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**Objectives**

1. Review the recent literature and guidelines regarding out-of-hospital cardiac arrest management and **post-cardiac arrest care**.
2. Discuss the **optimal hemodynamic targets** in the management of post cardiac arrest patients in the emergency department.
3. Discuss the optimal **management of post-resuscitation shock**.
4. Examine the recent evidence for non-traditional advanced therapies for cardiac arrest including **double sequential external defibrillation and ECMO/ECPR**.
5. Examine the evidence regarding the utility of **therapeutic hypothermia versus targeted temperature management**.

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**Airway**  
**Breathing**  
**Circulation**  
**Disability**  
**Environment**  
 Further Considerations

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**Airway**

Available online at ScienceDirect  
**Resuscitation**  
journal homepage: www.elsevier.com/locate/resuscitation

**Clinical paper**  
**First attempt success with continued versus paused chest compressions during cardiac arrest in the emergency department**

- **Q: First attempt intubation success with continuous vs paused CPR?**
- Hennepin ED
- Intubations mostly by senior EM residents ~ 85%.
- >90% intubations with C-Mac + standard blade + bougie.
- Successful placement confirmed by waveform capnography.
- **✓ First attempt success -- higher in continued CPR group (87%) vs interrupted CPR group (65%), + 22%.**

Robinson AE, et al. First attempt success with continued versus paused chest compressions during cardiac arrest in the emergency department. Resuscitation. 2023 Feb.

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✓ Mechanical Ventilation  
 ✓ Oxygenation Targets

Breathing **B**

The Ventilator is a Weapon!  
 The Ventilator is a Weapon!  
 The Ventilator is a Weapon!  
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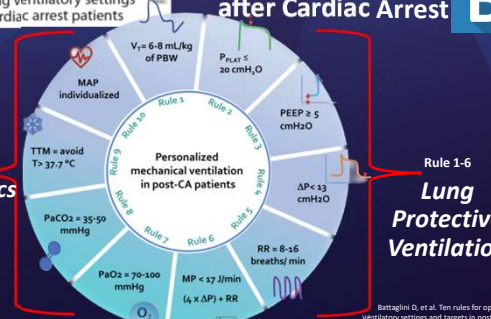
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REVIEW Open Access Mechanical Ventilation after Cardiac Arrest **B**

Ten rules for optimizing ventilatory settings and targets in post-cardiac arrest patients



Personalized mechanical ventilation in post-CA patients

Rule 1:  $V_t = 6-8 \text{ mL/kg}$  of PBW  
 Rule 2:  $P_{PLAT} \leq 28 \text{ cmH}_2\text{O}$   
 Rule 3:  $PEEP \geq 5 \text{ cmH}_2\text{O}$   
 Rule 4:  $\Delta P < 13 \text{ cmH}_2\text{O}$   
 Rule 5:  $RR = 8-16$  breaths/min  
 Rule 6:  $MP < 17 \text{ J/min}$  ( $4 \times \Delta P + RR$ )  
 Rule 7:  $PaO_2 = 70-100 \text{ mmHg}$   
 Rule 8:  $PaCO_2 = 35-50 \text{ mmHg}$   
 Rule 9:  $TTM = \text{avoid}$   $T > 37.7^\circ\text{C}$   
 Rule 10: MAP individualized

Hemodynamics TTM  
 Lung Protective Ventilation

Battaglini D, et al. Ten rules for optimizing ventilatory settings and targets in post-cardiac arrest patients. Crit Care. 2022; Dec

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Mechanical Ventilation after Cardiac Arrest **B**

REVIEW Open Access

Ten rules for optimizing ventilatory settings and targets in post-cardiac arrest patients

Sanjay Bangari<sup>1</sup>, Paolo Pelosi<sup>2,3</sup> and Chava Roberts<sup>4</sup>

PULMONARY ORIGINAL RESEARCH

Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial

Implementation of an ED-based bundled mechanical ventilation protocol improves adherence to lung-protective ventilation<sup>6</sup>

Yukun M. Healy<sup>1\*</sup>, Brittany A. Pilbeam, MD<sup>1</sup>, Alpha S. Davis, DNP<sup>1</sup>, Morgan B. Swanson<sup>1</sup>, Joshua K. Hurland, MPH, PhD<sup>1</sup>, Justin D. Rubin, MD, MPH, PhD<sup>1,2,3,4</sup>, Brian M. Fuller, MD, MS<sup>1,2,3</sup>, Nicholas M. Moller, MD, MS<sup>1,2</sup>

More on Lung Protective Ventilation...  
 "Updates in Critical Care Management in the ED" at 11:00am!!!

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### Oxygenation Targets

## The BOX Trial

Schmidt H, et al. Oxygen Targets in Comatose Survivors of Cardiac Arrest. *N Engl J Med.* 2022 Oct

**B**

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### Oxygenation Targets

IN THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

#### Oxygen Targets in Comatose Survivors of Cardiac Arrest

H. Schmidt, J. Kjaergaard, C. Hassager, S. Melstrom, J. Grand, B. Borregaard

- Open-label, Randomized trial
- 2x2 factorial design
- **Restrictive vs Liberal oxygen target**
- 789 patients – comatose + OHCA
- TTM at 36C + on vent for 24hrs

**Restrictive Oxygen Target**  
 $\text{PaO}_2$  9–10 kPa  
 (68–75 mm Hg)  
 (N=394)

**Liberal Oxygen Target**  
 $\text{PaO}_2$  13–14 kPa  
 (98–105 mm Hg)  
 (N=395)

**B**

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### Oxygenation Targets

IN THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

#### Oxygen Targets in Comatose Survivors of Cardiac Arrest

**Death or Hospital Discharge with Severe Disability or Coma After 90 days**

Adjusted HR, 0.95  
 (95% CI, 0.75–1.21); P=0.69

Target Group	Percentage of Patients
Restrictive Target	32.0
Liberal Target	33.9

**No difference... in death or severe disability or coma at 90 days.**

**B**

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### Oxygenation Targets

**Oxygenation:**

- SpO2 92% - 98%
- PaO2 75-100 mmHg
- adjust PEEP; FiO2

**Ventilation:**

- EtCO2 35-40 mmHg
- PaCO2 35-45 mmHg
- adjust RR; Tidal Volume

HR 71

SpO<sub>2</sub> 93

etCO<sub>2</sub> 29

**B**

Schmidt H, et al. Oxygen Targets in Comatose Survivors of Cardiac Arrest. N Engl J Med. 2022 Oct. Panchal AB, et al. 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020.

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### Circulation

## Hemodynamic Targets

*Which is better...High MAP or Low MAP in OHCA survivors?*

- Double-Blind, Randomized trial
- 2x2 factorial design
- 789 patients – comatose + OHCA

**The BOX Trial**

ORIGINAL ARTICLE

Blood-Pressure Targets in Comatose Survivors of Cardiac Arrest

J. Kjergaard, J.E. Møller, H. Schmidt, J. Grand, S. Malmström, B. Borregaard.

**MAP target**  
63 mmHg vs 77 mmHg

**C**

Kjergaard J, et al. Blood-Pressure Targets in Comatose Survivors of Cardiac Arrest. N Engl J Med. 2022 Oct.

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### Hemodynamic Targets

ORIGINAL ARTICLE

Blood-Pressure Targets in Comatose Survivors of Cardiac Arrest

**Probability of Survival Free from a Primary-Outcome Event**

**Death or Severe Disability or Coma within 90 Days (Primary Outcome)**

HR, 1.08 (95% CI, 0.84-1.37); P=0.56

**No significant difference in death or severe disability or coma at 90 days.**

**C**

Kjergaard J, et al. Blood-Pressure Targets in Comatose Survivors of Cardiac Arrest. N Engl J Med. 2022 Oct.

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### Refractory V Fib/V Tach after ACLS?

- ✓ ACLS
- ✓ Magnesium, Amiodarone
- ✓ Lidocaine
- ✓ Esmolol/Beta-Blockers
- **...Double Simultaneous/Dual Sequence Defibrillation??**



**DOUBLE SIMULTANEOUS DEFIBRILLATORS FOR REFRACTORY VENTRICULAR FIBRILLATION**

Benjamin W. Leacock, MD  
 Emergency Physicians of St. Louis, St. Louis, Missouri  
 Reprint Address: Benjamin W. Leacock, MD, Emergency Physicians of St. Louis, 10010 Kewberly Rd., St. Louis, MO 63128  
 J Emerg Med. 2014 Apr

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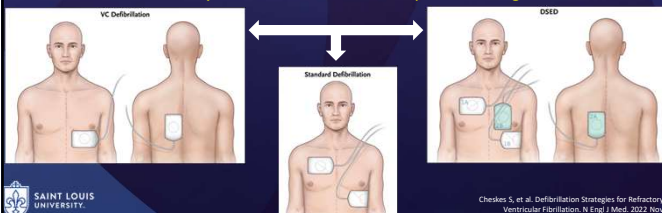
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### The DOSE-VF Trial

#### Defibrillation Strategies for Refractory Ventricular Fibrillation

- 3-group, cluster-randomized, controlled trial with crossover
- 405 adults in OHCA; 6 Canadian paramedic services
- **Primary outcome: Survival to Hospital discharge**



VC Defibrillation

Standard Defibrillation

DSED

Checkes S, et al. Defibrillation Strategies for Refractory Ventricular Fibrillation. N Engl J Med. 2021 Nov

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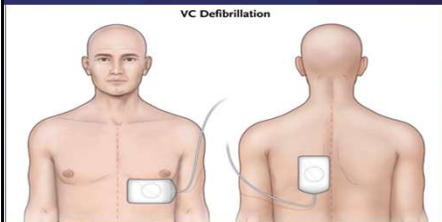
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### The DOSE-VF Trial

#### Defibrillation Strategies for Refractory Ventricular Fibrillation



VC Defibrillation

**“...Survival to hospital discharge occurred more frequently with DSED or VC defibrillation than with standard defibrillation.”**

- Major limitation - Trial Stopped due to COVID-19.

Checkes S, et al. Defibrillation Strategies for Refractory Ventricular Fibrillation. N Engl J Med. 2021 Nov

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Further Considerations

**ECMO for Cardiac Arrest?**

**CPR + ECMO = E-CPR aka ECLS**

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**Where should ECMO occur?**

- OR/Cath Lab
- ICU
- **Emergency Department**
- **...Prehospital/EMS?**

**UNM debuts new response to cardiac arrest**

Folkie it has happened! University of New Mexico has performed the first prehospital ECPR in the US

Hamway, Stephen. "UNM debuts new response to cardiac arrest." Albuquerque Journal. 7 October, 2019.

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**Key Scenarios for ED-ECMO**

Hypoxemic Respiratory Failure/COVID-19	Massive Pulmonary Embolism
Toxicologic Overdoses	Severe Cardiogenic Shock
<div style="border: 2px solid red; border-radius: 50%; padding: 5px; display: inline-block;"> <b>Cardiac Arrest/ Refractory Ventricular Tachyarrhythmias</b> </div>	

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## QUESTIONS?




**Kene Chukwuana, MD**  
[Kene.Chukwuana@health.slu.edu](mailto:Kene.Chukwuana@health.slu.edu)

Emergency Medicine





## Thank You!



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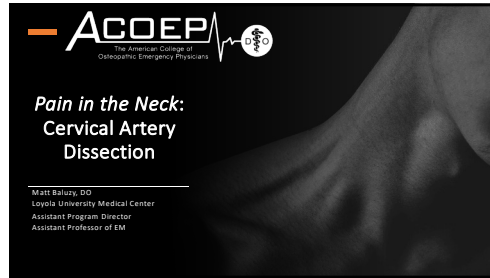
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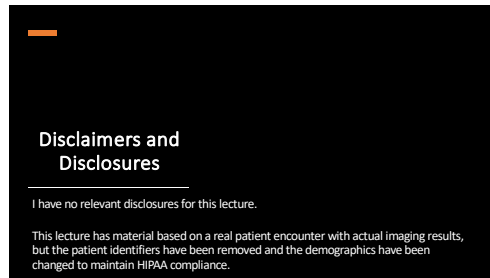
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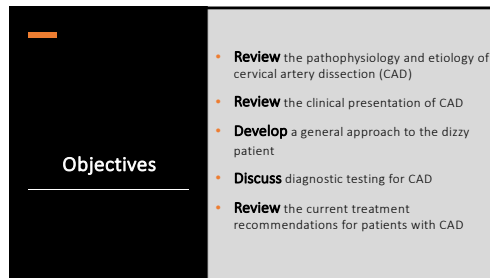
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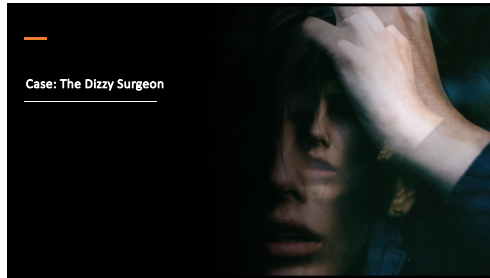
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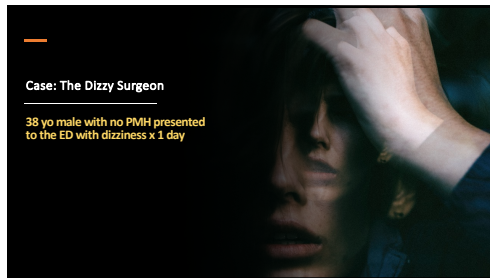
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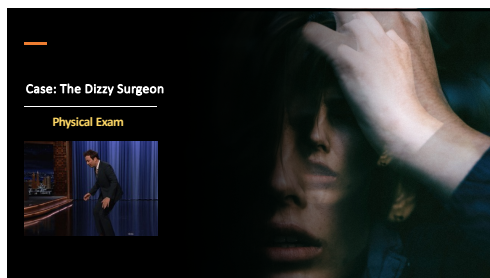
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A dizzy detour...

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A - B - C

A dizzy detour...

HR 120    BP 85/60



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A - B - C

A dizzy detour...

Neurologic Assessment

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A – B – C

A dizzy detour...

Neurologic Assessment

HINTS

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Cervical Artery Dissection

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Cervical Artery Dissection

**Fast Facts:**

**What is it?**

- Tear in the arterial wall under pressure, leading to a false lumen and hematoma formation
- Involves either the internal carotid artery or the vertebral artery

**Why should I care?**

- Causes 1-2% of all ischemic strokes BUT is the underlying cause of up to **25%** of ischemic strokes in young patients

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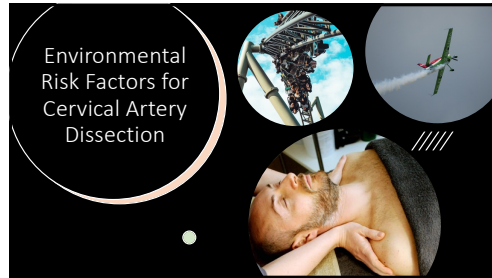
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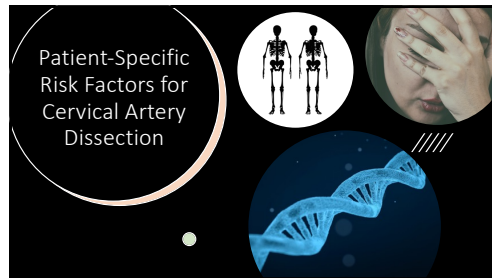
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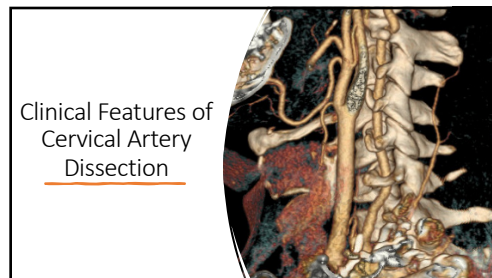
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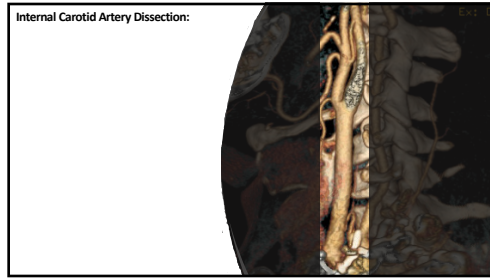
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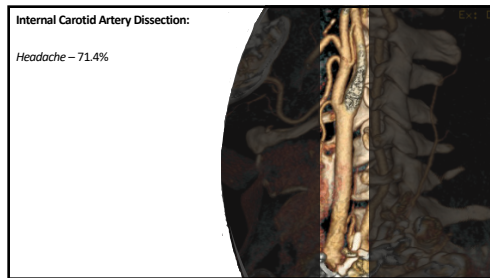
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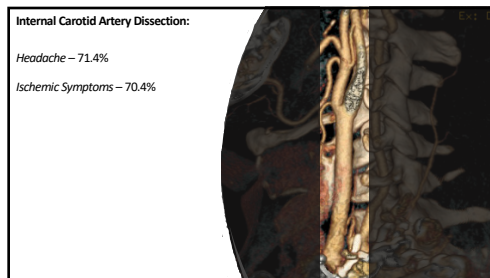
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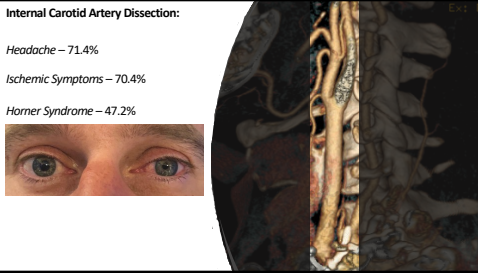
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**Internal Carotid Artery Dissection:**

- Headache – 71.4%
- Ischemic Symptoms – 70.4%
- Horner Syndrome – 47.2%



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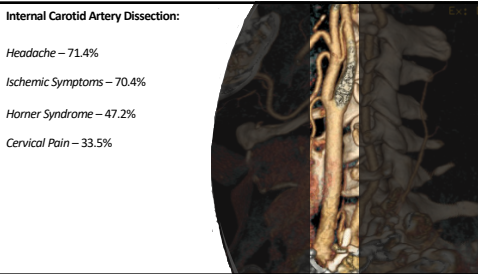
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**Internal Carotid Artery Dissection:**

- Headache – 71.4%
- Ischemic Symptoms – 70.4%
- Horner Syndrome – 47.2%
- Cervical Pain – 33.5%



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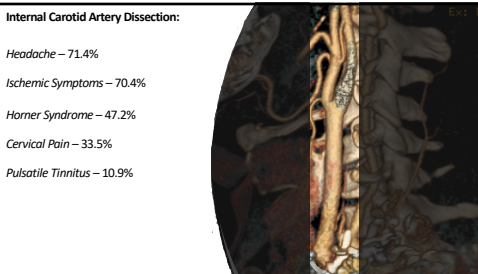
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**Internal Carotid Artery Dissection:**

- Headache – 71.4%
- Ischemic Symptoms – 70.4%
- Horner Syndrome – 47.2%
- Cervical Pain – 33.5%
- Pulsatile Tinnitus – 10.9%



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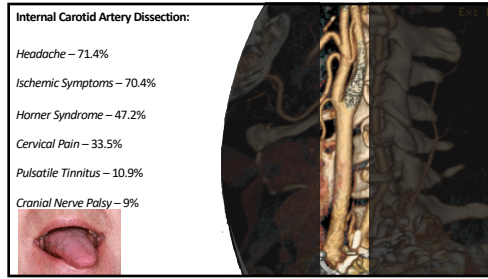
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**Internal Carotid Artery Dissection:**

- Headache – 71.4%
- Ischemic Symptoms – 70.4%
- Horner Syndrome – 47.2%
- Cervical Pain – 33.5%
- Pulsatile Tinnitus – 10.9%
- Cranial Nerve Palsy – 9%



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**Vertebral Artery Dissection**



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**Vertebral Artery Dissection**

Ischemic Symptoms – 84.4



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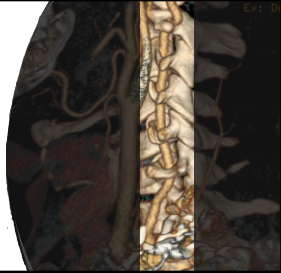
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**Vertebral Artery Dissection**

Ischemic Symptoms – 84.4

Headache – 70.4%

\*Thunderclap – 9.2%



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A thundering  
detour...



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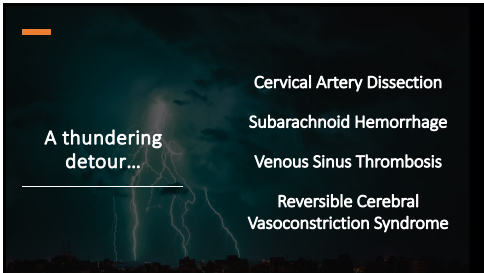
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A thundering  
detour...

- Cervical Artery Dissection
- Subarachnoid Hemorrhage
- Venous Sinus Thrombosis
- Reversible Cerebral Vasoconstriction Syndrome



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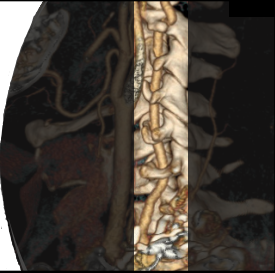
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**Vertebral Artery Dissection**

Ischemic Symptoms – 84.4  
Headache – 70.4%  
\*Thunderclap – 9.2%  
Cervical Pain – 65.8%



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**Diagnostic Imaging of Cervical Artery Dissection**

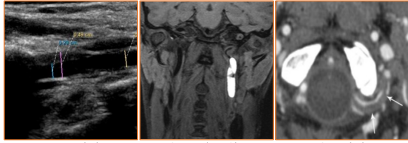


Image 1. Vertebral artery dissection on ultrasound.  
Image 2. Internal carotid artery dissection and mural hematoma on MRA.  
Image 3. Vertebral artery occlusion from dissection on CTA.

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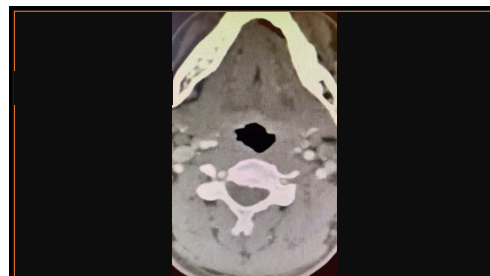
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### Treatment of Cervical Artery Dissection

Dissection with ischemic stroke < 4.5 hours from symptom onset	Dissection with ischemic stroke > 4.5 hours from symptom onset	Dissection without ischemic stroke
<ul style="list-style-type: none"> <li>Consider thrombolytics</li> <li>Antiplatelets OR Anticoagulants</li> <li>+/- Mechanical intervention</li> </ul>	<ul style="list-style-type: none"> <li>Antiplatelets OR Anticoagulants</li> <li>+/- Mechanical intervention</li> </ul>	<ul style="list-style-type: none"> <li>Antiplatelets OR Anticoagulants</li> </ul>

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### Treatment of Cervical Artery Dissection

Dissection with ischemic stroke < 4.5 hours from symptom onset	Dissection with ischemic stroke > 4.5 hours from symptom onset	Dissection without ischemic stroke
<ul style="list-style-type: none"> <li>Consider thrombolytics</li> <li>Antiplatelets OR Anticoagulants</li> <li>+/- Mechanical intervention</li> </ul>	<ul style="list-style-type: none"> <li>Antiplatelets OR Anticoagulants</li> <li>+/- Mechanical intervention</li> </ul>	<ul style="list-style-type: none"> <li>Antiplatelets OR Anticoagulants</li> </ul>

**\*\*Caveat: Intracranial Dissection**

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— Post-infarct Cerebellar Edema

A swollen detour...

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### Objectives

- **Review** the pathophysiology and etiology of cervical artery dissection (CAD)
- **Review** the clinical presentation of CAD
- **Develop** a general approach to the dizzy patient
- **Discuss** diagnostic testing for CAD
- **Review** the current treatment recommendations for patients with CAD

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# Heart Failure updates

Peter Alamia, DO  
ACOE Spring Seminar 2023

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### New York Heart Association (NYHA) Classification of severity of Heart Failure

<b>NYHA Class I</b>	No symptoms* with normal physical activity. Normal functional status.
<b>NYHA Class II</b>	Mild symptoms* with normal physical activity. Comfortable at rest. Slight limitation of functional status.
<b>NYHA Class III</b>	Moderate symptoms* with less than normal physical activity. Comfortable only at rest. Marked limitation of functional status.
<b>NYHA Class IV</b>	Severe symptoms* with features of heart failure with minimal physical activity and even at rest. Severe limitation of functional status.

Symptoms - Fatigue, palpitations, chest pain, dyspnea, syncope

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### Classification of HF by LVEF

- HF<sub>r</sub>EF (HF with reduced EF): LVEF <40%
- HF<sub>imp</sub>EF (HF with improved EF): Previous LVEF <40%, with follow up measurement >40%
- HF<sub>m</sub>rEF (HF with mildly reduced EF): LVEF 41% - 49%
- HF<sub>p</sub>EF (HF with preserved EF): LVEF >50%

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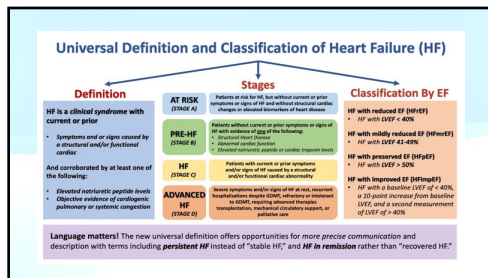
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**Use of biomarkers for Prevention, Initial Diagnosis, and Risk Stratification:**

- In patients presenting with dyspnea, BNP or NT-pro BNP is useful to support diagnosis or exclusion of heart failure
- In Emergency settings, BNP or NT-proBNP levels have a higher sensitivity than specificity and may be more useful for ruling out HF than ruling in HF
- Higher levels of biomarkers are associated with greater risk for adverse short-term and long-term outcomes
- Predischarge BNP and NT-proBNP are strong predictors of the risk of death or hospital readmission
- Reducing biomarker levels, results in improved longterm outcomes

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**Stage A:  
Primary Prevention**

- Patients with hypertension: BP should be controlled to prevent symptomatic HF
- Patients with diabetes mellitus and either established CVD or high cardiovascular risk, SGLT2i should be useful
- Patients at risk of developing HF: should have biomarker screening followed by cardiology evaluation to prevent LV dysfunction (systolic or diastolic) or new onset HF

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**Stage B:  
Preventing clinical HF syndrome in patients with Pre-HF**

- Patients with LVEF <40%: ACEi should be used to prevent symptomatic HF and reduce mortality
- Patients with recent or remote history of MI or ACS: Statins should be used to prevent symptomatic HF
- Patients with recent MI and LVEF <40%, who are intolerant to ACEi: ARB should be used to prevent symptomatic HF and reduce mortality
- Patients with recent or remote history of MI or ACS and LVEF <40%: Beta blockers should be used to reduce mortality
- Patients who are 40 days post-MI with LVEF <30% and NYHA class I: An ICD is recommended to prevent sudden death
- Patients with LVEF <50%: Non-dihydropyridine calcium channel blockers with negative inotropic effects may be harmful

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**Stage C:**

- Avoid excessive sodium intake
- Diuretics are recommended to relieve congestion, improve symptoms, and prevent worsening HF
- Addition of a thiazide diuretic to treatment with a loop diuretic should be reserved for patients who do not respond to moderate or high dose loop diuretics
- Patients with HFrEF and Class II to III symptoms: ARNI recommended to reduce morbidity and mortality
- Patients with HFrEF: ACEi is beneficial to reduce morbidity and mortality when use of a ARNI is not possible

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**Stage C:**

- Patients with HFREF: If intolerant to ACEi because of cough or angioedema and if ARNi is not feasible: Use of ARB is recommended to reduce morbidity and mortality
- PARADIGM-HF - Use of an ARNi vs ACEi (Sacubitril-Valsartan [Entresto] vs Enalapril) in symptomatic heart failure
  - ARNi reduced the endpoint of cardiovascular death and hospitalization by 20% relative to ACEi
- ARNi is composed of an ARB and a neprilysin inhibitor (Neprilysin is an enzymes that degrades natriuretic peptides, bradykinin, adrenomedullin, and other vasoactive peptides)

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**Stage C:**

**Beta Blockers:**

- Patients with HFREF, with current or previous symptoms: Use of a 1 of the 3 Beta blockers is recommended (Bisoprolol, Carvedilol, Metoprolol succinate)
- Improve LVEF
- Lessen the symptoms of HF
- Improve clinical status
- Even if Beta blocker do not improve symptoms, long term treatment helps prevent major cardiovascular events
- Should not be abruptly stopped - leads to clinical deterioration

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**Stage C:**

**Mineralocorticoid Receptor Antagonists (MRAs):**

- Aldosterone antagonists (Spironolactone or Eplerenone)
- Show consistent improvement in mortality, hospitalizations, and sudden cardiac death across a wide range of patients with HFREF
- Contraindicated in patients with eGFR <30 or serum potassium >5.0

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**Stage C:**  
**Sodium-Glucose Cotransporter 2 inhibitors (SGLT2i):**

- In patients with type 2 diabetes and established CVD or at high risk for CVD, SGLT2i prevent HF hospitalizations
- Reduction in hospitalization was irrespective of the presence of type 2 diabetes
- Two major studies:
  - DABA-HF
  - EMPORER-Reduced

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**Stage C:**  
**Sodium-Glucose Cotransporter 2 inhibitors (SGLT2i)**

- EMPORER-Reduced: with OR without diabetes
- 13% decrease in all cause death
- 14% decrease in cardiac death
- 26% decrease in hospitalization from HF
- 38% decrease in renal outcomes
- Canagliflozin (Invokana), Dapagliflozin (Farxiga), Empagliflozin (Jardiance), and Sotagliflozin (Zynquista)

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**Stage C:**  
**Hydralazine and Isosorbide dinitrate:**

- Combination of Hydralazine and Isosorbide dinitrate is beneficial in HFrEF.
- If patients with HFrEF cannot tolerate first line agents such as ARNI, ACEI, or ARB:
  - Combination of hydralazine and isosorbide dinitrate might be considered to reduce morbidity and mortality

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**Stage C:**  
**Drugs of no value or that may worsen HF:**

- Non-dihydropyridine calcium channel blocking drugs (Verapamil and Diltiazem) are not recommended – myocardial depressants
- Amlodipine - PRAISE-2 study showed no benefit
- Class IC anti-arrhythmics may increase mortality
- Flecainide and Encainide - increased mortality
- Amiodarone and Dofetilide - only anti-arrhythmics with neutral effects on mortality
- Thiazolidinediones increase the risk of worsening HF
- Patients with type 2 diabetes and high cardiovascular risk, DPP-4 inhibitors (Saxagliptin and Alogliptin) increase the risk of hospitalization
- NSAIDs worsen HF symptoms

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**Stage C:**  
**Digoxin:**

- Low dose Digoxin is better than high doses (0.125 to 0.25 mg daily)
- Higher serum concentrations of Digoxin are independently associated with a higher risk of mortality
- Clinical deterioration has been observed with withdrawal of Digoxin

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**Stage D (Advanced HF):**  
**Inotropic Support**

- Inotropes improve hemodynamic compromised patients
- Have not been shown to improve survival in inpatient or outpatient setting
- Still remain an option to help patients who are refractory to other therapies
- May be a necessity in patient suffering from end-organ hypoperfusion
- Continuous IV inotropic support is reasonable to maintain systemic perfusion and preserve end-organ performance
- Often utilized in patient awaiting heart transplant or mechanical circulatory support (MCS)

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**Stage D (Advanced HF)**  
**Inotropic Support**

- Inotropic support may lead to arrhythmias
- Ideally should be used with an ICD in case of lethal arrhythmia

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**Stage D (Advanced HF)**  
**Mechanical Circulatory Support**

- Therapeutic option to prolong life and improve functional capacity
- Effective for short-term support or long-term support
- Most appropriate for patient with HFREF and a dilated ventricle
- LVADs are considered in patients with NYHA Class IV dependent on intravenous inotropes
- Used as bridge to transplant
- Survival has greatly improved
  - 2 year survival > 80% with newer generation LVADs

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**Stage D (Advanced HF)**  
**Mechanical Circulatory Support**

- Require anticoagulation
  - Pump thrombosis
- Hemolysis
- Ischemic neurologic events

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**Acute Decompensated HF**  
**Common precipitating factors:**

- Acute coronary syndrome
- Uncontrolled hypertension
- Atrial fibrillation / Other arrhythmias
- Acute infections (Pneumonia, UTI, etc.)
- Medication non-compliance
- Dietary non-compliance
- Anemia
- Medications that increase sodium retention (NSAIDs)
- Medications with negative inotropic effect (Verapamil)

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**Acute Decompensated HF**  
**Diuretics**

- IV loop diuretic therapy provide the most rapid and effective treatment
- Titration to achieve effective diuresis may require:
  - Doubling dosage
  - Adding a thiazide diuretic
  - Adding an MRA
- Goal of therapy is to resolve signs and symptoms of congestion before discharge
- Persistent congestion at discharge = High rate of rehospitalization and mortality

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**Acute Decompensated HF**  
**Diuretics:**

- Loop diuretic bolus vs infusion?
- DOSE (Diuretic Optimization Strategies Evaluation) trial found NO significant difference in symptoms when diuretic therapy was given as a bolus vs infusion therapy

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**Acute Decompensated HF**  
**Vasodilators**

- Intravenous Nitroglycerin
  - Will acutely mitigate dyspnea and relieve pulmonary congestion
- Especially beneficial in patients with hypertension, coronary ischemia, or significant MR
- Overall, no data to support that intravenous vasodilators improve outcomes in patients (rehospitalization rates or mortality)
- However, will help mitigate dyspnea in patients with intact or high blood pressure

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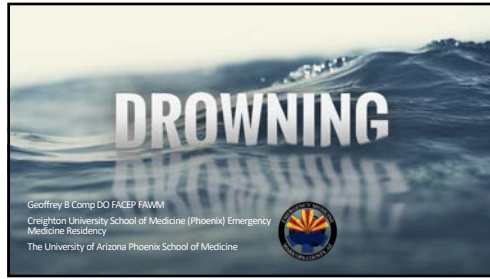
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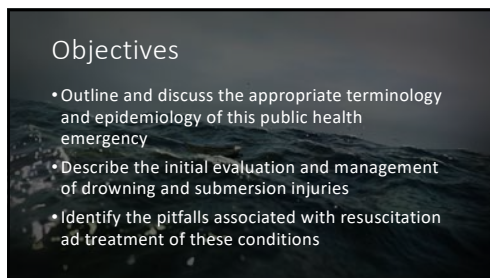
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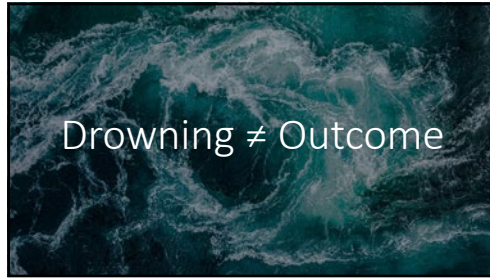
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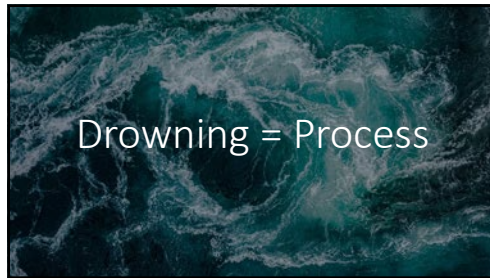
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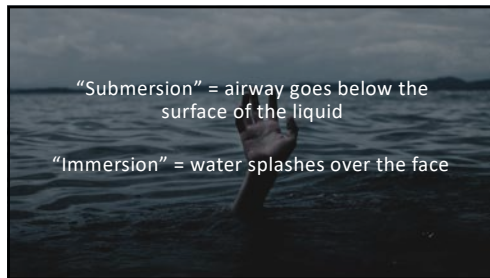
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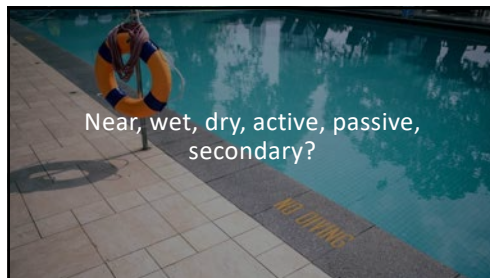
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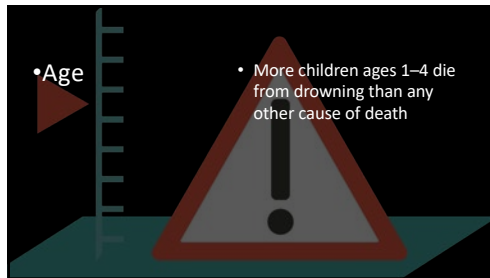
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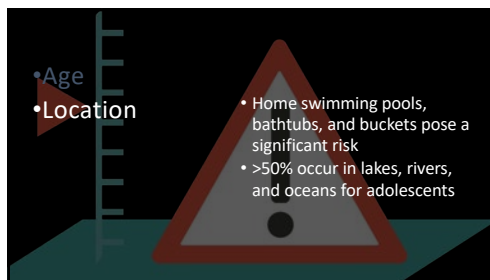
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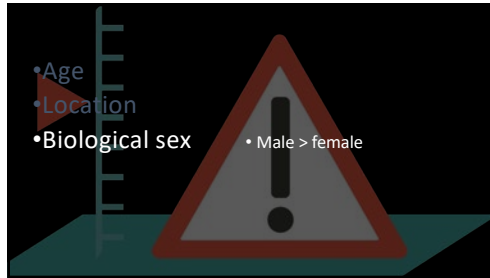
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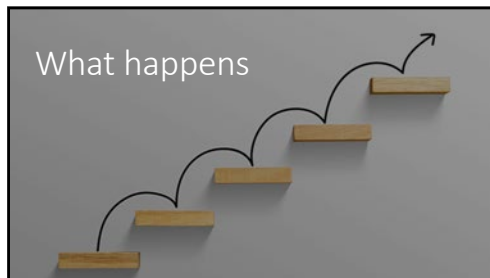
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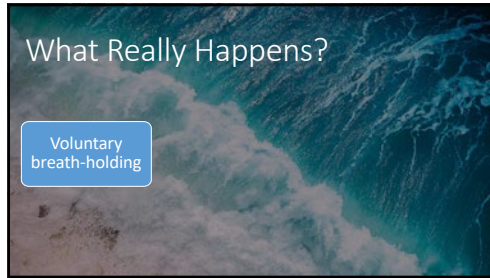
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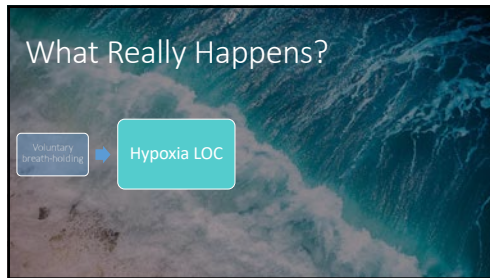
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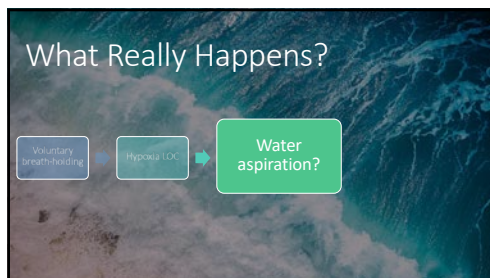
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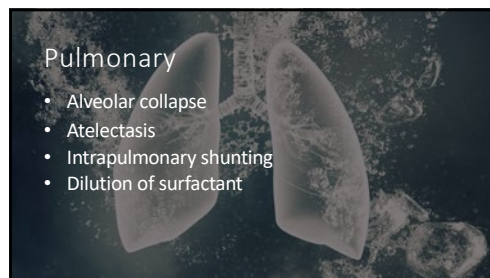
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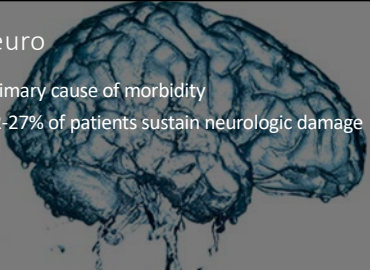
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Neuro

- Primary cause of morbidity
- 12-27% of patients sustain neurologic damage



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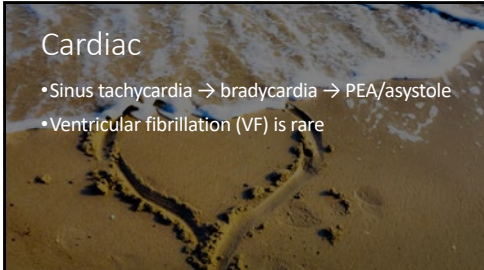
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Cardiac

- Sinus tachycardia → bradycardia → PEA/asystole
- Ventricular fibrillation (VF) is rare



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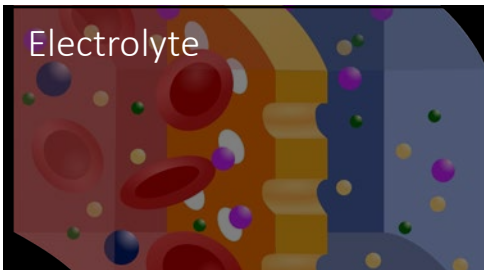
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Electrolyte



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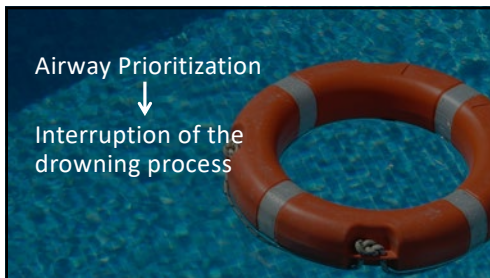
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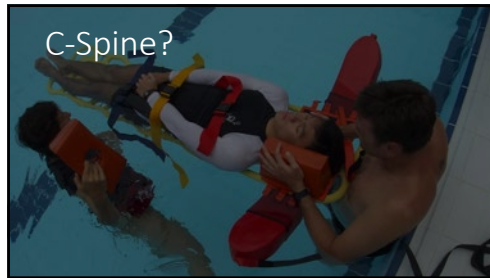
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Important Questions

- Description of scene
- Time submerged
- Potential known contaminants
- Water temperature
- Type of rescue
- Precipitating events

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Physical Exam

- Dyspnea
- Cough
- Rales, rhonchi, and wheezing
- Vital signs are vital
  - Pulse oximetry, accurate temperature

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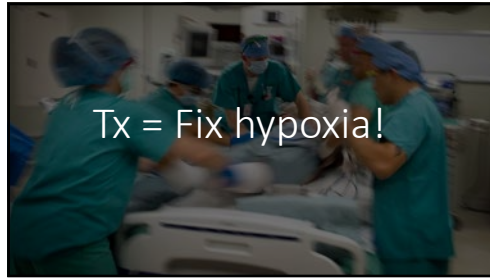
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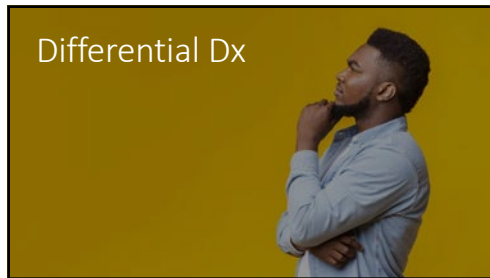
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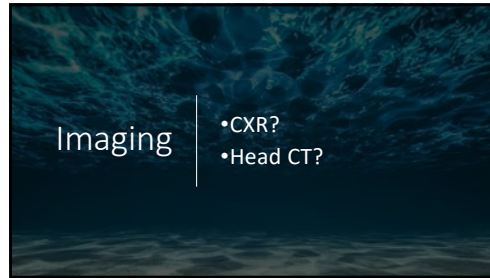
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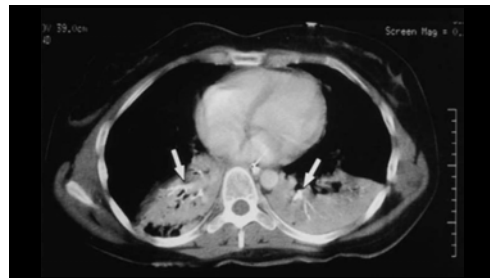
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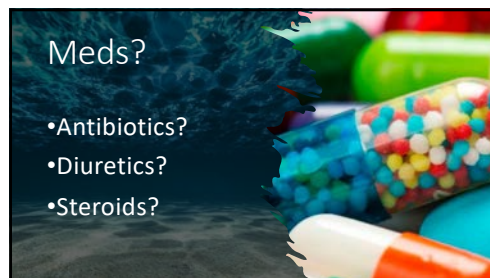
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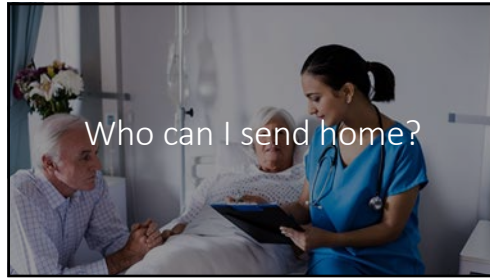
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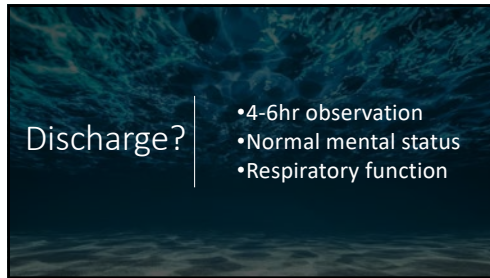
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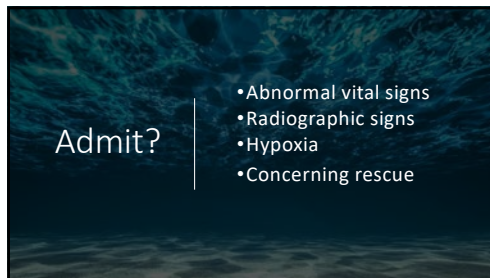
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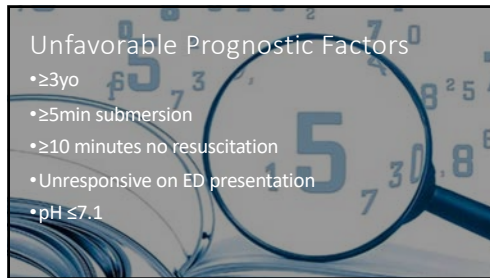
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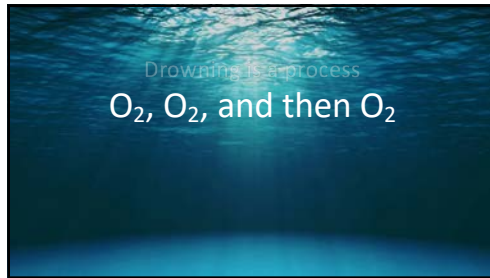
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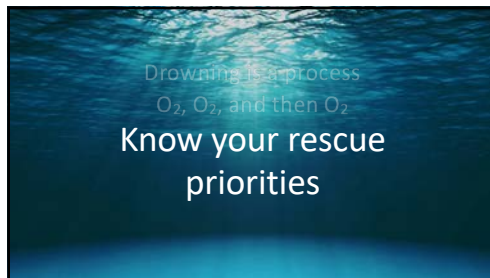
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**TW: INTENSE AND GRAPHIC  
MEDICAL PHOTOGRAPHY**

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**PENETRATING NECK  
TRAUMA**

Molly Hartrich MD, MPH  
University of Illinois at Chicago



Core EM

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**DISCLOSURES**

- Financial
- None



Photo by Craig Melvin

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**OBJECTIVES**

- Stats and definitions
- Zones/Anatomy
- Management
  - Respiratory
  - Vascular
  - Nervous
  - Digestive/GI



Medicalpedia

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I don't mean to offend you, but does your voice always sound like that?

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149  
100/61  
21  
96

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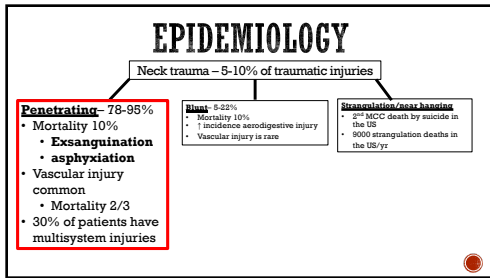
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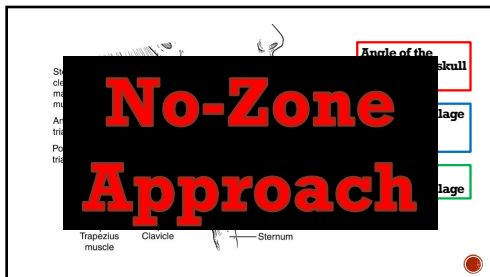
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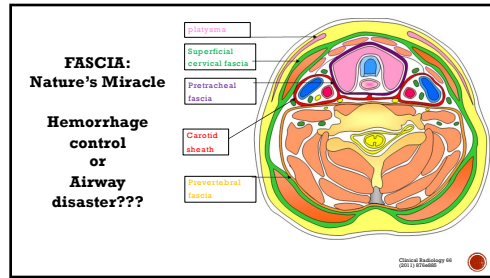
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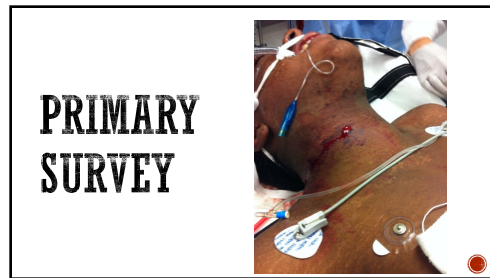
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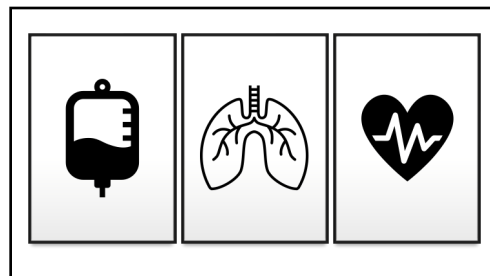
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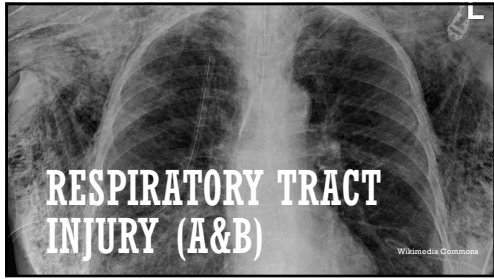
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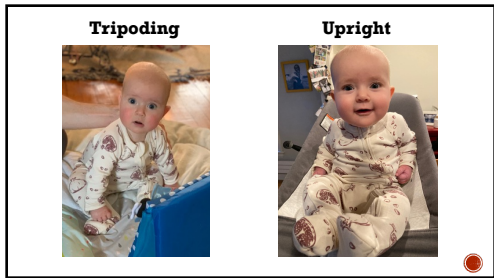
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**AIRWAY**

- Be safe – PPE
- “Dynamic Airway”
- Early intubation
  - ED vs OR
  - For CT
- Don't make it worse
- Your comfort = ↑ success

Etomidate 0.2% vs Succinylcholine 10mg/ml

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Preserved Neck Anatomy	Distorted Neck Anatomy	Significant Laryngotracheal injury
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Likelihood of surgical airway

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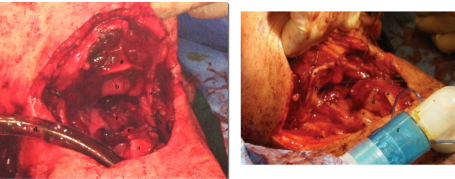
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CJEM 2015;17(1):88-93

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**BREATHING:**

Case Report in Emergency Medicine, 2014, Article ID 201262

Wikimedia Commons

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**VASCULAR INJURY (C)**

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**CIRCULATION:  
HEMORRHAGE CONTROL**

- **DO NOT PROBE** the injury
- Direct external pressure
- Balloon tamponade
- Resuscitate with blood products
  - BP goals - DCR
- Pre-trauma therapeutic AC reversal

Wikimedia Commons

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### SIGNS OF VASCULAR AND AERODIGESTIVE INJURY

Hard Signs	Soft Signs
Airway Compromise	Hemoptysis
Expanding or Pulsatile Hematoma	Oropharyngeal Blood
Active, Brisk Bleeding	Dyspnea
Hemorrhagic Shock	Dysphagia
Hematemesis	Dysphonia
Neurologic Deficit	Nonexpanding Hematoma
Massive Subcutaneous Emphysema	Chest Tube Air Leak
Air Bubbling Through Wound	Subcutaneous or Mediastinal Air
	Vascular Bruit or Thrill
	Crepitus

Rebel EM

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### SECONDARY SURVEY

- To collar or not to collar?
- Look for other injuries
  - Be thorough
  - eFAST
  - CXR

Rebel EM

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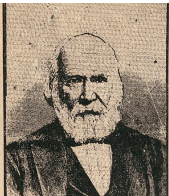
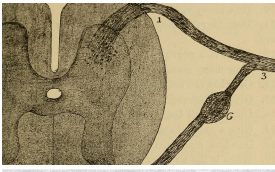
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**Edouard Brown-Séquard**  
Célebre physiologiste français  
1818-1895

### NERVOUS SYSTEM INJURY

© 2010 Rebel EM

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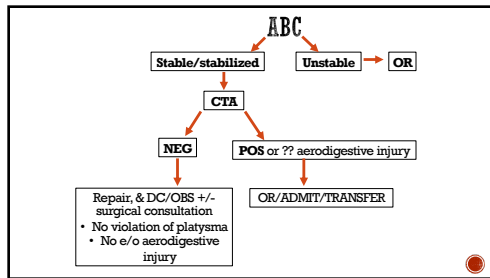
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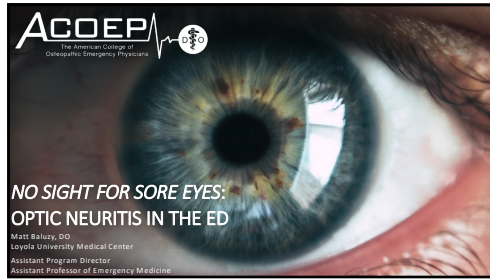
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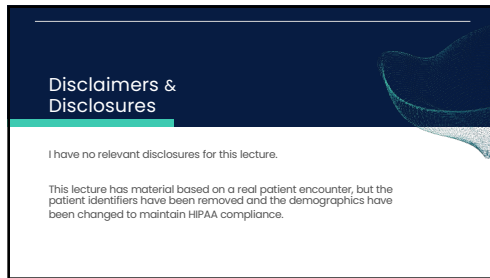
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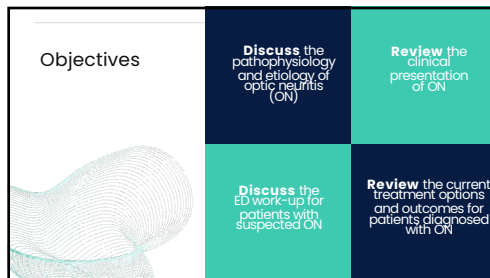
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**Case:**  
Change in Vision

**HPI**  
26 yo female with no PMH presents with eye pain and blurry vision

**Triage Visual Acuity**

- OD: 20/80
- OS: 20/20

**Vitals & General Physical Exam**



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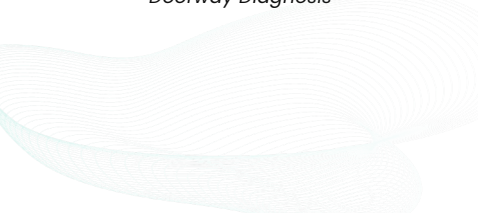
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An Approach to Eye Complaints:  
*Doorway Diagnosis*



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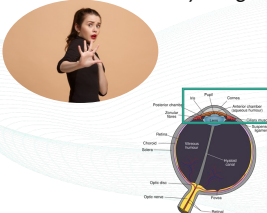
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An Approach to Eye Complaints:  
*Doorway Diagnosis*



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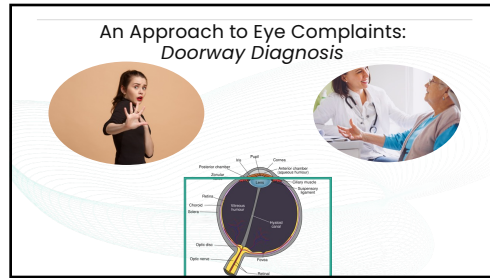
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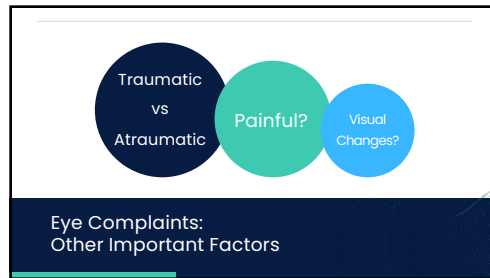
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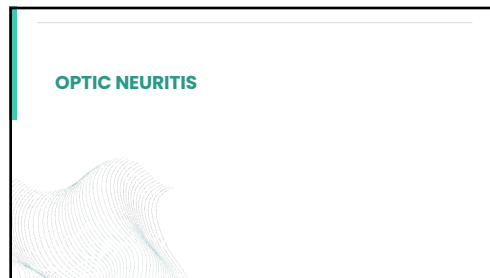
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**OPTIC NEURITIS**

*What is it?*

- Inflammation of the optic nerve

*How does it happen?*

- Two forms:
  - **Typical:** demyelinating process
  - **Atypical:** due to diseases not resulting in demyelination

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Historical Features of Optic Neuritis

Acute to Subacute Onset of Symptoms	Vision Changes	Pain
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Physical Exam Findings in Optic Neuritis

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Relative Afferent Pupillary Defect

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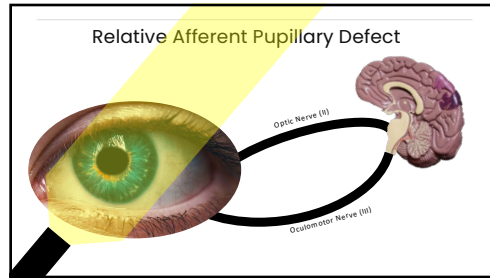
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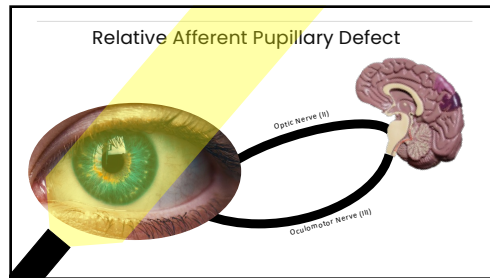
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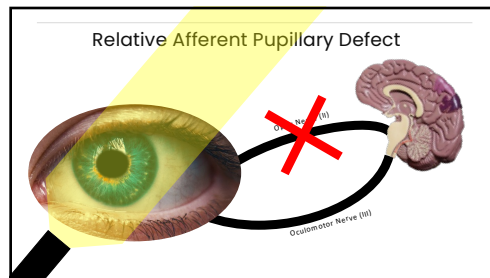
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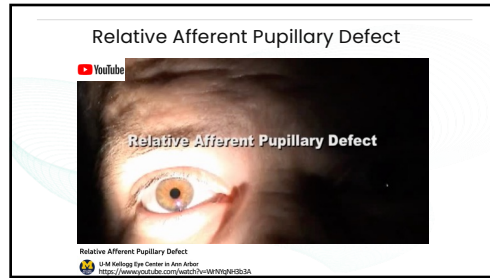
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**Case Continued:**  
Change in Vision

**HPI**  
26 yo female with no PMH presents with eye pain and blurry vision

**Triage Visual Acuity**

- OD: 20/80
- OS: 20/20

**Eye Exam**

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Diagnostic confirmation in the emergency department?

Clinical Diagnosis

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Case	Case #1	Case #2	Case #3	Case #4
Age (years)	35	48	34	28
Sex	Male	Male	Female	Female
OD Ultrasound image				
OS Ultrasound image				
Intraocular Pressure	OD - 18mm Hg OS - 17mm Hg	OD - 17mm Hg OS - 16mm Hg	OD - 16mm Hg OS - 17mm Hg	OD - 12mm Hg OS - 13mm Hg

Ultrasound

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MRI

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Treatment of ON  
Who will benefit?

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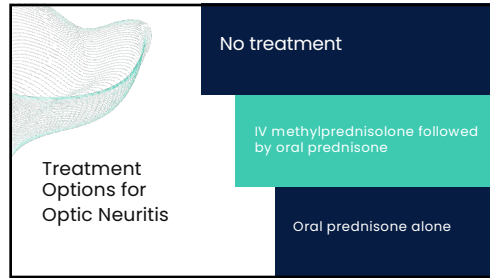
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Treatment Options for Optic Neuritis

- No treatment
- IV methylprednisolone followed by oral prednisone
- Oral prednisone alone

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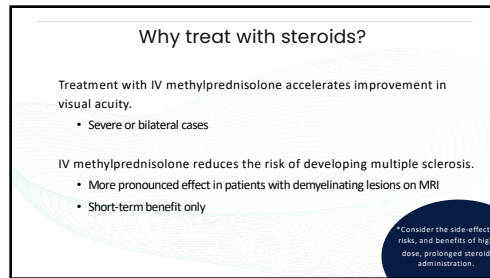
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### Why treat with steroids?

Treatment with IV methylprednisolone accelerates improvement in visual acuity.

- Severe or bilateral cases

IV methylprednisolone reduces the risk of developing multiple sclerosis.

- More pronounced effect in patients with demyelinating lesions on MRI
- Short-term benefit only

\*Consider the side-effects, risks, and benefits of high dose, prolonged steroid administration.

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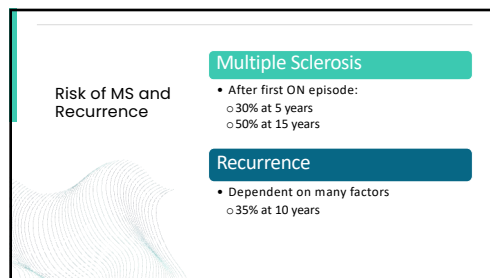
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### Risk of MS and Recurrence

- Multiple Sclerosis**
  - After first ON episode:
    - 30% at 5 years
    - 50% at 15 years
- Recurrence**
  - Dependent on many factors
    - 35% at 10 years

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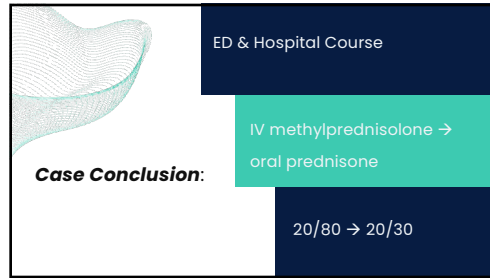
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ED & Hospital Course

**Case Conclusion:** IV methylprednisolone → oral prednisone

20/80 → 20/30

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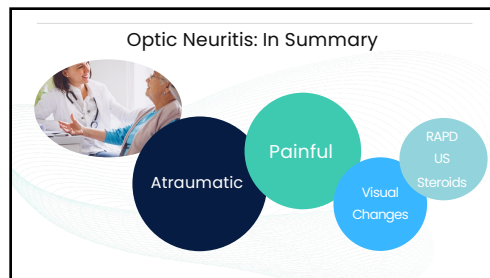
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Optic Neuritis: In Summary

Atraumatic

Painful

Visual Changes

RAPD  
US  
Steroids

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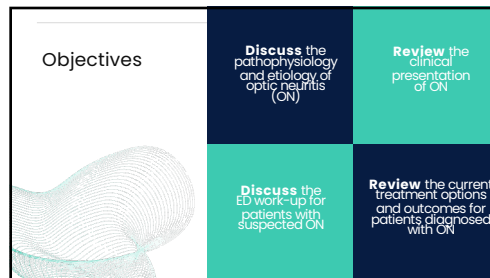
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**Objectives**

**Discuss** the pathophysiology and etiology of optic neuritis (ON)

**Review** the clinical presentation of ON

**Discuss** the ED work-up for patients with suspected ON

**Review** the current treatment options and outcomes for patients diagnosed with ON

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**Updates in Critical Care Management for the ED**  
 ACOEP Spring Seminar 2023

**Kene Chukwuana, M.D.**  
 Assistant Clinical Professor - Emergency Medicine & Critical Care Medicine  
 Associate Program Director, Emergency Medicine Residency  
 Director of Emergency Ultrasound  
 Saint Louis University School of Medicine

SAINT LOUIS UNIVERSITY  
 1818

ACOEP  
 The American College of  
 Emergency Physicians

April 2, 2023

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**DISCLOSURES**

I have **NO** financial disclosures, or other conflicts of interests in the content presented in this presentation.

SSM-Health  
 Saint Louis University Hospital

SLUCare  
 Physician Group

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**OBJECTIVES**

1. Review the recent literature and guidelines regarding the management of **critically ill patients** in the emergency department.
2. Examine **differences in intravenous fluid choice** for patients with sepsis and critical illness.
3. Discuss the recent evidence on **awareness after paralysis**.
4. Review and develop **strategies to improve mechanical ventilation and sedation** of critically ill patients in the emergency department.

SSM-Health  
 Saint Louis University Hospital

SLUCare  
 Physician Group

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T: 38.4°C  
79 AAF  
HR: 117  
BIBEMS from NH  
BP: 81/59  
CC: cough, fever  
RR: 28  
A&Ox0  
SpO2: 83% on RA

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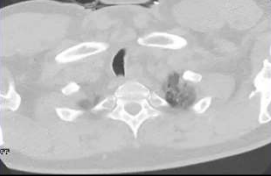
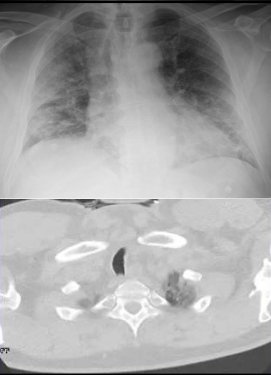

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**SpO2: 85%  
on NRB**



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**“CRITICAL CARE IN THE ED”  
TOPICS**

1. Optimizing Hemodynamics
2. IV Fluids
3. Sedation
4. Mechanical Ventilation



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### PREPARE II Trial

*In critically ill adult patients undergoing intubation, does a 500-mL IVF bolus decrease CV collapse?*



	Fluid bolus (n = 538)	No fluid bolus (n = 527)
<b>Primary outcome</b>		
Cardiovascular collapse, No. (%) <sup>a</sup>	113 (21.0)	96 (18.2)
New or increased receipt of vasopressors	111 (20.6)	93 (17.6)
Systolic blood pressure <65 mm Hg <sup>b</sup>	(n = 535) 21 (3.9)	(n = 524) 22 (4.2)
Cardiac arrest	9 (1.7)	8 (1.5)
Death	4 (0.7)	3 (0.6)
<b>Secondary outcome</b>		
In-hospital death prior to 28 d, No. (%)	218 (40.5)	223 (42.3)

Effect of Fluid Bolus Administration on Cardiovascular Collapse Among Critically Ill Patients Undergoing Tracheal Intubation  
A Randomized Clinical Trial

SAINT LOUIS UNIVERSITY

Russell DW, et al. PREPARE II Investigators. JAMA. 2022 Jul

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### PREPARE II Trial

*In critically ill adult patients undergoing intubation, does a 500-mL IVF bolus decrease CV collapse?*



Effect of Fluid Bolus Administration on Cardiovascular Collapse Among Critically Ill Patients Undergoing Tracheal Intubation  
A Randomized Clinical Trial

SAINT LOUIS UNIVERSITY

**IV fluid bolus (vs. no fluid bolus) did not significantly decrease the incidence of CV collapse.**

Russell DW, et al. PREPARE II Investigators. JAMA. 2022 Jul

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### The PLUS Trial

**What type of IV Fluids are best?**



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Fleisher S, et al. PLUS Study Investigators. Balanced Multielectrolyte Solution versus Saline in Critically Ill Adults. N Engl J Med. 2022 Mar

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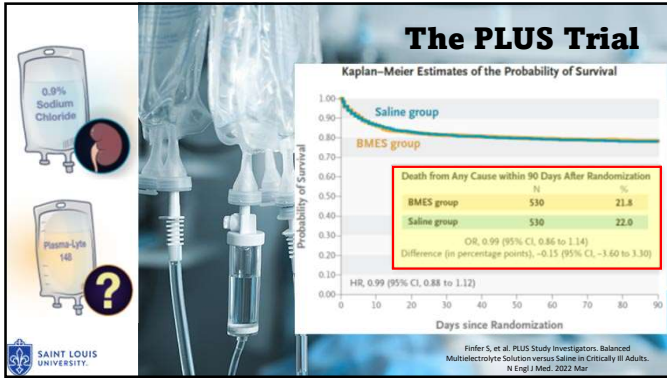
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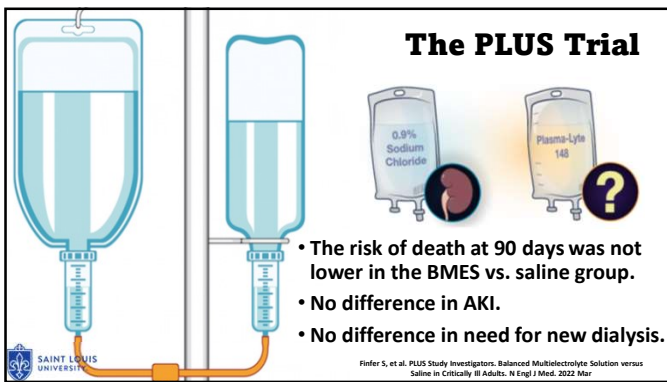
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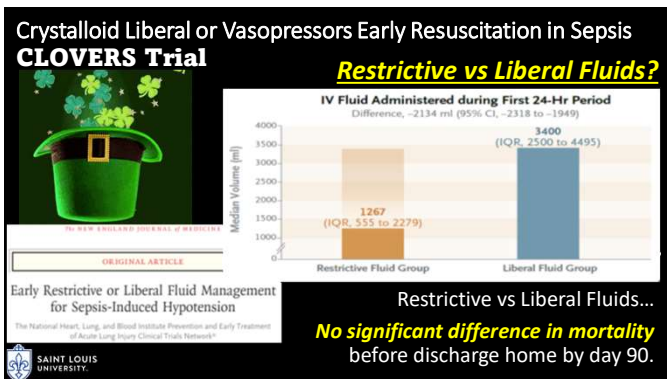
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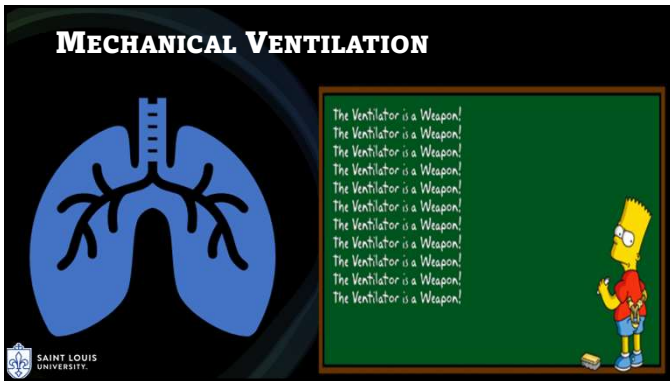
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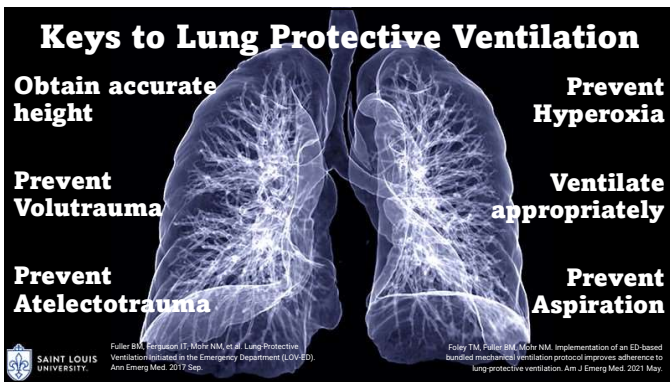
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**LUNG PROTECTIVE VENTILATION:**  
*The LOV-ED Trial*

Foley TM, Fuller BM, Mohr NM. Implementation of an ED-based bundled mechanical ventilation protocol improves adherence to lung-protective ventilation. *Am J Emerg Med.* 2021 May.

✓ **Lung-protective ventilation in the ED**

- Increased by 48.4% (intervention group).
- Decreased mortality – 34.1% vs 19.6%
- Increase vent-free & hospital-free days.

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**Initiate ED Ventilator Protocol**

```

graph TD
    A[Obtain accurate patient height] --> B[Obtain accurate patient height]
    B --> C[Prevent Volutrauma]
    C --> D[Prevent Atelectotrauma]
    D --> E[Prevent Hyperoxia]
    E --> F[Ventilate appropriately]
    F --> G[Prevent Aspiration]
    
```

**Obtain accurate patient height**  
 After patient stabilizes, use tape measure for height measurement.

**Prevent Volutrauma**  
 Set tidal volume (TV) according to ideal body weight (IBW) according to BMI chart - see figure 2.  
 • PEEP (if needed) to avoid ARDS  
 • Range of 6-8cm H<sub>2</sub>O if age >65.  
 • Keep PIP <30cm H<sub>2</sub>O if PIP remains above 30 cm H<sub>2</sub>O.  
 • Increase TV to 4-6 cm H<sub>2</sub>O if PIP or consider switching to direct mode to maintain plateau pressure.

**Prevent Atelectotrauma**  
 Set PEEP to 5cm H<sub>2</sub>O  
 • Estimated (IBW >30, see PEEP table below)  
 • Estimated (IBW <30, see PEEP table below)  
 • Body Mass Index (BMI) > 30  
 • Airway (30cm H<sub>2</sub>O) > 30  
 • See PEEP/FiO<sub>2</sub> table.

**Prevent Hyperoxia**  
 Initiate FiO<sub>2</sub> at 30-40 (not >0.5) after intubation  
 • If unable to titrate, initiate on PEEP (20cm H<sub>2</sub>O)  
 • If hyperoxia, use PEEP table for most appropriate FiO<sub>2</sub>/PEEP combination.

**Ventilate appropriately**  
 Set respiratory rate 10-18 breaths per minute  
 • 10-12 for patients on PEEP, or those who may be recruited  
 • 12-18 for patients without lung injury or lung disease, adjust RR for EtCO<sub>2</sub> <35 (if available)

**Prevent Aspiration**  
 Elevate head of bed >30 degrees.  
 • RR or trained on register after raise on one gastric tube.  
 • Place on dependent position per hospital protocol.

**PEEP-FiO<sub>2</sub> Table**

FiO <sub>2</sub>	30	40	50	60	70	80	90	100
PEEP	5	5	5	5	5	5	5	5

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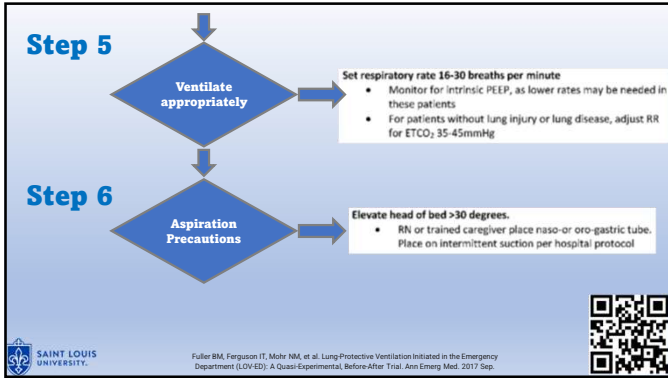
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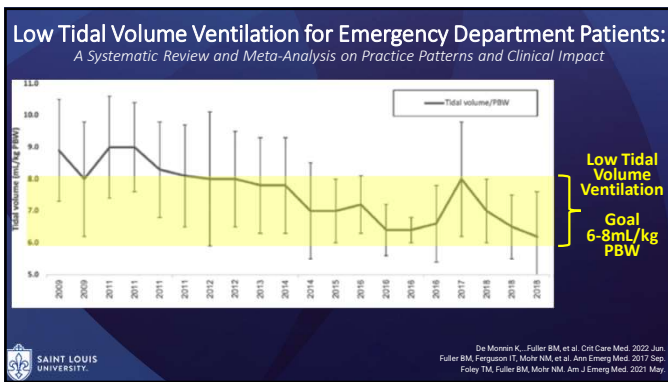
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**Low Tidal Volume Ventilation for Emergency Department Patients:**  
A Systematic Review and Meta-Analysis on Practice Patterns and Clinical Impact

**ED**

- Increase in ED LTVV with ED-based vent protocols.
- Significant reduction in ED TV (-1.5mL/kg PBW).

**ICU**

- Use of ED LTVV assoc with increase in ICU LTVV.
- Significant reduction in ICU TV (-1.0mL/kg PBW).

**Overall, decrease of -2.0mL/kg PBW over 10-year period.**

The Ventilator is a Weapon!  
The Ventilator is a Weapon!  
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The Ventilator is a Weapon!

SAINT LOUIS UNIVERSITY

De Mornin K., Fuller BM, et al. Crit Care Med. 2022 Jun.  
Fuller BM, Ferguson IT, Mohr NM, et al. Ann Emerg Med. 2017 Sep.  
Foley TM, Fuller BM, Mohr NM. Am J Emerg Med. 2021 May.

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### LUNG PROTECTIVE VENTILATION

**Outcomes & Costs**

*What is the association between use of lung-protective ventilation in the ED and outcomes?*

- 58.4% received LPV.
- Decreased mortality.
- Decreased ARDS.
- Shorter duration of mechanical ventilation (4 vs 5 days).
- Shorter hospital LOS (11 vs 14 days).

**Costs?**  
**Reduced total hospital costs in LPV...**  
**↓ ~\$6,000 /stay!**  
 (US\$34,153 vs \$40,418)

ST. LOUIS UNIVERSITY Fernando SM, et al. Lung-Protective Ventilation and Associated Outcomes and Costs Among Patients Receiving Invasive Mechanical Ventilation in the ED. Chest. 2021 Feb.

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### THE PILOT TRIAL

- Low ~ 90%
- Intermediate ~ 94%
- High ~ 98%

*"...use of various O2 targets did not affect survival or mechanical ventilation-free days through 28 days."*

**Oxygen-Saturation Targets for Critically Ill Adults Receiving Mechanical Ventilation**  
 Matthew W. Semler, M.D., Jonathan D. Casey, M.D.

**What is the optimal SpO<sub>2</sub> target?**  
**Low? Intermediate? High?**

ST. LOUIS UNIVERSITY Semler MW, et al. PILOT Investigators. Oxygen Saturation Targets for Critically Ill Adults Receiving Mechanical Ventilation. N Engl J Med. 2022 Nov.

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### THE PILOT TRIAL

**Oxygen-Saturation Targets for Critically Ill Adults Receiving Mechanical Ventilation**  
 Matthew W. Semler, M.D., Jonathan D. Casey, M.D.

**What is the optimal SpO<sub>2</sub> target?**  
**Low? Intermediate? High?**

ST. LOUIS UNIVERSITY Semler MW, et al. PILOT Investigators. Oxygen Saturation Targets for Critically Ill Adults Receiving Mechanical Ventilation. N Engl J Med. 2022 Nov.

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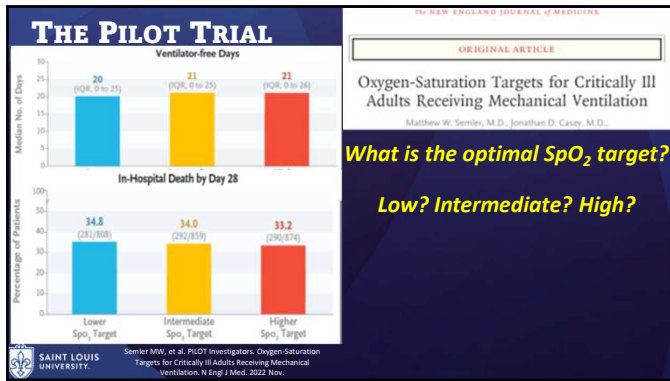
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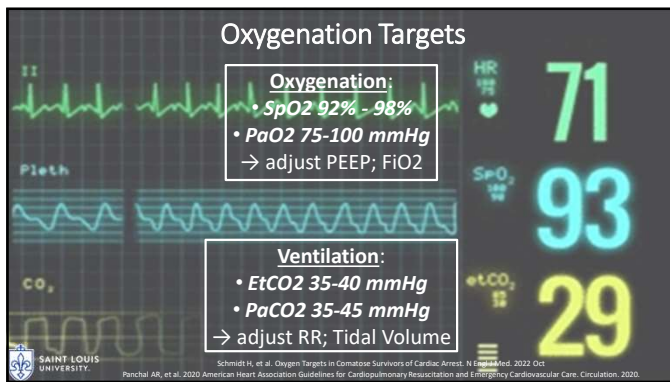
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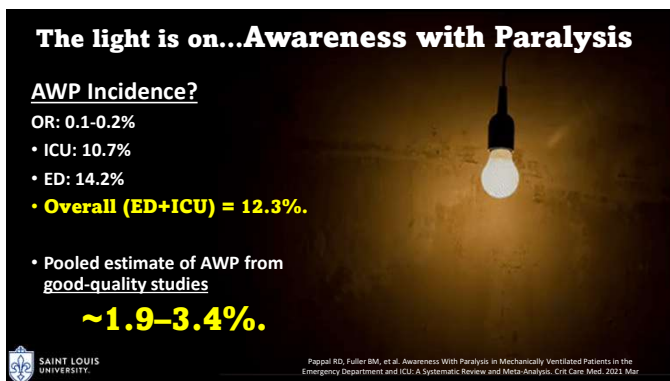
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**The light is on...Awareness with Paralysis**

- Single-center, prospective, observational
- 383 mechanically ventilated ED patients.
- Recall of AWP assessed by interview after extubation before hospital discharge.
- Three expert reviewers determined whether patients had AWP.

SAINT LOUIS UNIVERSITY

ABSTRACT ORIGINAL RESEARCH

The ED-AWARENESS Study: A Prospective, Observational Cohort Study of Awareness With Paralysis in Mechanically Ventilated Patients Admitted From the Emergency Department

Pappal RD, Fuller BM, et al. The ED-AWARENESS Study. Ann Emerg Med. 2021 May

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**The light is on...Awareness with Paralysis**

- **The prevalence of AWP = 2.6%.**
- **Exposure to rocuronium higher in the AWP group at 70%**
  - vs 31.4% with other NMBs.
- **AWP group had higher mean values on threat perception scale**
  - vs No AWP group – 13.4% vs 8.5%.

SAINT LOUIS UNIVERSITY

ABSTRACT ORIGINAL RESEARCH

The ED-AWARENESS Study: A Prospective, Observational Cohort Study of Awareness With Paralysis in Mechanically Ventilated Patients Admitted From the Emergency Department

Pappal RD, Fuller BM, et al. The ED-AWARENESS Study. Ann Emerg Med. 2021 May

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**The light is on...Awareness with Paralysis**

Recall of Awareness During Paralysis Among ED Patients Undergoing Tracheal Intubation

- Q1: What is the prevalence of recalled awareness with paralysis (AWP) in intubated ED patients?
- Q2: What clinical variables are associated with AWP?

SAINT LOUIS UNIVERSITY

Driver BE, et al. Recall of Awareness During Paralysis Among ED Patients Undergoing Tracheal Intubation. Chest. 2023 Feb.

CHEST

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**Use of a Drone-Delivered Automated External Defibrillator in an Out-of-Hospital Cardiac Arrest**

CLINICAL RESEARCH STUDY  
 Automated External Defibrillators Delivered by Drones to Patients With Suspected Out-of-Hospital Cardiac Arrest  
 Schierbeck et al.  
 Center for Resuscitation Science Karolinska Institutet, Sweden 2020



SAINT LOUIS UNIVERSITY

Schierbeck S, et al. Use of a Drone-Delivered Automated External Defibrillator in an Out-of-Hospital Cardiac Arrest. N Engl J Med. 2022 May 19;386(20):1911-1920. doi: 10.1056/NEJMoa2112111. Epub 2022 May 19. 2022

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**“CRITICAL CARE IN THE ED”**  
**SUMMARY**

SSMHealth  
 Saint Louis University Hospital


SLUCare  
 Physician Group

**1. Optimizing Hemodynamics**

- Early Pressors > Fluids

**2. IV Fluids**

- No difference - balanced fluids vs saline.
- Restrictive Fluids for volume overload?
- No difference in other conditions.



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**“CRITICAL CARE IN THE ED”**  
**SUMMARY**

SSMHealth  
 Saint Louis University Hospital


SLUCare  
 Physician Group

**3. Mechanical Ventilation**

- Lung Protective Ventilation is essential!
- Normalize oxygenation & ventilation.

**4. Sedation**

- Awareness with Paralysis is more than we think.
- Prioritize adequate sedation before & during intubation.
- Keep sedation light after.



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QUESTIONS?

Saint Louis University

Emergency Medicine

SSM-Health  
Saint Louis University Hospital

SLUCare  
Physician Group

Kene Chukwuanu, MD  
Kene.Chukwuanu@health.slu.edu

Thank You!

ACOEP  
SPRING SEMINAR  
PHOENIX, ARIZONA  
ACOEP

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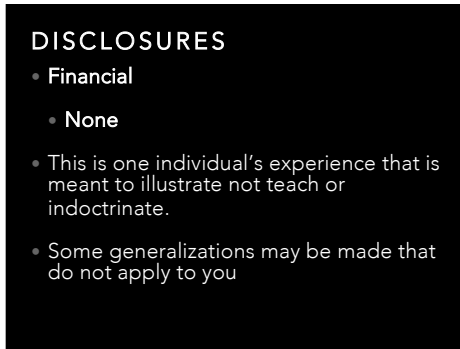
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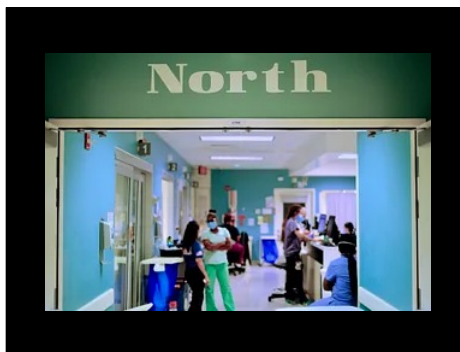
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- **VS:** HR 90 **BP 66/33** RR 20 **T 33** SpO2 100% RA
- **Gen:** lethargic, moaning, disheveled, dirty, +etoh on breath
- **HEENT:** atraumatic, PERRL, +icteric sclera, dry MM, dried blood to nares
- **CV:** RRR
- **Resp:** CTAB, no AMU
- **Abd:** Soft, distended
- **Ext:** 3+ pitting edema to sacrum
- **Skin:** jaundiced, scattered ecchymosis, cool, dry
- **Neuro:** A&Ox0, MAE, mumbling, no meaningful speech

POC glucose: 90  
**POC Hgb: 3.2**

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**KINSHIP**

- A relation between two or more persons that is based on common **ancestry (descent)** or **marriage (affinity)**.
- Chosen kin, fictive kin or voluntary kin
  - A form of extended family members who are not related by either blood or marriage.
- A feeling of being connected to other people

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Patient says his mother and sister are visiting him today  
and is very excited about it.

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IMPOSTER SYNDROME  
SELF-PITY SCARED  
IDIOT **SHAME**  
LONELY IMPATIENT FAILURE  
INCAPABLE SELF-LOATHING

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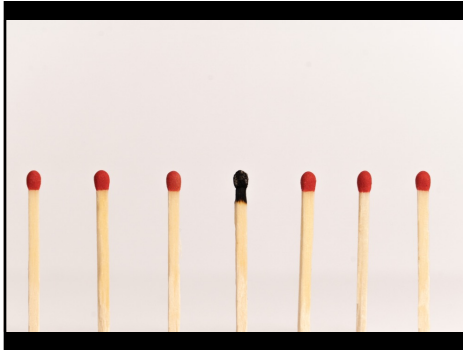
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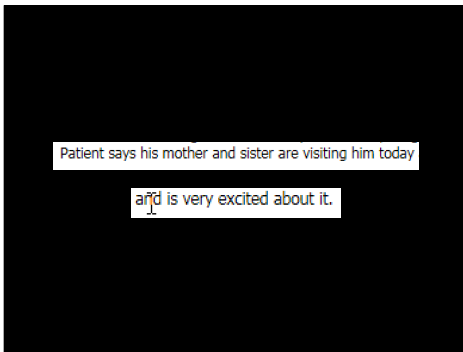
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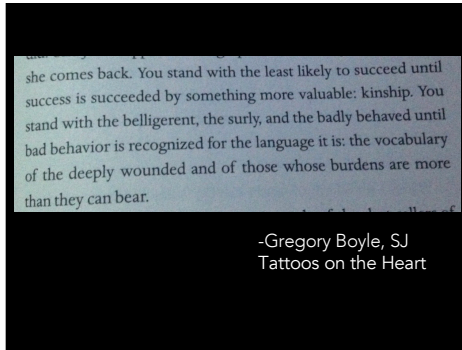
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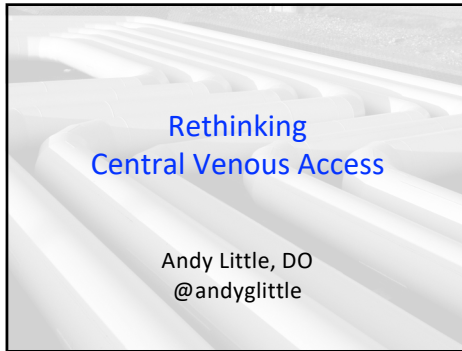
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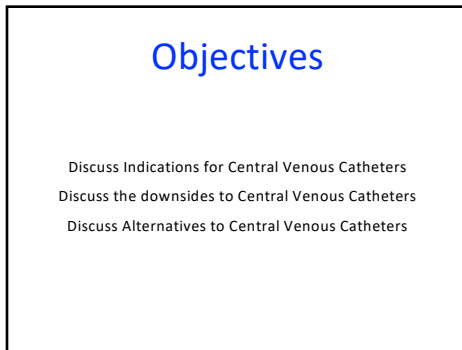
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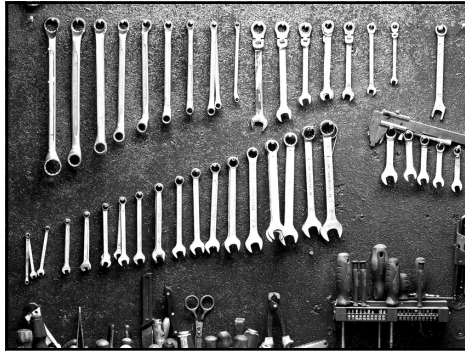
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Why Central Lines?

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Emergency venous access  
Volume resuscitation  
Vasopressor Therapy

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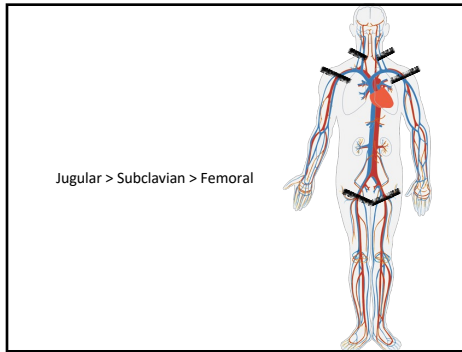
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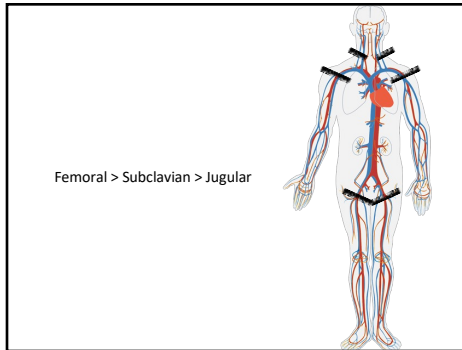
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Before Placing a CVC

When am I placing this line?

Why am I placing this line?

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### Flow Rates in IV/IO Access

Gauge	Approximate Flow Rate to Gravity (mL/min)	Time to Infuse L (min)
14G	250	4
16G	150	7
Cordis	130	8
18G	100	10
15G Humeral IO	80	13
16G Distal Port Triple Lumen	70	15
15G Tibial IO	70	15
20G	60	17
22G	35	24
18G Prox Port Triple Lumen	30	34

PMID: 20581377; 2057465

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Better Alternatives

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Intraosseous Lines

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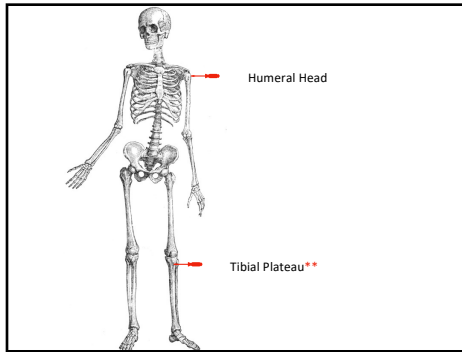
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### Flow Rates in IV/IO Access

Gauge	Approximate Flow Rate to Gravity (mL/min)	Time to Infuse L (min)
14G	250	4
16G	150	7
Cordis	130	8
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20G	60	17
22G	35	29
18G Prox Port Triple Lumen	30	34

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Large Bore P.I.V.

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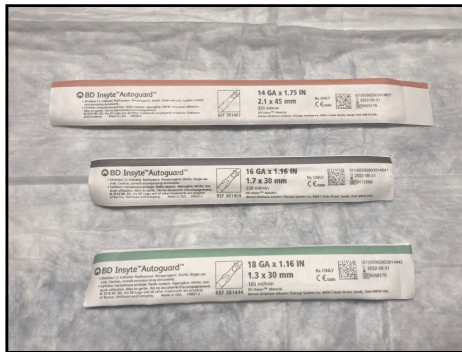
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### Flow Rates in IV/IO Access

Gauge	Approximate Flow Rate to Gravity (mL/min)	Time to Infuse L (min)
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Cordis	130	8
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22G	35	29
18G Prox Port Triple Lumen	30	34


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Midline Catheters

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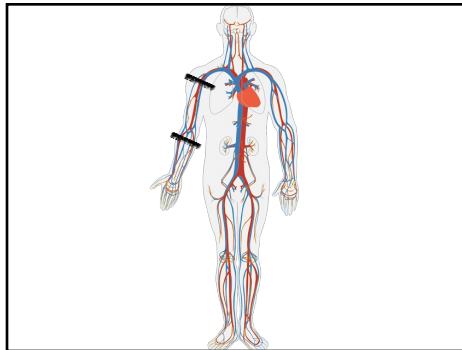
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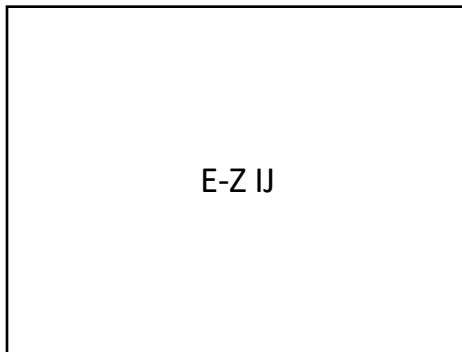
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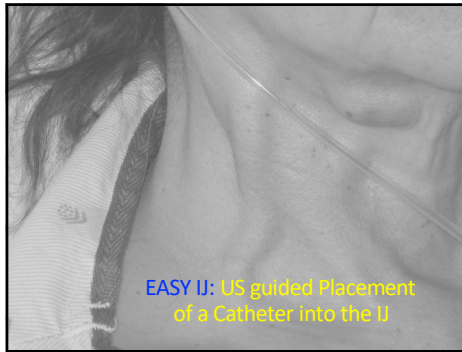
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EASY IJ: US guided Placement of a Catheter into the IJ

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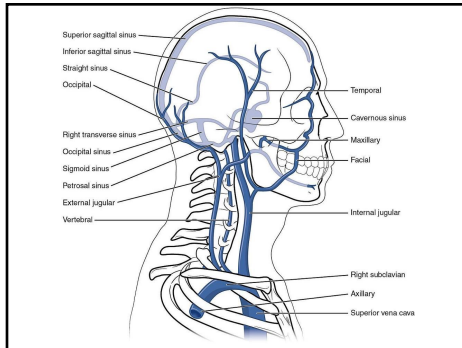
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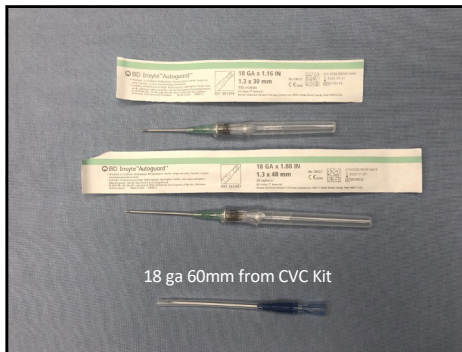
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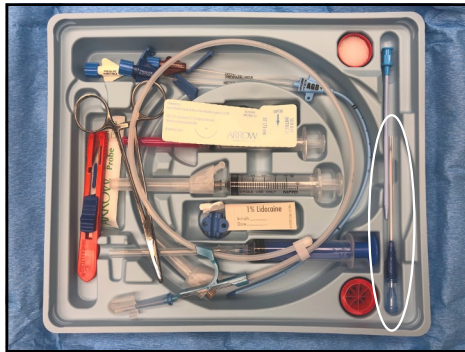
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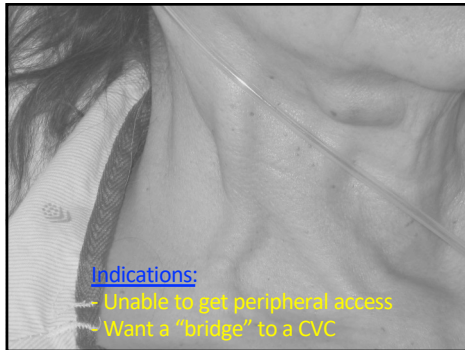
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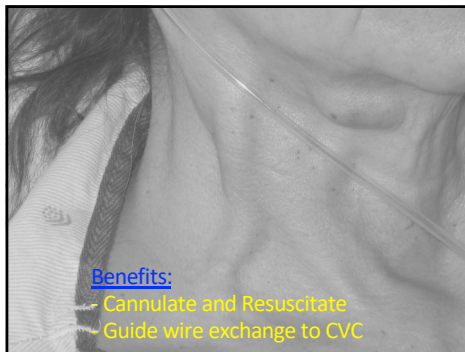
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### Flow Rates in IV/IO Access

Gauge	Approximate Flow Rate to Gravity (mL/min)	Time to Infuse L (min)
18G	250	4
16G	150	7
Cardis	130	8
18G	100	10
18G Humeral IO	80	13
16G Distal Port Triple Lumen	70	15
15G Tibial IO	70	15
20G	60	17
22G	35	29
18G Prox Port Triple Lumen	30	34

 PMID: 20581377; 20157465

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Why Central Lines?

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Consider Other Options

When am I placing this line?

Why am I placing this line?

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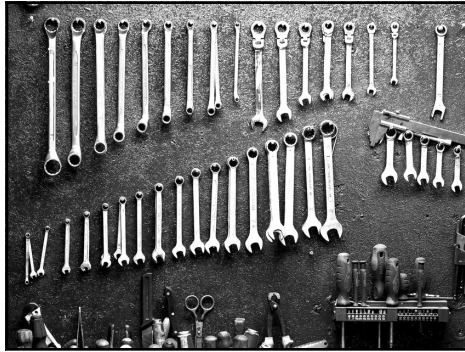
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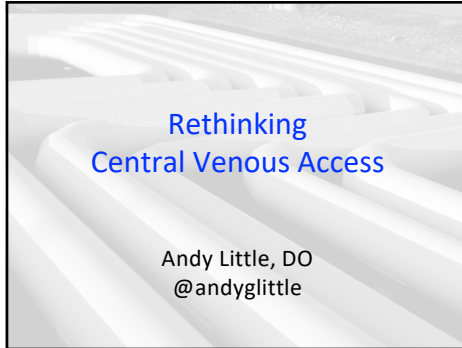
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