臺中榮民總醫院
Taichung Veterans General Hospital

PERCUTANEOUS TRACHEOSTOMY IN ICU
THE ROLE OF PULMONOLOGIST

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大綱

- 氣切手術時機，神經外科病人
- 經皮氣切的適應症與併發症
- 氣切移除原則

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Weaning from ventilator

Criteria
Subjective assessment
Adequate cough
No neuromuscular blocking agents
Absence of excessive trachea-bronchial secretion
Reversal of the underlying cause for respiratory failure
No continuous sedation infusion or adequate mentation on sedation
Objective measurements
Stable cardiovascular status
Heart rate ≤ 140 beat/minute
No active myocardial ischemia
Adequate hemoglobin level (≥ 8 g/dl)
Systolic blood pressure 90–160 mmHg
Afebrile (36∘ C < temperature < 38∘ C)
No or minimal vasopressor or inotrope (< 5 μg/kg/minute dopamine or dobutamine)

Adequate oxygenation
Tidal volume > 5 mL/kg
Vital capacity >10 mL/kg
Proper inspiratory effort
Respiratory rate ≤ 35/minute
$PaO_2 \geq 60$ and $PaCO_2 \leq 60$ mmHg
Positive end expiratory pressure ≤ 8 cmH_2O
No significant respiratory acidosis (pH ≥ 7.30)
Maximal inspiratory pressure (MIP) ≤ -20 – -25 cmH_2O
O_2 saturation > 90% on $FIO_2 \leq 0.4$ (or $PaO_2/FIO_2 \geq 200$)
Rapid Shallow Breathing Index (respiratory Frequency/Tidal Volume) < 105

Boles, Jean-Michel, et al. *European Respiratory Journal* 29.5 (2007): 1033-1056.

Indications for tracheostomy

- Prolonged mechanical ventilation for 7 days or more
- Upper airway obstruction (including vocal cord paralysis)
- Need for airway protection in patients with conditions such as neurologic disease or traumatic brain injury
- Need for more effective pulmonary hygiene, including the use of recruitment maneuvers and methods for clearing the airways of secretions.

Hashimoto, Daniel A., Andrea L. Axtell, and Hugh G. Auchincloss. "Percutaneous tracheostomy." *New England Journal of Medicine* 383.20 (2020): e112.

Cuff leak test in predicting post-extubation airway complications

- (+) cuff leak test: leak <110ml
- Meta-analysis 28 studies 4493 extubations

	Sensitivity	Specificity
Post-extubation airway obstruction	0.62	0.87
Reintubation	0.66	0.88

- High specificity→ consider intervening in patients with a positive test (eg. steroid)
- Low sensitivity → patients still need to be closely monitored post-extubation

Kuriyama, Akira, Jeffrey L. Jackson, and Jun Kamei. *Critical Care* 24 (2020): 1-11.

Clinical scenario

- 65歲男性無特殊疾病，車禍ICH住院術後，住院2周EVD已拔，GCS E2VTM4，欲轉RCC，會談時談到因意識狀態不清，如果為求安全，建議做氣切。家屬問：不能直接拔管嗎？

- Patients with brain injury
- Impaired mental status(GCS<8)
- The importance of tracheostomy in the weaning success ?

When should we perform extubation after brain injury?

- Coplin et al. 2000 AJRCCM
  - Delaying extubation, in order to wait for sufficient neurological recovery, did NOT guarantee successful extubation
  - Associated with increased nosocomial pneumonia, ICU and hospital lengths of stay and costs

GCS of 8 as a rule ?

- Navalesi P. Crit Care Med. 2008
  - GCS ≥ 8 + audible cough during suction
  - Significant ↑ in extubation success
- Namen AM. AJRCCM, 2001
  - GCS of 8
  - Highest AUC for predicting successful extubation

How to score the GCS

- Higher GCS was not associated with extubation success
  - Godet T. Anesthesiology. 2017
  - McCredie VA. Ann Am Thorac Soc. 2017
- Score the verbal component
  - As 1 in all intubated patients ?
  - As 1 in non-communicating patients and as 4 in patients who tried to speak with the endotracheal tube
- GCS has been inconsistently reported as a factor associated with extubation success

Other tools of predicting successful extubation

- Asehnoune K. Anesthesiology. 2017
  - (1)Age< 40 y/o, (2)visual pursuit, (3)attempts to swallow, (4)GCS > 10
- Godet T. Anesthesiology. 2017
  - (1)visual pursuit, (2)preserved upper airway reflexes
- McCredie VA. Ann Am Thorac Soc. 2017
  - (1)younger age, (2)negative fluid balance and the (3)presence of cough
- dos HFC R. J Crit Care. 2017
  - Cough

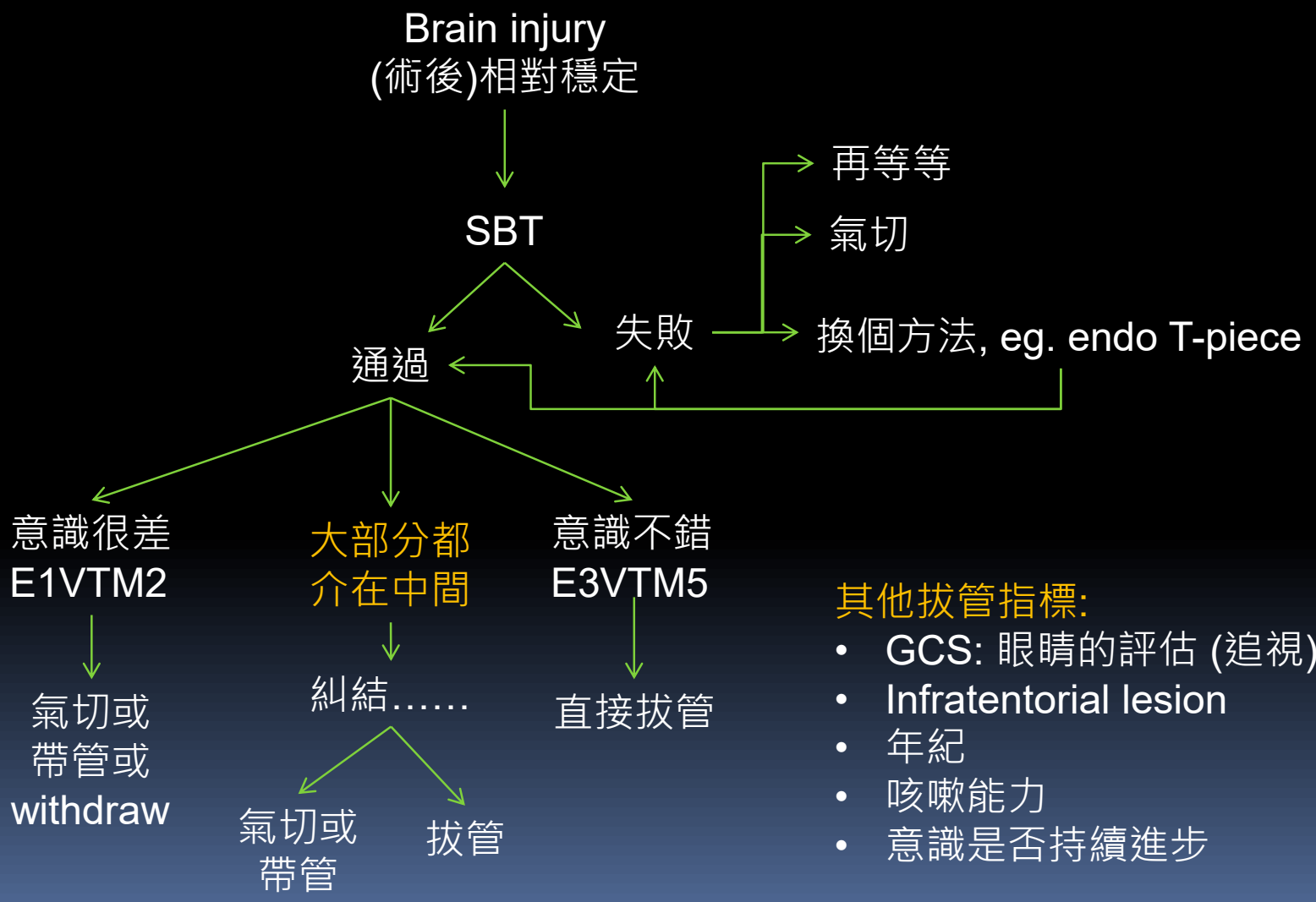
When should we perform tracheostomy after brain injury?

- Early vs. late tracheostomy ?
- Hyde GA. Injury. 2015 (early=5 days)
  - Head and chest injury
  - Favored early tracheostomy with less pneumonia, lower mechanical ventilation duration and ICU length of stay
- Alali AS. J Trauma Acute Care Surg. 2014 (early=8 days)
  - Traumatic brain injury
  - Supported an early tracheostomy
  - ↓ duration of mechanical ventilation, ↓ ICU stay, and ↓ hospital stay

When should we perform tracheostomy after brain injury?

- Bosel J. Stroke. 2012
  - Stroke patients (N=60 only)
  - Early tracheostomy did not result in a reduction in the ICU length of stay
  - But resulted in lower mortality
- In clinical practice, early tracheostomy is not recommended but could be considered in
  - High risk of extubation failure like infra-tentorial lesions
  - Protracted mechanical ventilation
  - In patients with poor neurological recovery and/or after extubation failure

腦傷病患呼吸器脫離



其他拔管指標:

- GCS: 眼睛的評估 (追視)
- Infratentorial lesion
- 年紀
- 咳嗽能力
- 意識是否持續進步

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VIDEOS IN CLINICAL MEDICINE

SUMMARY POINTS

Julie R. Ingelfinger, M.D., *Editor*

Percutaneous Tracheostomy

Daniel A. Hashimoto, M.D., Andrea L. Axtell, M.D., and Hugh G. Auchincloss, M.D.

The following text summarizes information provided in the video.

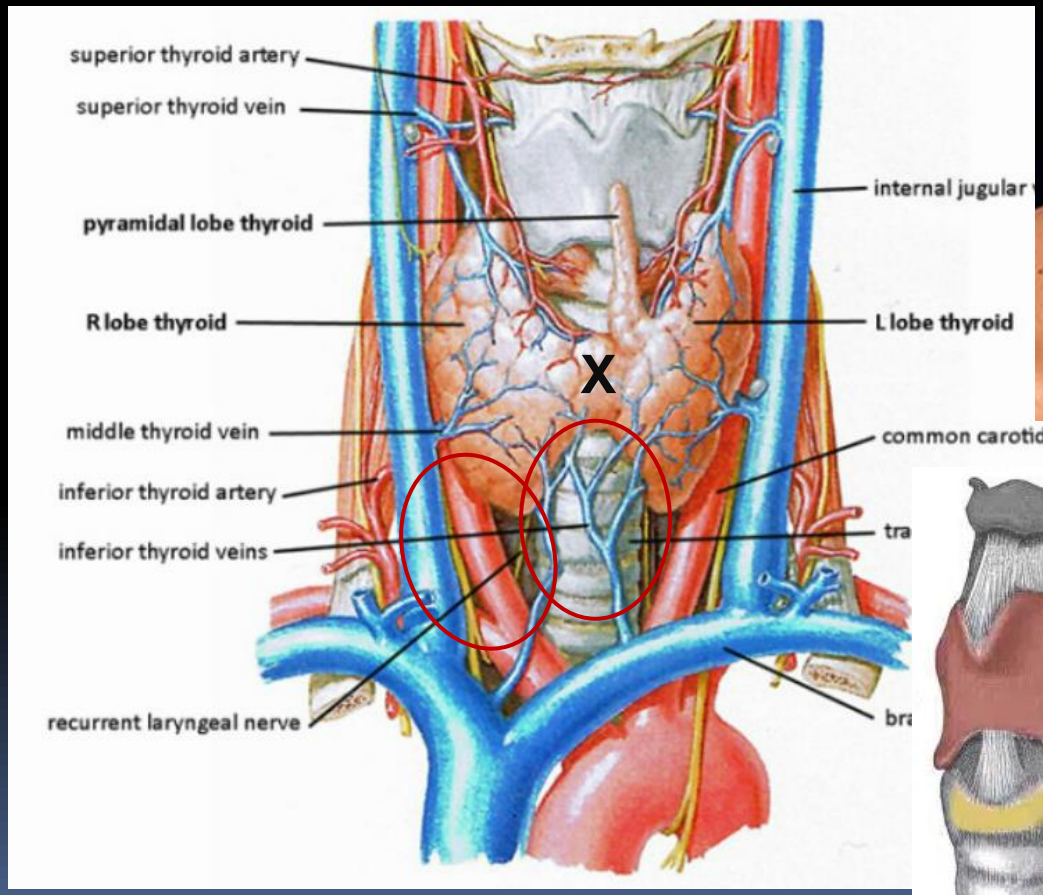
Hashimoto, Daniel A., Andrea L. Axtell, and Hugh G. Auchincloss. "Percutaneous tracheostomy." *New England Journal of Medicine* 383.20 (2020): e112.

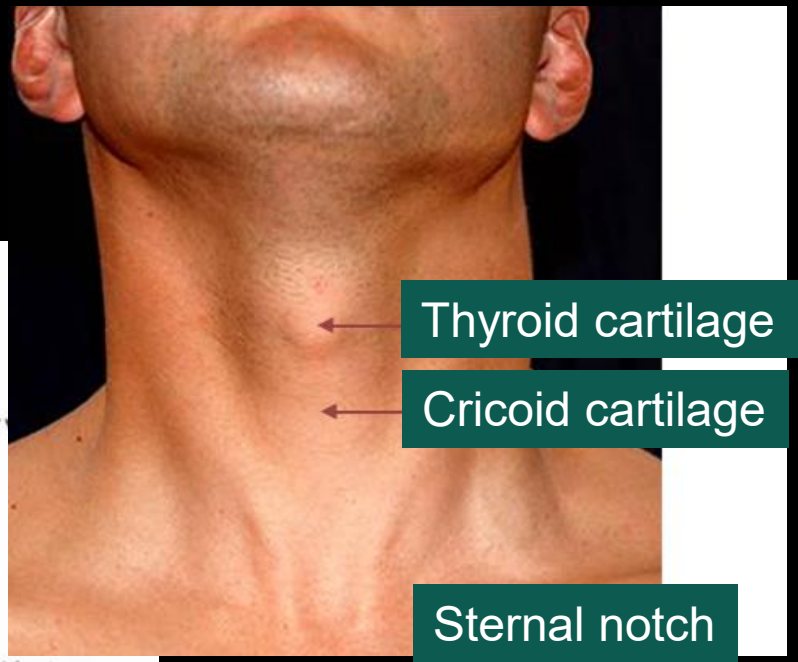
Contraindication

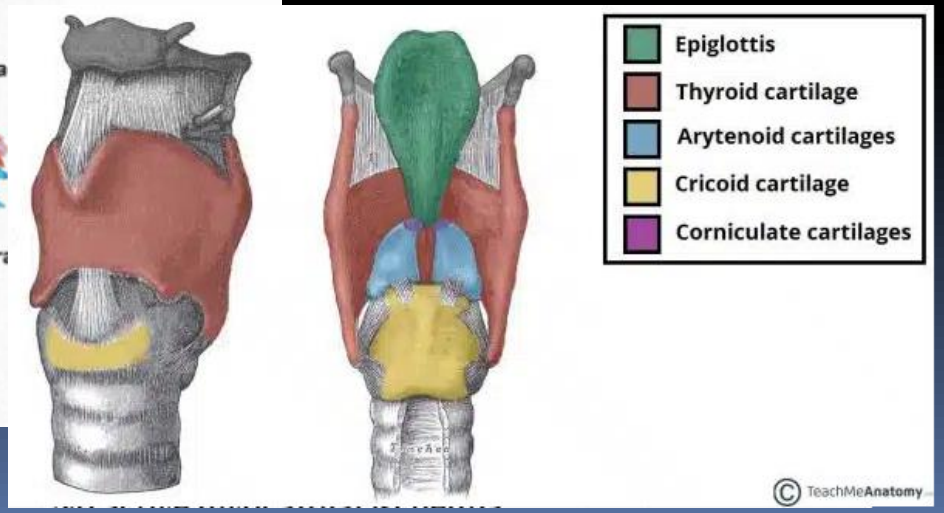
- Neither previous tracheostomy nor other types of neck surgery are contraindications.

- Absolute contraindications
  - Cervical instability
  - Uncontrolled coagulopathy
  - Infection at the planned insertion site.
- Relative contraindications
  - Difficult anatomy (short neck, morbid obesity, minimal neck extension, or tracheal deviation)
  - Severe respiratory disease resulting in the inability to withstand periods of apnea or in the loss of positive-pressure ventilation.

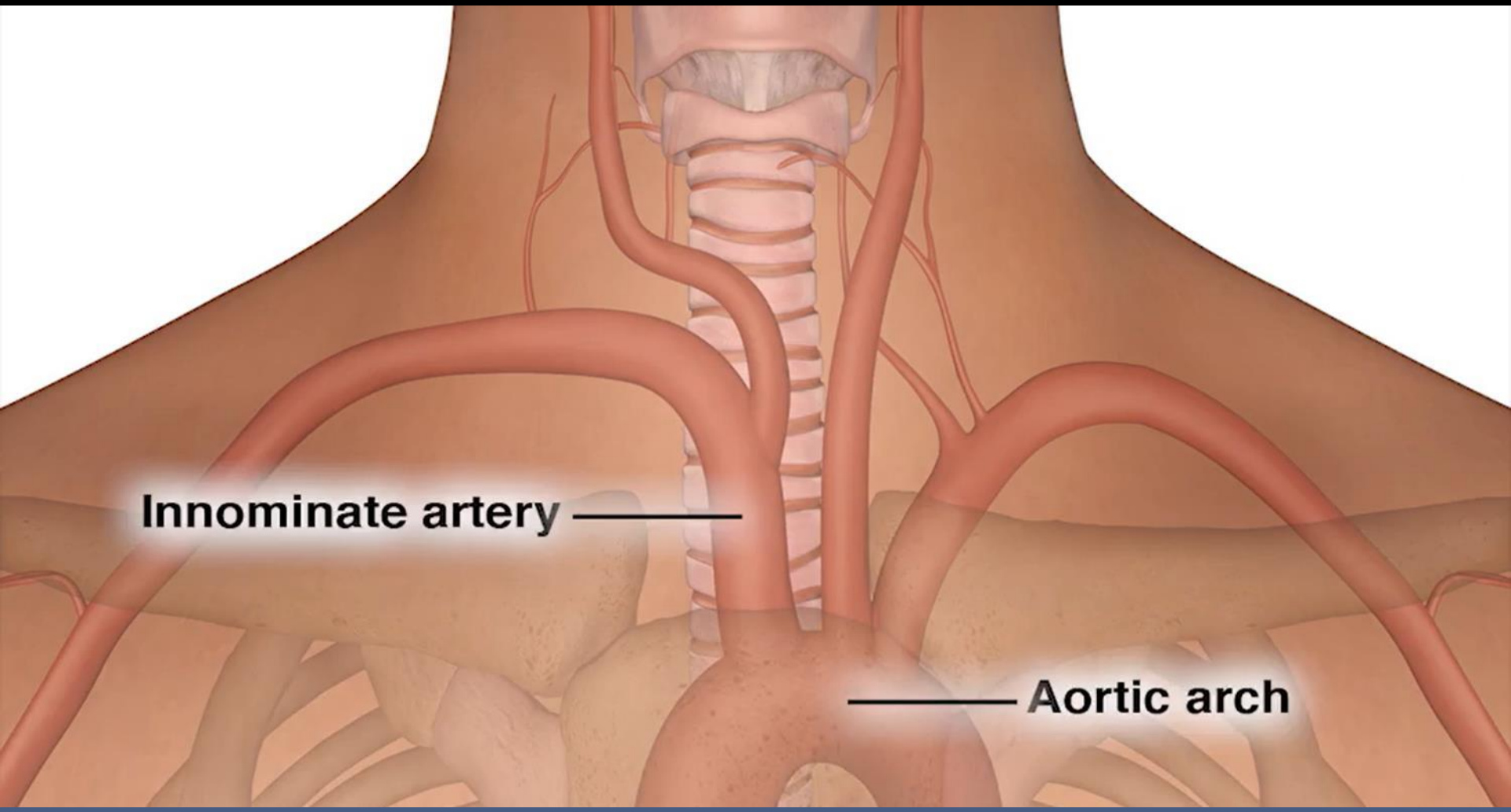
Anatomy


superior thyroid artery
superior thyroid vein
internal jugular
pyramidal lobe thyroid
R lobe thyroid
L lobe thyroid
X
middle thyroid vein
common carotid artery
inferior thyroid artery
inferior thyroid veins
recurrent laryngeal nerve


Thyroid cartilage
Cricoid cartilage
Sternal notch

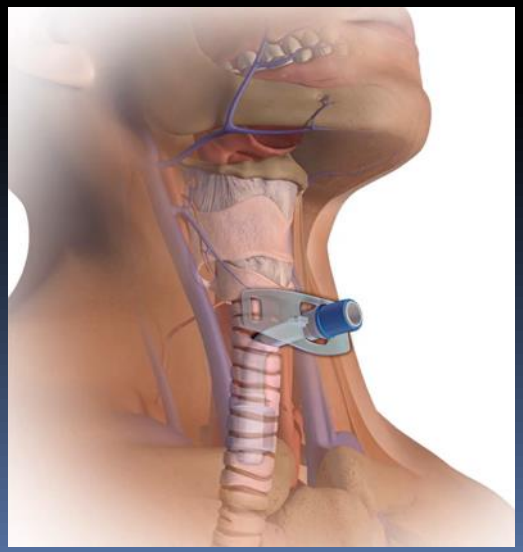

Epiglottis
Thyroid cartilage
Arytenoid cartilages
Cricoid cartilage
Corniculate cartilages
© TeachMeAnatomy

High riding innominate artery



Identification of landmarks

- Thyroid cartilage, the cricoid cartilage, and the sternal notch.
- The ideal location for placement of the tracheostomy tube is between the second and third tracheal rings



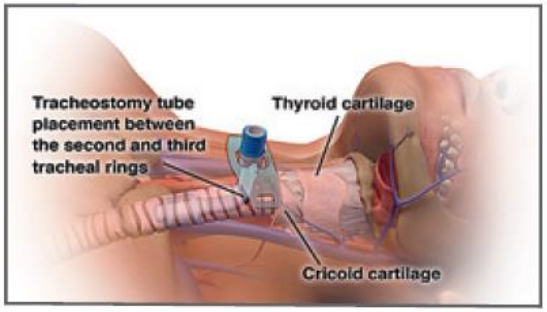
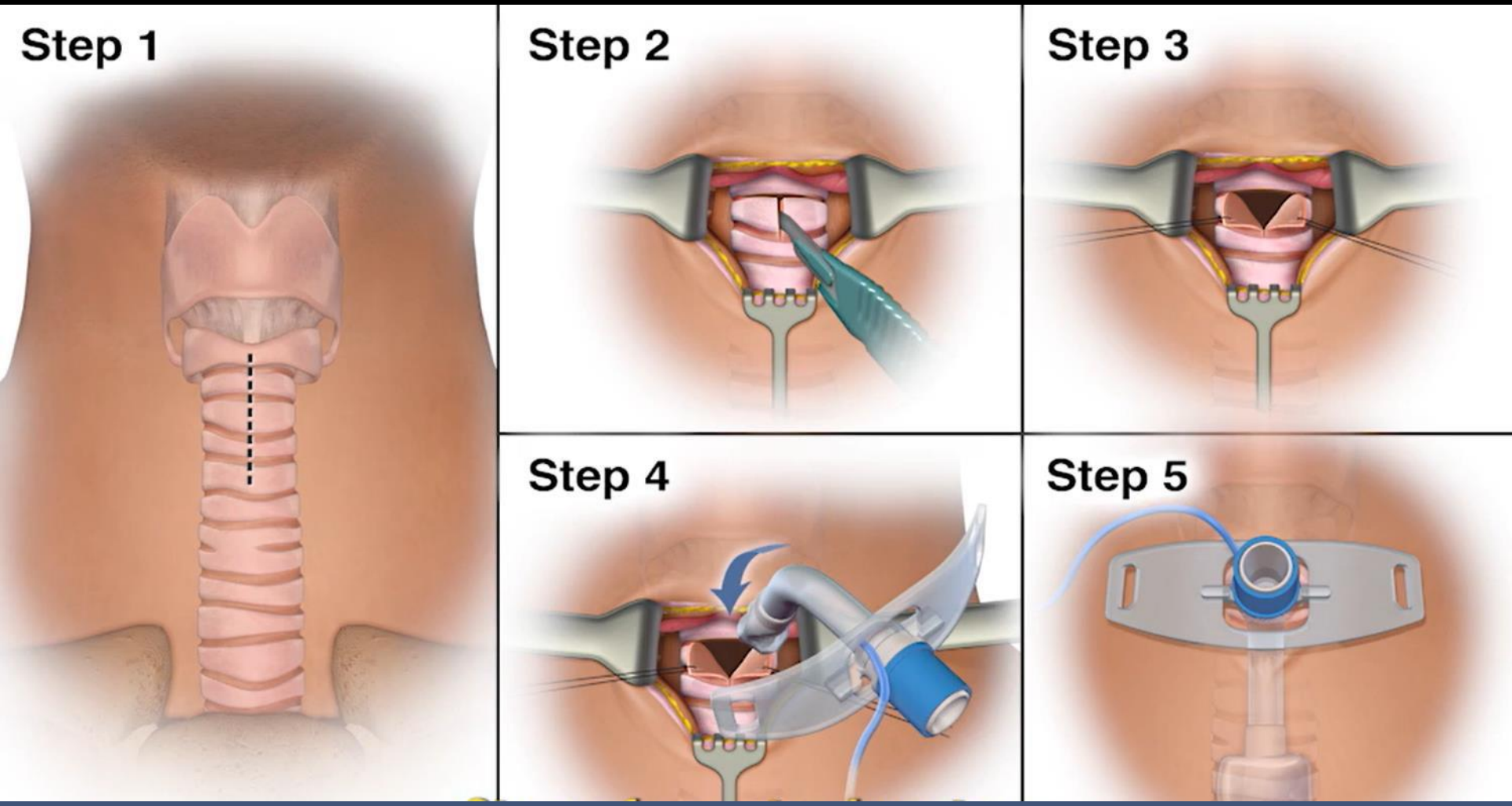


Figure 1. Tracheal Anatomy and Location for Placement of the Tracheostomy Tube.

The ideal location for placement of the tracheostomy tube is between the second and third tracheal rings.

Open tracheostomy

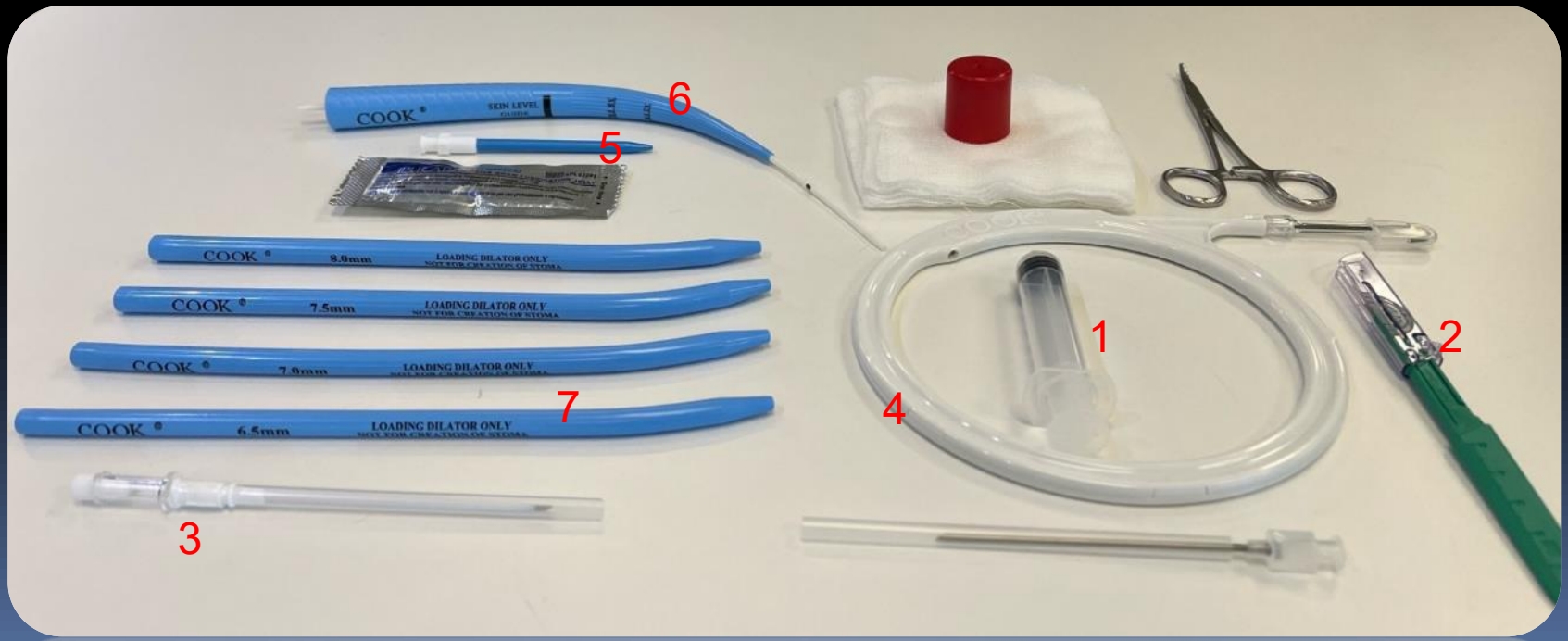


產品介紹

- 中文品名：「曲克」藍犀牛氣管引導器組
- 英文品名：Blue Rhino Percutaneous Tracheostomy Introducer Set
- 醫材等級：第二等級
- 健保碼/價：CRT10PTS02CK / $4,500
- 健保給付規定：限使用於加護病房之病患。
- 製造廠：COOK INCORPORATED
- 製造國別：UNITED STATES
- 衛署醫器輸字第011835號

規格配件

① 15G導管針
② 潤滑膠
③ 紗布(4*4inch)
④ 有定位標記0.052inch(1.32mm)導線
⑤ 8Fr.之導管長29cm兩邊尖頭有安全邊緣及定位標記
⑥ 14Fr.擴張器4.5cm長，定位擴張器四支，20cm長(6.5、7.0、7.5、8.0mm擴張器直接寫對應氣切號，方便對應)
⑦ 6c.c.拋棄式針筒
⑧ 拋棄式手術刀



Procedure

Video: 08:00~ 10:58

Figure 2. Insertion of the Introducer Needle and Guidewire.

The introducer needle and guidewire are inserted through the anterior wall of the trachea under direct bronchoscopic guidance (inset).

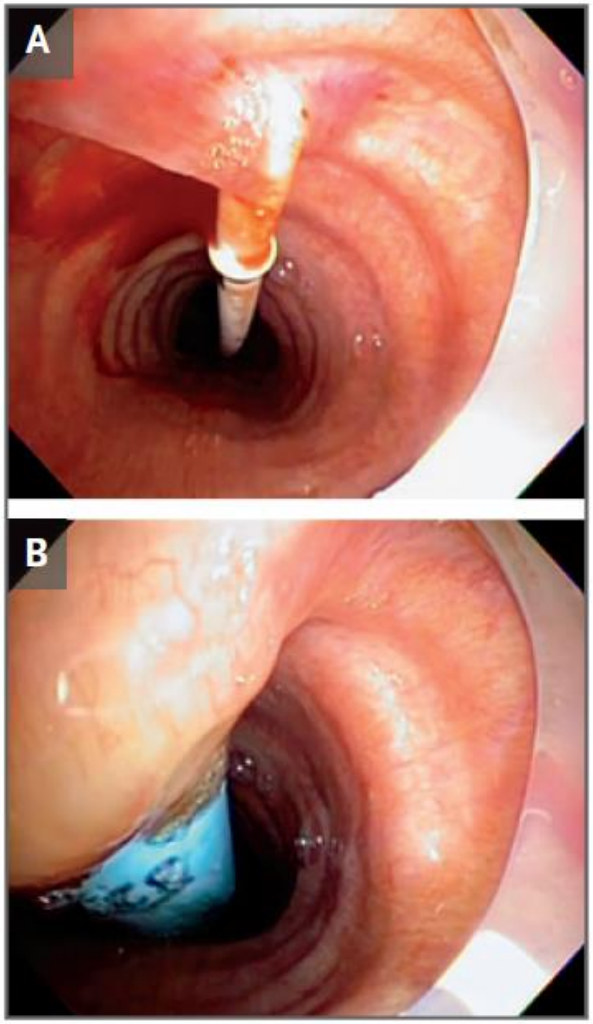
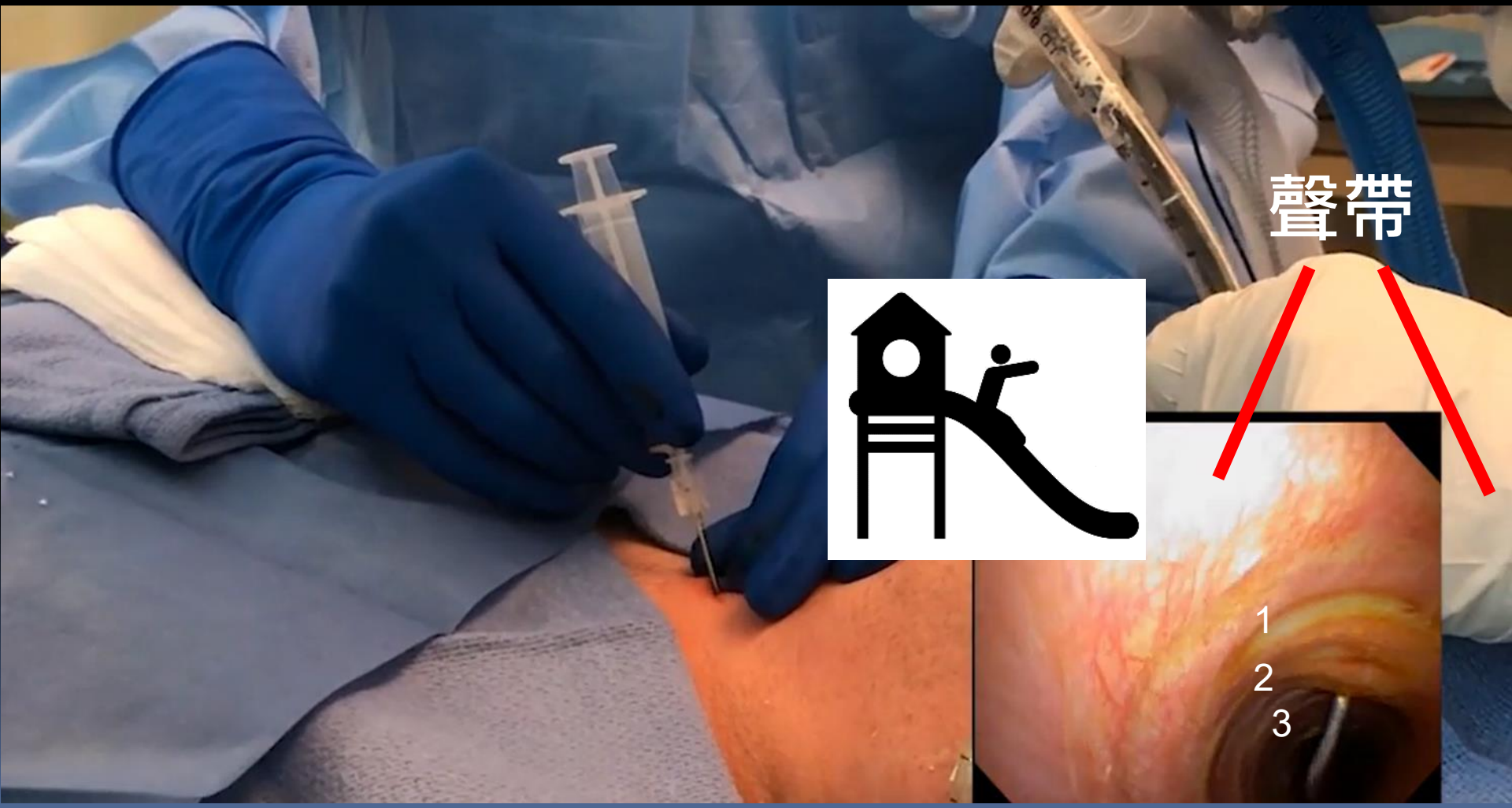


Figure 3. Tracheal Dilation.

The small tracheal dilator is advanced over the guidewire to dilate the tract. The small tracheal dilator is removed, the protective sheath is loaded (Panel A), and the single-stage progressive dilator is advanced over the guidewire (Panel B).

關鍵步驟: 退氣管內管, 找到2/3 tracheal ring



置放流程(圖示)

效益評估

項目	藍犀牛經皮氣切	外科手術氣切
麻醉	僅需**局部麻醉**，節省麻醉費用	需全身麻醉
麻醉風險	局部麻醉對重症患者風險較低	全身麻醉對重症患者風險較高
施行地點	ICU-可節省使用手術室的成本	手術室(OR)
轉移病人	不需要	須將病人轉移到手術室，增加藥物中斷及窒息風險
施行時間	不同研究時間不同 大多在**10分鐘以下**	至少一小時
醫護人員人力	較少	較多
併發症	文獻顯示**較少**	較多，術後有較多傷口發炎或溢痰
氣切傷口	小，**復原快**	較大，復原較不易
傷口感染率	PDT 0%	ST 28%

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ScienceDirect

journal homepage: www.jfma-online.com

Original Article

Antiplatelet agents and anticoagulants increased the bleeding risk of bedside percutaneous dilational tracheostomy in critically ill patients

Yen-Hsiang Huang [a,b,c], Chien-Hua Tseng [d,e], Ming-Cheng Chan [f,g], Bor-Jen Lee [b], Chih-Hung Lin [h,i,**,1], Gee-Chen Chang [a,j,k,*,1]

Demographic data

Table 1 Patients' characteristics and demographic data.

Characteristics	N = 312
Age (years), mean (SD)	69.6 (17.7)
Gender, n (%)	
Male	208 (66.7)
Female	104 (33.3)
APACHE II score, mean (SD)	25.3 (6.3)
BMI, mean (SD)	22.4 (4.2)
Disease for intubation	
Respiratory disorders	160 (51.3)
Neurologic disorders	102 (32.7)
Cardiovascular disorders	12 (3.8)
Gastrointestinal disorders	17 (5.4)
Genitourinary disorders	8 (2.6)
Post-CPCR	9 (2.9)
Others[a]	4 (1.3)
Site	
Medical ICUs	196 (62.8)
Surgical ICUs	86 (27.6)
Respiratory care center	30 (9.6)
Rate of antiplatelet agent or anticoagulant use, % (n)	17.9 (56)
Platelet count, $\times 10^3/\mu L$, mean (SD)	263 (140)
PT INR, mean (SD)	1.12 (0.20)

(2016/02~2018/12)

Complication rate of PDT, % (n)	14.4 (45)
Weaning rate after PDT, % (n)	50.3 (157)
In-hospital mortality rate after PDT, % (n)	17.0 (53)
Length from ICU admission to consultation (days), mean (SD)	17.2 (11.0)
Length from intubation to consultation (days), mean (SD)	20.3 (12.8)
Length from consultation to PDT (days), mean (SD)	1.4 (1.9)
Length from ICU admission to PDT (days), mean (SD)	18.6 (11.3)
Length from intubation to PDT (days), mean (SD)	21.6 (13.0)
Length of ICU stay (days), mean (SD)	26.4 (16.9)

Complications

Table 2 Complications of bedside percutaneous dilational tracheostomy (N = 312).

Complication	Number (%)
Total	45 (14.4)
Peri-operative	
Transient hypotension	2 (0.7)
Minor bleeding	1 (0.3)[a]
Posterior tracheal wall injury	1 (0.3)[b]
Loss of airway	1 (0.3)
Post-operative	
Minor bleeding	30 (9.6)[a]
Wound infection	4 (1.3)
Major bleeding	3 (1.0)
Pneumomediastinum	1 (0.3)[b]
Subcutaneous emphysema	1 (0.3)[b]
Loss of tracheostomy	1 (0.3)

[a] Patient had both peri-operative and post-operative minor bleeding.

[b] The complications occurred in the same patient.

- Minor bleeding was defined as requiring packing with epinephrine-soaked gauze packs or absorbable hemostatic aggregates to stop the bleeding

- Major bleeding was defined as needing a blood transfusion, suturing or surgical intervention.

Complications- bleeding risk

Table 3 The association between patients' characteristics and bleeding risk of PDT.

Characteristics	N	Complication of bleeding		*p* value
		Yes	No	
Age, mean (SD)	312	73.4 (13.2)	69.2 (18.2)	0.102[a]
APACH II score, mean (SD)	312	25.0 (7.0)	25.3 (6.2)	0.768[a]
BMI, mean (SD)	312	22.6 (3.4)	22.4 (4.3)	0.753[a]
Gender, n (%)				0.030[b]
Male	208	16 (7.7)	192 (92.3)	
Female	104	17 (16.3)	87 (83.7)	
Disease for intubation, n (%)				>0.99[b]
Respiratory disorders	160	17 (10.6)	143 (89.4)	
Non-respiratory disorders	152	16 (10.5)	136 (89.5)	
Site, n (%)				0.816[b]
Medical ICU	196	20 (10.2)	176 (89.2)	
Surgical ICU	86	9 (10.5)	77 (89.5)	
Respiratory care center	30	4 (13.3)	26 (86.7)	
Antiplatelet agent or anticoagulant use, n (%)				<0.001[b]
With	56	15 (26.8)	41 (73.2)	
Without	256	18 (7.0)	238 (93.0)	
Platelet count, $\times 10^3/\mu L$, mean (SD)	312	222 (99)	267 (143)	0.023[a]
PT INR, mean (SD)	312	1.16 (0.21)	1.12 (0.19)	0.256[a]

PDT, percutaneous dilational tracheostomy; SD, standard deviation; APACHE II, acute physiology and chronic health evaluation II; BMI, body mass index; ICU, intensive care unit; PT INR, the international normalized ratio of prothrombin time.

[a] By Student's *t*-test.

[b] By Fisher's exact test.

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介入性檢查及治療抗凝血劑使用停用及輸血指引

Drug	Elimination half-life	Time to normal platelet function/ coagulation activity after drug discontinuation
Heparins		
UFH	1–2 h	
LMWH	3–7 h	
Heparinoids		
Danaparoid	24 h	
Bivalirudin	25 min	
Argatroban	30–35 min	
Fondaparinux	17–20 h	
Antiplatelet drugs		
NSAIDs 註 1		24 h
Ticlopidin		1-2 weeks
Aspirin		5–7 d
Clopidogrel		5–7 d
Prasugrel		5–7 d
Ticagrelor		3–5 d
Cilostazol		2-3 d
Tirofiban		4–8 h
Eptifibatide		4–8 h
Abciximab		24–48 h
Dipyridamole		24 h
Oral anticoagulants		
Warfarin	4–5 d	3–4 d
Rivaroxaban prophylaxis [> 30 ml/min CC]	7-9 h	
Rivaroxaban treatment [> 30 ml/min CC]	7-11 h	
Dabigatran [> 80 ml/min CC]	12-17 h	
Dabigatran [50–80 ml/min CC]	15 h	
Dabigatran [30–50 ml/min CC]	18 h	
Apixaban prophylaxis	12 h	
Fibrinolytic drugs		
Alteplase, anistreplase reteplase, streptokinase	4-24 min	24-28 h

註－NSAID 由於作用機制差異，對於預防出血的停藥時間建議亦有差異。
(1)術前停藥 24 hrs: Diclofenac、Ibuprofen、Indomethacin、Ketoprofen。
(2)術前停藥 3 days: Diflunisal、Naproxen、Sulindac
(3)術前停藥 10 days: Meloxicam、Nabumetone、Piroxicam

血小板與PT的建議

（七）胸腔部

依據 2015 年 N Engl J Med guildline，制定胸腔科侵入性檢查前應注意檢查項目/藥物(Version 1.0 2015/09/25)，並置於網站供參。

	項目	可接受檢查之血凝標準	備註
1	Thoracentesis or drainage only	Platelet> 50,000/μL, PT/aPTT< 1.5 times the upper limit of the normal range	避免使用抗凝血劑，儘量以一週內檢驗值參考
2	Percutaneous lung aspiration	Platelet> 100,000/μL, PT/aPTT < 1.5 times the upper limit of the normal range	
3	Percutaneous lung biopsy or pleural biopsy	Platelet> 100,000/μL, PT/aPTT < 1.5 times the upper limit of the normal range	避免使用抗凝血劑，儘量以一週內檢驗值參考
4	Pig-tail catheterization	Platelet> 100,000/μL, PT/aPTT < 1.5 times the upper limit of the normal range	
5	Bronchoscopy (including screening, biopsy, BAL, laser, etc)	Platelet> 100,000/μL, PT/aPTT < 1.5 times the upper limit of the normal range	

抗凝血劑/抗血小板要停多久

3. Medication：北榮目前抗凝血劑/抗血小板製劑品項(按學名字母排列)

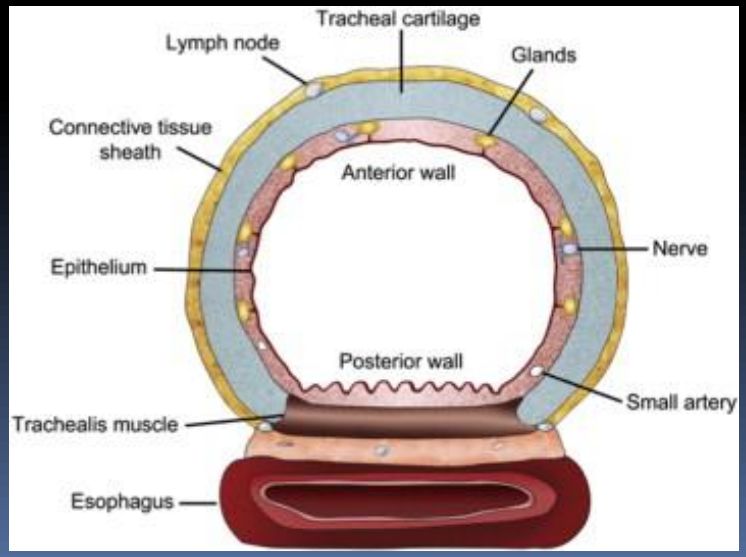
學名	商品名	機轉	建議停藥時間
Apixaban	Eliquis	Selective factor Xa inhibitor	1-2 days
Asprin	Aspirin protect EC, Aspirin VPP, Bokey EM, Espin EM, Ropal, Tapal	TXA2 inhibitor	7-10 days
Asprin+Dipyridamole	Aggrenox	TXA2 inhibitor+PDE inhibitor	7-10 days
Clopidogrel	Plavix	ADP receptor antagonist	5 days
Cilostazol	Pletaal	PDE III inhibitor	2 days
Coumadin	Wafarin, Cofarin	Vitamin K inhibitor	Correct INR <1.5
Dabigatran	Pradaxa	direct thrombin inhibitor	CCr>5: 1-2 days； CCr<50: 3-5 days
Dipyridamole	Persantin	PDE inhibitor	7-10 days
Enoxaparin	Clexane	Factor Xa, IIa inhibitor	24 hrs
Heparin	Agglutex, Calciparin, Heparin-Fresenius, Heparin LEO	antithrombin III activator	IV form: 2-6 hrs；SC form: 12-24 hrs
Rivaroxaban	Xarelto	selective factor Xa inhibitor	CCr >90: 1 day； CCr 60-89: 2 days； CCr 30-59: 3 days； CCr <30: 4 days
Ticlopidine	Licodin	ADP receptor antagonist	10-14 days
Tirofiban	Aggrastat	GP IIb/IIIa inhibitor	4-8 hrs

氣切流血之處理

- 常在術後2-6小時發生
- 除了抗凝血劑/抗血小板製劑，其他造成流血之危險因子:
  - 血液透析
  - 手術後搬動病人
  - 傷口附近有痣或neurofibromatosis
- 處理：
  用1*1 epinephrine紗布塞入氣切傷口。

其他可能之併發症

- Tracheoesophageal fistula
- Guidewire related tracheal laceration
- Apnea related hypercapnia
- Tracheostomy inflammation/infection



大綱

- 氣切手術時機，神經外科病人
- 經皮氣切的適應症與併發症
- 氣切移除原則

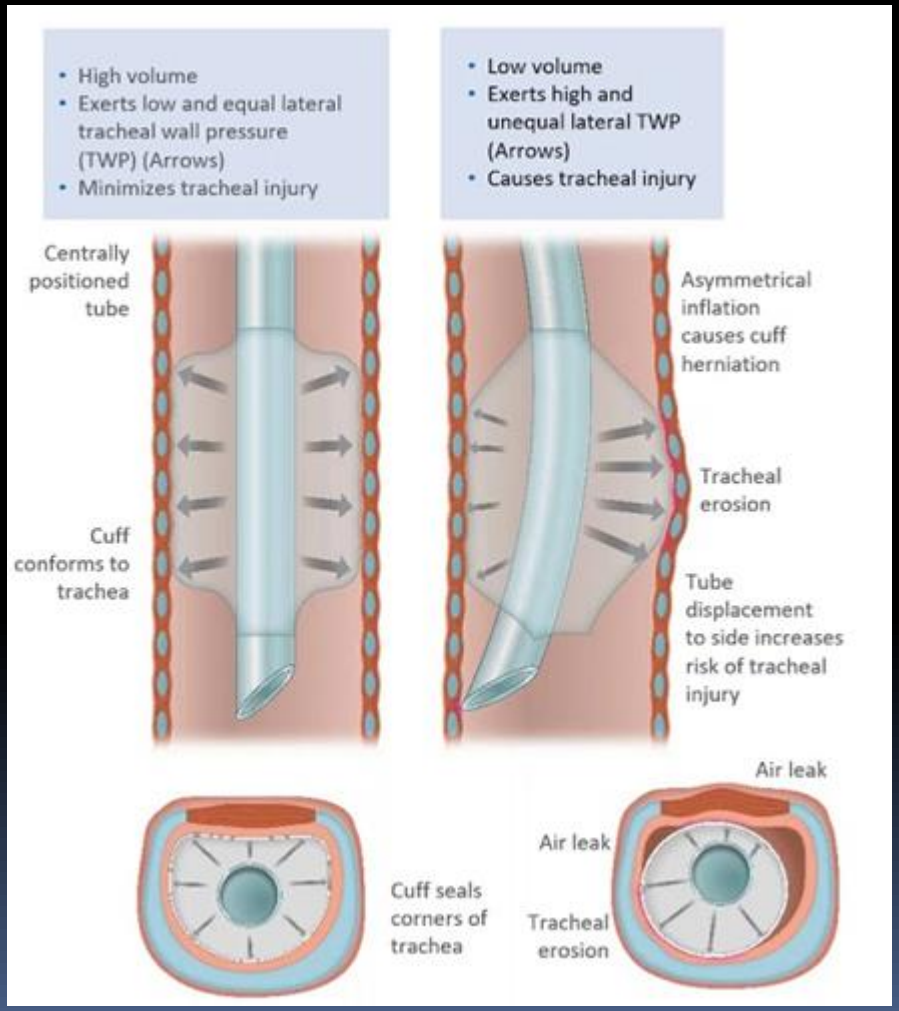
如何說服病人氣切?

- 病患舒適度
- 減少感染
- 脫離呼吸器機率:
  0%(維持現狀) vs. 50%(氣切)
- 氣切是暫時性的，未來有進步可以換成可以說話的氣切甚至拿掉氣切。

氣切種類

塑膠製氣切
(打氣囊/每月更換)

Hi-Lo: high volume low pressure



氣切種類

Subglottic Suctioning

Bivona氣切管
(打水球)

氣切種類

Shiley

胸腔內科更換氣切(塑切換shiley)作業流程

- 一般塑切更換成shiley之建議更換條件如下：
  - 經由主治醫師評估後決定更換。
  - 意識清楚，有自行說話意願與需求。
  - 可以由口進食不會有嗆咳情形超過兩週。
  - 將塑切洞口塞住，塑切cuff鬆開，可由口發聲超過兩週。
  - 可自行咳出痰液至氣切口超過兩週以上。
- 第一次由塑切更換成shiley應住院更換。
- 不論7號或8號塑切，一律換成6號shiley。
- 6號塑切因外徑較小問題，不建議直接更換成shiley。
- 如果更換過程遇到障礙，建議換回原本的塑切。
- 如果更換過程遇到病人躁動無法配合、劇烈咳嗽、氣管痙攣，建議使用鎮靜藥物(例如：Dormicum)後再行置換。

台中榮總一般塑切之內外管徑一覽表

台中榮總一般塑切之內外管徑一覽表

型號	內徑(mm)	外徑(mm)
(Hi-Lo EVAC) 6.0	6.0	8.3
(Hi-Lo EVAC) 7.0	7.0	9.7
(Hi-Lo EVAC) 8.0	8.0	**11.0**

台中榮總shiley之內外管徑一覽表

型號	內徑(mm)	外徑(mm)
4 CFN(無cuff)/FEN(有cuff)	5.0	9.4
6 CFN(無cuff)/FEN(有cuff)	6.4	**10.8**
8 CFN(無cuff)/FEN(有cuff)	7.6	12.2

胸腔內科移除氣切作業流程

- 經由主治醫師評估後決定移除氣切
  評估標準：
  - 病人可以坐起於床旁或輪椅30分鐘以上。
  - 可自行咳出痰液不需抽痰超過兩週以上。
  - 使用可說話型氣切兩週以上，血氧維持95%以上。
  - 可由口進食兩週以上，使用鼻胃管灌食及胃造口除外。
- 門診時主治醫師需告知移除氣切後之風險及再次插管之機率約為3~5%，評估是否需要支氣管鏡協助檢查後移除氣切，並安排病人住院移除氣切。
- 住院後移除氣切需觀察24小時血氧濃度及呼吸型態即可返家，但72小時內仍可能發生呼吸窘迫情形。

- 需做支氣管鏡流程〉預約PPC時段，安排檢查時間，氣管鏡檢查步驟先由氣切進入確定氣管內無息肉等異物，再由鼻腔進入上呼吸道確認Vocal Cord有無異常。
- 不需氣管鏡流程〉 預約住院時段，住院後由主治醫師診視，由住院醫師或總醫師移除氣切，觀察24小時後返家。

O'Connor, Heidi H., and Alexander C. White. "Tracheostomy decannulation." *Respiratory care* 55.8 (2010).

結論

- 腦傷病患是否需要選擇氣切，除考慮病人意識，尚須評估咳痰能力、腦傷位置、年紀、意識進步情形等因素。
- 經皮氣切之禁忌症包括頸部手術、凝血功能異常，頸部感染、脖子太短、太胖、頸部結構異常、呼吸器無法短暫暫停運作。
- 經皮氣切主要併發症包括出血、感染、氣縱膈等，約10-15%，大部分可內科處理。
- 要移除氣切，病患最好能自行坐起、自行咳痰、自行進食、血氧濃度穩定。

感謝聆聽