Section A-Research paper

An Overview About Hemodynamic Response and Management During Laryngoscopy & Intubation

Ayoub Mohammed Masoud Khayr[1], Zaki Saleh Taha [2], Yasser Mohamed Nasr [2], Mohamed Gaber [2]

[1] MBBCH, Faculty of Medicine, Benghazi University –Libya
[2] Anesthesia, Intensive Care and pain management, Faculty of Medicine - Zagazig University
Email: a.khir022@medicine.zu.edu.eg, Ayoubalgadafi1@gmail.com

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Abstract

Background: Patients undergoing surgical procedures that require deep relaxation for long periods of time are best suited for general anesthesia if there are no contraindications. Surgeries that cannot be adequately anesthetized with local or regional anesthesia require general anesthesia. Operations likely to result in significant blood loss or in which breathing will be affected necessitate general anesthesia. Uncooperative patients are also better treated with general anesthesia, even for more minor procedures. Patient preference can also influence the decision to undergo anesthesia. The advancement of the endotracheal tube has closely followed advancements in anesthesia and surgery. Modifications and minimize aspiration, isolate the lung, administer medications, and prevent airway fires. Despite advances with the endotracheal tube, more research to optimize its use is necessary. Laryngoscopy and tracheal intubation are potent stimulators of the sympathetic and parasympathetic nervous systems, with variable and sometimes unpredictable responses. Hemodynamic response is characterized by a sudden surge in mean arterial pressure (MAP) and heart rate (HR), arising within 30 seconds following direct laryngoscopy and endotracheal intubation, approaching baseline in about 10 minutes. A rate pressure product (RPP) more than 11000 has been associated with signs of myocardial ischemia in patients with coronary artery disease. Laryngoscopy and intubation can lead to an average increase in blood pressure of 40 to 50%, and a 20% increase in heart rate. Sudden increase in blood pressure may cause rupture of aortic / cerebral aneurysm, imbalance of myocardial oxygen supply and demand, increase cerebral blood flow due to increased cerebral metabolic activity and systemic cardiovascular effects, and dysrhythmias. When the stress response during laryngoscopy without intubation was compared among Macintosh, Miller and McCoy laryngoscopes, the maximum response was obtained with the use of Miller and minimum response with the McCoy laryngoscope. The tip of the Miller's blade which is inserted posterior to the epiglottis stimulating the vagus, causes maximum response. The stress response to laryngoscopy appears to be less marked with the McCoy blade probably due to a reduction in the force necessary to obtain a clear view of the larynx.

Keywords: Hemodynamic Response, Laryngoscope Intubation

Introduction

General anesthesia (GA) is a state induced by medications of anesthetic drugs to produce a controlled reversible physiological loss of consciousness, analgesia, some degree of muscle relaxation "akinesia" & amnesia with concomitant stability of the autonomic nervous system **(1)**.

Patients undergoing surgical procedures that require deep relaxation for long periods of time are best suited for general anesthesia if there are no contraindications. Surgeries that cannot be adequately anesthetized with local or regional anesthesia require general anesthesia. Operations likely to result in significant blood loss or in which breathing will be affected necessitate general anesthesia. Uncooperative

patients are also better treated with general anesthesia, even for more minor procedures. Patient preference can also influence the decision to undergo anesthesia **(2)**.

A safe and secure airway is the cornerstone for any administered anesthesia. Endotracheal intubation is the definitive procedure to secure the airway during general anesthesia. This is usually performed via direct laryngoscopy. Laryngoscopy, endotracheal intubation, surgical incision, and extubation could initiate remarkable sympathetic activity and are accompanied with transient but serious hemodynamic perturbations, called the pressor or hemodynamic response **(3)**.

These hemodynamic derangements are characterized by a sudden rush in mean arterial pressure (MAP) and heart rate (HR), arising 30 seconds following direct laryngoscopy and endotracheal intubation and approaching baseline in about 10 minutes. These short-lived extreme changes may precipitate hypertensive episodes, cardiac dysrhythmias/ischemia, intracranial hypertension and or hemorrhage in susceptible patients. The endotracheal tube (ETT) was first reliably used in the early 1900s. In its simplest form, it is a tube constructed of polyvinylchloride (PVC) that is placed between the vocal cords through the trachea to provide oxygen and inhaled gases to the lungs. It also serves to protect the lungs from contamination such as gastric contents and blood. The advancement of the endotracheal tube has closely followed advancements in anesthesia and surgery. Modifications have been made to minimize aspiration, isolate the lung, administer medications, and prevent airway fires. Despite advances with the endotracheal tube, more research to optimize its use is necessary **(4)**.

The Endotracheal Tube

The endotracheal tube has a length and diameter. The endotracheal tubes size refers to its internal diameter in millimeters (mm). The ETT will typically list both the inner diameter and outer diameter on the tube (for example, a 6.0 endotracheal tube will list both the internal diameter, ID 6.0, and outer diameter, OD 8.8). The narrower the tube, the greater resistance to gas flow. PVC is not radiopaque, and thus a radiopaque linear material is included throughout the length of the tube to make it easier to visualize the placement on x-ray. Ideally, the distal tip of the ETT is 4 cm (+/- 2 cm) above the carina on chest x-ray in adults **(5)**

The Cuff

A cuff is an inflatable balloon at the distal end of the ETT. Pediatric ETTs are produced with and without cuffs. The inflated cuff produces a seal against the tracheal wall; this prevents gastric contents from entering the trachea and facilitates the execution of positive pressure ventilation. Ideal cuff pressure should be 20 cm H_2O or less. If the pilot balloon does not hold air, it must be assumed the cuff of the ETT has been damaged and is non-functional **(4)**.

The Murphy's Eye

ETTs have a built-in safety mechanism at the distal tip known as Murphy's eye, which is another opening in the tube positioned in the distal lateral wall. If the distal end of the ETT should become obstructed by the wall of the trachea or by touching the carina, gas flow can still occur via Murphy's eye, this prevents complete obstruction of the tube **(4)**.

The Connector

Endotracheal tube connectors attach the ETT to the mechanical ventilator tubing or an Ambu bag. For adult and pediatric ETTs, it is customary to use the universal 15 mm connector **(4)**.

Equipments

Equipment necessary to optimize the use and function of the ETT:

- Laryngoscope
- Stylet
- Syringe for cuff/pilot balloon
- Universal 15 mm connector
- End-tidal CO_2 device

Laryngoscopy:

A direct laryngoscopy allows visualization of the larynx. It is used during general anesthesia, surgical procedures around the larynx, and resuscitation. This tool is useful in multiple hospital settings, from the emergency department to the intensive care unit and the operating room. By visualizing the larynx, endotracheal intubation is facilitated. This is an important step for a range of patients who are unable to secure their own airway, including those with altered mental status and those who are undergoing a surgical procedure **(6)**.

Before direct laryngoscopy can begin, it is important to place the patient on cardiac monitoring and a continuous pulse oximeter, the suctioning device should be prepared and accessible for immediate use, appropriate lighting, and positioning of the patient as successful preparation of patient and equipment are equally important to the procedure (**7)**.

Direct laryngoscopy and subsequent endotracheal intubation require a laryngoscope handle, blades (Macintosh or curved, Miller, or straight with a curved end, Jackson-Wisconsin or straight), appropriately sized ETT with a stylet and an ETT one size bigger and one smaller. Most tracheal intubations in an emergency or perioperative setting in adults can be accomplished with 7.5 mm cuffed tubes. In the intensive care setting, larger tubes are preferred as these make tracheal suctioning and flexible bronchoscopy possible through the ETT; in addition, larger tubes cause less resistance to flow of air through a ventilator. Equipment for direct laryngoscopy also includes adjunct airway management devices such as a "Bougie," which is an ETT introducer, oral and nasal airways, and rescue airway device such as a Combitube or supraglottic airway tubes. An end-tidal carbon dioxide monitor (capnography) is required to help confirm the appropriate placement of the ETT. Lastly, all direct laryngoscopy equipment includes back-up devices to access the airway, such as video laryngoscopes, rescue airway devices (laryngeal mask airway) and if nothing works, a cricothyrotomy or tracheostomy tray. If a difficult airway is known or suspected, the instruments for a surgical airway should be opened and ready before beginning laryngoscopy **(8)**.

Technique

Successful direct laryngoscopy involves multiple steps:

1. One must first properly position the patient. The classic position is the “sniffing” position where the atlanto-occipital extension with a head elevation of three to seven centimeters; however, patients with cervical spine injury should not have head and neck manipulation performed.
2. Next, one must open the patient’s mouth by using the right hand. An effective method is by using the scissor technique. This is performed by flexing the thumb and middle finger past each other, with the thumb pressing on the mandibular dentition and the middle finger pressing on the maxillary dentition.
3. The laryngoscope is then inserted in the right side of the mouth, and the blade is then used to sweep the tongue to the left, then the blade is smoothly advanced to the epiglottis. If a Macintosh blade is used, it is advanced to the vallecula, and if a Miller blade is used, it is advanced over the epiglottis to the entrance of the trachea proximal to the vocal cords.
4. The laryngoscope is then moved anteriorly to reveal the vocal cords **(9)**.

Complications

The laryngoscope may cause blunt or penetrating trauma to the oropharynx, larynx, and trachea or may chip teeth or lacerate the lips. Direct laryngoscopy involves the possibility of vocal cord damage as well as arytenoid cartilage dislocation. Meticulous technique is always required to avoid these complications. The most common complication of this procedure is a sore throat, which is reported to occur in 14% to 57% of patients who undergo intubation for general anesthesia. Sore throat is a broad definition but includes pain, discomfort, hoarseness of voice, dysphagia, and dry throat; these can occur alone or in a combination. Sore throat is usually mild and temporary and mostly resolves within 48 hours **(10)**.

Non traumatic complications of direct laryngoscopy and ETT placement include aspiration of gastric contents, hypoxic brain injury from a prolonged attempt at intubation without adequate oxygenation, and bronchospasm. Sympathetic surge causing tachycardia, dysrhythmias, myocardial ischemia, and/or infarction and hypertension can occur because of stimulation of the highly innervated glottis by the laryngoscope.

blade. Similarly, especially in younger patients, the laryngoscopy blade can stimulate the vagus nerve, which can cause profound bradycardia **(11)**.

Hemodynamic response

Laryngoscopy and tracheal intubation are potent stimulators of the sympathetic and parasympathetic nervous systems, with variable and sometimes unpredictable responses. Hemodynamic response is characterized by a sudden surge in mean arterial pressure (MAP) and heart rate (HR), arising within 30 seconds following direct laryngoscopy and endotracheal intubation, approaching baseline in about 10 minutes. The hyperdynamic increase in blood pressure or heart rate, or both, during airway manipulation has been the focus of a tremendous amount of time and energy in the elective operating room to temper such a response with the goal of reducing its impact on cardiovascular risk and patient morbidity. This response can represent a devastating cardiovascular insult in a critically ill patient with comorbidities who require emergency airway management **(12)**.

The hemodynamic changes are of little concern in relatively healthy patients but can be detrimental to a high-risk population. Both hypotension and hypertension can lead to an imbalance of myocardial oxygen supply and demand and result in morbidity. Diseases of the cardiovascular system, like hypertension, additionally affect the normal physiological response of the body to anesthesia induction and intubation. The changes associated with laryngoscopy and intubation can be more severe and more dangerous in hypertensive patients. In addition, this response is complicated by the anti-hypertensive therapy **(13)**.

Physiology of hemodynamic response:

The response is maximum at approximately 30-45 seconds after laryngoscopy and tracheal intubation. Blood Pressure (BP), Heart Rate (HR), plasma adrenaline, noradrenaline and vasopressin concentrations increase slightly in response to laryngoscopy and tracheal intubation; all returning to baseline within 5 minutes with no change in angiotensin converting enzyme activity in normotensive patients. However, a three-fold increase in plasma noradrenaline levels which returned to baseline nearly 10 minutes following laryngoscopy and tracheal intubation was observed in hypertensives. Further, an increase in plasma adrenaline level was observed in hypertensives 1 minute after laryngoscopy **(14)**.

Effects of hemodynamic responses on organ systems:

A rate pressure product (RPP) more than 11000 has been associated with signs of myocardial ischemia in patients with coronary artery disease. Laryngoscopy and intubation can lead to an average increase in blood pressure of 40 to 50%, and a 20% increase in heart rate. Sudden increase in blood pressure may cause rupture of aortic / cerebral aneurysm, imbalance of myocardial oxygen supply and demand, increase cerebral blood flow due to increased cerebral metabolic activity and systemic cardiovascular effects, and dysrhythmias **(15)**

Transient increase in the choroid blood flow can force vitreous gel forward into the anterior chamber duringopen eye surgery or can increase intraocular pressure in an intact eye. Patients with raised intracranial pressure who have minimal reserve in intracranial compliance are at a risk for brainstem herniation and sudden death during laryngoscopy and tracheal intubation **(6)**.

Hemodynamic response in relation to age

In infants and small children, response may manifest initially as bradycardia owing to an increased vagal tone. In geriatric patients, SBP and MAP increased significantly though the tachycardia response was less severe as the age advanced which was attributed to impaired β response with normal α responsiveness. It was also noted that the mean plasma norepinephrine concentrations were significantly less in the elderly **(16)**.

Effect of force applied, duration and number of attempts:

Various forces applied onto a Macintosh laryngoscope (the forces acting along the axis of the handle, as well as forces exerted by anesthetist to prevent the laryngoscope from turning) were studied for their influence on hemodynamics. A modified laryngoscope was designed to measure these forces and four different parameters were determined:

1. The duration of laryngoscopy
2. The maximally applied forces
3. The mean force

4. The integral of the force over the time (area under the curve)

The duration of laryngoscopy, the forces applied parallel to the axis of the handle and the increased stretching of the tissues were found to be responsible for the severity of the hemodynamic perturbations **(17)**.

Hemodynamic response to various laryngoscopes:

When the stress response during laryngoscopy without intubation was compared among Macintosh, Miller and McCoy laryngoscopes, the maximum response was obtained with the use of Miller and minimum response with the McCoy laryngoscope. The tip of the Miller's blade which is inserted posterior to the epiglottis stimulating the vagus, causes maximum response. The stress response to laryngoscopy appears to be less marked with the McCoy blade probably due to a reduction in the force necessary to obtain a clear view of the larynx **(18)**.

Fiberoptic intubation:

The fibreoptic endoscope enables the visualization of the glottis with minimum force, but the need of maneuvers or instruments to clear the airway results in hemodynamic response. Hemodynamic response was found to be more severe with the use of Macintosh laryngoscopy as an aid for fibreoptic orotracheal intubation as compared to a combined maneuver of lingual traction and jaw thrust. Factors like prolonged tracheal stimulation, jaw thrust maneuver in fibreoptic intubation and external neck manipulation also contribute to the hemodynamic response. Effective suppression of hemodynamic response was achieved by combining fibreoptic intubation with 4% lidocaine spray of the larynx and glossopharyngeal nerve block. But it was shown that no advantage with the use of fibreoptic scope for intubation in patients undergoing coronary artery bypass graft (CABG) **(19)**.

Nasotracheal intubation:

The hemodynamic response after nasotracheal intubation is significantly greater than that after orotracheal intubation as there would be considerable stimulation of the irritant receptors in the nostrils **(20).**

Videolaryngoscopes (VLS):

The VLS have been introduced in 2002 to aid intubation without the need for the alignment of oral, pharyngeal, and laryngeal axes. In most of the VLS the blades have been angulated to enhance the visualization of the glottis. This necessitates the use of stylet or laryngeal manipulation to aid the successful intubation. The use of stylet or laryngeal manipulations has been shown to increase the hemodynamic response **(17)**.

Management:

Nerve blocks:

Awake direct laryngoscopy is a well-established technique for use in patients with an anticipated difficult airway, as well as for those who are at increased risk for loss of airway patency or protective airway reflexes after induction of general anesthesia. Although awake direct laryngoscopy is performed for patient safety, it is often accompanied by hemodynamic disturbances and patient discomfort. Therefore, local anesthetics are commonly administered before awake laryngoscopy **(21)**.

Local anesthetics have been shown to act on both dilator and tensor muscles of the pharynx and larynx, therefore resulting in increased respiratory resistance. Studies also suggest the possible role of alternative upper airway receptors (joint and muscular) in the central processing of upper airway reflexes. Overall, there appears to be sufficient evidence to suggest that topical anesthesia negatively affects upper airway dynamics **(21)**.

There are several methods of administering local anesthetic before awake direct laryngoscopy, including (but not limited to) 2% viscous lidocaine swish and gargle, 10% lidocaine spray, superior laryngeal nerve and bilateral glossopharyngeal nerve (GPN) blocks. Topical anesthetics are administered to provide analgesia by blocking tactile receptors in the peroral mucosa, but they are considered inadequate to block submucosal deep-pressure receptors **(21)**.

Deep-pressure receptors in the posterior one third of the tongue are innervated by sensory afferent branches of the GPN and are responsible for reflex-mediated gag and pressor responses to direct laryngoscopy. Given this, bilateral blockade of the GPN, or "tongue block," may be more successful at

mitigating pressor, gag, and pain responses to direct laryngoscopy. Nevertheless, it is unclear from previous studies which route of local anesthetic administration best prevents hemodynamic disturbances and discomfort during awake laryngoscopy **(21)**.

The larynx is a potent reflexogenic region rich in sensory afferents that elicit various reflexes in response to mechanical stimulation. The sensory innervation of the larynx is provided by the internal branch of the superior laryngeal nerve (SLN) which can be blocked bilaterally, and this block is commonly performed as a part of local nerve block of the upper airway during rigid direct laryngoscopy, or for awake fiberoptic bronchoscopy. It was also reported that the block of internal branch of superior laryngeal nerve can attenuate hemodynamic response and catecholamine release associated with direct laryngoscopy in patients undergoing coronary artery bypass grafting **(22)**.

The superior laryngeal nerve branches out of the vagus nerve just below the nodose ganglion, then it descends close to the pharynx, behind the internal carotid artery, and ends by dividing into two branches; the external branch that descends on the larynx, beneath the sternothyroid muscle then penetrates cricothyroid muscle to give it motor supply, while the internal branch passes 2–4 mm inferior to the great cornu of hyoid bone where it pierces the thyrohyoid membrane then ramifies to give sensory supply to the base of tongue, epiglottis and mucosa of the larynx as far as inferiorly as the vocal cords **(22)**.

During endoscopic laryngeal surgeries, combining the bilateral block of the internal branch of superior laryngeal nerve as an adjuvant to general anesthesia was associated with better intubation conditions, better intraoperative hemodynamic response to intubation and surgical procedure and better recovery profile in the form of improved postoperative cough and sore throat **(4)**.

Pharmacological management of the hemodynamic response:

The pressor response to laryngoscopy and tracheal intubation could be mitigated by many pharmacological agents without a perfect profile. This includes increasing the depth of anesthesia e.g., with potent volatile anesthetics, intravenous opioids as fentanyl or remifentanil, intravenous or transtracheal lidocaine, vasodilators e.g., Na^{+} nitroprusside or nitroglycerin, β blockers e.g., esmolol, Ca^{++} channel blockers e.g., verapamil, and or presynaptic α 2 agonists e.g., clonidine. Although most of these techniques can be used, none of them can stand alone as a perfect choice for obliterating the hemodynamic perturbations associated with endotracheal intubation **(23)**.

Opioids:

Use of opioids showed an obtundation of both BP and HR when compared to placebo. Fentanyl 2 μg/kg, remifentanil 1 μg/kg, sufentanil 0.1 μg/kg and 0.2 μg/kg, and alfentanil 25 μg/kg were trialed to obtund the hemodynamic responses to laryngoscopy. Remifentanil 3 μg/ kg and sufentanil 0.3 μg/kg appear to completely abolish the response but at the expense of cardiovascular instability in unstimulated patients before the start of surgery **(24)**.

In different studies remifentanil in doses of 0.75 μg/kg to 3 μg/kg attenuated the response in a dose-related manner. Sufentanil 0.1–0.3 μg/kg also resulted in dose-related attenuation. Fentanyl showed a variable response in different studies. Some of these differences can be explained based on differential effects of different opioids on baroreceptors and central vagal tone. Side-effects such as chest wall rigidity, oxygen desaturation and coughing were few and seen only in spontaneously breathing patients who received alfentanil or remifentanil. Arrhythmias were observed in seven studies, but in all cases these were transient. While adverse effects were rare, the studies had insufficient power to fully assess morbidity **(24)**.

Beta and Calcium channel blockers:

Short acting beta blockers e.g., esmolol can be used to attenuate the pressor response to laryngoscopy. Esmolol is a short-acting, cardio-selective beta-blocker, and class II antiarrhythmic agent. The onset of action is within 60 seconds and has a 9-minute half-life with rapid renal clearance. Esmolol can be administered as a bolus of 500 mcg/kg over 1 minute, followed by 50 mcg/kg per minute infusion for 4 minutes. The effect of esmolol is vanished by rapid hydrolysis by the esterase enzyme in RBCs. Labetalol is often chosen as treatment of acute hypertension peri-operatively as it produces a dose-related decrease in blood pressure without reflex tachycardia or significant reduction in heart rate. These effects are produced through its alpha- and beta-blocking effects **(25)**.

Verapamil is a phenylalkylamine calcium channel blocker used in the treatment of hypertension, dysrrhythmias, and angina. It is a member of the non-dihydropyridine class of calcium channel blockers. Verapamil is administered in a dosage of 2.5-5 mg intravenous over 2 minutes. Verapamil is indicated in the treatment of vasopastic angina, unstable angina, and chronic stable angina. It is also indicated to treat hypertension, for the prophylaxis of paroxysmal supraventricular tachycardia, and in combination with digoxin to control ventricular rate in patients with atrial fibrillation **(26)**.

Drugs used to prevent or attenuate the laryngoscopy and tracheal intubation response, may also cause hypotension and/or bradycardia in significant numbers of patients post induction. In current practice most patients with ischemic heart disease and hypertension are either on mono or multi therapy. Many of these patients are either treated with beta blockers (BB) or a combination of beta blockers and calcium channel blockers (BB+CCB). An increasing number of such patients are now scheduled for surgery. A combination of beta blocker and calcium channel blockers may lead to varying degree of atrioventricular conduction block. Also, the negative inotropic effect of this combination may also cause profound hypotension and or bradycardia **(27).**

Beta blockers have little effect on normal heart in a resting patient, but they decrease heart and myocardial contractility when sympathetic activity is decreased. Anesthesia imposes additional myocardial depression in beta blocked patients, but this is well tolerated as anesthesia is commonly accompanied by vasodilation that unloads ventricles and facilitates forward flow. In Stone study, hypotension (SAP <70 mmHg) occurred after induction in a substantial number of beta blocker group, but to a lesser extent in those treated with oxprenolol compared to labetalol and atenolol perhaps because of the intrinsic sympathetic activity. This fall in BP was not accompanied by myocardial ischemia **(27).**

Antihypertensive therapy with beta blockers and calcium channel blockers can affect the hemodynamic responses at induction of anesthesia and expose patients to hypotension. The mean fall in SAP after induction exceeded 20% of baseline in both groups in the post induction period, whereas changes in HR were minimal. The hemodynamic response to laryngoscopy and intubation and incision were obtunded but at the expense of preintubation low pressures, but the SAP again fell to more than 20% of baseline 5 minutes post laryngoscopy **(27).**

Nitroglycerin

Nitroglycerin is another option used in some studies to prevent hemodynamic stress-induced ischemia. Nitroglycerin is a vasodilator that acts on vascular smooth muscle and is taken intravenously mixed with 5% dextrose. Also, it is used as topical or as a spray in the nose. Its dilating effect on the veins is noticeable, but it also dilates the arteries dose dependently. Bolus doses of 1 and 2 μg/kg nitroglycerin in non-cardiac elective surgery prevents the increase of mean systolic, diastolic, and mean arterial blood pressure but has no significant effect on the heart rate after intubation. It has a beneficial, rapid, and reversible effect on reducing afterload and preload in patients with heart failure. Reflex tachycardia can occur but is usually slight. There may be a dose-dependent fall in arterial oxygen saturation due to inhibition of hypoxic pulmonary vasoconstriction **(28)**.

Nitroprusside

Sodium nitroprusside is a direct acting vasodilator agent used to treat hypertension, to reduce postoperative bleeding, to induce controlled hypotension, and to manage acute congestive heart failure. Nitroprusside relaxes the vascular smooth muscle and so, produce consequent dilatation of peripheral arteries and veins with a half-life of about 2 minutes. Overdosage of nitroprusside can result in excessive hypotension or cyanide toxicity or as thiocyanate toxicity **(29)**.

The usual dose rate is 0.5 to 10 mcg/kg/minute, but infusion at the maximum dose rate should never last more than 10 minutes. Depending on the desired concentration, the solution containing 50 mg of sodium nitroprusside injection must be further diluted in 250 to 1000 mL of sterile 5% dextrose injection. The diluted solution should be protected from light, using any opaque material. It is not necessary to cover the infusion drip chamber or the tubing **(29)**.

Dexmedetomidine:

Dexmedetomidine is an α_2 adrenergic agonist, with sedative, anxiolytic, and analgesic effects. It requires a 10-minute loading dose, followed by a continuous infusion, and is recommended for sedation when preservation of spontaneous respiration is needed. Evaluation of sleep staging demonstrated that DEX sedation results in nonrapid-eye-movement (NREM) sleep without significant respiratory depression. All four studies evaluating DEX reported that it has a minimal effect on upper airway cross-sectional area. A comparison between DEX and propofol reported that propofol is more likely to decrease airway cross-sectional area and thus affect upper airway dynamics **(30)**.

Lidocaine

Lidocaine has a rapid onset of action (1–5 minutes) and intermediate duration of efficacy (10–15 minutes) when used topically. It is safe to use during upper airway endoscopy, with minimal potential for systemic toxicity. Studies assessed the impact of topical lidocaine on upper airway obstruction and three reported an increase in airway obstruction, whereas four demonstrated no significant effect. Lidocaine 1.5 mg/kg given approximately 4 to 4.5 minutes before intubation was beneficial to attenuate the pressor response to laryngoscopy and intubation and reduced the incidence of cardiac dysrhythmias **(15).**

References

1. **Evers, A. S., Crowder, C. M., & Balser, J. R. (2006).** General anesthetics. Goodman & Gilman's The Pharmacologic Basis of Therapeutics. 11th ed. Brunton LL, Lazo JS, Parker KL (Eds). New York, McGraw-Hill, 341-368.
2. **Brown, Emery N., Ralph Lydic, and Nicholas D. Schiff. (2010)** "General anesthesia, sleep, and coma." New England Journal of Medicine 363.27: 2638-2650.
3. **Langeron, O., Amour, J., Vivien, B., & Aubrun, F. (2006).** Clinical review: management of difficult airways. Critical Care, 10(6), 243.
4. **Ahmed, R. A., & Boyer, T. J. (2023).** Endotracheal Tube. In StatPearls. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK539747/
5. **Salem, M. R. (2001).** Verification of endotracheal tube position. Anesthesiology Clinics of North America, 19(4), 813–839.
6. **Peterson, K., Ginglen, J. G., Desai, N. M., & Guzman, N. (2023).** Direct Laryngoscopy. In StatPearls. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK513224/
7. **López, A. M., Belda, I., Bermejo, S., Parra, L., Áñez, C., Borràs, R., Sabaté, S., Carbonell, N., Marco, G., Pérez, J., Massó, E., Soto, J. M., Boza, E., Gil, J. M., Serra, M., Tejedor, V., Tejedor, A., Roza, J., Plaza, A., … Listado de autores y miembros de la Secció de via aèria SEVA de la SCARTD. (2020).** Recommendations for the evaluation and management of the anticipated and non-anticipated difficult airway of the Societat Catalana d'Anestesiologia, Reanimació i Terapèutica del Dolor, based on the adaptation of clinical practice guidelines and expert consensus. Revista Espanola De Anestesiologia Y Reanimacion, 67(6), 325–342.
8. **Eisenberg, M. A., Green-Hopkins, I., Werner, H., & Nagler, J. (2016).** Comparison Between Direct and Video-assisted Laryngoscopy for Intubations in a Pediatric Emergency Department. *Academic Emergency Medicine: Official Journal of the Society for Academic Emergency Medicine*, *23*(8),870–877.
9. **Baker, J. B., Maskell, K. F., Matlock, A. G., Walsh, R. M., & Skinner, C. G. (2015).** Comparison of Preloaded Bougie versus Standard Bougie Technique for Endotracheal Intubation in a Cadaveric Model. *The Western Journal of Emergency Medicine*, *16*(4), 588–593.

10. **Lehmann, M., Monte, K., Barach, P., & Kindler, C. H. (2010).** Postoperative patient complaints: A prospective interview study of 12,276 patients. *Journal of Clinical Anesthesia*, *22*(1), 13–21.
11. **Artime, C. A., Roy, S., & Hagberg, C. A. (2019).** The Difficult Airway. *Otolaryngologic Clinics of North America*, *52*(6), 1115–1125.
12. **Wang, H. E., Peitzman, A. B., Cassidy, L. D., Adelson, P. D., & Yealy, D. M. (2004). Out-of-hospital endotracheal intubation and outcome after traumatic brain injury. *Annals of Emergency* Medicine**, *44*(5), 439–450.
13. **Capuzzo, M., Verri, M., & Alvisi, R. (2010).** Hemodynamic responses to laryngoscopy and intubation: Etiological or symptomatic prevention? Minerva Anestesiologica, 76(3), 173–174.
14. **Kayhan, Z., Aldemir, D., Mutlu, H., & Oğüş, E. (2005).** Which is responsible for the haemodynamic response due to laryngoscopy and endotracheal intubation? Catecholamines, vasopressin or angiotensin? *European Journal of Anaesthesiology*, *22*(10), 780–785.
15. **Splinter, W. M., & Cervenko, F. (1989).** Haemodynamic responses to laryngoscopy and tracheal intubation in geriatric patients: effects of fentanyl, lidocaine and thiopentone. Canadian journal of anaesthesia, 36, 370-376.
16. **Joffe, A. M., & Deem, S. A. (2013).** Physiologic and Pathophysiologic Responses to Intubation. In *Benumof and Hagberg's Airway Management* (pp. 184-198.e4). Elsevier.
17. **Sachidananda, Roopa, and G. Umesh. (2019).** A review of hemodynamic response to the use of different types of laryngoscopes. Anaesthesia, Pain & Intensive Care, 201–208.
18. **Haidry, M. A., & Khan, F. A. (2013).** Comparison of hemodynamic response to tracheal intubation with Macintosh and McCoy laryngoscopes. *Journal of Anaesthesiology, Clinical Pharmacology*, *29*(2), 196–199.
19. **Aghdaii, N., Azarfarin, R., Yazdanian, F., & Faritus, S. Z. (2010).** Cardiovascular responses to orotracheal intubation in patients undergoing coronary artery bypass grafting surgery. Comparing fiberoptic bronchoscopy with direct laryngoscopy. Middle East Journal of Anaesthesiology, 20(6), 833–838.
20. **Singh, T. M., & M, S. (2021).** Efficacy of intravenous nitroglycerine in attenuation of hemodynamics to laryngoscopy and intubation. Indian Journal of Clinical Anaesthesia, 4(1), 128–131.
21. **Sitzman, T. B., Rich, G. F., Rockwell, J. J., Leisure, G. S., Durieux, M. E., & DiFazio, C. A. (1997).** Local Anesthetic Administration for Awake Direct Laryngoscopy: Are Glossopharyngeal Nerve Blocks Superior? *Anesthesiology*, *86*(1), 34–40.
22. **De Oliveira, G. S., Fitzgerald, P., & Kendall, M. (2011).** Ultrasound-assisted translaryngeal block for awake fibreoptic intubation. *Canadian Journal of Anesthesia/Journal Canadien d'anesthésie*, *58*(7), 664–665.
23. **Wadbrook, Paula Susanna. (2000).** "Advances in airway pharmacology: emerging trends and evolving controversy." Emergency medicine clinics of North America 18.4: 767-788.
24. **Nazir, M., Salim, B., & Khan, F. A. (2016).** Pharmacological agents for reducing the haemodynamic response to tracheal intubation in paediatric patients: A systematic review. *Anaesthesia and Intensive Care*, *44*(6), 681–691.
25. **Bansal, S., & Pawar, M. (2002).** Haemodynamic responses to laryngoscopy and intubation in patients with pregnancy-induced hypertension: effect of intravenous esmolol with or without lidocaine. International journal of obstetric anesthesia, 11(1), 4-8.
26. **Pascual, Isaac, Cesar Moris, and Pablo Avanzas. (2016).** "Beta-blockers and calcium channel blockers: first line agents." Cardiovascular drugs and therapy 30: 357-365.
27. **Samad, K., Khan, F., & Azam, I. (2008).** Hemodynamic effects of anesthetic induction in patients treated with beta and calcium channel blockers. Middle East Journal of Anaesthesiology, 19(5), 1111–1128.

28. Hajian, P., Sharifi, S., Nikooseresht, M., & Moradi, A. (2021). The Effects of Intravenous Nitroglycerin Bolus Doses in Reducing Hemodynamic Responses to Laryngoscopy and Endotracheal Intubation. *BioMed Research International*, *2021*, 6694150.

29. Hottinger, D. G., Beebe, D. S., Kozhimannil, T., Prielipp, R. C., & Belani, K. G. (2014). Sodium nitroprusside in 2014: A clinical concepts review. Journal of anaesthesiology, clinical pharmacology, 30(4), 462.

30. Ehsan, Z., Mahmoud, M., Shott, S. R., Amin, R. S., & Ishman, S. L. (2016). The effects of Anesthesia and opioids on the upper airway: A systematic review. *The Laryngoscope*, *126*(1), 270–284.