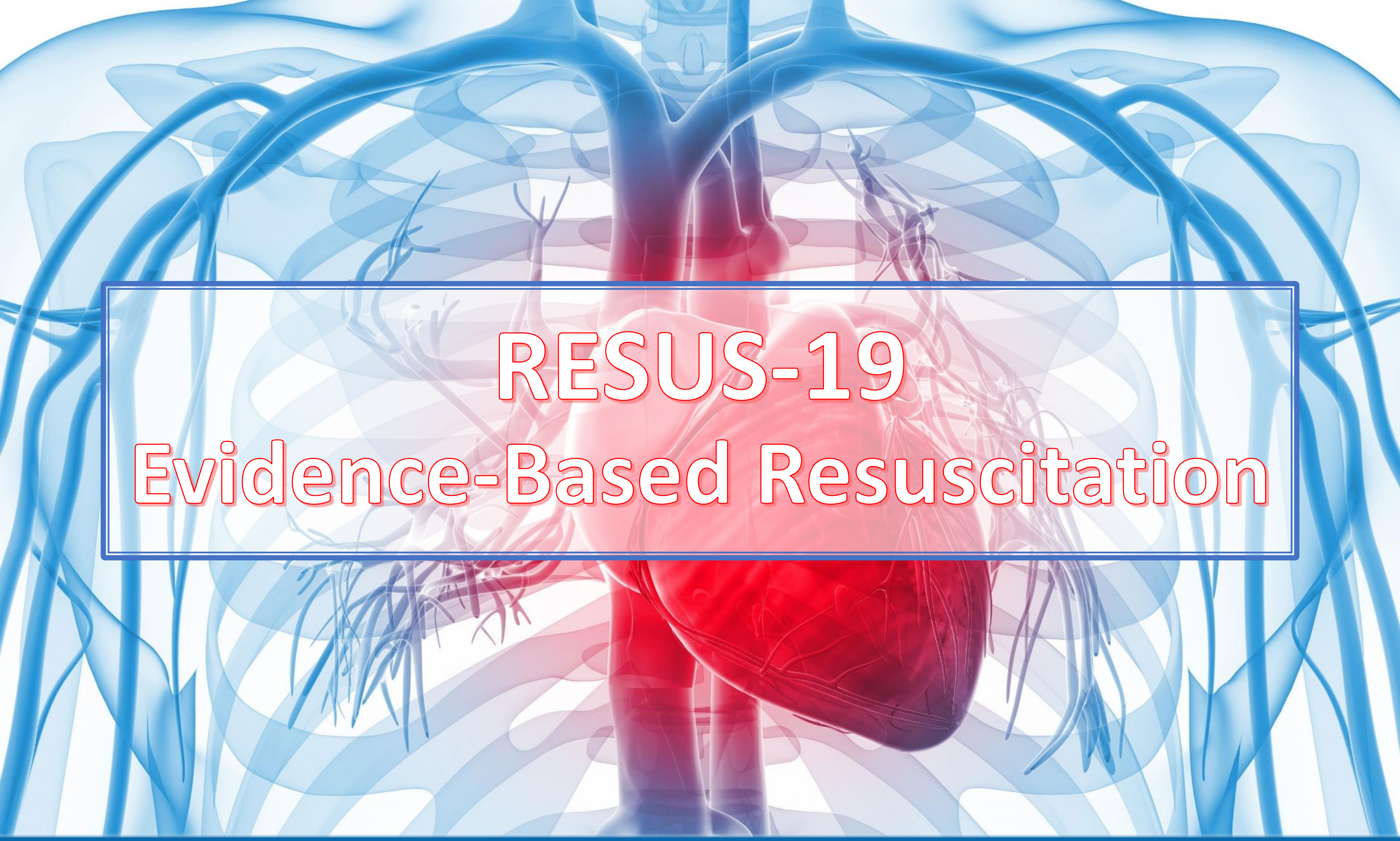


RESUS-19
Evidence-Based Resuscitation

Jacob A. Miller, ACNP, FNP, CNS, CCRN, CFRN, EMT-P, FP-C

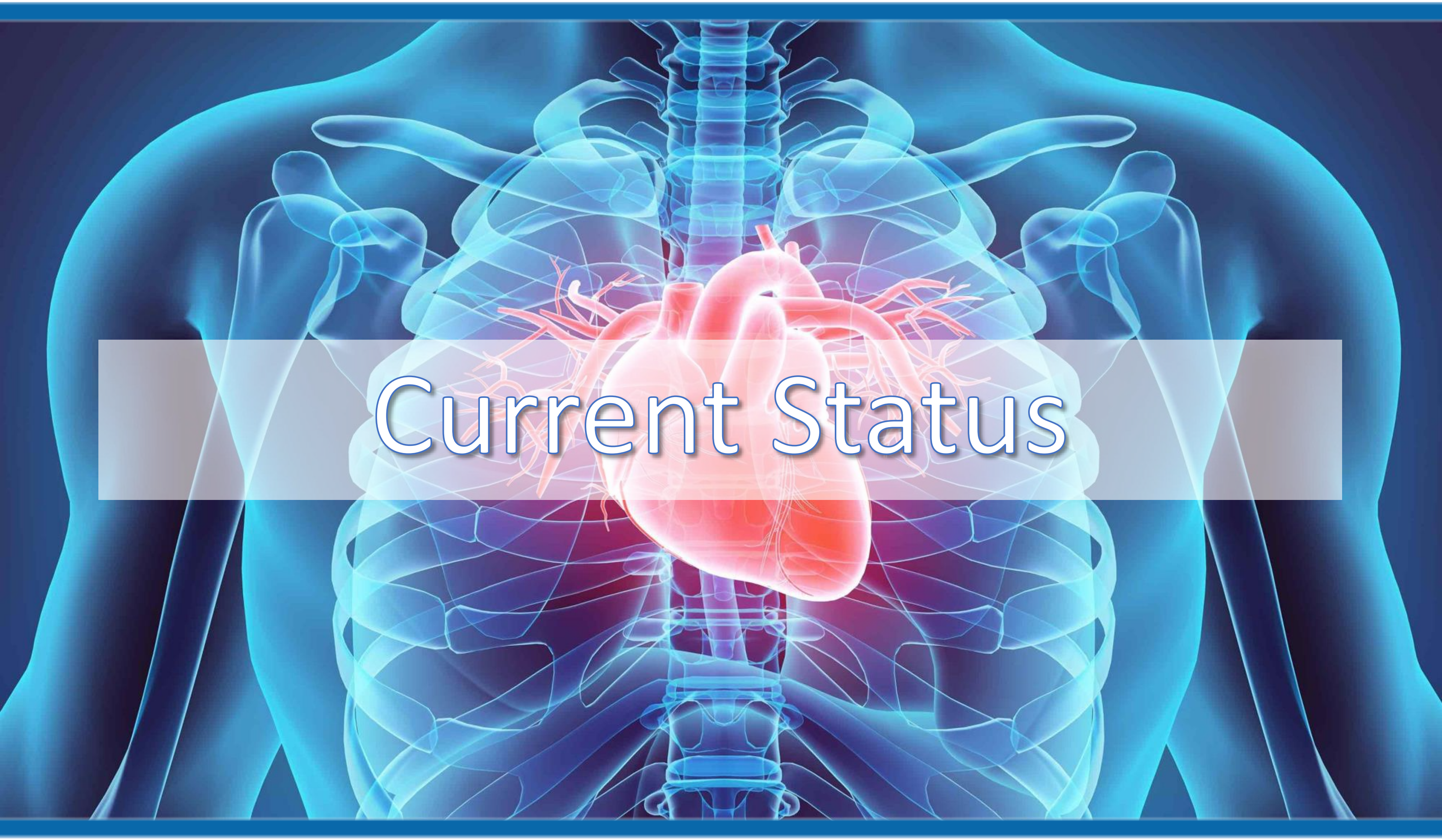
Flight Nurse Practitioner & Clinical Nurse Specialist

Disclosures & Disclaimers

- No conflicts of interest
- Off-label discussion re: epi dosing
- Views, opinions, & suggestions are **my own** and do not necessarily reflect those of my employers
- Read and interpret the literature for yourself!
- KNOW AND FOLLOW **<u>YOUR</u>** PROTOCOLS

Objectives

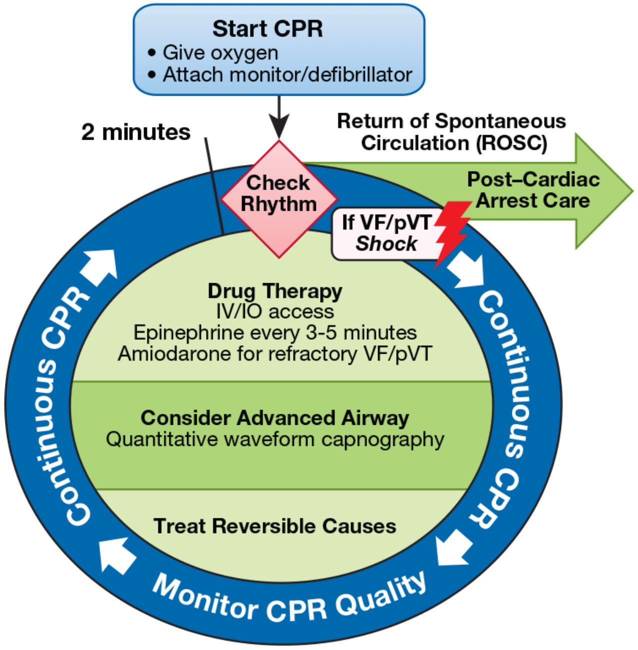
- Review and discuss current literature surrounding cardiac arrest management
- Discuss limitations to current evidence and directions for future research
- Formulate evidence-based resuscitation strategies
- **Foster discussion**
- **Inspire future research**



Current Status

CPR&ECC Guidelines

Adult Cardiac Arrest Circular Algorithm—2015 Update



CPR Quality

- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality
- Intra-arterial pressure.
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

The Problem…

ORIGINAL CONTRIBUTION

CME Prehospital Advanced Cardiac Life Support for Out-of-hospital Cardiac Arrest: A Cohort Study

Conclusions: In a tiered-response urban emergency medical service setting, prehospital ACLS is not associated with an improvement in survival to hospital discharge in patients suffering from OHCA and in potential E-CPR candidates, but with an improvement in prehospital ROSC and with longer delay to hospital arrival.

Cossette, PhD, Luc Londei-Leduc, MD, Yoan Lamarche, MD, MSc, Judy Morris, MD, MSc, Éric Piette, MD, MSc, Raoul Daoust, MD, MSc, Jean-Marc Chauny, MD, MSc, Catalina Sokoloff, MD, Yiorgos Alexandros Cavayas, MD, Jean Paquet, PhD and André Denault, MD, PhD

New Engl J Med 2004;351:647-56
Acad Emerg Med 2017;24:1100-9

The Problem…

The NEW ENGLAND JOURNAL *of* MEDICINE

ORIGINAL ARTICLE

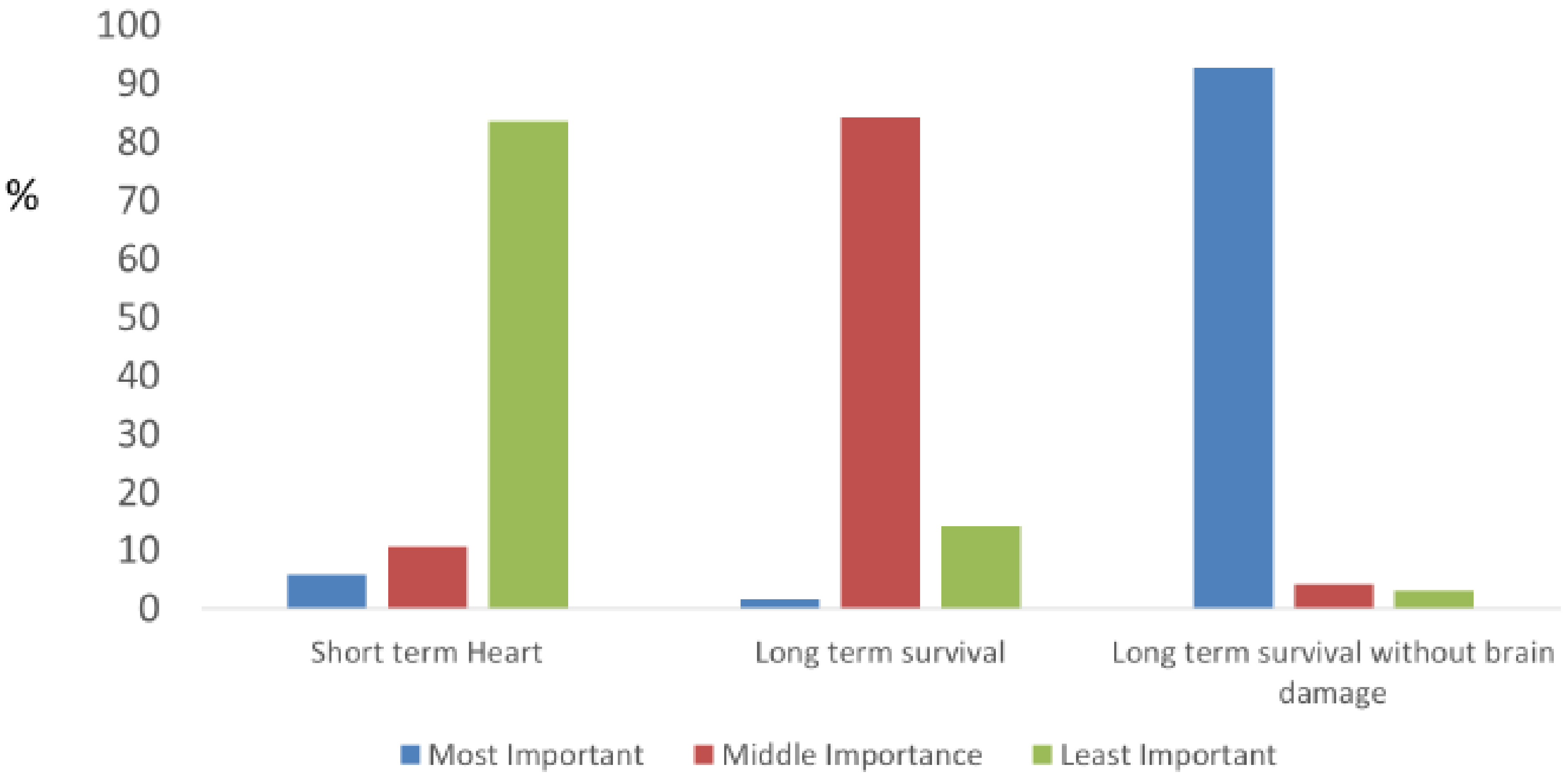
Advanced Cardiac Life Support in Out-of-Hospital Cardiac Arrest

Ian G. Stiell, M.D., George A. Wells, Ph.D., Brian Field, A.C.P., M.B.A., Daniel W. Spaite, M.D., Lisa P. Nesbitt, M.H.A., Valerie J. De Maio, M.D., Graham Nichol, M.D., M.P.H., Donna Cousineau, B.Sc.N., Josée Blackburn, B.Sc., Doug Munkley, M.D., Lorraine Luinstra-Toohey, B.Sc.N., M.H.A., Tony Campeau, M.Ed., Eugene Dagnone, M.D., and Marion Lyver, M.D., for the Ontario Prehospital Advanced Life Support Study Group

CONCLUSIONS
The addition of advanced-life-support interventions did not improve the rate of survival after out-of-hospital cardiac arrest in a previously optimized emergency-medical-services system of rapid defibrillation. In order to save lives, health care planners should

New Engl J Med 2004;351:647-56
Acad Emerg Med 2017;24:1100-9

What Matters?



N Engl J Med 2018;379:711-21

Outcome measures

CPC CEREBRAL PERFORMANCE CATEGORY	INTERPRETATION	VALUE	INTERPRETATION	mRS MODIFIED RANKIN SCALE
		0	Good	*No symptoms* Normal function, no symptoms
Good cerebral performance Conscious. Can lead normal life and work. May have minor deficits.	Good	1	Good	*No significant disability* Able to carry out all usual activities, despite some symptoms
Moderate cerebral disability Conscious. Cerebral function adequate for part-time work in a sheltered environment, or independent ADLs. May have seizures or permanent memory, mental, or motor deficits.	Good	2	Good	*Slight disability* Able to look after own affairs without assistance, but unable to carry out all previous activities
Severe cerebral disability Conscious. Dependent on others for daily support due to neurologic deficit. Wide range of severe disabilities can exist.	Poor	3	(Fair?)	*Moderate disability* Requires some help, but able to walk (and eat, use toilet, perform basic hygiene) without assistance from another person
Coma or vegetative state Unconscious, no interaction with environment	Poor	4	Poor	*Moderately severe disability* Unable to attend to own bodily needs or walk without assistance from somebody
Death Death by neurologic or conventional criteria. Electroencephalographic silence.		5	Poor	*Severe disability* Requires constant nursing care and attention; Bedridden, incontinent
		6		*Death* Died as a result of incident

Resuscitation 2011;82:1036-40

Airway

Airway studies

Research

JAMA | Original Investigation

Effect of Bag-Mask Ventilation vs Endotracheal Intubation During Cardiopulmonary Resuscitation on Neurological Outcome After Out-of-Hospital Cardiorespiratory Arrest

A Randomized Clinical Trial

Patricia Jabre, MD, PhD; Andrea Penaloza, MD, PhD; David Pinero, MD; Francois-Xavier Duchateau, MD; Stephen W. Borron, MD, MS; Francois Javaudin, MD; Olivier Richard, MD; Diane de Longueville, MD; Guillem Bouilleau, MD; Marie-Laure Devaud, MD; Matthieu Heidet, MD, MPH; Caroline Lejeune, MD; Sophie Fauroux, MD; Jean-Luc Greingor, MD; Alessandro Manara, MD; Jean-Christophe Hubert, MD; Bertrand Guihard, MD; Olivier Vermylen, MD; Pascale Lievens, MD; Yannick Auffret, MD; Celine Maisondieu, MD; Stephanie Huet, MD; Benoît Claessens, MD; Frederic Lapostolle, MD, PhD; Nicolas Javaud, MD, PhD; Paul-Georges Reuter, MD, MS; Elinor Baker, MD; Eric Vicaut, MD, PhD; Frédéric Adnet, MD, PhD

Research

JAMA | Original Investigation

Effect of a Strategy of Initial Laryngeal Tube Insertion vs Endotracheal Intubation on 72-Hour Survival in Adults With Out-of-Hospital Cardiac Arrest

A Randomized Clinical Trial

Henry E. Wang, MD, MS; Robert H. Schmicker, MS; Mohamud R. Daya, MD, MS; Shannon W. Stephens, EMT-P; Ahamed H. Idris, MD; Jestin N. Carlson, MD, MS; M. Riccardo Colella, DO, MPH; Heather Herren, MPH, RN; Matthew Hansen, MD, MCR; Neal J. Richmond, MD; Juan Carlos J. Puyana, BA; Tom P. Aufderheide, MD, MS; Randal E. Gray, MEd, NREMT-P; Pamela C. Gray, NREMT-P; Mike Verkest, AAS, EMT-P; Pamela C. Owens; Ashley M. Brienza, BS; Kenneth J. Sternig, MS-EHS, BSN, NRP; Susanne J. May, PhD; George R. Sopko, MD, MPH; Myron L. Weisfeldt, MD; Graham Nichol, MD, MPH

JAMA | Original Investigation

Effect of a Strategy of a Supraglottic Airway Device vs Tracheal Intubation During Out-of-Hospital Cardiac Arrest on Functional Outcome

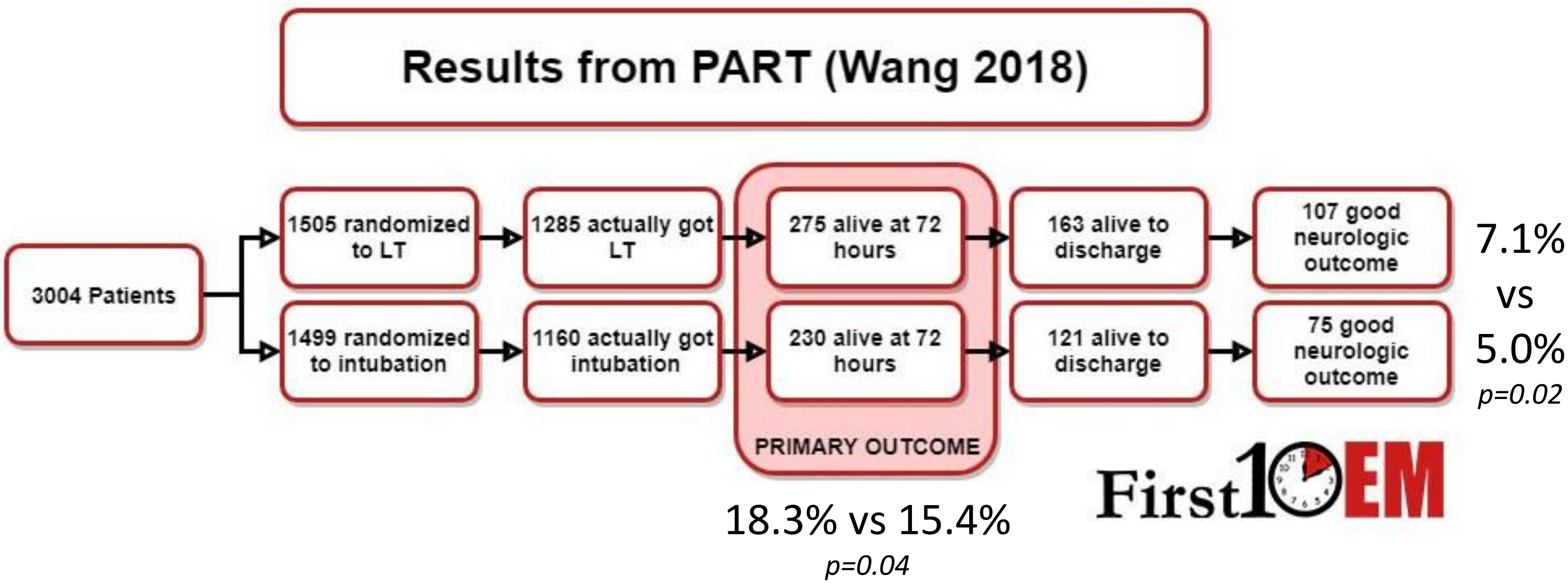
The AIRWAYS-2 Randomized Clinical Trial

Jonathan R. Benger, MD; Kim Kirby, MRes; Sarah Black, DClinRes; Stephen J. Brett, MD; Madeleine Clout, BSc; Michelle J. Lazaroo, MSc; Jerry P. Nolan, MBChB; Barnaby C. Reeves, DPhil; Maria Robinson, MOst; Lauren J. Scott, MSc; Helena Smartt, PhD; Adrian South, BSc (Hons); Elizabeth A. Stokes, DPhil; Jodi Taylor, PhD; Matthew Thomas, MBChB; Sarah Voss, PhD; Sarah Wordsworth, PhD; Chris A. Rogers, PhD

JAMA 2018;319:779-87
JAMA 2018;320:769-78
JAMA 2018;320:779-91

PART Trial

- Multicenter, cluster-crossover, open-label, randomized trial (United States)
- King LT vs ET tube



CONCLUSIONS AND RELEVANCE Among adults with OHCA, a strategy of initial LT insertion was associated with significantly greater 72-hour survival compared with a strategy of initial ETI.

JAMA 2018;320:769-78

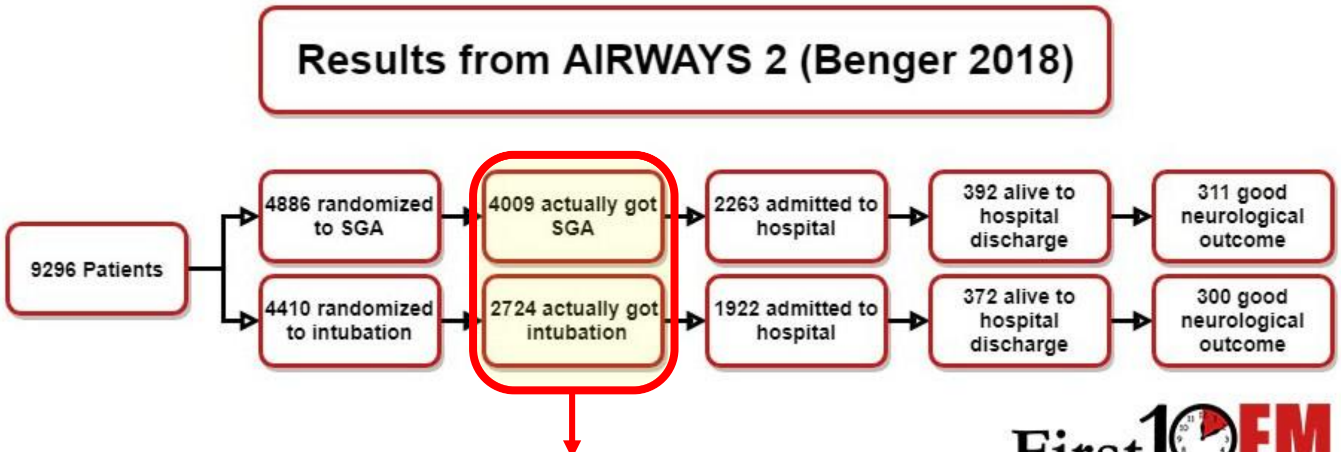
PART Trial

- Received BVM only
  - ET: 200 (13.3%)
  - LT: 152 (10.1%)
- Time to airway management (min)
  - ET: 12.5
  - LT: 9.8
- Time to place airway (min)
  - ET: 0.9
  - LT: 0.5
- First-pass success
  - ET: 51.6%
  - LT: 90.3%
- No info on CPR metrics

JAMA 2018;320:769-78

AIRWAYS-2 Trial

- Multicenter, cluster randomized trial (England)
- iGel vs ET tube



6.4%

vs

6.8%

First10EM

Patients randomized to ET tube:

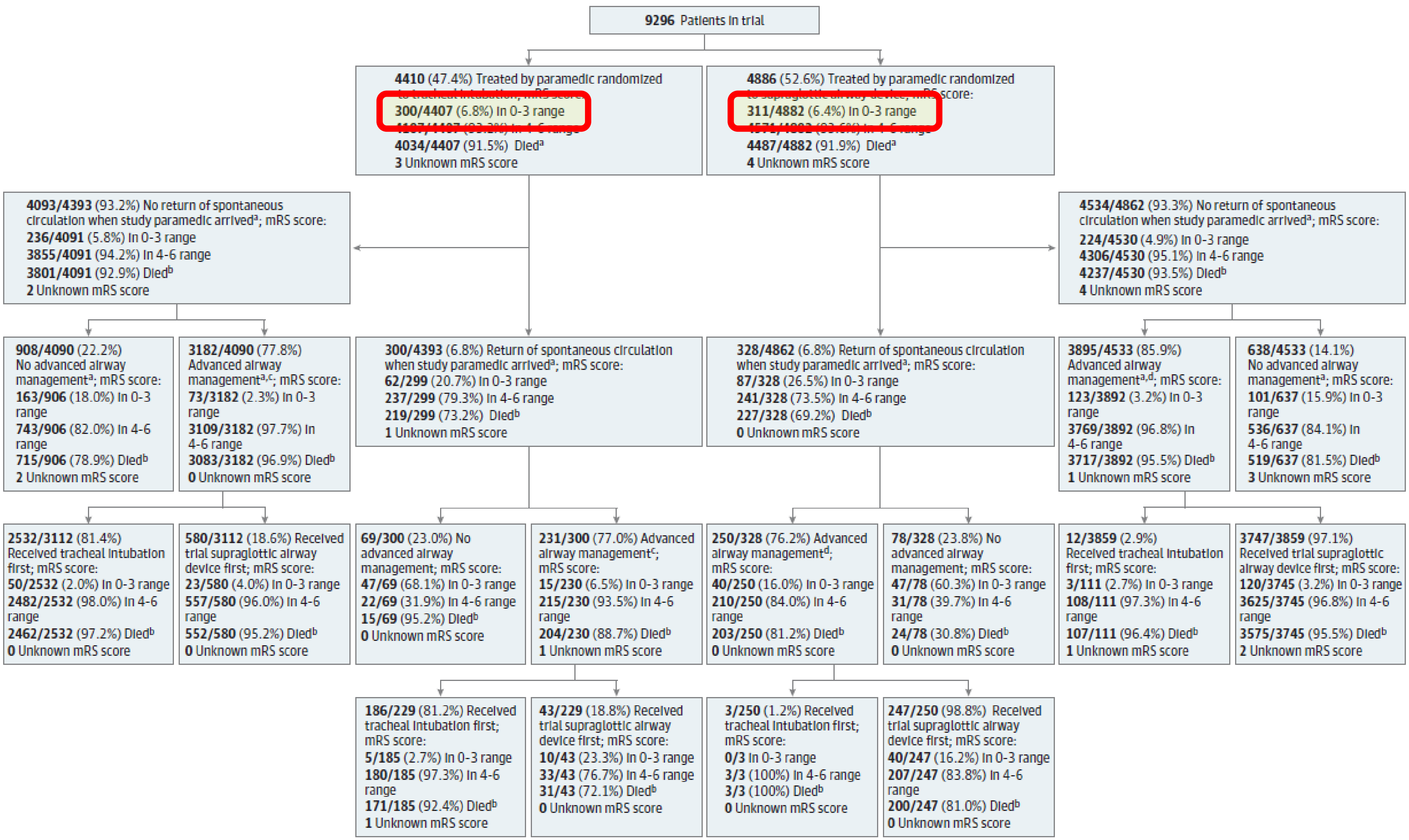
- More likely to get BVM only (22.2% vs 14.9%)
- More likely to cross-over (18.6% vs 2.9%)
- Less likely to have successful ventilation within 2 attempts (79 vs 87.4%)

CONCLUSIONS AND RELEVANCE Among patients with out-of-hospital cardiac arrest, randomization to a strategy of advanced airway management with a supraglottic airway device compared with tracheal intubation did not result in a favorable functional outcome at 30 days.

JAMA 2018;320:779-91

AIRWAYS-2 Trial

Figure 2. Patient Interventions and Outcomes by Trial Randomization Assignment of Study Paramedics



JAMA 2018;320:779-91

AIRWAYS-2 Trial

eTable 4. Sensitivity analyses for primary outcome (modified Rankin Scale (mRS) score at discharge or 30 days)

Sensitivity analysis 1: Trial patients plus patients attended by a Trial paramedic but not resuscitated[1]	**Randomised to TI (n=10,744)**		**Randomised to Trial SGA (n=11,466)**		**Odds Ratio estimate (95% CI)**	**p-value**	**ICC**	**Risk difference estimate (95% CI)**	**p-value**
	n	**%**	**n**	**%**					
mRS (0 to 3; good recovery)	300/10741	2.79%	311/11462	2.71%	0.96 (0.81, 1.14)	0.63	0.06	-0.002 (-0.006, 0.003)	0.45
Sensitivity analysis 2: Trial patients who received at least one AAM[1]	**Randomised to TI (n=4,410)**		**Randomised to Trial SGA (n=4,886)**		**Odds ratio estimate (95% CI)**	**p-value**	**ICC**	**Risk difference estimate (95% CI)**	**p-value**
	n	**%**	**n**	**%**					
mRS (0 to 3; good recovery)	88/3418	2.6%	163/4158	3.9%	1.57 (1.18, 2.07)	0.002	0.10	0.014 (0.005, 0.022)	0.001
Sensitivity analysis 3: Trial patients who received at least one AAM[2]	**Received TI first (n=2,840)**		**Received Trial SGA first (n=4,632)**		**Odds ratio estimate (95% CI)**	**p-value**	**ICC**	**Risk difference estimate (95% CI)**	**p-value**
	n	**%**	**n**	**%**					
mRS (0 to 3; good recovery)	58/2838	2.0%	193/4630	4.17%	2.06 (1.51, 2.81)	<0.001	0.10	0.021 (0.012, 0.029)	<0.001

TI=Tracheal Intubation, SGA=Supraglottic Airway Device, CI=Confidence Interval, ICC=Intraclass Correlation Coefficient, AAM=advanced airway management.

Note:

[1] Patients are grouped by the allocation of the first study paramedic on scene.

[2] Patients are grouped by the first trial treatment they received. This only includes patients who have received at least one attempt at TI or trial SGA.

Odds ratios and risk differences are adjusted for stratification factors fitted as fixed effects. Odds ratios were obtained from a mixed effects logistic regression model with study paramedic fitted as a random effect. Risk differences were obtained by fitting a generalised linear model (binomial family and identity link) with standard errors adjusted for clustering. Wald p-values are displayed.

JAMA 2018;320:779-91

AIRWAYS-2 Trial

- ET tube first-pass success not reported

- Limited CPR data available:

eTable 6. Compression fraction (used in two ambulance trusts for a subset of patients)

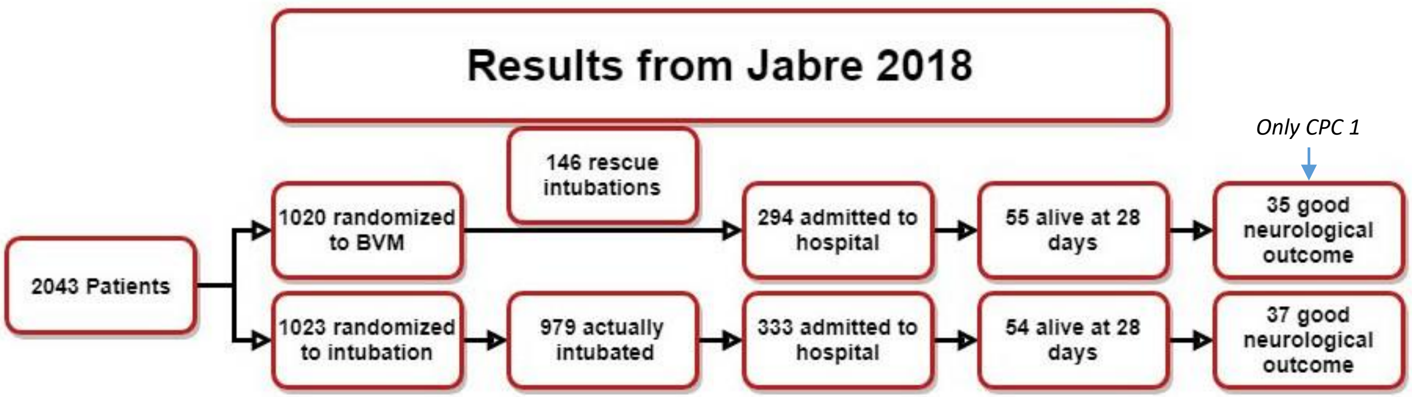
Trial patients enrolled during the period that compression fraction data were collected	**Randomised to TI (n=32)**			**Randomised to Trial SGA (n=34)**				
	n	**Median**	**IQR**	**n**	**Median**	**IQR**	**Estimate (95% CI)**	**p-value**
Compression Fraction[1]	32	83	(74, 89)	34	86	(81, 91)	GMR=0.82[2] (0.62, 1.07)	0.14

TI=Tracheal Intubation, SGA=Supraglottic Airway Device, IQR=Interquartile Range, CI=Confidence Interval, GMR=geometric mean ratio.

  - Doesn't list duration of CPR interruption for airway

BVM vs ETT

- Randomized, parallel group, noninferiority, multicenter trial (Belgium & France)
- BVM vs ETT *during CPR*
  - Intubated post-ROSC in both groups



Only CPC 1

CPC 1 & 2

ITT & PP
4.3%
vs
4.2%

ROSC: 34.2% vs 38.9% (ITT), 34.4% vs 30.0% (PP)

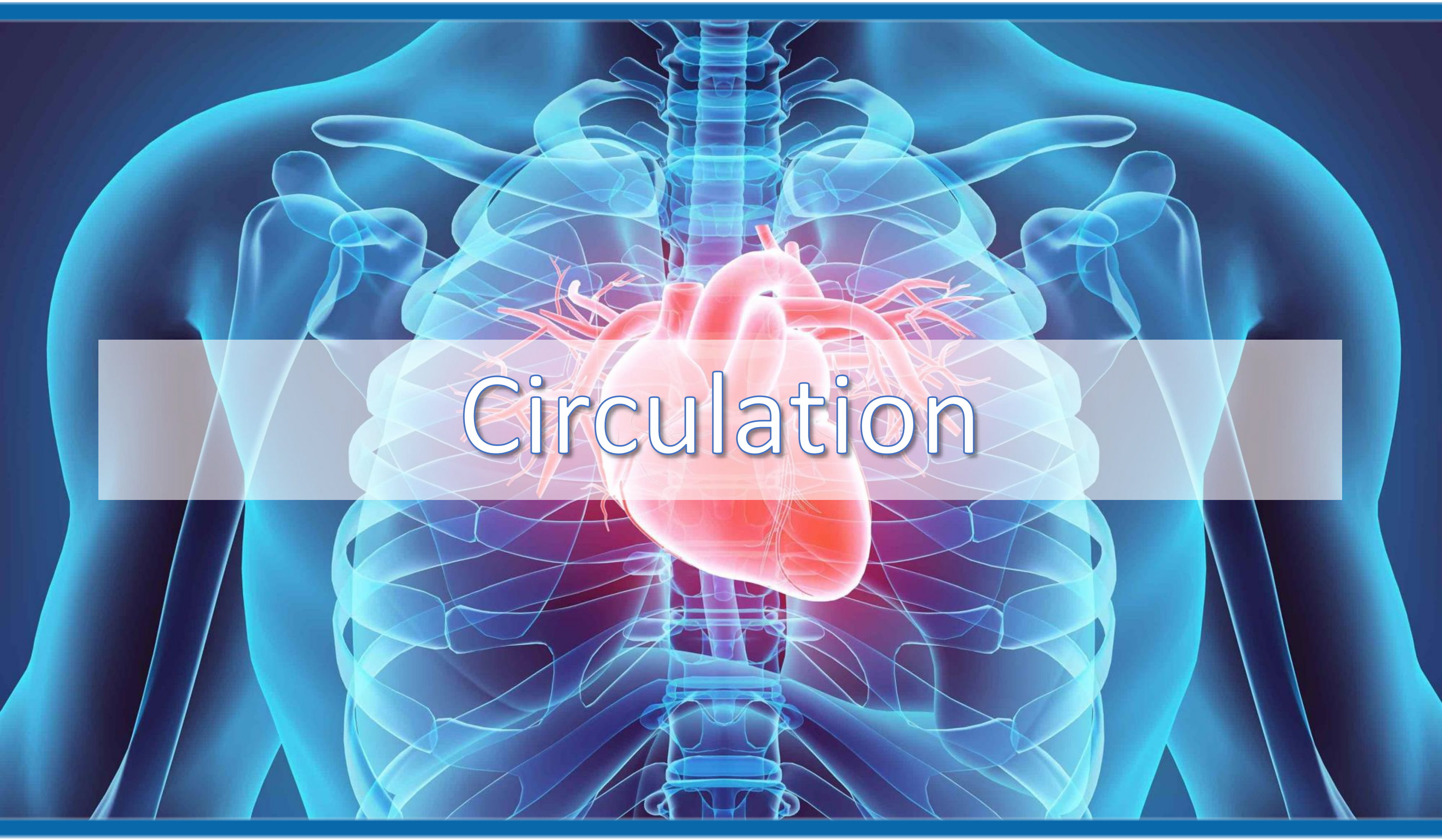
p=0.03, 0.01

CONCLUSIONS AND RELEVANCE Among patients with out-of-hospital cardiorespiratory arrest, the use of BMV compared with ETI failed to demonstrate noninferiority or inferiority for survival with favorable 28-day neurological function, an inconclusive result. A determination of equivalence or superiority between these techniques requires further research.

JAMA 2018;319:779-87

Airway: Summary

- BVM alone is *probably* not worse than ETI
- SGA is *probably* better than ETI
  - ETI *might* be better if you're really good at it
- Regurgitation BVM > ETT = SGA
  - BVM: 15% vs 7%
  - PART & AIRWAYS-2: Overall similar (~25%)
    - ETI: More regurg noted pre-intervention
    - SGA: More regurg noted post-intervention
- King *might be* better than iGel??
  - Totally a stretch, no trial directly compared them
    - PART: King failure 8.4%
    - AIRWAYS-2: iGel failure 10.7%


Circulation

Manual CPR in Transit

- In general, it sucks

ORIGINAL RESEARCH

A Comparison of Chest Compression Quality Delivered During On-Scene and Ground Transport Cardiopulmonary Resuscitation

Christopher S. Russi, DO*
Lucas A. Myers, BAH‡
Logan J. Kolb, BS*
Christine M. Lohse, MS†
Erik P. Hess, MD, MSc*§
Roger D. White, MD¶

*Mayo Clinic, Department of Emergency Medicine, Rochester, Minnesota
†Mayo Clinic, Division of Biomedical Statistics and Informatics, Rochester, Minnesota
‡Mayo Clinic, Gold Cross, Rochester, Minnesota
§Mayo Clinic, Division of Health Care Policy and Research, Rochester, Minnesota
¶Mayo Clinic, Division of Cardiovascular and Thoracic Anesthesia, Division of Cardiovascular Diseases, Rochester, Minnesota

Rate (/min)

		SCENE	TRANSPORT
Pre-Feedback	Correct Depth	41.9%	8.7%
	Correct Rate	45.5%	11.1%
Post-Feedback	Correct Depth	75.7%	14.0%
	Correct Rate	48.2%	19.0%

Depth (mm)

West J Emerg Med 2016;17:634-9
Br Paramedic J 2017;2:6-15

Manual CPR in Transit

- In general, it sucks

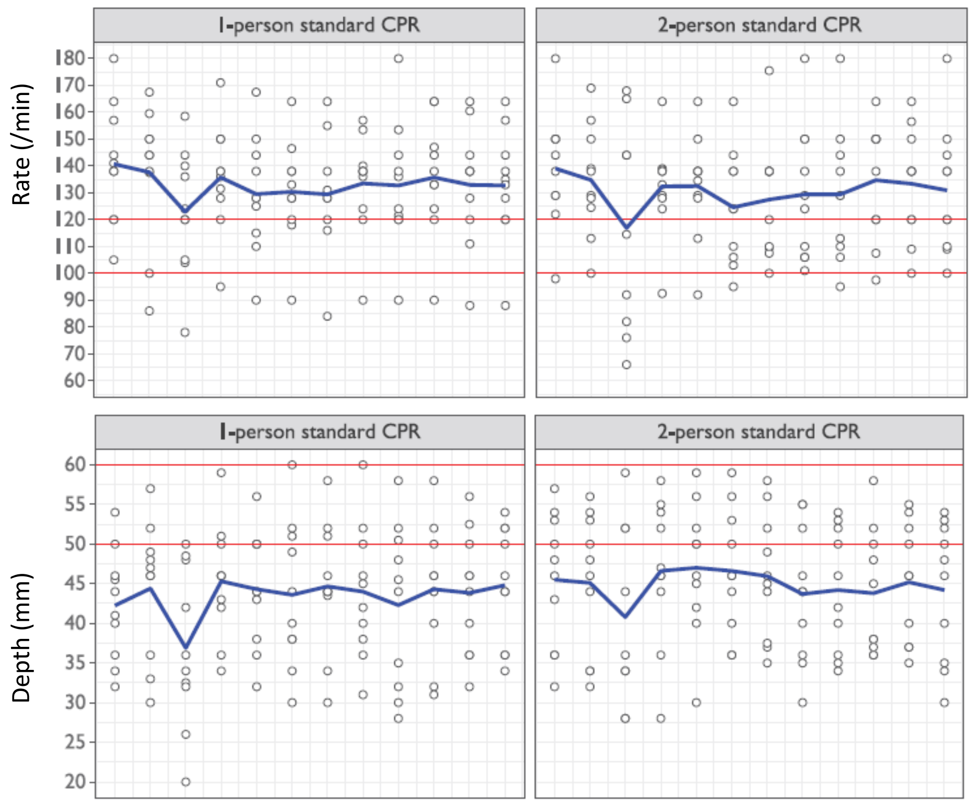
british paramedic journal

Service evaluation

COLLEGE OF paramedics
leading the development of the paramedic profession

Comparison of manual and mechanical cardiopulmonary resuscitation on the move using a manikin: a service evaluation

British Paramedic Journal
2017, vol. 2(3) 6–15



West J Emerg Med 2016;17:634-9
Br Paramedic J 2017;2:6-15

Manual CPR in Transit

…also, it's dangerous

N.C. ambulance crashes while crew performing CPR on patient

Multiple people taken to hospital after crash that left ambulance on its side and significant damage to a truck

Feb 3, 2015

Prehosp Emerg Care 2009;13:388-97
Institue of Medicine 2015

Types of mCPR Devices

PISTON-STYLE

BAND-STYLE

mCPR Trials

- LINC trial (JAMA, 2014)
  - Piston-type CPR device
  - No significant ROSC or survival rate at 4 hours
  - Non-significant trend toward better 6-month CPC with mCPR
- CIRC trial (Resuscitation, 2014)
  - Band-type CPR device
  - No significant difference in ROSC, survival, or discharge
  - Non-significant trend favoring manual CPR
- PARAMEDIC trial (Lancet, 2015)
  - Piston-type CPR device
  - No significant difference in ROSC or 30d/3m/12m survival
  - No significant difference in 12-month CPC scores

JAMA 2014;311:53-61
Resuscitation 2014;85:741-8
Lancet 2015;385:947-55

mCPR SRMAs

Resuscitation, 2015

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
1.4.1 LUCAS				
LINC	0.1107	0.1478	31.5%	1.12 [0.84, 1.49]
PARAMEDIC	-0.3285	0.166	30.0%	0.72 [0.52, 1.00]
Smekal 2011	0	0		Not estimable
Subtotal (95% CI)			**61.6%**	**0.90 [0.59, 1.39]**
Heterogeneity: Tau² = 0.07; Chi² = 3.90, df = 1 (P = 0.05); I² = 74%				
Test for overall effect: Z = 0.47 (P = 0.64)				
1.4.2 Autopulse				
ASPIRE	-0.9471	0.353	16.7%	0.39 [0.19, 0.77]
CIRC	-0.2231	0.2714	21.8%	0.80 [0.47, 1.36]
Subtotal (95% CI)			**38.4%**	**0.58 [0.28, 1.17]**
Heterogeneity: Tau² = 0.16; Chi² = 2.64, df = 1 (P = 0.10); I² = 62%				
Test for overall effect: Z = 1.53 (P = 0.13)				
Total (95% CI)			**100.0%**	**0.76 [0.53, 1.11]**
Heterogeneity: Tau² = 0.09; Chi² = 9.40, df = 3 (P = 0.02); I² = 68%				
Test for overall effect: Z = 1.42 (P = 0.16)				
Test for subgroup differences: Chi² = 1.13, df = 1 (P = 0.29), I² = 11.1%				

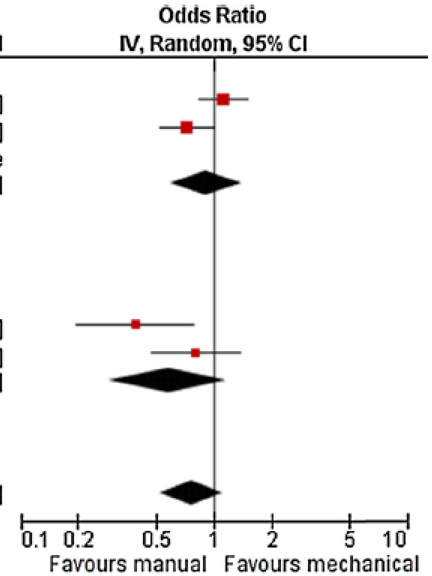
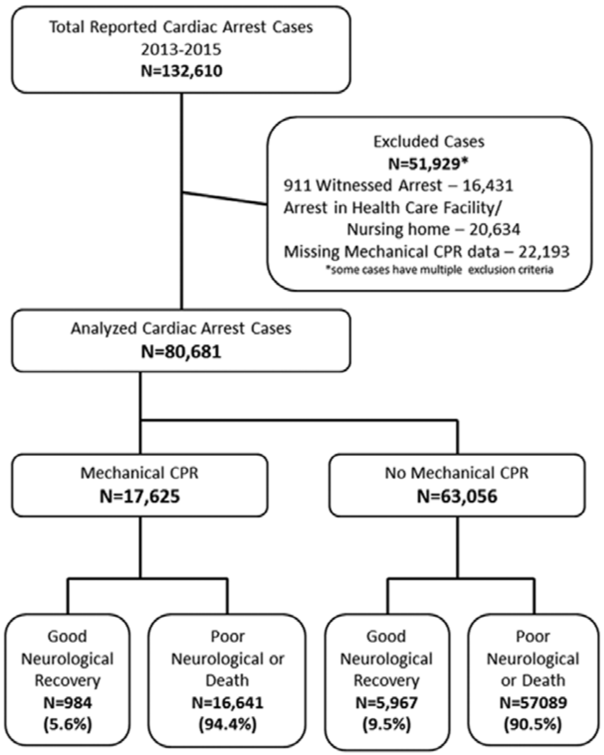
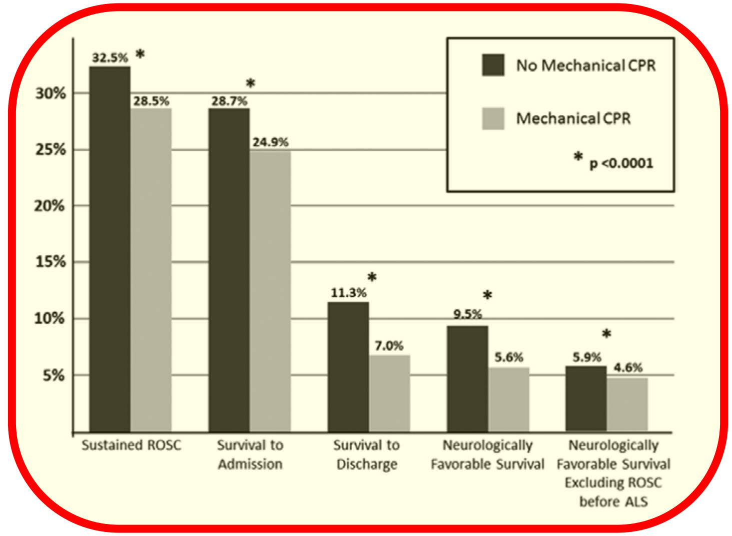


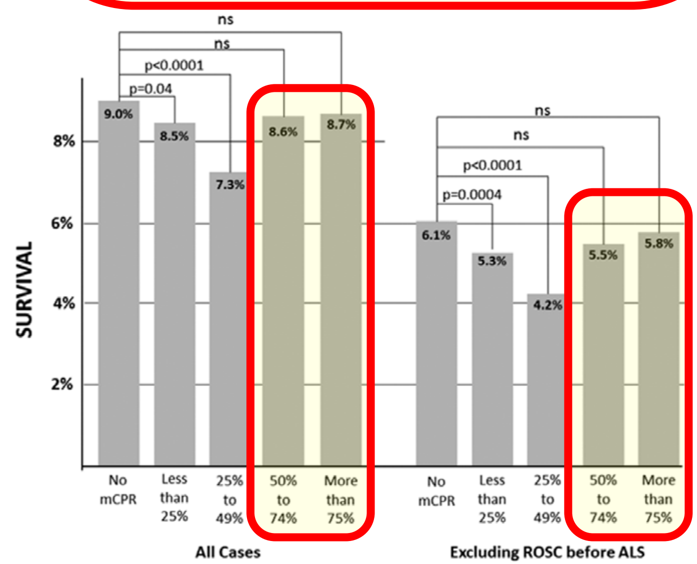
Fig. 5. Survival with CPC 1–2 or mRS 0–3.

mCPR SRMAs

Circulation, 2016







Circulation 2016;134:2131-3

Man v Machine – *Who Wins?*

- Routine use is unclear
- May be useful in specific circumstances

Drugs

IV or IO?

EMERGENCY MEDICAL SERVICES/ORIGINAL RESEARCH

Intraosseous Vascular Access Is Associated With Lower Survival and Neurologic Recovery Among Patients With Out-of-Hospital Cardiac Arrest

CrossMark

Takahisa Kawano, MD, PhD*; Brian Grunau, MD, MHSc; Frank X. Scheuermeyer, MD, MHSc; Koichiro Gibo, MD, MMSc; Christopher B. Fordyce, MD, MHS; Steve Lin, MD, MSc; Robert Stenstrom, MD, PhD; Robert Schlamp, MEd; Sandra Jenneson, MD; Jim Christenson, MD

*Corresponding Author. E-mail: takahisa.kawano@ubc.ca.

- Secondary analysis of PRIMED Trial (NEJM, 2011)
  - 95% got IV, only 5% got IO
  - IV arm more likely to have
    - Initial shockable rhythm (26 vs 14%)
    - Defibrillation (42 vs 25%)
    - Witnessed arrest (51 vs 40%)
    - Public location (16 vs 10%)
  - Unknown IV/IO site, time to place, time to drug, etc.

Am J Emerg Med 2017;35:222-6
Ann Emerg Med 2018;71:588-96

IV or IO?

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

Intravenous vs. intraosseous access and return of spontaneous circulation during out of hospital cardiac arrest☆,☆☆,★

Brian Clemency, DO [a,b,*], Kaori Tanaka, DO [a], Paul May, MA [a], Johanna Innes, MD [a], Sara Zagroba [a], Jacqueline Blaszak [a], David Hostler, PhD [a,c], Derek Cooney, MD [b,d], Kevin McGee, DO [a], Heather Lindstrom, PhD [a]

- Observational study
- IO non-inferior to IV for field ROSC
    - IOs predominantly tibial

Am J Emerg Med 2017;35:222-6
Ann Emerg Med 2018;71:588-96

ALPS Study

Table 3. Outcomes According to Trial Group in the Per-Protocol Population.*

Outcome	Amiodarone (N=974)	Lidocaine (N=993)	Placebo (N=1059)	Amiodarone vs. Placebo		Lidocaine vs. Placebo		Amiodarone vs. Lidocaine	
				Difference (95% CI)	P Value	Difference (95% CI)	P Value	Difference (95% CI)	P Value
				percentage points		*percentage points*		*percentage points*	
Primary outcome: survival to discharge — no./total no. (%)†	237/970 (24.4)	233/985 (23.7)	222/1056 (21.0)	3.2 (−0.4 to 7.0)	0.08	2.6 (−1.0 to 6.3)	0.16	0.7 (−3.2 to 4.7)	0.70
Secondary outcome: modified Rankin score ≤3 — no./total no. (%)‡	182/967 (18.8)	172/984 (17.5)	175/1055 (16.6)	2.2 (−1.1 to 5.6)	0.19	0.9 (−2.4 to 4.2)	0.59	1.3 (−2.1 to 4.8)	0.44
Mechanistic (exploratory) outcomes									
Return of spontaneous circulation at ED arrival — no./total no. (%)	350/974 (35.9)	396/992 (39.9)	366/1059 (34.6)	1.4 (−2.8 to 5.5)	0.52	5.4 (1.2 to 9.5)	0.01	−4.0 (−8.3 to 0.3)	0.07
Admitted to hospital — no. (%)	445 (45.7)	467 (47.0)	420 (39.7)	6.0 (1.7 to 10.3)	0.01	7.4 (3.1 to 11.6)	<0.001	−1.3 (−5.7 to 3.1)	0.55
Modified Rankin score in all patients‡	5.0±1.9	5.1±1.8	5.2±1.8	−0.14 (−0.30 to 0.02)	0.09	−0.06 (−0.22 to 0.10)	0.45	−0.08 (−0.24 to 0.08)	0.34
Modified Rankin score in survivors‡	2.0±2.7	2.2±2.7	2.0±2.6						

Table 4. Adverse Events in the Per-Protocol Population.*

Event	Amiodarone (N=974)	Lidocaine (N=993)	Placebo (N=1059)	Overall P Value
	number (percent)			
Thrombophlebitis within 24 hr	1 (0.1)	3 (0.3)	2 (0.2)	0.61
Anaphylaxis within 24 hr	0	0	0	NA
Clinical seizure activity within 24 hr	31 (3.2)	51 (5.1)	39 (3.7)	0.07
Temporary cardiac pacing within 24 hr†	48 (4.9)	32 (3.2)	29 (2.7)	0.02
Complications of intravenous or intraosseous access within 24 hr	2 (0.2)	0	2 (0.2)	0.37
Any nonfatal serious adverse event within 24 hr‡§	11 (1.1)	12 (1.2)	4 (0.4)	0.09
Any nonfatal adverse event within 24 hr§	81 (8.3)	84 (8.5)	69 (6.5)	0.18
Death before hospital discharge	733 (75.3)	752 (75.7)	834 (78.8)	0.16
Any adverse event within 24 hr or death before hospital discharge	763 (78.3)	775 (78.0)	851 (80.4)	0.20

N Engl J Med 2016;374:1711-22

ALPS Study

	Amiodarone	Lidocaine	Placebo	P-value
Emergency Department/Hospital Procedures (among patients transported to hospital)				
Antiarrhythmic therapy within 24 hours, n (%) [N=801;815;874]	418 (52%)	472 (58%)	492 (56%)	0.05
Amiodarone within 24 hours, n (%) [N=801;814;874]	283 (35%)	372 (46%)	385 (44%)	<0.001
Lidocaine within 24 hours, n (%) [N=801;814;873]	50 (6%)	56 (7%)	66 (8%)	0.57
Any CPR, n (%) [N=803;817;876]	525 (65%)	519 (64%)	610 (70%)	0.03

Table S2. Survival to Discharge in A Priori Subgroups in the Per-Protocol Population

	Amiodarone	Lidocaine	Placebo	Amiodarone vs Placebo Difference (95% CI) P	Lidocaine vs Placebo Difference (95% CI) P	Amiodarone vs Lidocaine Difference (95% CI) P
Witnessed status						
EMS witnessed, n (%) [N=57;43;54]	22 (38.6%)	10 (23.3%)	9 (16.7%)	21.9% (5.8%, 38.0%) P=0.01	6.6% (-9.5%, 22.7%) P=0.42	15.3% (-2.6%, 33.2%) P=0.09
Bystander witnessed, n (%) [N=618;632;684]	171 (27.7%)	176 (27.8%)	155 (22.7%)	5.0% (0.3%, 9.7%) P=0.04	5.2% (0.5%, 9.9%) P=0.03	-0.1% (-5.1%, 4.9%) P=0.97
Unwitnessed, n (%) [N=271;282;286]	41 (15.1%)	45 (16.0%)	48 (16.8%)	-1.7% (-7.8%, 4.4%) P=0.58	-0.8 (-6.9%, 5.3%) P=0.80	-0.9% (-6.9%, 5.1%) P=0.77
Bystander CPR						
Yes, n (%) [553;546;593]	161 (29.1%)	144 (26.4%)	149 (25.1%)	4.0% (-1.2%, 9.1%)	1.2% (-3.8%, 6.3%)	2.7% (-2.6%, 8.0%)

N Engl J Med 2016;374:1711-22

PARAMEDIC2 Study

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 AUGUST 23, 2018 VOL. 379 NO. 8

A Randomized Trial of Epinephrine in Out-of-Hospital Cardiac Arrest

G.D. Perkins, C. Ji, C.D. Deakin, T. Quinn, J.P. Nolan, C. Scomparin, S. Regan, J. Long, A. Slowther, H. Pocock, J.J.M. Black, F. Moore, R.T. Fothergill, N. Rees, L. O'Shea, M. Docherty, I. Gunson, K. Han, K. Charlton, J. Finn, S. Petrou, N. Stallard, S. Gates, and R. Lall, for the PARAMEDIC2 Collaborators*

- Randomized, double-blind, placebo-controlled trial
- Similarities between groups:
  - IV vs IO (~70/30)
  - SGA vs ET (~70/30)
  - Response time (~6½ min)
  - Time to drug (~22 min)
- Epinephrine group
  - More ROSC (36 vs 12%)
  - More transports to ER (51 vs 31%)

N Engl J Med 2018;379:711-21

PARAMEDIC2 Study

Table 3. Primary and Secondary Outcomes.*

Outcome	Epinephrine	Placebo	Odds Ratio (95% CI)†	
			Unadjusted	Adjusted
Primary outcome				
Survival at 30 days — no./total no. (%)‡	130/4012 (3.2)	94/3995 (2.4)	1.39 (1.06–1.82)	1.47 (1.09–1.97)
Secondary outcomes				
Survival until hospital admission — no./total no. (%)§	947/3973 (23.8)	319/3982 (8.0)	3.59 (3.14–4.12)	3.83 (3.30–4.43)
Median length of stay in ICU (IQR) — days				
Patients who survived	7.5 (3.0–15.0)	7.0 (3.5–12.5)	NA	NA
Patients who died¶	2.0 (1.0–5.0)	3.0 (1.0–5.0)	NA	NA
Median length of hospital stay (IQR)				
Patients who survived	21.0 (10.0–41.0)	20.0 (9.0–38.0)	NA	NA
Patients who died‖	0	0	NA	NA
Survival until hospital discharge — no./total no. (%)	128/4009 (3.2)	91/3995 (2.3)	1.41 (1.08–1.86)	1.48 (1.10–2.00)
Favorable neurologic outcome at hospital discharge — no./total no. (%)	87/4007 (2.2)	74/3994 (1.9)	1.18 (0.86–1.61)	1.19 (0.85–1.68)
Survival at 3 mo — no./total no. (%)	121/4009 (3.0)	86/3991 (2.2)	1.41 (1.07–1.87)	1.47 (1.08–2.00)
Favorable neurologic outcome at 3 mo — no./total no. (%)	82/3986 (2.1)	63/3979 (1.6)	1.31 (0.94–1.82)	1.39 (0.97–2.01)

N Engl J Med 2018;379:711-21

Titration-dose epi?

Hemodynamic-Directed Cardiopulmonary Resuscitation Improves Neurologic Outcomes and Mitochondrial Function in the Heart and Brain

Andrew J. Lautz, MD[1,2]; Ryan W. Morgan, MD, MTR[1]; Michael Karlsson, MD[1];
Constantine D. Mavroudis, MD, MS[3]; Tiffany S. Ko, MS[4]; Daniel J. Licht, MD[5];
Vinay M. Nadkarni, MD, MS[1]; Robert A. Berg, MD[1]; Robert M. Sutton, MD, MSCE[1]; Todd J. Kilbaugh, MD[1]

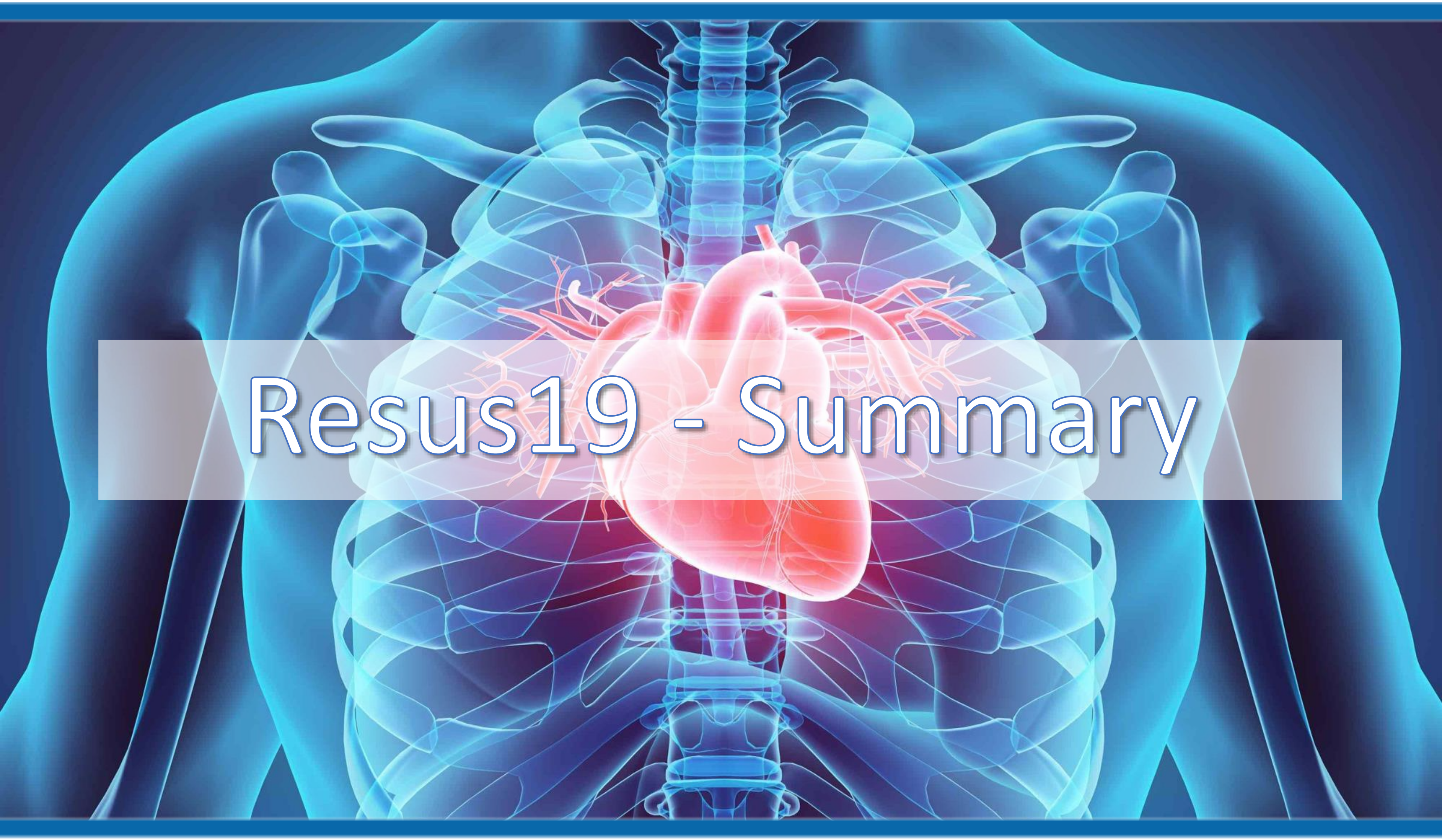
- Vasopressor titration to maintain CPP >20, SBP >90
  - Better neuro outcome than CPR + q4 epi
- Similar to prior swine models

Crit Care Med 2013;41:2698-704
Resuscitation 2013;84:696-701
Crit Care Med 2106;44:e1111-7
Crit Care Med 2019; epub ahead of print

Meds Proven to Improve Mortality:

Drugs: Summary

- IV vs IO – still no good evidence
- Amio or Lido probably better than nothing?
- Epi – worse morbidity without mortality benefit
  - (Maybe we're doing it wrong?)


Resus19 - Summary

Resuscitation Plan 2019

- **<u>Focus on what works</u>**:
  - Bystander & EMS CPR
    - Supplement with mechanical when necessary
  - Early defibrillation, minimize peri-shock pause
- Place SGA during CPR
  - ?ET if you're *really* good at it
- Probably humeral IO
  - ?IV if you're good at it
- Really rethink giving drugs
  - Still reasonable in the field for now
- Transport? – *that's a whole other topic!*

Jacob A. Miller, ACNP, FNP, CNS, EMT-P

JacobMillerACNP.wordpress.com