CODE BLUE

Internal Medicine Noon Conference

July 18, 2014

Mark warner, MD

CPR FACTS

In the hospital setting, among participating centers in the Get With The Guidelines-Resuscitation quality improvement program, the median hospital survival rate from adult cardiac arrest is 18% (interquartile range, 12%–22%) and from pediatric cardiac arrest, it is 36% (interquartile range, 33%–49%).

Circulation. 2013;128:417-435

CPR FACTS

- In a hospital setting, survival is >20% if the arrest occurs between the hours of 7 am and 11 pm but only 15% if the arrest occurs between 11 pm and 7 am.
- There is significant variability with regard to location, with 9% survival at night in unmonitored settings compared with nearly 37% survival in operating room/post anesthesia care unit locations during the day.

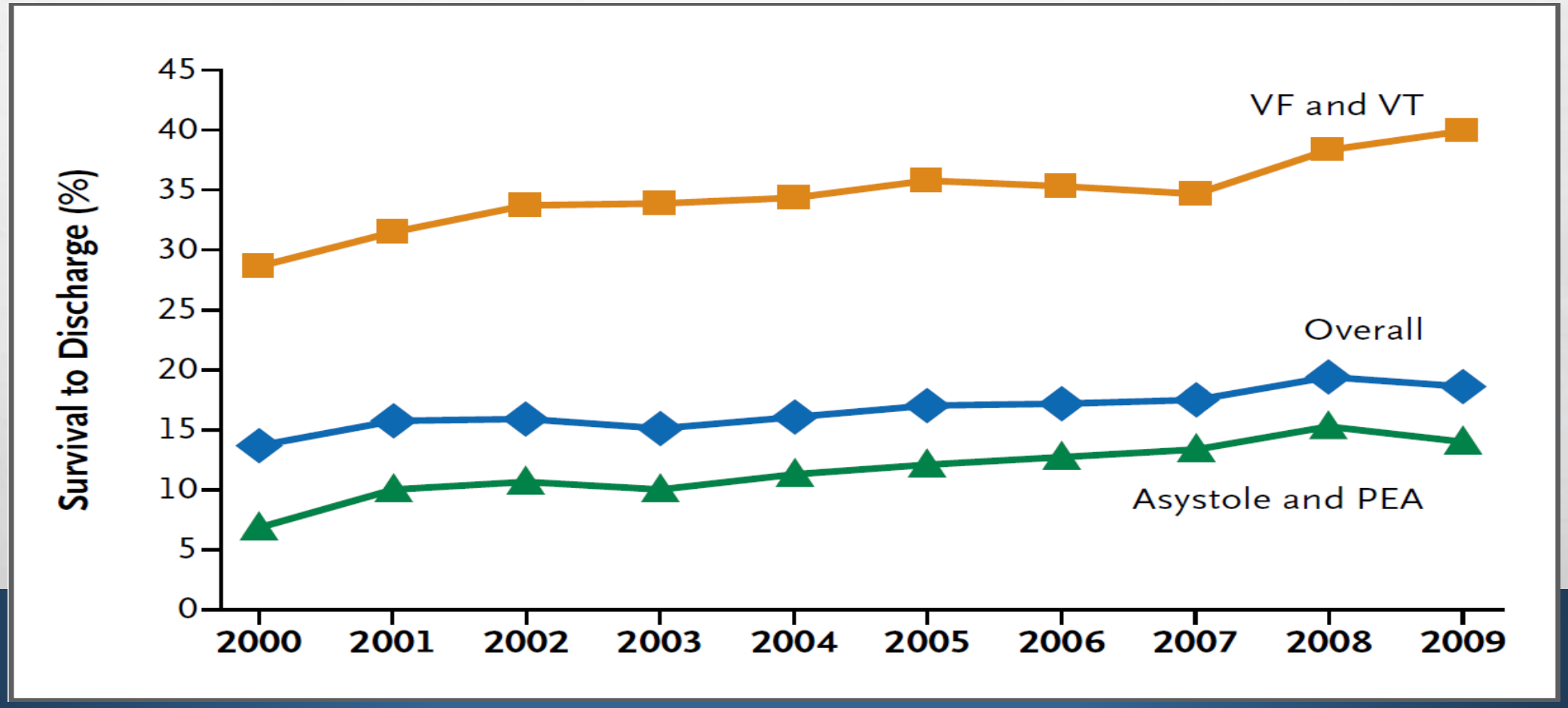
Circulation. 2013;128:417-435

CPR FACTS

- Patient survival is linked to quality of cardiopulmonary resuscitation (CPR).
- When rescuers compress at a depth of <38 mm, survival-to-discharge rates after out-of-hospital arrest are reduced by 30%.
- Similarly, when rescuers compress too slowly, return of spontaneous circulation (ROSC) after in-hospital cardiac arrest falls from 72% to 42%.

Circulation. 2013;128:417-435

SURVIVAL AFTER IN-HOSPITAL CARDIAC ARREST



Girotra, NEJM 2012

SURVIVAL AFTER IN-HOSPITAL CARDIAC ARREST

Table 2. Trends in Survival and Neurologic Outcomes.*

Outcome	Risk-Adjusted Rates†										Adjusted Rate Ratio per Year (95% CI)‡	P Value for Trend‡
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009		
	percent											
Survival to discharge	13.7	17.1	18.2	17.8	18.9	20.0	20.5	21.2	23.3	22.3	1.04 (1.03–1.06)	<0.001
Acute resuscitation survival§	42.7	45.1	45.4	46.0	47.0	48.6	49.7	52.5	55.2	54.1	1.03 (1.02–1.04)	<0.001
Postresuscitation survival¶	32.0	38.3	40.0	39.0	40.8	42.1	42.4	41.5	43.6	42.9	1.02 (1.01–1.03)	0.001
Neurologic outcome in survivors												
Clinically significant disability‖	32.9	35.7	31.9	34.3	34.0	33.1	33.0	32.7	31.8	28.1	0.98 (0.97–1.00)	0.02
Severe disability**	10.1	10.5	9.8	10.5	11.5	11.5	9.7	12.2	11.7	10.7	1.01 (0.98–1.04)	0.37

Girotra, NEJM 2012

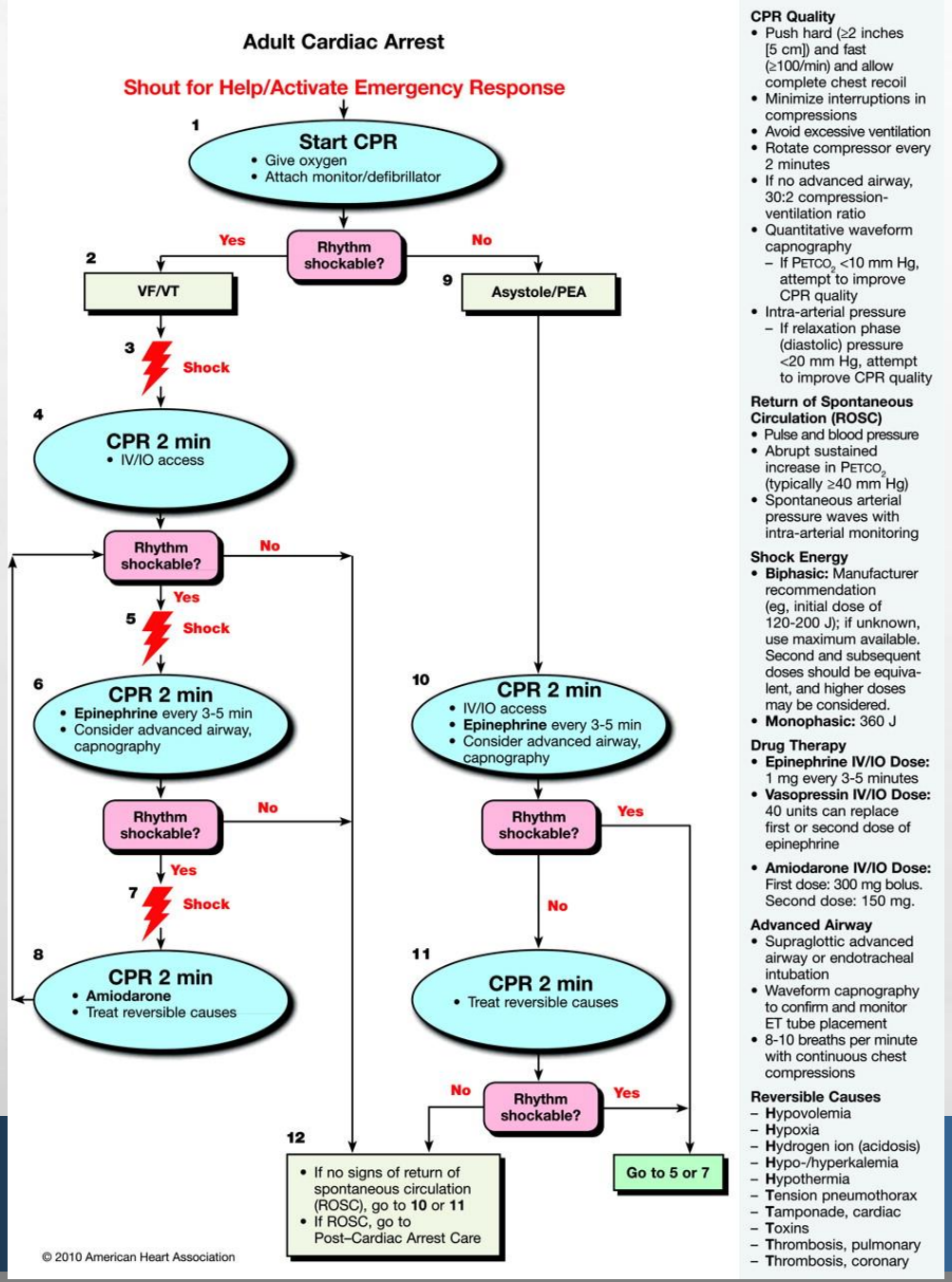
SCENARIO #1

- You respond to a code blue for a patient in 4 Jones rehabilitation unit.
- On arrival you find the patient in the corner of the room in a vail bed, pulseless
- What do you do next?

WHAT DO YOU DO?

A. Freak out
B. Tear open the vail bed with Hulk-like strength
C. Unzip the vail bed and start chest compressions
D. Yell at the 43 nurses in the room to get the crash cart

ACLS Cardiac Arrest Algorithm.



CPR Quality
- Push hard (≥2 inches [5 cm]) and fast (≥100/min) and allow complete chest recoil
- Minimize interruptions in compressions
- Avoid excessive ventilation
- Rotate compressor every 2 minutes
- 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

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

Shock Energy
- **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
- **Vasopressin IV/IO Dose:** 40 units can replace first or second dose of epinephrine
- **Amiodarone IV/IO Dose:** First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway
- Supraglottic advanced airway or endotracheal intubation
- Waveform capnography to confirm and monitor ET tube placement
- 8-10 breaths per minute with continuous chest compressions

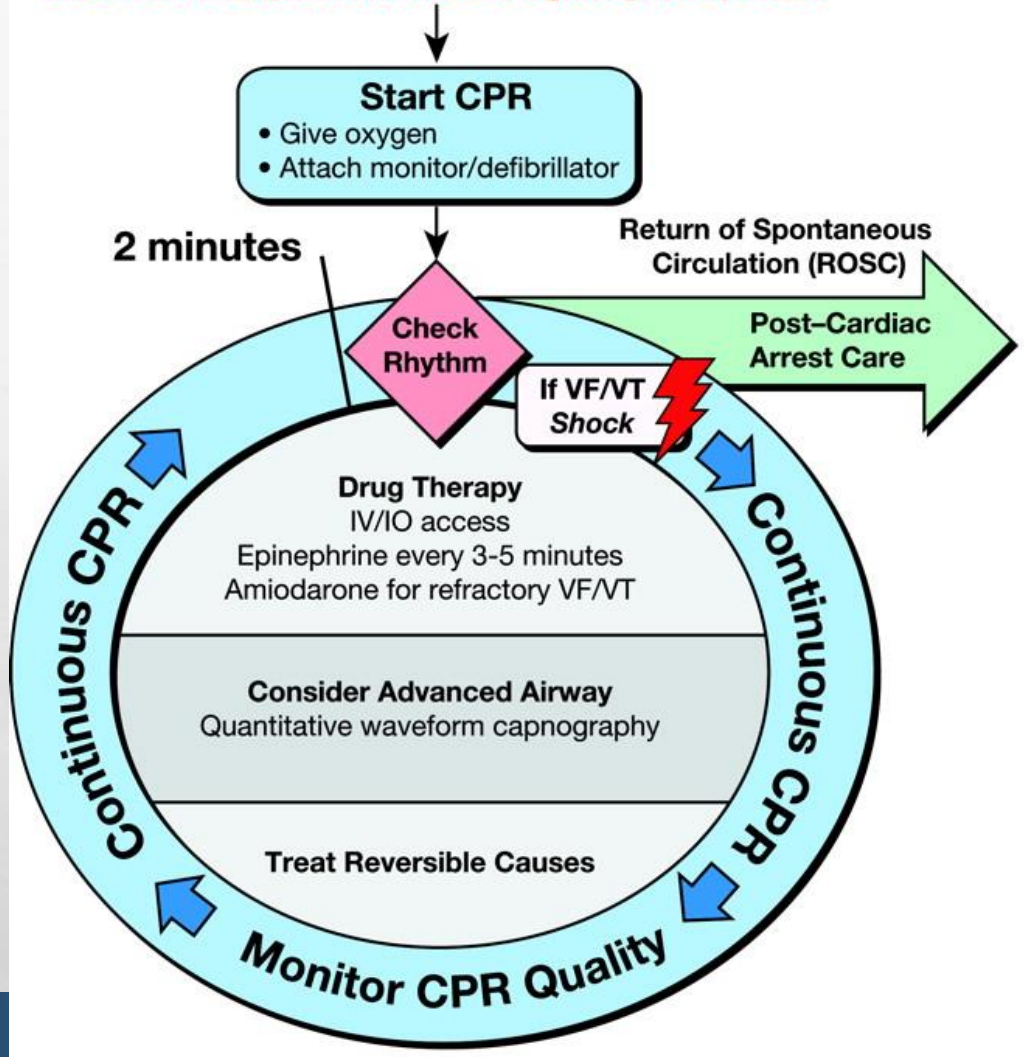
Reversible Causes
- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

Neumar R W et al. Circulation 2010;122:S729-S767

American Heart Association
Learn and Live

American Heart Association
Learn and Live

Adult Cardiac Arrest



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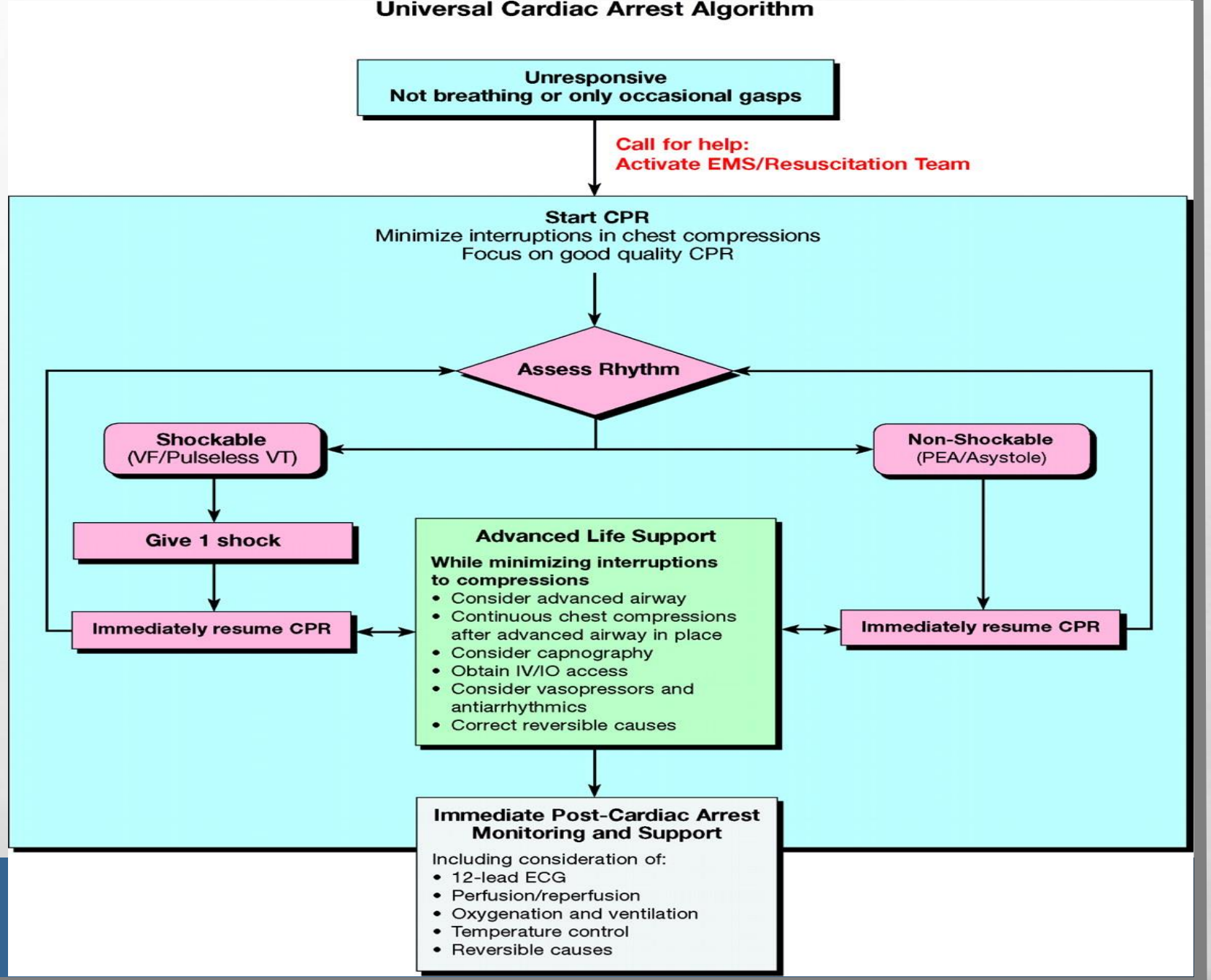


Hazinski M F et al. Circulation. 2010;122:S250-S275

American Heart Association.

ORIGINS OF CPR

Airway

"But that life may . . . be restored to the animal, an opening must be attempted in the trunk of the trachea, into which a tube of reed or cane should be put."

Andreas Vesalius, 1540[2]

Breathing

"I applied my mouth close to his, and blowed my breath as strong as I could."

William Tossach, 1744[10]

Circulation

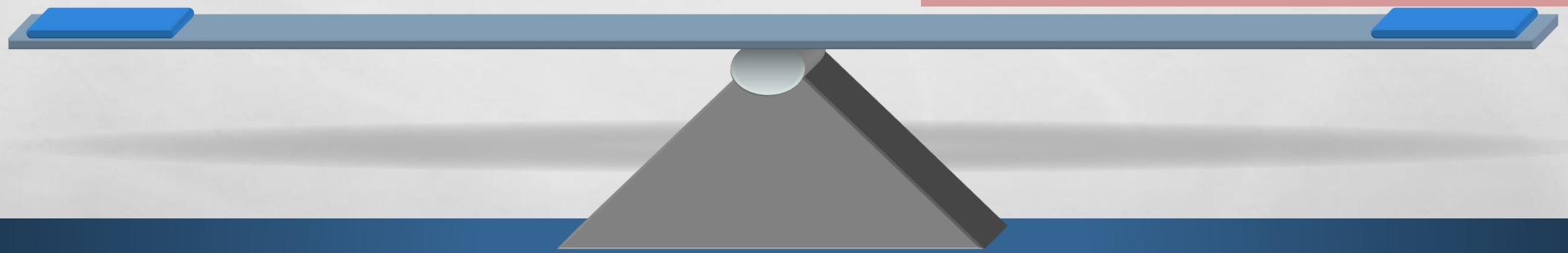
"I now had to regard the patient as dead. In spite of this, I returned immediately to the direct compression of the region of the heart."

Friedrich Maass, 1892[23,24]

INTERACTION OF DIFFERENT FACTORS

- Age
- Gender/Race/Ethnicity
- Morbidity

- First Monitored Rhythm
- Event Intervals
- Event Duration
- Hospital Location
- Time of Day



SCENARIO #1 (CONT.)

- You indeed tear open the vail bed and start compressions
- You yell at the 43 nurses standing around
- The crash cart is opened
- The cardiology fellow is placing a line
- You are doing chest compressions
- No one is bagging the patient

SCENARIO #1 (CONT.)

- Others finally come to your aid and good quality chest compressions are being done
- The patient is asystole when hooked up to the crash cart monitor
- A femoral central line is secured and IV medications are being given as well as IVF
- You attempt to bag the patient but you are getting very weak chest rise
- And the bed is stuck in the down position
- You get down on the floor and attempt intubation but are unable to intubate the patient after 2 attempts
- Anesthesia is on holiday and are unable to assist you
- What do you do to obtain an airway?

WHAT DO YOU DO TO OBTAIN AN AIRWAY?

A. Intubate the patient with GlideScope
B. Place an LMA
C. Emergent surgical airway
D. Bag the patient with an oral airway

DIFFICULT AIRWAY ALGORITHM

Plan A: Direct Laryngoscopy

Plan B: GlideScope

Plan C: Fiberoptic Intubation

Plan D: Intubate through LMA

Bailout: Ventilate through LMA and call for help

Plan Last: Emergent Surgical Airway

SCENARIO #2

- You are called to see a patient that is sent from MIMU to MICU by rapid response
- On arrival, the patient is awake and delirious
- HR 40, BP 80/42, sPo2 94%
- What do you do next?

APPROACH TO BRADYCARDIA

Causes

- Intrinsic
  - Sinus node dysfunction
  - Athletic heart
  - Inferior MI
  - Surgery
  - Collagen-vascular disease
  - Infiltrative disease
- Extrinsic
  - Vagal-mediated
  - Hypothermia
  - Metabolic acidosis
  - Hypoxia
  - Electrolyte disorders
  - Sepsis
  - Increased ICP
  - Medications

Treatments

- Is the patient symptomatic?
  - Remove medications causing bradycardia
  - Correct metabolic disturbances
  - Avoid triggers causing vagal-mediated reaction
- Medical intervention
  - Atropine
  - Epinephrine
  - Dopamine
  - Isoproterenol
  - Glucagon
- Temporary/permanent pacing

SCENARIO #2 (CONT.)

- You recognize the patient's confusion to be a sign of inadequate cerebral perfusion
- You correctly label the patient's condition as symptomatic bradycardia
- You start a dopamine drip and connect the transcutaneous pacer pads
- You call cardiology for emergent transvenous pacer
- You then have a chance to read the chart and realize that the team has been giving escalating doses of beta-blocker medication to this patient

APPROACH TO CHANGE IN MENTAL STATUS

Questions to answer:

Is my patient having a stroke?

- When in doubt/if patient has focal deficits, get a STAT noncontrast Head CT.

Is my patient having an MI?

- Consider EKG, cardiac enzymes

Does my patient have sepsis?

- Does your patient need IVF bolus for hypotension?
- Does your patient need IV antibiotics urgently?

DEFINITIONS OF IMPAIRED CONSCIOUSNESS

- **Drowsiness**
  - State of impaired awareness associated with desire or inclination to sleep
- **Stupor**
  - State of impaired consciousness where the individual shows markedly diminished reactivity to environmental stimuli
- **Comatose**
  - State of profound unconsciousness where one cannot be aroused

DELIRIUM

1. Acute onset of fluctuating mental status
2. Inattention
3. Disorganized thinking
4. Altered level of consciousness

For diagnosis need 1 & 2 + 3 or 4

Delirium is a medical emergency!

CLUES IN ASSOCIATIONS

- Altered mental status + Diabetes
  - Think of oral hypoglycemics, get a finger stick!
- Altered mental status + Fever
  - Think meningitis/encephalitis/UTI
- Altered mental status + Hypotension
  - Think sepsis or inferior MI
- Altered mental status + Dyspnea
  - Think pneumonia or MI/CHF
- Altered mental status + Hemparesis or Dysarthria
  - Think stroke
- Altered mental status + Failure to thrive
  - Think hyponatremia

SCENARIO #3

- You respond to code blue on 3 cullen
- On arrival to the room, you notice the patient is a 20 yr old white man
- He is found half way between the bathroom and the bed
- He is pulseless
- What do you do?

WHAT DO YOU DO?

A. Put him back in bed
B. Code him on the floor

SCENARIO #3 (CONT.)

- You call for help and the cavalry arrives
- You place him into bed
- Chest compressions are started
- A sinus brady rhythm is showing on the monitor, but he is pulseless

PEA DIFFERENTIAL DX

H's

- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hyper/hypokalemia
- Hypoglycemia
- Hypothermia

T's

- Tablets/Toxins
- Tamponade (cardiac)
- Tension pneumothorax
- Thrombosis (coronary)
- Thrombosis (pulmonary)
- Trauma

SCENARIO #3 (CONT.)

- You continue to code the 20 year old for 30 minutes
- You have central access and according to perfect acls algorithm, he has gotten pulse checks every 2 minutes and epinephrine every 3-5 minutes
- He has an advanced airway in place that has been verified by capnography and bilateral breath sounds
- You place $EtCO_2$ and it shows 10-20 mm Hg
- What additional considerations might you have at this point?

PREDICTORS OF SURVIVAL- ETCO2?

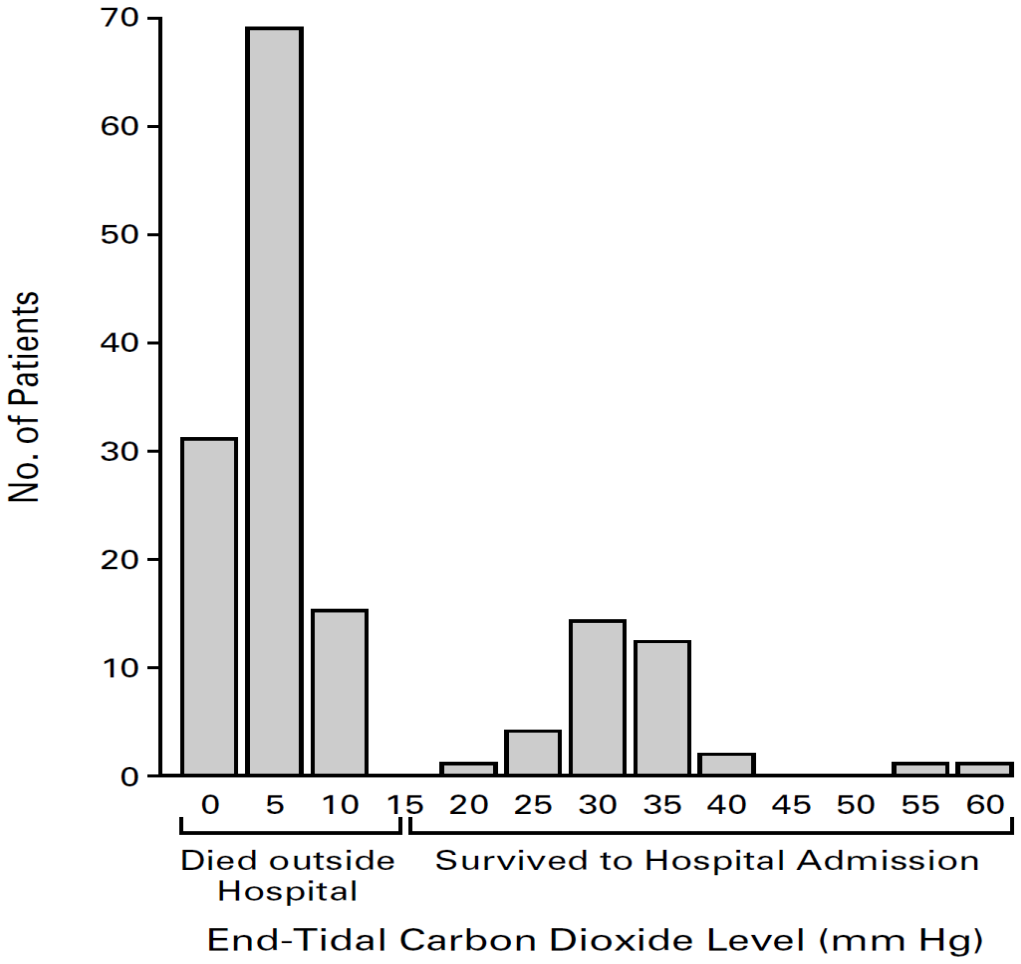


Figure 1. Histogram of Number of Patients (Frequency) at Each Value for End-Tidal Carbon Dioxide, with Standard "Midpoint" Groupings.

TABLE 2. END-TIDAL CARBON DIOXIDE VALUES IN PATIENTS WHO DIED IN THE HOSPITAL AND IN THOSE WHO SURVIVED TO DISCHARGE FROM THE HOSPITAL.

VARIABLE	DIED IN HOSPITAL (N = 19)	SURVIVED TO DISCHARGE (N = 16)*	P VALUE†
	mean ±SD (range)		
Age (yr)	76.8±6.9 (64–89)	65.2±15.7 (27–90)	0.009
End-tidal carbon dioxide (mm Hg)‡			
Initial	11.9±5.1 (5–20)	12.5±4.1 (7–22)	0.68
Final	31.8±7.3 (18–56)	34.0±7.7 (24–58)	0.28

*Fourteen of these 16 patients were still alive six weeks after discharge from the hospital.

†P values were calculated with the Wilcoxon rank–sum statistic.

‡Initial end-tidal carbon dioxide levels were determined immediately upon intubation. Final end-tidal carbon dioxide levels were determined after 20 minutes of advanced cardiac life support.

Levine, NEJM 1997

WHO SHOULD GET E-CPR?

- Young patients
- Reversible cause
- Early initiation
- Good quality CPR
- Make sure ECMO is available

HOW MUCH TIME SHOULD YOU BE CODED?

Between 2000 and 2008, 64,339 patients with cardiac arrests at 435 US hospitals within the Get With The Guidelines—Resuscitation registry.

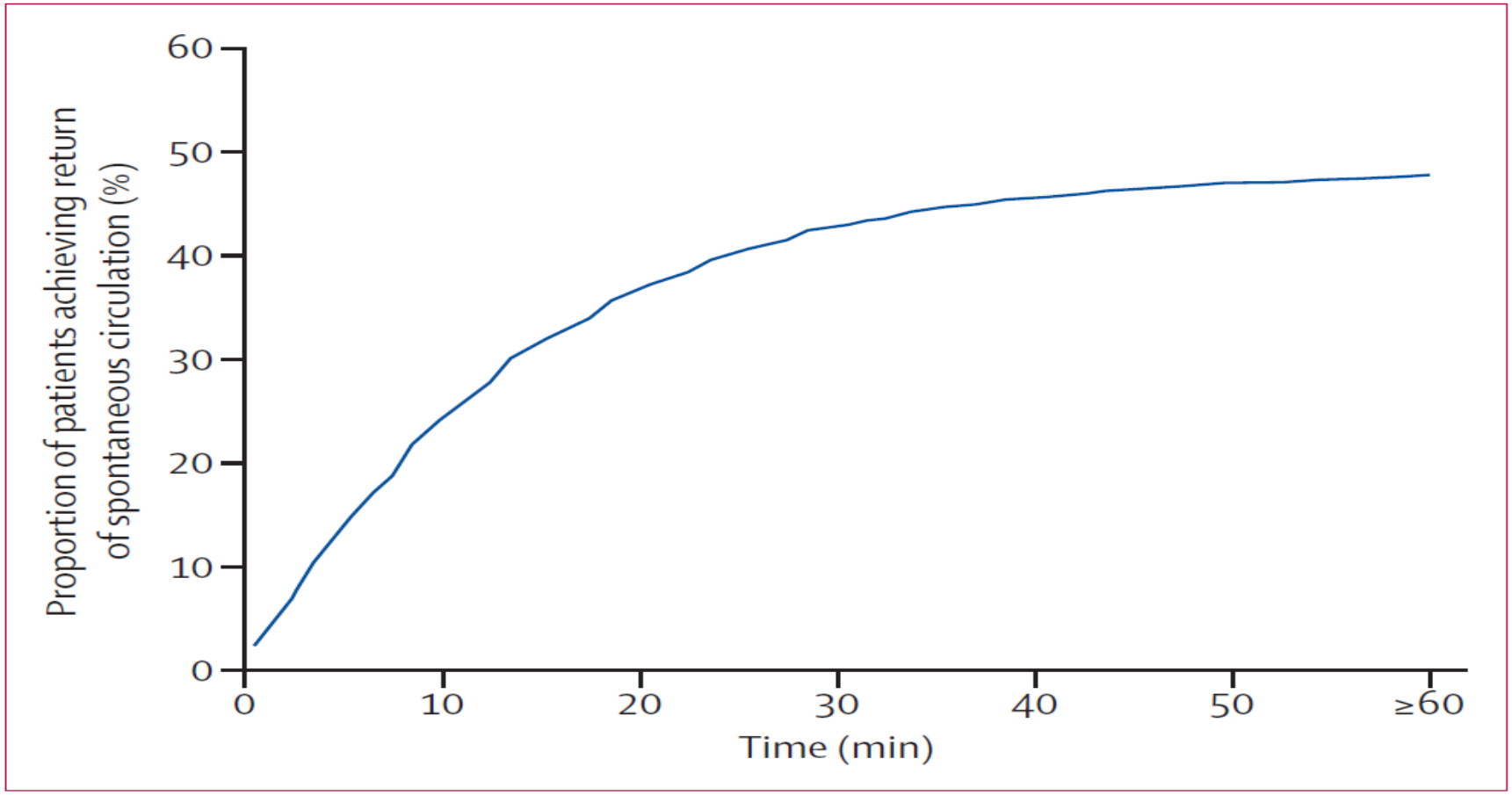


Figure 1: Cumulative proportion of patients achieving return of spontaneous circulation

Goldberger, Lancet 2012

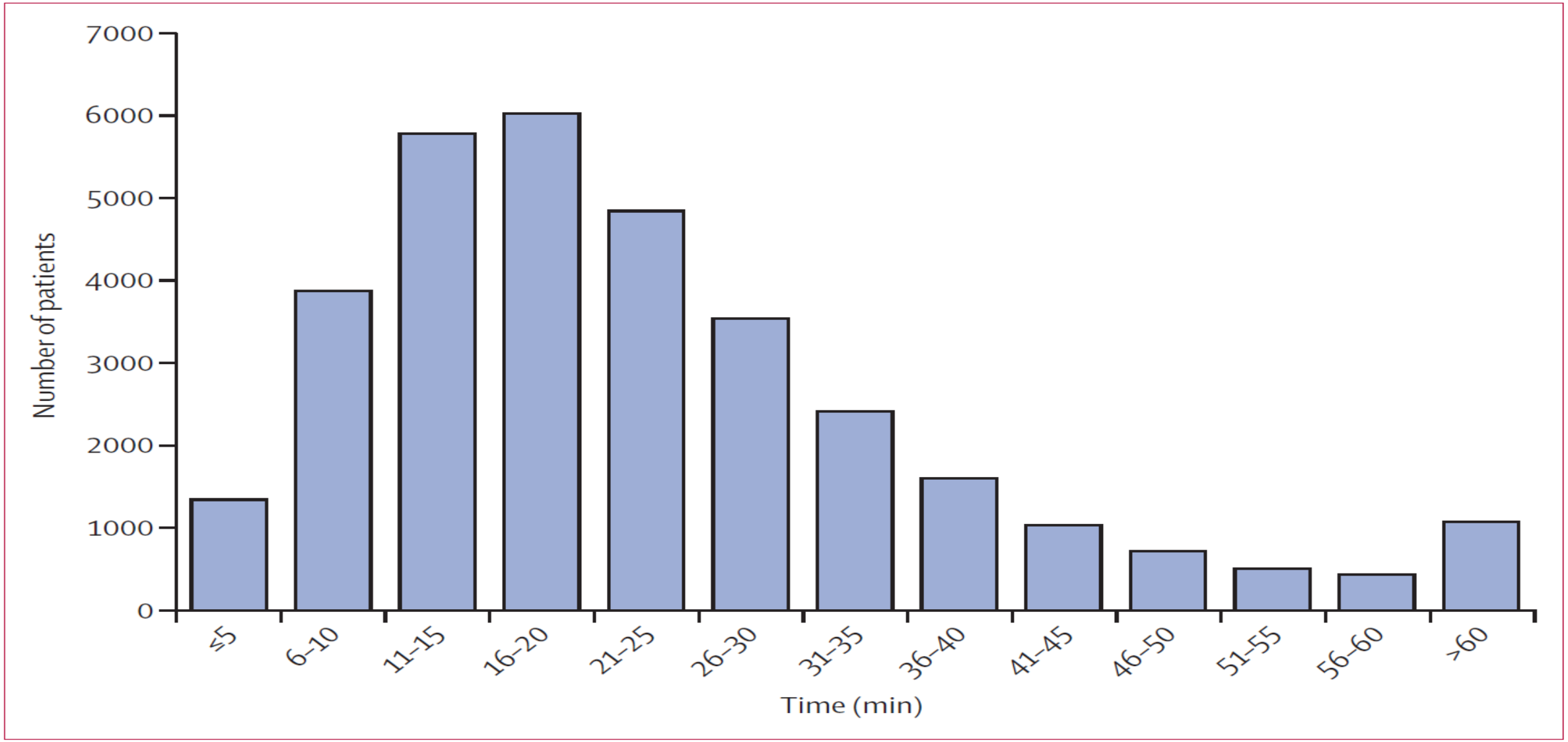


Figure 2: **Duration of resuscitation attempts in non-survivors**
N=33 141.

Goldberger, Lancet 2012

Duration of resuscitation efforts and survival after in-hospital cardiac arrest: an observational study

	Return of spontaneous circulation*			Survival to discharge†		
	Adjusted risk ratio (95% CI)	Adjusted rate	p value	Adjusted risk ratio (95% CI)	Adjusted rate	p value
Quartile 1 (13 994 patients at 113 hospitals)	1·00	45·3%	..	1·00	14·5%	..
Quartile 2 (18 783 patients at 121 hospitals)	1·04 (0·99–1·09)	47·0%	0·116	1·05 (0·96–1·14)	15·2%	0·304
Quartile 3 (19 106 patients at 107 hospitals)	1·08 (1·03–1·13)	48·8%	0·002	1·05 (0·96–1·14)	15·2%	0·280
Quartile 4 (12 456 patients at 94 hospitals)	1·12 (1·06–1·18)	50·7%	<0·0001	1·12 (1·02–1·23)	16·2%	0·021

*p for trend <0·0001. †p for trend 0·031.

Table 3: Return of spontaneous circulation and survival to discharge in all patients, by hospital quartile

Goldberger, Lancet 2012

Table 4: Return of spontaneous circulation in patients stratified by presenting rhythm of pulseless electrical activity or asystole versus ventricular tachycardia or fibrillation, by hospital quartile*

	Pulseless electrical activity or asystole†			Ventricular tachycardia or fibrillation‡		
	Adjusted risk ratio (95% CI)	Adjusted rate	p value	Adjusted risk ratio (95% CI)	Adjusted rate	p value
Quartile 1 (13 994 patients at 113 hospitals)	1·00	41·6%	..	1·00	60·6%	..
Quartile 2 (18 783 patients at 121 hospitals)	1·04 (0·99–1·09)	43·1%	0·158	1·03 (0·98–1·08)	62·4%	0·224
Quartile 3 (19 106 patients at 107 hospitals)	1·10 (1·04–1·16)	45·6%	0·001	1·02 (0·98–1·07)	61·8%	0·400
Quartile 4 (12 456 patients at 94 hospitals)	1·15 (1·08–1·22)	47·7%	<0·0001	1·06 (1·01–1·11)	64·1%	0·027

*p for interaction 0·002. †p for trend <0·0001. ‡p for trend 0·065.

Table 5: Survival to discharge in patients stratified by presenting rhythm of pulseless electrical activity or asystole versus ventricular tachycardia or fibrillation, by hospital quartile*

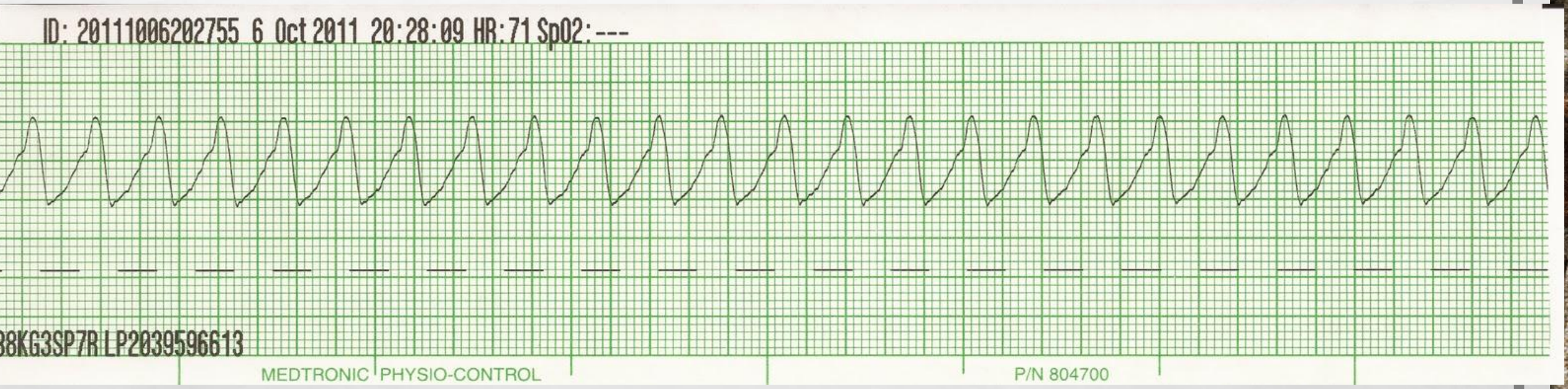
	Pulseless electrical activity or asystole†			Ventricular tachycardia or fibrillation‡		
	Adjusted risk ratio (95% CI)	Adjusted rate	p value	Adjusted risk ratio (95% CI)	Adjusted rate	p value
Quartile 1 (13 994 patients at 113 hospitals)	1·00	10·2%	..	1·00	32·1%	..
Quartile 2 (18 783 patients at 121 hospitals)	1·06 (0·94–1·18)	10·7%	0·351	1·03 (0·96–1·11)	33·2%	0·399
Quartile 3 (19 106 patients at 107 hospitals)	1·09 (0·97–1·23)	11·1%	0·132	0·98 (0·90–1·06)	31·4%	0·570
Quartile 4 (12 456 patients at 94 hospitals)	1·20 (1·05–1·36)	12·2%	0·006	1·02 (0·93–1·12)	32·8%	0·662

*p for interaction <0·0001. †p for trend 0·005. ‡p for trend 0·886.

Goldberger, Lancet 2012

SCENARIO #4

- You are in the CCU
- You are a budding cardiologist
- You are seeing a 75 year old man with some hypoxemia on nasal cannula and obtaining a history
- He has atrial fibrillation on the monitor and you hear a harsh 3/6 SEM at the LUSB
- As you sit him up in bed, he becomes unresponsive
- On the monitor you see…


ID: 20111006202755 6 Oct 2011 20:28:09 HR:71 SpO2:---
88KG3SP7R LP2039596613
MEDTRONIC PHYSIO-CONTROL
P/N 804700

WHAT DO YOU DO?

A. Call a code
B. Push lidocaine
C. Start amiodarone
D. Give metoprolol
E. Pass out

SCENARIO #5

- You are minding your own business walking through 3C at night
- You have just finished a wonderful LBJ cafeteria meal
- You are checking on a middle-aged man that your co-resident admitted earlier in the day
- His history is unfamiliar to you but you think he has cancer and you heard the nurse say something about fever
- You notice his heart rate is 110 on the monitor, his BP 90/40, his SpO2 92% on nasal cannula and for some reason, the respiration monitor is picking up and says 30 bpm

YOU ARE WHICH OF THE FOLLOWING?

A. Not interested, you are already having a long day
B. Curious about the chemotherapy regimen that he is on
C. Too busy watching the world cup
D. Curious, but not enough to examine him
E. Concerned enough to call a rapid response

WHEN TO CONSIDER RAPID RESPONSE

- When the patient is hypotensive and not responsive to 2L IVF
- When patient has an unstable tachyarrhythmia
- When the patient is tachypneic and not readily responding to conservative measures
- When the patient is obtunded
- If you require NIPPV for rescue
- When the patient's vital signs are deteriorating
- Bottom line: better to call rapid response before the 'code blue'

SIRS CRITERIA

- Temperature < 36° C or > 38° C
- Heart Rate > 90 bpm
- Respiratory Rate > 20 breaths/MIN or $PaCO_2$ < 32 mmHg
- White Blood Cell Count > 12,000 or < 4,000 cells/mm^3 or > 10% bands

SHOCK

- Cardiogenic shock - a major component of the the mortality associated with cardiovascular disease (the #1 cause of U.S. deaths)
- Hypovolemic shock - the major contributor to early mortality from trauma (the #1 cause of death in those < 45 years of age)
- Septic shock - the most common cause of death in American ICUs (the 13th leading cause of death overall in US)

APPROACH TO HYPOTENSION

Question 1: Is this patient in shock?

*Are there signs of end-organ hypoperfusion?

- Altered mental status/obtundation
- AKI manifested by oliguria
- Lactic acidosis
- Cool skin/extremities
- Decreased mean blood pressure
- Tachycardia

Question 2: If the patient is in shock, do they need to be intubated?

Question 3: Is the patient's cardiac output adequate?

APPROACH TO HYPOTENSION

Hypotension + Reduced Cardiac Output

Signs:

- Narrow pulse pressure
- Cool extremities/ delayed capillary refill (>3 sec)

Differential diagnosis:

- Hypovolemic Shock
- Cardiogenic Shock
- Obstructive Shock

Possible Causes:

- Hypovolemic Shock
  - Volume depletion/dehydration
  - Hemorrhage
- Cardiogenic Shock
  - Myocardial Ischemia
  - Valvular lesions
- Obstructive Shock
  - Acute Pulmonary Embolus
  - Pericardial Tamponade

Hypotension + Increased Cardiac Output

Signs:

- Widened pulse pressure
- Warm extremities/ bounding pulses

- Differential diagnosis: You can infer from this situation that the increased cardiac output with hypotension is due to reduced SVR = DISTRIBUTIVE SHOCK

Possible Causes:

- Sepsis/Septic Shock
- Liver failure
- Pancreatitis
- Burns/Trauma
- Anaphylaxis
- Thyrotoxicosis
- Neurogenic Shock

RESPIRATORY FAILURE

Is the patient appropriate for NIPPV (Noninvasive Positive Pressure Ventilation a.k.a. CPAP or BiPap®)?

- ✓ COPD exacerbation
- ✓ Cardiogenic pulmonary edema
- ✓ Hypoxemic respiratory failure in immunosuppressed patients
- ✓ Hypoxemic respiratory failure in post-thoracotomy patients
- ✓ End of life palliative respiratory failure

When Not to use NIV

Hemodynamic Instability	Aspiration Risk	Ineffective Therapy/ Delay in Therapy	Facial Anatomy Concerns
• Shock • Cardiac arrest	• Coma/altered mentation • Inability to protect airway • Vomiting/bowel obstruction • Recent upper GI surgery	Life threatening hypoxemia • Severe pneumonia • Pneumothorax	• Facial/upper airway surgery • Facial burns/trauma • Fixed upper airway obstruction • Copious secretions

Meduri, Clin Chest Med 1996
Gupta, Respiratory Care 2013

NEWEST RECOMMENDATIONS

High-quality CPR should be recognized as the foundation on which all other resuscitative efforts are built. Target CPR performance metrics include:

- **a. CCF >80% (proportion of code that chest compressions are ongoing)**
- **b. Compression rate of 100–120/min**
- **c. Compression depth of ≥50 mm in adults with no residual leaning**
  - **i. (At least one third the anterior-posterior dimension of the chest in infants and children)**
- **d. Avoid excessive ventilation**
  - **i. (Only minimal chest rise and a rate of <12 breaths/min)**

Circulation. 2013;128:417-435

QUALITY IMPROVEMENT

- Simplify CPR
  - 15:2→30:2→Continuous Chest Compressions
  - “Hands Only” for Adults
  - Conventional CPR for Children
- Quality CPR
- De-emphasis of ACLS Drugs
- Minimize interruptions in Chest Compressions and Compression-Shock interval
- Organized Post-Cardiac Arrest Care

"A-B-C" TO "C-A-B"

- Early onset of chest compressions (30 sec to 18 sec)
- Early chest compressions→ Early defibrillation
- Increase likelihood of bystander CPR with emphasis on chest compressions
- "It is reasonable for healthcare providers to tailor the sequence of rescue actions to the most likely cause of arrest."

AIRWAY MANAGEMENT

- Class I recommendation for adults: use of quantitative waveform capnography for confirmation and monitoring of endotracheal tube placement.
- The use of supraglottic advanced airways continues to be supported as an alternative to endotracheal intubation for airway management during CPR.
- The routine use of cricoid pressure during airway management of patients in cardiac arrest is no longer recommended.

THE END