 cm
Atlanto-occipital range of motion	Cannot touch chin to chest or cannot extend
Resting mandible position	Retracted
Mandibular protrusion	Grade B or C
Mallampati score	Grade III or IV
Laryngoscopic examination grade	Grade III or IV

Several steps may be quickly performed at the bedside to evaluate the airway. To assess spontaneous breathing effort, the clinician can look, listen, and feel for diminished or absent air movement. Airway patency can be estimated by opening the mouth and measuring the thyromental distance (<6 cm indicates an extremely difficult intubation), the atlanto-occipital extension, and the ability to protrude the mandible (mandibular protrusion test) [**Figure 2-2**].

Figure 2-2. Mandibular protrusion test.



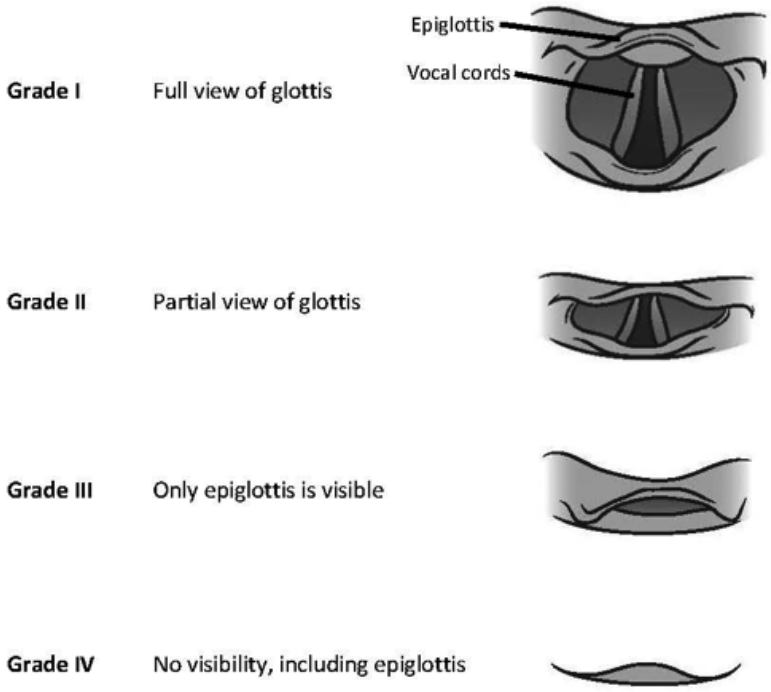
Data from Rajaram SS. *Critical care procedure book*. New York: Nova Biomedical; 2015.

The laryngoscopic exam developed by Cormack and Lehane employs 4 grades to classify the ratio between the visualization of the glottis and difficulty in intubation (**Figure 2-3**). Grade 3 airways (the epiglottis may be viewed, but not the glottis), as defined in this classification, are relatively common in pregnant patients and are associated with difficult intubations (**Table 2-1**).

The patient's Mallampati class is also important (**Figure 2-1**). The higher the class, the less visible is the connection between the soft and hard palate and the more difficulty anticipated with laryngoscopy and intubation. No single determination has a high predictive value, but ≥2 abnormal determinations can predict a difficult intubation.

In a study of pregnant patients, investigators looked at 5 bedside methods of predicting airway difficulty (Mallampati score, sternomental distance, thyromental distance, inter-incisor gap, and atlanto-occipital extension) and compared the results to the Cormack-Lehane laryngoscopic grade. A positive result from any of the bedside tests had a sensitivity of 0.21, specificity of 0.92, positive predictive value of 0.15, and negative predictive value of 0.95 for a Cormack-Lehane grade indicating a difficult intubation. These results suggested that 79% of the patients with potential airway problems will be missed by bedside assessment. The findings were further supported by a review of failed intubation in obstetric patients, which found that only about one-third of airways had been predicted to be difficult based on the assessment. These study results are not meant to discourage the use of the clinical exam, but rather to remind of limitations. Evaluation of the patient's airway must be attempted before labor or surgery.

Figure 2-3. Cormack and Lehane grades for difficulty in intubation.



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In summary, the risk of failed intubation is approximately 8 to 10 times greater, and the incidence of fatality in failed intubation 13 times greater, in the obstetric population (with an incidence of 0.4%) compared to other patient populations. Risk factors that may predict failed intubation are a short neck (strongly associated with obesity), retracted mandible, and mandibular incisors that tend to protrude. Although facial edema and swelling of the tongue are predictive of laryngeal edema, neither is associated with difficulty in intubation. The literature findings cited reflect the experience of anesthesiologists; less-skilled practitioners may have even more difficulty with airway management.

IV. MANAGEMENT OF THE DIFFICULT AIRWAY IN PREGNANCY

Preparation is important. The best way to avoid an accident related to the airway is not to manipulate it. A neuraxial block is preferred to general anesthesia for surgical procedures. Neuraxial techniques (spinal, epidural) are often possible to employ even in the obese pregnant patient. Coagulopathy or thrombocytopenia (platelets <80,000/μL) must be corrected before a neuraxial technique is undertaken, however, to avoid the possibility of a spinal or epidural hematoma. In women in whom intubation may be difficult and who are at higher risk for cesarean delivery, epidural placement early in the labor process is prudent to avoid a general anesthetic. If general anesthesia is required for a surgical procedure and the airway is expected to present

problems, several techniques may be considered, including awake fiberoptic intubation, videolaryngoscopy, or in an emergency, use of a supraglottic airway device, such as a laryngeal mask airway. Emergency surgical airway access is sometimes required via either cricothyrotomy or tracheotomy.

Figures 2-4 and 2-5 provide algorithms from the Obstetric Anaesthetists' Association and Difficult Airway Society that outline approaches for 2 scenarios.

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A protocol for management of the airway should be followed, depending on the urgency of the surgical procedure and whether the patient can be oxygenated without intubation.

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Figure 2-4. Management of failed tracheal intubation in an obstetric patient.

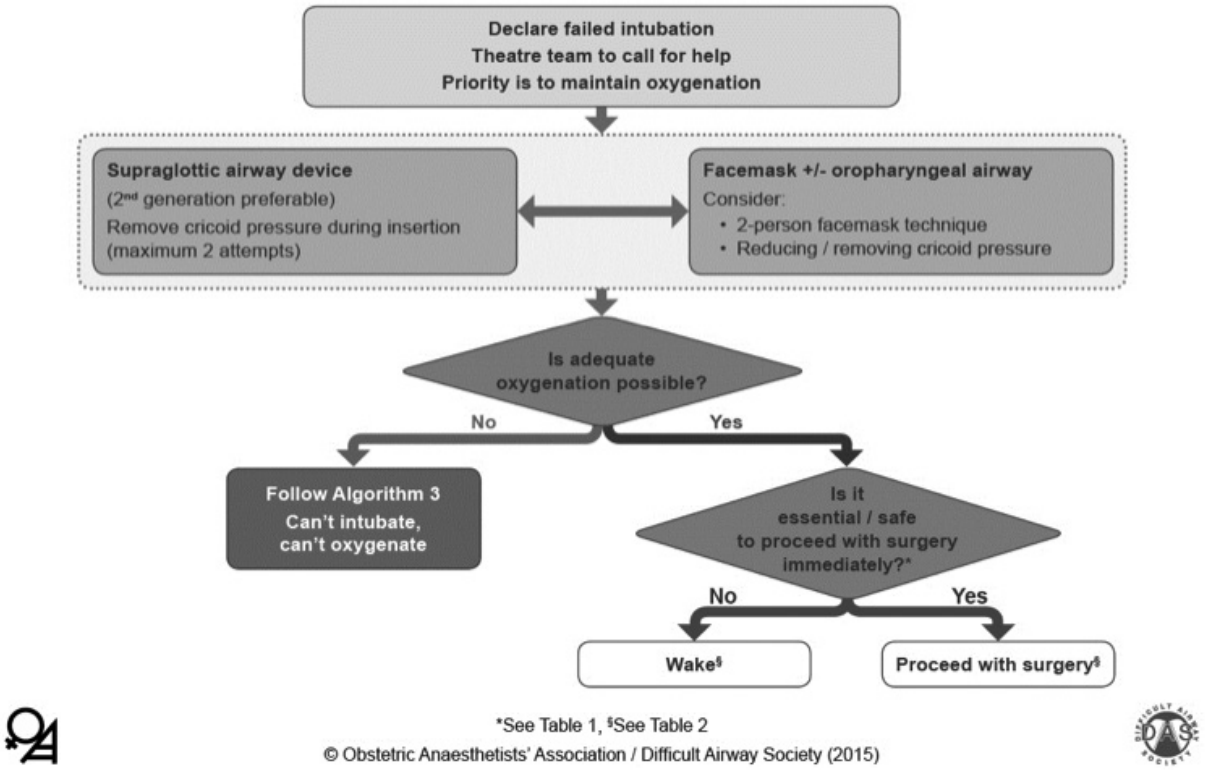

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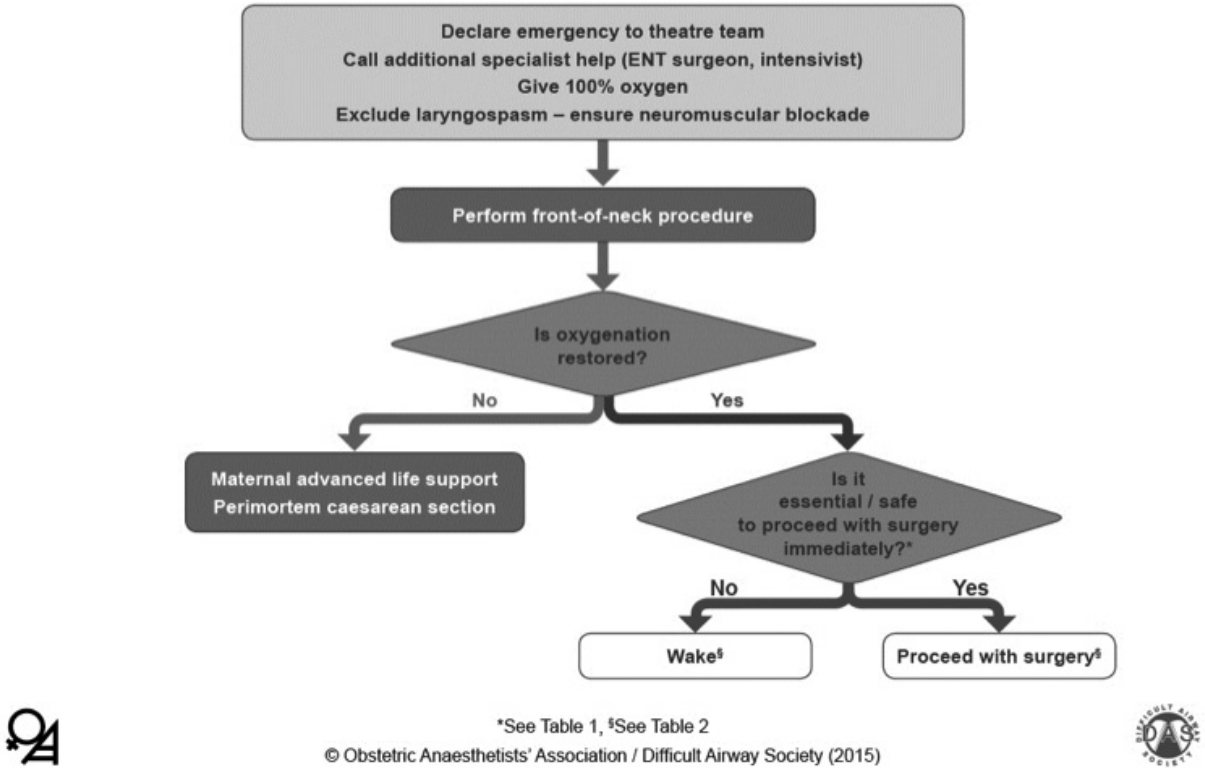
Figure 2-5. Management of failed intubation, failed oxygenation in an obstetric patient.



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A. Aspiration Risk Reduction

Pregnancy increases the chances of aspiration, especially when the patient is in the supine position or has received opioids or sedative drugs. If a definitive airway is not established, hand ventilation via bag and mask may lead to gastric distention and further increase the risk of aspiration. For this reason, mask ventilation is avoided during induction of general anesthesia in the obstetric patient. Aspiration risk is high due to reduced pressure of the esophageal sphincter, and higher gastric volumes and delayed gastric emptying, especially in labor. The probability of a fatal aspiration is up to 7 times greater in pregnant patients than in the nonpregnant population. This risk can be reduced by proper positioning of the patient (left uterine displacement and a 20° to 30° head-up position), keeping the patient from eating for 6 to 8 hours (clear liquids may be allowed), and premedicating with a clear antacid (eg, sodium citrate) and, in some cases, H_2-receptor antagonists.

B. Preoxygenation

Due to the reduced functional residual capacity during pregnancy, increased oxygen requirement by the rest of the body, and decreased chest wall compliance, a pregnant patient has little reserve to avoid desaturation. If the patient becomes apneic, she will quickly become hypoxemic. In cases of elective procedures, preoxygenate the patient with 100% oxygen through a tight-fitting mask for at least 2 or 3 minutes of spontaneous ventilation. Avoid positive-pressure ventilation with bag and mask, which can cause distention of the stomach and increase the risk for aspiration. The patient should receive supplemental oxygen administered through a nasal cannula for passive oxygenation while the intubation is attempted, even if the patient is apneic. In an emergency, the preoxygenation period can be shortened by having the patient take 8 deep breaths over 1 minute using a non-rebreathing mask.

C. Rapid-Sequence Induction

General anesthesia in a pregnant woman in whom an airway difficulty is not anticipated can be initiated with an induction agent (eg, thiopental, propofol) and a neuromuscular blocking agent; however, this will prevent the patient from self-rescue with spontaneous ventilation if the attempt at intubation is unsuccessful. Cricoid pressure may be applied by an assistant during rapid-sequence induction in an attempt to prevent regurgitation of gastric contents, but this procedure is no longer universally used.

D. Medications

Before intubation, the pharmacologic goal is to provide the patient with optimal analgesia, anesthesia, amnesia, and sedation without altering her cardiorespiratory stability. At times, preservation of spontaneous ventilator drive is necessary. Rapid-acting, short-lived, and reversible agents are preferred for sedation, while a deeper level of effect is required to initiate a general anesthetic. No single agent has every desirable feature, and more than a single agent may be considered to provide a balanced technique (**Table 2-2**). The status of the patient's intravascular volume and cardiac function must be carefully considered during selection of a drug and its dosage. Most of these agents induce hypotension, and the clinician should be prepared to manage this with fluid boluses and/or vasopressors. The placenta is no barrier to sedative or anesthetic drugs (although neuromuscular blocking agents do not cross), so the fetus will also be affected for a period. This is important only if delivery occurs shortly after administration; because neonatal metabolism and drug excretion are immature processes, the effect can be prolonged, making it prudent to prepare for a possible neonatal resuscitation.

Table 2-2 Drugs to Facilitate Endotracheal Intubation in Pregnancy

Agent	Dosing	Benefits	Cautions
Pretreatment			
Fentanyl:	0.5-2 µg/kg IV bolus every several minutes, titrated to analgesic effect	Rapid onset of action; short-acting agent; reversible with naloxone	Chest wall rigidity with rapid administration; respiratory depression; does not inhibit patient awareness; crosses placenta and can cause neonatal respiratory depression at high doses
Glycopyrrolate:	IM: 4 µg/kg with administration of preanesthetic opioid and/or sedative	Onset of action 15-30 min for IM, within minutes for IV administration	Causes drowsiness and blurry vision
Lidocaine 2%-4% topical:	4 mL atomized lidocaine applied to tongue and pharynx	Topical action, used for awake intubation; onset of action within 3-5 min	Do not exceed maximal dose of 4 mg/kg; can have systemic side effects if absorbed
Dexmedetomidine:	IV: loading infusion of 1 µg/kg over 10 min, followed by maintenance infusion of 0.7 µg/kg/h until endotracheal tube secured	Rapid onset of action; no respiratory depression	Can cause decrease in sympathetic outflow and reduced blood pressure and bradycardia
Midazolam:	0.1-0.3 mg/kg bolus titrated to sedation every several minutes	Provides amnesia; rapid onset of action; short-acting agent; reversible with flumazenil	Additive respiratory depression when combined with narcotic; does not provide analgesia; crosses placenta and can cause neonatal respiratory depression in high doses
Induction			
Propofol:	1-2 mg/kg IV bolus	Rapid onset; short-acting agent; provides amnesia; effect dissipates when discontinued	Severe hypotension in volume-depleted patients; does not provide analgesia; causes respiratory depression
Etomidate:	0.1-0.3 mg/kg single IV bolus	Provides hypnosis; may be preferred in head injuries; no adverse cardiovascular effects	May induce myoclonus, mild trismus (consider premedication with 50 µg fentanyl); no reversal agent; transient adrenal suppression
Paralytics			
Succinylcholine:	1-1.5 mg/kg IV bolus	2-3 min to onset; total duration, 4-6 min	Hyperkalemia; malignant hyperthermia
Rocuronium:	0.45-0.6 mg/kg IV bolus	Onset of action 1 min; total duration of action ≈45 min; reversed with sugammadex	Effect maybe prolonged in patients with liver disease
Cisatracurium:	0.15-0.2 mg/kg IV bolus	Onset of action 1-2 min; duration ≈45 min; reversed with sugammadex	Can cause bradycardia; generally well tolerated

IV, intravenous; IM, intramuscular

E. Nasal Intubation

Pregnancy leads to a friable mucosa with capillary engorgement. For this reason, nasal airways should be avoided in these patients to minimize the risk of bleeding.

F. Endotracheal Intubation During Pregnancy

Direct laryngoscopy with orotracheal intubation is the principal method for tracheal intubation in pregnancy. Endotracheal tube size should be small (eg, 7.0 mm) to minimize airway trauma and maximize success rates. Videolaryngoscopy is an alternative to direct laryngoscopy and may be preferred in many cases.

Steps to effect intubation are as follows:

1. Ensure the necessary equipment is available and functioning (oxygen, suction, selection of laryngoscopes and endotracheal tubes, airway adjuncts, rescue devices). Assess the patient's airway. Describe the process to the patient if she is conscious; gain her consent and cooperation.

2. Manage aspiration risk.

3. Position the patient appropriately.

4. Preoxygenate.

5. Provide appropriate analgesia, sedation, amnesia, and neuromuscular blockade as required for a safe procedure (**Table 2-2**). If necessary, intubation can be performed in an awake patient using topical anesthesia; this has the advantage of preserving spontaneous ventilation.

6. Insert the laryngoscope and visualize the glottis. Pass the endotracheal tube through the vocal cords under direct visualization. Remove the laryngoscope, inflate the tube cuff, and verify the position via auscultation and/or capnography. Secure the tube.

7. If the first attempt is unsuccessful, try repositioning the patient's head, adjusting or removing any cricoid pressure, adding a stylet, or bending the tube around an existing stylet.

8. No more than 2 or 3 attempts should be made before moving on to alternative techniques of airway management. Multiple attempts can result in periglottic edema and create subsequent difficulty with mask ventilation.

9. If intubation is unsuccessful, it is crucial to ascertain immediately whether ventilation is still possible. If the patient cannot be intubated but can be ventilated, oxygenation and ventilation can be maintained with bag and mask. If the purpose was to effect a general anesthetic, the decision to wake the patient or proceed with surgery must be made quickly. If the intubation was a response to respiratory failure or cardiac arrest, bag mask ventilation can be continued. In this setting, concerns about gastric distention with bag-mask ventilation take a back seat to the real risk of profound hypoxemia.

10. If intubation is unsuccessful, the patient cannot achieve ventilation on her own, and face-mask ventilation is unsuccessful, a supraglottic airway should be inserted. If this does not allow ventilation, a surgical airway will be required, either via cricothyroidotomy (with a scalpel, needle, or trocar/cannula) or percutaneous tracheostomy.

If airway problems are anticipated, consider an awake fiberoptic intubation with topical anesthesia and preserved spontaneous ventilation. The advantage is that the natural airway is maintained with preservation of normal muscle tone and anatomical landmarks. Rapid-sequence induction with neuromuscular blockade in this setting has a high risk of creating a situation in which the patient cannot be intubated or ventilated.

G. Failed intubation

Airway management and ventilation are important components of resuscitation after cardiopulmonary arrest. This topic is covered in **Chapter 8**.

H. Post-intubation Challenges

During and after tracheal intubation, significant alterations in hemodynamics may be anticipated. Hypertension and tachycardia may result from sympathetic stimulation, and some patients may require therapy with antihypertensive medications or sedatives. Hypotension may occur because of the effect of positive-pressure ventilation on venous return and cardiac output.

Extubation should occur under controlled circumstances, when the woman is awake and cooperative, adequately oxygenated, and capable of maintaining a reasonable tidal volume and negative inspiratory force. The risk of regurgitation and aspiration is increased at extubation, just as at intubation. A strategy for reintubation, if needed, should be determined before extubation.

Key Points

- Airway management in an obstetric patient may be challenging because of the anatomic and physiologic changes of pregnancy.
- Airway assessment before intubation and recognition of potential difficulties can help avoid catastrophic situations, but not all difficulties can be predicted by bedside assessment.
- The risk of a failed airway is much higher in a pregnant patient than a nonpregnant patient, and obesity further increases this risk.
- The probability of fatal aspiration is greater in obstetric patients than in those who are not pregnant, so preintubation prophylaxis with a nonparticulate antacid should be employed.

- Medications for sedation, induction agents, neuromuscular blockers, and vasoactive drugs may be used in a pregnant woman as needed for intubation.
- Nasotracheal intubation should be avoided during pregnancy.
- Use of smaller endotracheal tubes (size 6-7) is recommended.
- If a difficult airway is anticipated, avoid rapid-sequence induction with neuromuscular blockade.
- A protocol for management of the difficult or failed airway in obstetrics should be in place, and the necessary equipment should be available.

Suggested Readings

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