MAKING CARDIAC ARREST PERSONAL

Dr Nick Taylor

Snr Staff Specialist and co-DEMT Emergency Medicine

Associate Dean, Phase 2, ANU Medical School

TIME LINE

- 1891 Chest compressions tried on a human
- 1955 defibrillation ‘invented’
- 1956 EAR ‘invented’
- 1960 CPR started in USA by AHA
- 1964 Adrenaline routinely given after Pearson’s dog studies
- 1970s Defibs more commonplace
- 1989 AEDs invented
- 1970s-2018 Drugs come and drugs go…and stay with the 1970s status quo
- 2010 CCR sort of gets a guernsey and AHA sort of unendorses EAR

We having been essentially doing non evidenced based one sized fits all resuscitation for 60 years

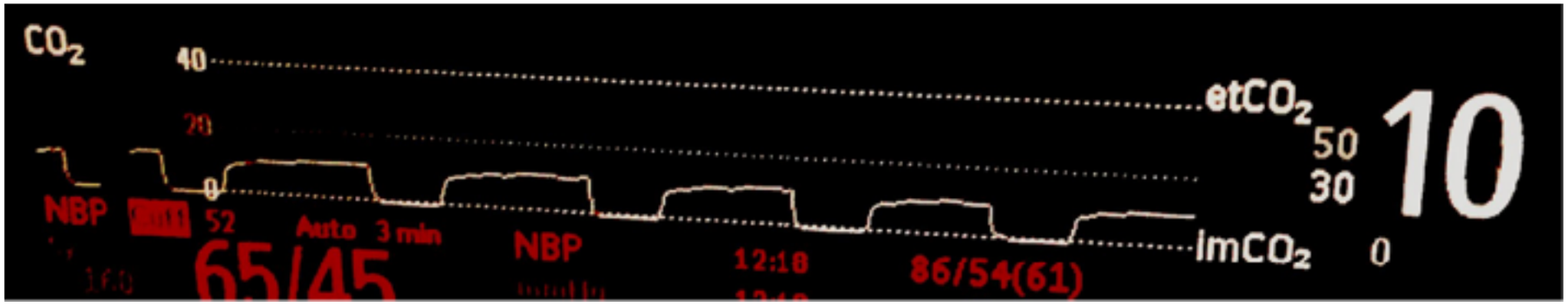
GOOD TEAMS

- Knowledge of Roles in the Team
- Closed Loop Communication (COACHED)
- Use each others names
- Frequent Changes of CPRers
- Be a good ‘Team Leader’ or good ‘Team Member’
- Have a Knowledge of ‘Human Factors’ and ‘ Crisis Resource Management (CRM)’
- Active debrief

COGNITIVE OFFLOADS: MECHANICAL CPR

- Probably equivalent to good manual CPR at a cost of possibly more injuries
  - Meta- analyses suffer from device differences, placement issues, patient comparability and vary in their conclusions
- Consistent, non-fatigueable
- Transportable

COGNITIVE OFFLOADS: END TIDAL CO2



- Helps predict ROSC (if over 25mmHg)
- Helps prognosticate (if <10mmHg)

J Intensive Care Med. 2015 Oct;30(7):425-35. doi: 10.1177/0885066614530830. Epub 2014 Apr 22.

Systematic Review and Meta-Analysis of End-Tidal Carbon Dioxide Values Associated With Return of Spontaneous Circulation During Cardiopulmonary Resuscitation.

Hartmann SM[1], Farris RW[2], Di Gennaro JL[3], Roberts JS[4].

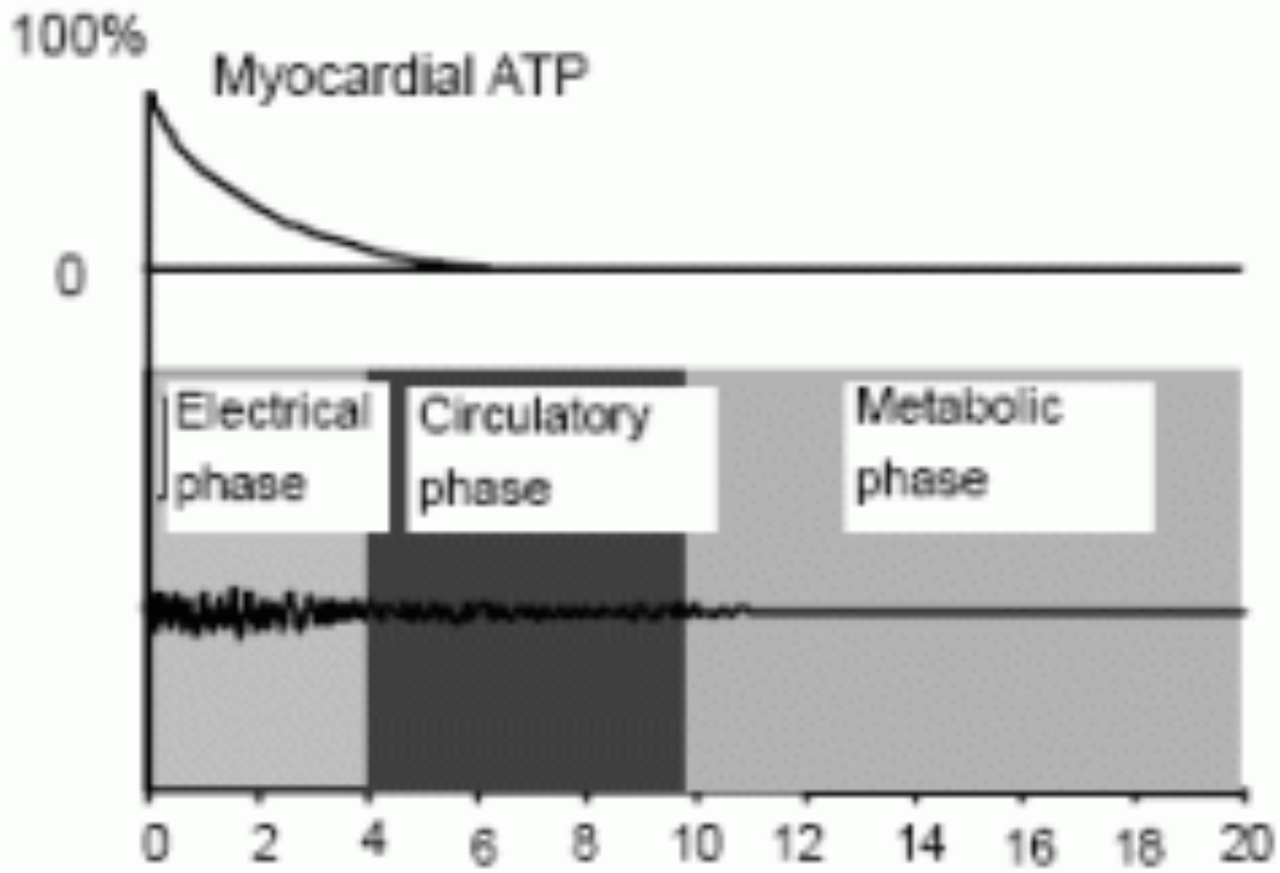
⊕ Author information

COGNITIVE OFFLOADS: POCUS

- Reversible cause? (Hs, Ts)
- PEA or low output? (unreliable pulses)
- Prognosticate (REASON trial)

- Long B et al Echocardiography in cardiac arrest: An emergency medicine review. Am J Emerg Med 2018 Mar; 36(3) 488-493

Figure 1. Three-Phase Model of VF Cardiac Arrest



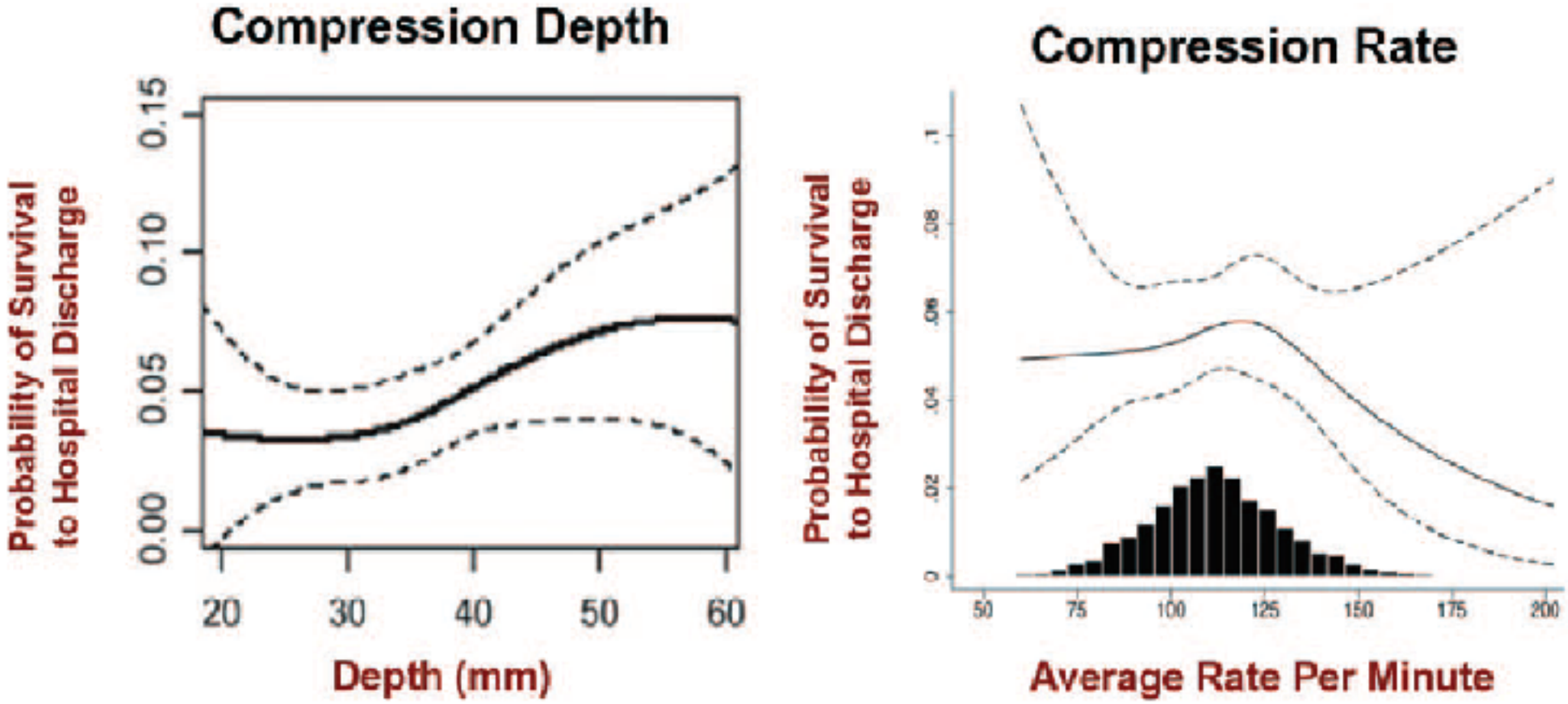
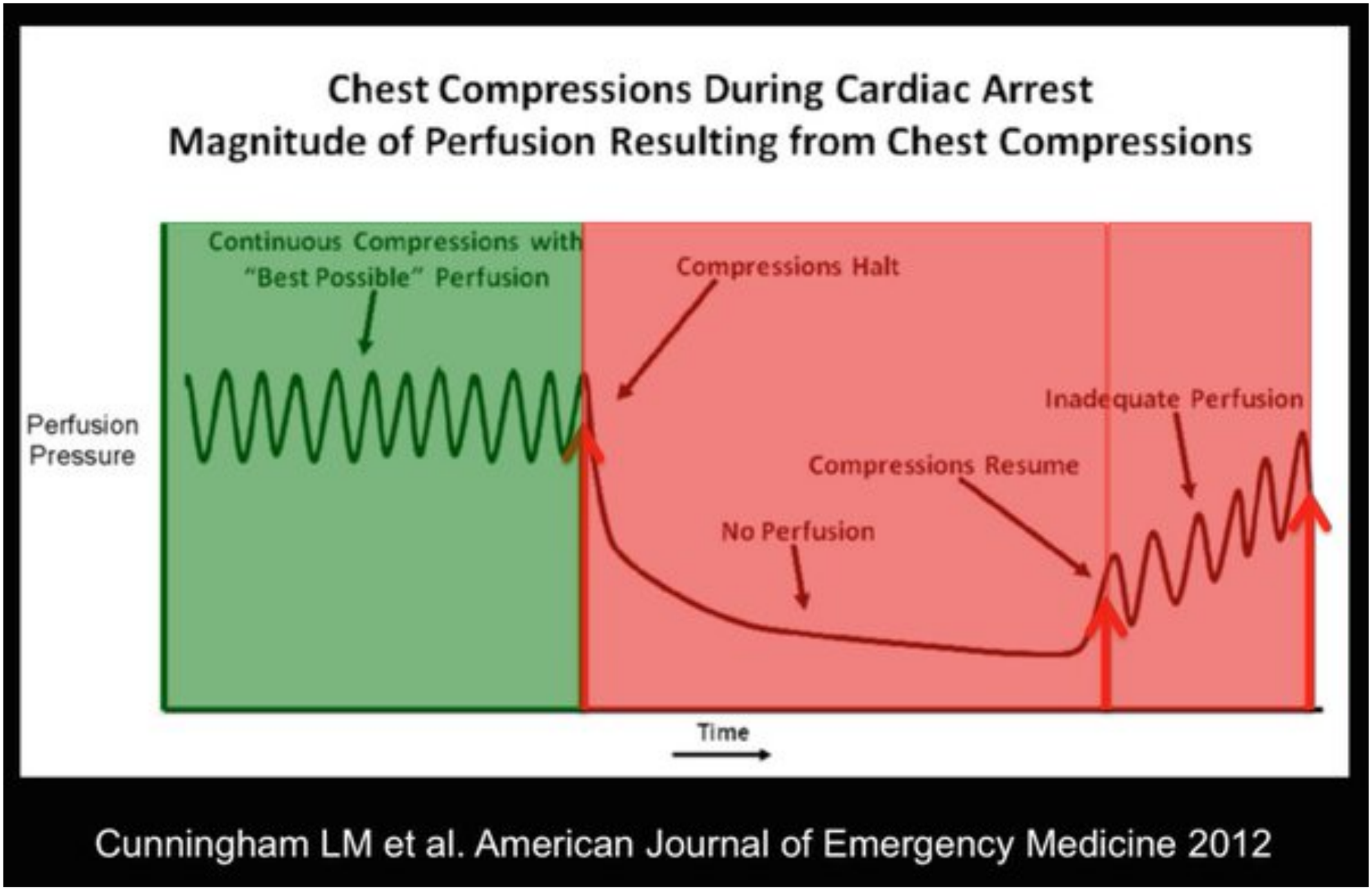
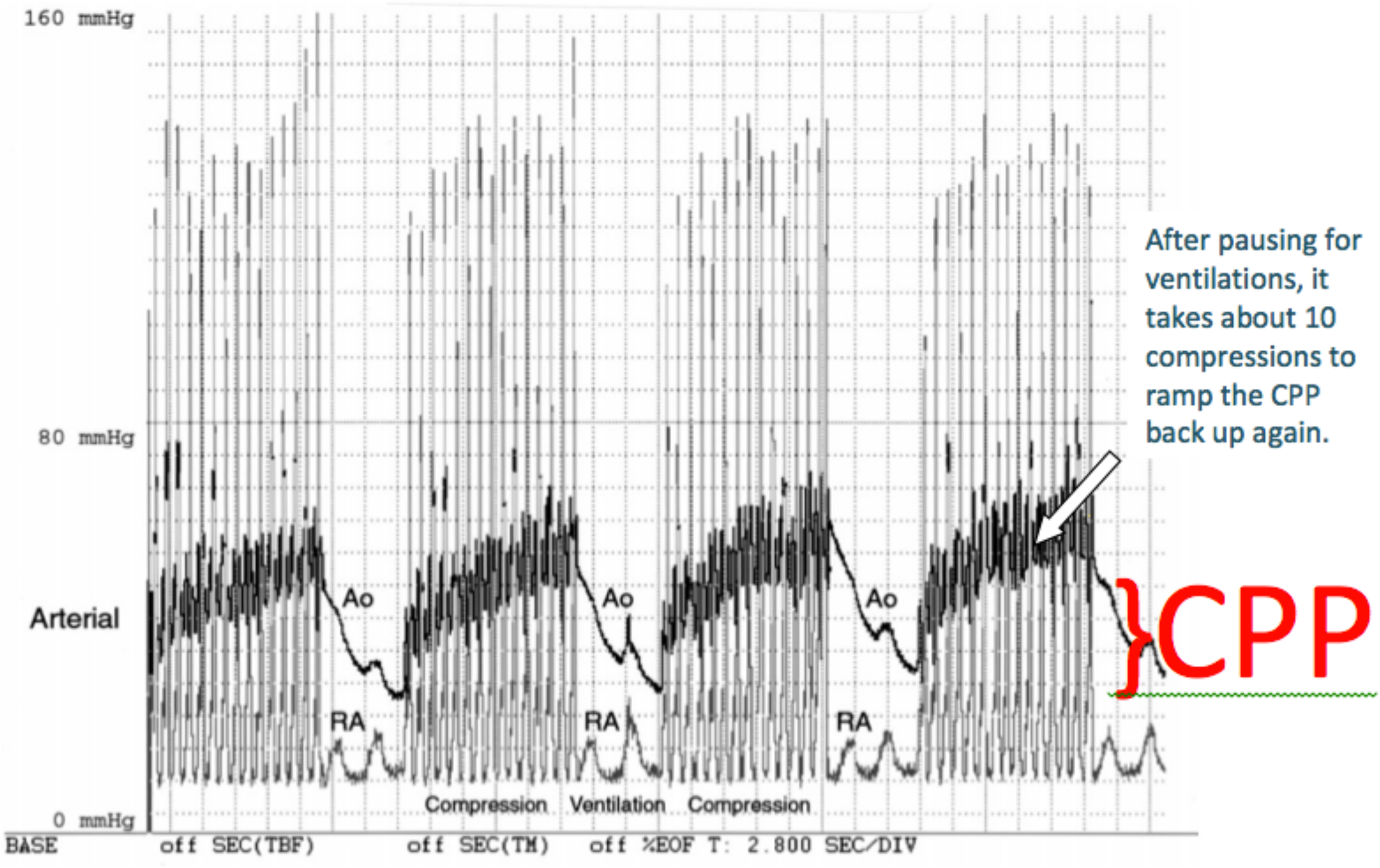


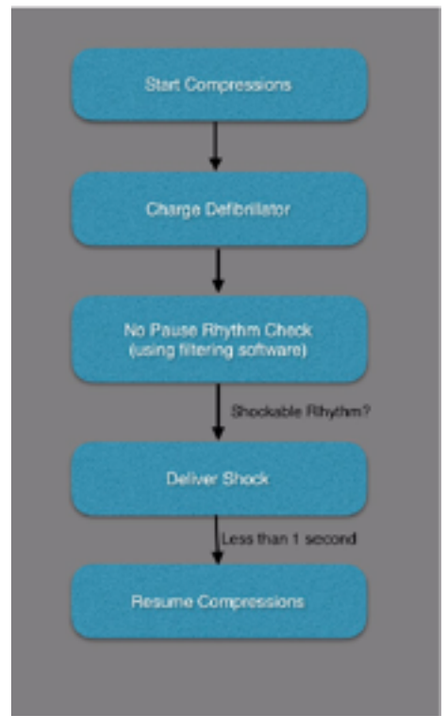
Figure 2. Relationship between chest compression depth and rate and the probability of survival to hospital discharge in the National Institutes of Health Resuscitation Outcomes Consortium PRIMED study.[7,8]


Chest Compressions During Cardiac Arrest
Magnitude of Perfusion Resulting from Chest Compressions
Continuous Compressions with "Best Possible" Perfusion
Compressions Halt
Inadequate Perfusion
Compressions Resume
No Perfusion
Perfusion Pressure
Time
Cunningham LM et al. American Journal of Emergency Medicine 2012


160 mmHg
80 mmHg
Arterial
0 mmHg
Ao
Ao
Ao
RA
RA
RA
Compression
Ventilation
Compression
BASE
off SEC(TBF)
off SEC(TM)
off %EOF T: 2.800 SEC/DIV
After pausing for ventilations, it takes about 10 compressions to ramp the CPP back up again.
}CPP

NEW MONITORS

- Filtering software to do a no pause rhythm check
- Accelerometers to guide CPR depth and rate
- Integrated ETCO2



PCI? REFRACTORY ARREST

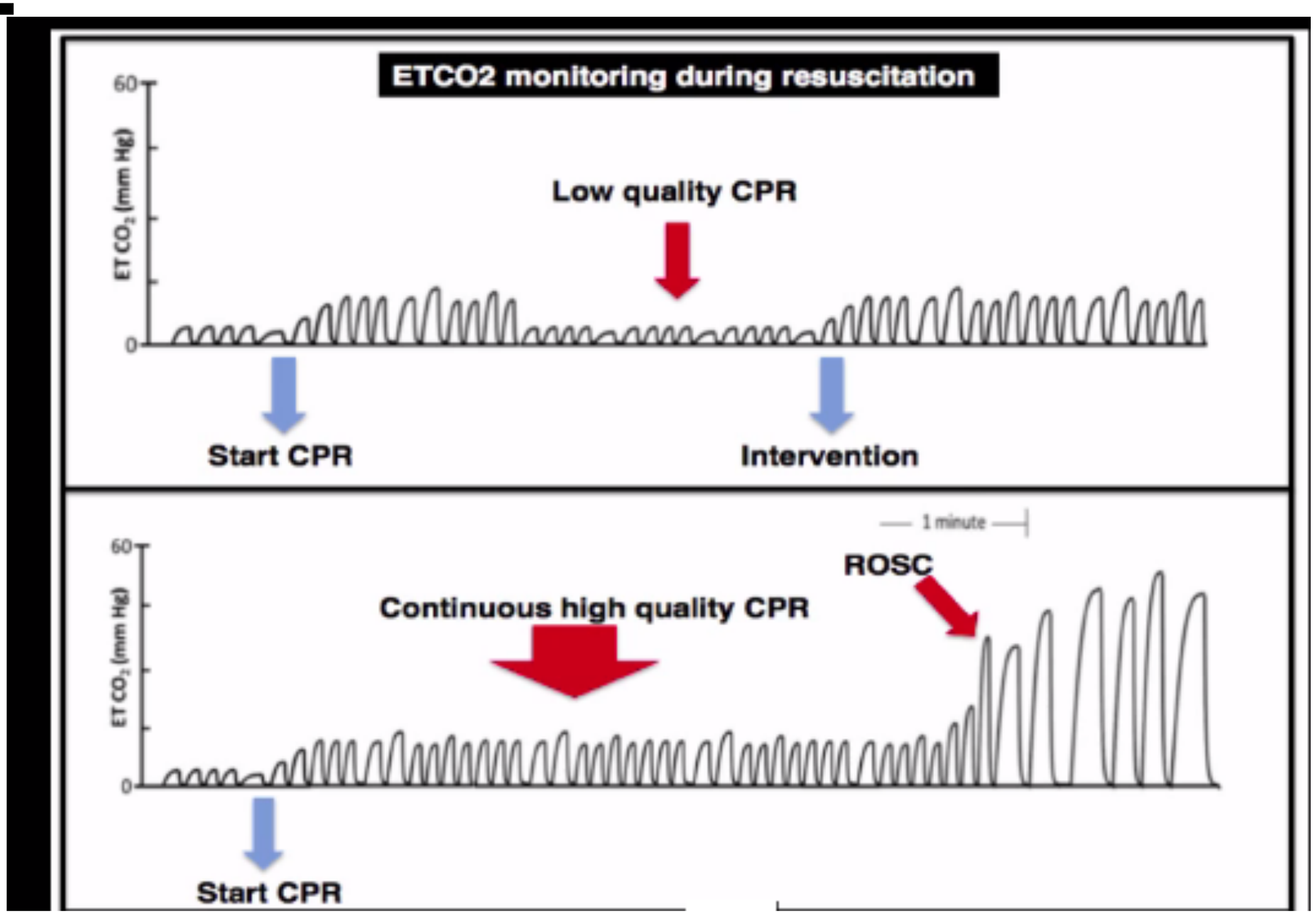
- Early transport to a cath lab for refractory VF/VT
- 84% signif CAD
- 65% acute thrombotic lesions
- 84% got a stent
- 42% DC with good cerebral performance scores vs 15% in historical comparison group (OR 4.0, p<0.0001)

- Yannopoluous D et al Coronary Disease in Patients with Out f Hospital Refracvtory VF Cardiac Arrest. J Am Coll Cardiol 2017 Aug29;70(9)1109-1117

PCI? NSTE

- NSTE: 25% have occluded coronary artery as cause for arrest
- Successful PCI is an ECG independent survival marker
- ESC and AHA 2017: Consider PCI in all if myocardial ischaemia thought likely (II-A)
- European Association for Percutaneous CV Intervention: CA within 2hrs for NSTE.

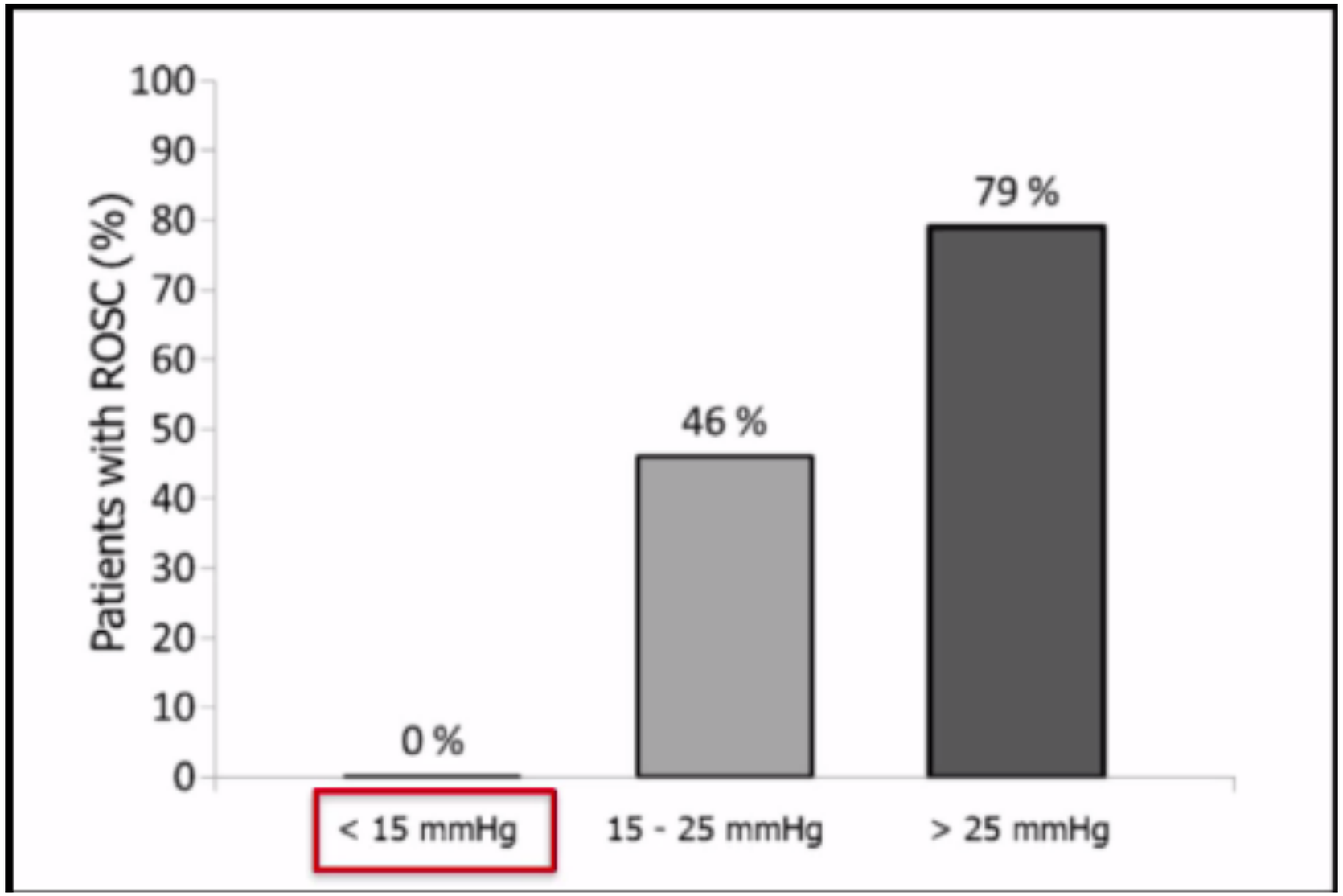
ETCO2


ETCO2 monitoring during resuscitation
60
ET CO2 (mm Hg)
0
Low quality CPR
Start CPR
Intervention
1 minute
60
ET CO2 (mm Hg)
0
ROSC
Continuous high quality CPR
Start CPR

CORONARY PERFUSION PRESSURE

- CPP= DBP-CVP
- This the theoretical reason why CPR leads to ROSC and why Adrenaline may be useful

CPP AS PREDICTOR OF ROSC



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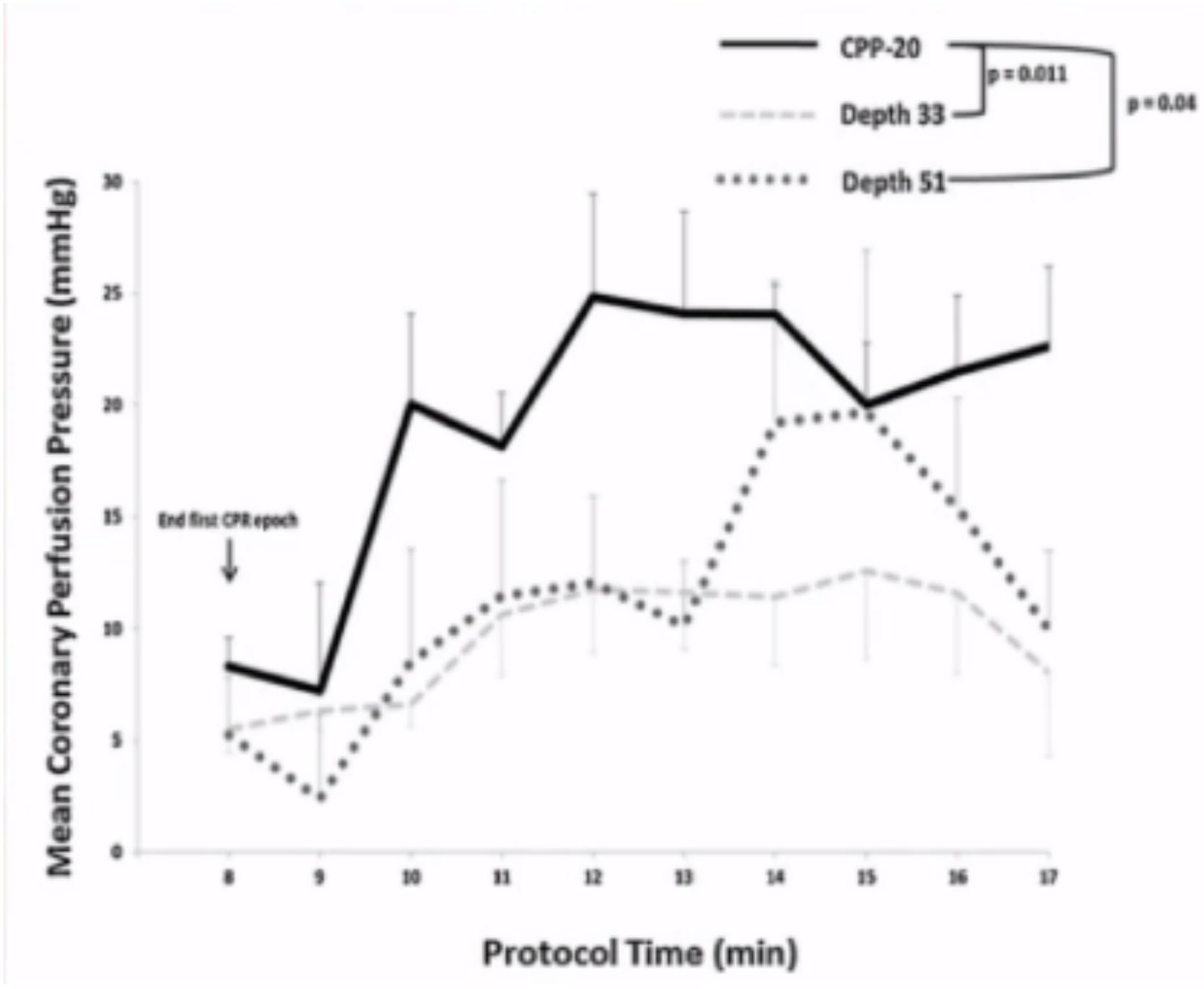
HAEMODYNAMIC DIRECTED CPR IMPROVES SURVIVAL

- CPR depth 33mm + ADR q4min (realistic) vs
- CPR depth 51mm + ADR q4min (optimal) vs
- CC depth to aim SBP 100 and ADR to get CPP>20

- Sutton R et al. Hemodynamic directed CPR improves short term survival from asphyxia associated cardiac arrest. Resuscitation 2013 May: 84-(5) 696-701


CPP-20
Depth 33
Depth 51
p = 0.011
p = 0.04
Mean Coronary Perfusion Pressure (mmHg)
0
5
10
15
20
25
30
End first CPR epoch
8
9
10
11
12
13
14
15
16
17
Protocol Time (min)

AHA CONSENSUS 2013

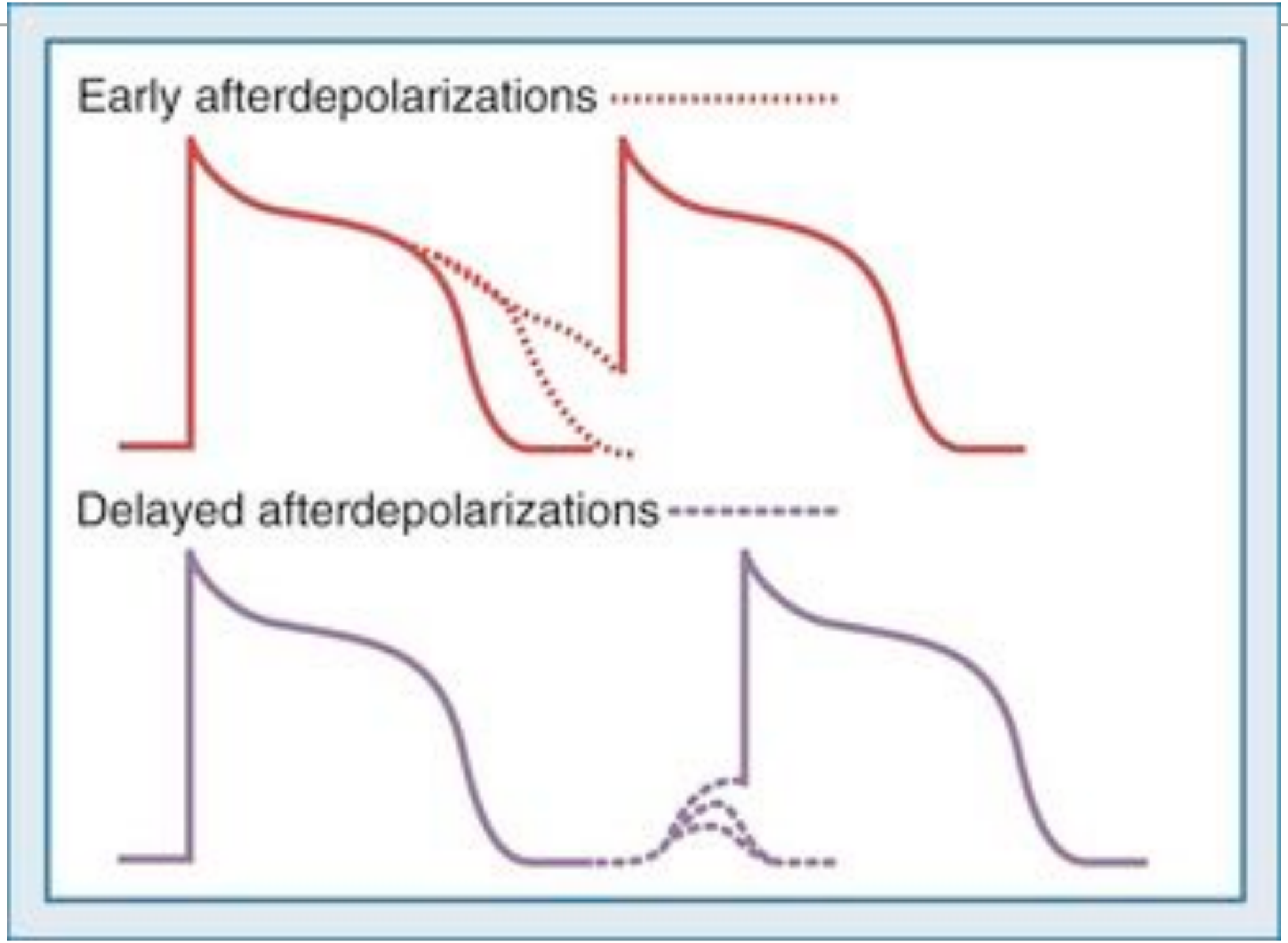
- If A line and CVP Aim CPP>20
- If A line only , aim DBP >25

MAKING COMPRESSIONS BETTER?

- https://emberproject.org/2016/11/06/high-quality-chest-compressions/

EADS AND DADS

- EADs (Early After Depolarisations): secondary depol occurring before full repolarisation. Happen when AP prolonged (eg long QT syndrome)
- DADs (Delayed) when elevated Ca2+ load increases Protein Kinase II activity eg tachycardia or Beta Adrenergic stim. If big enough, INa is activated and a new AP occurs (eg VT, VF)
  - Tsuji Y et al. Electrical storm: recent pathophysiological insights and therapeutic consequences. Basic Res Cardiol (2013) 108:336


Early afterdepolarizations
Delayed afterdepolarizations

SYMPATHETIC STIMULATION

- For most VF/VT, the final pathway of Beta stimulation to cAMP to Ca2+ is the initiator/ perpetuator

SHOULD WE KEEP ADRENALINE?

- Survival not improved or worsened
  - Sanhavi et al, PMID: 26236978, Nakahara et al PMID:24326886, Hagihara et al PMID:22436956, J, Stiel et al PMID: 15306666, Holmberg et al PMID: 12104107
- May improve survival in non shockable rhythms
  - Prehosp Emerg Care. 2017 Feb 7:1-10. doi: 10.1080/10903127.2016.1274347 and Rev Lat Am Enfermagem. 2016 Dec 8;24:e2821. doi: 10.1590/1518-8345.1317.2821.

PARAMEDIC – 2

- 8014 well matched patients with OHCA
- 4015 IV Adrenaline; 3999 IV saline placebo
- Adrenaline increased survival (3.2% to 2.4% NNT: 112, FI: 6)
- Only about 20% had shockable rhythms and those with early ROSC removed
- Median time of administration was 21 minutes
- For 1000 OHCA : ADR = 246 extra ROSC, 158 extra admissions to hospital, and 8 extra survivors at 30 days. Of those 8 extra survivors, 3 good neurologic outcome and 5 bad outcome (https://first10em.com/paramedic2/)

- Perkins G.D. et al. A Randomized Trial of Epinephrine in Out-of-Hospital Cardiac Arrest NEJM 2018 DOI: 10.1056/NEJMoa1806842

TIMING MATTERS

- Early may be better Koscik et al Crit Care. 2013. Sep 3;17(5):R188 PMID:23523823
- Very early may be worse in VF/VT Andersen et al BMJ. 2016; 353: i1577. Published online 2016 Apr 6. doi: 10.1136/bmj.i1577PMCID: PMC4823528
- Late may be worse overall Am J Emerg Med. 2017 May 1. pii: S0735-6757(17)30316-9. doi: 10.1016/j.ajem.2017.04.052.

SHOULD ADRENALINE BE GONE?

- Makes sense to stay for PEA
- Makes sense early to improve CPP
- Makes no sense in resistant arrhythmias

DOES SYMPATHETIC BLOCKADE STOP VF/VT?

- Yes
- Electrical Storm literature supports sympathetic ablation (by drugs, sedation, stellate ganglion blockade, sympathectomy)
  - Maruyama, M. Management of electrical storm: The mechanism matters. J of Arrhyth, 30 (2014) 242-249.

ARRYTHMIAS THAT ESMOLOL SHOULD WORK FOR

- Monomorphic VT (normal or abnormal hearts)
- Polymorphic VT/VF in structural HD
- Congenital long QTc
- CPVT

ARRYTHMIAS THAT ESMOLOL MIGHT WORSEN

- Brugada
- Acquired LQTS

SOME PRELIMINARY CLINICAL SUPPORT

- Esmolol used (at 500mcg/kg and then 0-100mcg/kg/min)
  - 25 Refractory VF/VT patients (Low numbers)
  - 67% sustained ROSC (esmolol) vs 32% (Standard care)
  - 50% survived with good outcome vs 11% (Standard care)
    - Driver et al 2014 doi: 10.1016/j.resuscitation.2014.06.032
  - 41 Refractory VF/VT patients
  - Sustained ROSC 56% vs. 16%, p=0.007).
  - Survival and good neurological outcomes at 30 days, 3 months and at 6 months were >2-fold better in the esmolol group
    - Lee et al 2016 doi: 10.1016/j.resuscitation.2016.07.243

ITS HERE!

- AHA 2017
- Level IIb: IV B blocker for
- VT due to ischaemia
- Recent AMI with recurrent VF/VT

HEAD UP CPR?

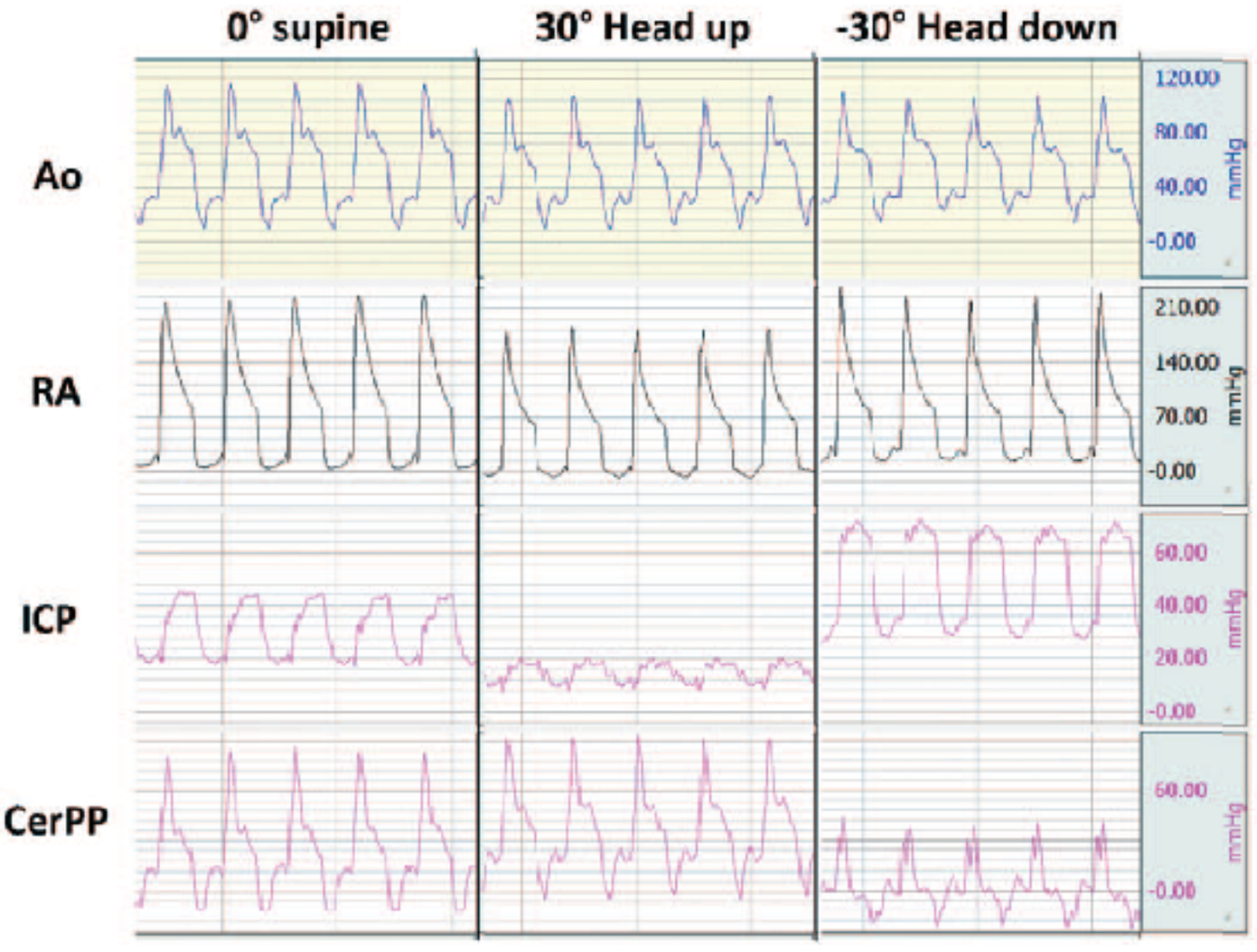
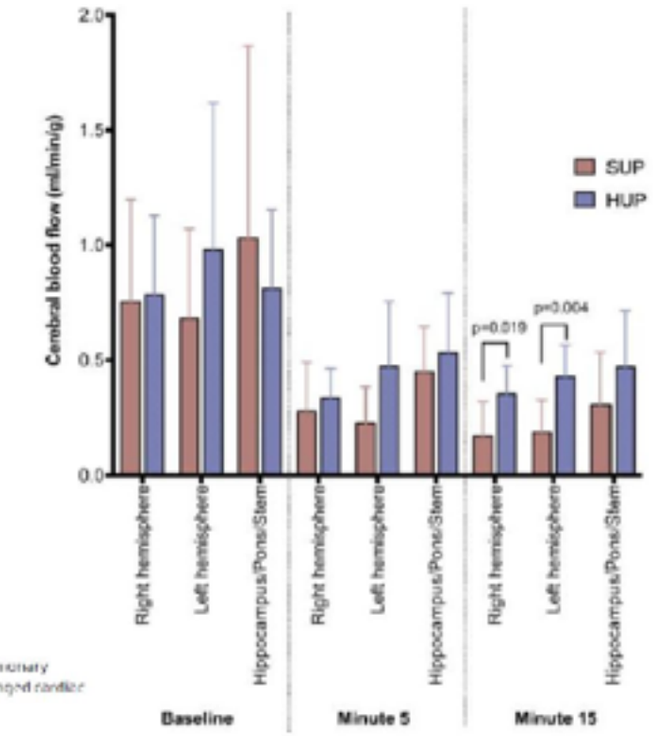


Figure 1. Representative pressure curve during 0° supine cardiopulmonary resuscitation (CPR), 30° head-up CPR, and −30° head-down CPR showing aortic pressure (Ao), right atrial pressure (RA), intracranial pressure (ICP), and cerebral perfusion pressure (CerPP). Pressure curves from a representative animal study in the experiments described by Debaty et al.[14]

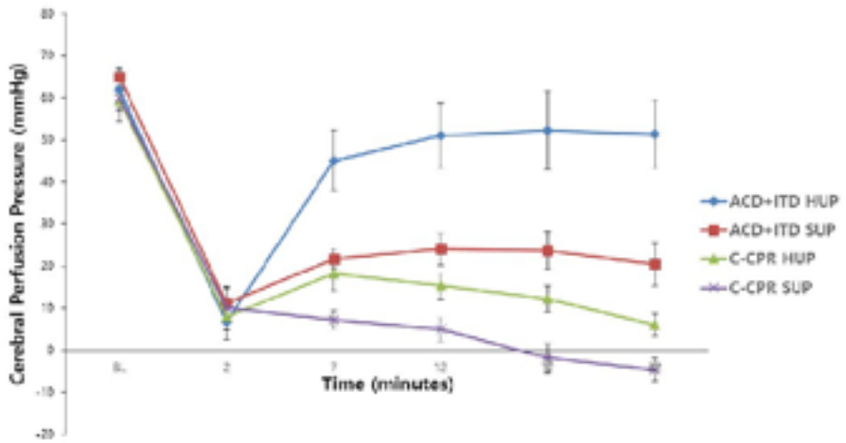
- Debaty, G et al . Tilting for perfusion:Head-up position during CPR improves brain flow in a porcine model of cardiac arrest. Resuscitation, 2015;87:38-43

HEAD UP NEEDS ACD AND ITD

Brain blood flow at 15 min:
ACD+ITD Flat at 0.21 ± 0.04 mg/mL/g tissue
ACD+ITD Head Up 0.42 ± 0.05 mg/mL/g tissue (p = 0.01)



Moore JC, Segal N et al. Head and thorax elevation during active compression decompression cardiopulmonary resuscitation with an impedance threshold device improves cerebral perfusion in a swine model of prolonged cardiac arrest. Resuscitation 2017; 111:195-200.



Cerebral Perfusion Pressure = Mean Arterial Pressure- Intracranial Pressure
ACD: Active Compression Decompression
ITD: Impedance Threshold Device

Ryu HH, Moore JC, Yannopoulos D, Lick M, McKnite S, Shin SD, Kim TY, Metzger A, Rees J, Tsangaris A, Debaty G, Lurie KG. The effect of head up cardiopulmonary resuscitation on cerebral and systemic hemodynamics. Resuscitation. 2016;100:29-34

E-CPR

- ECMO trials very promising but still have ethical outcome considerations
- Highly selected patients do better (CHEER, 2CHEER)

- Ortega-Deballon I, Hornby L, Shemie SD, Bhanji F, Guadagno E.Extracorporeal resuscitation for refractory out-of-hospital cardiac arrest in adults: a systematic review of international practices andoutcomes. Resuscitation 2016; 101: 12–20

DUAL SHOCK: MORE ROSC SAME DEAD

- Ross EM1, Redman TT2, Harper SA2, Mapp JG2, Wampler DA3, Miramontes DA3. Dual defibrillation in out-of-hospital cardiac arrest: A retrospective cohort analysis. Resuscitation. 2016 Sep;106:14-7.

- Cortez E1, Krebs W2, Davis J3, Keseg DP4, Panchal AR5.Use of double sequential external defibrillation for refractory ventricular fibrillation during out-of-hospital cardiac arrest. Resuscitation 2016 Nov;108:82-86..

BIOCHEMICAL

- Post conditioning eg Cyclosporin A, inert gases: no benefit yet
- Synthetic surfactants (restore BBB and reduce injury cascades)
- Hyperoxia an independent predictor of poor outcome

SUMMARY

- Team Training Matters
- Consider a mechanical CPR device
- Optimise LV compression with echo and EtCO2
- Aim for DBP>25
- Adrenaline for first 3 cycles to help get DBP >25
- Continue Adrenaline if PEA/Asystole
- Give esmolol 500mcg/kg after 3rd cycle of VF/VT unless Brugada known/suspected or suspected acquired LQTS (TdeP)