CPR Quality: How To Improve?

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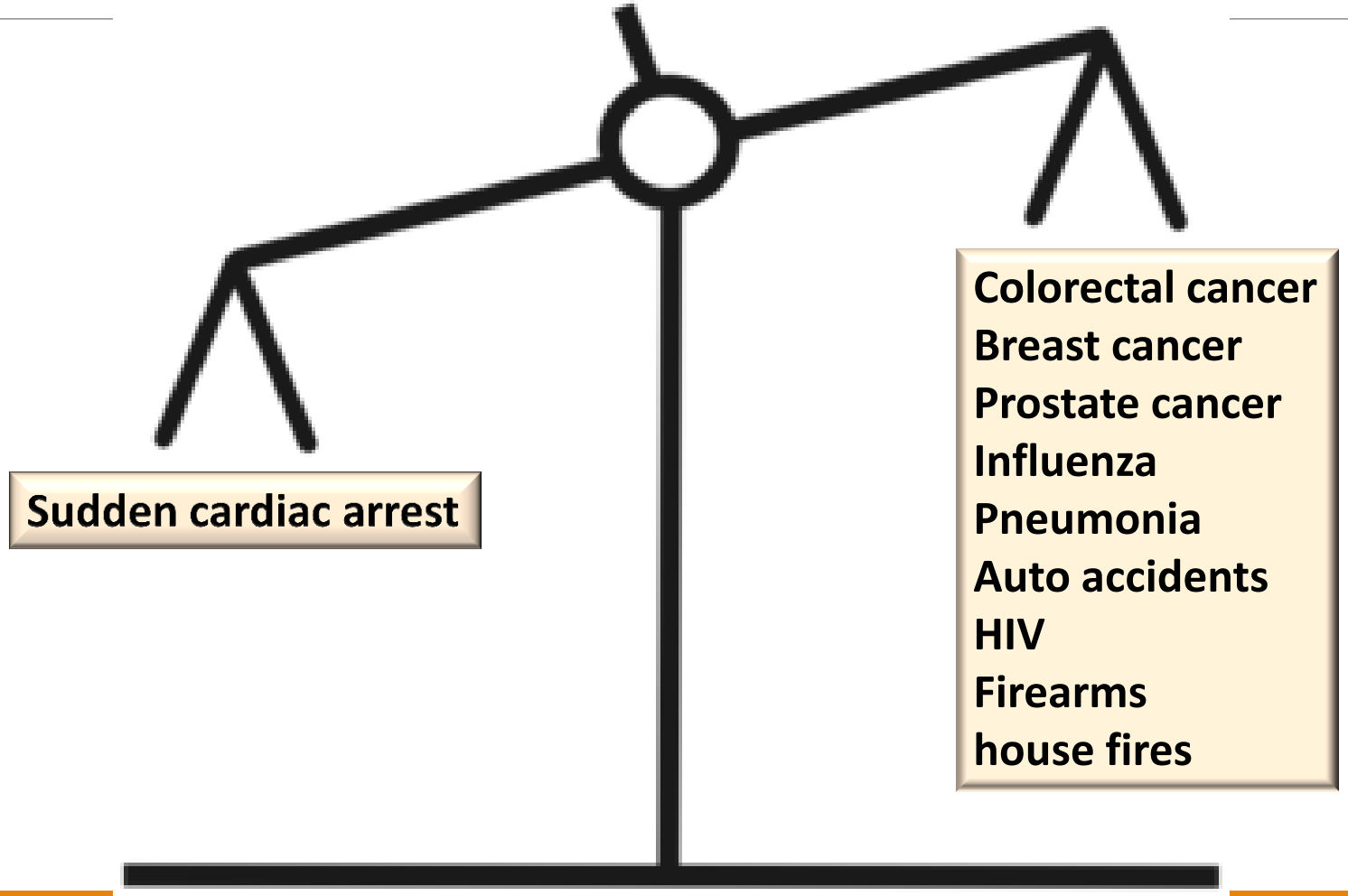
Cardiac Arrest: A major cause of death

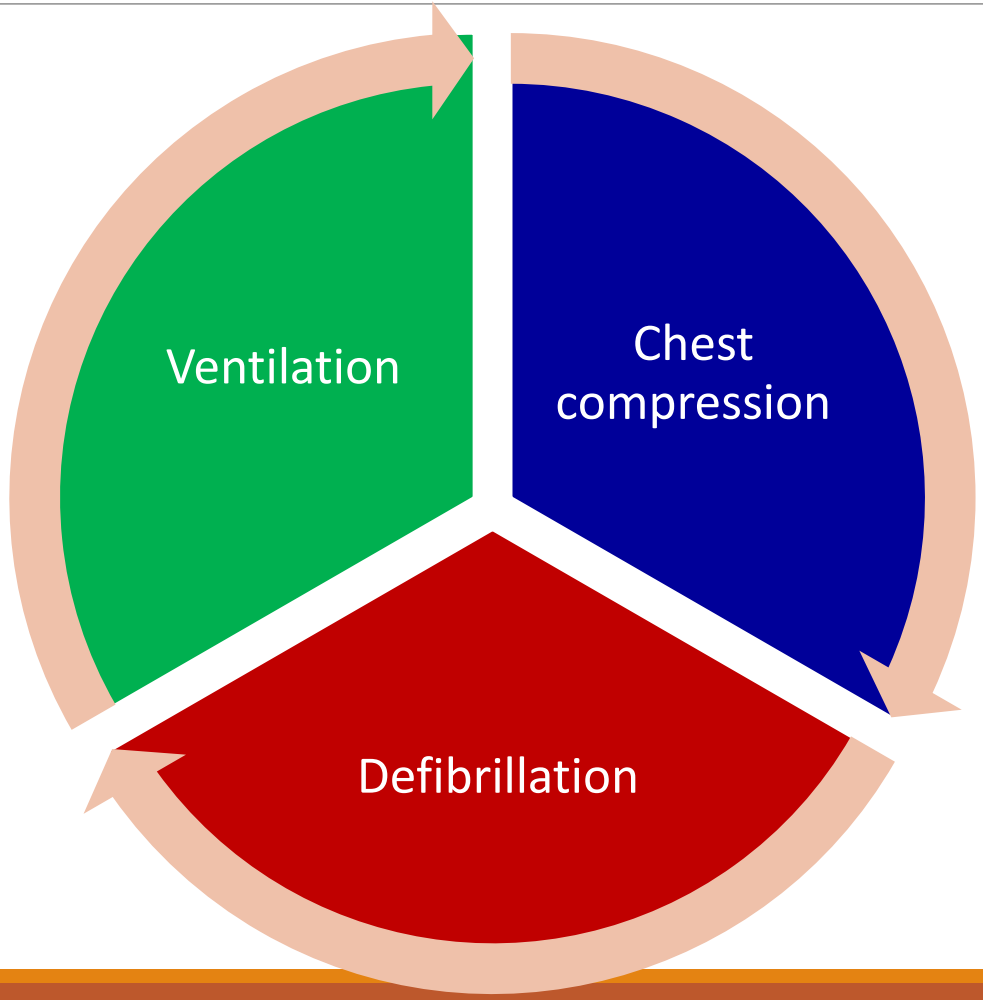


Centers for Disease Control and Prevention. National Vital Statistics Reports, December 29, 2011.

Cardiopulmonary resuscitation (CPR)

- Accounts for the only treatment available for cardiac arrest
- It can resume heart activity and prevent loss of vital activities of body organs

Modern CPR first developed in 1960



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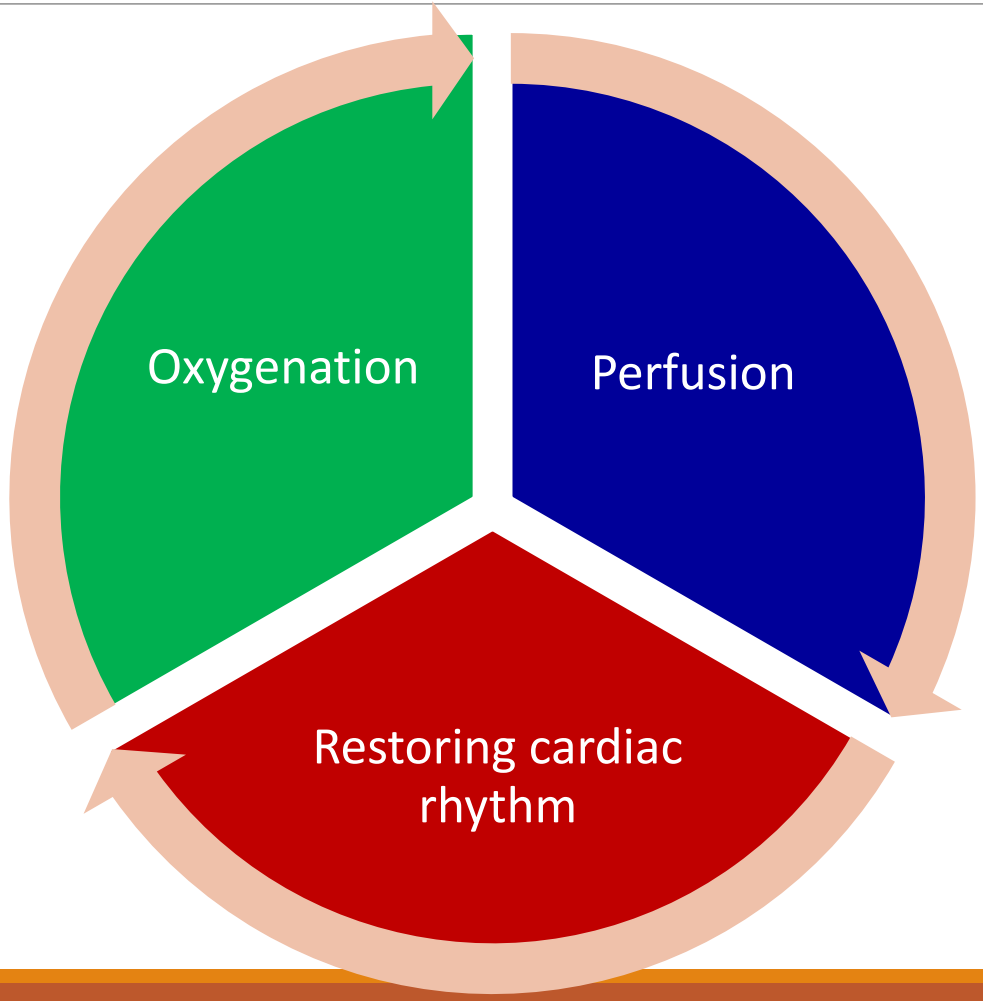
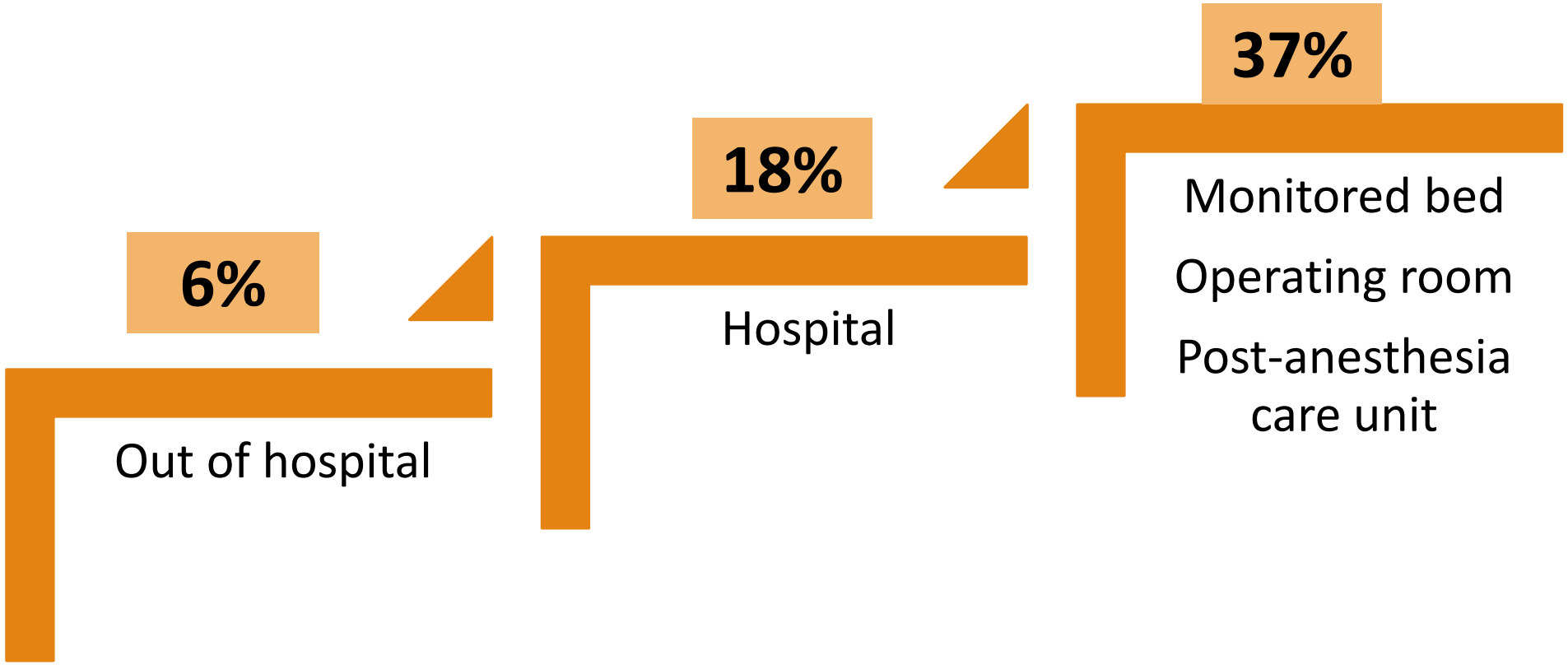


Post-CPR survival Rates



Key Factors to Improve CPR Outcomes

- Time to start CPR
- CPR quality
- Time to shock
- Advanced cardiac life support
- Post-CPR care

Key Factors to Improve CPR Outcomes

- Time to start CPR → Bystander training
- CPR quality → High performance CPR
- Time to shock → AED
- Advanced cardiac life support → Advanced airway & drugs
- Post-CPR care → Goal directed management & cooling

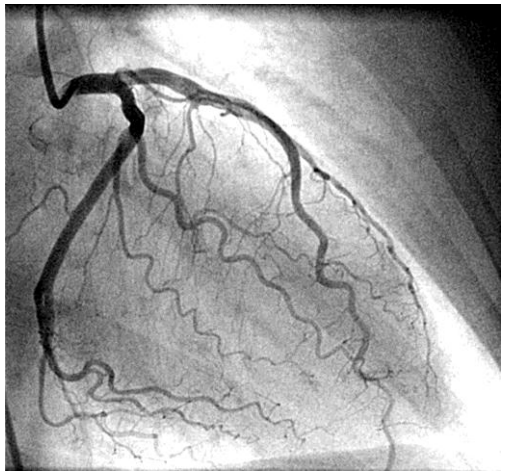
Significant changes in 2010 AHA Guidelines for CPR

- A change in the CPR sequence, from A-B-C to C-A-B
- Emphasis on providing high-quality chest compressions:
  - Push hard, push fast
  - Minimize interruptions
  - Allow full chest recoil
  - Avoid excessive ventilation
- Recommendation that the chest should be depressed ≥2 inches versus 1 ½ to 2 inches
- Recommendation that chest compressions should be performed at a rate of ≥ 100/min versus at a rate of about 100/min
- The creation of a simplified universal algorithm for adult CPR

2010 AHA Guideline: A bold role for chest compressions

- Initiation of compressions before ventilations
- More compression depth
- Allowance for complete chest recoil
- Higher compression rate
- Option for chest compression only CPR

The Goals of CPR

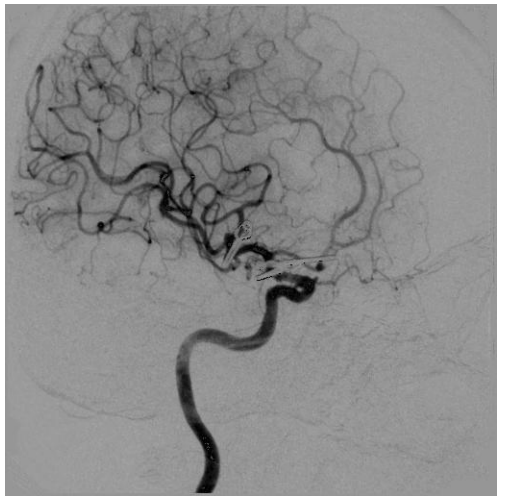


Primary Goal

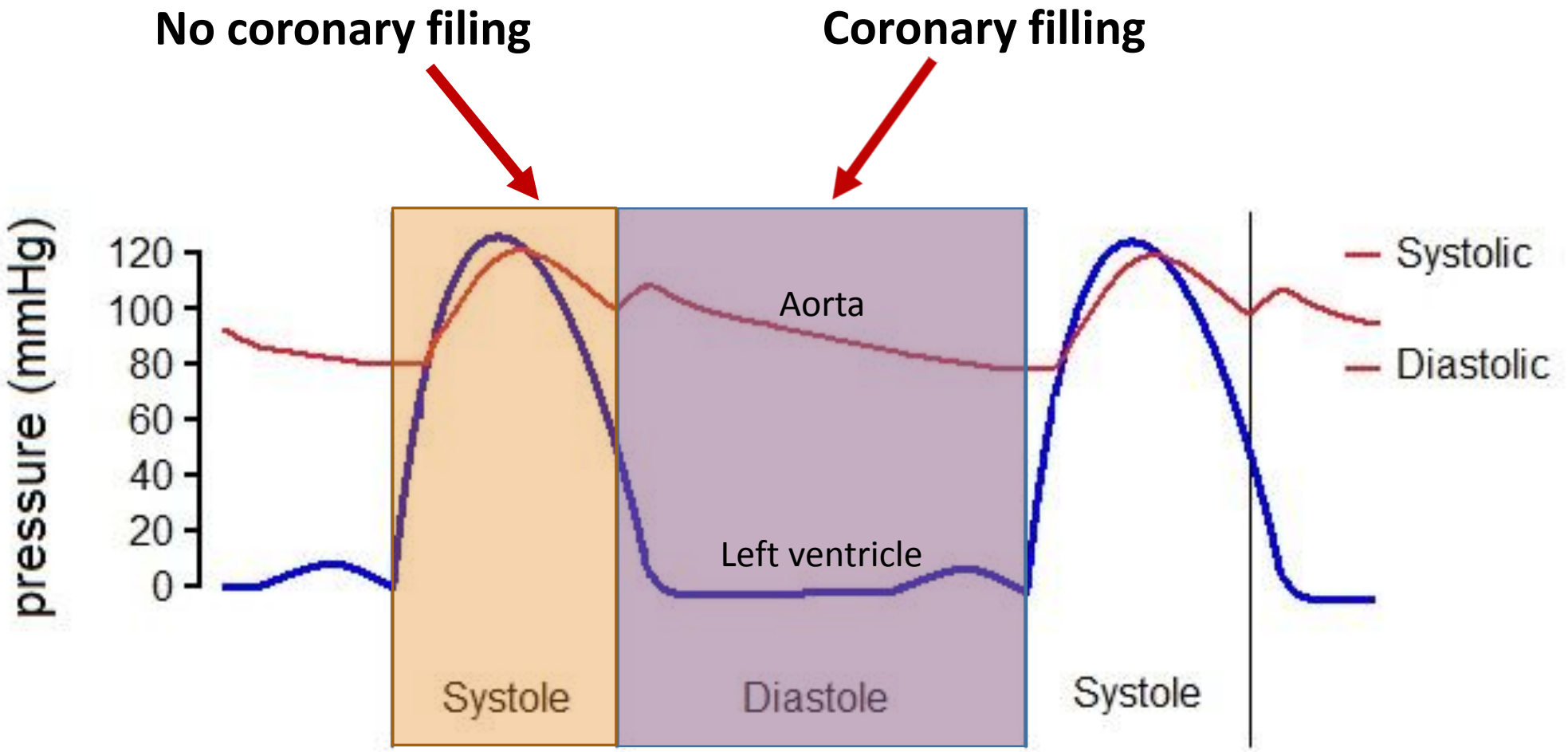
- ROSC
- Coronary perfusion Pressure

Ultimate Goal

- Neurologic Recovery
- Cerebral Perfusion Pressure



Coronary perfusion pattern in cardiac cycle



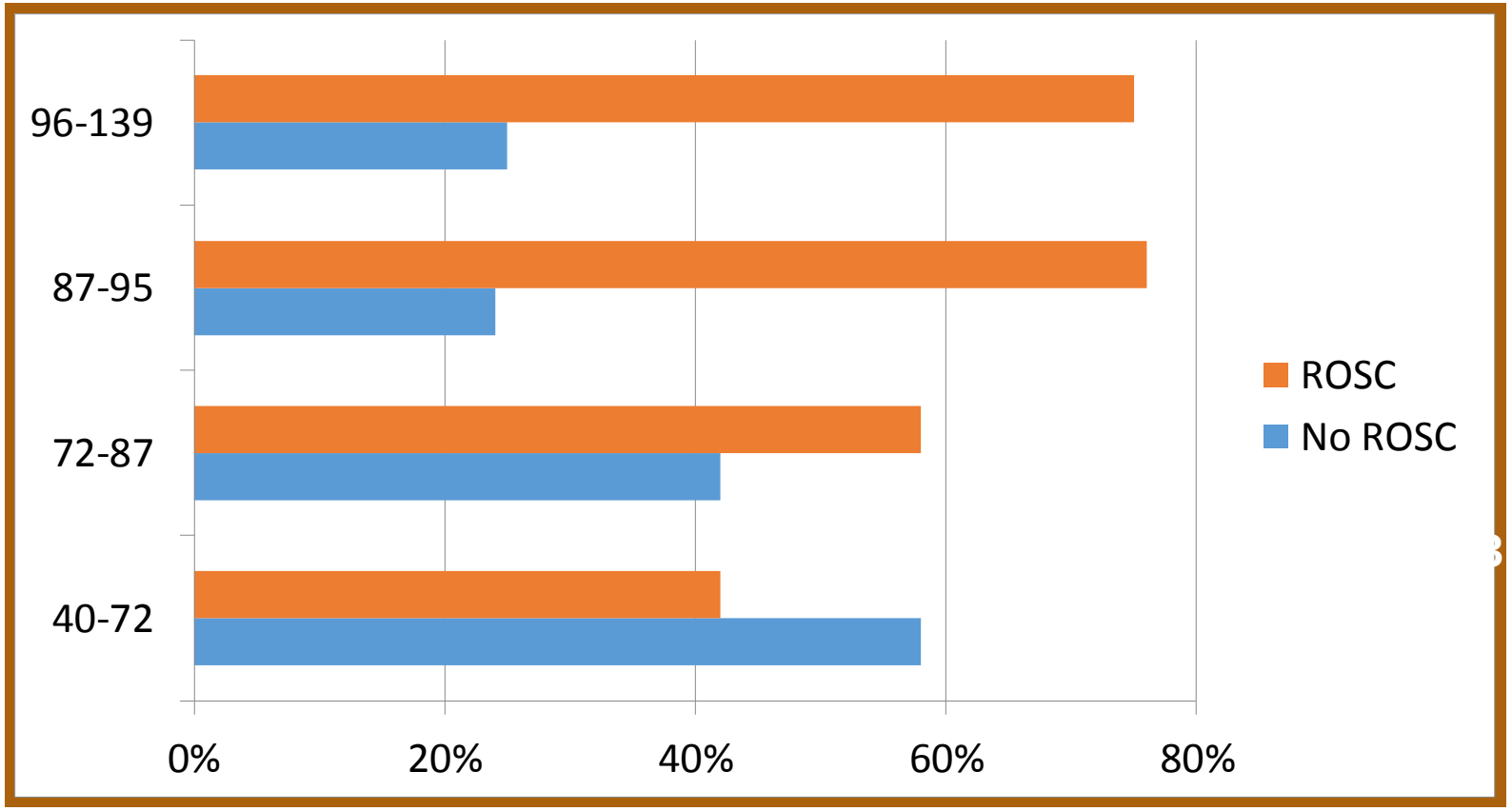
Coronary perfusion pressure: Why is important during CPR?

- Primary determinant of myocardial blood flow
- Primary goal of CPR
- Can predict ROSC
- As cannot be measured directly in ED resuscitation, rescuers should focus on some specific components of CPR

Chest Compression Rate

- Guideline recommends a chest compression rate of ≥100/min
- Edris et al (2015) found that the number of chest compressions were not correlated with ROSC, however, after adjustment for covariates including chest compression depth and fraction (n = 6,399), the global test found a significant relationship between compression rate and survival (p = 0.02).
- Chest compression >120/min may decrease the chance of ROSC

CPR Rate vs. ROSC



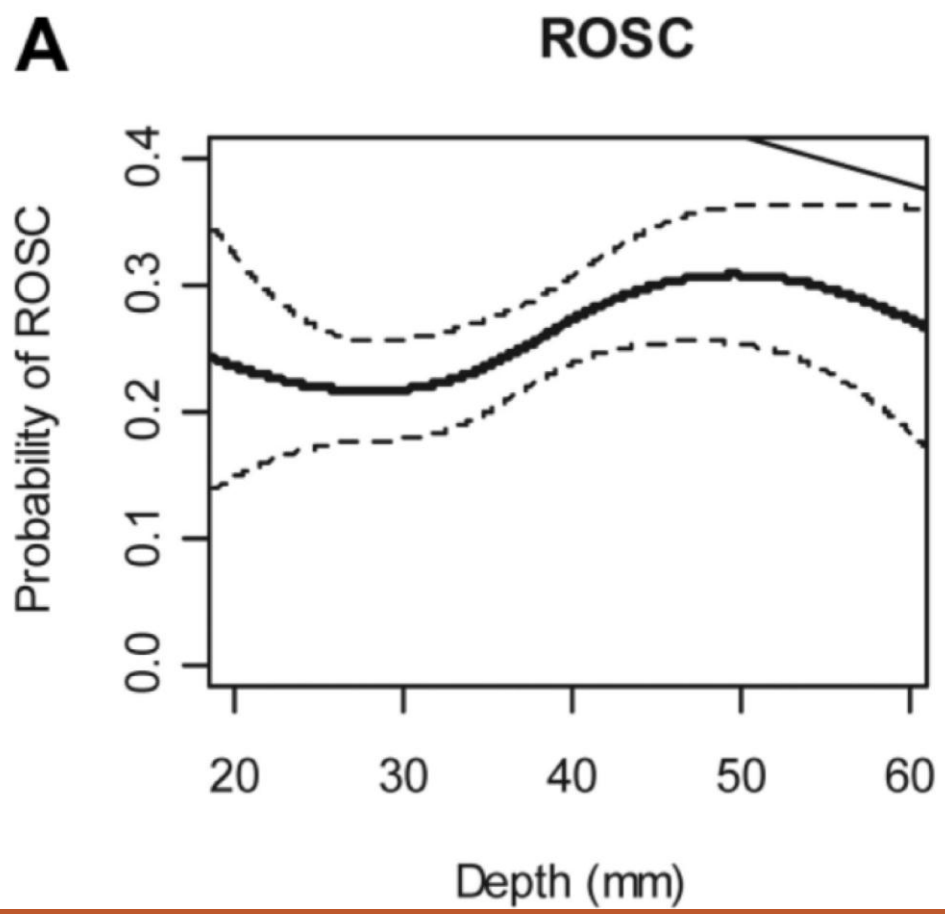
Abella e al. Circulation. 2005;111:428-434

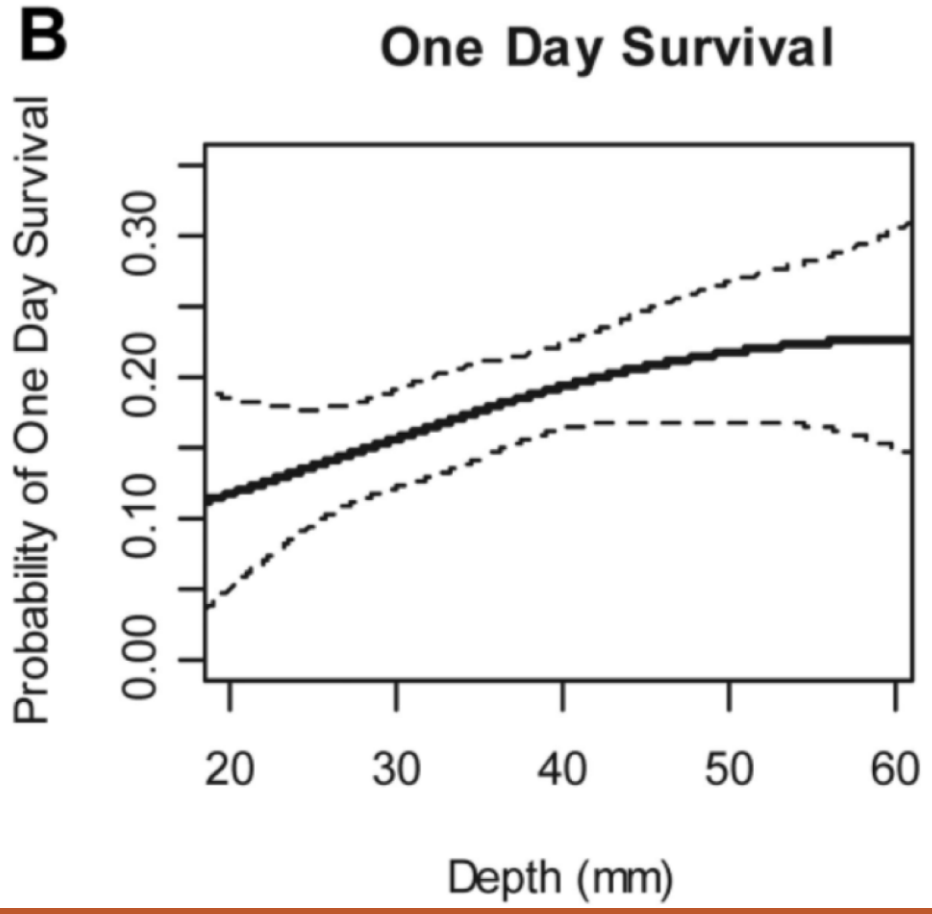
Chest Compression Depth

- Guideline recommends depth of ≥50 mm in Adults and at Least One Third the Anterior-Posterior Dimension of the Chest in Infants and Children
- Stiell et al (2012) examined chest compression depth and survival in out-of-hospital cardiac arrest in adults and concluded that a depth of <38 mm was associated with a decrease in ROSC and rates of survival

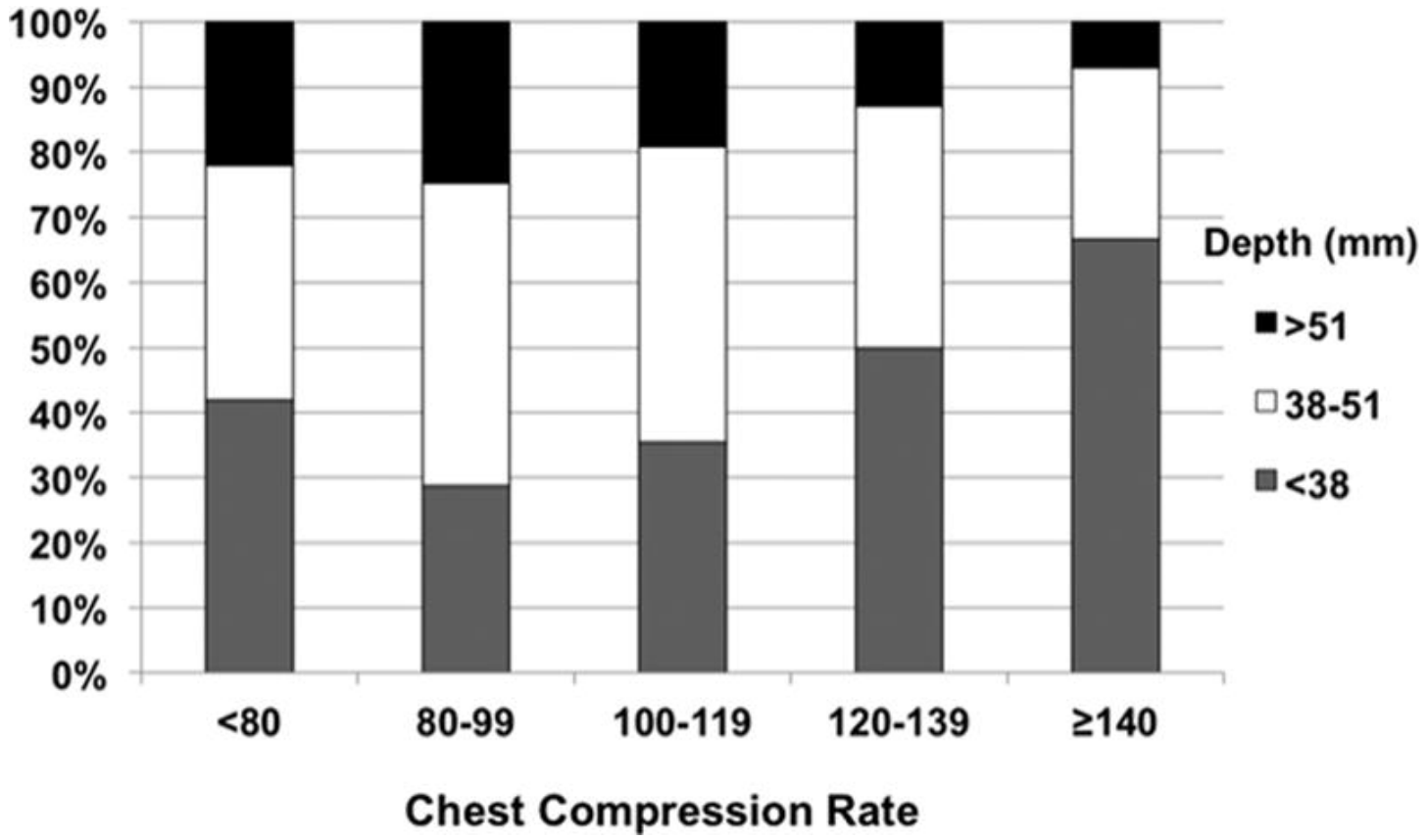
Compression Depth and CPR Outcome

Stiell et al. Crit Care Med. 2012





Chest compression rate versus depth



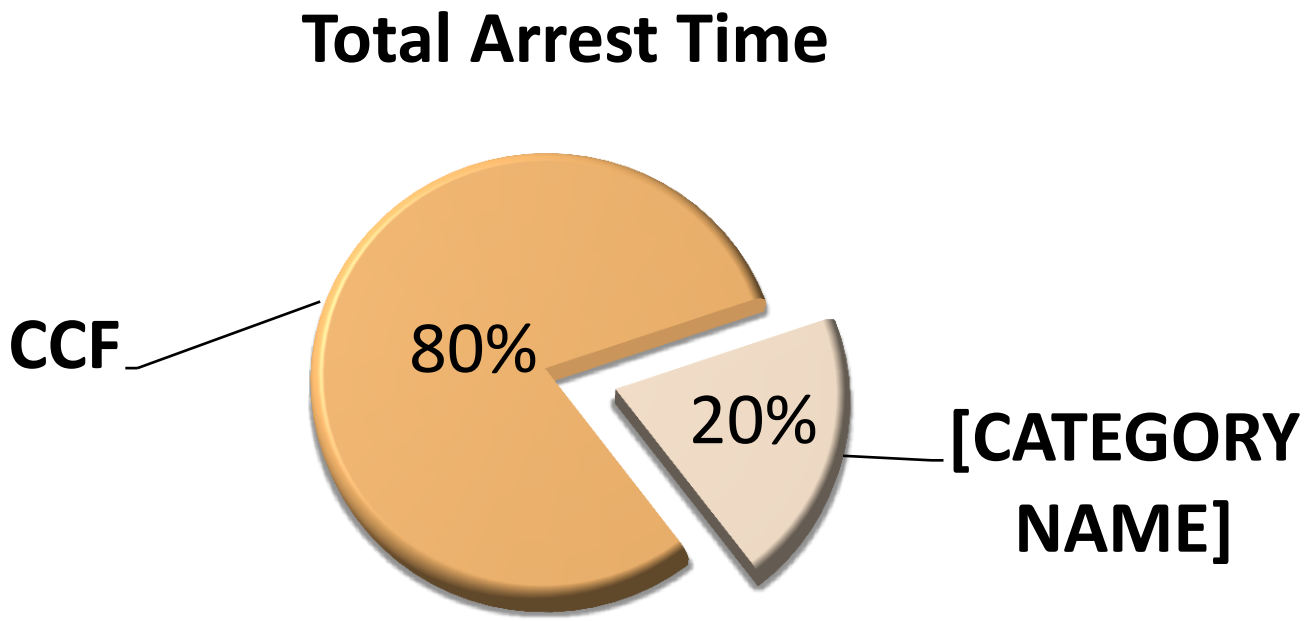
Idris et al. Critical Care Medicine. 43(4):840-848, April 2015.

Chest Compression Depth by Rescuers in Out of Hospital CPR

Compression Depth	Proportion
>38 mm	49.2%
38-51 mm	39.7%
>51 mm	11.1%

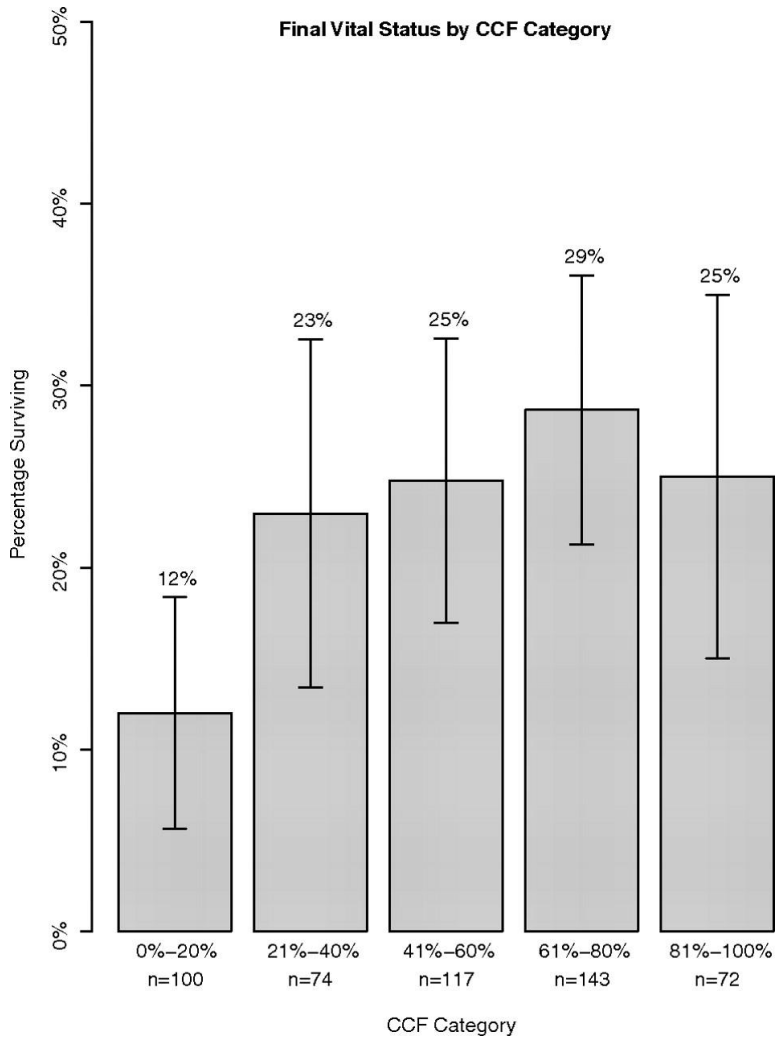
Stiell et al. Crit Care Med 2012

Chest Compression Fraction (CCF)



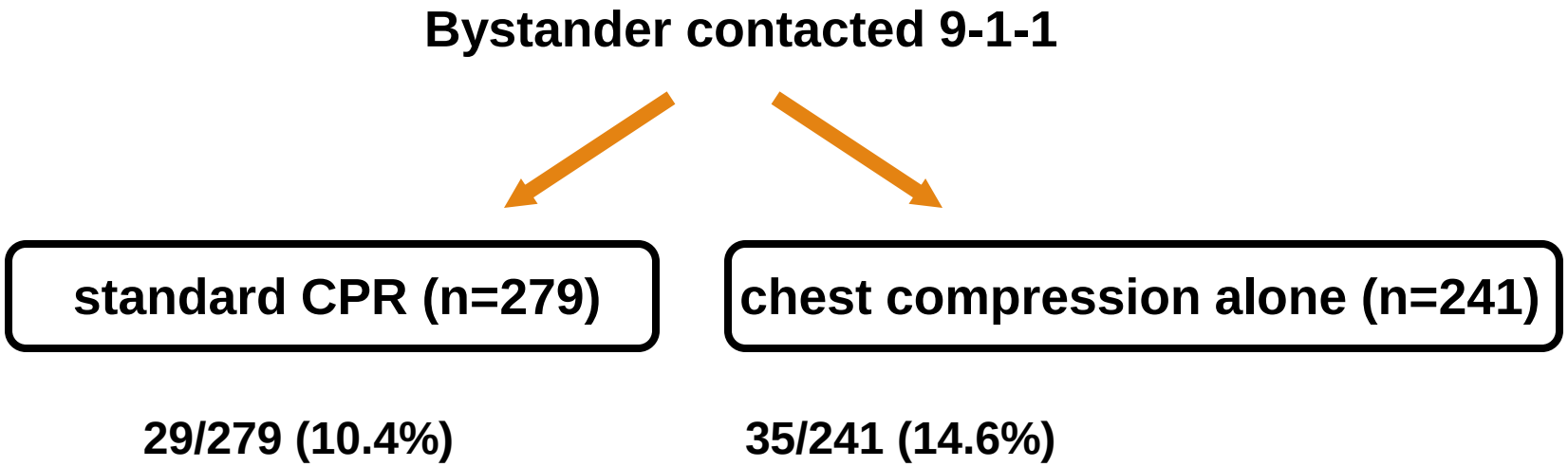
- Proportion of time that chest compressions are performed during a cardiac arrest

Survival to discharge for each category of chest compression fraction.



Jim Christenson et al. Circulation. 2009;120:1241-1247

Chest compressions alone in out-of-hospital arrest

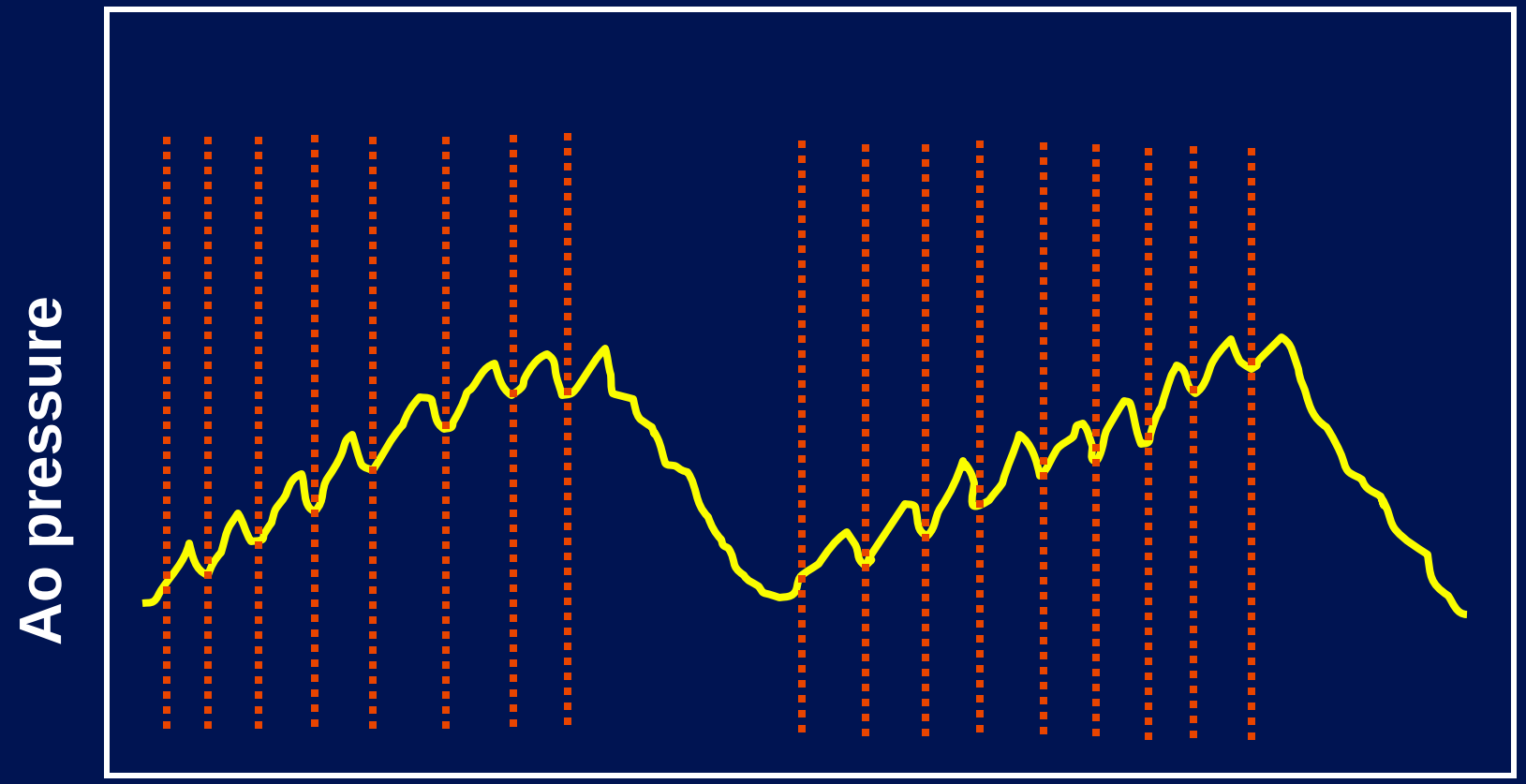


Improvement, if any, due to:

- **Less time to train?**
- **Higher CCF?**

Hallstrom et al, 2000

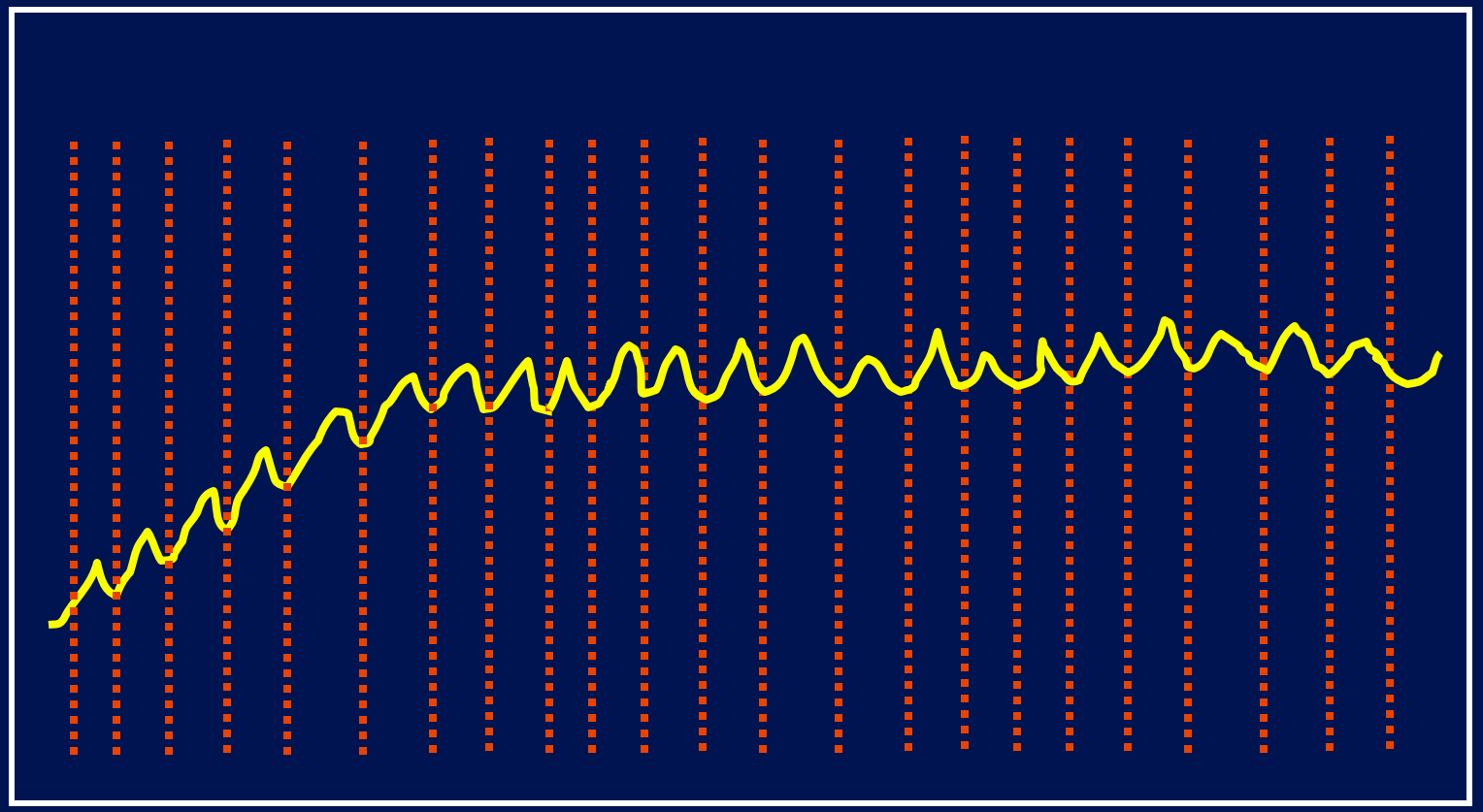
Standard CPR (CC+RB)



= chest compression

Berg et al, 2001

Chest Compression alone



= chest compression

Maximizing CCF

- Minimize Peri-shock Pauses
- Minimize Interruptions for Airway Placement
- Avoid Unnecessary Pulse Checks
- Choreograph Team Activities

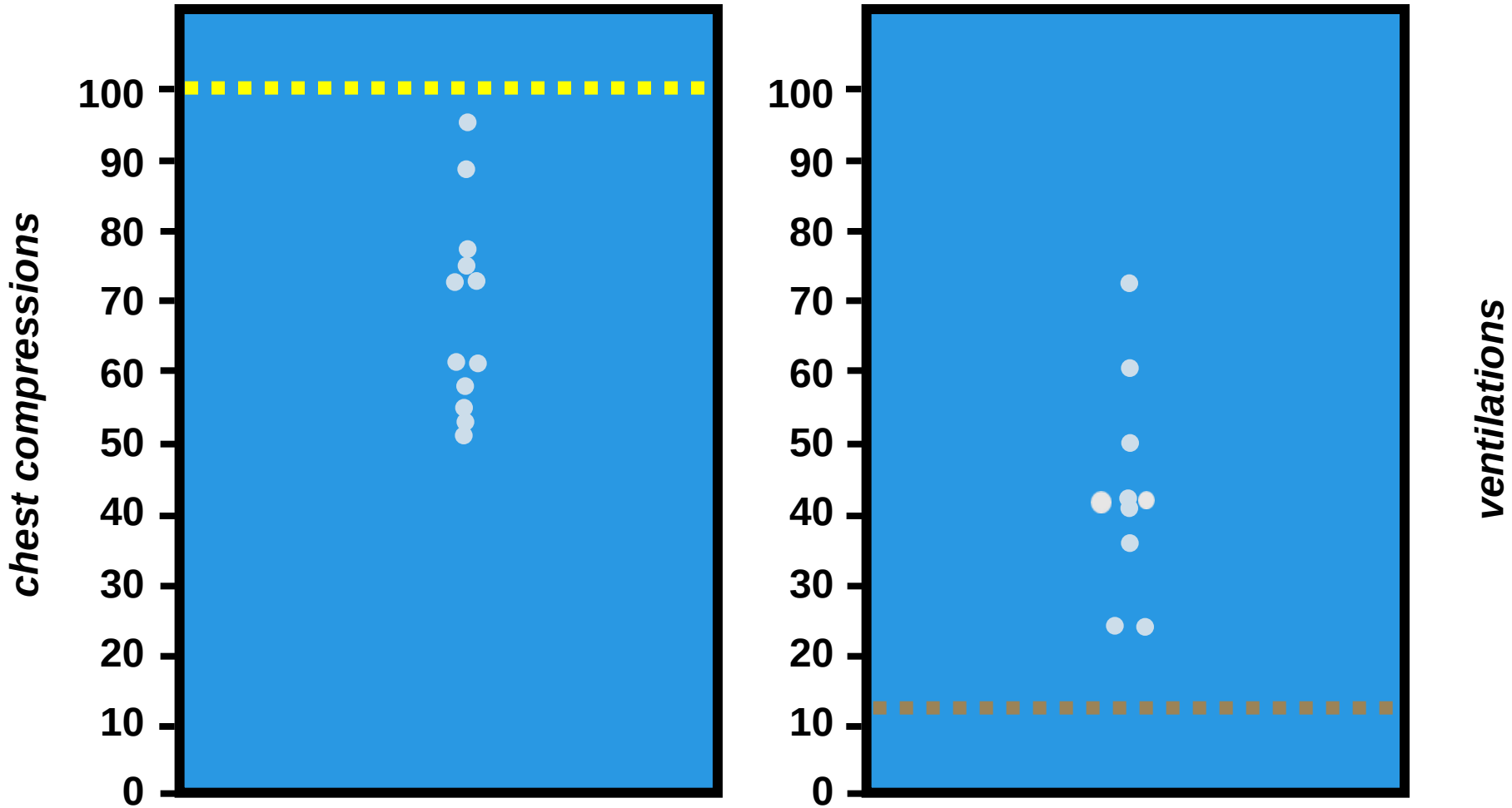
Full Chest Recoil

- Guideline recommends to allow full chest decompression
- Residual leaning impairs cardiac output and coronary perfusion in piglet cardiac arrest. *Zuercher et al 2010*.
- Fried et al analyzed 112,569 chest compressions from 108 arrest episodes. Leaning was present in 98/108 (91%) cases; 12% of all compressions exhibited leaning. *Resuscitation.2011*

Optimal ventilations?

Ventilations good:	**oxygenation**
	maintain pH (ventilation)
Ventilations bad:	**gastric inflation → increased abd pressure**
	pauses in chest compressions → low CPP
	bystander reluctance
	increased intrathoracic pressure

12 patients, 45 sec of recording per patient



Milander et al, 1995

Avoid Excessive ventilations

Disadvantages of hyperventilation:

- Decreased venous return
- Gastric distention
- Decreases CCF

AHA 2010 recommends:

- Rescue breathing < 12/ min
- Minimal chest rise

Monitoring and Feedback

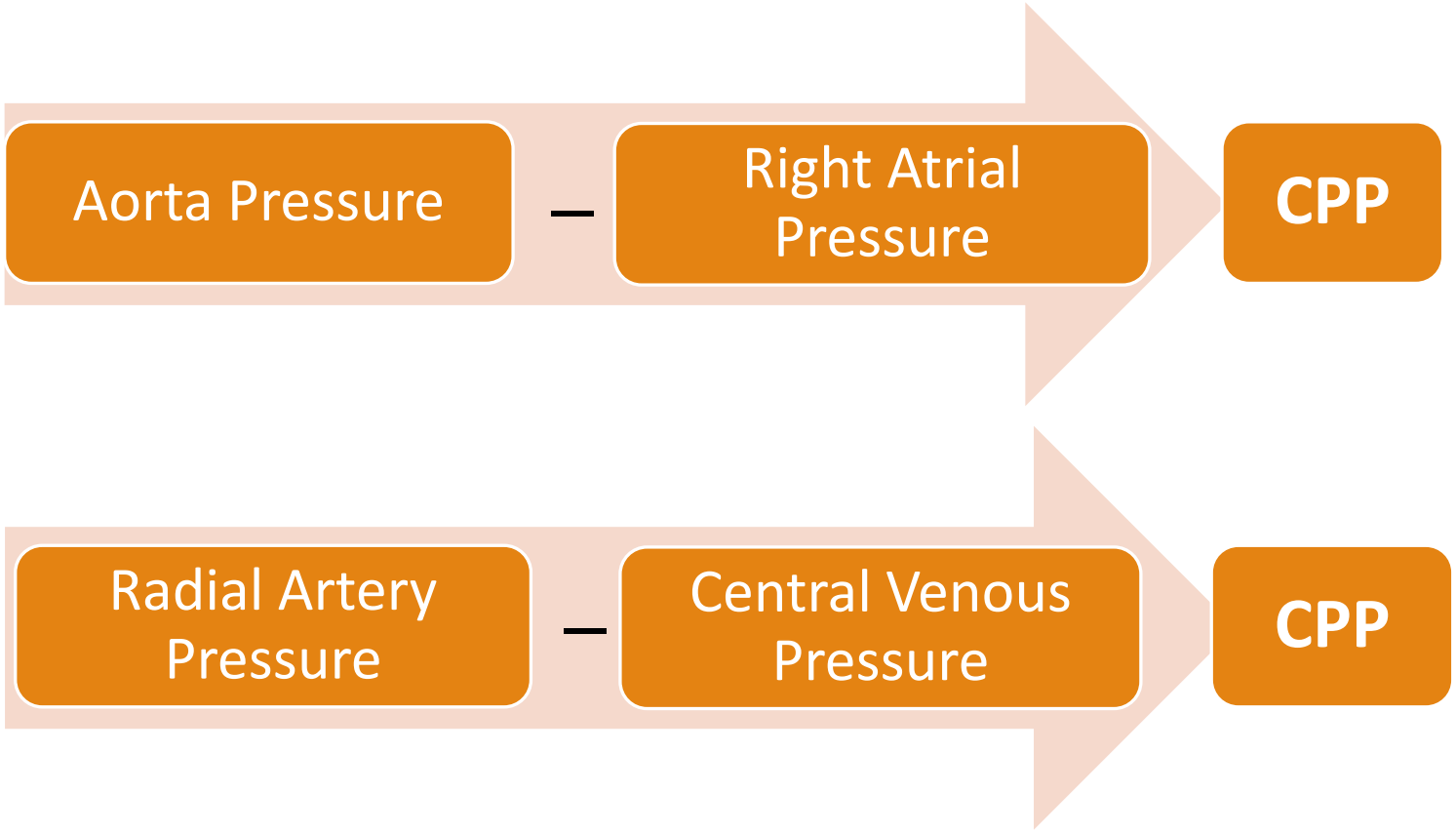
- “If you don’t measure it, you can’t improve it”
- New technology is capable of monitoring CPR parameters during resuscitation.
- Monitoring of CPR quality is one of the most significant advances in resuscitation practice in the past 20 years.
- AHA recommends this should be incorporated into every resuscitation and every professional rescuer program.

Types of Monitoring for CPR Quality

Physiological Assessments	• How the patient is doing?
Performance assessments	• How the rescuers are doing?

- Both can provide both real-time feedback to rescuers and retrospective system-wide feedback

Invasive Monitoring: CPP >20 mm Hg



Arterial Line Only: Diastolic Pressure >25 mm Hg

- DBP of ≥ 25 mmHg is a physiological target when an arterial catheter is in place without a central venous catheter at the time of the cardiac arrest and CPR.
- The 2010 AHA Guidelines recommend optimizing chest compression parameters or giving vasopressors or both if DBP is <20 mm Hg.

Capnography Only: ETCO2 >20 mm Hg

- ETCO2 during CPR is a determinant of pulmonary blood flow and therefore reflect cardiac output.
- ETCO2 at <10 mm Hg is indicative of poor CPR outcome.
- Why monitor ETCO2 during CPR?
  - To improve chest compression performance if ETCO2< 10 mmHg
  - To indicate ROSC if abruptly increases to a normal value 35 - 40 mm Hg
- Try to improve chest compression performance to obtain ETCO2 of >20 mm Hg.

Metrics for High Quality CPR

Compression Rate	• Target heart rate: 100 -120/ min
Compression Depth	• Target depth ≥ 5 cm
Chest Compression Fraction	• Target fraction: 80%
Chest Recoil	• Target level: Full recoil
Ventilation	• Target level: < 12 breaths/ min; minimal chest rise

❖ These CPR components were identified because of their contribution to blood flow and outcome.

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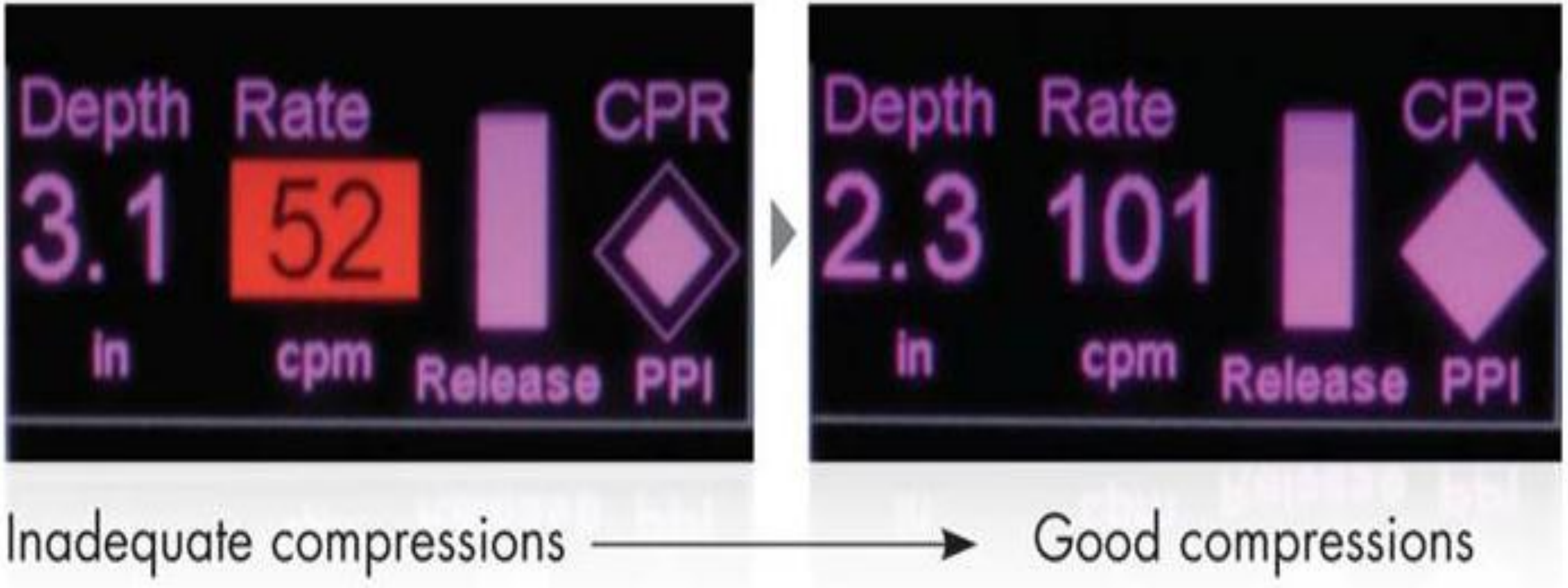
Depth
Rate
CPR
3.1
52
in
cpm
Release
PPI
Depth
Rate
CPR
2.3
101
in
cpm
Release
PPI
Inadequate compressions
Good compressions

Summary

Key indicators

Time to first compression:	00:01:04
Average time to shock after compressions stopped:	00:00:32
Average time to compressions after shock delivered:	00:00:40
Mean compression depth:	1.67 in
Mean compression rate:	100.76 cpm

Entire case

Case duration:	00:06:07	
Time in CPR:	00:03:36	(58.86 %)
Time not in CPR:	00:02:31	(41.14 %)

CPR periods

Time in compressions:	00:01:57	(54.17 %)
Time not in compressions:	00:01:39	(45.83 %)
Compressions in target:	84.92 %	

Depth:			Rate:		
Standard deviation:	0.21 in		Standard deviation:	17.08 cpm	
Above target zone:	0	(0.00 %)	Above target zone:	4	(2.01 %)
In target zone:	174	(87.44 %)	In target zone:	185	(92.96 %)
Below target zone:	25	(12.56 %)	Below target zone:	10	(5.03 %)

Debriefing

- A focused post-event discussion in which individual actions and team performance are reviewed.
- Very effective for achieving improved performance
- CPR quality is reviewed while the resuscitation is fresh in the rescuer’s mind.

Conclusion

Common Errors During CPR

Too few chest compressions

Too weak chest compressions

Too many ventilations

Too many interruptions

Conclusion

- High quality CPR is a key to successful resuscitation
- Avoid excessive ventilations
- Employ advance technology to get real-time feed back
- Future of CPR probably would be a goal directed approach