

SWESEM's utbildningsutskott

Rubrik

Coniotomi och nålcricothyrotomi

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Introduktion

Coniotomi (kirurgisk cricothyrotomi) eller nålcricothyrotomi är indicerade i situationer där patienter som behöver ventileras varken kan intuberas eller oxygeneras på ett annat sätt ("can't intubate, can't oxygenate")^{1,3}. Litteraturen betonar vikten av att inse när intubation eller övriga luftvägsåtgärder har misslyckats och att då genomföra coniotomi eller nålcricothyrotomi utan dröjsmål².

Procedurerna behövs i en situation som redan är stressande där många andra åtgärder är på gång. Teamets uppmärksamhet behöver samlas, så att alla teammedlemmar är medvetna om behovet av en urakut, invasiv luftvägsåtgärd.

I specialisttentamen

Vissa coniotomikit innehåller utrustning för att genomföra coniotomi med Seldingerteknik. Dessa kit är inte tillgängliga överallt. Vid specialisttentamen testas därför förmågan att genomföra coniotomi eller nålcricothyrotomi med enkel, allmänt tillgänglig utrustning. Exempel på utrustning för nålcricothyrotomi visas nedan, även om bäst är en kateter/kanyl som inte knickas.



Jetventilation. Väggtagg, slang från vanlig syrgasmask, 3-vägskran med 10 cm slang, 14 G PVK



Ventilation med Rubens via 14 G PVK
2,5 ml spruta utan kolv, och kopplingen
från endotrakealtub storlek 7 mm

CONIOTOMI

Indikation

- När patienten inte kan intuberas eller oxygeneras på ett annat sätt^{1, 3}

Kontraindikation

- Barn < 10 år⁴

1-Förbereder patienten

- ☐ Patienten på rygg⁵
- ☐ Nacken rak eller hyperextenderad⁶
- Tvätta huden med klorhexidin eller motsvarande om tiden tillåter⁷

2-Förbereder utrustning

- Skyddsutrustning⁸ (handskar), rock och ögonskydd om tiden tillåter
- ☐ Skalpells #10 eller #11⁹
- ☐ Bougie
- ☐ Endotrakealtub nr 6; kontrollerar kuffen¹⁰
- ☐ Rubens blåsa eller motsvarande¹¹
- ☐ Tejp eller motsvarande för att fixera tuben¹²

3-Ingrepp¹³

- ☐ Stabilisera sköldbrusket med den icke-dominanta handen¹⁴
- ☐ Försök lokalisera membrana cricothyroidea¹⁵; om denna inte kan lokaliseras görs en longitudinell incision i medellinjen för att hitta membranet¹⁶
- ☐ Tryck skalpellbladet transversellt genom membranet¹⁷
- ☐ Vidga hålet genom att skära lateralt
- ☐ Vrid skalpellen 90° så att den skarpa delen av bladet är nu riktad mot patientens fötter
- ☐ Dra skalpellen lateralt för att skapa ett triangulärt hål
- ☐ Inför bougien längs skalpellen in i trakea
- ☐ Dra ut skalpellen och avancera bougien caudalt i trakea
- ☐ Sätt endotrakealtuben på bougie och inför den in i trakean genom att rotera den kring bougien
- ☐ Kuffa tuben och dra den tillbaka tills att motstånd känns
- ☐ Dra ut bougien

4-Kontroller

- ☐ Ventilera med blåsa¹⁸
- ☐ Kontrollera tubläge med lungauskultation, inspektion av bröstkorgen, EtCO₂¹⁹
- ☐ Fixera tuben²⁰
- ☐ Utvärdera resultat med pulsoximetri

NÅLCRICOTHYROTOMI

Indikation²¹

- Kan varken intubera eller ventileras
- Barn < 10 år

Kontraindikationer²²

- Avsliten trakea distalt (absolut)
- Total övre luftvägsobstruktion (relativ)
- Vuxen patient (relativ)

1-Förbereder patienten²³

- ☐ Patienten på rygg
- ☐ Nacken rak eller hyperextenderad
- Tvättar huden med klorhexidin eller motsvarande om tiden tillåter, ev lokalbedövning

2-Förbereder utrustning

- ☐ Skyddsutrustning (handskar, rock, ögonskydd)²⁴
- ☐ 12- eller 14-gauge PVK kopplad till en spruta delvis fylld med koksalt²⁵
- ☐ Om patienten är < 5 år: utrustning för att koppla till Rubens blåsa²⁶
- ☐ Om patienten är > 5 år: utrustning för jetventilation²⁷

3-Ingrepp

- ☐ Identifierar membrana cricothyroidea²⁸
- ☐ För in nålen/katetern genom huden under pågående aspiration tills luft aspireras²⁹
- ☐ Håller nålen stilla, för in katetern och tar bort nålen³⁰
- ☐ Om patienten är < 5 år: kopplar katetern till Rubens blåsa och ventilerar³¹
- ☐ Om patienten är > 5 år: kopplar katetern till syrgasuttag (vägg eller syrgastub) och jetventilerar³²
- ☐ Fixerar katetern (manuellt eller alternativ)³³

4-Kontroller

- ☐ Inspekterar bröstkorgsrörelser³⁴
- ☐ Utvärderar resultat med pulsoximetri
- ☐ Förbereder för definitiv luftväg³

ANTECKNINGAR

1-"Can't intubate, can't oxygenate"

"Inability to orotracheally intubate an emergency patient and adequately maintain oxygenation is the prime indication for surgical or needle cricothyroidotomy. Orotracheal (or nasotracheal) intubation should be attempted first. Inline cervical stabilization must be maintained in trauma patients. If orotracheal intubation is unsuccessful, and adequate oxygenation cannot be maintained while "rescue" devices are tried, then cricothyroidotomy should be considered. Surgical cricothyroidotomy is usually reserved for patients >10 to 12 years old. Needle cricothyroidotomy is the procedure of choice in those <10 to 12 years old." (Tintinalli 2011 Chapter 31)

2-Luftvägsalgoritm

"when approaching a patient in respiratory distress, the clinician must have a clear algorithm in mind with a well-defined point at which attention is shifted from laryngoscopy to cricothyrotomy" (Hebert 2009)

3-Coniotomi: indikationer

"Subglottic surgical cricothyrotomy is the final airway solution when traditional laryngoscopy and rescue airways have failed or are impossible, and the patient cannot be oxygenated. The most common indication is the "can't intubate, can't ventilate" scenario, which is extremely rare in emergency pediatric airway management." (Tintinalli 2011 Chapter 29)

"A failed airway is defined as three unsuccessful attempts at intubation by an experienced operator or failure to maintain oxygenation." (Tintinalli 2011 Chapter 30)

"Approximately 3% of intubation attempts are in difficult airways where a surgical airway should be anticipated. The rate of failed ED intubations and subsequent surgical airway placement is below 0.6%. However, it would be prudent to prepare for a "worst case scenario" during all intubations." (Tintinalli 2011 Chapter 31)

"The indications for an emergency surgical airway are several; however, most emergency surgical airways are performed due to an inability to establish an endotracheal airway in a patient that cannot be oxygenated and ventilated adequately while alternative "rescue" methods are attempted. Difficulty in establishing an airway may be due to anatomy (short, obese neck), a disease state (epiglottitis, laryngeal edema, paralyzed vocal cords, or retropharyngeal abscess), trauma from distortion of the neck by hematoma (cervical fracture or major vessel injury), aspiration of blood (facial trauma), or loss of supporting structures (mandibular fractures)." (Tintinalli 2011 Chapter 31)

"Surgical cricothyroidotomy is always preferred over needle cricothyroidotomy (except for children <10 to 12 years old, as noted above in Age) because the large diameter of the 6-mm (internal diameter) endotracheal or tracheostomy tube provides better airflow and ventilation compared with the smaller diameter 14- or 12-gauge needle cricothyroidotomy catheter. Emergency tracheostomy should be performed only by physicians who are familiar with surgical anatomy and skilled in the procedure. (Tintinalli 2011 Chapter 31)

"When surgical airway management is required, cricothyrotomy is the procedure of choice in the emergency setting, where it is faster, more straightforward, and more likely to be successful than tracheotomy. Cricothyrotomy is indicated when oral or nasal intubation is impossible or fails and

when BMV cannot maintain adequate oxygen saturation (the “can't intubate, can't ventilate” situation). Several large series have established that the incidence of cricothyrotomy is approximately 1% of all ED intubations.” (Walls 2009)

“The major indication for cricothyroidotomy is the inability to establish an airway through orotracheal or nasotracheal intubation, which may be due to difficult patient anatomy, excessive blood in the mouth or nose, massive facial trauma, or airway obstruction resulting from angioedema, trauma, burns, or a foreign body obstructing the airway.” (Hsiao 2008)

“The chief indication for surgical cricothyrotomy is the inability to secure the airway by noninvasive techniques in a patient with impending or ongoing hypoxia.[19] Surgical cricothyrotomy, like any invasive procedure, has significant complications and should not be attempted until less invasive measures have failed. When the time and clinical situation allow, it may be appropriate to attempt to intubate multiple times or to try alternative intubation techniques. However, at some point, it becomes clear that further attempts at intubation become futile and the benefits of the surgical airway outweigh the risks the patient will incur from ongoing hypoxia” (Hebert 2009)

“The difficult airway is one in which mask ventilation or tracheal intubation is challenging. Approximately 1% to 3% of tracheal intubations prove impossible with standard techniques. Difficult mask ventilation is defined as the inability to maintain O₂ saturation above 90% despite optimal positioning and airway adjuncts. A failed airway is defined as three unsuccessful attempts at intubation by an experienced operator or failure to maintain oxygenation.” (Tintinalli 2011 Chapter 30)

“If more than one intubation attempt is required, oxygen saturation is monitored continuously, and if saturation falls to 90% or less, BMV is performed until saturation is recovered for another attempt. If the clinician cannot maintain oxygen saturation with BMV, despite optimal use of a two-person, two-handed technique with an oral airway in place, a failed airway exists. This is referred to as a “**can't** intubate, **can't** oxygenate” situation. In addition, if three attempts at direct laryngoscopy have been unsuccessful, a failed airway exists because subsequent attempts at laryngoscopy by the same clinician are unlikely to succeed. The three failed laryngoscopy attempts are defined as attempts by an experienced clinician, using best possible patient positioning and technique. A further attempt at direct laryngoscopy by the same clinician or one of equivalent experience is inadvisable, unless the clinician identifies a specific situation on the third laryngoscopy that is amenable to correction, justifying a fourth attempt. Also, if the clinician ascertains after even a single attempt that intubation will be impossible (e.g., grade IV laryngoscopic view despite optimal patient positioning), a failed airway is present.” (Walls 2009)

4-Coniotomi: kontraindikation

“surgical cricothyrotomy is contraindicated in children <10 years old, as the cricothyroid membrane is too small. Therefore, in children <10 years of age, needle cricothyrotomy is the subglottic, invasive airway of choice.” (Tintinalli 2011 Chapter 29)

“Open surgical cricothyrotomy is not an option in children <10 years old, due to the small cricothyroid membrane. Needle cricothyrotomy is, therefore, recommended in children <10 years old.” (Tintinalli 2011 Chapter 29)

“Cricothyrotomy is relatively contraindicated by distorted neck anatomy, preexisting infection, and coagulopathy; these contraindications are relative, however, and the establishment of the airway takes precedence over all other considerations. Successful cricothyrotomy after systemic fibrinolytic therapy has been reported. The procedure should be avoided in children younger than 10 years old, in whom anatomic considerations make it exceedingly difficult. Studies suggest that approximately five “practice” cricothyrotomies on a simulator or animal model are sufficient to achieve at least baseline capability with the procedure.” (Walls 2009)

“Given that surgical cricothyrotomy is often resorted to only after other techniques have been unsuccessful and/or the patient is not oxygenating or ventilating, most authors state that the only absolute contraindication is age. Because of the anatomic differences between children versus adults including the smaller cricothyroid membrane and the rostral funnel shaped more compliant pediatric larynx, surgical cricothyrotomy has been contraindicated in infants and young children. However, the exact age at which a surgical cricothyrotomy can be done is controversial and not well defined. Various textbooks list the lower age limit from 5 years[27] to 10 years[28] or 12 years[29] and only one of these textbooks cites any references.[30] ACLS and PALS define the infant airway as age up to 1 year, and the child airway as age 1–8 years.” (Hebert 2009)

5-Patienten på rygg

“Place the patient supine, with the neck straight and not angulated.” (Tintinalli 2011 Chapter 31)

6-Nacken rak eller hyperextenderad

“Positioning plays a critical role in success; however, the *ideal positioning may be impossible*, based on clinical parameters. For example, hypoxic patients often cannot recline. Ketamine anesthesia does not suppress respiratory drive and may aid patient cooperation and positioning if not otherwise contraindicated. When feasible, use the supine position with the neck exposed. Unless the patient has a known or suspected cervical spine injury, it is important to *hyperextend the neck* to more readily identify the landmarks. Surgical cricothyrotomy can be safely and successfully performed with minimal cervical spine movement.” (Hebert 2009)

7-Tvättar huden med klorhexidin

If time permits, apply povidone-iodine solution to the skin.”(Tintinalli 2011 Chapter 31)

“Prepare the skin of the anterior neck with antiseptic solution and create a sterile field using drapes or towels. If the patient is awake or responding to pain, give a subcutaneous and transtracheal injection of lidocaine with epinephrine as a local anesthetic.” (Hebert 2009)

8-Skyddsutrusning

“Personal protective equipment” (Tintinalli 2011 Chapter 31)

“Wear sterile gloves and take standard precautions by wearing a mask, goggles, and gown. All preparatory steps are time permitting and depend on the urgency with which the procedure is to be performed.” (Herbert 2009)

9-Skalpell #10 eller #11

“Scalpel with a #10 (preferable because of its greater width) or #11 blade” (Tintinalli 2011 Chapter 31)

“The equipment necessary to perform a traditional surgical cricothyrotomy includes a scalpel with a No. 11 blade” (Hebert 2009)

“Scalpel blades are also available in different sizes, and although a No. 11 blade is most commonly used, a No. 20 blade is recommended in some variations of the technique.” (Hebert 2009)

10-Endotracheal tube, innerdiameter 6 mm; kontrollerar kuffen

“A 6-mm endotracheal tube or tracheostomy tube (preferred)” (Tintinalli 2011 Chapter 31)

“A tracheostomy tube is preferred to an endotracheal tube for several reasons. A tracheostomy tube has an obturator, which makes entry through the narrow cricothyroid membrane easier. The tracheostomy tube is shorter and easier to suction. The tracheostomy tube has flanges on each side that allow it to be sutured to the neck and secured with a cloth ribbon around the neck (Figure 31-1). When an endotracheal tube is placed during cricothyroidotomy, the tube is very difficult to affix to the neck and moves easily no matter how well it has been secured with adhesive tape.

Unfortunately, many EDs are not stocked with tracheostomy tubes, because of their infrequent need, or, even if they are stocked, they may not be readily available in the proper size. Therefore, an endotracheal tube is most commonly used and is readily available. When a tracheostomy tube becomes available, a tube change can be made by using the Seldinger technique. Use a suction catheter with the suction vent cut off at one end as an obturator for endotracheal tube removal and tracheostomy tube insertion.” (Tintinalli 2011 Chapter 31)

“The diameter of the tube inserted is crucial. A 6-mm tracheostomy or 6-mm endotracheal tube is preferred (never >7 mm in either case). Tubes with internal diameters >7 mm are difficult to insert in the narrow space between the cricoid and thyroid cartilages. If airway pressures are high with the small-diameter tube, the cricothyroidotomy tube may be changed to a tracheostomy or endotracheal tube with a larger diameter at a later, convenient time.” (Tintinalli 2011 Chapter 31)

“The equipment necessary to perform a traditional surgical cricothyrotomy includes a scalpel with a No. 11 blade, a Trousseau dilator, a tracheal hook, and a tracheostomy tube or modified ET tube (Fig. 6–3). Bent 18-gauge needles may substitute for tracheal hooks. In addition, the sterile tray may include a syringe and lidocaine with epinephrine for local anesthesia, sterile drapes or towels, antiseptic preparation solution, 4 × 4 sterile gauze, scissors, hemostats, and suture material.” (Hebert 2009)

“Given that the average adult's cricothyroid membrane is about 9 mm longitudinally and 30 mm horizontally, familiarize yourself with the dimensions of several standard tracheostomy and ET tubes in order to select the appropriate size. Cuffed tracheostomy tubes are recommended, and they come in various sizes. Shiley tracheostomy tubes are commonly available in most EDs. The No. 4 tube has an inner diameter of 5.0 mm and an outer diameter of 9.4 mm, and the No. 6 tube has an inner diameter of 6.4 mm and an outer diameter of 10.8 mm. Shiley tracheostomy tubes come with three parts: the cuffed outer cannula, a removable inner cannula, and a removable obturator that is solid and removed after insertion (Fig. 6–4). ET tubes are often used temporarily in place of a tracheostomy tube. ET tubes with an inner diameter of 6.0 and 8.0 mm have outer diameters of 8.2 and 10.9 mm, respectively.[31]” (Hebert 2009)

“Prepare the tracheostomy tube by testing the balloon, removing the inner cannula, and inserting the solid white obturator.” (Hebert 2009)

11-Rubens blåsa eller motsvarande

“Bag-valve mask device and oxygen source.” (Tintinalli 2011 Chapter 31)

12-Tejp eller motsvarande för att fixera tuben

“Tape to secure the endotracheal tube in place

Cloth ribbon and sutures to secure tracheostomy tube in place” (Tintinalli 2011 Chapter 31)

13-"Scalpel-Bougie-Tube" metoden

Se följande två video:

<https://www.youtube.com/watch?v=EGktLfqwUFk>

<https://www.youtube.com/watch?v=SbhEyGIf9Y4>

14-Fixerar sköldbrösket med den icke-dominanta handen

“If you are right-hand dominant, stand on the patient's right side. Stabilize the larynx with the nondominant hand by grasping both sides of the lateral thyroid cartilage with the thumb and middle finger.” (Hebert 2009)

“Using the thumb and middle finger of the nondominant hand, stabilize the two cartilages.” (Tintinalli 2011 Chapter 31)

15-Lokaliserar membrana cricothyroidea

“The cricothyroid membrane is found approximately one third the distance from the manubrium to the chin in the midline in patients with normal habitus. In a patient with a short, obese neck, the membrane may be hidden at the level of the manubrium; in a patient with a thin, long neck, it may be midway between the chin and the manubrium.” (Tintinalli 2011 Chapter 31)

“Identify the cricothyroid membrane by first locating the prominent thyroid cartilage superior to it. The thyroid cartilage consists of two lateral laminae that join at an acute angle in the midline to form the laryngeal prominence, which is more pronounced in males and is commonly known as the “Adam's apple.” . . .

The cricoid cartilage forms the inferior border of the cricothyroid membrane and is the only completely circumferential cartilaginous structure of the larynx. It is composed of a broad posterior segment that tapers laterally to form a narrow anterior arch. The tracheal rings descend inferiorly to the cricoid cartilage.

Identify the cricothyroid membrane between the previously mentioned structures as a shallow depression measuring about 9 mm longitudinally and 30 mm transversely. If the depression is obscured by soft tissue swelling, estimate the location of the cricothyroid membrane at about 2 to 3 cm inferior to the laryngeal prominence or four fingerbreadths above the sternal notch” (Hebert 2009)

“Palpate the depression over the cricothyroid membrane with the index finger. Control the larynx throughout the procedure by stabilizing it in this manner. At this juncture, an option is to enter the trachea through the membrane with an 18-gauge needle on a syringe (see Fig. 6–5 step 1 inset). When air is obtained, disconnect the syringe and leave the needle in place as a guide to further surgical procedures.” (Hebert 2009)

16-Skär longitudinellt i medellinjen genom huden över membranet

“Use the scalpel to make a *vertical* incision in the midline between the two cartilages. Incise through the skin and subcutaneous tissues. The structures are superficial, so do not incise deeper,

because this may result in damage to the cricoid or thyroid cartilage or vascular structures.” (Tintinalli 2011 Chapter 31)

“using a vertical neck incision decreases the chance of bleeding.” (Tintinalli 2011 Chapter 31)

“Holding the scalpel with a No. 11 blade in the dominant hand, make an approximately 2- to 3-cm vertical incision through the skin and subcutaneous tissues (see Fig. 6–5 step 2).” (Hebert 2009)

17-Skär transversellt genom membranet

“With the scalpel blade positioned horizontally, perforate the cricothyroid membrane so that the blade goes in approximately half its length.” (Tintinalli 2011 Chapter 31)

“With the index finger of the nondominant hand, palpate the cricothyroid membrane through the incision (see Fig. 6–5 step 2 inset). It is important to understand that the remainder of the procedure should be performed by palpation of the anatomy, not visualization, because bleeding may obscure the field and there is no time to delay while trying to achieve hemostasis. If the cricothyroid membrane cannot be palpated, extend the initial incision superiorly and inferiorly and try to palpate again. Using the stabilizing index finger as a guide, make a horizontal incision of less than 1.0 cm in length through the cricothyroid membrane (see Fig. 6–5 step 3). Note that the skin incision is vertical, but the membrane incision is horizontal. Place the index finger into the stoma momentarily to exchange the scalpel for the tracheal hook.” (Hebert 2009)

18-Ventilerar med Rubens blåsa

“Connect to a bag-valve mask device for ventilation. Check for breath sounds with ventilation. If no ventilation is heard bilaterally, then pull the tube out and reinsert it. Constantly recheck for breath sounds to ensure that the endotracheal tube is correctly positioned. If breath sounds are absent only on the left side, then the tube has been inserted down the right mainstem bronchus and needs to be pulled back a few centimeters. This usually occurs with the use of an endotracheal tube.” (Tintinalli 2011 Chapter 31)

19-Kontrollerar tubläge med lungauskultation, inspektion av bröstkorgen, EtCO₂

“Confirm proper placement in the same manner as with ET tube placement: end-tidal CO₂, bilateral chest movement, and breath sounds.” (Hebert 2009)

“If the openings in the cricothyroid membrane and larynx are not carefully stabilized during the procedure, the tube may be inadvertently inserted into the subcutaneous tissue, which may be recognized by the presence of subcutaneous emphysema when attempting to ventilate the patient. It is essential to recognize this immediately to prevent the development of hypoxia. In addition, failure to detect end-tidal CO₂ and absence of breath sounds by auscultation should alert the physician to a misplaced tube. If suspected, remove the tube and reassess the airway.” (Hebert 2009)

20-Fixerar tuben

“Secure the tube carefully with a ribbon and/or adhesive tape. If using an endotracheal tube, take special care that the tube is inserted no more than 2–3 cm; otherwise, the tube will slip down the right mainstem bronchus with even minimal movement.” (Tintinalli 2011 Chapter 31)

“Endotracheal tubes are extremely difficult to secure properly to the neck and should be changed to tracheostomy tubes whenever possible.” (Tintinalli 2011 Chapter 31)

“Secure the tracheostomy tube with a circumferential tie around the neck or with sutures.” (Hebert 2009)

21-Nålcricothyrotomi: indikationer

“The primary indication for transtracheal ventilation in the ED is the initiation of emergency oxygenation for a pediatric patient who is apneic (either because of the presenting condition or because of administration of an NMBA) and in whom intubation and BMV are impossible. Cricothyrotomy is extremely difficult or impossible in children younger than 10 years old, and transtracheal ventilation should be considered the surgical rescue modality of choice in this age group. For children younger than 5 years old, bag ventilation is used with the percutaneous catheter, and pressurized devices are avoided.” (Walls 2009)

”The indications and contraindications for needle cricothyrotomy with TTJV are similar to those for surgical cricothyrotomy. Needle cricothyrotomy with TTJV can be used in place of surgical cricothyrotomy in adults in the same failed airway scenarios. Its indications include failed attempts at ET intubation with the inability to bag-mask ventilate or airway obstruction above the level of the cricothyroid membrane.” (Hebert 2009)

”As mentioned previously, surgical cricothyrotomy is contraindicated in infants and young children. The contraindication arises from the fact that the cricothyroid membrane is too small to insert a tracheostomy tube and there is a significant risk of injury to the surrounding structures. Therefore, needle cricothyrotomy is the preferred method of securing the airway in crash airway situations in infants and young children.[79]” (Hebert 2009)

“surgical cricothyrotomy is contraindicated in children <10 years old, as the cricothyroid membrane is too small. Therefore, in children <10 years of age, needle cricothyrotomy is the subglottic, invasive airway of choice.” (Tintinalli 2011 Chapter 29)

22-Nålcricothyrotomi: kontraindikationer

“Absolute contraindications to needle cricothyrotomy in adults include transection of the distal trachea, because the airway would need to be established below this injury.” (Hebert 2009)

“Complete upper airway (oropharyngeal) obstruction may be considered a contraindication to needle cricothyrotomy because there is nowhere for exhaled gas to escape, thus leading to a buildup of CO₂ and increased lung volumes.[80] The operator may, therefore, elect to perform a surgical cricothyrotomy if this situation presents itself.” (Hebert 2009)

“Upper airway obstruction has been considered a contraindication to transtracheal jet ventilation, but ventilation still can be successful, although at the cost of higher intrapleural pressure and possibly pulmonary barotrauma.” (Walls 2009)

“In general, when upper airway obstruction is present in adults, percutaneous or surgical cricothyrotomy is preferred.” (Walls 2009)

“Needle cricothyrotomy involves the insertion of a large needle (ideally 10-gauge) through the cricothyroid membrane into the airway. When inserted, the needle is used to ventilate the patient with a standard wall oxygen source. Because of the high-velocity ventilation that ensues through the narrow catheter, this procedure is called transtracheal jet ventilation. Transtracheal jet

ventilation has been used successfully in humans and has been subjected to various animal experiments to determine its uses and limitations. It rarely has been used in patients in EDs, however, where its role as a rescue device in the “can't intubate, can't ventilate” situation is vastly inferior to cricothyrotomy. The jet ventilator should include a regulator and gauge so that pressures can be monitored and reduced, especially in children (Fig. 1-18).” (Walls 2009)

”Needle cricothyrotomy may be relatively indicated over surgical cricothyrotomy in adults based on the operator's experience. Much of the otolaryngology literature supports the use of TTJV as a means of nonemergent ventilation during head and neck surgeries owing to the fact that the smaller ventilation catheter provides a relatively unobstructed field to work around.[74–76] With regard to an emergent airway situation, needle cricothyrotomy has been shown to be a successful bridge to establishing an airway via the ET route.[77] Case reports describe TTJV to be relatively indicated over the more invasive surgical cricothyrotomy when ET intubation has failed owing to copious oropharyngeal secretions. Providing temporary ventilation through the needle catheter may allow sufficient time to clear the upper airway of secretions or obstructions, giving the operator more time to establish an ET intubation.[78]” (Hebert 2009)

23-Förbereder patienten

“As with the surgical cricothyrotomy technique, place the patient in the supine position with the neck exposed. Prepare the skin of the anterior neck Hyperextend the patient's neck unless a suspected cervical spine injury prohibits it. Infiltrate the skin with local anesthetic.” (Hebert 2009)

24-Skyddsutrustning

“Personal protective equipment.” (Tintinalli 2011 Chapter 31)

“Wear appropriate protective equipment such as sterile gloves, gown, and protective eye and face shield.” (Hebert 2009)

25-12- eller 14-gauge nål kopplad till en spruta delvis fylld med koksalt

“The procedure involves placing a large-gauge, over-the-needle catheter (usually 14 gauge) through the cricothyroid membrane or upper trachea. Nonkinking catheters are available for this purpose and preferred, but a standard 14-gauge over-the-needle catheter can be used.” (Tintinalli 2011 Chapter 29)

“A 14- or 12-gauge sheathed needle catheter” (Tintinalli 2011 Chapter 31)

“The larger the diameter of the catheter, the greater the oxygen flow will be, depending on the method of oxygen delivery.[81] Commercial catheters such as wire-coiled nonkinking catheters and fenestrated catheters are available as part of prearranged kits (Fig. 6–11). Larger-caliber 3.0- to 4.0-mm interior diameter percutaneous tracheal catheter devices are also available” (Hebert 2009)

“Attach a 3-mL syringe to the catheter (12 or 14 gauge).” (Tintinalli 2011 Chapter 31)

26-Om patienten är < 5 år: utrustning för att koppla till Rubens blåsa

“In children <5 years old, ventilate through the catheter with a bag ventilator. This method can be used in older children also. Use the adapter from a 3.0 mm ID endotracheal tube to connect a standard catheter to the bag.” (Tintinalli 2011 Chapter 29)

“A 3-mL syringe

Adapter from the end of a 7-mm endotracheal tube” (Tintinally 2011 Chapter 31)

“There are two different basic means, and thus two different armories of equipment to choose from, to deliver oxygen through the transtracheal catheter. In one method, use a standard ventilation bag to supply oxygen through the needle. This requires the constant efforts of manual bag insufflation as long as the patient is being oxygenated and ventilated this way. Attach the bag to the adapter of a 7.0-mm ET tube inserted into the back of a plungerless 3-mL syringe connected to the transtracheal catheter. Alternatively, attach the bag directly to the catheter with the adapter of a 3.5-mm pediatric ET tube.[82] An inherent problem with this setup is that the whole system is rigid. Although the transtracheal catheter itself is flexible, there is no flexibility or give from the hub of the catheter to the bag. Thus, slight movements of the bag relative to the patient may cause dislodgment of the catheter. To ameliorate this obstacle, connect standard intravenous infusion tubing directly to the transtracheal catheter and attach the distal cut end to a 2.5-mm ET tube attached to the bag.” (Hebert 2009)

27-Om patienten är > 5 år: utrustning för jetventilation

“Jet ventilation, through high-pressure oxygen tubing attached directly to 50-psi wall-mounted oxygen and the catheter, should only be used for children >5 years old due to the potential for barotrauma. If jet ventilation is used in children, the pressure should be reduced using a pressure gauge or air leak available in commercial transtracheal jet ventilation devices designed for this purpose.” (Tintinally 2011 Chapter 29)

“The essential materials needed for TTJV include a needle with an overlying catheter, oxygen tubing, an oxygen source with a means to regulate the pressure, and a means to connect the apparatus together. Commercial kits are available, but a standard 12- or 14-gauge angiocath attached to a 3- or 5-mL syringe normally found in the ED can be used to make the puncture through the cricothyroid membrane; then the catheter can be left in place to serve as the conduit for oxygen delivery.” (Hebert 2009)

“Wall oxygen source at 15 L/min (40–50 lb per square in.) connected by tubing with a Y connector or fashioned with a side hole.” (Tintinally 2011 Chapter 31)

“In an alternative method, supply oxygen from a standard 50-psi wall source. High-pressure oxygen tubing is needed to connect the system with a manual on/off valve along with a Luer-Lok or three-way stopcock to connect the oxygen tubing to the hub of the catheter. The on/off valve can be as simple as holes placed at the end of the oxygen tubing (see Fig. 6–11) that the operator manually covers in order to control oxygen flow through the catheter and the inspiratory-to-expiratory (I/E) ratio. A pressure gauge connected to a hand-triggered jet injector may also be used to control the amount of air pressure reaching the catheter.[83] Commercial kits are available that contain prepackaged systems already assembled. Otherwise, assemble the apparatus in the ED. In an emergency situation, it is unlikely that one would be able to assemble a TTJV apparatus from individual components in a timely manner. If a prepackaged TTJV kit is not available, prepare the appropriate components from the ED ahead of time and place it with other airway supplies for easy access.” (Hebert 2009)

28-Identifiera membrana cricothyroidea

“Similar to the needle insertion technique employed for guidewire-assisted surgical cricothyrotomy, locate the cricothyroid membrane with the nondominant hand by locating the thyroid cartilage and

cricoid cartilage and palpating the cricothyroid membrane in the depression between these, keeping in mind that this depression will be proportionately smaller in children.” (Hebert 2009)

29-Inför nålen/katetern under pågående aspiration tills luft aspireras

“Introduce the catheter into the subcutaneous tissue at a 90-degree angle to the skin. Aspirate gently while advancing the catheter over the needle.” (Tintinalli 2011 Chapter 31)

“Attach a 12- to 14-gauge angiocath to a 3- or 5-mL syringe filled with 1 to 2 mL of saline or lidocaine. Once the cricothyroid membrane has been located, insert the catheter through the overlying skin, subcutaneous tissue, and membrane directed at a 30° to 45° angle caudally. While doing so, aspirate gently with the syringe (Fig. 6–12). The cricothyroid membrane has been pierced and the airway entered when bubbles are seen in the fluid or there is an increase in the ease with which air is aspirated.” (Hebert 2009)

30-Håller nålen stilla, för in resten av katetern och tar bort nålen

“When air suddenly returns (indicating entry into the airway), change the angle to 45 degrees and advance the catheter over the needle into the larynx. Withdraw the needle and syringe.” (Tintinalli 2011 Chapter 31)

“Once through the membrane, hold the needle in place and advance the catheter to the hub, then remove the needle. Hold the catheter by hand until the oxygen supply is connected and appropriate placement is confirmed.” (Hebert 2009)

31-Om patienten är < 5 år: kopplar katetern till Rubens blåsa och ventilerar

“In children <5 years old, ventilate through the catheter with a bag ventilator. This method can be used in older children also. Use the adapter from a 3.0 mm ID endotracheal tube to connect a standard catheter to the bag.” (Tintinalli 2011 Chapter 29)

“With the ventilation bag, you manually inflate the lungs through the catheter. Children, especially those under 5 years old, have small total lung capacities and need smaller tidal volumes; therefore, the bag should be used instead of the jet ventilator to prevent barotrauma. Using this setup, you can control the volume of air inspired and adjust it breath-by-breath based on chest wall motion and pulse oximetry. This method is not appropriate for adults because the operator cannot both provide appropriate tidal volumes and allow enough time for exhalation.” (Hebert 2009)

“5. Disconnect the 3-mL syringe from the bare needle. 6. Withdraw the plunger from the syringe and attach the plungerless 3-mL syringe barrel to the catheter in the neck. 7. Attach the adapter (from the end of a 7-mm endotracheal tube) to the open end of the 3-mL syringe or place a 7-mm endotracheal tube into the empty syringe barrel and inflate the balloon.” (Tintinalli 2011 Chapter 31)

32-Om patienten är > 5 år: kopplar katetern till syrgasuttag och jetventilerar

“Attach the oxygen source to the adapter and start ventilation with a 100% oxygen source. Intermittent jet insufflation (50 lb per square in.) can be achieved by occluding the Y connector or side hole in the connecting tubing. Insufflate for 1 s and then release the occlusion for 4 s. To achieve the required high pressures, use a jet injector regulated by a flowmeter attached to a wall unit on a tank. An unregulated wall unit or tank is a less optimal.” (Tintinalli 2011 Chapter 31)

“The inspiration to expiration ratio may need to be 1:10 to 1:15 to allow for expiration.” (Tintinalli 2011 Chapter 31)

“Oxygen can be supplied to the catheter in two different ways. The choice of whether to use the ventilation bag setup or the high-flow oxygen system is determined primarily by what tidal volumes are needed to ventilate the patient. The high-flow oxygen system connects to a *wall oxygen source at full output* and provides a maximal output pressure of 50 psi. When connected through a 14-gauge catheter, a pressure of 50 psi will flow at 1600 mL/sec. Therefore, if you want to provide a tidal volume of 10 mL/kg in an 80-kg adult (800 mL/breath), you must provide 0.5 second of oxygen flow per cycle. The operator also controls the I : E ratio by letting go of the distal openings in the oxygen tubing or of the jet injector valve.” (Hebert 2009)

33-Fixerar katetern

“The operator must hold the catheter securely, as it can become displaced with minimal movement. . . . Stabilization is maintained by the operator until another choice of airway is established, either tracheostomy or oro- or nasotracheal intubation (if possible). Dressings are not necessary.” (Tintinalli 2011 Chapter 31)

“Make sure that the hub of the catheter is flush against the skin to avoid air leak and then secure it with a circumferential tie around the neck. Keep one hand on the hub of the catheter until the entire procedure is completed and the airway is secured to prevent it from being dislodged.” (Hebert 2009)

34-Kontrollerar bröstorgsrörelser

Inspektion av thorax för att se att för högt luftvägstryck inte byggs upp (hyperinsufflerad thorax, risk om total övre luftvägsobstruktion) och om jetventilationen lyckas åstadkomma oscillerande bröstorgsrörelser som tecken på intratrakealt kanylläge och ev lyckad ventilation (behöver inte ske).

35-Förebereder definitiv luftväg

“Adults can be oxygenated for only approximately 15 to 20 minutes and should have an alternative airway secured immediately (by surgical cricothyroidotomy, endotracheal intubation, or tracheostomy).” (Tintinalli 2011 Chapter 31)

“Needle cricothyroidotomy is the insertion of a catheter (generally an IV catheter) through the cricothyroid membrane. Although this procedure is easier to perform than surgical cricothyroidotomy, it does not provide adequate ventilation over time, and is a temporizing measure. The diameter of the catheter used is the limiting factor for airflow.” (Tintinalli 2011 Chapter 31)

“Needle cricothyroidotomy does not provide for adequate ventilation, and this technique is only a temporizing measure until definitive airway establishment.” (Tintinalli 2011 Chapter 31)

“Needle cricothyroidotomy is the preferred emergency surgical airway in children younger than approximately 10 to 12 years old who cannot be intubated orotracheally or nasotracheally. A 12- or 14-gauge catheter over a needle will support oxygenation in a child until a tracheostomy can be performed in the operating room by a surgeon familiar with the anatomy of a child's neck. The larynx is easily damaged by surgical cricothyroidotomy, and children have more late airway complications.” (Tintinalli 2011 Chapter 31)

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