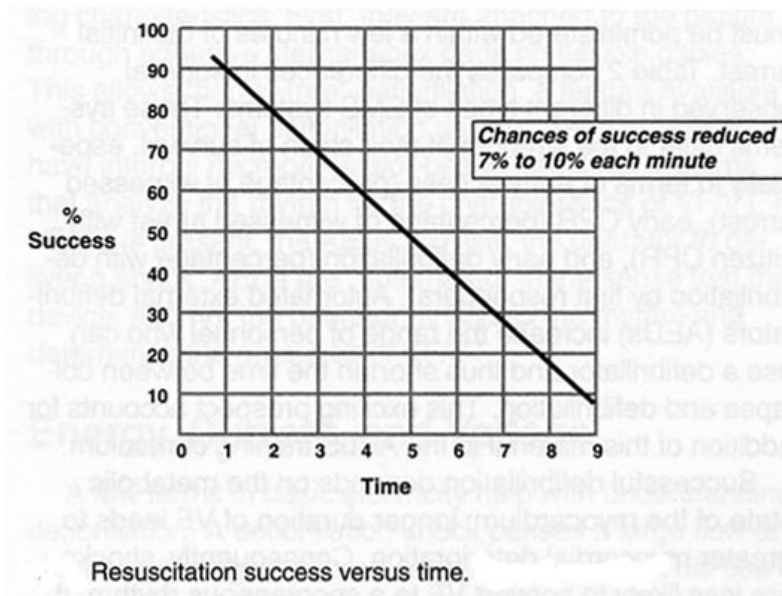
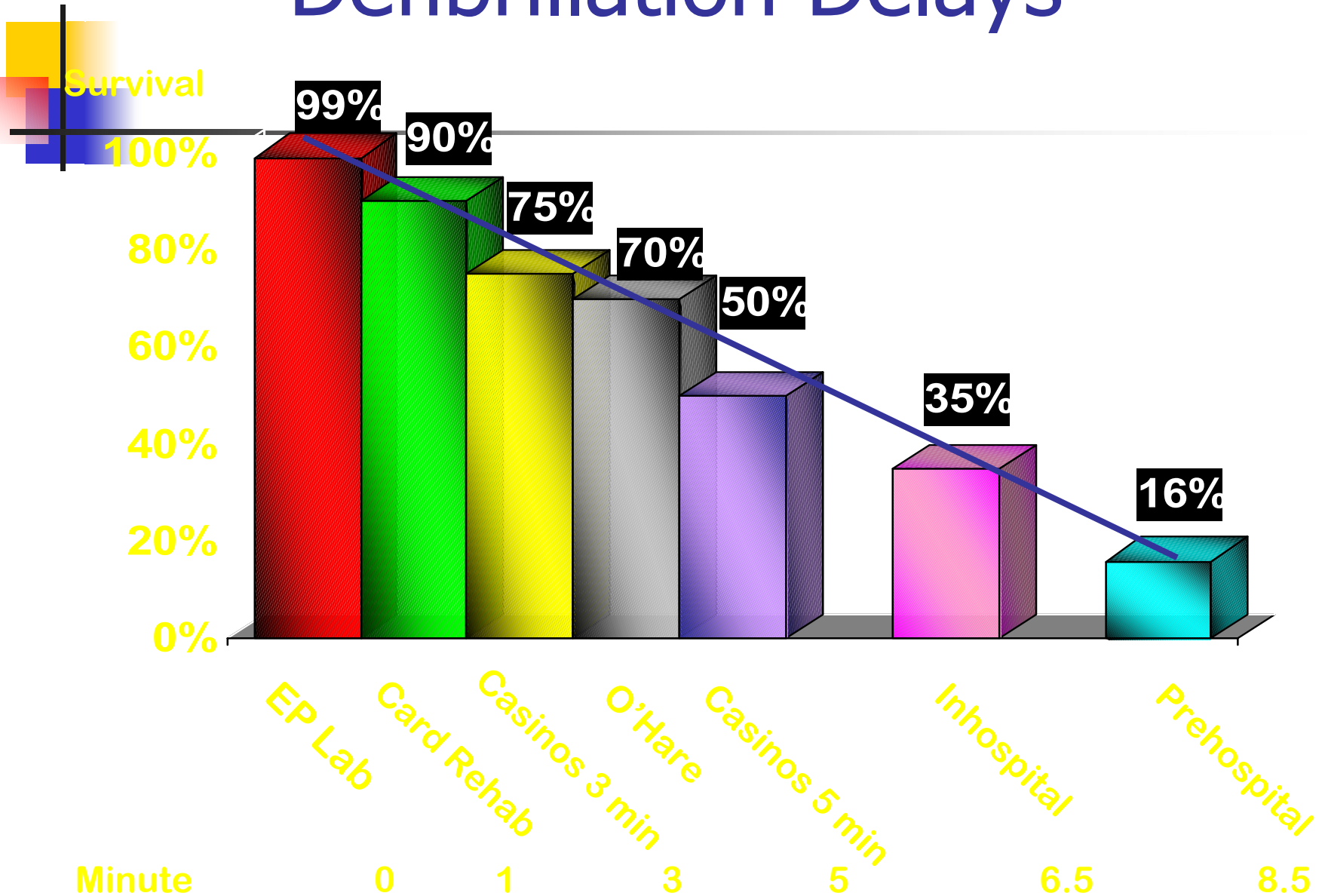


3-Phase Model of Resuscitation



- Electrical Phase
 - 0-4 minutes
 - early defibrillation can result in survival rates approaching 50%
 - survival decreases approximately 10% for each minute delay in defibrillation

Defibrillation Delays





Hyperventilation is Deadly

- If ventilation is good, more must be better huh?...

WELL, NOT EXACTLY!!



Hyperventilation is Deadly

- *"The single most important issue in healthcare worker-provided CPR."*



Hyperventilation is Deadly

- “Be prepared to deliver approximately 10 to 12 breaths per minute...” p. I-34
- “Once the airway is secured... compressions may be continuous and ventilations may be asynchronous, with a ratio of 5 compressions to 1 ventilation.” p. I-41

Guidelines 2000 for Cardiopulmonary Resuscitation and
Emergency Cardiovascular Care, 2000



Hyperventilation is Deadly

- City of Milwaukee EMS personnel ventilated at 37 ± 4 breaths/min during baseline period, underwent intensive retraining, and were then recorded ventilating at 22 ± 3 breaths/minute



Hyperventilation is Deadly

- Animal study
 - 9 pigs
 - anesthetized (ketamine, propofol)
 - intubated and ventilated
 - induction of ventricular fibrillation
 - untreated ventricular fibrillation x 6 min
 - CPR initiated at 100 compressions/minute with pneumatic compressor

Aufderheide et. al., Circulation 2004; 109: 1960-5



Hyperventilation is Deadly

- Animals randomized to receive 3 different ventilatory modes in random order
 - 12 breaths/minute x 2 minutes
 - 20 breaths/minute x 2 minutes
 - 30 breaths/minute x 2 minutes
- ABGs/hemodynamic parameters measured



Hyperventilation is Deadly

	12/min	20/min	30/min	P
SAP	68.8 \pm 4.7	62.7 \pm 4.2	60.1 \pm 3.6	0.33
CPP	23.4 \pm 1.0	19.5 \pm 1.8	16.9 \pm 1.8	0.03
MIP	7.1 \pm 0.7	11.6 \pm 0.7	17.5 \pm 1.0	<.0001
pH	7.34 \pm 0.02	7.45 \pm 0.03	7.52 \pm 0.03	.0006
PaCO ₂	22.7 \pm 2.7	15.6 \pm 2.2	11.6 \pm 1.5	.005
PaO ₂	340.9 \pm 40.7	403.3 \pm 47.0	403.7 \pm 48.0	.59

Aufderheide et. al., Circulation 2004; 109: 1960-5



Hyperventilation is Deadly

- Animal study
 - 21 pigs
 - anesthetized (ketamine, propofol)
 - Intubated and ventilated, randomized to
 - 12 breaths/minute, 100% O₂
 - 30 breaths/minute, 100% O₂
 - 30 breaths/minute, 5% CO₂/95% O₂
 - ventricular fibrillation x 6 minutes

Aufderheide et. al., Circulation 2004; 109: 1960-5



Hyperventilation is Deadly

- defibrillated after 6 minutes
- Results
 - 12 breaths/minute: 6/7 survived
 - 30 breaths/minute (O₂): 1/7 survived
 - 30 breaths/minute (O₂/CO₂): 1/7 survived



Hyperventilation is Deadly

- Take home message
 - hyperventilation kills!!
 - ventilation rate: no > 12 breaths/minute
 - ventilation duration: no > 1 second/breath
 - 8:1 compression:ventilation ratio
 - incomplete chest recoil potentiates the effects of hyperventilation
 - rotate compressors at least every 3 min

Aufderheide et. al., Circulation 2004; 109: 1960-5



Hyperventilation is Deadly

- “Possibly, by focusing so much attention on discovering more effective drugs and more sophisticated defibrillator technology, we have lost sight of the vital importance of more mundane therapies, such as timely and proper provision of rescue breathing and chest compressions.”

Pitts and Kellerman, Lancet 2004; 364: 313-5



Pauses in Compressions Are Deadly

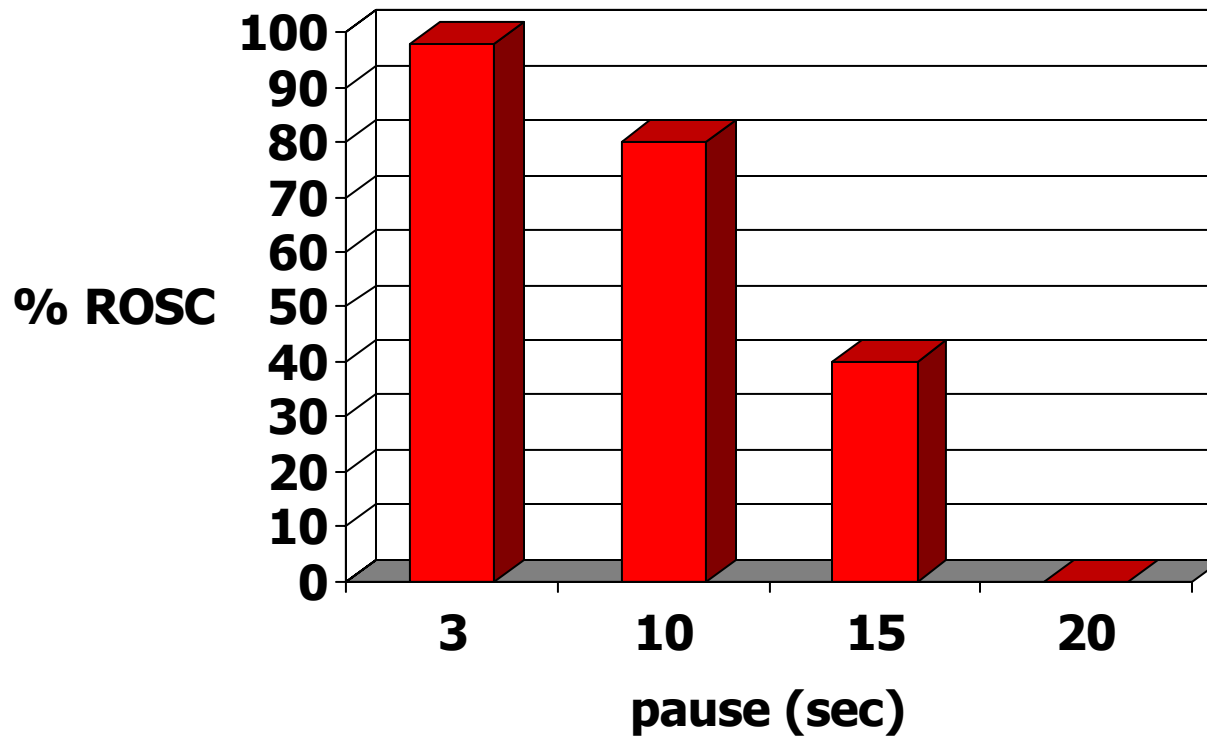
- Animal study
 - 20 pigs
 - anesthetized (ketamine, pentobarbital)
 - intubated and ventilated
 - ventricular fibrillation induced
 - ventricular fibrillation x 7 minutes
 - CPR started x 1 minute



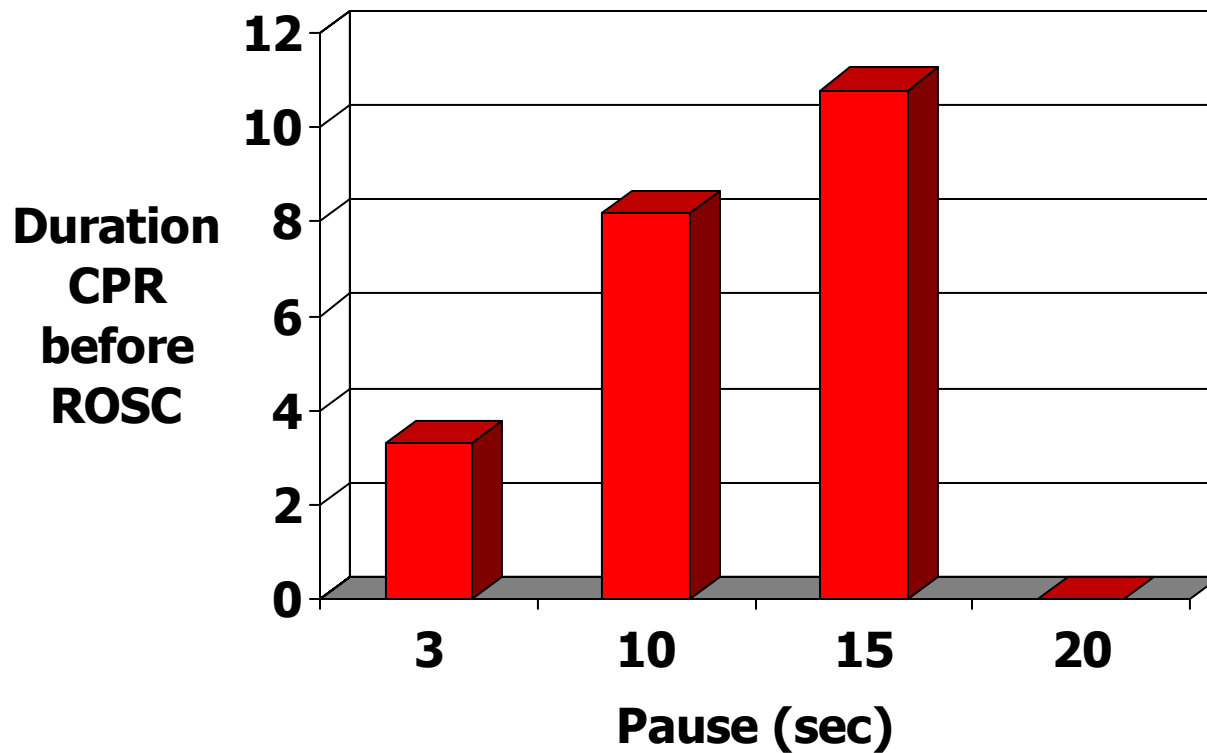
Pauses in Compressions Are Deadly

- Animal study
 - CPR stopped and animals randomized to a pause
 - 3, 10, 15, or 20 seconds
 - defibrillation attempted after pause
 - if necessary, CPR x 1 minute then pause then defibrillated again

Pauses in Compressions Are Deadly



Pauses in Compressions Are Deadly





Pauses in Compressions Are Deadly

- Seattle EMS
 - Introduced AEDs with the expectation of increased survival rates from OOH CA
 - Survival fell by almost 50%
 - What happened?



NRCPR Data

- 368 hospitals
- Composition mirrors US hospitals at large
- 53,813 events on file



NRCPR Data

The First 14,720 Cases

- 86% of arrests witnessed and/or monitored
- Event location
 - ICU...48%
 - Inpatient...32%
 - ED...11%
 - Diagnostic area...4%
 - Operating room...2%



NRCPR Data

The First 14,720 Cases

- First pulseless rhythm
 - VF/VT... 25%
 - PEA... 30%
 - Asystole... 36%
 - Unknown by documentation... 9%



NRCPR Data

The First 14,720 Cases

Rhythm	ROSC	Survival to discharge
Overall	44%	17%
Asystole	35%	10%
PEA	39%	10%
VF	58%	34%
Pulseless VT	63%	35%

Peberdy, Resuscitation 2003; 58: 297-308



NRCPR Data

The First 14,720 Cases

- Documentation of invasive airway placement
 - Auscultation...48%
 - End-tidal CO₂...35%