How Can We Increase the Safety of Tracheal Intubation in Critically Ill Patients?

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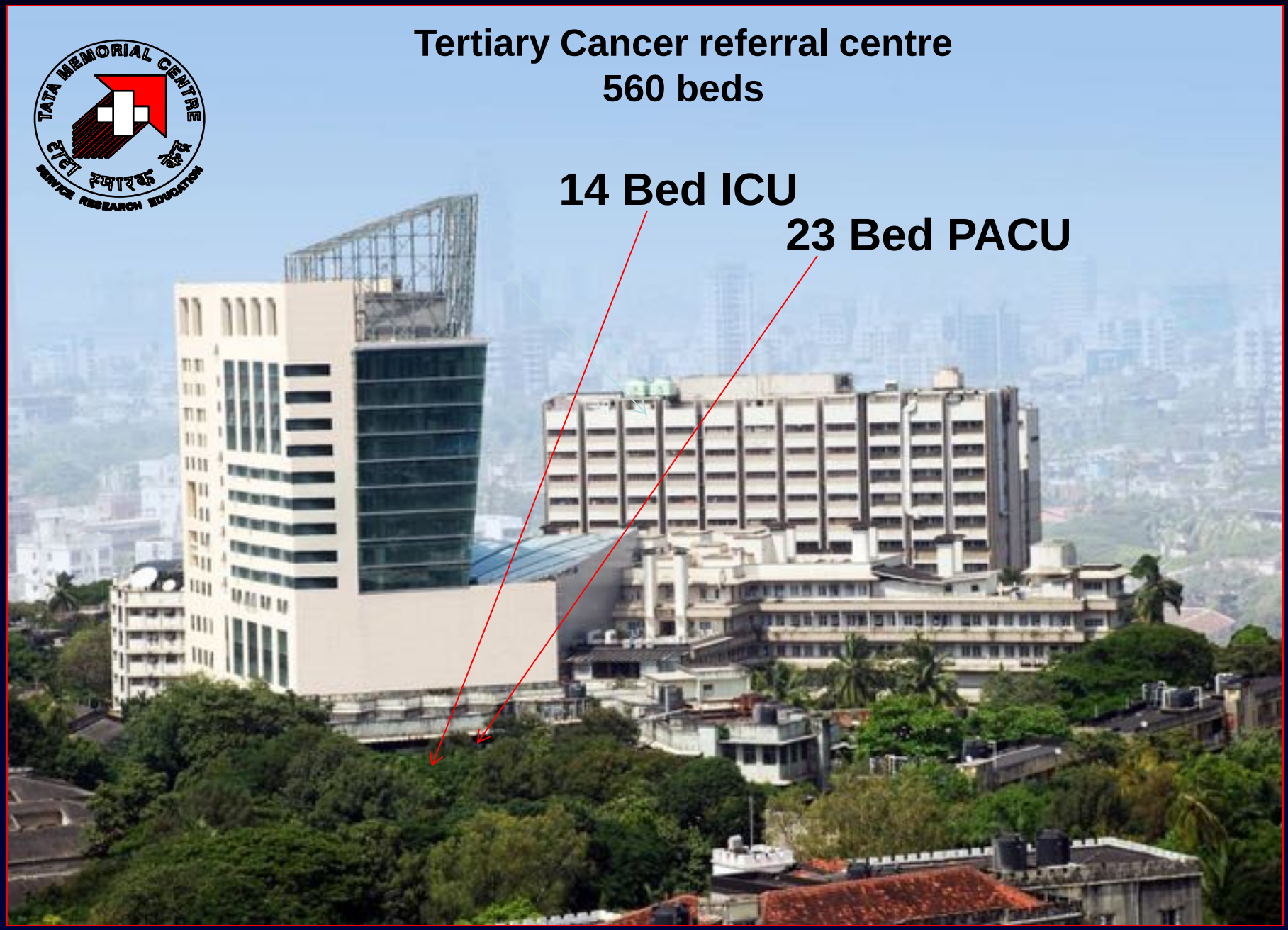
인도에서 인사말.
초대해 주셔서 영광입니다.
감사합니다.

Greetings from India
Thank you for inviting me
I am deeply honoured

Tata Memorial Hospital



Intubation in OT vs ICU

Intubation in OT

- Skilled anaesthesiologists
- Generally stable patients, good physiological reserve
- Mostly elective intubations, prepared patients
- Optimal conditions

Intubation in ICU

- Varying skill levels
- Unstable patients with little or no physiological reserve
- Little or no time for patient preparation
- Suboptimal environment

Complications of Intubation in Critically ill

Study	DI / MA %	Hypoxia %	Hypotension %	Oeso Int %	Aspiration %	Cardiac Arrest %
Schwartz 1995	8			8	4	3
Mort 2004	10	4.7		9.7	2.1	1.8
Griesdale 2006	13.2	19.1	9.6	7.4	5.9	0
Jaber 2008	12	26	25	4.6	2	2
Martin 2011	10.3			1.3	2.8	
Mayo 2011	20	14	6	11	2	1
Bowles 2011	9	14	26	1	5	1
Simpson 2012	0	22	20	2		

Anaesthesia 2011;66:81–92; BJA 2011;107:687; BJA 2012;108:792

Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments†

T. M. Cook[1*], N. Woodall[2], J. Harper[3] and J. Benger[4], on behalf of the Fourth National Audit Project

- 184 complications Sept 1, 2008, to Aug 31, 2009
- > 60% events in ICU led to death or brain damage (compared with 14% in anaesthesia)
- Events in ICU and the ED more likely than during GA
  - to occur out-of-hours
  - be managed by doctors with less anaesthetic experience
  - lead to permanent harm.
- Failure to use capnography contributed to 74% of cases of death or persistent neurological injury

BJA 2011;106:632

Multiple Intubation Attempts

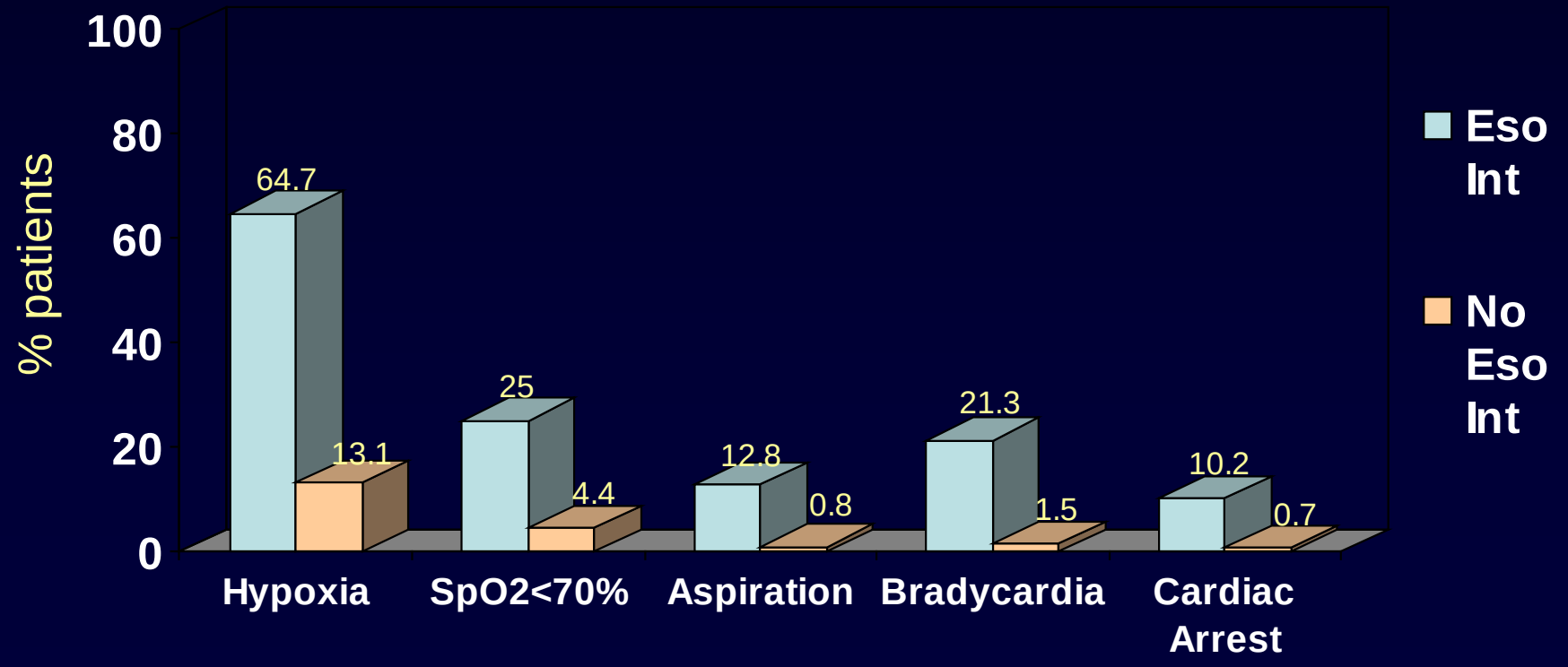
Complication	≤ 2 attempts	> 2 attempts	Risk Ratio (95% CI)
Hypoxemia	10.5%	70%	9 (4.2 -15.9)
SpO2 < 70%	1.9%	28%	14 (7.4 – 24.3)
Esophageal Intubation	4.8%	51.4%	6 (3.7 – 8.7)
Aspiration	0.8%	13%	4 (1.9 – 7.2)
Bradycardia	1.6%	18.5%	4 (1.7 – 6.7)
Cardiac arrest	0.7%	11%	7 (2.4 – 9.9)

- Limit attempts at intubation to 2

Mort. Anesth Analg 2004;99:607-13

Esophageal Intubation during Emergency ETI

- Single episode : 51% hypoxemia,
- Risk of hypoxemia 11-fold (95% CI, 7.7–13.2)
- ≥2 Eso Ints : 85% incidence of hypoxemia



Mort. J Clin Anesth 2005;17:255-62

Intubation Skills and Supervision

- ETI performed by a junior supervised by a senior protected against complications
- Supervision by an attending anesthesiologist was associated with fewer complications
- ≥3 intubation attempts is an independent risk factor for severe complications (OR 3.31, 95% CI: 1.30, 8.40)
- In Scotland , higher first-time success rate and few technical complications ; longer formal training in anaesthesia and junior trainees routinely supervised.

Schmidt et al. Anesthesiology 2008; 109:973–7; Griesdale et al. Intens Care Med 2008; 34:1835–1842; BJA 2012;108:792

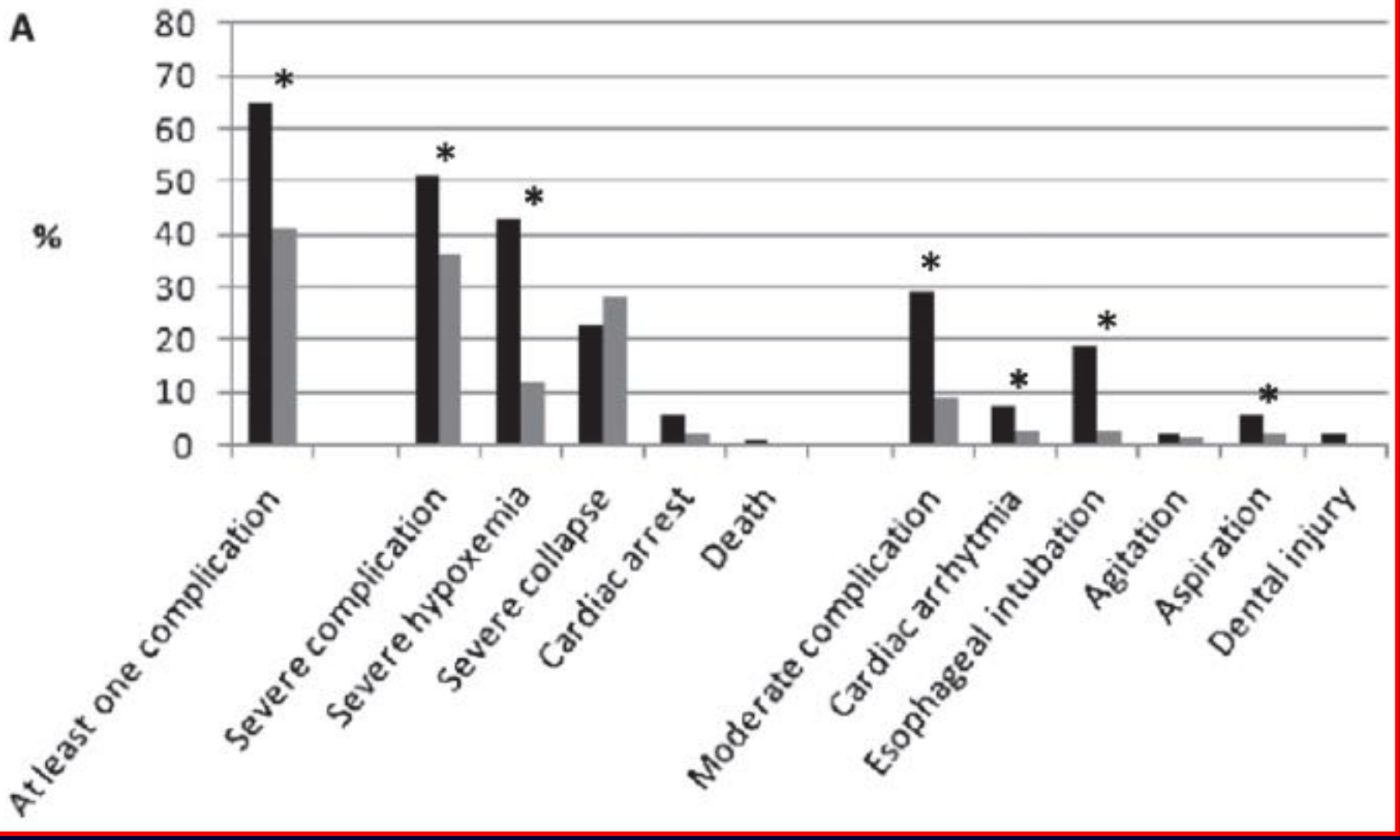
Skills and ICU Intubation
Two Hospitals in Mumbai

	TMH (Anaesthesia)	HH (Physician)
Prolonged intubation	2 / 72 (3%)	17 / 100*
Esophageal intubation	1 / 72 (1.4%)	4 / 100
Desaturation	10 / 72 (14%)	24 / 100
Cardiac arrest	1 / 72 (1.4%)	0

(p-=0.003; rest p = NS)

TMH & HH Unpublished Data

Intubation Difficulty & Complications



AJRCCM 2013; 187:832-9

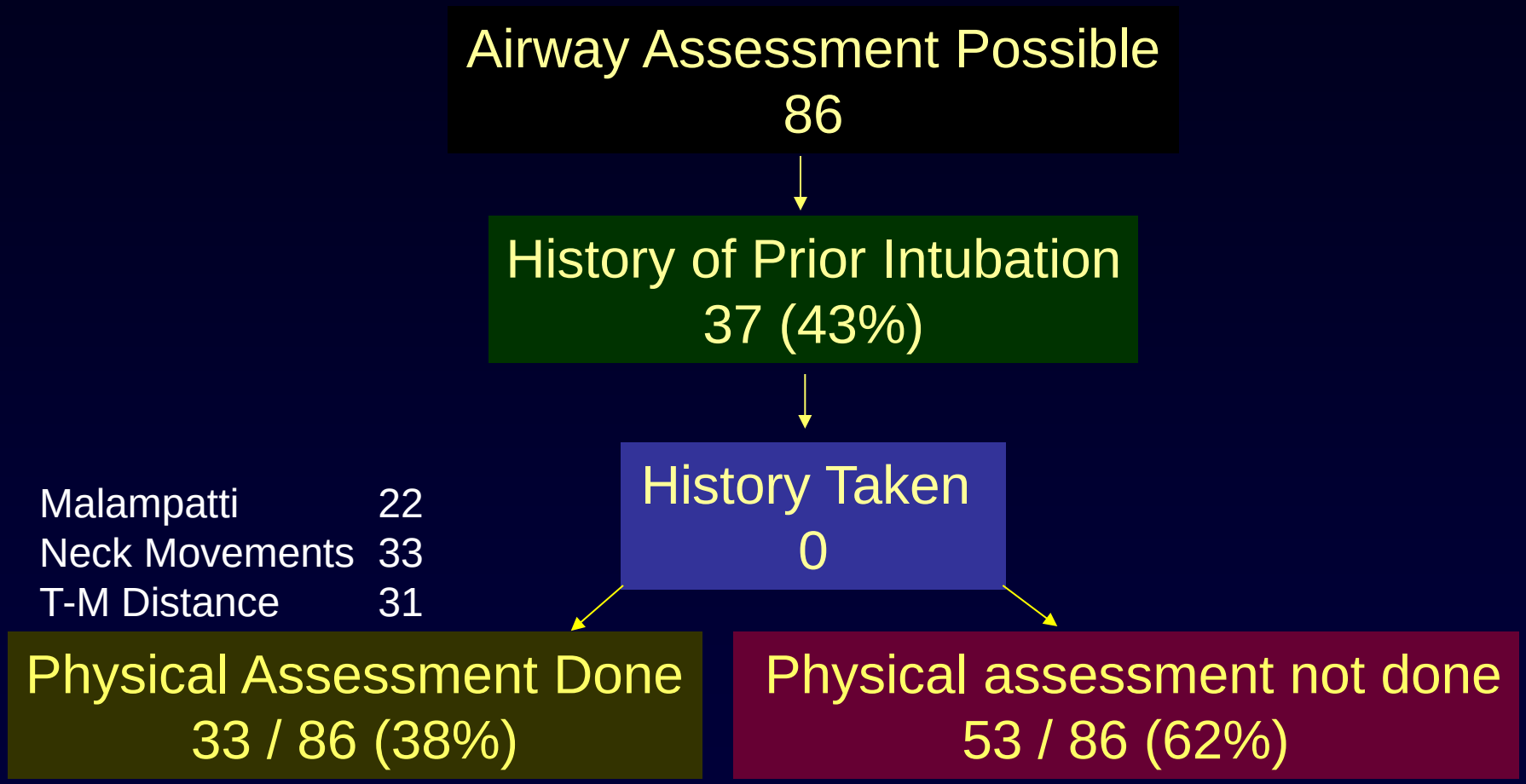
Intubation Difficulty : MACOCHA Score

Mallampati score III / IV; Apnea syndrome (obstructive); Cervical spine limitation; Opening of mouth < 3 cm; Coma, Hypoxia; Anesthesiologist nontrained.

Factor	Score
Factors related to patient	
Mallampati score III or IV	5
Obstructive sleep apnea syndrome	2
Reduced mobility of cervical spine	1
Limited mouth opening < 3 cm	1
Factors related to pathology	
Coma	1
Severe hypoxemia (<80%)	1
Factor related to operator	1
Nonanaesthesiologist (<24 months training)	1
Total	12

Score from 0 to 12: 0 = easy; 12 = very difficult.

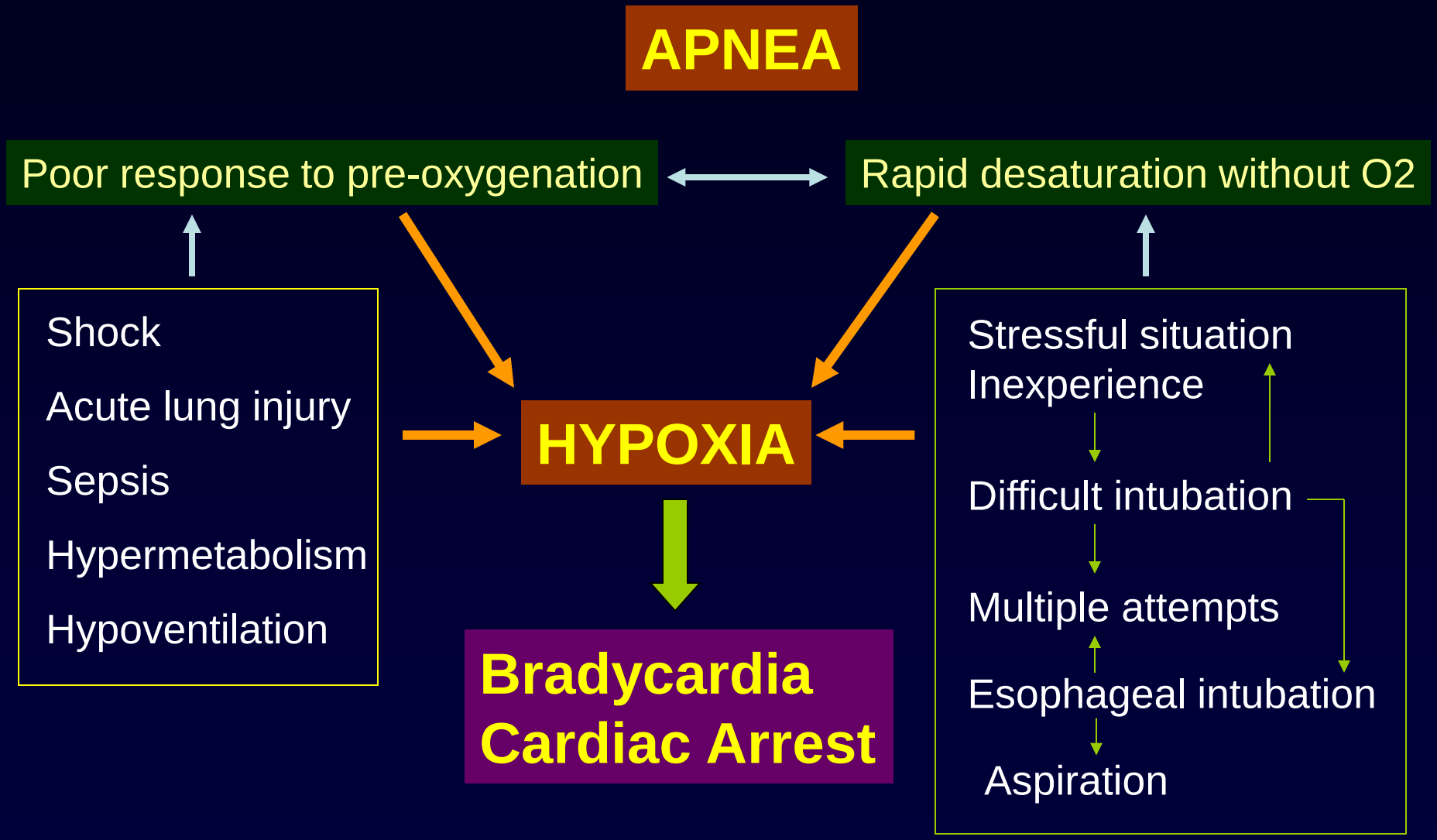
AJRCCM 2013; 187:832-9


Airway Assessment Possible
86
History of Prior Intubation
37 (43%)
History Taken
0
Malampatti 22
Neck Movements 33
T-M Distance 31
Physical Assessment Done
33 / 86 (38%)
Physical assessment not done
53 / 86 (62%)

TMH Data

Intubation using PPE

Decompensation during Intubation Anaesthesia and Muscle Relaxant



Awake Intubation

- Avoids apnea
- Patients may be sedated due to hypoxia, sepsis, etc
- Topical anaesthesia followed by a quick look
- Sedation if required, maintaining spontaneous breathing
- May be difficult in unco-operative, dyspneic, struggling patients
- Videolaryngoscopy may help in awake intubation
  - Not well studied in critically ill patients

Critical Care 2015; 19:258

Videolaryngoscopy and Awake Intubation

Rapid Sequence Intubation vs. No Muscle Relaxant

	RSI		No MR		*P* Value
Total cases	166		67		
Cases with complications	46	28%	52	78%	<.0001
Multiple attempts (≤3)	41	25%	29	43%	<.0001
Multiple attempts (≥4)	3	2%	16	24%	<.0001
Esophageal intubation	5	3%	12	18%	<.0001
Unable to intubate	1	1%	12	18%	<.0001
Airway trauma	0	0%	19	28%	<.0001
Aspiration	0	0%	10	15%	<.0001
Death	0	0%	2	3%	.03

RSI significantly reduces complications of emergency airway management and should be used by physicians trained in its use

Am J Emerg Ued 1999;17:141-144

Poor Response to Pre-oxygenation
Little Oxygen Reserve

- Pre-oxygenation by bag-valve-mask for 4 minutes
- 34 stable controls undergoing cardiac surgery
  - PaO_2 increased from 79 ± 12.3 to 403.6 ± 71.8
- 34 unstable patients intubated in the ICU
  - PaO_2 increased from 64.2 ± 3.5 to 86.8 ± 9.5
  - 41% had <5% change from baseline PaO_2
  - Only 6% had ΔPaO_2 > 50 mmHg with preoxygenation
  - Only 15% patients reached a PaO_2 of 100mmHg

Mort. Crit Care Med 2005; 33:2672–2675

External PEEP Valve and Apneic Oxygenation

- External PEEP valve on exhalation port of a BMV device
  - PEEP 5 to 20 cm H2O
- Provides PEEP/CPAP during spontaneously breathing and IPPV
- Apneic oxygenation with Nasal oxygen at 15 L/min
  - can extend the duration of safe apnea after the administration of muscle relaxants

Ann Emerg Med. 2012;59:165-175

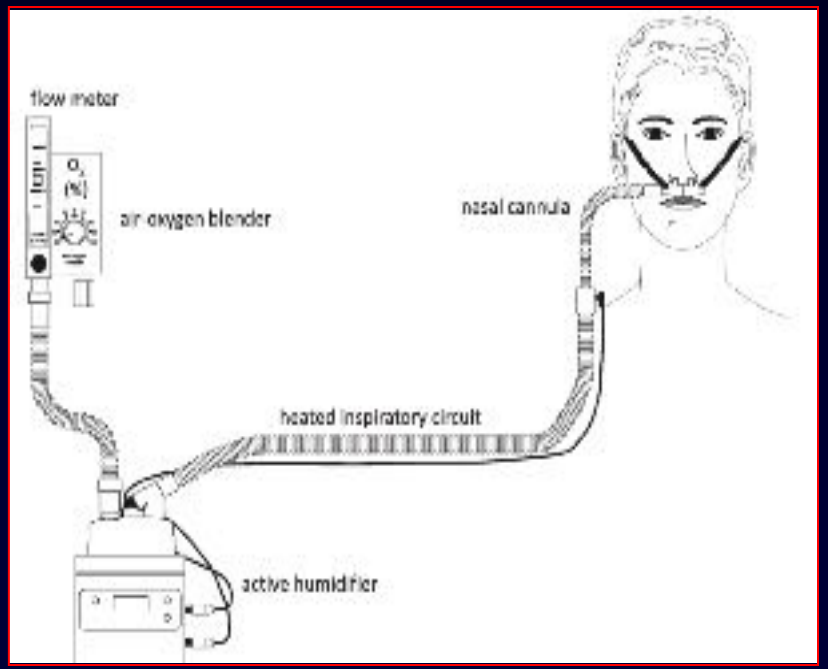
NIV to improve Preoxygenation

- NIV for 3 min (PSV, PEEP 5) vs. nonrebreather BVM

	Control	NIV
SpO_2 after preoxygenation	93 ± 6%	98 ± 2%
SpO_2 during TI	81 ± 15%	93 ± 8%
SpO_2 < 80% during TI	12 (46%)	2 (7%)
SpO_2 5min after TI	94 ± 6%	98 ± 2

Baillard et al. AJRCCM 2006;174:171-77

High-flow nasal cannula oxygen



- Heated and humidified gas at up to 60 L/min of flow
  - reduction of anatomical dead space
  - PEEP effect with mouth closed
  - Constant FiO2
- HFNC can be used to deliver O2 during the apneic period of tracheal intubation.

Journal of Intensive Care (2015) 3:15

Use of High-Flow Nasal Cannula Oxygen Therapy to Prevent Desaturation During Tracheal Intubation of Intensive Care Patients With Mild-to-Moderate Hypoxemia*

Romain Miguel-Montanes, MD[1]; David Hajage, MD[2]; Jonathan Messika, MD[1,3,4]; Fabrice Bertrand, MD[1]; Stéphane Gaudry, MD[1,3,4]; Cédric Rafat, MD[1]; Vincent Labbé, MD[1]; Nicolas Dufour, MD[1,3,4]; Sylvain Jean-Baptiste, MD[1]; Alexandre Bedet, MD[1]; Didier Dreyfuss, MD[1,3,4]; Jean-Damien Ricard, MD, PhD[1,3,4]

- Before Period : Preoxygenation with nonrebreathing bag reservoir facemask (NRM)
  - 6l/min O2 thru nasal catheter during apnea
- After Period : Preoxygenation wit high-flow nasal cannula oxygen (HFNC) 60L/min, FiO2 1.0
  - Continued during apnea
- HFNC improved preoxygenation and reduced prevalence of severe hypoxemia

Crit Care Med 2015; 43:574–583

High-flow nasal cannula oxygen during endotracheal intubation in hypoxemic patients: a randomized controlled clinical trial

- PREOXYFLOW RCT in 6 French ICUs
- HFNC was maintained throughout the procedure (n = 62)
- HFFM removed after induction of GA
- 119 patients (n = 57)
- Lowest saturation was 91.5 % (80–96) for HFNC vs. 89.5 % (81–95) for HFFM group (p = 0.44)
- HFNC preoxygenation device did not reduce the lowest level of desaturation

Intensive Care Med 2015; DOI 10.1007/s00134-015-3796-z

Drugs for Intubation

Etomidate versus ketamine for rapid sequence intubation in acutely ill patients: a multicentre randomised controlled trial

*Patricia Jabre, Xavier Combes, Frederic Lapostolle, Mohamed Dhaouadi, Agnes Ricard-Hibon, Benoit Vivien, Lionel Bertrand, Alexandra Beltramini, Pascale Gamand, Stephane Albizzati, Deborah Perdrizet, Gaelle Lebail, Charlotte Chollet-Xemard, Virginie Maxime, Christian Brun-Buisson, Jean-Yves Lefrant, Pierre-Edouard Bollaert, Bruno Megarbane, Jean-Damien Ricard, Nadia Anguel, Eric Vicaut, Frederic Adnet, on behalf of the KETASED Collaborative Study Group**

Lancet 2009; Published Online July 1, 2009 DOI: 10.1016 / S0140-6736(09)60949-1

655 patients who needed sedation for emergency intubation

0·3 mg/kg of etomidate (n=328) or 2 mg/kg of ketamine (n=327) followed by succinylcholine

No difference in mean maximumSOFA in first 3 days
No difference in intubating conditions
More patients with adrenal insufficiency with etomidate 86% vs. 48%

Can Videolaryngoscopy reduce Difficult Intubation in ICU?

- Systematic review and meta-analysis of RCTs, prospective and retrospective observational studies comparing VL with standard DL
- 9 trials with 2,133 participants (1,067 in DL and 1,066 in VL)
- VL reduced the risk of difficult OTI, Cormack 3/4 grades, and esophageal intubation and increased the first attempt success
- No difference for severe hypoxemia, severe cardiovascular collapse or airway injury.

Intensive Care Med 2014 40:629–639

Preplanned Airway Strategy

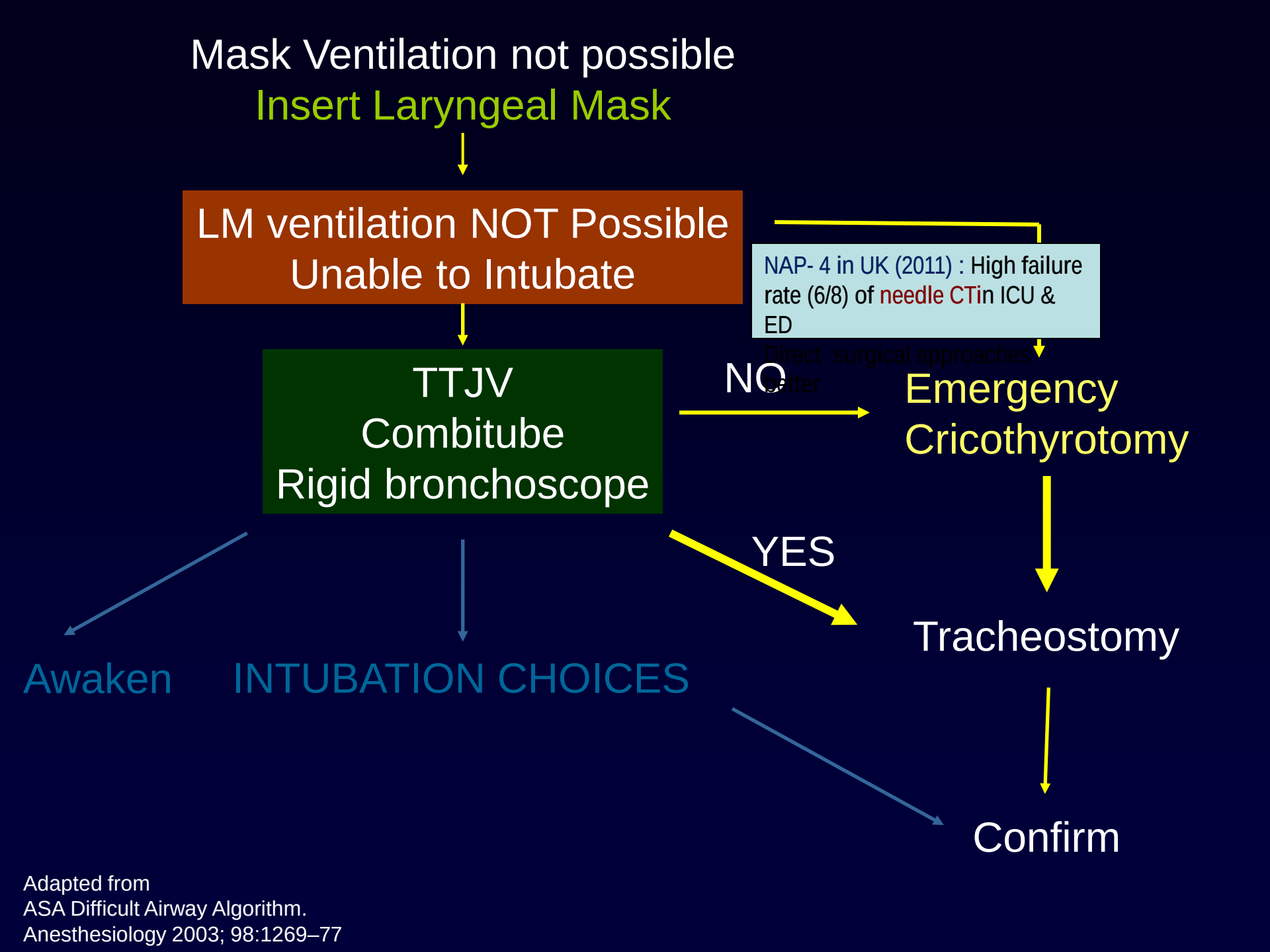
- "…Because most patient populations show a low prevalence of difficult airway and tests have low predictive power, a preplanned strategy is central to managing airway problems "

Anaesthesia 2002;57:105-9
Crit Care Med 2004; 32:S186-92

Does a planned approach work?

- Retrospective review of 3,035 critically ill patients undergoing emergency airway management
- 2 time periods, 1990 - 1995 and 1995 – 2002
- Implementation of a protocol requiring the availability of advanced airway equipment and ETT verifying devices at the bedside.
- Cardiac arrest within 5 min of intubation reduced by 50% from 2.8% to 1.4% between the first and the second time period analyzed

Mort. J Clin Anesth 2004;16:508–516



Adapted from
ASA Difficult Airway Algorithm.
Anesthesiology 2003; 98:1269–77

Percutaneous Tracheostomy in Failed Intubation

- Has been used in failed intubation, airway obstruction
- Ideally used after ventilation is restored
  - Failed intubation in ICU managed with LM & PDT
  - Emergency ventilation in a CVCI situation in the ICU initiated by TTJV via cannula inserted below the cricoid. Definitive airway access secured by PT over a guide wire inserted through the transtracheal cannula.

Divatia et al. Anaesth Intens Care 1999; 27: 409-11
Divatia et al. Anesthesiology 2002;96:1519-20

Intubation Bundle

Pre-intubation

1. Presence of two operators
2. Fluid loading (isotonic saline 500 ml or starch 250 ml) in absence of cardiogenic pulmonary edema
3. Preparation of long-term sedation
4. Preoxygenation for 3 min with NIPPV in case of acute respiratory failure (FiO2 100%, PSV 5 -15 cmH2O to obtain an expiratory TV 6 - 8 ml/kg and PEEP of 5 cmH2O)

Intensive Care Med (2010) 36:248–255

Intubation Bundle

During intubation

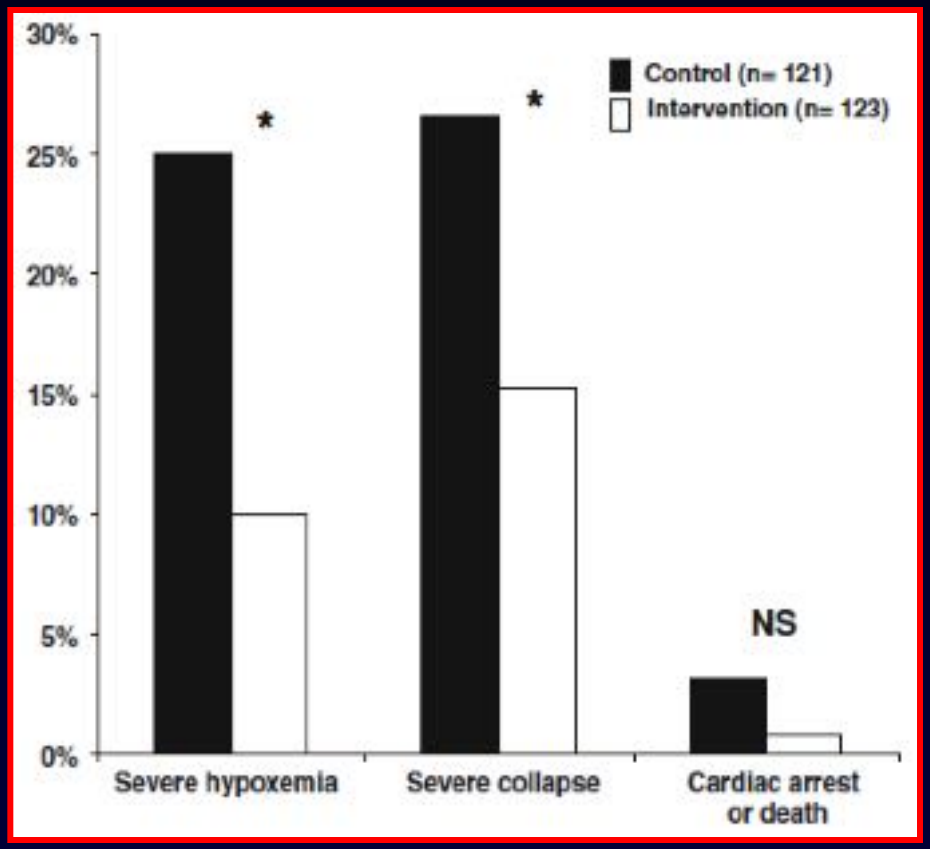
5. Rapid sequence induction: etomidate 0.2–0.3 mg/kg or ketamine 1.5–3 mg/kg combined with succinylcholine 1–1.5 mg/kg in absence of conntraindications
6. Sellick maneuver

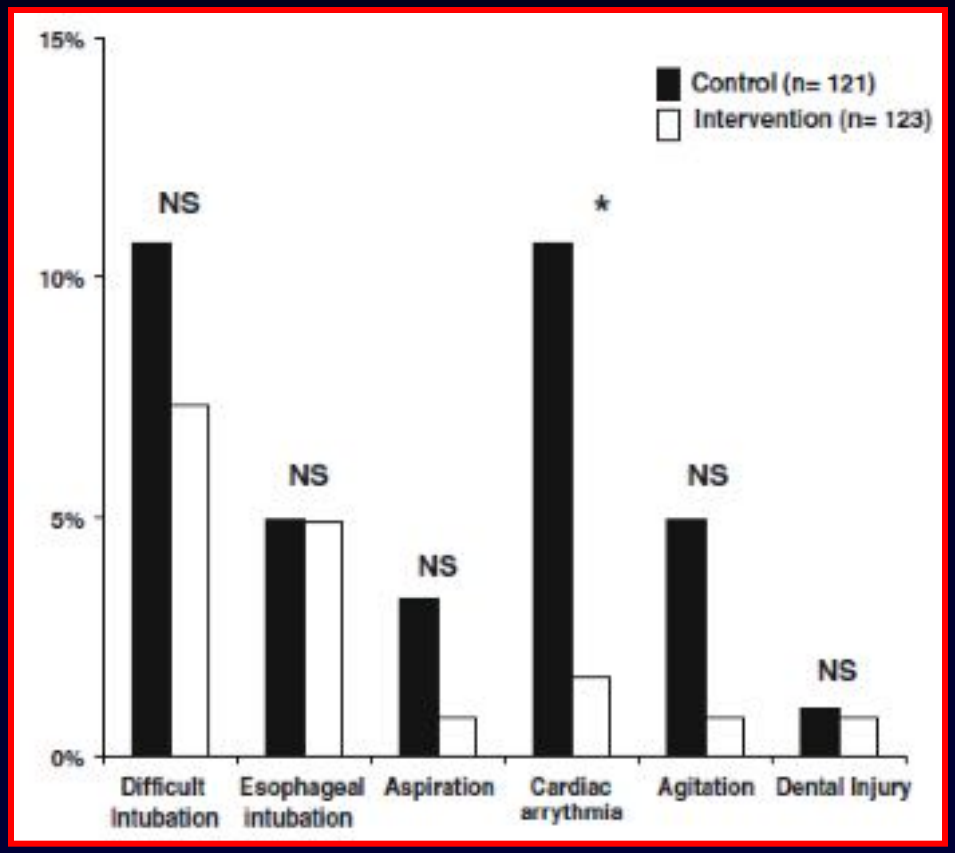
Post-intubation

7. Immediate confirmation of tube placement by capnography
8. Norepinephrine if DBP remains < 35 mmHg
9. Initiate long-term sedation
10. Initial ‘‘protective ventilation’’: TV 6–8 ml/kg IBW, FiO2 100%, plateau pressure < 30cmH2O

Intensive Care Med (2010) 36:248–255

Impact of the use of an Intubation Bundle





Significant decreases in life-threatening complications (21 vs.34%, p = 0.03) and other complications (9 vs. 21%, p = 0.01) compared to the control phase (n = 123)

Intensive Care Med (2010) 36:248–255

Audit of Compliance with the Intubation Bundle

Prospective, observational study at TMH ICU

- 14 months; November 2013 to December 2014
- Patients > 12 years requiring intubation in the ICU
- All intubations by residents / fellows with ≥ 2yrs experience in anaesthesiology
- **Exclusion criteria**
  - Re-intubation for unplanned extubation
  - Awake Fibreoptic Intubation
  - Intubation done during CPR

TMH Audit
Reasons For Intubation

Indications	**(n=158)**
Acute Respiratory Failure	127 (80.4%)
Shock	51 (32.3%)
Neurologic	28 (17.7%)
Others	1 (0.6%)

Complications

78 /158 intubations (49.4%)

Complication type	Number of Complications
Severe hypotension	64 (40.5%)
Severe Hypoxemia	9 (5.7%)
Cardiac Arrest	2 (1.3%)
Aspiration	2 (1.3%)
Difficult Intubation	6 (3.7%)
Esophageal intubation	3 (1.9%)
Dental and other airway injury	5 (3.2%)
Other Complications	5 (3.2%)

TMH Audit
Bundle Compliance & Complications

Part of Intubation bundle	Compliance	Compliance Complications	Non-Compliance Complications	p
All Elements	62 (39.2 %)	52%	48%	0.65
Pre-intubation	98 (62%)	49%	50%	0.52
During Intubation	106 (67.1%)	50%	48%	0.87
Post-intubation	105 (66.5%)	47%	55%	0.34

TMH Audit

- Fewer hypoxic complications and Difficult intubations compared to other audits
  - More hypotension
- Experienced operators
- Intubation bundle needs further validation

Safety during intubation

- Fluid preload
- Monitoring and preparation
- Two persons, including one experienced supervisor
- NIV for preoxgenation / ? HFNC
- Sedation with ketamine, use muscle relaxant
- Apneic oxygen during laryngoscopy
- ? Videolaryngoscopy
- Avoid multiple attempts
- Capnography to confirm tracheal intubation

Improving airway management in ICU

- Education and training
  - Develop and acquire skills
  - Appreciate difficulty and complexity in ICU environment
- Staffing
- Intubation Checklist
- Availability of airway equipment
- Recognition of difficulty and backup planning
- Use and correct interpretation of Capnography
- Cricothyrotomy: more training? surgical?

관심을 가져 주셔서
감사합니다!

Thank You