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Intubation and Extubation in ICU

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Keywords: Endotracheal intubation; Anesthesiology; Mechanical ventilation, Trachea; Humidifiers

Abbreviations: SBT: Spontaneous Breathing Trial; RSBI: Rapid Shallow Breathing Index; TV: Tidal Volume; RR: Respiratory Rate; MIP: Maximal Inspiratory Pressure

Review of Literature

When one looks back in years of training in Anesthesiology, Emergency Medicine and critical Care the most important decision which gave you the credit or discredit is, "when you intubate" or "when you do not intubate or extubate correctly". The meaning of intubation in a dictionary simply says insertion of a tube into the body particularly into the trachea to facilitate mechanical ventilation. This is the most important tool to save a life. Everyone remembers the cardiopulmonary resuscitation started with ABC meaning airway, breathing and circulation, giving all the importance to airway and breathing first. Of course, it is now referred to as CAB. As time has shown that the circulation is important particularly in resuscitating cardiac arrest to prevent brain dysfunction and to achieve ROSC at the earliest.

Intubation is the most common procedure in Anesthesiology. A day does not pass without this procedure. Even in critical care or emergency it ranks as one of the most performed procedures in saving lives, giving artificial ventilation and thereby protecting the airway from aspiration of gastric contents. It is an important procedure and every doctor, nurse, technician or a therapist must understand in depth not only as how to do the procedure but how to maintain it without complications and finally how and when to get rid of the tube when it is no longer needed. From the history one realizes that intubation was performed in both India (2000 BC) & Egypt (1500BC) from early times. Arabian doctor Avicenna (980-1037) described the first Oro tracheal intubation in dyspnea. Vesalius in 1543 reported the first tracheal intubation in animals by intubating with a hollow reed. Many reports of tracheal intubation in animals & humans established it as a lifesaving procedure [1].

The history of per oral endotracheal intubation actually began in the 18th century when the first Anesthetic was given in 1846. At that time obstetricians and lifesavers used breathing tubes. In 1880 Macewen preoperatively intubated a patient to prevent the aspiration of blood during extirpation of a tumor from the base of the tongue. Unfortunately, the pioneer himself did not live to see his method become a routine procedure. Regular oral intubation to keep the respiratory tract clear during narcosis was first applied by Franz Kuhn in 1900. It was only as late as 1945, that endotracheal intubation became part of hospital practice [1]. By 1945 intubation has become order of the day in anesthesia practice to protect the airway, control ventilation, ventilate patient and improve breathing as well as to carry out surgery without hindrance.

In the early 1870 Trendelenburg from Germany first performed the endotracheal intubation in man for anesthesia. In 1878 McEwen performed the first elective ET intubation for elective surgery. Khun, who was the first man to administer cocaine to reduce cough and subsequently the same practice was used in the 1st world war. Magill (1887-1986) recognized the advantage of tracheal intubation. By his efforts anesthesia became an independent specialty. In 1913, the first anesthesia laryngoscope was introduced by Chevalier Jackson later modified by Magill and Macintosh. In 1942 curare was introduced as the muscle relaxant and there was no looking back [2]. In the ICU, one intubates a patient for isolating to protect airway; in acute or any type of Respiratory failure, to resuscitate cardiac arrest, or support oxygenation in any type of shock. In the ICU intubation is almost an emergency or can be referred to as unanticipated difficult airway in an urgent situation (Figure 1).

Difficulties in ET intubation increase morbidity & mortality & more so in the ICU. In a study it has been shown that 30% were easy, 47% were moderately easy and 23% as difficult. More

were performed by Anesthesiologists or their trainees, and few by surgical trainees [3]. In the ICU every intubation should be considered as moderately difficult. Therefore, the airway algorithm should be slightly modified to suit the need for unanticipated difficult airway. It is mandatory to have separate difficult airway carts apart from crash trolley in every ICU, as difficult situations may arise many a times in these areas. Therefore, it is mandatory to check this trolley at least two times a day by the duty personnel so that it gets replenished with needed equipment and medicines. (Figure 2) represents a complete kit along with a fiber optic laryngoscope. The airway algorithm is to a certain extent modified in ICU to make it simple, understandable and easy to use it in a routine fashion (Table 1).

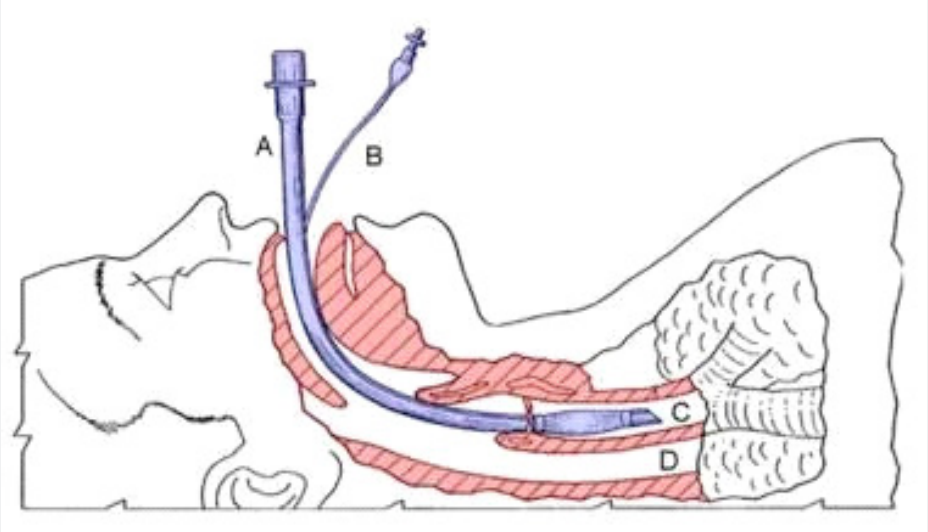

Figure 1: The correctly placed endotracheal tube.

Figure 2: Difficult Airway Kit.

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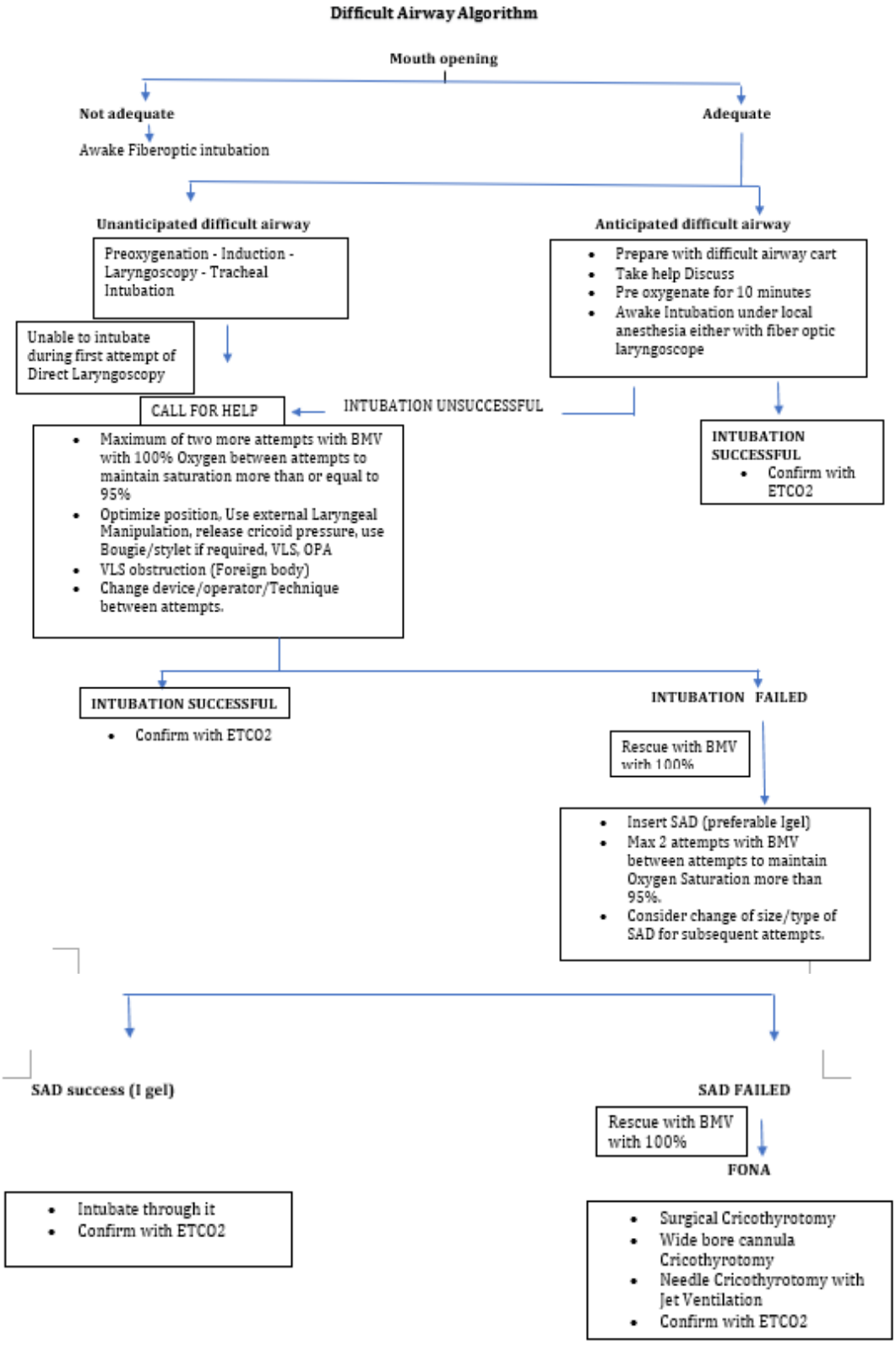
Table 1: FONA (Front of Neck Acess).



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Never ever get into a situation of cannot ventilate and cannot intubate. This should be all the time on one's mind-preventing it religiously than treating it. In the emergency department and in the ICU it is not possible to have the same conditions as in elective anesthesia. Therefore, slight modification and having a protocol is mandatory to successfully intubate without stress even in a difficult situation. It is always easy to intubate, but what is more difficult, is to manage it for next few days untill the patient gets extubated successfully or goes on for a tracheostomy to get released from the endotracheal tube, or sometimes may get re intubated for a different reason.

In both Emergency and Anesthesia, the period of intubation lasts for a few hours to a day. However, it lasts for a minimum of 5-7 days in critical care and most of the time they are connected to a mechanical ventilator. An endotracheal tube is a greatest irritant in the trachea and the patient will try to pull it out any time, or it may get dislodged, if the patient is not properly sedated. The first 24 hours are very crucial and may require muscle paralysis and deep sedation. The tracheal mucosa is highly sensitive. We do experience in our life when by mistake food enters the airway which results in severe bouts of coughing and spasm. The same happens when we place an endotracheal tube into the trachea. Due to sympathetic stimulation leading to hemodynamic response as depicted by increase in heart rate and blood pressure and spasm which can lead to deleterious effects if not sedated adequately. All patients are pre oxygenated for a period of 5 minutes with 100% oxygen with adequate seal with a face mask.

Many drugs have been tried to reduce this response. One of the earliest at the time of induction with a sedative, analgesic and an anesthetic agent as well as a muscle relaxant is plain 2% lignocaine 1-2mg /Kg body weight before intubation. One has to understand as to which the optimal time is to intubate after giving this drug. In our paper we have seen 3 minutes is ideal time after giving the drug and it correlated well with highest concentration of the drug level in the blood [4]. Number of anesthetic and analgesic drugs like fentanyl, sufentanyl, propofol, dexmeditomedine have been tried and found to give best suppression between 2-3 minutes after administration of the respective drug [5]. Drugs like esmolol has shown promise but is not used on a regular basis as it should be given as an infusion. Magnesium is another drug which showed promise and is usually used in acute exacerbation in asthmatic patients in ICU. Intubation can exacerbate asthma and has been linked to 13-16% risk of mortality therefore coupling magnesium with lignocaine is particularly useful when asthmatic patients are intubated [6].

The idea for reducing these responses is more essential, especially in unstable neurological patients. Lignocaine 2mg/kg blunts the cough and gag reflex halting the transmission of intrathoracic pressure to the cerebrum. However, in a patient who is paralyzed it may not be a great concern. The decrease in ICP is probably related to sympathetic activity. It also reduces the cerebral metabolism and stabilizes the cell membrane by blocking the membrane sodium channels. Prophylactic lignocaine also decreases the intra orbital pressure that accompanies the tracheal manipulation. This response is independent of paralytic agents. Donegan, Bradford et al. postulated that its effect is due to its dual ability to not only attenuate the rise in mean arterial pressure, but also directly decrease the cough and gag reflex [7].

Once the tube is inserted it is mandatory to be checked whether it is in the right place with the help of an $Etco_2$ monitor. It has become the point of care for safety to indicate that it is in the right place. Followed by checking with stethoscope should also be mandatory to avoid right bronchial intubation. Five-point auscultation and particularly the left apex auscultation to check the air entry. The $Etco_2$ will show this problem after a few minutes if not auscultated properly and should be observed keenly on the $Etco_2$ monitor (Figure 3). This bifid waveform represents the differential ventilation of two lungs. Basically, the ETT is positioned mainly in the right main bronchus, the airflow through the right lung is the best, and right-sided gas forms the first (brisk and steep) part of the waveform. Afterwards, one notices that there is a secondary transitional phase, which is the gas from the left lung escaping slowly up into the ETT unless the cuff blocks the left bronchus totally.

Another important aspect which should always be kept in mind is capillary pressure. It is usually around 25mm Hg. We have to inflate the cuff to a pressure which should be around 18-20mm of Hg, this in turn will prevent inflammation, and necrosis in the trachea in the long term. This pressure should be checked a minimum of twice daily to prevent these complications. The amount of air injected into the cuff should just prevent leak and there by aspiration. Over inflation can lead to the problems discussed above. Fixing the tube is also a very important aspect which often is not done in a proper manner. The tube should be fixed at 22cm level in men and 19-21cm in women. Depending on the stature and height, minimum alterations can be made. It is always ideal to fix the tube with transparent plaster and then use the thicker plaster just below the level of the first one. This will make the tube not move up and down and the soft plaster does not cause blisters at the time of removal. Hydration, nebulization, suctioning after pre oxygenation for 5 minutes is a must and should be done on a regular basis to prevent drying up and inspissation of secretions. It prevents thickening of secretions and thereby leading to partial blockage of the airway as well as the tube.

Now the disposable humidifiers are being used. The humidifiers should provide humidity level of 33-44mg/H2O/L per square and temperature 34-41 degrees c at the circuit at y piece with a relative humidity of 100% to prevent drying up of secretions in the artificial airway. One should check them and change them on a regular basis [8]. Topical and IV lignocaine reduces the hemodynamic response and incidence of sore throat at the time of extubation in surgical patients. In a randomized study, we documented 4% lignocaine versus air when instilled in the cuff reduced the post extubation stridor, and the amount of sedation [9].

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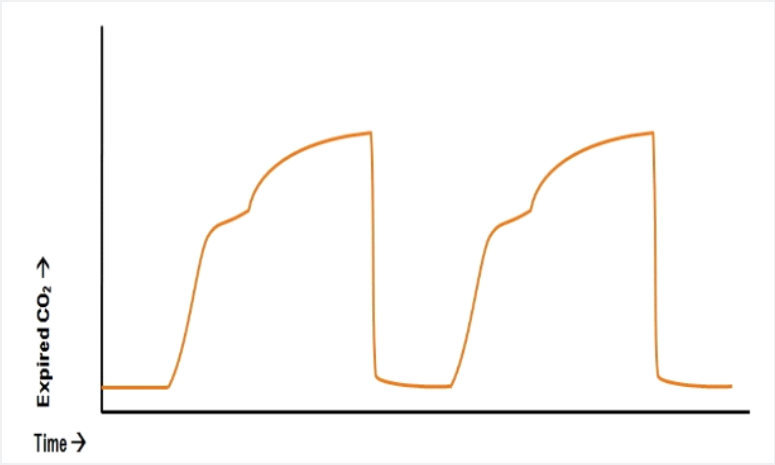

Figure 3: Bifid Wave Form of Endobronchial Intubation.

The most important aspect is to use less relaxants unless very much indicated as in ARDS and neurosurgical patients. It should be mandatory to reduce relaxants and come down on sedation and analgesia by the second day after intubation. Use of dexmeditomidine reduces the number of opioids, fentanyl and midazolam for sedation. It also circumvents the ICU delirium. The only disadvantage is the inability to use it in hypotension and shock or in patients with bradycardia. Using it in very small doses makes it an ideal drug for both sedation and analgesia. This is only a drug which does not have a prolonged effect even when used for long time as infusion. The patient wakes up in a few minutes after stopping the infusion as it has a very short half-life. The complications associated with prolonged intubation can to a great extent overcome by combining all the various methodologies suggested very diligently. Once the primary problem is corrected and taken care of, it is ideal to release the patient from mechanical ventilation by adopting various weaning criterion. Clinical and various tests are performed to release mechanical ventilation. (Weaning is gradual reduction of ventilation).

Weaning is a process to reduce the mechanical ventilation and see that patient breathes on their own without much assistance or minimum assistance. There are many criteria for weaning patients, which are clinical, basic respiratory function testing, using some indices. However, one must confirm the basic problem for which a patient is put on ventilator is to a large extent solved. The patient should be awake and able to understand and communicate by signs before we start to wean by normalising I:E ratio, reducing Fio_2 (usually to less than <0.6). The next one is reducing PEEP which keeps good oxygenation, appropriate underlying respiratory rate, to be around 16-18 per minute, appropriate tidal volume with moderate airway pressures 350ml in adults [10]. The other common indices to weaning parameters to consider initiating the spontaneous breathing trial (SBT) are RSBI of less than 100, The rapid shallow breathing index (RSBI) is calculated as the ratio of tidal volume (TV) in liters to respiratory rate (RR) in breaths/minute: RSBI = TV/RR. a. With RSBI <105, a weaning attempt can be expected to be successful 78% of the time.

The maximal inspiratory pressure (MIP) of less than -30cm of water, and minute ventilation of less than 10 liters per minute are the common parameters included for successful weaning protocol. The SBT trial can be started by explaining the procedure to the patient that it will last only for a short period of time. Put the patient in 30-degree head up if he is not in that position, Reduce Fio_2 first and then the pressures, respiratory rate and encourage the patient to breathe normally. One can utilize SIMV mode at the time of weaning by watching the spontaneous minute ventilation and the rate and using pressure support for the spontaneous breaths. After satisfactory trail with this mode, put the patient in a comfortable position after suctioning, see if he is able to breath spontaneously with the tube in situ This should not be for a long period as the resistance to breathing is much higher with tube in place and causes problems.

Sometimes giving them minimum pressure support and peep can make them less anxious. Monitor increase in rate of breathing or any labored breathing or even an increase in $ETco_2$. If all parameters are within normal limits one can extubate and support for an hour on minimum pressure support and PEEP on NIV. This will increase the patient's confidence to a great extent. A new systematic review suggests that noninvasive ventilation after early extubation helps in reducing the total days spent on invasive mechanical ventilation, and there by the patients spending less time on invasive ventilation had lower rates of ventilator-associated-pneumonia [11].

The role of physiotherapy in Mechanical Ventilation and Weaning is very well understood. Traditionally physiotherapists have been involved in the respiratory care of patients on

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mechanical ventilation in ICU [12]. Respiratory care involves optimization of ventilation, airway clearance, prevention of pulmonary complications, and hastening weaning from mechanical ventilation. Techniques used by physiotherapy to help improve patient breathing and wean patients off ventilators may include Suctioning, Postural drainage, and Percussion Vibrations, which have been largely taken over by the respiratory therapists who are now part of the ICU team.

After successfully weaned the patient from mechanical ventilation the next most important step is to release them from the endotracheal tube or extubate the patient. Even when all criteria are met, some percentage of people get re intubated leading to undesirable situation for the intensivist, treating physician and the patient as well as their relatives. If we look at the percentage of re intubations, they vary widely. The reintubation rates following planned extubation are around 10-20% in the general ICU population [13]. There is evidence that extubation failure and re-intubation can worsen the outcome, with studies suggesting ICU mortality rates between 25-50% in these patients [14].

Therefore, it is mandatory that every effort should be made to decrease this event. In our own study we have seen that extubation stridor which is one of the major causes for re intubation can be reduced by measuring the airway column width before and at the time of extubation. Keeping it at 0.9mm will prevent the stridor. Therefore, it is mandatory that every effort should be made to decrease this.

The incidence of stridor in our study was 6.9% (5/72). The duration of mechanical ventilation was 5.60 ± 1.14 days and 3.91 ± 1.45 days in the stridor and non-stridor group, respectively. All 72 patients were extubated when cuff leak was >100ml. The average volume of cuff leak in stridor and non-stridor group was 112.0 ± 10.36ml and 191.34 ± 54.00ml respectively. The mean air column width in stridor group after intubation (cuff deflation) was 5.98 ± 0.19mm and before extubation (cuff deflation) was 4.46 ± 0.20mm. The mean air column width in the non-stridor group after intubation (cuff deflation) was 6.01 ± 0.38mm and before extubation (cuff deflation) was 5.64 ± 0.38mm. The air column width ratio (before extubation/after intubation) in stridor and non-stridor groups were 0.74 ± 0.04mm and 0.93 ± 0.02mm respectively. In our study five patients with an air column width ratio of 0.8 or less had post extubation stridor even with standard cuff leak test volume of >100 ml [15].

I. The cuff leak test is performed on every patient who is on a ventilator before extubation. It is performed systematically in the following way.

II. Suction endotracheal and oral secretions and set the ventilator in the assist control mode with the patient receiving volume-cycled ventilation.

III. With the cuff inflated, the record displayed inspiratory and expiratory tidal volumes to see whether these are similar.

IV. Deflate the cuff.

V. Directly record the expiratory tidal volume over the next six breathing cycles as the expiratory tidal volume will reach a plateau value after a few cycles.

VI. Average the three lowest values.

VII. The difference between the inspiratory tidal volume (measured before the cuff was deflated) and the averaged expiratory tidal volume (after cuff deflation) is the cuff leak volume.

VIII. suggested approach is to use 110 mL or 10% of tidal volume as the cut-off.

IX. tracheal extubation can still be successful in many patients with a positive test (low value)

X. a low value for cuff leak can also be caused by encrusted secretions around the tube rather than by a narrowed upper airway [16].

Once the patient is extubated, they have to be monitored closely by looking at respiratory effort, respiratory rate, oxygenation, heart rate and rhythm, end tidal Co_2 and the level of consciousness. It may be useful to use minimum bi level in patients who were on ventilator for more than 5 days as it gives adequate support and therefore confidence to patients as well as the intensivist that things are under good control. This can lead to an easy environment to extubate successfully. This will be very useful if they show a high respiratory rate after extubation. Weaning from mechanical ventilation based on clinical parameters and rapid shallow breathing index (RSBI) is associated with a higher weaning failure. Ultrasound of the diaphragm is gaining popularity to assess the diaphragm function. In recent times the respiratory excursions of the diaphragm on ultrasound also gives a good indication about the state of the principal muscle of respiration and its functional capacity. It was shown in a study that Diaphragm ultrasound helps in predicting successful weaning in mechanically ventilated patients. Both DE (diaphragmatic excursion) and DTF (diaphragm thickening fraction) showed a higher specificity than RSBI and a combination of RSBI-DE and RSBI-DTF was better than using RSBI alone [17].

It is also very important to prevent ventilator associated events. Following infection prevention protocols and monitoring the CPIS gives a great advantage to track ventilator associated pneumonia at an early stage as we have demonstrated in a study tracking VAP [18]. It is not how well we intubated without any complication but how well we took care of the patient without causing any complication and how we can reduce even the lowest re intubation rate, thereby making it a successful procedure anywhere it is performed. Though it is a common procedure

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performed in any hospital by different groups of persons, it is indeed ideal to perform it diligently with care. Combined medical precision and protocols, we will be able to avoid unnecessary complications which can jeopardize patient's safety. Always my adage to everyone who works in these settings is- Intubate when you are in doubt and do not extubate when you are in a dilemma.

References

1. H Luckhaupt, T Brusis (1986) History of intubation. Laryngol Rhinol Otol (Stuttg) 65(9): 506-510.
2. Tiberiu E, Shmuel E, Henry H, Yehuda R (2005) Tracheostomy and endotracheal intubation: a short history. Harefuah 144 (12): 891-893.
3. JF Heuer, TA Barwing, J Barwing, SG Russo, E Bleckmann, et al. (2012) Incidence of difficult intubation in intensive care patients: analysis of contributing factors. Anesth intensive care 40(1): 120-127.
4. S Manimala Rao, MUR Naidu et al. (1995) Pharmacokinetics of intravenous lignocaine and its correlation with hemodynamic responses to tracheal intubation. Journal of anaesthesiology and clinical pharmacology 11: 199-202.
5. Keith AL, Eric DS (2019) Medications used in Tracheal intubation. Medscape.
6. Fabricio TM, Lucas MGMQ, Cristina CRG, Alexandre CDX (2017) Effects of lidocaine and magnesium sulfate in attenuating hemodynamic response to tracheal intubation: single-center, prospective, double-blind, randomized study. Rev Bras Anestesiol 67(1): 50-56.
7. Donegan M, Bedford RF, Dacey R (1979) IV lidocaine for prevention of intracranial hypertension. Anesthesiology 51: S201.
8. Resterpo RD, Walsh BK, AARC Clinical practice Guidelines (2012) Humidification during invasive and noninvasive mechanical ventilation. Respiratory care 57(5): 782-788.
9. Manimala R, Snigdha, Taggu A, Kumar V (2013) Instillation of 4% lidocaine versus air in the endotracheal tube cuff to evaluate post intubation morbidity- A randomised double blind study. Journal of Anesthesiology and Clinical Science 2: 19.
10. Boles JM, Bion J, Connors A, Herridge M, Marsh B, et al. (2007) Weaning from mechanical ventilation. European Respiratory Journal 29: 1033-1056.
11. Vaschetto R, Pecere A, Perkins GD, Mistry D, Cammarota G, et al. (2021) Effects of early extubation followed by noninvasive ventilation versus standard extubation on the duration of invasive mechanical ventilation in hypoxemic non-hypercapnic patients: a systematic review and individual patient data meta-analysis of randomized controlled trials. Critical care 25(1): 189.
12. Bhat A, Vasantha IT, Babu AS (2017) Role of Physiotherapy in weaning of patients from mechanical ventilation in intensive care unit. Indian Journal of Respiratory Care 6: 813-839.
13. Kinsley J, Reddy P, Iqbal A (2012) A case control study of failed extubation crit care 16(suppl).
14. D Whitmore, T Mahambray (2015) Re intubation follow up planned extubation Incidence, mortality and risk factors. Filence case Med Exp (suppl1): A684.
15. Pradeep MV, K Mahendrakar, SM Rao, Dnyaneshwar PM, Chetan GS, et al. (2015) Laryngeal air column width ratio in procedures post extubation slides; Indian J Crit Care Med 19(3): 170-173.
16. Sengupta S. Chkravarthy C, Rudra A (2018) Evidence-Based Practice of Weaning from Ventilator: A Review.
17. Ravi S, K Nivedita, K Karthik, R Venkatraman (2022) Role of diaphragm ultrasound in weaning mechanically ventilated patients: A prospective observational study: Ind J Anaesth 66(8): 591-598.
18. Yogesh H, Manimala RS, Jyothinarayan S, Aanchal B, Betham S, et al. (2013) Detection of ventilator associated pneumonia, using clinical pulmonary infection score (CPIS) in critically ill neurological patients. Journal of Anaesth & clinical Science.

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