Are Patients Hypoperfused in the ED?

Rapid Perfusion Assessment in the Emergency Department

R. Benjamin Saldaña DO, FACEP
Associate Medical Director
Methodist Emergency Care Center, Houston TX

Disclosure

- Honoraria for speaking
  - Hutchinson Technology Inc.
- No other financial interests
Patients often present with various etiologies affecting circulatory status.

Common assessments are not always accurate or timely when determining circulatory status.

Are hypoperfused patients waiting to be treated and more importantly are some slipping through?

**Emergency Department**
**Process Improvement Considerations**

**StO\textsubscript{2}**
**Tissue Oxygen Saturation**

Rapid, Noninvasive Perfusion Assessment
What is StO₂?

- **StO₂** = hemoglobin oxygen saturation of the microcirculation

SaO₂ and SpO₂ measure O₂ saturation in the arteries.

StO₂ measures O₂ saturation in the microcirculation where O₂ diffuses to tissue cells. StO₂ is a measure of tissue oxygenation and is a sensitive indicator of tissue perfusion status.

ScvO₂ measures O₂ saturation in the superior vena cava. SvO₂ measures O₂ saturation in the pulmonary artery.

StO₂ is not SpO₂

Cohn, J Trauma. 2007;62:44.
Why Measure Thenar Muscle?

- During shock, blood flow to peripheral muscles and core organs (liver, gut and kidneys) is reduced in order to preserve brain and heart oxygenation.
- Thenar muscle group is peripheral muscle.
- \( \text{StO}_2 \) measured in thenar allows noninvasive monitoring of early changes in perfusion status during low perfusion states and resuscitation.


The Supporting Data

- Published studies have demonstrated that low \( \text{StO}_2 \) (=75%) is associated with poor outcomes in different patient types:
  - Traumatic shock
  - Septic shock
  - Mixed ICU patient populations
- Monitoring patients with sepsis has clinical utility.
- Medical bleeding has similar pathophysiology to trauma.
Trauma Study #1:
Cohn et al

- Seven level I trauma centers
- 383 severely injured trauma patients
- Study endpoints: MODS and death
- Conclusions:
  - StO$_2$ predicted development of MODS or death
  - 75% StO$_2$ cutoff provided best trade-off of sensitivity/specificity

Cohn, J Trauma. 2007;62:44.

Trauma Study #2:
Moore et al

- Same data set as Cohn
- 114 patients (30%) required massive transfusion
- Study endpoints: MODS and death
- Conclusions:
  - Persistent low StO$_2$ only consistent predictor of poor outcome
  - Knowing this early may change treatment strategies and improve outcome

Moore, J Trauma. 2008;64:1010.
Trauma Study #3: Sagraves et al

Tissue Oxygenation Monitoring in the Field: A New EMS Vital Sign

- Pre-hospital, ambulance and helicopter
- 41 patients
- Study endpoints: Mortality
- Conclusions
  - StO₂, during transport, was significantly different between survivors and non-survivors
  - As StO₂ decreased, the odds of dying increased
  - For every 10% StO₂ drop, odds of death increased 3 times

Sagraves, J Trauma. 2009;67:441.
Trauma Conclusions

- Low StO\textsubscript{2} is associated with poor outcomes
  - Low StO\textsubscript{2} is a Red Flag and should be investigated
- StO\textsubscript{2} helps guide resuscitation in trauma patients

ICU Study #1:
Leone et al

- Resuscitated ICU septic shock patients
- 42 patients enrolled; 13 (31%) died
- Study endpoint: Relationship of StO\textsubscript{2} to 28-day mortality

Conclusions
- StO\textsubscript{2} significantly lower in those who died
- Patients with StO\textsubscript{2} below 78% at increased risk of mortality
- ScvO\textsubscript{2}, lactate, MAP, UO, CI, cap refill time, nor hemoglobin distinguished survivors from non-survivors
ICU Study #2:
Lima et al

- Critically ill ICU patients
- 22 patients enrolled
- Study endpoint: organ dysfunction and disease severity
- Conclusion
  - Pts who failed to normalize StO$_2$ had more severe organ dysfunction and disease severity
  - Persistently low StO$_2$ was associated with increased mortality

ICU Study #3:
Veening et al

- Abstract only; Mixed ICU population
- 41 patients; one-time StO$_2$ measurement
- Study endpoint; incidence of low StO$_2$ and mortality
- Conclusion
  - Incidence of abnormal StO$_2$ in critically ill pts is high despite having first resuscitated the patients
  - Very low StO$_2$ values are found frequently and may be associated with increased mortality
Other Bleeders

- GI bleed
- Vaginal bleed
- Nose bleed
- Good data now coming for transfusion

Treatment versus Triage

- Most non ED data is on treatment criteria
- Does StO$_2$ have promise as a triage tool for a broader range of ED patients
Limited Research

- One study
- Near infrared spectroscopy to assess systemic perfusion and improve triage in the emergency department and critically ill

The Patients

- 856 patients
- Triaged all incoming patients
- 93 admissions (11%)
- Initial reading did not correlate to admission
- StO₂ did correlate to ICU admission
The Gestalt

- What does this study mean?
- Very low admission rate?
- What were they studying?
- Is medical admission an accurate endpoint?
- Should they have zoned in on a specific group?

ED Assumptions

Patients often present to the ED with etiologies which may affect circulatory status

StO$_2$ can help detect circulatory insufficiency
(hypoperfusion, StO$_2$ = 75%)
- Despite non-alarming clinical signs
- Despite treatments to achieve target vital signs
Emergency Department Evaluation Objective

- Identify the incidence of circulatory insufficiency (hypoperfusion) in at risk ED patients

- The At-risk Patient Population
  - All elderly, ≥65, high acuity patients
  - Any age, at risk for medical bleeding
  - Any age, high risk for hypoperfusion

ED Evaluation Methods

- StO₂, Tissue Oxygenation Monitor, applied to the thenar

- Single StO₂ measurement recorded after sensor in place 30 seconds to 2 minutes

- Data collected: StO₂, vital signs, primary complaint, age, ESI category
  - During initial patient assessment
  - Recorded periodically until patient discharged or admitted
  - StO₂ below 75% reported to physician who could choose to further assess patient
## Results: Multiple Sites

11 sites...n=492

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### 11 ER Sites - Lowest StO$_2$ n=492

33% with StO$_2$ <75% (range 14-70%)

- StO$_2$ <70% 13%
- StO$_2$ 71-75% 20%
- StO$_2$ >75% 67%
11 ER Sites - StO₂ Post Treatment  n=440
25% with StO₂ <75%  (range 10-46%)

- StO₂ <70%  13%
- StO₂ 71-75%  12%
- StO₂ >75%  75%

Patient Primary Complaints and Diagnostic Impressions*

- 13% Shortness of Breath
- 10% Chest Pain
- 7% Abdominal Pain
- 6% Bleeding - GI
- 5% Dizziness
- 5% Fall – Ground Level
- 5% Syncope
- 4% Fever
- 4% Weakness - General
- 3% Vomiting, Nausea, and/or Diarrhea
- 3% Heart Rhythm Irregular (A Fib, palpitations)
- 3% Swelling or Edema (arm, leg, groin)
- 3% Hypotension

*Partial list of primary complaints
Evaluation Discussion

- StO\textsubscript{2} identified reduced circulatory status (hypoperfusion) and in some patients hypoperfusion persisted following standard treatments in the ED
  - Elderly patients’ fluid status seems to be harder to evaluate
  - StO\textsubscript{2} may find people whose hypoperfusion may have been unaddressed

The Methodist Experience

- 1200 bed hospital
- 40,000 ED visits per year
- Admit 46% of all ED visits
- StO\textsubscript{2} measurements taken in ED over four consecutive days
**Results** n=37

- 68% of the monitored patients had circulatory insufficiency (hypoperfusion) as identified by StO$_2$ = 75%
  - 44% with StO$_2$ = 70%

- Following treatment, 46% continued to have StO$_2$ = 75%
  - 19% with StO$_2$ = 70%

**Lowest Recorded StO$_2$ in ER**

68% with StO$_2$ < 75%  n=37

- StO$_2$ < 70% 44%
- StO$_2$ 71-75% 24%
- StO$_2$ > 75% 32%
StO2 Following Treatment in ER

46% with StO2 <75%  n=37

- StO2 <70% 19%
- StO2 71-75% 27%
- StO2 >75% 54%

Case Study

- Male > 65 y/o.
- Present in ER due to hypotension
  - Lactate in ER 2.4
  - 2 liters NS administered

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• Hospital Course:
  • Transferred to the floor
  • Additional fluids after transfer.
Case Study

- Male > 65 y/o presented with rectal bleeding which had persisted for 3 days
  - Lactate 1.3
  - Hgb 9.5
  - T 96.8

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- Hospital Course:
  Pt transferred to medical floor
  2 blood transfusions administered day 2
  1 blood transfusion administered day 3
  Discharged to home day 5

Conclusions

- StO₂ still in its infancy in ED
- Appears to have utility as monitoring tool for critically ill, trauma, bleeding and septic patients
- May have tremendous utility as a screening tool for the elderly
FINAL CONCLUSION

- ELDERLY PATIENTS HELD IN THE EMERGENCY DEPARTMENT HAVE A VERY HIGH RATE OF HYPOPERFUSION
  - Despite non-alarming vital signs
  - Despite treatment to achieve target vital signs