Serum Lactate

Applicable for Trauma Triage?

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What if there was something:

Identifies cellular hypoperfusion well before changes in vital signs

Potential to reduce morbidity & mortality

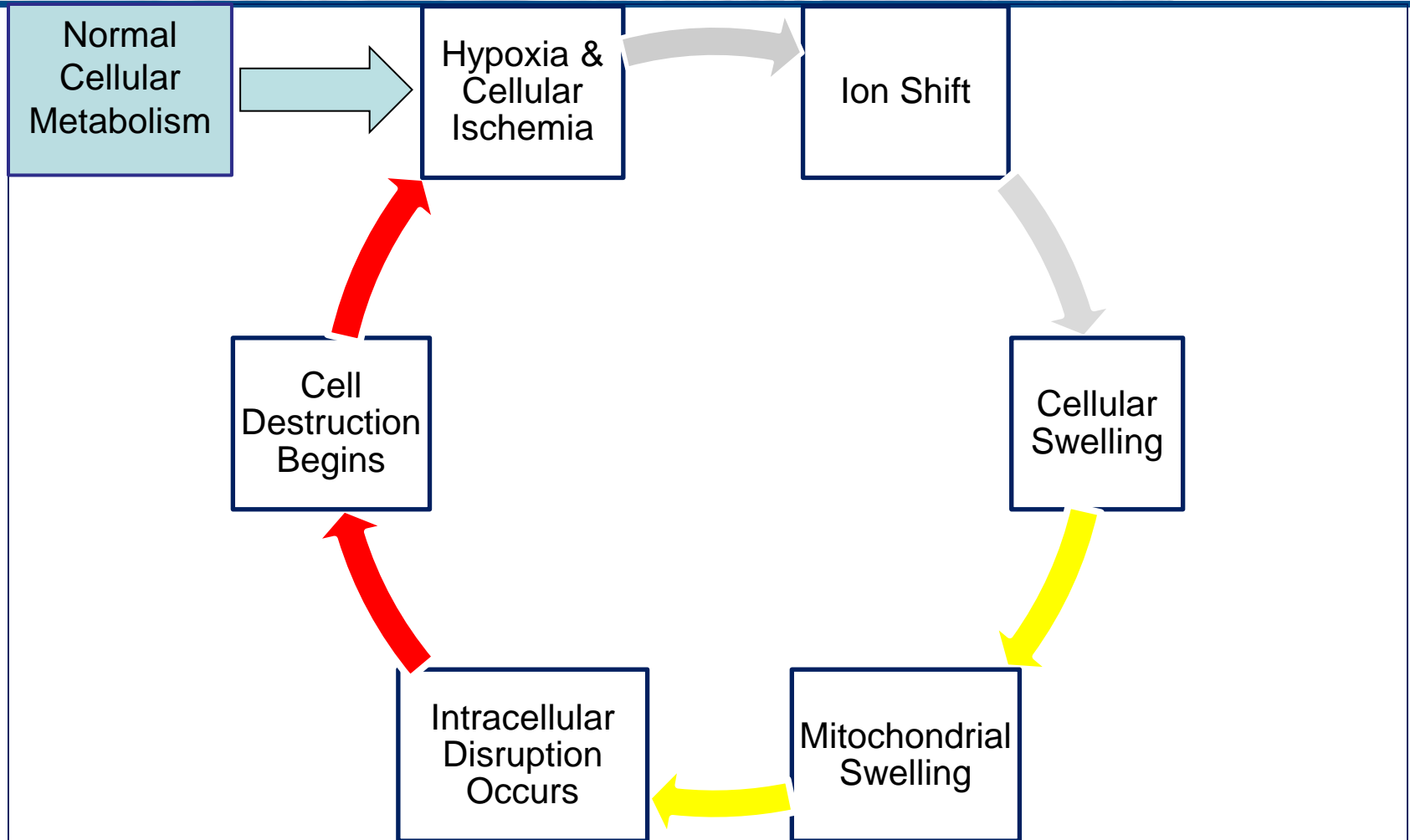Guides early intervention and destination decision

Easily obtained in the field

Does NOT increase scene time

Is inexpensive

Would You Use It?

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Shock

Classic Shock Pattern

- **Early shock**
  - 15–25% blood volume
  - Tachycardia
  - Pallor
  - Narrowed pulse pressure
  - Thirst
  - Weakness
  - Delayed capillary refill

- **Late shock**
  - 30–45% blood volume
  - Hypotension
    - First sign of "late shock"
  - Weak or no peripheral pulse
  - Prolonged capillary refill

Serum Lactate Levels

- Normal serum lactate level is between 0.5 – 1.0 mmol/L

- Hyperlactatemia – mild to moderate persistent increase in blood lactate concentration (2.0 – 4.0 mmol/L) without metabolic acidosis

- Lactic acidosis – persistently increased blood lactate levels (usually >4.0 – 5.0 mmol/L) in association with metabolic acidosis.

Cohen, R., & Woods, H. (1976). *Clinical and Biochemical Aspects of Lactic Acidosis*. London, United Kingdom: Blackwell Scientific Publications.

Mizock, B. A., & Falk, J. L. (1992). Lactic acidosis in critical illness. *Crit Care Med*. 20(1), 80-93.

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Pre-hospital Serum Lactate

- Serum lactate (BL, pLA) is a predictive of compromised perfusion and is associated with hypovolemic shock. (Guyette, 2009)

- Limited number of studies specific to Out-of-hospital environment utilization

- *Value of BL in out-of-hospital environment?*
  - Sensitivity measures the probability of "something" being tested positive
    - Number of true positives (correctly identified)/[Number of true positives+ Number of false negatives (incorrectly rejected)]
  - Specificity measures the probability of something being tested negative
    - Number of true negatives (correctly rejected)/ Number of true negatives+ Number of false positives (incorrectly identified)

- Questions to Explore:
  - Potential utility in early identification of patients with significant injury?
  - What value is indicative of an acute or evolving poor physiologic condition?

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Jansen, T. C., van Bommel, J., Mulder, P. G., Rommes, H. J., Schieveld, S. JM., Bakker, J. (2008). The prognostic value of blood lactate levels relative to that of vital signs in the pre-hospital setting: a pilot study. *Critical Care.* **12(6). Web access http://ccforum.com/content/12/6/R160**

Journal of
Critical Care

- Prospective Observational; In-hospital mortality; 124/135 patients enrolled; Scene arrival to ED 27 minutes (+/- 10); 92 survivors/ 32 deaths

- Lactate drawn T1, T2 and ED
  - Change in lactate level and the GCS were independently associated with in-hospital mortality; prognostic value was independent of vital signs
  - A 3.5 mmol/L or more resulted in mortality rate 41% T1 and 47% T2
  - NPV 88% with low lactate level; more sensitive marker
  - Clinical relevance
    - Triage tool in out-of-hospital (OOH) setting
    - Optimization of oxygen delivery
  - Limitations – data 10 years old; patients utilized presented with abnormal vital signs; unable to generalize across OOH; inclusion criteria utilized hypotension compensatory mechanisms; small sample

- Outcome
  - Pre-hospital blood lactate predicts in-hospital mortality
  - Prognostic value over and above common vital signs
  - Lactate more sensitive in identifying at-risk population than BP or HR

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Vandromme, M. J., Griffin, R. L., Weinberg, J. A., Rue, L. W., & Kerby, J. D. (2010). Lactate is a better predictor than systolic blood pressure for determining blood requirements and mortality: Could prehospital measures improve trauma triage? *J Am Coll Surg.* **210**, 861-869.

- Retrospective Observational: PRBC transfusion or in-hospital mortality; 2,413/787/ 31,032; nine year enrollment period

- Systolic BP between 90 – 110 mmHg
  - BL level categorized (≤ 2.5, > 2.5 to 5.0, > 5.0 to 7.5, or > 7.5)
  - Number of PRBC received in first 24 hours
  - Two –fold increase in risk for PRBC and mortality doubled when BL increased into the > 2.5 to 5.0 range (p < 0.0001)
  - Clinical Relevance
  - Superior in mortality prediction than base deficit at initial and 24 hour
  - Not affected by acute drug or alcohol intoxication
  - Limitations – Retrospective based on SBP from registry; Unable to extrapolate to PH setting; Study looked at SBP range for 90-110 (how about with permissive hypotension?)

- Outcome
  - Increase in BL identified significant risk of need for transfusion and mortality
  - No absolute abnormal value of BL was determined

Guyette, F., Suffoletto, B., Castillo, J. L., Qintero, J., Callaway, C., & Puyana, J. C. (2011). Prehospital serum lactate as a predictor of outcomes in trauma patients: A retrospective observational study. *J Trauma*. 70(4), 782-786.

- Retrospective Observational; Determine pLA identifies morbidity/ mortality independent of vital signs; In-hospital mortality, surgery & MODS; 1,168/2,190 patients
  - Median pLA 2.4 mmol/L
  - Median pLA 3.8 mmol/L mortality (5.7%) , 3.4 mmol/L surgery (7.4%), 3.8 mmol/L MODS (5.7%); 2.3 mmol/L survived to discharge
  - Sensitivity issue – identified 8% at-risk individuals with normal pLA
  - Clinical Relevance
    - Use provides additional prognostic information of in-hospital morbidity and mortality independent of clinical shock, respiratory distress and altered sensorium
    - Did not address minimum predictive value, venous vs. capillary sample or titration of prehospital therapy
  - Limitations – population primarily blunt trauma, higher acuity, not generalizable to trauma population
- Outcomes
  - pLA considered ADJUNCT to increase injury detection (sensitivity) in and NOT utilized as a test to rule out injury (specificity)

Additional Studies

- **Callaway, D. W., Shapiro, N. I., Donnino, M. W., Baker, C., Rosen, C. L. (2009). Serum lactate and base deficit as predictors of mortality in normotensive elderly blunt trauma patients. J Trauma. 66(4), 1040–1044.**
    - Elderly patients, blunt injury, SBP 90mmHg, In-hospital mortality 2.8 mmol/L ±1.8 mmol/L vs. 2.0 mmol/L ± 1.0 mmol/L, *p* 0.001
    - Mortality 15% 0 – 2.4; 23.4% 2.5 – 4.0 and 39.6% > 4.0 mmol/L
    - Greater than 25% were identified to be in occult shock, as evidenced by an elevated BL, even though SBP was 90 mmHg

- **Van Beest, P. A., Mulder, P. J., Oetomo, S. B., van den Broek, B., Kuiper, M. A., & Spronk, P., E. (2009). Measurement of lactate in a prehospital setting is related to outcome. *E J EM*. 16, 318-322.**
    - Retrospective chart review of 216 patients; LOS or mortality utilized; criteria serum lactate obtained in PH setting
    - Categorized shock/ non-shock groups by clinical presentation; BL 0 – 4.0 and > 4.0 mmol/L
    - Mortality for non-shock BL 0 – 4.0 mmol/L 1.2% vs Shock BL > 4.0 26/7%

- **Serum lactate and Sepsis**
    - Not included for this presentation

LACTATE PRO 2
Portable Blood Lactate Analyzer

arkray

- A blood lactate test meter, the "Lactate Pro 2" requires a 0.3μl blood sample and provides measurement in 15 sec.

- US FDA Approved - Waived Status under the Clinical Laboratory Improvement Amendments. Device employs methodologies that are so simple and accurate as to render the likelihood of erroneous results negligible.

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So What's the Message?

- Serum lactate is a better predictor of injury/ in-hospital mortality than vital signs

- Does **<u>NOT</u>** replace clinical evaluation

- Threshold defining acuity unknown

- Ability to generalize to trauma population unknown

To Use or Not To Use

- Technology is improving
- Research is ongoing
- Not a standard in industry
- MAY assist with early identification of shock in patients with SBP ≥ 90 mmHg and absence of traditional clinical shock patterns

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