



Results of the INTUBE Study



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25. COLOURS OF SEPSIS
Festival intenzivní medicíny



Conflict of interests

- None regarding this topic

Airway management in the critically ill: the same, but different

A. Higgs¹, T. M. Cook² and B. A. McGrath^{3,*}

Operating room



- Difficult ventilation
- Difficult intubation
- Full stomach

ICU



- Hypoxemia
- Shock
- Metabolic acidosis
- Full stomach
- Operator's experience
- Equipment availability



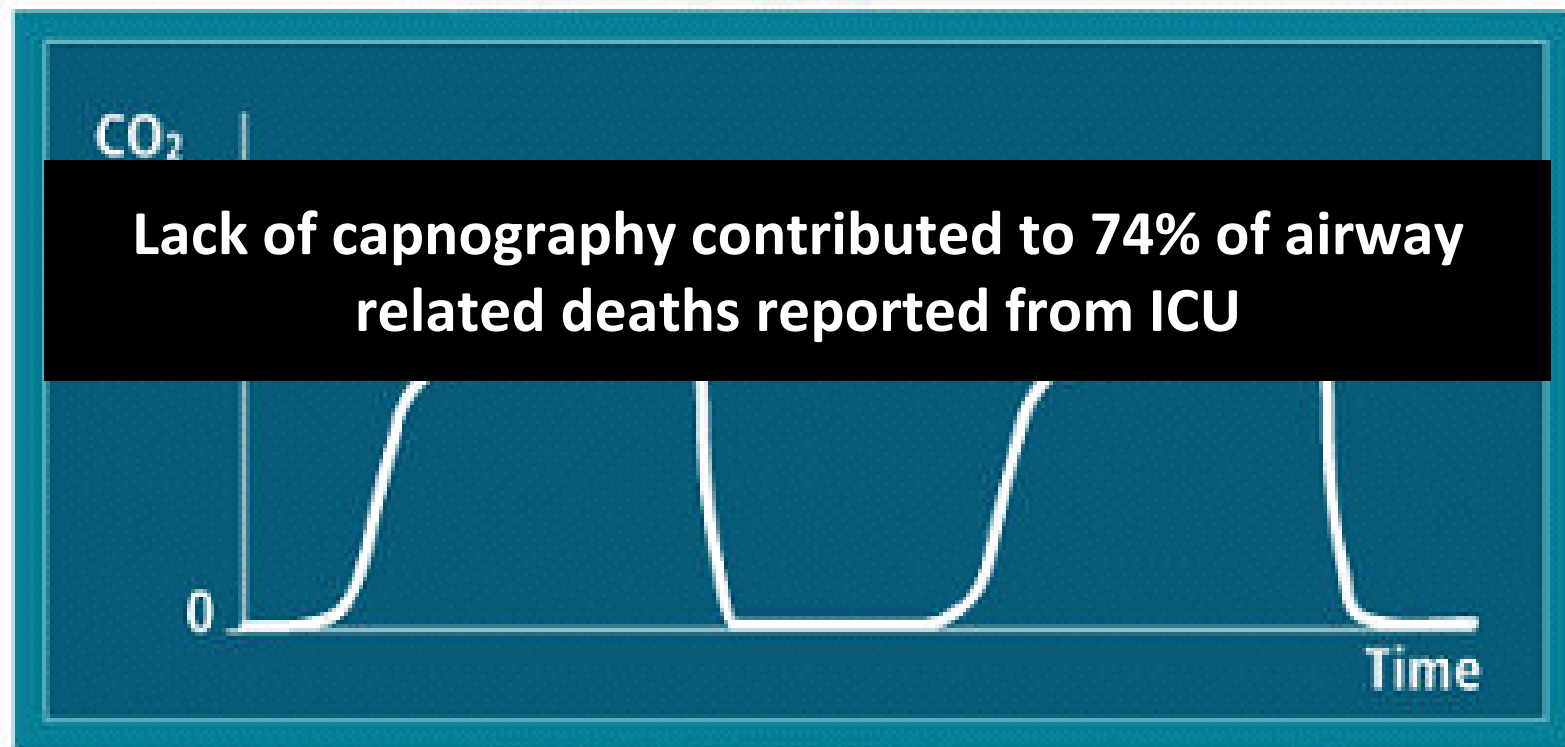
Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments[†]

T. M. Cook^{1*}, N. Woodall², J. Harper³ and J. Bengner⁴, on behalf of the Fourth National Audit Project

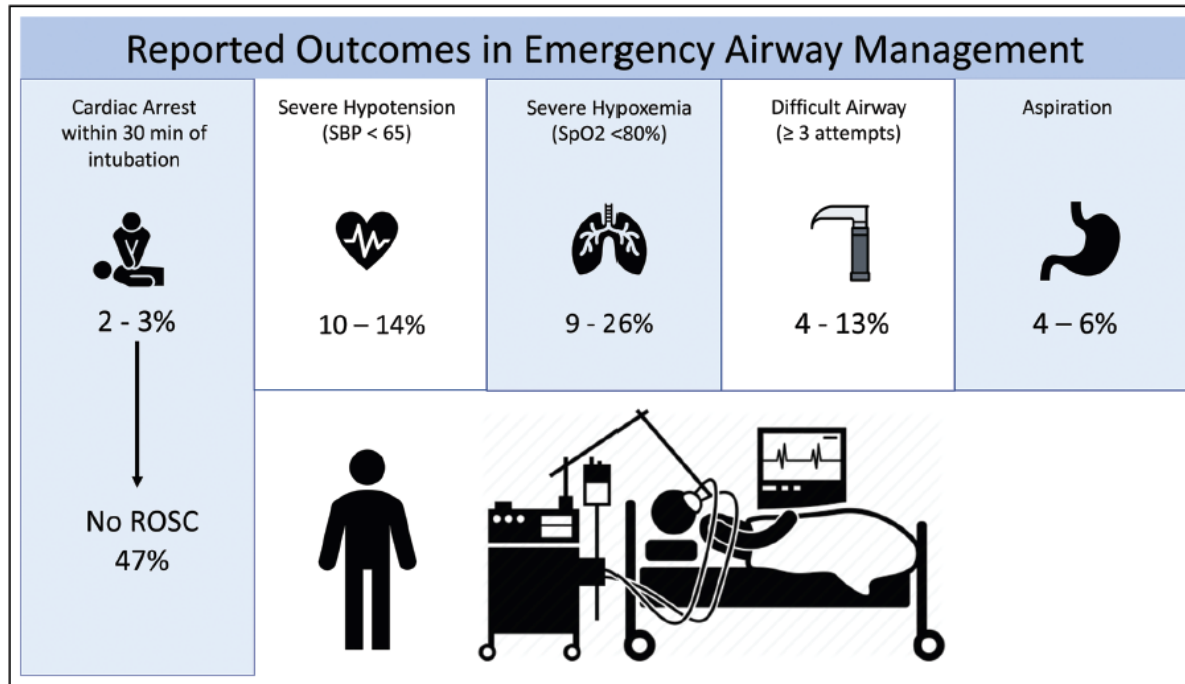
2008 - 2009

- National Audit Project of Adverse Airway Events in UK in 2008-9
 - Major events: death, brain injury, emergent surgical airway, ICU admission
 - Locations: ICU, Operating Rooms, ED
- 20% of all major events from ICU (1 major event/6 ICUs/year) and 8% from ED
- High morbidity resulting from adverse airway events in critically ill
 - 61% of airway complications in ICU led to death or brain damage
 - Comparison rate was 14% in Operating Room

Capnography was largely underused or misinterpreted in ICU and ED



Tracheal intubation is a risky procedure in critical care!



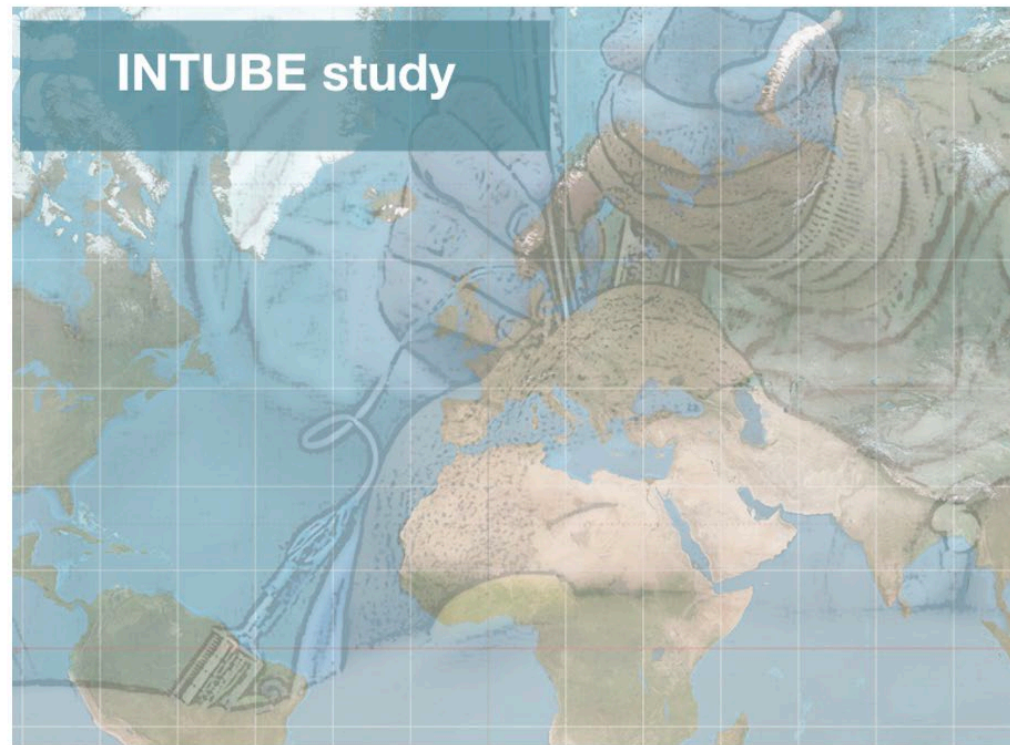
Challenges and outcomes in airway management outside the operating room

Mary Jarzeowski^a, Stephen Estime^b, Vincenzo Rusotto^c
and Kunal Karamchandani^d

If you can't
MEASURE it
you can't **MANAGE** it.



FIGURE 1. Outcomes reported with emergency airway management. ROSC, return of spontaneous circulation; SpO₂, oxygen saturation.



Steering Committee:

Principal Investigator: Vincenzo Russotto (Monza, Italy)

Principal Investigator: Giacomo Bellani (Monza, Italy)

Giuseppe Foti (Monza, Italy)

Roberto Fumagalli (Milan, Italy)

Antonio Pesenti (Milan, Italy)

Paolo Pelosi (Genoa, Italy)

Luigi Camporota (London)

Philippe R Bauer (Rochester, USA)

Konstanty Szuldrzynski (Cracow, Poland)

Sheila Nainan Myatra (Mumbai, India)

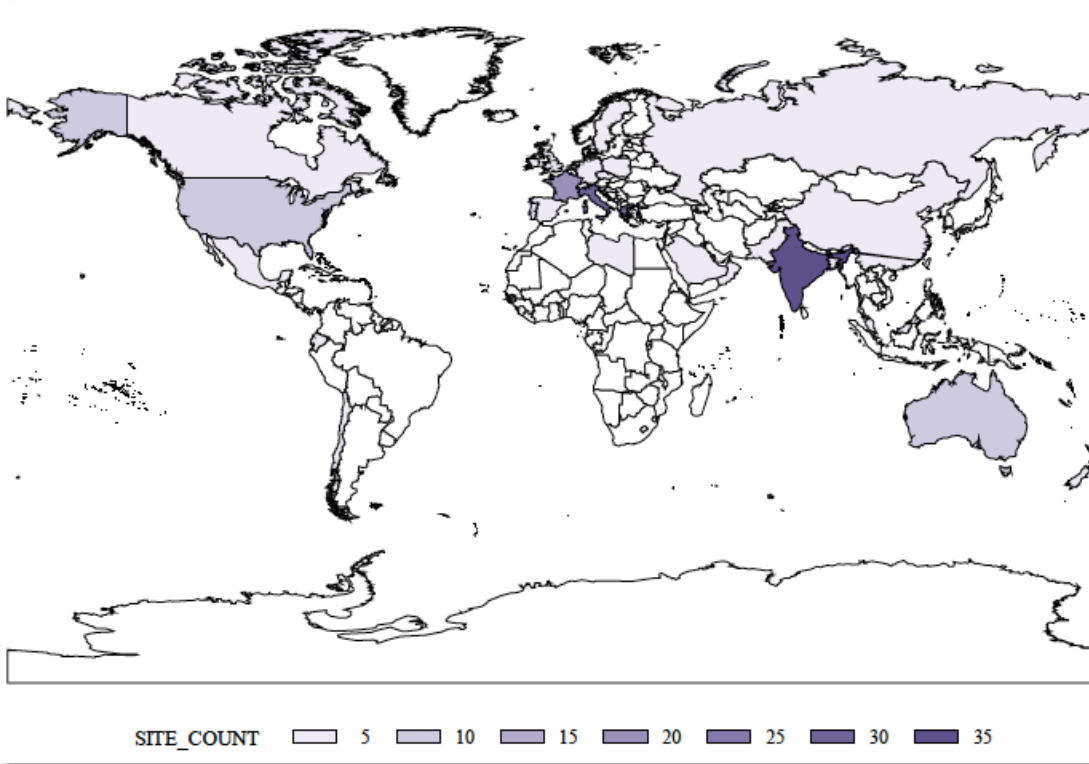
Massimiliano Sorbello (Catania, Italy)

Jonathan Tan Jit Ern (Singapore)

John Laffey (Ireland)

Intubation Practices and Adverse Peri-intubation Events in Critically Ill Patients From 29 Countries

Vincenzo Russotto, MD; Sheila Nainan Myatra, MD; John G. Laffey, MD, MA; Elena Tassistro, MS; Laura Antolini, PhD; Philippe Bauer, MD, PhD; Jean Baptiste Lascarrou, MD, PhD; Konstanty Szuldrzyński, MD, PhD; Luigi Camporota, MD; Paolo Pelosi, MD; Massimiliano Sorbello, MD; Andy Higgs, MD; Robert Greif, MD; Christian Putensen, MD; Christina Agvald-Öhman, MD, PhD; Athanasios Chalkias, MD, PhD; Kristaps Bokums, MD; David Brewster, MD; Emanuela Rossi, MS; Roberto Fumagalli, MD; Antonio Pesenti, MD; Giuseppe Foti, MD; Giacomo Bellani, MD, PhD; for the INTUBE Study Investigators



INTUBE STUDY

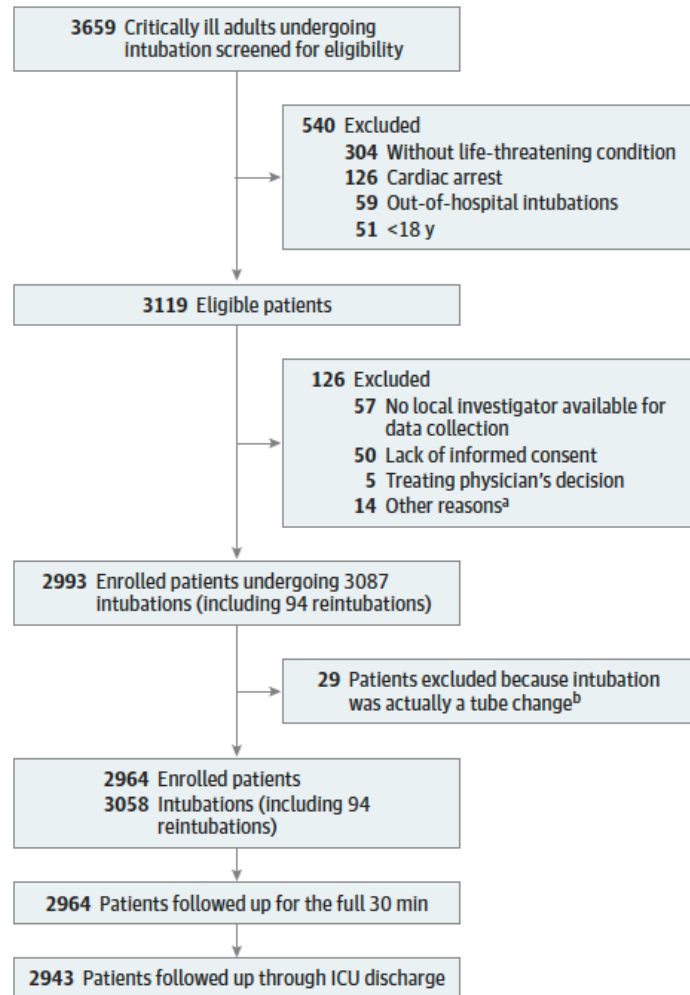
- International prospective observational study conducted from 1 October 2018 to 31 July 2019
- Convenience sample of 197 sites across 5 continents.
- **Inclusion criteria:** adult (≥ 18 years) critically ill patients undergoing in-hospital TI

INTUBE STUDY: primary outcome

At least one of the following events < 30 min from the start of TI

- (1) severe hypoxemia ($SpO_2 < 80\%$)
- (2) cardiac arrest;
- (3) cardiovascular instability (either: systolic arterial pressure < 65 mmHg recorded at least once; systolic arterial pressure < 90 mmHg for > 30 minutes; new requirement for, or increase of vasopressors; fluid bolus > 15 ml/kg to maintain the target blood pressure)

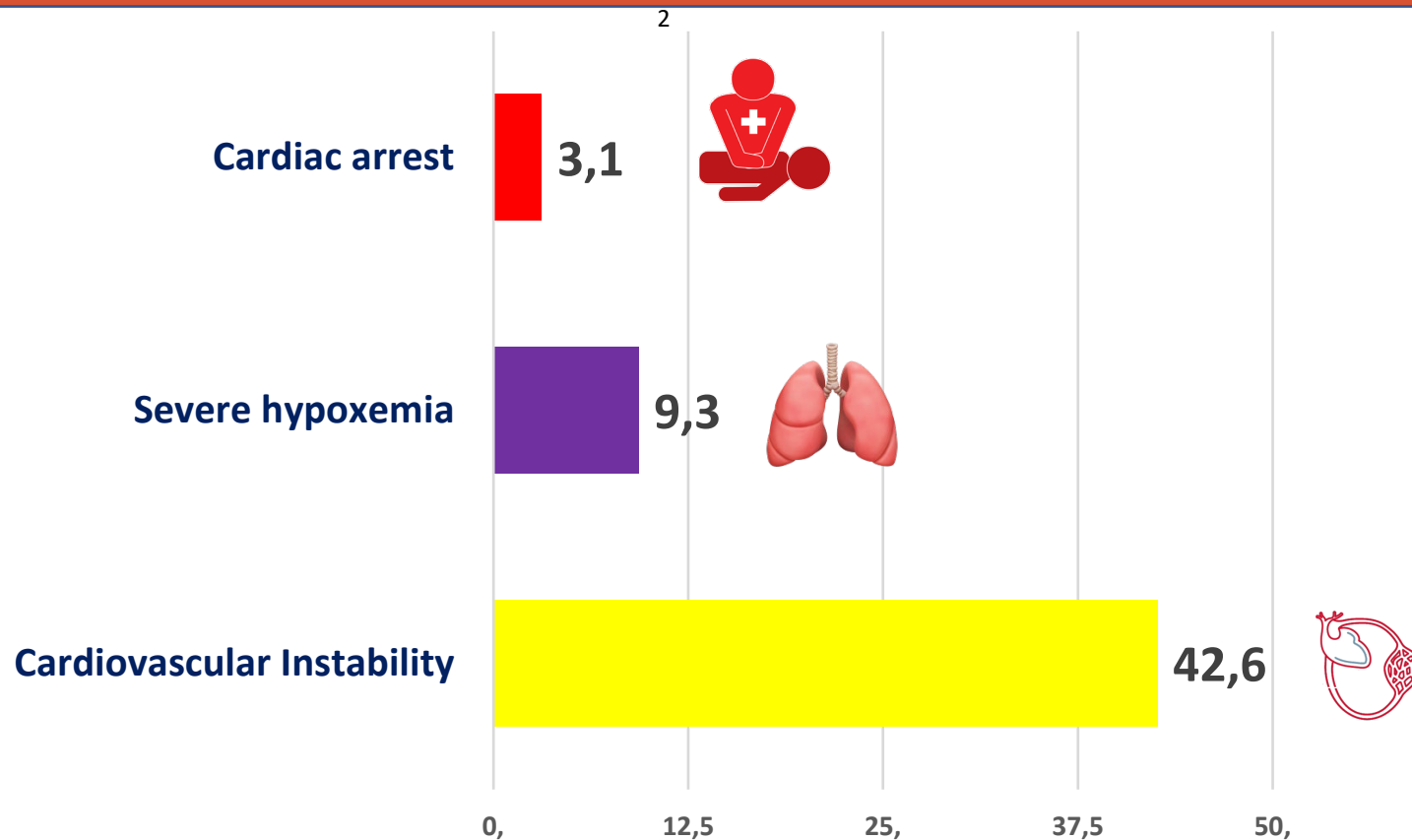
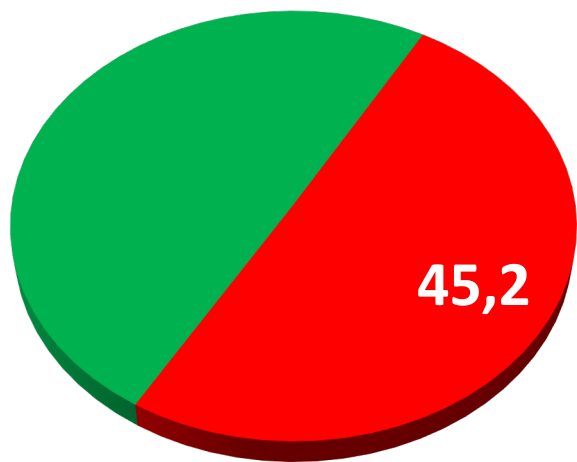
Results



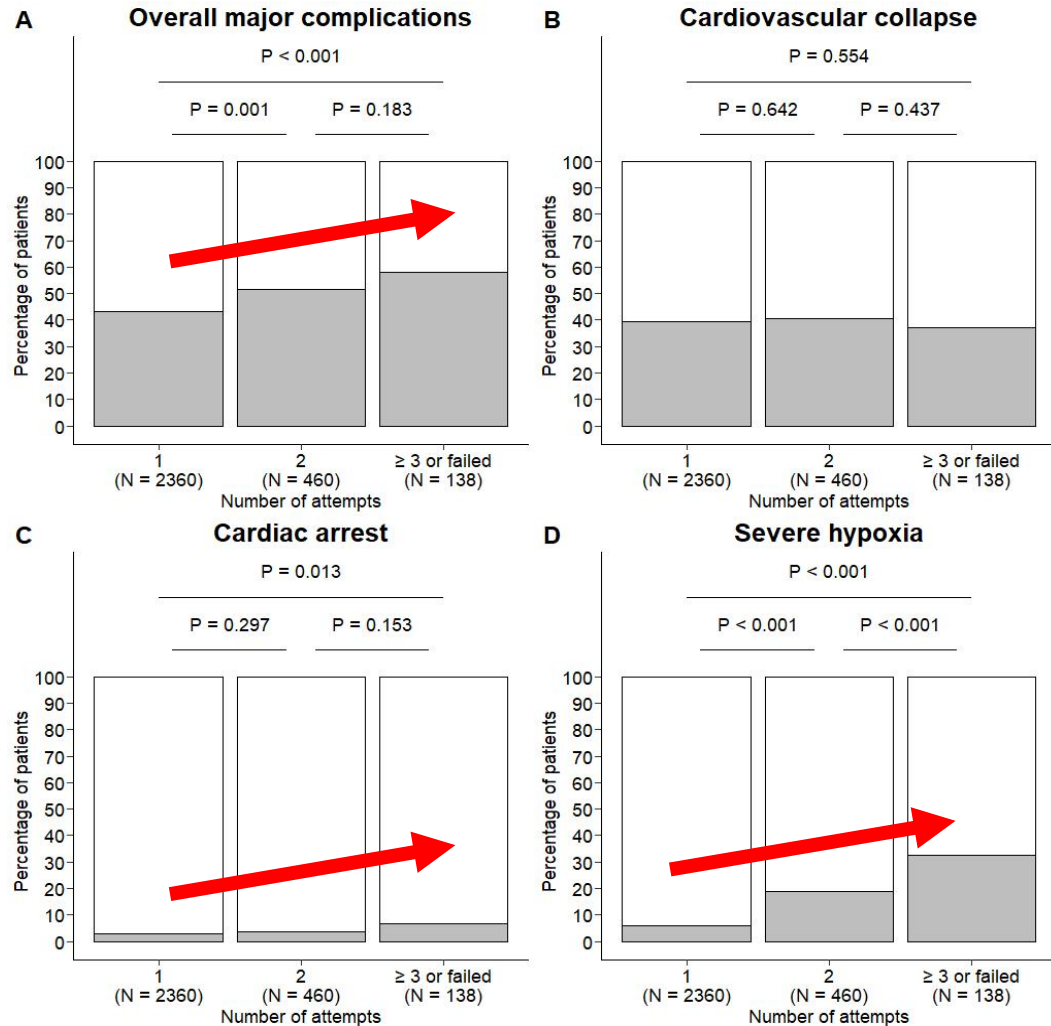
- 3,659 patients screened for eligibility
- 2,964 patients enrolled, undergoing 3,058 intubations, including 94 reintubations
- 2,964 patients followed up for the full 30 minutes
- 2,943 patients followed up until ICU discharge

INTUBE STUDY: primary outcome

■ at least 1 major event
■ no event

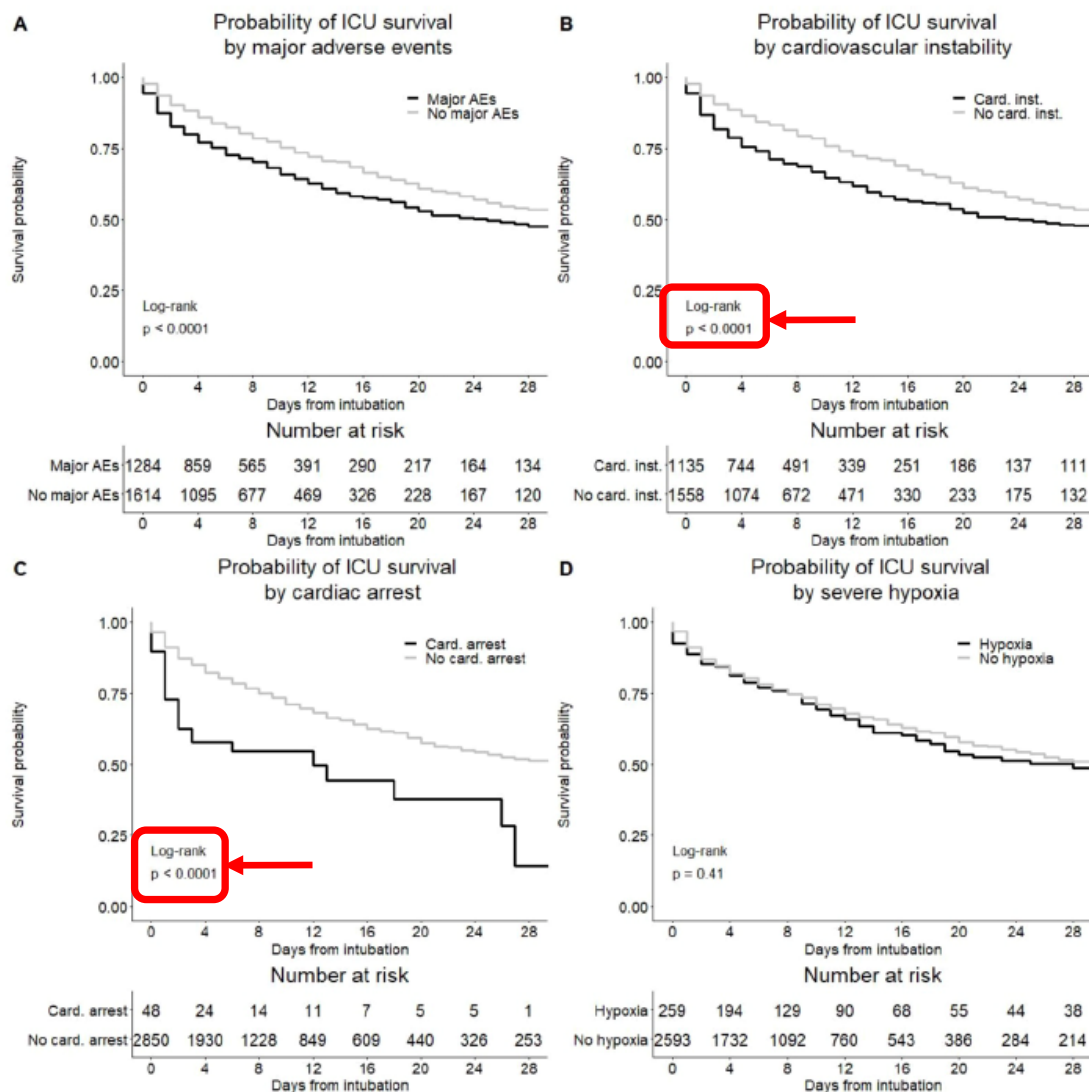


Repeated intubation attempts are associated with severe hypoxia and cardiac arrest



Success, No./total (%)	
First pass	2360/2958 (79.8)
Second pass	460/2958 (15.6)
Emergency front-of-neck access ^m	4 (0.13)

Long-term outcome



Patients experiencing the overall outcome, **cardiovascular instability** and **cardiac arrest** had a higher risk of mortality at 28-days from intubation

Adjusted 28-day mortality
OR 1.44 (95% CI 1.19 – 1.74, $p < 0.001$)

Intubation setting

Location of intubation	
ICU	1992 (67.2)
Emergency department	623 (21.0)
Medical ward	186 (6.3)
Surgical ward	69 (2.3)
Other ^e	94 (3.2)
Reason for intubation (n = 2960)	
Respiratory failure	1548 (52.3)
Neurological impairment	902 (30.5)
Cardiovascular instability	277 (9.4)
Airway obstruction	137 (4.6)
Emergency or urgent procedure	29 (1.0)
Degree of emergency (n = 2962)	
Tracheal intubation required	
Without any delay	1536 (51.9)
<1 h	1065 (35.9)
≥1 h	361 (12.2)
≥1 Anatomical reason to anticipate a difficult airway (n = 2798)	1308 (46.8)
MACOCHA score ≥3 ^g	426 (14.4)

Intubation procedure

Method of laryngoscopy (n = 2963)

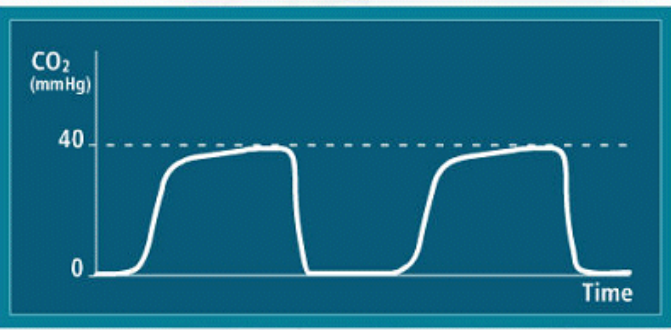
Direct laryngoscopy with Macintosh or Miller blade	2416 (81.5)
Video laryngoscopy	505 (17.1)
Other method ^g	42 (1.4)

Use of intubation adjuncts (n = 1055)

Stylet	816 (77.4)
Bougie	230 (21.8)
Other ^h	9 (0.8)

First method used to confirm intubation (n = 2956)

Auscultation	1711 (57.9)
Waveform capnography ⁱ	758 (25.6)
Colorimetric carbon dioxide detection ^j	222 (7.5)
Capnometry ^k	138 (4.7)
None	7 (0.2)
Other ^l	120 (4.1)



Use of waveform capnography to confirm tracheal intubation

ICU



40% of all TIs

ED



23.3% of all TIs

WARD



6.9% of all TIs

Intubation Practices and Adverse Peri-intubation Events in Critically Ill Patients From 29 Countries

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IMPORTANCE Tracheal intubation is one of the most commonly performed and high-risk interventions in critically ill patients. Limited information is available on adverse peri-intubation events.

OBJECTIVE To evaluate the incidence and nature of adverse peri-intubation events and to assess current practice of intubation in critically ill patients.

DESIGN, SETTING, AND PARTICIPANTS The International Observational Study to Understand the Impact and Best Practices of Airway Management in Critically Ill Patients (INTUBE) study was an international, multicenter, prospective cohort study involving consecutive critically ill patients undergoing tracheal intubation in the intensive care units (ICUs), emergency departments, and wards, from October 1, 2018, to July 31, 2019 (August 28, 2019, was the final follow-up) in a convenience sample of 197 sites from 29 countries across 5 continents.

EXPOSURES Tracheal intubation.

MAIN OUTCOMES AND MEASURES The primary outcome was the incidence of major adverse peri-intubation events defined as at least 1 of the following events occurring within 30 minutes from the start of the intubation procedure: cardiovascular instability (either: systolic pressure <65 mm Hg at least once, <90 mm Hg for >30 minutes, new or increase need of vasopressors or fluid bolus >15 mL/kg), severe hypoxemia (peripheral oxygen saturation <80%) or cardiac arrest. The secondary outcomes included intensive care unit mortality.

RESULTS Of 3659 patients screened, 2964 (median age, 63 years; interquartile range [IQR], 49-74 years; 62.6% men) from 197 sites across 5 continents were included. The main reason for intubation was respiratory failure in 52.3% of patients, followed by neurological impairment in 30.5%, and cardiovascular instability in 9.4%. Primary outcome data were available for all patients. Among the study patients, 45.2% experienced at least 1 major adverse peri-intubation event. The predominant event was cardiovascular instability, observed in 42.6% of all patients undergoing emergency intubation, followed by severe hypoxemia (9.3%) and cardiac arrest (3.1%). Overall ICU mortality was 32.8%.

CONCLUSIONS AND RELEVANCE In this observational study of intubation practices in critically ill patients from a convenience sample of 197 sites across 29 countries, major adverse peri-intubation events—in particular cardiovascular instability—were observed frequently.

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Corrected on May 24, 2021.

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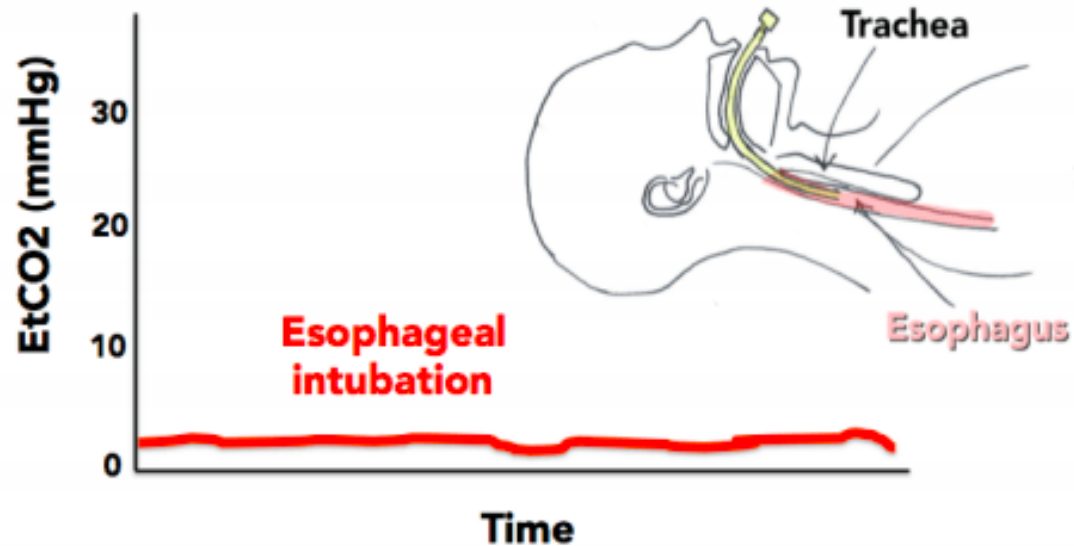
Author Affiliations: Author affiliations are listed at the end of this article.

Group Information: The INTUBE Study Investigators are listed in Supplement 2.

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Section Editor: Christopher Seymour, MD, Associate Editor, JAMA (christopher.seymour@jamanetwork.org).

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- Esophageal intubation in 5.6% of procedures
- Capnography not used in 70% of patients with esophageal intubation
- Lowest SpO₂ during procedure in patients with esophageal intubation!

Capnography use in the critical care setting: why do clinicians fail to implement this safety measure?

Vincenzo Russotto^{1,*} and Tim M. Cook^{2,3}

¹Department of Emergency and Intensive Care, University Hospital San Gerardo, Monza, Italy, ²Royal United Hospitals Bath NHS Foundation Trust, Bath, UK and ³School of Medicine, University of Bristol, Bristol, UK



**Equipment
unavailability?**

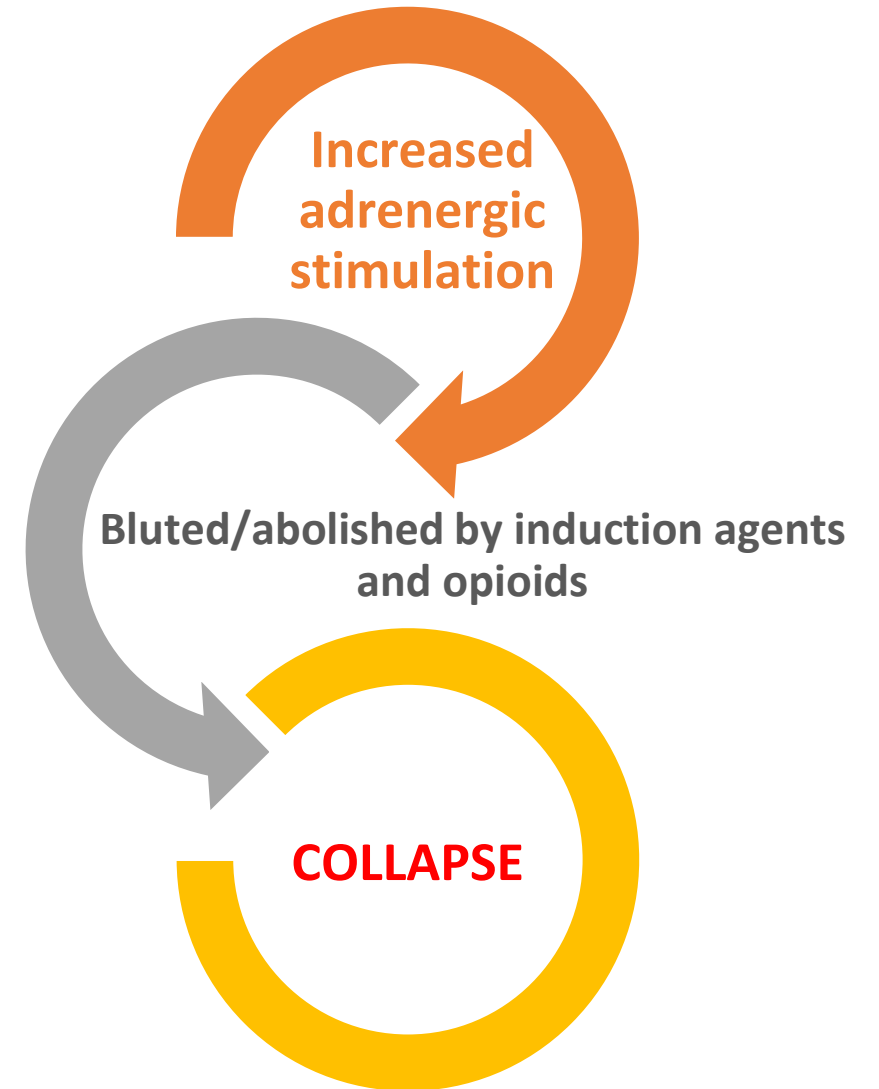


Not identified as priority?



**Inappropriate reliance
on clinical signs**

Adrenergic response and intubation

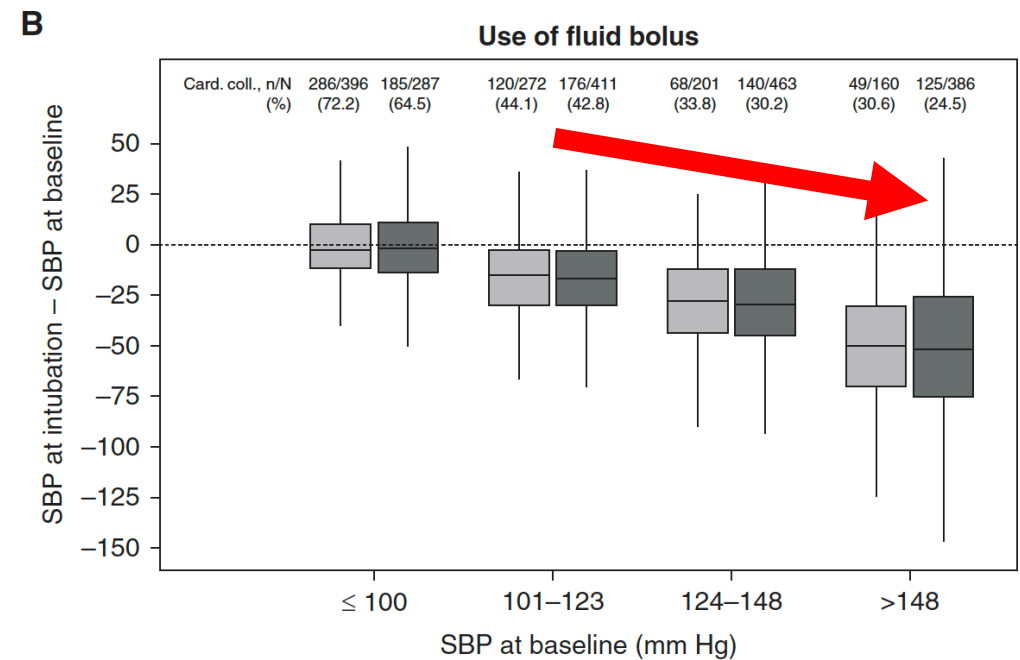
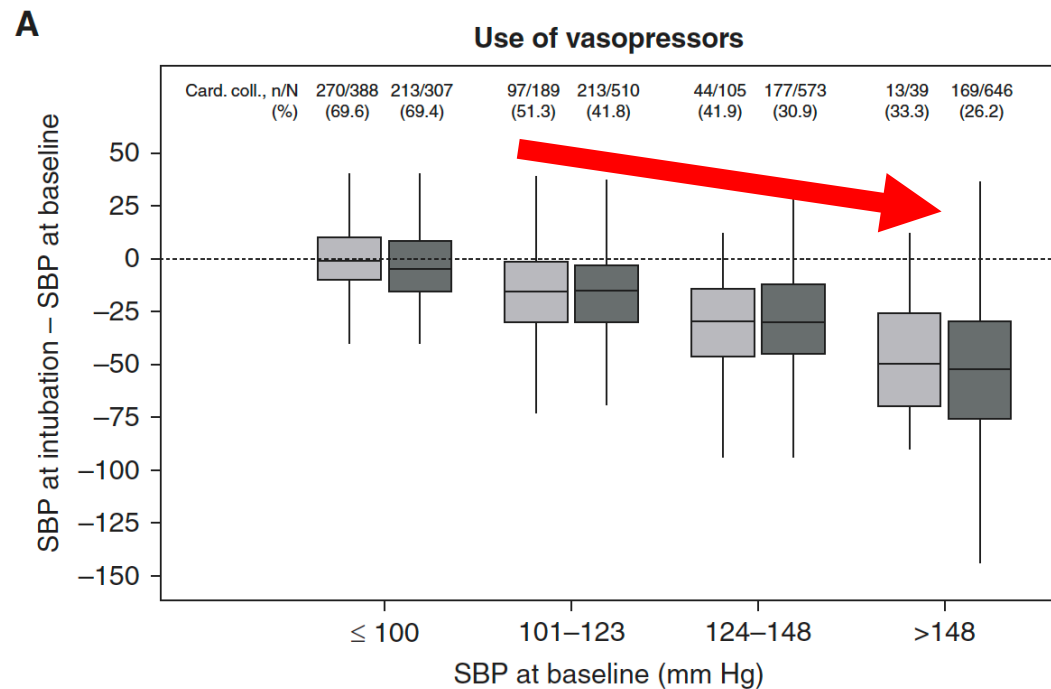


Peri-intubation Cardiovascular Collapse in Patients Who Are Critically Ill

Insights from the INTUBE Study

Vincenzo Russotto^{1*}, Elena Tassistro^{2,3*}, Sheila N. Myatra⁴, Matteo Parotto^{5,6}, Laura Antolini^{2,3}, Philippe Bauer⁷, Jean Baptiste Lascarrou⁸, Konstanty Szuldrzyński^{9,10}, Luigi Camporota¹¹, Christian Putensen¹², Paolo Pelosi^{13,14}, Massimiliano Sorbello¹⁵, Andy Higgs¹⁶, Robert Greif^{17,18}, Antonio Pesenti¹⁹, Maria Grazia Valsecchi^{2,3}, Roberto Fumagalli^{3,20}, Giuseppe Foti^{3,21}, Giacomo Bellani^{3,21}, and John G. Laffey^{22,23}, for the INTUBE Study Investigators

The higher the baseline systolic blood pressure, the higher its post-intubation drop!



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Table 3. Effect of Vasopressors, Fluid Bolus, Use of Propofol, Age, Adjusted Sequential Organ Failure Assessment Score, Heart Rate, Oxygen Saturation as Measured by Pulse Oximetry/ $F_{I_{O_2}}$, Systolic Blood Pressure on Cardiovascular Instability/Collapse by a Multiple Logistic Regression Model

Variable	OR	(95% CI)	P value
Vasopressors	1.143	(0.854–1.530)	0.37
Fluid bolus	1.187	(0.962–1.464)	0.11
Use of propofol	1.283	(1.047–1.572)	0.016
Age (yr)	1.022	(1.016–1.028)	<0.001
Adjusted SOFA	1.024	(0.995–1.053)	0.101
Heart rate	1.008	(1.004–1.012)	<0.001
$Sp_{O_2}/F_{I_{O_2}}$	0.998	(0.997–0.999)	<0.001
Systolic blood pressure (mm Hg)	0.983	(0.980–0.987)	<0.001

Propofol use worldwide

Research

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT Intubation Practices and Adverse Peri-intubation Events in Critically Ill Patients From 29 Countries

Vincenzo Rusotto, MD, Sheila Nainan Myatra, MD, John G. Laffey, MD, MA, Elena Tassistro, MS, Laura Antolini, PhD, Philippe Bauer, MD, PhD, Jean Baptiste Lascarrou, MD, PhD, Konstanty Szuldrzyński, MD, PhD, Luigi Camporota, MD, Paolo Pelosi, MD, Massimiliano Sorbello, MD, Andy Higges, MD, Robert Greif, MD, Christian Puettemann, MD, Christina Agvald-Othman, MD, PhD, Athanasios Chalkias, MD, PhD, Kristaps Bokums, MD, David Brewster, MD, Emanuela Rossi, MS, Roberto Fumagalli, MD, Antonio Pesenti, MD, Giuseppe Foti, MD, Giacomo Bellani, MD, PhD, for the INTUBE Study Investigators

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Editorial page 1157
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Section Editor: Christopher Seymour, MD, Associate Editor, JAMA (christopher.seymour@jamanetwork.org).

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1164

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Rapid sequence induction, No./total (%) ^e	1727/2777 (62.2)
Cricoid pressure, No./total (%)	1120/2956 (37.9)
Induction agent, No./total (%) ^f	2774/2964 (93.6)
Propofol	1230 (41.5)
Midazolam	1079 (36.4)
Etomidate	527 (17.8)
Ketamine	421 (14.2)
Muscle relaxant use, No./total (%)	2095/2776 (75.5)
Rocuronium	1239 (41.8)
Succinylcholine	646 (21.8)
Vecuronium	95 (3.2)
Cisatracurium	85 (2.9)
Opioid use for intubation, No./total (%)	1415/2776 (51.0)

Median dose/weight = 1.12 (0.71–1.67) mg/kg

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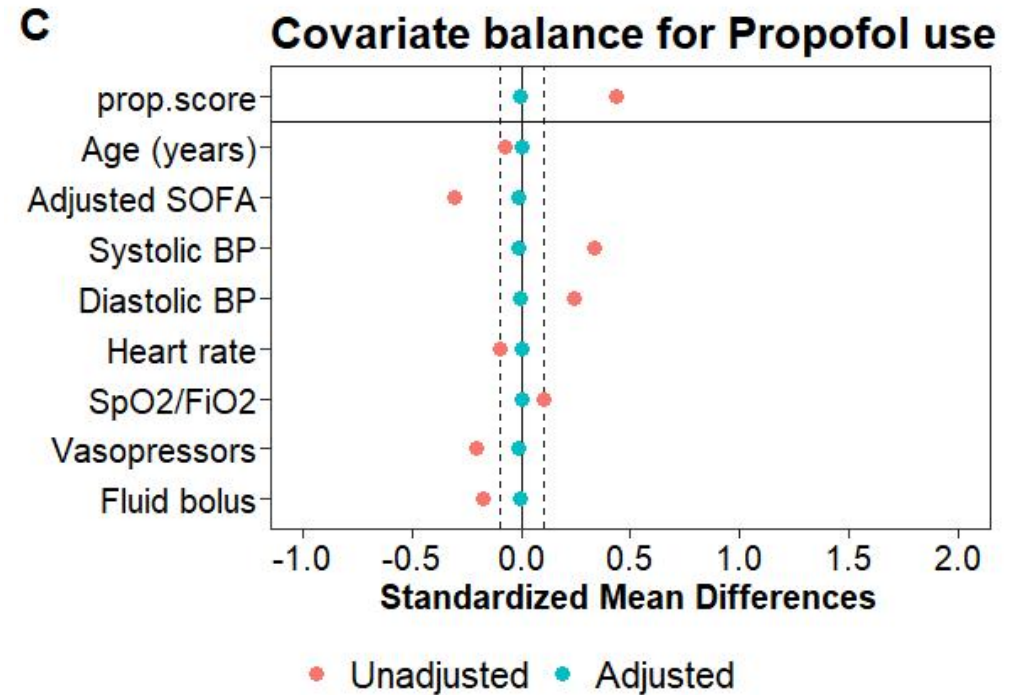
Propofol was more frequently used by anesthesiologists (49.2%) compared with nonanesthesiologists (i.e., emergency physicians and intensivists) (32.0%) patients, $P < 0.001$.

ORIGINAL ARTICLE

Peri-intubation Cardiovascular Collapse in Patients Who Are Critically Ill

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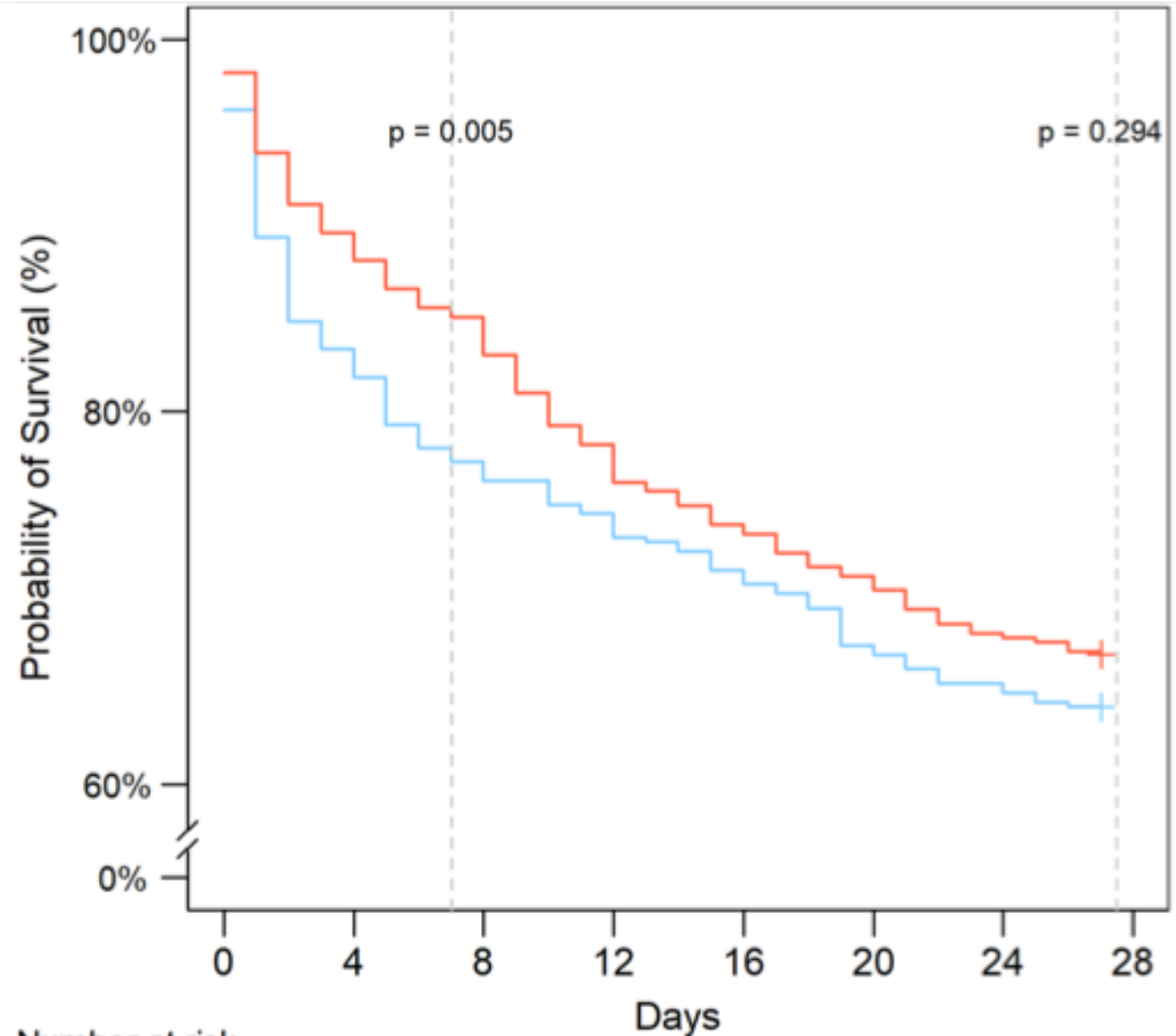


Propofol is the single modifiable intervention associated with cardiovascular collapse in critically ill patients

(OR 1.28, 95% CI 1.05 - 1.57)

The EvK Clinical trial: an open-label RCT

- *Matchett et al., Intensive Care Med. 2022; 48: 78-91*
- 801 critically ill patients (USA), emergency intubation
- **etomidate vs ketamine**
- Day 7 survival lower with etomidate (77.3%) than ketamine (85.1%)
- **Day 28 survival not different**



Number at risk		Days							
	0	4	8	12	16	20	24	28	
Etomidate	396	324	302	290	280	265	257	253	
Ketamine	395	348	328	301	290	278	268	264	

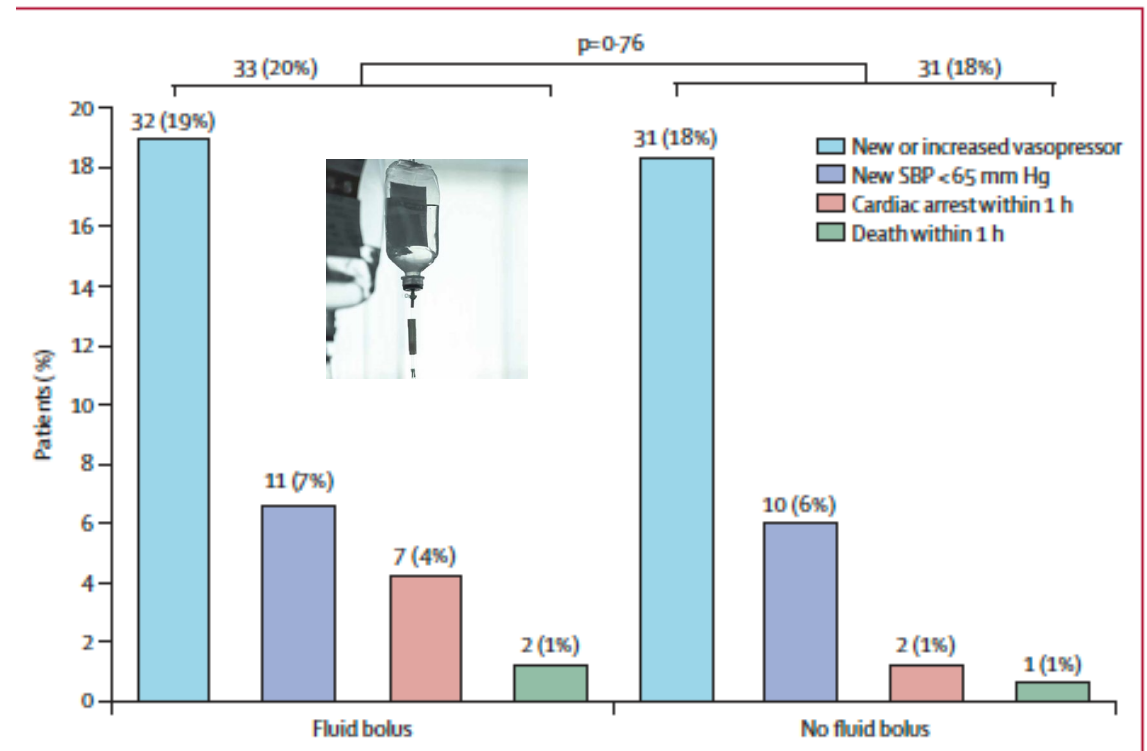
Effect of a fluid bolus on cardiovascular collapse among critically ill adults undergoing tracheal intubation (PrePARE): a randomised controlled trial



David R Janz, Jonathan D Casey, Matthew W Semler, Derek W Russell, James Dargin, Derek J Vonderhaar, Kevin M Dischert, Jason R West, Susan Stemppek, Joanne Wozniak, Nicholas Caputo, Brent E Heideman, Aline N Zouk, Swati Gulati, William S Stigler, Itay Bentov, Aaron M Joffe, Todd W Rice, for the PrePARE Investigators* and the Pragmatic Critical Care Research Group

PREPARE (2019)

- 168 pts randomized to 500 ml of crystalloids fluid bolus
- 169 pts randomized to no fluid bolus before induction
- Primary outcome: hemodynamic collapse between induction and 2 min after intubation
- Trial interrupted for futility



PREPARE II (2022)

JAMA

QUESTION In critically ill adult patients undergoing tracheal intubation, does intravenous infusion of a crystalloid solution as a 500-mL fluid bolus decrease the incidence of severely low blood pressure, cardiac arrest, or death during or shortly after the procedure?

CONCLUSION Among critically ill adults undergoing tracheal intubation, administration of a fluid bolus did not significantly decrease the incidence of cardiovascular collapse.

POPULATION

617 Men
448 Women



Critically ill adult patients undergoing tracheal intubation

Median age: 62 years

LOCATIONS

11 ICUs in the US



INTERVENTION



1067 Patients randomized
1065 Patients analyzed

538

Fluid bolus

500-mL intravenous infusion of isotonic crystalloid solution of the clinician's choice

529

No fluid bolus

Initiation of a new intravenous fluid bolus was not permitted except as treatment for hypotension

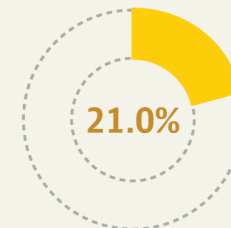
PRIMARY OUTCOME

Cardiovascular collapse (new or increased vasopressor receipt or a systolic blood pressure <65 mm Hg between induction and 2 minutes after intubation, or cardiac arrest or death)

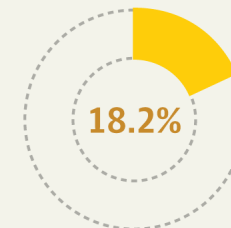
FINDINGS

Cardiovascular collapse

Fluid bolus
113 of 538 patients



No fluid bolus
96 of 527 patients



The between-group difference was not significant:

Absolute difference, 2.8%
(95% CI, -2.2% to 7.7%); $P = .25$

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Russell DW, Casey JD, Gibbs KW, et al; PREPARE II Investigators and the Pragmatic Critical Care Research Group. Effect of fluid bolus administration on cardiovascular collapse among critically ill patients undergoing tracheal intubation: a randomized clinical trial. *JAMA*. Published online June 16, 2022. doi:10.1001/jama.2022.9792

Potential solutions

Cardiovascular Collapse During Tracheal Intubation in the Critically Ill

CONTRIBUTING FACTORS

Critical illness
(e.g. sepsis, hypovolaemia,
vasoplegia, cardiac dysfunction)

**Drugs used for tracheal
intubation**
(e.g. propofol, benzodiazepines,
opioids)

Loss of sympathetic drive

Positive pressure ventilation



POTENTIAL SOLUTIONS

Rapid assessment of volume status

**Prefer ketamine or etomidate
as induction agents**

**Pre-intubation haemodynamic
optimisation**
? Fluid bolus
? Pre-emptive use
of low dose vasopressors

**? Use low PEEP and tidal volume after
tracheal intubation if applicable**

PEEP: positive end expiratory pressure

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INTENSIVE SPRING CONFERENCE

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