Where We Are with RSI:
A Look Through the Glottic Opening

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Where it All Started

THE USE OF NEUROMUSCULAR BLOCKERS AND ADVANCED SEDATION BY FIELD EMT-PARAMEDICS TO PROMOTE MORE EFFECTIVE AIRWAY MANAGEMENT IN ADULT TRAUMA PATIENTS WITH GLASGOW COMA SCALE OF 8 OR LESS

SUCCINYLCHOLINE
ROCURONIUM
MIDAZOLAM

EMT-P Trial Study Proposal
County of San Diego Department of Health Services
Division of Emergency Medical Services

Principal Investigator
Mel A Ochs, MD, FACEP

Presented to California EMS Authority
December 16, 1996


82
Rural/Metro
Ambulance
PARAMEDIC
1185

Figure 1 **San Diego County**

Intubation success on trauma patients, based on Glasgow Coma Score (GCS). 1/1/95 through 6/30/95

Glasgow Coma Score	Number of cases	Intubations Successful	Intubations Unsuccessful	No attempt	% Successful
8	11	1	1	9	9%
7	17	3	5	9	18%
6	8	3	0	5	38%
5	4	2	1	1	50%
4	6	1	4	1	17%
3	71	44	14	13	50%

(Note: In GCS=3, the patients who were dead on scene were excluded in the above numbers. These included 10 successful intubations, 2 unsuccessful intubations, 13 not attempted.)

Rationale

- Mitigate increases in ICP
- Decrease incidence of hypoxia

All prehospital traumatically injured adult patients with a GCS of 8 or less will be intubated in the field beginning 1 Jul 97. Mortality rate and as well as rate of complications listed in the Trauma Registry for the patients intubated with, or subsequently receiving, neuromuscular blocking agents will be compared to the cohort of patients who were not intubated, and will be matched for AIS for head injury, AIS for other body regions, ISS and age.

The Jurisdiction and Set-Up

- San Diego county population of 3 M
- ALS provided by 12 agencies
- 120,000 transports per year
- 8 hour didactic course
- Continuous Sp02 monitoring

The Results

Table 4 Scene Time, Arrival SBP, Arterial Blood Gas Values, and Serum Ethanol for RSI Patients (n = 209) Versus Pooled Matched Controls (n = 627)

	Controls	RSI	*p* Value
Minutes on scene (mean)	16.4	22.8	<0.0001
Systolic blood pressure			
Mean (mmHg)	138.4	138.6	0.907
SBP $\leq$90 mmHg (%)	6.4	6.8	1.000
ABG data			
pH (mean)	7.36	7.36	0.850
pO2 (mean in mmHg)	216	315	<0.0001
pCO2 (mean in mmHg)	38.3	34.9	<0.0001
Base excess (mean)	−3.4	−4.3	0.002
Inadvertent hyperventilation (%)	8.0	15.4	0.014
Mean serum ethanol (mg/dl)	101	111	0.656

RSI, rapid sequence intubation; SBP, systolic blood pressure; ABG, arterial blood gas.

→ Increased scene time
→ Decreased pC02
→ Increased hyperventilation

The Results

Table 6 Primary Outcome Measures for the RSI Cohort (n = 209) Versus Controls (n = 627)

Outcome measure	Controls (%)	RSI (%)	Odds ratio
Mortality			
All patients	24.2	33.0	1.6 (1.1–2.2)*
Head/neck AIS 3 or greater	30.3	41.1	1.6 (1.1–2.3)*
Non-aeromedical	24.3	33.0	1.6 (1.1–2.2)*
Good outcome¶			
All patients	57.9	45.5	1.6 (1.2–2.3)†

The Aftermath

The Impact of Hypoxia and Hyperventilation on Outcome after Paramedic Rapid Sequence Intubation of Severely Head-Injured Patients

Daniel P. Davis, MD, James V. Dunford, MD, Jennifer C. Poste, Mel Ochs, MD, Troy Holbrook, PhD, Dale Fortlage, BA, Michael J. Size, MD, Frank Kennedy, MD, and David B. Hoyt, MD

- **426 trial patients**
- **59 had complete EtC02/Sp02**
- **Matched with 177 control patients**

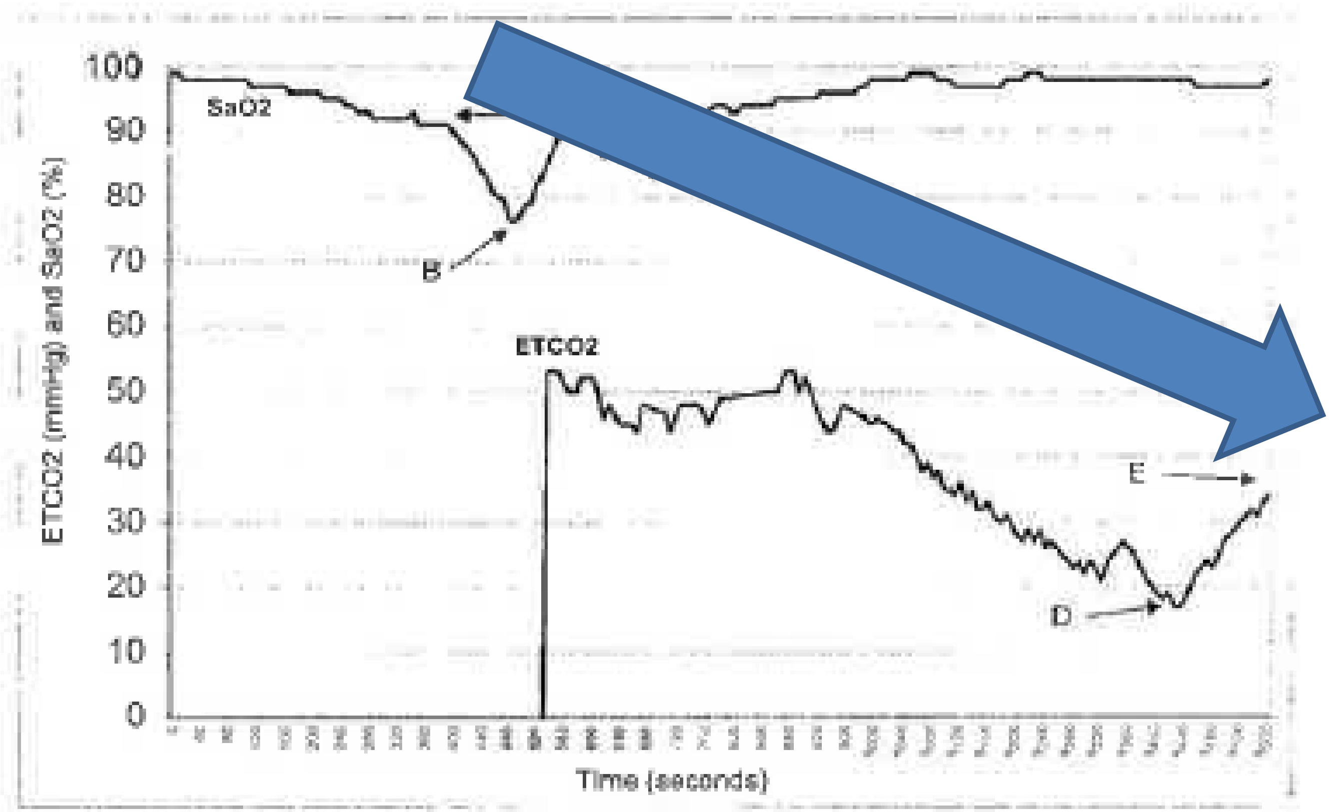


Fig. 1. *Outcome variables used in logistic regression analysis included duration of preintubation Spo_2 below 90% (A); lowest preintubation Spo_2 recorded (B), lowest postintubation Spo_2 recorded (C), lowest $ETCO_2$ value (D), and final $ETCO_2$ value (E).*

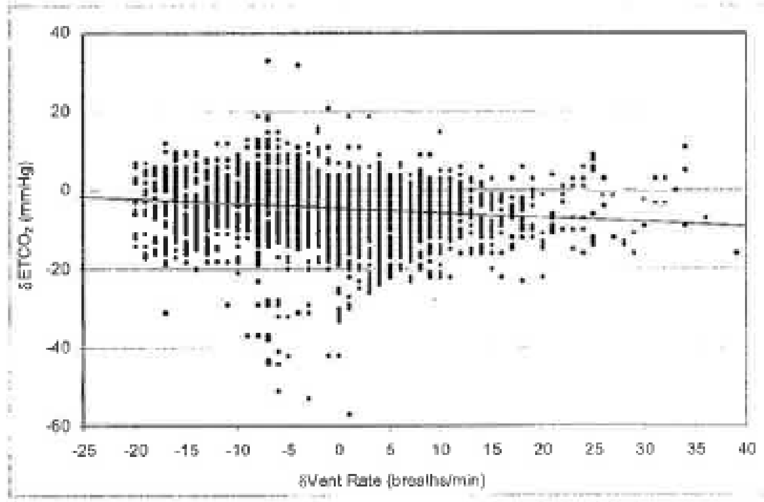
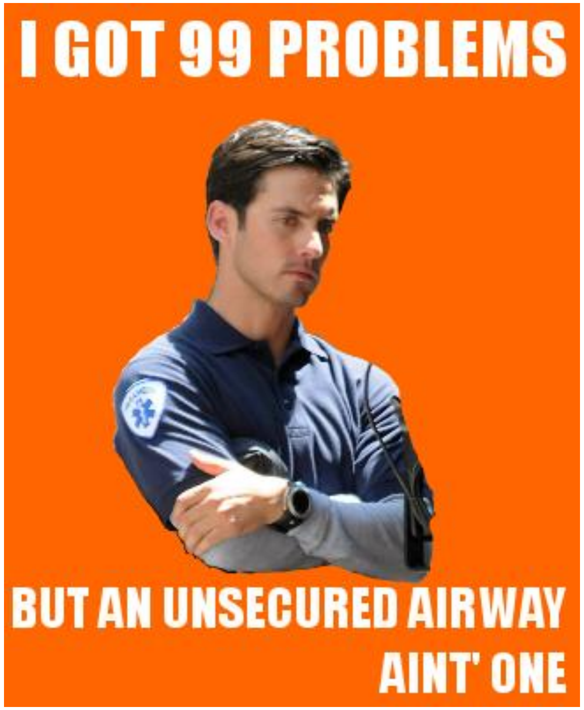


Fig. 2. *Linear regression analysis documenting a statistically significant association between the changes in $ETCO_2$ and ventilatory rate after a 90-second equilibration period ($r = -0.13$, $p < 0.0001$).*

- Mortality in RSI 40.7% RSI vs 21.5%
- Adverse effect with profound desaturation
- Greater delta C02 seen with increased RR
- Association between lowest recorded ETc02 and mortality
- EtC02 values less than 25 mm Hg seen in 59% of patients

The Bottom Line Bad News:

- Study halted early due to increased mortality
- Hyperventilation was common- and lethal
- Complicated definition of “intubation success”



Fairfax One:
Current RSI Program

Prehospital Rapid Sequence Intubation for Head Trauma: Conditions for a Successful Program.

Fakhry, Samir; MD, FACS; Scanlon, James; Robinson, Linda; MA, MS; Askari, Reza; Watenpaugh, Rolland; Fata, Paola; MD, FRCSC; Hauda, William; Trask, Arthur; MD, FACS

Journal of Trauma-Injury Infection & Critical Care.
60(5):997-1001, May 2006.
DOI: 10.1097/01.ta.0000217285.94057.5e

Retrospective RSI Review

Table 1 Characteristics of Study Population (n = 175)

Characteristic	Data
Age (years)	31.9 ± 19.2
Sex (male/female)	74%/26%
Blunt mechanism	91%
ISS	25.7 ± 13.9
Head AIS	3.96 ± 1.19
GCS	4.8 ± 2.4

Results

Table 3 Results of RSI

Result	Data
Malpositioned ETT	5 (2.9%) right main stem bronchus 2 (1.2%) dislodged enroute
Arterial desaturation (<92%)	4 (2.3%)
Arrival pCO_2, mean	36.7 ± 8
ICU length of stay (days)	6.2 ± 8.1
Hospital length of stay (days)	11.2 ± 18.5
Overall mortality	31%

Fairfax Training Model

TRAINING MODEL ITEM	DESCRIPTION
Candidates	Police officers with EMS and paramedic training
Initial training	Intensive advanced airway training
Competency evaluation	Preflight performance examination
Skills maintenance	3 days every 6 months; 20-40 supervised intubations, simulation
QI	RSI reviewed by medical director
Outcome	Small number of highly trained, very experienced operators

Components of a Successful RSI Program

- Evidence based
- ***100% quality assurance***
- ***Initial and ongoing training***
- Reliance on actual intubation encounters
- Pre-established minimums for compentencies
- End tidal C02
- Rigid protocolization

RAPID SEQUENCE INDUCTION CHECKLIST

PATIENT

- **pre-oxygenate**
  - 5min 8L/min O_2
- **position**
  - 'sniffing the morning air'
  - 'RAMP' if obese
- **IF DIFFICULT AIRWAY ANTICIPATED CALL ANAESTHETIST IN CHARGE (ext: 3186) for possible awake fibre-optic**
  - **upper airway obstruction/ trauma**
  - **morbidly obese/ OSA**
  - **c-spine immobilisation**

EQUIPMENT

- **"SOAPME"**
- **S**uction
- **O**xygen
  - Bag Valve Mask
- **A**irway equipment
  - 2 laryngoscopes
  - 2 ETTs
  - bougie
- **P**harmacological agents
  - pretreatment
  - induction agent
  - paralytic agent
  - ongoing anaesthesia
  - vasoconstrictor
- **M**onitoring **E**quipment
  - SpO_2
  - $ETCO_2$
  - ECG monitoring
  - NIBP

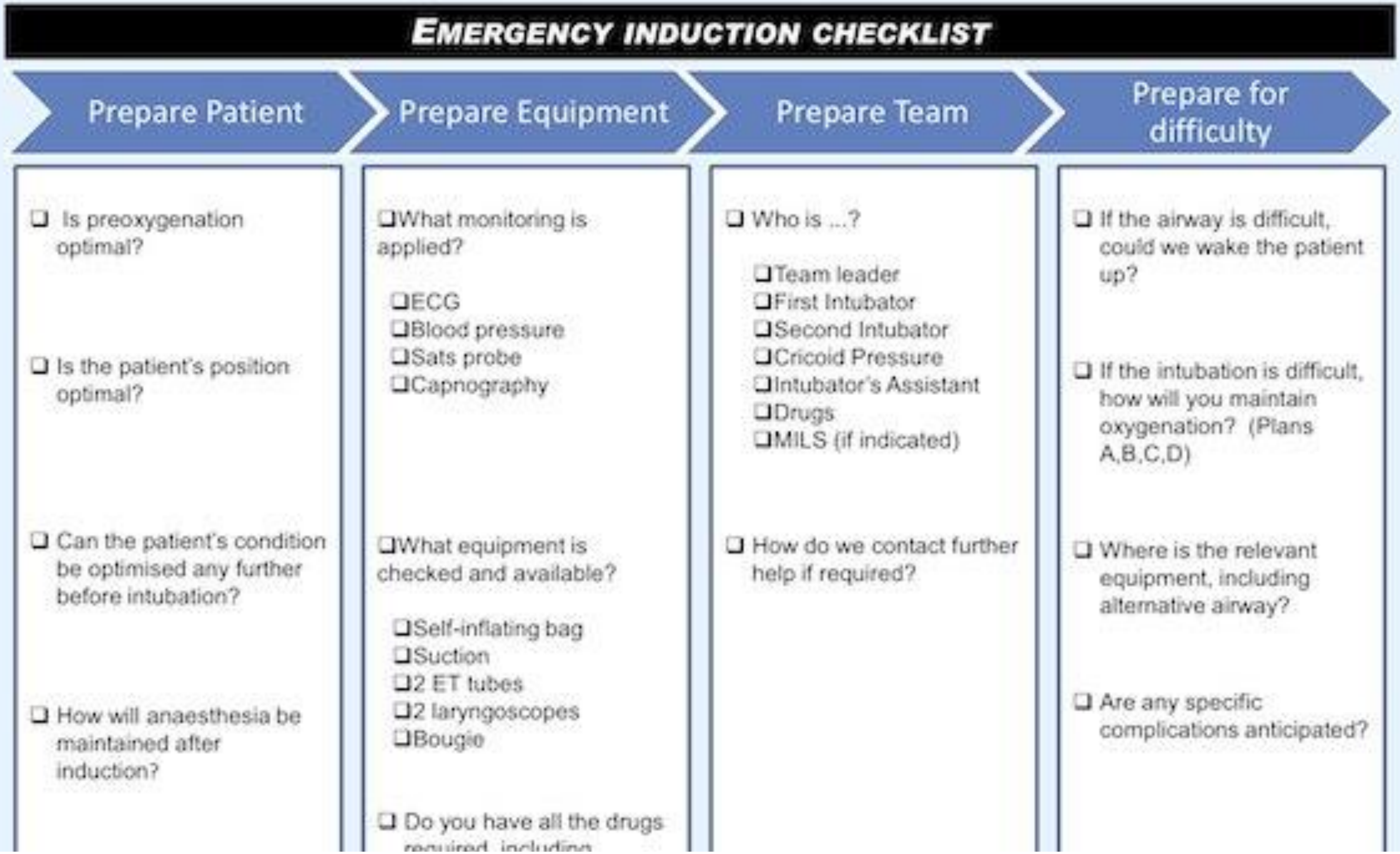
TEAM

- **team leader**
  - consultant if available
- **airway doc**
  - must have anaesthetic experience
- **airway nurse**
- **drugs**
  - JMO/nurse
- **scribe & timer**
  - nurse
- cricoid pressure
  - optional JMO/ nurse
- **IF DIFFICULT AIRWAY ANTICIPATED CALL ANAESTHETIST IN CHARGE (ext: 3185)**

HAVE A PLAN

- know your back up airway plan
  - **see default strategy for failed RSI algorithm** and let your team know if you are doing something different
- have a ventilator strategy
  - **see Oxylog 3000 plus algorithm**

modified from www.safetyintubation.com



EMERGENCY INDUCTION CHECKLIST

Prepare Patient

- ❑ Is preoxygenation optimal?
- ❑ Is the patient's position optimal?
- ❑ Can the patient's condition be optimised any further before intubation?
- ❑ How will anaesthesia be maintained after induction?

Prepare Equipment

- ❑ What monitoring is applied?
  - ❑ ECG
  - ❑ Blood pressure
  - ❑ Sats probe
  - ❑ Capnography
- ❑ What equipment is checked and available?
  - ❑ Self-inflating bag
  - ❑ Suction
  - ❑ 2 ET tubes
  - ❑ 2 laryngoscopes
  - ❑ Bougie
- ❑ Do you have all the drugs required, including

Prepare Team

- ❑ Who is ...?
  - ❑ Team leader
  - ❑ First Intubator
  - ❑ Second Intubator
  - ❑ Cricoid Pressure
  - ❑ Intubator's Assistant
  - ❑ Drugs
  - ❑ MILS (if indicated)
- ❑ How do we contact further help if required?

Prepare for difficulty

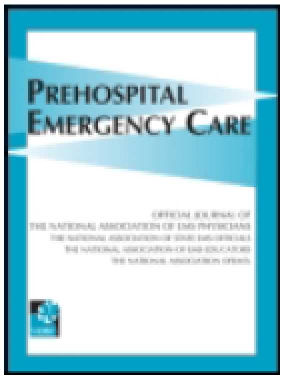
- ❑ If the airway is difficult, could we wake the patient up?
- ❑ If the intubation is difficult, how will you maintain oxygenation? (Plans A,B,C,D)
- ❑ Where is the relevant equipment, including alternative airway?
- ❑ Are any specific complications anticipated?

"Regular training, standardization, and checklists to ensure task completion allow us to develop both individual and team cognitive resilience."

T. Leeuwenburg. www.kidocs.org

Remember, Remember!

- Foundation critical to RSI success
- Initial training emphasis
- Strive for “ZERO MISS” but understand that successful placement is not the most ideal outcome measure
- Raise the intubation standard for RSI credentialing



Prehospital Emergency Care

ISSN: 1090-3127 (Print) 1545-0066 (Online) Journal homepage: http://www.tandfonline.com/loi/ipec20

A Meta-Analysis of Prehospital Airway Control Techniques Part I: Orotracheal and Nasotracheal Intubation Success Rates

Words of Caution

- Pooled data, retrospective
- Overall quality “poor”
- Success related to PLACMEMENT only
- Higher success rates with RSI and DFI
- Lower success rates with trauma, non arrest, and pediatric patients
- Low rate of success for NTI

TABLE 4. Subanalysis Results: Success Rate (%) and 95% Confidence Interval

Patient Group	All Clinicians	All Nonphysicians*	Ground Paramedics	Nonphysician Flight Crews*	Physicians
OETI†					
All	86.5 (83.3–89.2)	86.3 (82.6–89.4)	87.5 (83.7–90.5)	88.1 (65.7–96.6)	91.8 (85.0–95.6)
Trauma only	73.7 (62.6–82.5)	69.8 (60.1–78.0)	73.7 (62.1–82.7)	—	—
Nontrauma only	88.6 (83.6–92.2)	—	87.9 (82.2–91.9)	—	94.0 (86.3–97.5)
Cardiac arrest	91.2 (88.8–93.1)	—	91.1 (88.0–93.4)	—	91.8 (85.0–95.6)

OROTRACHEAL INTUBATION POOLED SUCCESS RATES

Overall	**86.5%**
Trauma only:	**73.7%**
Trauma only (non doc):	**69.8%**
Non arrest only:	**70.4%**

	ALL CLINICIANS	ALL NON PHYSICIANS
RSI		
All	96.1 (94.5–97.3)	96.7 (94.7–98.0)
Trauma only	93.8 (89.8–96.3)	94.0 (89.2–96.7)
Nontrauma only	98.4 (96.9–99.1)	—
DFI		
All	86.2 (79.9–90.8)	86.8 (80.2–91.4)
Trauma only	94.8 (16.8–99.9)	—
Nontrauma Only	87.1 (77.1–93.2)	—

Take Home Points to Ponder

- What defines success?
- Self reporting vs. verification
- Advocate for a ZERO percent miss rate
- Role for continuous waveform capnography

Silvestri, et al, found that rate of tube misplacement was 23.3% without capnography and 0% with capnography.

Take Home Points to Ponder

- Is NTI a viable rescue alternative?
- Should "DFI" be considered safer?
- RSI clearly associated with increased success
- Continued challenges with trauma/pediatrics

Where We Need to Go

- Ban RSI ?
- Selective RSI ?
- Increased training
- Increased oversight
- Continuing education

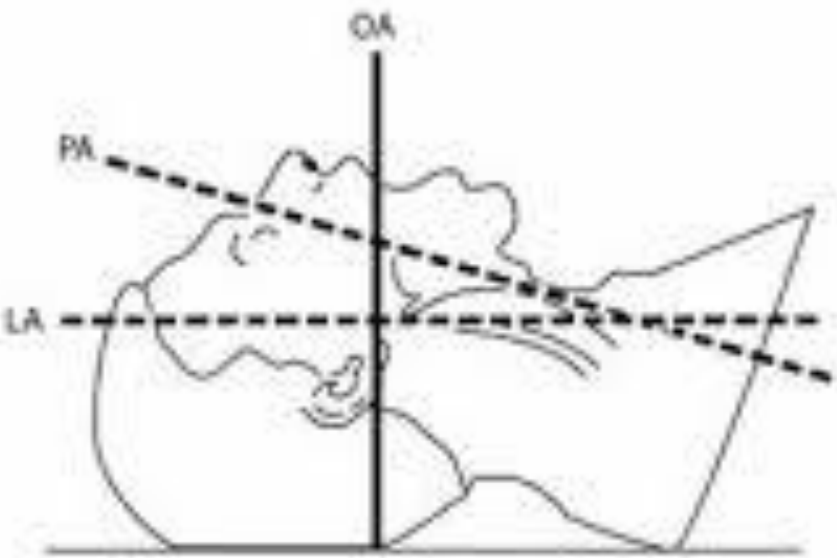
Is there an Ideal Prehospital RSI Protocol ?

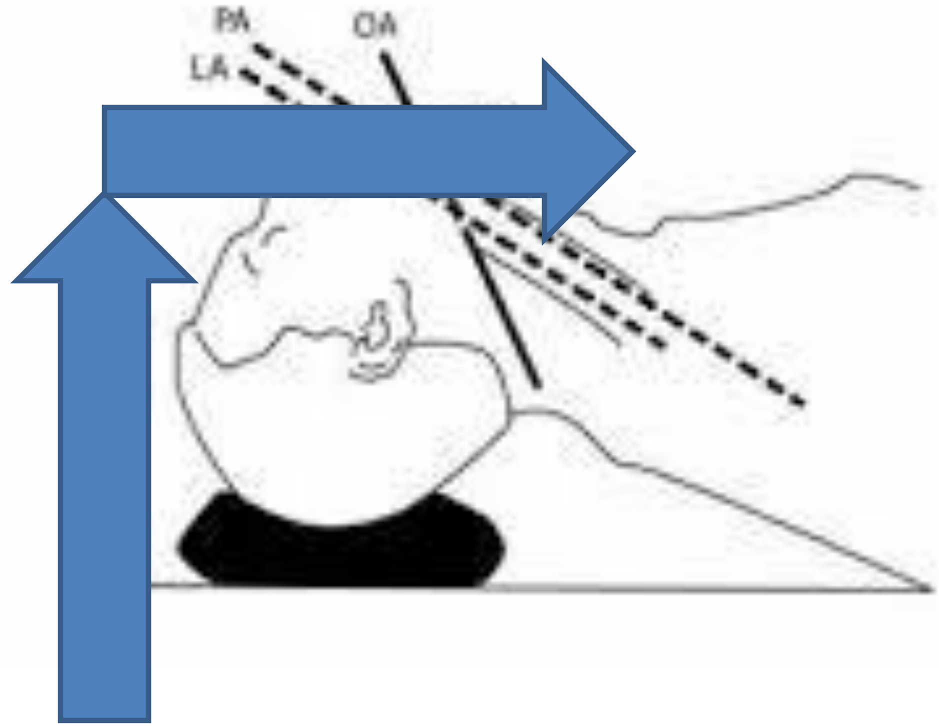
-
  - oxyg
  - etreatment
  - aralysis
  - ection
- t
- Post

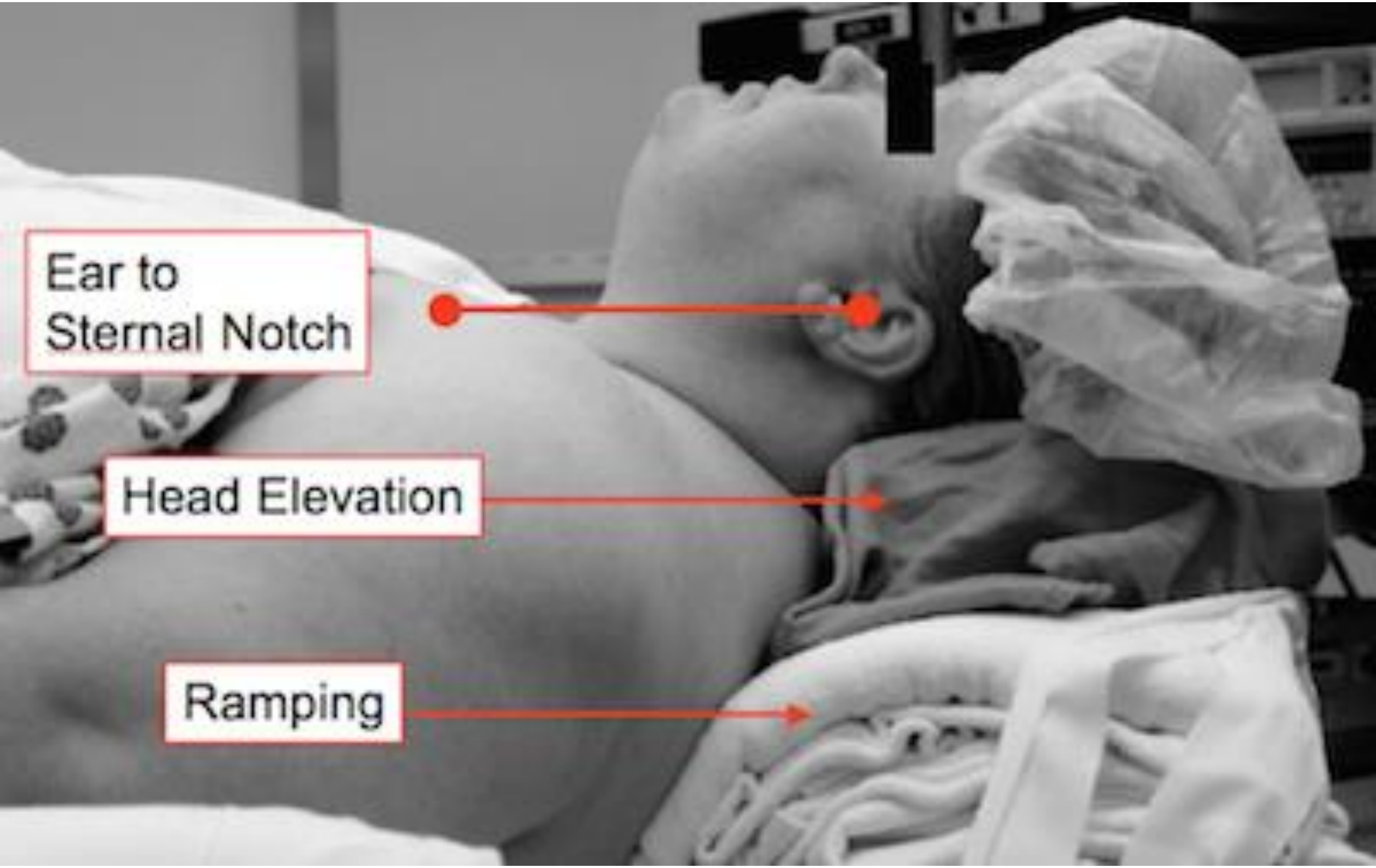
Preparation

- Two tubes
- Two blades
- Difficult airway plan
- Cricothyroidotomy equipment
- Suction
- Additional rescuer

Positioning






Ear to
Sternal Notch
Head Elevation
Ramping

Pretreatment

- Lidoca
- Fen
- De ulating ag
- Atro

2001

The authors could find no evidence that in acute traumatic head injury pretreatment with IV lignocaine/lidocaine before a RSI reduces ICP or improves neurological outcome. The evidence for such an effect and the benefit of pretreatment comes from 42 fully premedicated patients undergoing elective neurosurgery, with elective anaesthesia not RSI, for tumour resection. The evidence obtained from

2012

American Journal of Emergency Medicine (2012) 30, 1782–1787

ELSEVIER

The American Journal of Emergency Medicine

www.elsevier.com/locate/ajem

Original Contribution

Postintubation hemodynamic effects of intravenous lidocaine in severe traumatic brain injury

Chi-Chun Lin MD, Jiun-Hao Yu MD, Chih-Chuan Lin MD, Wen-Cheng Li MD, Yi-Ming Weng MD*, Shou-Yen Chen MD

Chi-Chun et al, 2012

- 101 patients
- 46 received IV lidocaine
- Retrospective study, isolated brain injury
- No significant changes in BP

Conclusion: Intravenous lidocaine in addition to RSI before endotracheal intubation was not associated with significant hemodynamic changes in patients with severe traumatic brain injury.

Atropine's gone, too ?

Should the routine use of atropine before succinylcholine in children be reconsidered?

Georgina McAuliffe MB BS FRCA,
Bruno Bissonnette MD FRCPC,
Christine Boutin MD FRCPC*

- 41 children
- Group 1 received 20 mcg/kg atropine and 1.5 mg/kg SUX
- Group 1 received 1.5 mg/kg SUX
- ECG tracings continuously recorded

TABLE II Heart rate (beats · min^{-1})

Time	Heart rate: Group S	Heart rate: Group AS	*P < 0.05
Pre-induction	108 ± 25 (70–165)	108 ± 17 (83–140)	NS
Pre-laryngoscopy	128 ± 24† (95–160)	142 ± 15† (116–169)	*
Post-laryngoscopy	128 ± 18† (92–157)	150 ± 13† (116–168)	*
2 mins post-laryngoscopy	117 ± 18† (78–146)	149 ± 12† (123–165)	*

Mean ± SD; (range); NS = not significant;
AS = atropine/succinylcholine: S = succinylcholine alone.
†$P < 0.05$ compared with pre-induction value.

Induction and Paralysis

- Etomidate
- Propofol
- Ketamine
- Midazolam
- Fentanyl

Prevention of Hypotension and Hypoxia

- IV fluid bolus
- Push dose pressors
- Apneic oxygenation
- Hyperoxygenation

Draw up 1 mL of EPI

Draw up 9 mL Saline

10 mcg/mL EPI

Admin 5-20 mcg (0.5-2mL) q 1-5 mins

But Doc, How Can We Predict Which Patients are Going to Get Hypotensive?

….aren't you glad you asked?

American Journal of Emergency Medicine (2008) 26, 845–851

ELSEVIER

The American Journal of Emergency Medicine

www.elsevier.com/locate/ajem

Original Contribution

The prognostic factors of hypotension after rapid sequence intubation

Chih-Chuan Lin MD[a,b], Kuan Fu Chen MD[a,b], Chia-Pang Shih MHA[c], Chen-June Seak MD[a,b], Kuang-Hung Hsu PhD[c,*]

- ED based study
- 149 patients
- 28 patients hypotensive (<90 mm Hg before RSI)
- 121 patients in the control group (>90 mm Hg)

EXCLUSIONS

- Patients in profound shock
- Patients in cardiac arrest
- Patients receiving inotropic agents
- Patients receiving aggressive fluid resuscitation
- >3 intubation attempts

Table 4 Logistic model for predicting hypotension after RSI

Variables		Group 1 (n = 28)	Group 2 (n = 121)	Estimate	*P* value	odds ratio
Pre-SBP (mm Hg)	≦140	20	50	1.42	.01	4.14
	>140	8	71			1.00
COPD	Yes	7	12	1.56	.01	4.75
	No	21	108			1.00
Sepsis	Yes	9	8	2.29	.00	9.91
	No	19	113			1.00
Body weight (kg)	≦55	20	55	1.19	.02	3.27
	>55	8	66			1.00

AFTER THE USUAL LOGISTIC REGRESSION MODELING

- Relative hypotension
- Sepsis
- COPD
- Use of lidocaine
- Use of albumin
- Low body weight

Journal of Critical Care (2012) 27, 587–593

ELSEVIER

Journal of
Critical Care

Predictors of the complication of postintubation hypotension during emergency airway management☆

Alan C. Heffner MD[a,b,*], Douglas S. Swords BA, MS IV[b], Marcy L. Nussbaum MS[c], Jeffrey A. Kline MD[b], Alan E. Jones MD[b,d]

→ Retrospective cohort
→ ETI in large, urban ED
→ Patients > 17 and had NO ystolic BP <90 mm Hg for 30 or more mins

RESULTS

- Hypotension in 66/300 (22%)
- Patients with hypotension had increased mortality
- Examined patient specific factors associated with hypotension

Table 2 Results of logistic regression analysis for the end point of PIH

Variable	OR	95% CI
Preintubation SI	55.1	13-232
End-stage renal disease	3.7	1.1-13.1
Chronic renal insufficiency	3.4	1.2-9.6
Intubation for respiratory failure	2.1	1.0-4.5
Age	1.03	1.01-1.04
ACE inhibitor use	0.3	0.1-0.7
Intubation paralysis	0.04	0.003-0.4

Model fit: *C* statistic, 0.81; Hosmer-Lemeshow test, $P = .35$.

RS-Implications

- ***"Individualized" selection of patients***
- Consider hemodynamically stable induction agents at reduced dose
- Slow, low TV ventilation
- Empiric volume loading
- Vasopressor support

SHOCK INDEX: HR/SBP
Normal 0.5 to 0.7

Paralysis

- To fasciculate or not to fasciculate
- Succinylcholine 1.0-1.5 mg/kg
- Rocuronium 0.6-1.0 mg/kg
- Vecuronium 0.1 mg/kg

What SUX about SUX

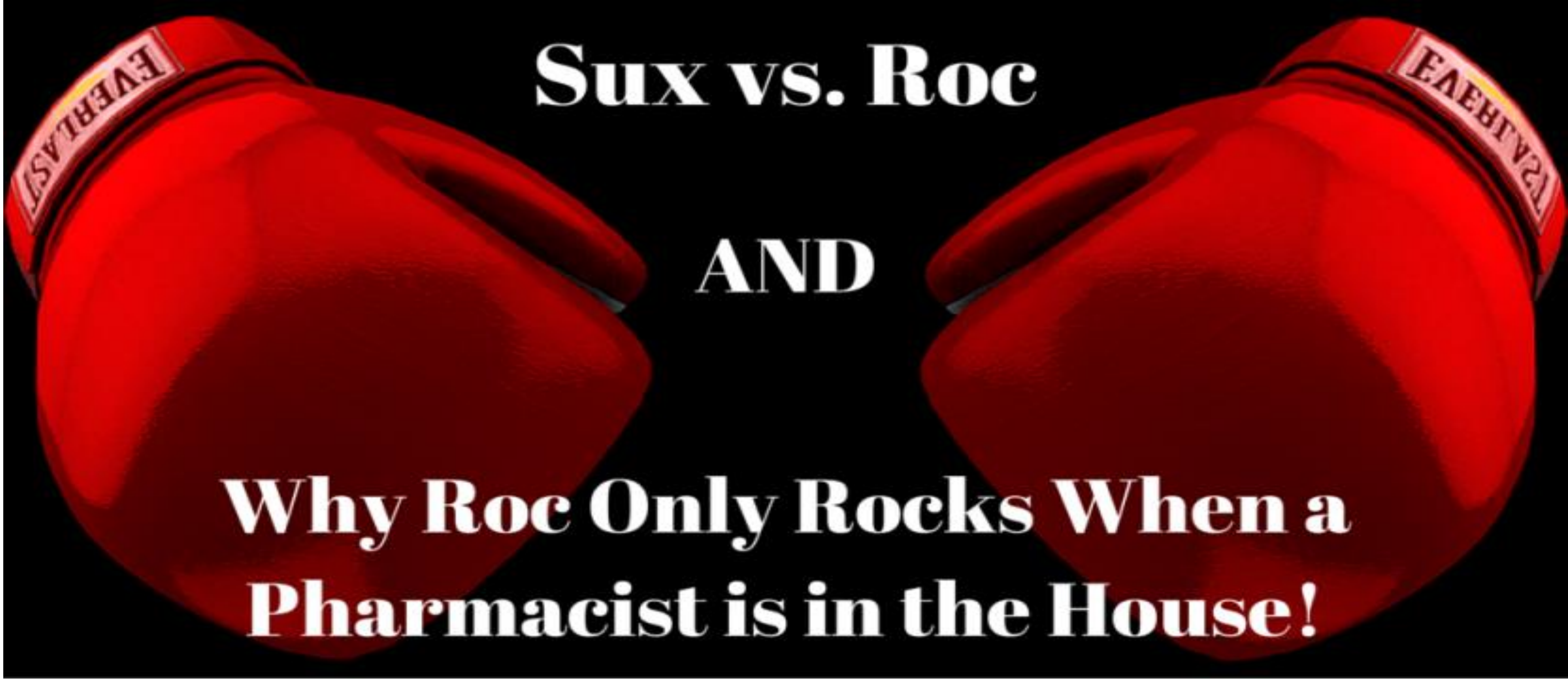
- Depolarizing NB
- “Superior intubating conditions”
- Rapid onset
- Rapid offset
- Simple dosing
- Several contraindications
- Redosing problematic

What ROCS about ROC

- Less rapid onset
- Non depolarizing
- Simple dosing 1.0 mg/kg IV
- Extended duration of paralysis
- No redosing

Vexations over Vec

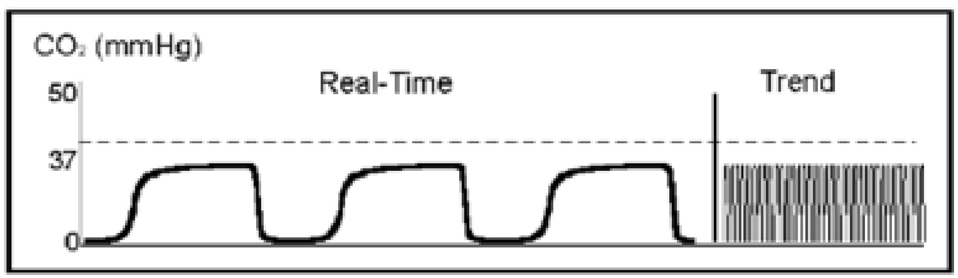
- Non depolarizing
- Inexpensive
- Shorten onset with increased dosing
- 0.1 mg/kg→ 0.3 mg /kg IV
- Extended paralysis duration



- Longer time to sedation with rocuronium
- Intubating conditions more approximate SUX when ROC dose is increased

Post Intubation Management

- End tidal capnography
- Ventilator management
- Post intubation sedation



- Provides validation of $ETCO_2$ value
- Visual assessment of patient airway integrity
- Verification of proper ET tube placement
- Assessment of ventilator / breathing circuit integrity

Ventilator Management

- Use IBW or PBW
- Protective lung ventilation
- 6 mL/kg
- Evidence in ARDS and non ARDS patients

Post Intubation Management: Sedation

- Prolonged paralysis→ out
- Analgesia first→ in
- Sedation increases ventilator compliance
- Tailor choices to patient condition

Prehospital Sedation: Midazolam

- Respiratory depression
- Hypotension
- May increase time on ventilator
- Dose dependent hypotension
- Short acting
- Increase delirium in elderly patients

Prehospital Sedation: Fentanyl

- Familiar
- Hemodynamically neutral
- No histaminergic response
- Well tolerated
- Adverse effects at higher doses

The New P’s of RSI

- Position
- Preparation
- Preoxygenation
- Prevention of hypotension
- Paralysis
- Placement of tube
- Protection of tube
- Post intubation management

Case Studies in RSI

80 yo F presents to the ED with confusion. Family reports three days of feeling "unwell" with associated vomiting and fever. Pt becomes more somnolent and confused; requires airway protection

T:	39
P:	130
BP:	90/50
R:	22
Spo2:	93%

Case #1

- Septic shock
- Relative hypotension
- Suspected acidosis
- Induction agent?

Case #2

22 yo M extricated from single vehicle vs tree. Pt is combative and experiences seizure. Suspected TBI. Pt's teeth are clenched.

BP:	180/100
P:	56
R:	6/irregular
Sp02:	85% RA

Case #2

- Probable ICH
- Avoidance of hypoxia/hypotension
- Minimization of intracranial pressure
- Induction agent / paralytic ?

Ketamine $\nrightarrow$ $\uparrow$ICP

Ketamine Koncern

- Literature from early 1970’s
- ICP increases found in paitents with obstructive neurologic pathology
- May actually increase CBF

J Anesth (2014) 28:821–827
DOI 10.1007/s00540-014-1845-3

ORIGINAL ARTICLE

Ketamine does not increase intracranial pressure compared with opioids: meta-analysis of randomized controlled trials

- 5 trials, 198 patients
- ICP levels within first 24 hours following administration
- Patients received continuous infusions and bolus dosing

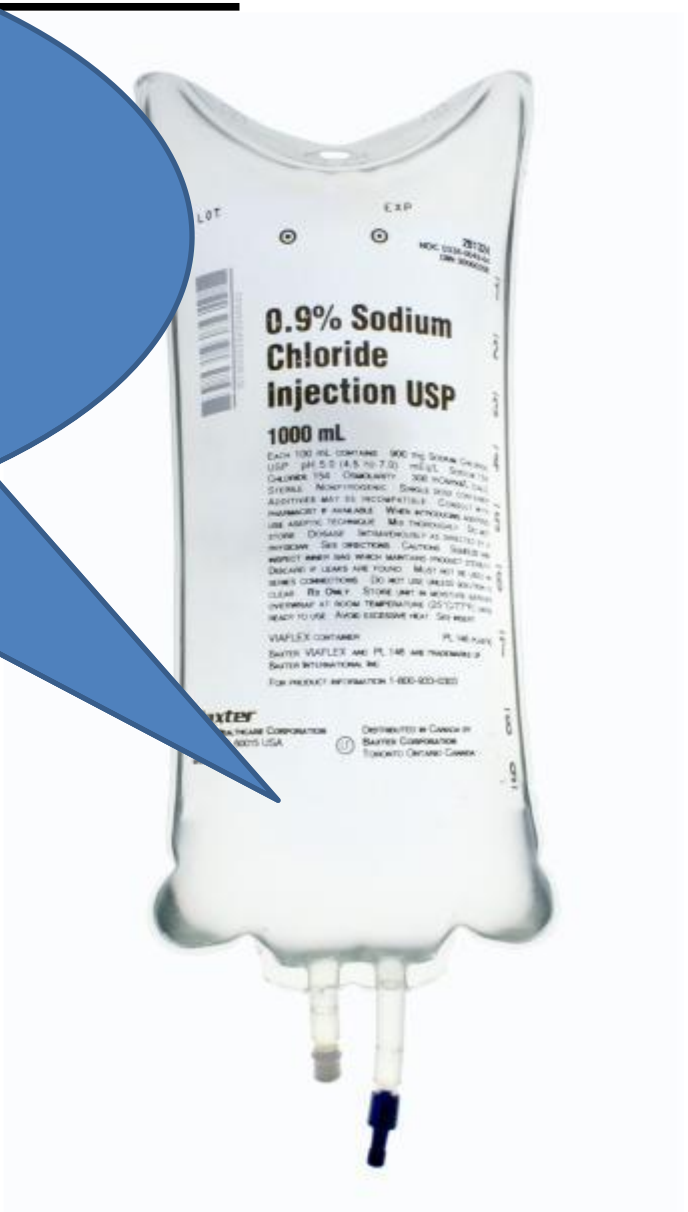
- **Place nasal cannula**
- **Turn flow meter all the way up**

PREOXYGENATE !!!!

P... tension

Finally! An evidence based indication for normal saline and prehospital crystalloid!

- IVF and p...



Pretreatment→ Forget about it!

- ***Ketamine 2 mg / kg***
- ***Rocuronium 1 mg / kg***

Pass the tube!

- DL or DL with VL back up
- Focus on tube delivery
- Have back up / rescue at the ready
- Cricothyroidotomy on standby

SUMMARY

- RSI has the potential to improve success and patient outcomes
- RSI must be implemented as part of a comprehensive educational and training intiative
- Protocolize the approach to RSI to minimize efforts and reduce cognitive load
- Remember the 8 P's of RSI

Thank you!

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