Anaesthesia considerations for prehospital resuscitation of life-threatening bleeding

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THOR RDCR Symposium 2017 Bergen Norway

Declaration

- *The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of any given organisation*
- *Conflicts of interest - none*

Acknowledgements:

History: ((intitle:"haemorrhage shock" OR intitle:"hemorrhage shock" OR intitle:"haemorrhagic shock" OR intitle:"hemorrhagic shock" OR intitle:"hypovolemic shock") AND (Ventilation OR intubation))

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Extras ?

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3	**MAIN TEXT WORDS**											
4				shock	trauma	"haemorrhage shock"		positive pressure ventilation			Survival	
5						"hemorrhage shock"		Rapid Sequence Intubation			complications	
6						"haemorrhagic shock"		PHEA			"Treatment Outcome"	
7						"hemorrhagic shock"		Prehospital emergency anaesthesia			"Patient Outcome Assessment"	
8						"hypovolemic shock"		Prehospital emergency anesthesia				
9								Ventilation				
10	**ADDITIONAL TERMS**							intubation				
11												
12		battlefield			traumatic			"Emergency Cricothyroidotomy"			filetype:ppt	
13		Gunshot wounds			Blast Injuries			"Emergency cricothyrotomy"			filetype:pptx	
14		military medicine			multiple trauma			"Emergency tracheal intubation"				
15		combat casualties			traumatic shock			ETI				
16		"army medics"			Wounds and Injuries			"Emergency endotracheal intubation"				
17												
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19												
20	**FIELDS**	"Military Medicine"[MeSH]		shock[MeSH]	Blast Injuries[M	hemorrhage[MeSH]		"Positive-Pressure Respiration"[MeSH]			Survival[MeSH]	
21					"multiple trauma"[MeSH]						complications[MeSH]	
22					Shock, Traumatic[MeSH]						"Treatment Outcome"[MeSH]	
23					shock[MeSH]						"Patient Outcome Assessment"[MeSH]	
24					"Wounds and Injuries"[MeSH]						Mortality[MeSH]	
25												
26												
27												
28						"haemorrhage shock"[TI]						
29						"hemorrhage shock"[TI]						

Searches Automatically with Selected Terms

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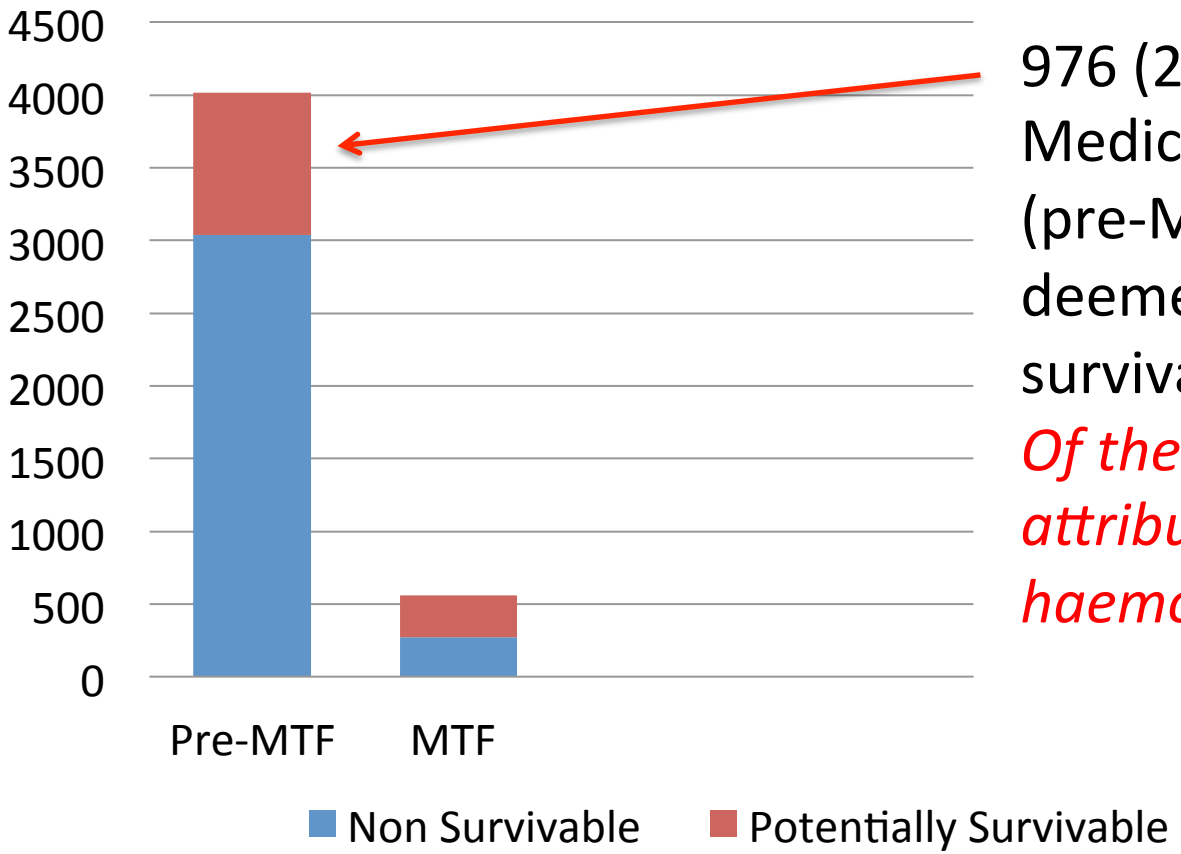
Emergency Department

Anaesthesia considerations for prehospital resuscitation of life-threatening bleeding – Care Under Fire:

US Armed Forces battlefield fatalities 2001 – 2011
Potentially survivable injuries:

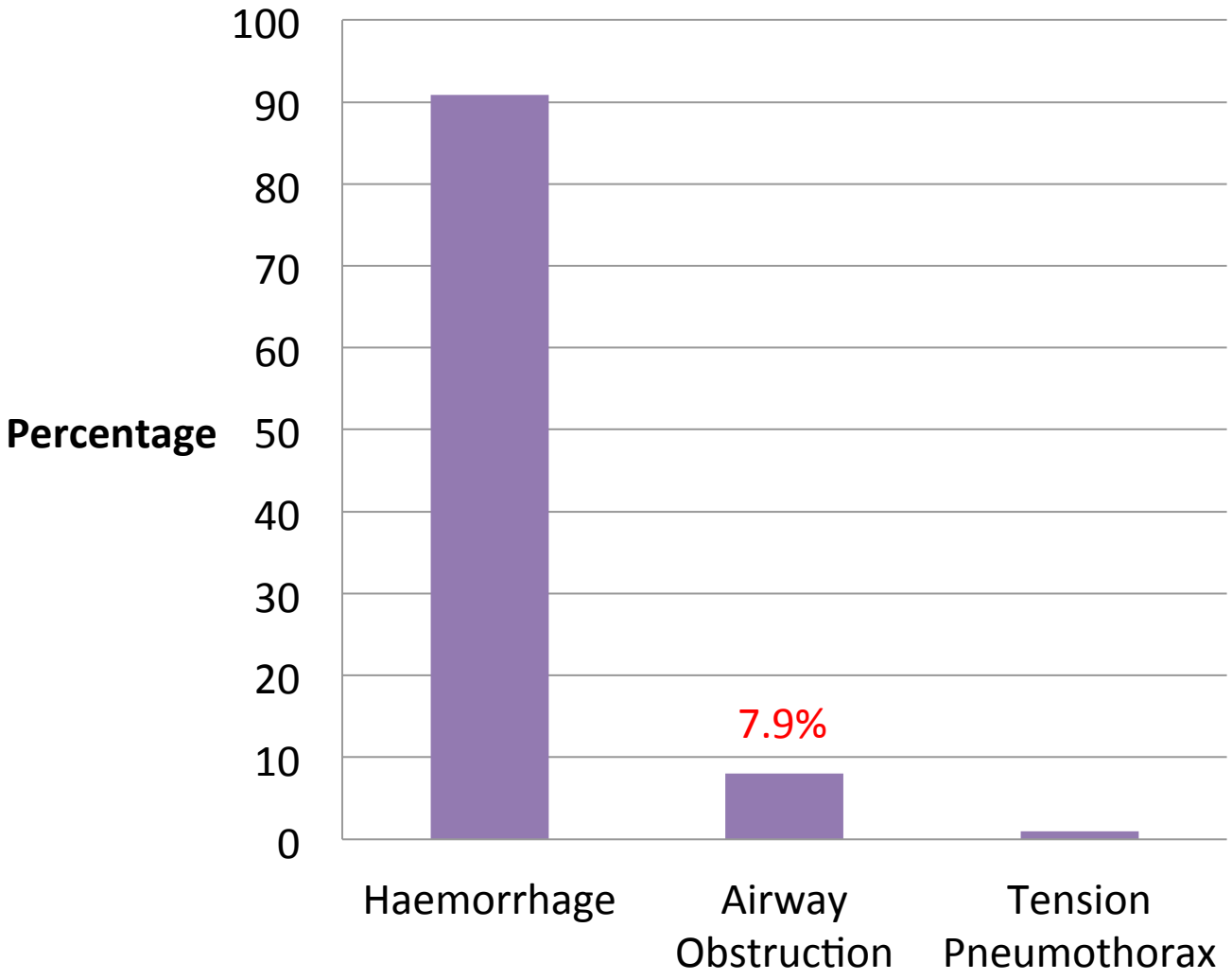


976 (24.3%) of the pre-Medical Treatment Facility (pre-MTF) deaths were deemed potentially survivable.

Of these 90.9% were attributed to haemorrhage.

Eastridge, B. J., Mabry, R. L., Seguin, P., Cantrell, J., Tops, T., Uribe, P., . . . Blackbourne, L. H. (2012). Death on the battlefield (2001-2011): implications for the future of combat casualty care. *J Trauma Acute Care Surg*, 73(6 Suppl 5), S431-437.

Pre-Medical Treatment Facility
Potentially Survivable injuries: mortality cause



December 7th 1941

Halford, F. J. A critique of intravenous anesthesia in war surgery. *Anesthesiology*, 1 1943, Vol.4, 67-69.

A CRITIQUE OF INTRAVENOUS ANESTHESIA IN WAR SURGERY

F. J. HALFORD, M.D., F.A.C.S.

Honolulu, T. H.

EVERY advance in anesthesia has been marked by its tragedies. So far as I know, a critical study of intravenous anesthesia in traumatic shock in human beings has not been published. The distribution of 1,800,000

And in conclusion:

As Admiral Gordon-Taylor of the British Navy has so aptly said, "Spinal anesthesia is the ideal form of euthanasia in war surgery"—then let it be said that intravenous anesthesia is also an ideal method of euthanasia.

Should we subject the shocked trauma patient to anaesthesia in the prehospital setting?

Really Sensible Idea

RESEARCH Open Access

The European guideline on management of major bleeding and coagulopathy following trauma: fourth edition

Rolf Rossaint[1], Bertil Bouillon[2], Vladimir Cerny[3,4,5,6], Timothy J. Coats[7], Jacques Duranteau[8], Enrique Fernández-Mondéjar[9], Daniela Filipescu[10], Beverley J. Hunt[11], Radko Komadina[12], Giuseppe Nardi[13], Edmund A. M. Neugebauer[14], Yves Ozier[15], Louis Riddez[16], Arthur Schultz[17], Jean-Louis Vincent[18] and Donat R. Spahn[19*]

"There are well-defined situations in which intubation is mandatory, for example airway obstruction, altered consciousness [Glasgow Coma Score (GCS) ≤8], haemorrhagic shock, hypoventilation or hypoxaemia" [1]

Really Shocking Idea

- "Field intubation in civilian patients with hemorrhagic shock is associated with higher mortality"[2]

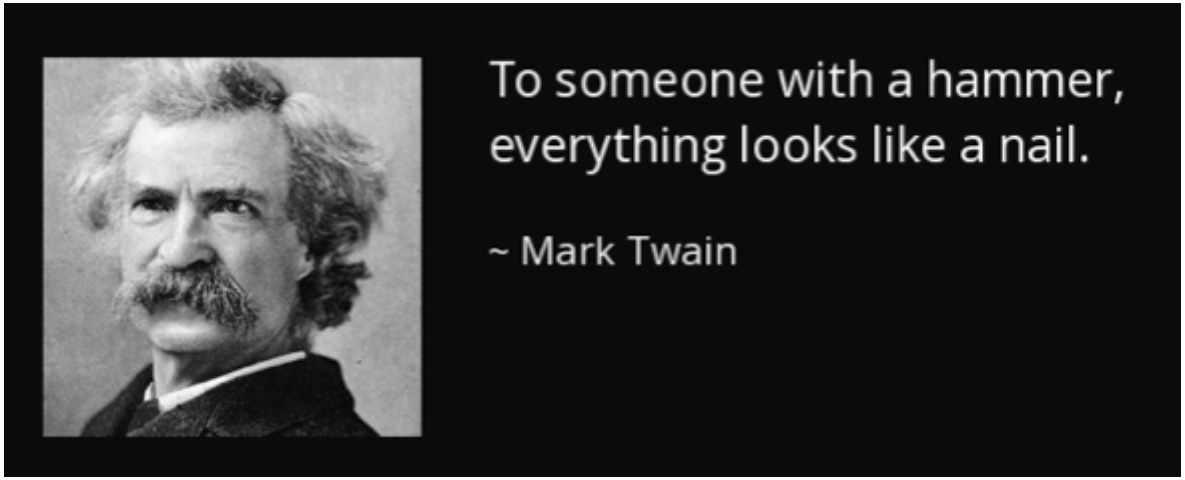
?

Rossaint, R., Bouillon, B., Cerny, V., Coats, T. J., Duranteau, J., Fernandez-Mondejar, E., . . . Spahn, D. R. (2016). The European guideline on management of major bleeding and coagulopathy following trauma: fourth edition. *Crit Care, 20*, 100.

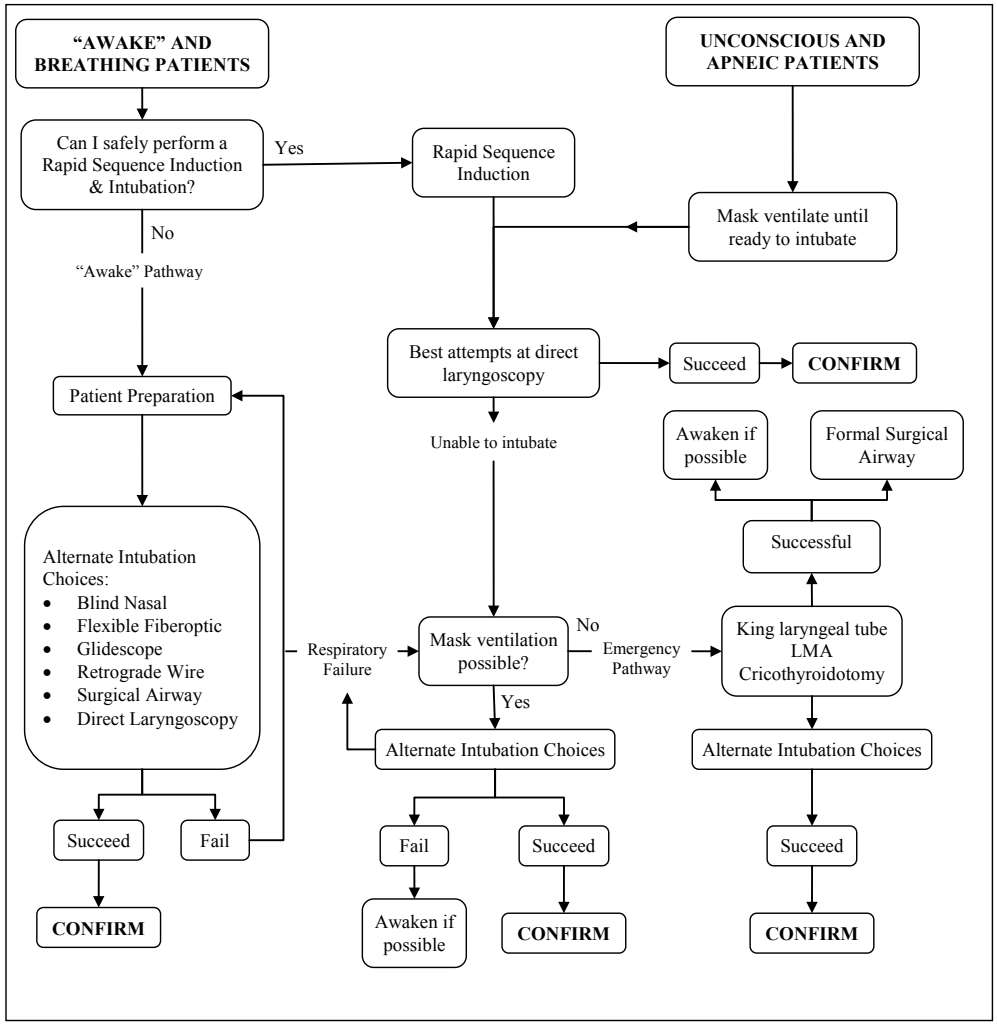
Chou, D., Harada, M. Y., Barmparas, G., Ko, A., Ley, E. J., Margulies, D. R., & Alban, R. F. (2016). Field intubation in civilian patients with hemorrhagic shock is associated with higher mortality. *J Trauma Acute Care Surg, 80*(2), 278-282.

Why would we want to subject the shocked trauma patient to anaesthesia in the prehospital setting?

- cABCDE problems?
  - Airway failure − direct injury, failure to maintain
  - Breathing failure − compromised ventilation
  - Circulation failure - ???
  - D problems − combative head injury, failure to maintain airway
  - E - humanitarian
- Because we can?



Decision making- complex!



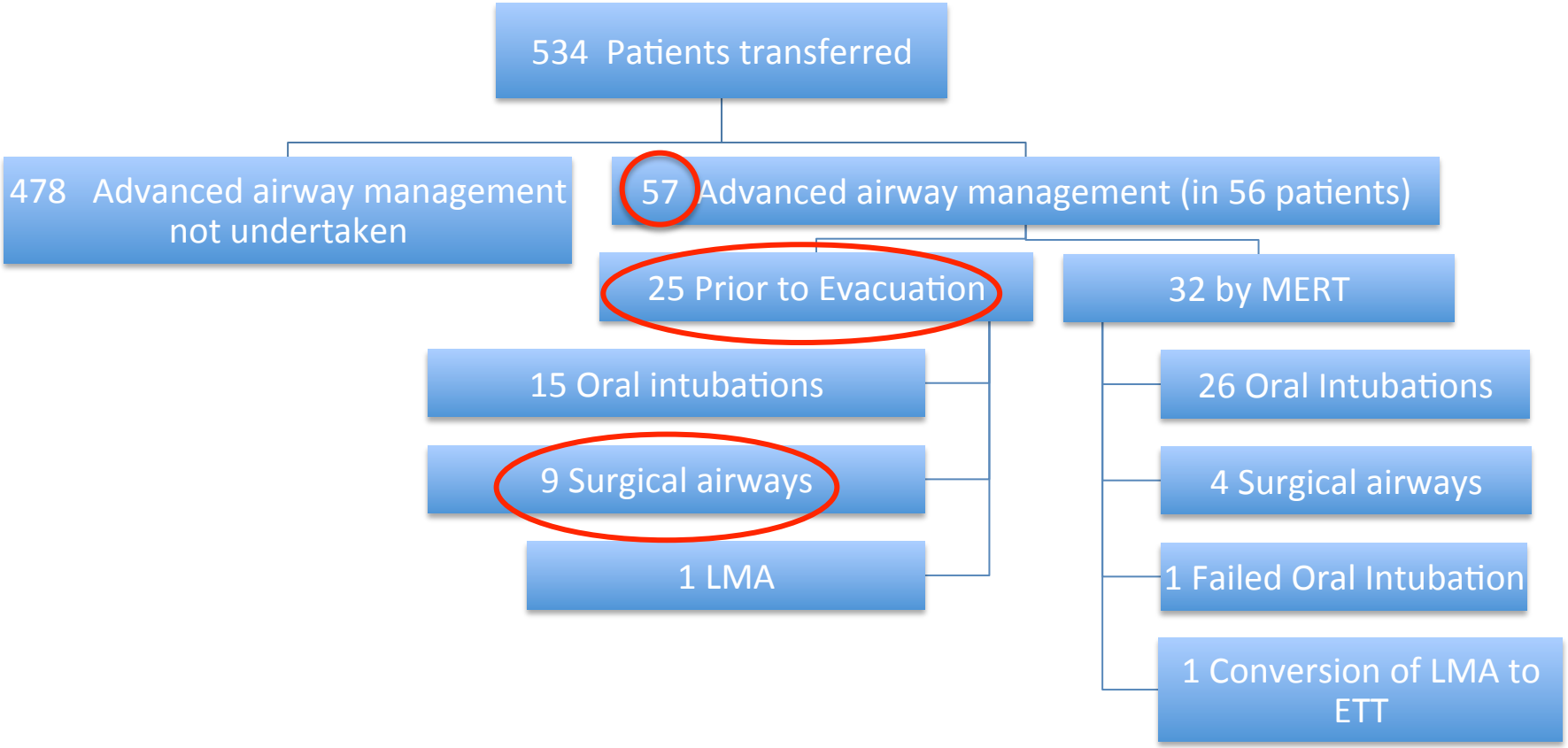
Joint Theater Trauma System Clinical Practice Guideline. Trauma Airway Management. June 2012

Prehospital advanced airway intervention indications:

- Operation Iraqi Freedom 2005 - 2007
- 4.2% of 6875 casualties arriving at combat support hospitals required prehospital advanced airway interventions
- 95.7% of ETTs correctly placed by prehospital teams
- Suggested indications:
    - Cardio-pulmonary resuscitation in progress
    - Glasgow Coma Score ≤ 8
    - Oxygen saturations (SpO_2) < 80%
    - Base deficit > 20
    - Systolic blood pressure < 80mmHg
    - pH < 7.0

Adams, B. D., Cuniowski, P. A., Muck, A., & De Lorenzo, R. A. (2008). Registry of emergency airways arriving at combat hospitals. *J Trauma, 64(6),* 1548-1554.

UK Medical Emergency Response Team (MERT) advanced airway interventions:



Haldane, A. G. (2010). Advanced airway management--a medical emergency response team perspective. *J R Army Med Corps*, 156(3), 159-161.

Surgical airway success rates:

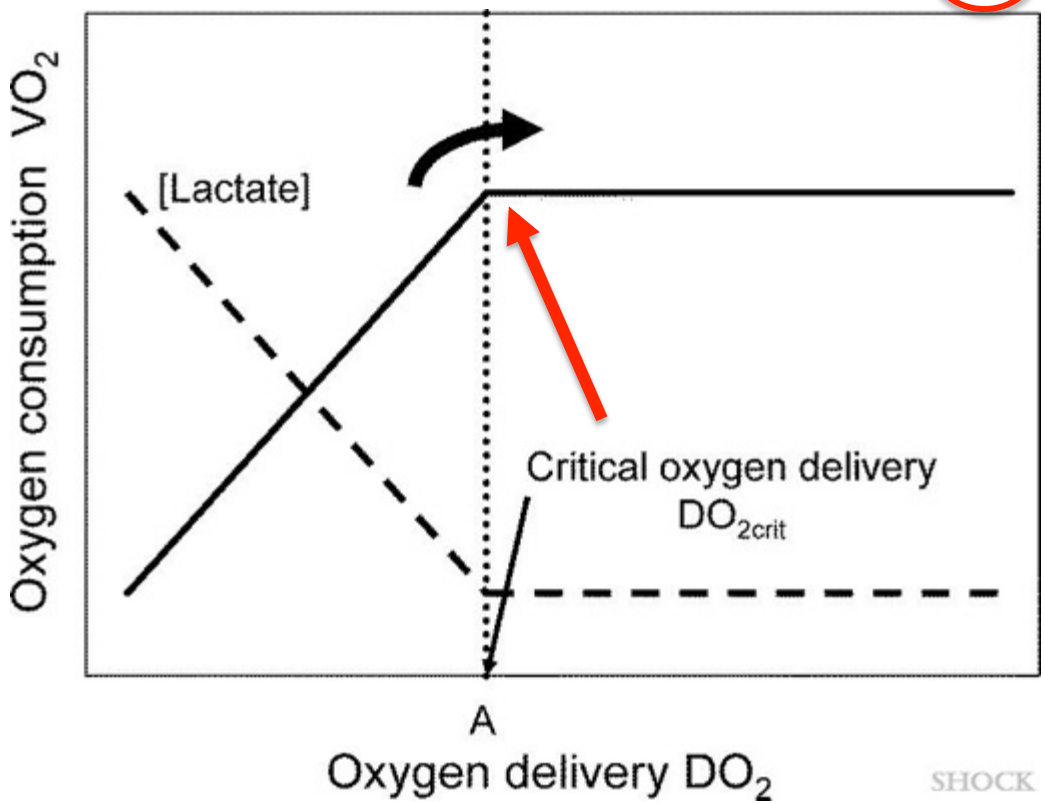
- UK
  - 92%. Combat Medical Technicians or GDMOs. 24% survived to hospital discharge[1]
- Israeli
  - 93%. Paramedic or physician[2]
- US
  - 68% (combat medic 67% v Dr/PA 85%)[3]
  - 82%. Combat medic or aeromed medic[4]

1. Kyle, T., le Clerc, S., Thomas, A., Greaves, I., Whittaker, V., & Smith, J. E. (2016). The success of battlefield surgical airway insertion in severely injured military patients: a UK perspective. *J R Army Med Corps, 162*(6), 460-464.
2. Katzenell, U., Lipsky, A. M., Abramovich, A., Huberman, D., Sergeev, I., Deckel, A., . . . Glassberg, E. (2013). Prehospital intubation success rates among Israel Defense Forces providers: epidemiologic analysis and effect on doctrine. *J Trauma Acute Care Surg, 75*(2 Suppl 2), S178-183.
3. Mabry, R. L. (2012). An analysis of battlefield cricothyrotomy in Iraq and Afghanistan. *J Spec Oper Med, 12*(1), 17-23.
4. Barnard, E. B., Ervin, A. T., Mabry, R. L., & Bebarta, V. S. (2014). Prehospital and en route cricothyrotomy performed in the combat setting: a prospective, multicenter, observational study. *J Spec Oper Med*, 14(4), 35-39.

Rapid Sequence Intubation:

What are we trying to achieve by prehospital intubation of the shocked trauma patient?

- Maintain Airway and maximise oxygenation ie DO_2
- NB Ficks equation: $DO_2 = 1.34 \times Hb \times SaO_2 \times CO$



Barbee, R. W., Reynolds, P. S., & Ward, K. R. (2010). Assessing shock resuscitation strategies by oxygen debt repayment. *Shock, 33(2),* 113-122.

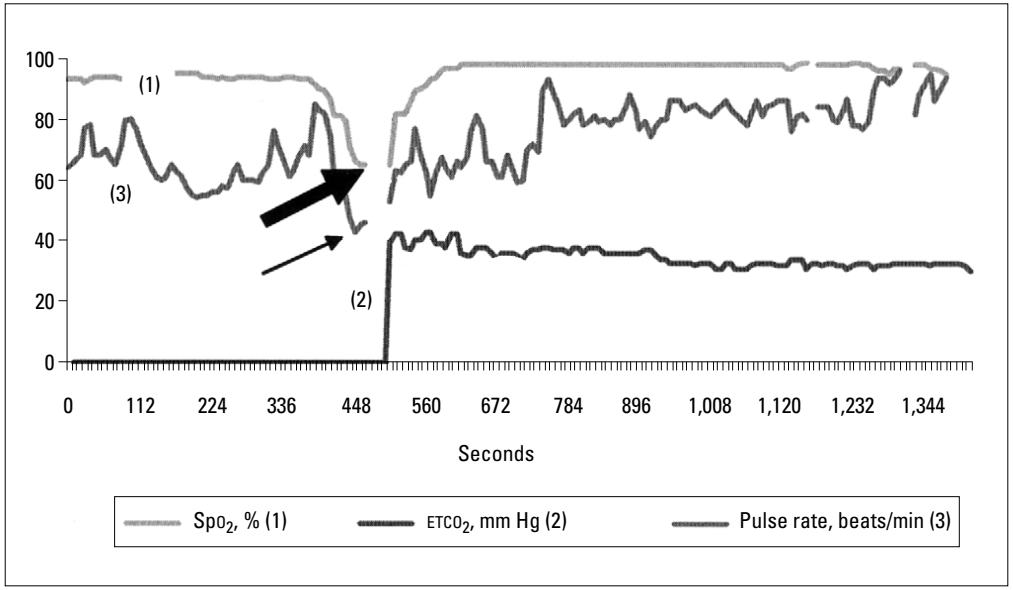
So what's the problem with RSI in haemorrhagic shock?

- "Pent, sux, start CPR" − Richard Dutton
- Rapid sequence intubation:
  - Paralysis and apnoea − increased respiratory acidosis.
  - Hypotensive effect of induction agent
    - Decreased cardiac output → reduced DO_2
  - Hypotensive effect of positive pressure ventilation
    - Decreased cardiac output → reduced DO_2

RSI induced hypoxia:

- 31 of 54 patients (57%) desaturated during RSI performed by paramedics
- 84% of these 31 events had sats ≥ 90% pre-RSI

Figure 1.
Desaturation to SpO_2 equal to 65% (large arrow) with bradycardia to 43 beats/min (small arrow). Target $ETCO_2$ of 30 to 35 mm Hg was achieved.

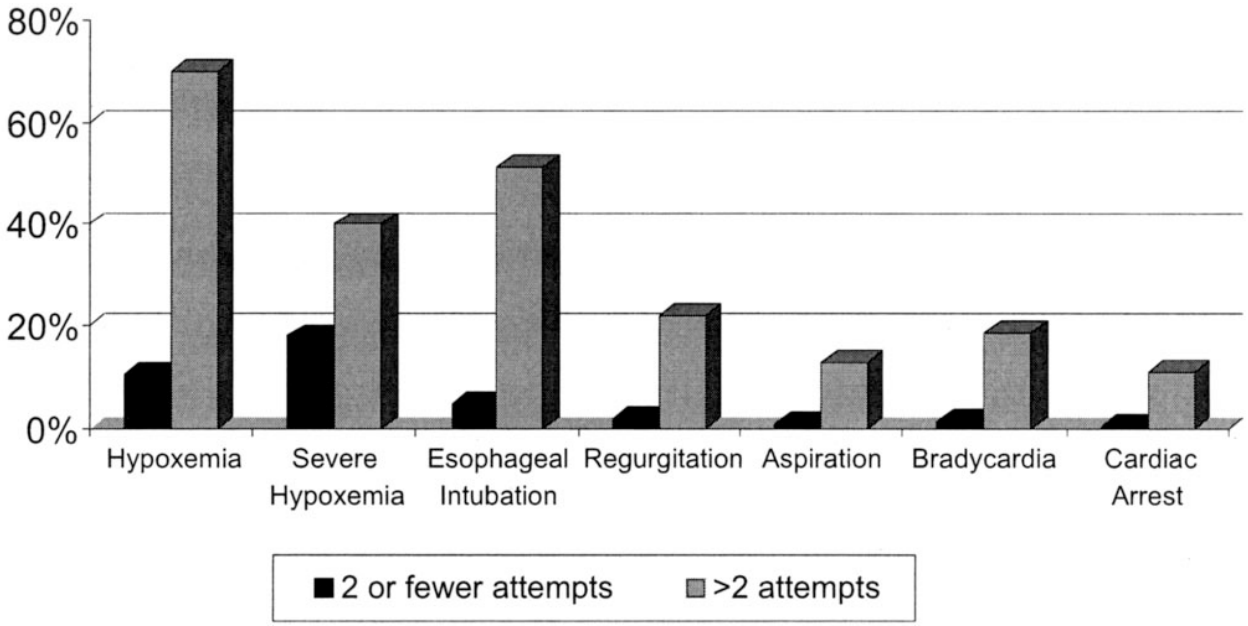


Dunford, J. V., Davis, D. P., Ochs, M., Doney, M., & Hoyt, D. B. (2003). Incidence of transient hypoxia and pulse rate reactivity during paramedic rapid sequence intubation. *Ann Emerg Med, 42(6),* 721-728.

Table 5. Complications by Intubation Attempts

Complication	2 or fewer attempts (90%)	>2 attempts (10%)*	Relative risk for >2 attempts	95% CI for risk ratio
Hypoxemia	10.5%	70%	9X	4.20 – 15.92
Severe hypoxemia	1.9%	28%	14X	7.36 – 24.34
Esophageal intubation	4.8%	51.4%	6X	3.71 – 8.72
Regurgitation	1.9%	22%	7X	2.82 – 10.14
Aspiration	0.8%	13%	4X	1.89 – 7.18
Bradycardia	1.6%	18.5%	4X	1.71 – 6.74
Cardiac arrest	0.7%	11%	7X	2.39 – 9.87

* All categories $P < 0.001$ when comparing 2 or fewer attempts to >2 attempts.



Mort, T. C. (2004). Emergency tracheal intubation: complications associated with repeated laryngoscopic attempts. *Anesth Analg, 99(2),* 607-613, table of contents.

Positive pressure ventilation decreases cardiac output:

PHYSIOLOGICAL STUDIES OF THE EFFECTS OF INTERMITTENT POSITIVE PRESSURE BREATHING ON CARDIAC OUTPUT IN MAN[1, 2]

ANDRE COURNAND, HURLEY L. MOTLEY[3], LARS WERKO[4] AND DICKINSON W. RICHARDS, JR.

From the Department of Medicine, Columbia University, and the Chest and Medical Services of the Columbia University Division, Bellevue Hospital, New York, New York

Received for publication August 18, 1947

Cournand, A., Motley, H. L., & et al. (1948). Physiological studies of the effects of intermittent positive pressure breathing on cardiac output in man. *Am J Physiol, 152(1),* 162-174.

Post intubation hypotension (PIH):

- Retrospective trauma registry review
- 444 adult trauma patients undergoing Endotracheal Intubation in ED
- Post Intubation Hypotension
  - SBP ≤ 80 mmHg or decrease SBP ≥ 20% from baseline
  - MAP ≤ 60 mm Hg
  - If SBP ≤ 90 mmHg pre-intubation any SBP decrease > 5 mmHg
  - Administration of vasopressor
- PIH group older and more likely to have ISS ≥ 12
- 36.3% experienced post intubation hypotension
  - PIH group in-hospital mortality 29.8%
  - Non PIH group in-hospital mortality 15.9%

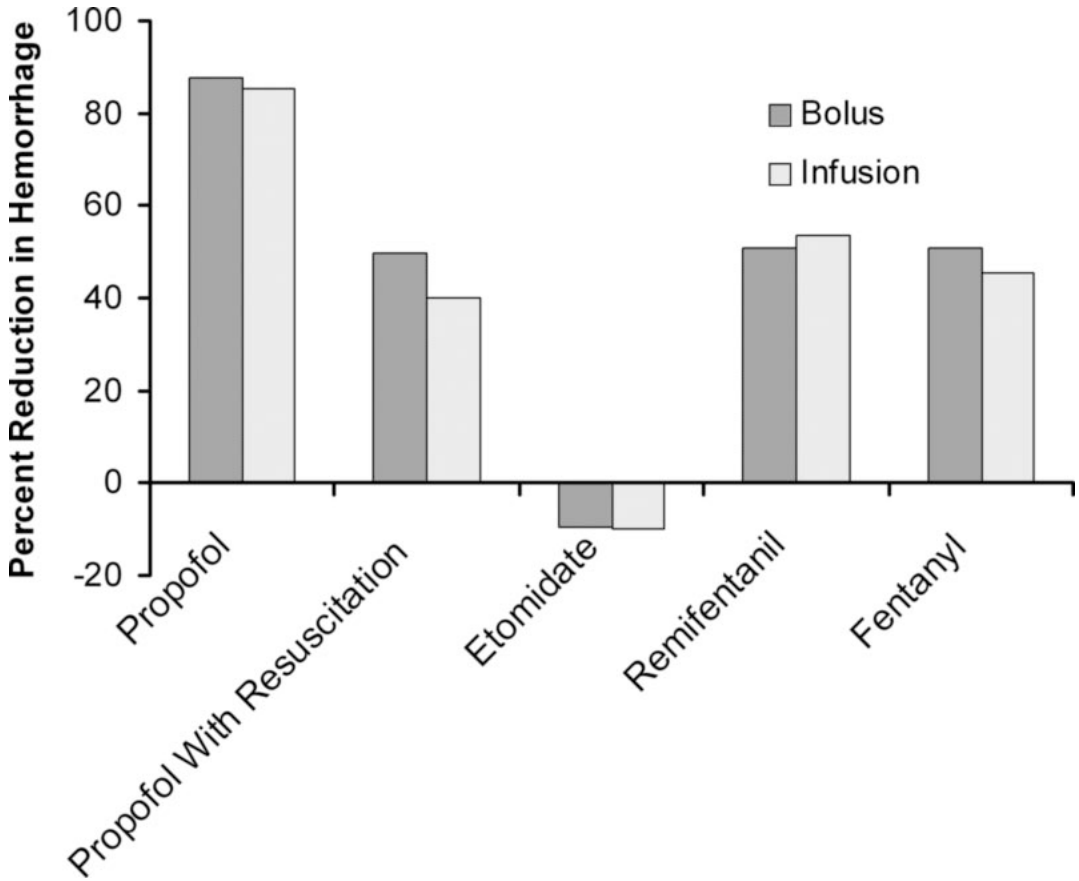
Green, R. S., Butler, M. B., & Erdogan, M. (2017). Increased mortality in trauma patients who develop post-intubation hypotension. *J Trauma Acute Care Surg*.

What about positive pressure ventilation in hypovolemic trauma patients?

- Retrospective review US National Trauma Data Bank: 1994 -2002
- Inclusion: Pre-hospital GCS < 8 and ISS > 16
- 871 intubated pre-hospital v 6581 intubated in ED
- Logistic regression to control for potential confounders including age, ISS, AIS and body region
- Results
  - Comparable groups except head injury (pre-hospital 71% v ED 83%) and ISS (pre-hospital 36 v ED 33)
  - **Patients intubated pre-hospital more likely to be hypotensive (SBP ≤ 90mmHg) on arrival to ED (pre-hospital 54% v ED 33%)**
  - **Worse survival – pre-hospital 24% v ED 45%**
  - **BUT – not all were RSI − were the intubated patients sicker?**

Shafi, S., & Gentilello, L. (2005). Pre-hospital endotracheal intubation and positive pressure ventilation is associated with hypotension and decreased survival in hypovolemic trauma patients: an analysis of the National Trauma Data Bank. *J Trauma, 59(5),* 1140-1145; discussion 1145-1147.

What is the effect of the induction agent?



Shafer, S. L. (2004). Shock values. *Anesthesiology, 101(3),* 567-568.

Ketamine:

- Increases heart rate and blood pressure via endogenous catecholamine release[1]
- In vitro and animal studies has negative inotropic effect (usually overridden in vivo by effects of catecholamine release)[2]

1. Chernow, B., Lake, C. R., Cruess, D., Coyle, J., Hughes, P., Balestrieri, F., . . . Fletcher, J. R. (1982). Plasma, urine, and CSF catecholamine concentrations during and after ketamine anesthesia. *Crit Care Med, 10*(9), 600-603.
2. Gelissen, H. P., Epema, A. H., Henning, R. H., Krijnen, H. J., Hennis, P. J., & den Hertog, A. (1996). Inotropic effects of propofol, thiopental, midazolam, etomidate, and ketamine on isolated human atrial muscle. *Anesthesiology*, 84(2), 397-403.

Ketamine in shock?

Anaesthesia
Journal of the Association of Anaesthetists of Great Britain and Ireland

Anaesthesia, 2009, **64**, pages 532–539 doi:10.1111/j.1365-2044.2008.05835.x

REVIEW ARTICLE

Anaesthesia in haemodynamically compromised emergency patients: does ketamine represent the best choice of induction agent?

C. Morris,[1] A. Perris,[2] J. Klein[1] and P. Mahoney[3]

1 Consultant in Anaesthesia and Intensive Care Medicine, 2 Specialist Registrar in Emergency Medicine, Derby Hospitals Foundation Trust Derby, UK
3 Defence Professor Anaesthesia, Department of Military Anaesthesia and Critical Care, Royal Centre for Defence Medicine, Birmingham Research Park, Edgbaston, Birmingham, UK

Morris, C., Perris, A., Klein, J., & Mahoney, P. (2009). Anaesthesia in haemodynamically compromised emergency patients: does ketamine represent the best choice of induction agent? *Anaesthesia, 64(5),* 532-539.

YES! – *"KETAMINE FAR FORWARD"*

C. Morris et al. • Anaesthesia in haemodynamically compromised emergency patients Anaesthesia, 2009, **64**, pages 532–539

Table 2 Summary of relevant clinical studies using ketamine. 'Resource poor' refers to developing world and conflict settings, or other remote situations with no piped gas supplies and minimal monitoring.

Study	Clinical setting	Nature of publication	Principal finding/conclusion
Baraka et al. [5]	Resource poor obstetrics	Randomised trial of ketamine vs thiopentone in resource poor obstetric setting	Favors ketamine to thiopentone (end-point was intubating condition; rocuronium used as neuromuscular blocking agent)
White [47]	Emergency surgery	Randomised trial of thiopentone vs ketamine	Superior haemodynamics with ketamine (and emergence phenomena prevented by co-administration of midazolam)
Craven [48]	Resource poor	Review	Favours ketamine for hypovolaemic shock
Pesonen [49]	Resource poor	Case series (65 cases)	Low incidence of hypoxia breathing room air with ketamine anaesthesia
Magabeola [50]	Resource poor	Case series (135 cases)	Satisfactory increase in BP with ketamine (co-administration of atropine)
Porter [51]	Pre-hospital, non-anaesthetist use	Case series (32 cases)	Satisfactory use of ketamine for extricating trauma victims and providing analgesia while maintaining spontaneous breathing
Bonnanno [52]	Resource poor	Case series (62 cases)	Satisfactory use of ketamine with minimal monitoring available
Gofrit et al. [53]	Pre-hospital/conflict, non-anaesthetist use	Pilot study in trauma	Satisfactory use of ketamine in restless patients with trismus
Mulvey et al. [54]	Resource poor	Case series (149 cases)	Strongly advocates ketamine as first-line induction agent in disaster area surgery
Mellor [55]	Resource poor	Review	Favors use of ketamine especially for non-physician use
Meo et al. [56]	Resource poor	Review	Favors use of ketamine including emergency surgery
Wood [57]	Pre and in-hospital trauma	Review	Favors ketamine for trauma

Cardiac Arrest Following Ketamine Administration for Rapid Sequence Intubation:

- 2 cases – critically ill patients
  - Cardiac arrest post intubation
- Suggested mechanism of catecholamine depletion in the *critically ill*
- May also reflect dangers of Positive Pressure Ventilation rather than ketamine

Dewhirst, E., Frazier, W. J., Leder, M., Fraser, D. D., & Tobias, J. D. (2013). Cardiac arrest following ketamine administration for rapid sequence intubation. *J Intensive Care Med*, 28(6), 375-379.

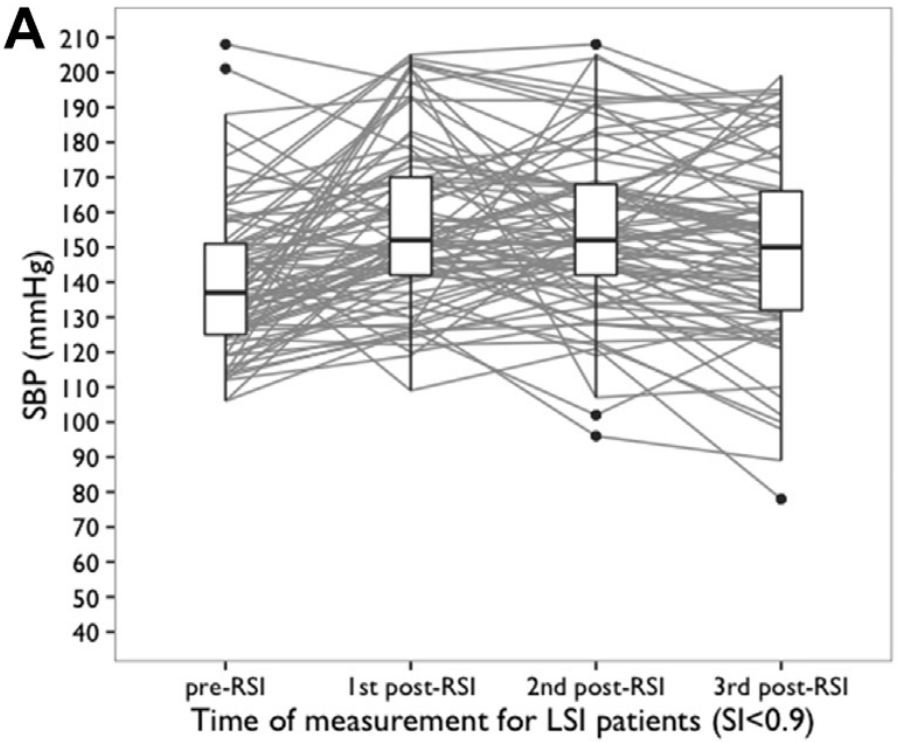
Effect of ketamine in shocked patients?

- Prospective observational study of patients undergoing prehospital RSI
- Shock index (Heart rate/Systolic BP) pre ketamine RSI
    - SI > 0.9 predicts increased mortality and likely need for transfusion
- Low shock index (ie <0.9) v high SI (≥0.9) groups
  - Low SI group 1.4mg/kg v High SI group 1.2 mg/kg
- More High SI patients (26%) became hypotensive than Low SI patients (2%)

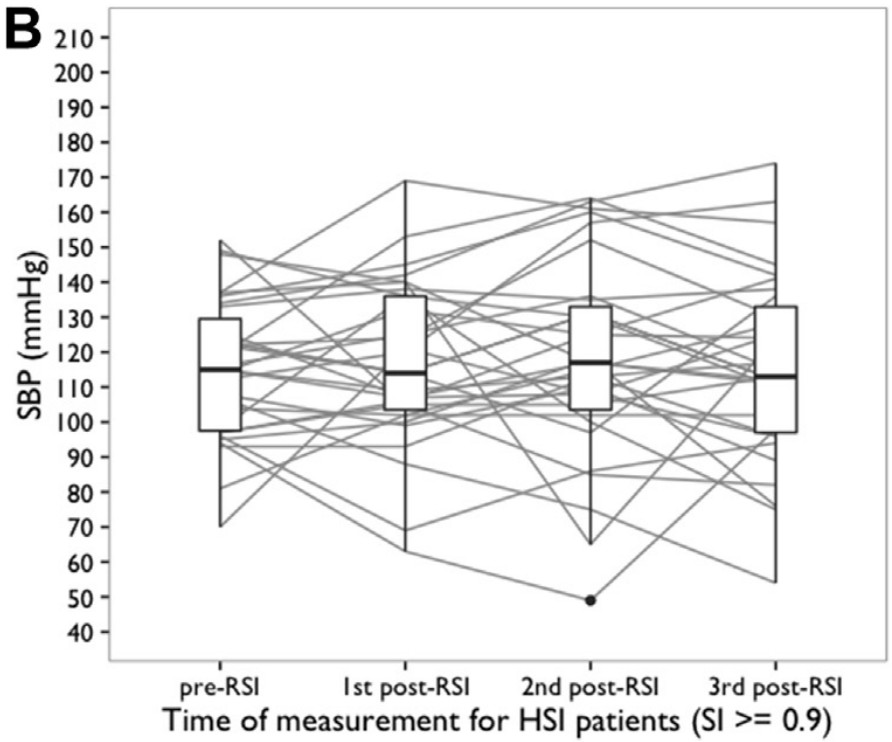
Miller, M., Kruit, N., Heldreich, C., Ware, S., Habig, K., Reid, C., & Burns, B. (2016). Hemodynamic Response After Rapid Sequence Induction With Ketamine in Out-of-Hospital Patients at Risk of Shock as Defined by the Shock Index. *Ann Emerg Med, 68(2),* 181-188.e182.

SBP for Low and High SI groups pre and post RSI:

Low Shock Index patients



High Shock Index patients



Miller, M., Kruit, N., Heldreich, C., Ware, S., Habig, K., Reid, C., & Burns, B. (2016). Hemodynamic Response After Rapid Sequence Induction With Ketamine in Out-of-Hospital Patients at Risk of Shock as Defined by the Shock Index. *Ann Emerg Med, 68(2),* 181-188.e182.

Ketamine and TBI

- Increasing evidence that ketamine is not harmful in TBI
- Theoretical concerns that ketamine elevates ICP
  - In vivo studies in severe TBI ketamine reduces ICP[1]
- In RDCR TBI patients hypotension due to haemorrhage is often the overriding problem hence ketamine's effect on BP is vital
  - Studies show CPP and MAP increased with ketamine[1]
- Ketamine may have a neuroprotective effect[2]

1. Zeiler, F. A., Teitelbaum, J., West, M., & Gillman, L. M. (2014). The ketamine effect on ICP in traumatic brain injury. *Neurocrit Care, 21*(1), 163-173.
2. Himmelseher, S., & Durieux, M. E. (2005). Revising a dogma: ketamine for patients with neurological injury? *Anesth Analg, 101(2),* 524-534, table of contents.

What about not intubating?

Does intubation and manual ventilation confer survival advantage over BVM ventilation in haemorrhagic shock?

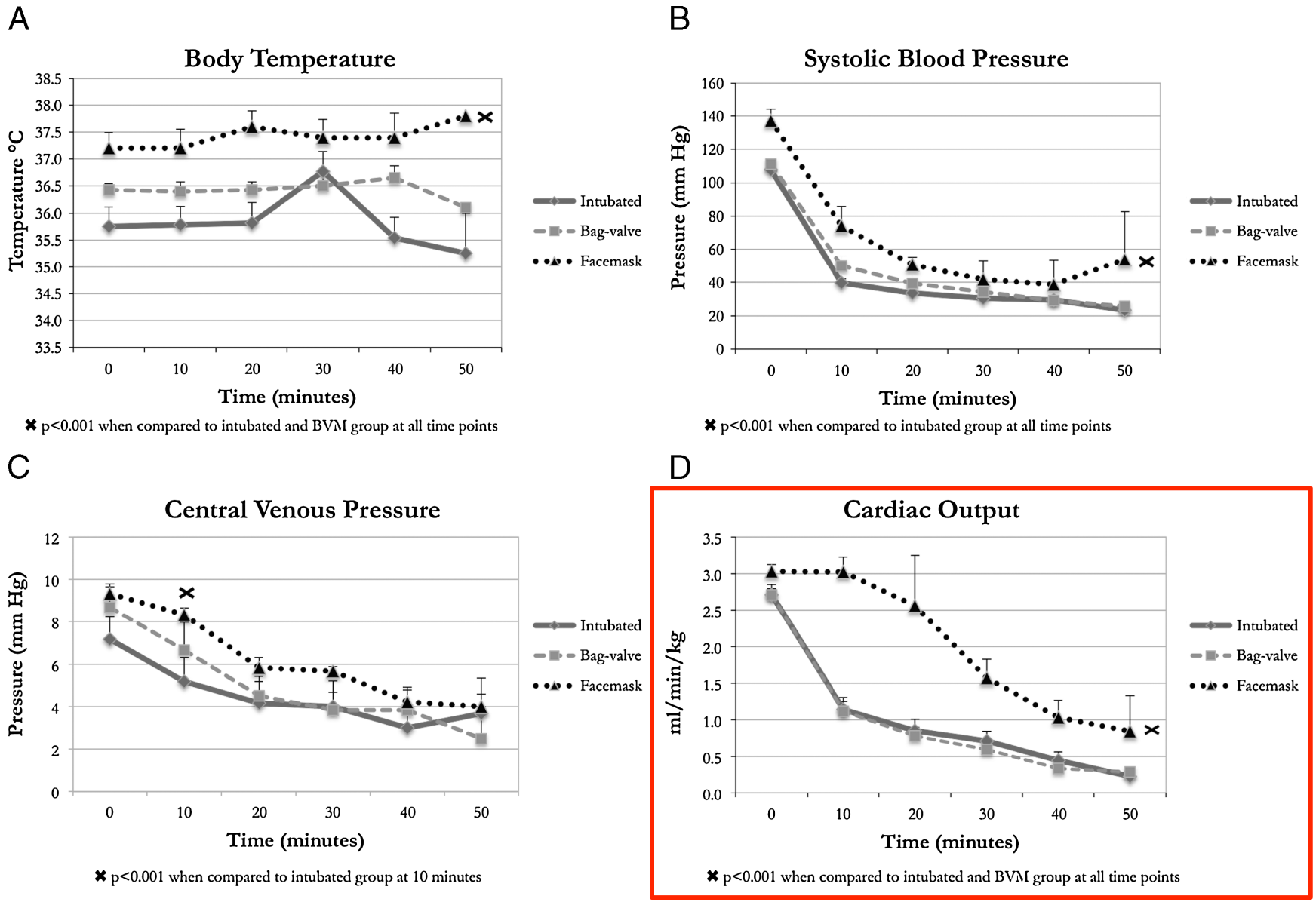
- Swine model of exsanguinating haemorrhage
- Propofol infusion + exsanguinating haemorrhage
- Intubation + ventilation group versus bag valve mask ventilation alone group
- No difference in time to death between groups
- Greater blood loss from intubated group
- Intubated animals more hypothermic
- Higher lactate in intubated group at 10 mins (2.4 v 1.8)
- Conclusion
  - "Intubation does not confer survival advantage and may result in more profuse hemorrhage, worse hypothermia and higher lactate compared with BVM ventilation"

Taghavi, S., Jayarajan, S. N., Khoche, S., Duran, J. M., Cruz-Schiavone, G. E., Milner, R. E., . . . Goldberg, A. J. (2013). Examining prehospital intubation for penetrating trauma in a swine hemorrhagic shock model. *J Trauma Acute Care Surg, 74*(5), 1246-1251.

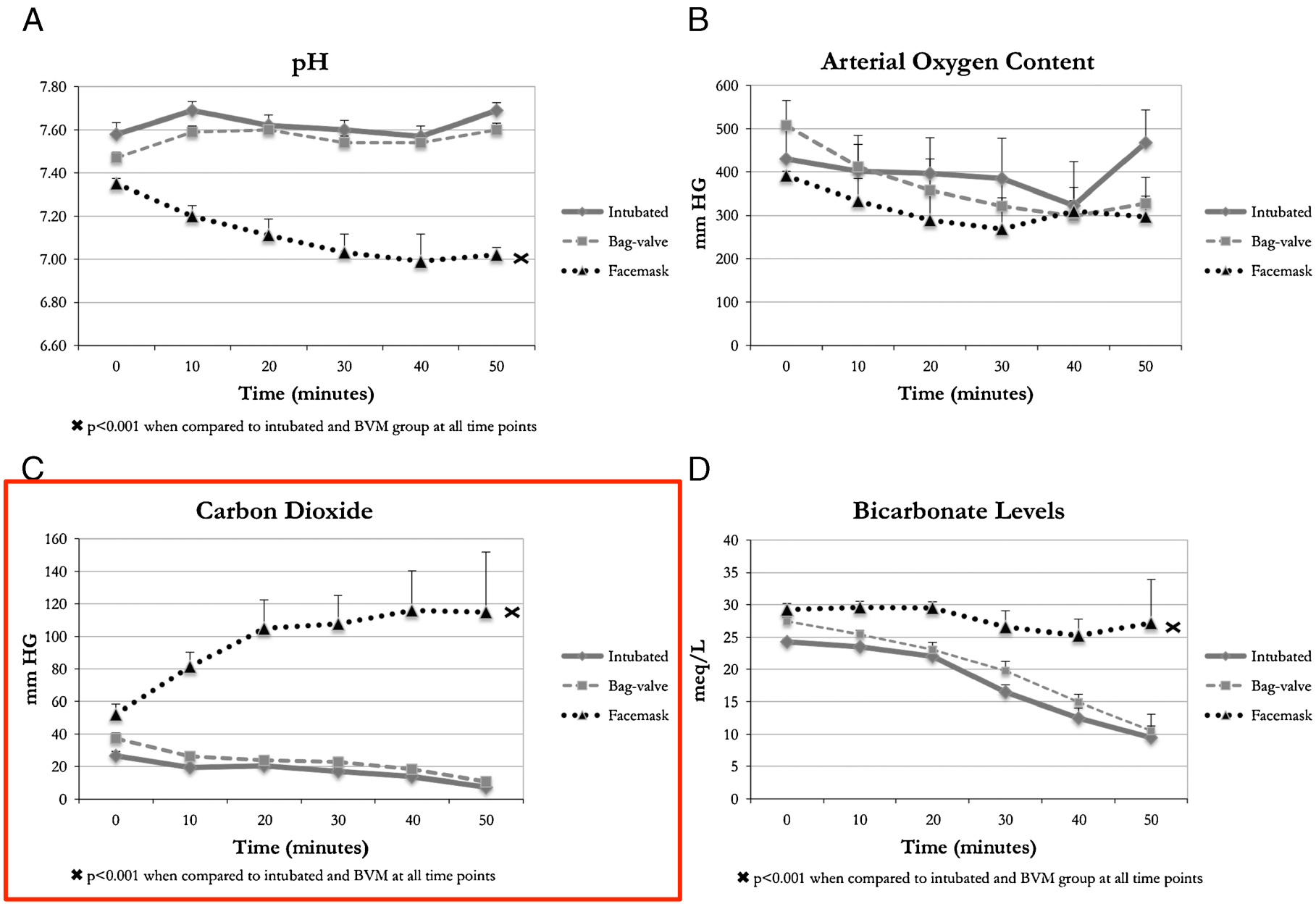
Is there a role for spontaneous ventilation?

- Swine model of exsanguinating haemorrhage
  - Propofol infusion + exsanguinating haemorrhage
  - Group 1 – intubated + PPV (manually)
  - Group 2 – PPV via BVM
  - Group 3 – supplemental O_2 via facemask
- Results:
  - Mean survival time similar in all groups
  - Physiological parameters:

Taghavi, S., Jayarajan, S. N., Ferrer, L. M., Vora, H., McKee, C., Milner, R. E., . . . Goldberg, A. J. (2014). "Permissive hypoventilation" in a swine model of hemorrhagic shock. *J Trauma Acute Care Surg, 77(1),* 14-19.



Taghavi, S., Jayarajan, S. N., Ferrer, L. M., Vora, H., McKee, C., Milner, R. E., . . . Goldberg, A. J. (2014). "Permissive hypoventilation" in a swine model of hemorrhagic shock. *J Trauma Acute Care Surg, 77(1),* 14-19.



Taghavi, S., Jayarajan, S. N., Ferrer, L. M., Vora, H., McKee, C., Milner, R. E., . . . Goldberg, A. J. (2014). "Permissive hypoventilation" in a swine model of hemorrhagic shock. *J Trauma Acute Care Surg, 77(1),* 14-19.

Conclusions:

- “PPV in severe hemorrhagic shock does not result in a survival advantage and may result in greater hemodynamic suppression when compared with passive ventilation by facemask”

Taghavi, S., Jayarajan, S. N., Ferrer, L. M., Vora, H., McKee, C., Milner, R. E., . . . Goldberg, A. J. (2014). "Permissive hypoventilation" in a swine model of hemorrhagic shock. J Trauma Acute Care Surg, 77(1), 14-19.

Inflammatory effects of PPV:

- Some evidence that positive pressure is independently associated with inflammatory response in haemorrhagic shock
- Effect of inflammatory mediators on acute traumatic coagulopathy?

van Wessem, K. J., Hennus, M. P., Heeres, M., Koenderman, L., & Leenen, L. P. (2013). Mechanical ventilation is the determining factor in inducing an inflammatory response in a hemorrhagic shock model. *J Surg Res*, 180(1), 125-132.

What about RSI for hemorrhagic shock if there may be associated TBI?

- Single O_2 saturation < 90% independently associated with ≥ doubling of mortality in TBI[1]
- Single episode of systolic BP < 90mmHg is independently associated with ≥ doubling of mortality in TBI. Repeated episodes associated with 8 fold increase in mortality[2]
- Combination of hypotension and hypoxia associated with six fold increase in mortality in TBI[2]
- Hyperventilation (post RSI) independently associated with ≥ doubling of mortality (one study showed six fold increase)[4]

1. Chesnut, R. M., Marshall, L. F., Klauber, M. R., Blunt, B. A., Baldwin, N., Eisenberg, H. M., . . . Foulkes, M. A. (1993). The role of secondary brain injury in determining outcome from severe head injury. *J Trauma, 34*(2), 216-222.
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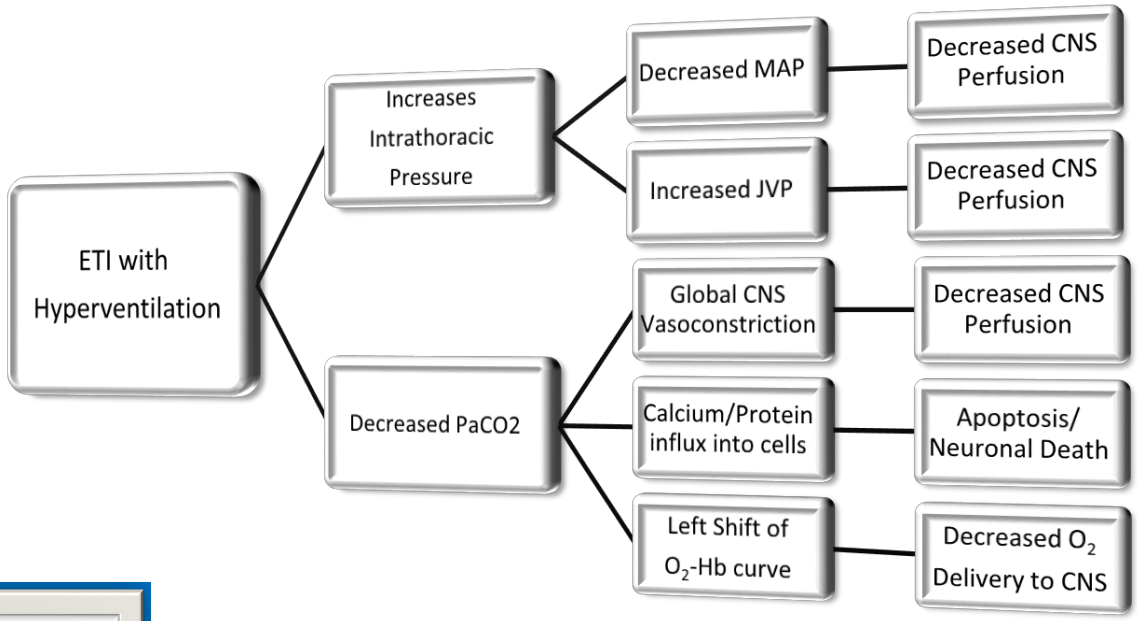
Excellence in Prehospital Injury Care – TBI:



EPIC-TBI
Excellence in Prehospital Injury Care
Traumatic Brain Injury Project

Avoid the 4 H Bombs of secondary injury in TBI:

- HYPERVENTILATION
- HYPOTENSION
- HYPOXIA
- HYPOGLYCAEMIA

Prospective randomised controlled trial of prehospital RSI v standard care for TBI:

- Outcome
  - Median extended Glasgow Outcome Scale (GOSe) at 6 months
- Results
  - Favourable neurological outcome (GOSe 5- 8) at 6/12:
    - 51% in RSI group v 39% in non RSI group
  - Median GOSe at 6/12 higher in RSI group (5) v non RSI (3)
    - But not statistically significant
  - More cardiac arrests in RSI group (6.3% v 1.3%) but no difference in overall survival
  - Proportionally more patients lost to follow up from non RSI group − if good outcomes inclusion may have confounded results

Bernard, S. A., Nguyen, V., Cameron, P., Masci, K., Fitzgerald, M., Cooper, D. J., . . . Judson, R. (2010). Prehospital rapid sequence intubation improves functional outcome for patients with severe traumatic brain injury: a randomized controlled trial. *Ann Surg, 252(6),* 959-965.

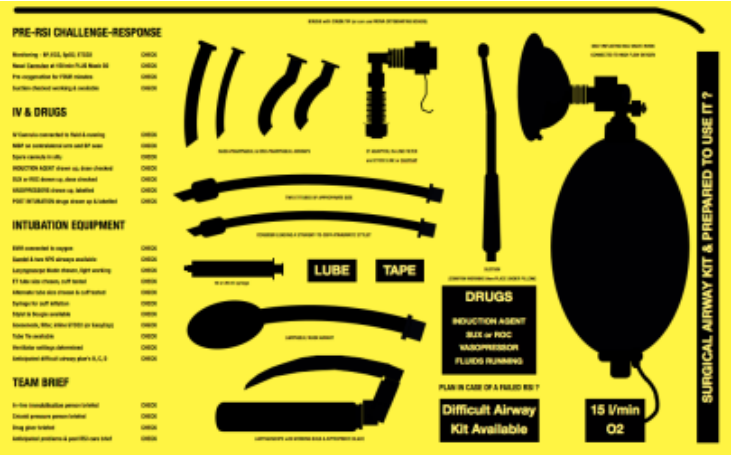
Experience counts:

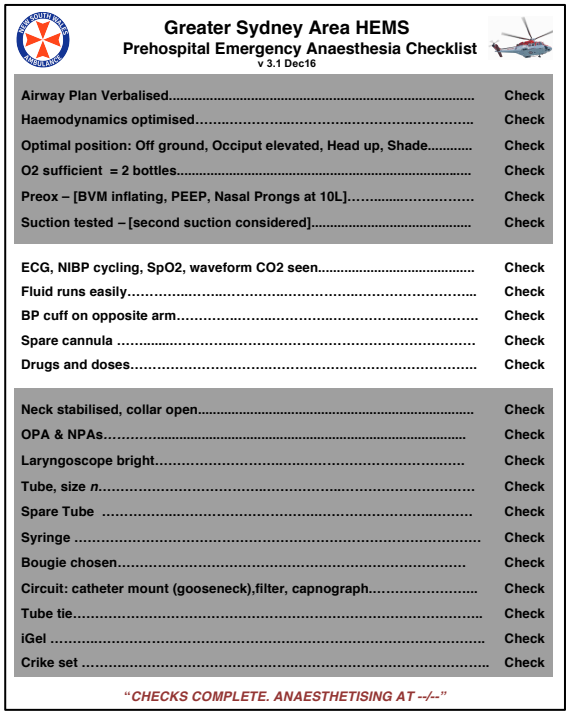
- Prehospital intubation by providers with limited experience associated with approx twofold increase in odds of mortality (OR 2.33, 95% CI 1.61 – 3.38, p<0.001)
- No evidence of higher mortality in patients intubated by experienced providers (OR 0.75, 95% CI 0.52 – 1.08, p0.126)

Bossers, S. M., Schwarte, L. A., Loer, S. A., Twisk, J. W., Boer, C., & Schober, P. (2015). Experience in Prehospital Endotracheal Intubation Significantly Influences Mortality of Patients with Severe Traumatic Brain Injury: A Systematic Review and Meta-Analysis. *PLoS One, 10(10),* e0141034.

Other considerations:

- Impact of training, checklists, audit
- Pre treatment eg fentanyl
- Pre-oxygenation/ apnoeic oxygenation
- Choice of paralytic agent and dose
- Intubation technique
- Ventilation strategies





Greater Sydney Area HEMS
Prehospital Emergency Anaesthesia Checklist
v 3.1 Dec16

Airway Plan Verbalised	Check
Haemodynamics optimised	Check
Optimal position: Off ground, Occiput elevated, Head up, Shade	Check
O2 sufficient = 2 bottles	Check
Preox – [BVM inflating, PEEP, Nasal Prongs at 10L]	Check
Suction tested – [second suction considered]	Check
ECG, NIBP cycling, SpO2, waveform CO2 seen	Check
Fluid runs easily	Check
BP cuff on opposite arm	Check
Spare cannula	Check
Drugs and doses	Check
Neck stabilised, collar open	Check
OPA & NPAs	Check
Laryngoscope bright	Check
Tube, size *n*	Check
Spare Tube	Check
Syringe	Check
Bougie chosen	Check
Circuit: catheter mount (gooseneck),filter, capnograph	Check
Tube tie	Check
iGel	Check
Crike set	Check

"CHECKS COMPLETE. ANAESTHETISING AT --/--"

Outcomes?

- No prospective RCT of clinical outcomes for prehospital RSI in haemorrhagic shock
- Retrospective studies flawed:
  - Are poor outcomes due to the intervention or do sicker patients have the intervention?[1]
  - What is the effect on outcome for patients who underwent the intervention but didn't need it?[2]

1 Floccare, D., Galvagno, S. (2016). Field intubation for hemorrhagic shock: A flawed syllogism. *J Trauma Acute Care Surg, 81(3),* 615

2 Hussmann, B., Lefering, R., Waydhas, C., Ruchholtz, S., Wafaisade, A., Kauther, M. D., & Lendemans, S. (2011). Prehospital intubation of the moderately injured patient: a cause of morbidity? A matched-pairs analysis of 1,200 patients from the DGU Trauma Registry. *Crit Care, 15(5),* R207.

Conclusions:

British Journal of Anaesthesia 1995; 75: 366–368

HISTORY

Thiopentone anaesthesia at Pearl Harbor

F. E. BENNETTS

"It is clear that the rumoured death rate from this cause has been greatly exaggerated"

Bennetts, F. E. (1995). Thiopentone anaesthesia at Pearl Harbor. *Br J Anaesth, 75(3),* 366-368.

Conclusions:

- Prehospital advanced airway care has a crucial role in RDCR
- Surgical airway has a high success rate in combat settings
- $DO_2 = 1.34 \times Hb \times SaO_2 \times CO$ − we can't escape this!
- Haemorrhagic shock per se is not an indication for RSI and PPV
- Positive Pressure Ventilation decreases cardiac output - for short evacuation times exemplary basic airway management will avoid risks of RSI and PPV
- TBI patients present extra challenges
  - hyperventilation, hypotension, hypoxaemia and hypoglycaemia must be avoided
- Some patients will need RSI +/- PPV − advanced training, technical skills and decision making required to minimise risk
- *Blood far forward, surgical airway skills far forward, ketamine far forward!*

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Anaesthesia 2017, 72, 379–390 doi:10.1111/anae.13779

Guidelines

AAGBI: Safer pre-hospital anaesthesia 2017

Association of Anaesthetists of Great Britain and Ireland

D. J. Lockey,[1] K. Crewdson,[2] G. Davies,[3] B. Jenkins,[4] J. Klein,[5] C. Laird,[6] P. F. Mahoney,[7] J. Nolan,[8] A. Pountney,[9] S. Shinde,[10] S. Tighe,[11] M. Q. Russell,[12] J. Price[13] and C. Wright[14]

REVIEW ARTICLE

Scandinavian SSAI clinical practice guideline on pre-hospital airway management

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Discussion: