SURVIVING SEPSIS: TIPS AND TOOLS FOR THE PACU NURSE

MAUREEN F. MCLAUGHLIN, MS, RN, ACNS-BC, CPAN, CAPA

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Case Study

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84 yo gentleman postop hip repair/replacement
- Assisted living
- Fall from standing
- CAD, DM, otherwise "healthy"

Post spinal, arrives hypotensive, neo
Spinal wearing off, still neo
IV fluid w/ transient response
Labs (routine post-op): WBC 28,000
?thoughts?

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Sepsis: '*putrefication*'

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Sepsis: systemic response to infection
- Dysregulated "host" response to infection
  - Organ dysfunction
  - Potentially (often) life-threatening
  - Massive inflammatory response
- ~ 6% incidence in hospitalized adults
  - BUT infants, children and pregnant women not exempt
- Leading cause of hospital mortality
  - ~ 1 in every 2-3 deaths

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Continuum of Severity

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- Infection
- Systemic inflammation
- Septic shock
- Mortality > 40% a/w shock

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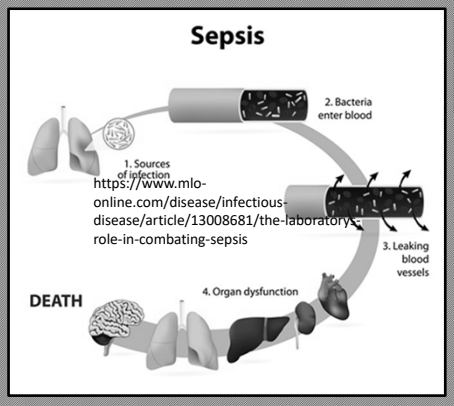

https://www.mlo-online.com/disease/infectious-disease/article/13008681/the-laboratorys-role-in-combating-sepsis

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Severe Sepsis

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- Organ dysfunction
- Hypoperfusion
- Hypotension

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Septic Shock

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- Hypotension despite fluid resuscitation
- Perfusion abnormalities:
  - Lactic acidosis
  - Oliguria
  - Acute change MS
- Hypotension: SBP < 90
- MODS: altered organ function – homeostasis cannot be maintained

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Multi-Organ Dysfunction Syndrome

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- Progressive physiologic failure of organs
  - Cell death
- >> morbidity and mortality
- ALI: worsening oxygenation despite ventilatory support
- Oliguria: CRRT
- Hemodynamic instability: escalating vasopressors

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Sepsis Consensus Conference #1

- 1991
- Define terms sepsis & organ failure
- Define/describe the systemic inflammatory response to infection
  - Progressive, injurious, fatal
  - Elderly, debilitated, immunocompromised critically ill most vulnerable

ACCP/SCCM Consensus Conference Committee. (1992). *CCM 20*(6):864-874.

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Definitions

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- Infection: inflammatory response to presence of microorganisms
- Bacteremia: bacteria in blood
- SIRS: systemic inflammatory response to the above:
  - Temp > 38 (100.4) or < 36 (96.8)
  - HR > 90
  - RR > 20 or $PaCO_2$ <32
  - WBC > 12,000 or < 4000
- Sepsis: systemic response characterized by…as a result of infection (as in SIRS)

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(2nd) International Sepsis Consensus ~ 2001

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- Broadening of diagnostic criteria:
  - Altered mental status
  - Hyperglycemia in absence of DM
  - Add'l lab studies
  - Hypotension: SBP < 90, MAP < 70, SBP decrease > 40 mm Hg
  - SVO_2 > 70% / Cardiac index > 3.5
- Organ dysfunction: P/F < 300, end-organ function
- Tissue perfusion abnorm: > lactate, mottling, cyanosis

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P/F Ratios

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- P: perfusion
- F: fraction inspired oxygen
- Pt mechanically ventilated @ 70% FIO_2
  - Abgs: PO_2 110
  - P/F = $\frac{110}{.70}$ = 157

Fairly simple tool to assess oxygenation/ventilation in critically ill

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(2nd) International Sepsis Consensus

- PIRO:
  - Predisposition
  - Infection
  - Response
  - Organ dysfunction
    - Dysregulation of inflammatory response, coag
- Management:
  - Antis, resuscitation, good source control

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Surviving Sepsis Campaign

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- Launched 2002 ~ "bundled" approach
- EGDT
- Resuscitation: (w/in 6 hours)
  - Serum lactate
  - Antis + time frames
  - Hypotension: fluid , then vasopressors
- Management: begin ASAP & over 24 hours

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Surviving Sepsis 2016: Sepsis-3

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- Require that sepsis be triggered by infection
- Assess organ function: Sequential Organ Failure Assessment (SOFA)
  - RR, coags, hepatic, CV, CNS & renal
  - Labs: bili, cre, coag, ABG

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qSOFA

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- Abbreviated organ dysfunctional assessment
- 3 variables/1 point each:
  - SBP (≤ 100)
  - RR (≥ 22 breaths/minute)
  - Mentation (change in MS)
- Score > 2 = > risk for extended ICU stay/death

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Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock 2021

- Screening [acutely ill & high risk]
  - Early Rx: SOP
  - MEWS/NEWS/SIRS
  - Lactate- *low quality evidence*
- Initial resuscitation
- Mean arterial pressure > 65
- Vasopressor Rx: norepi
- Maximize ventilation: low tidal volume ~ 6ml/kg
- Source control

Evans, L. et al. CCM. (2021). E1063-e1143

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MEWS

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- RR
- Sats
- Systolic BP
- HR
- LOC/new confusion
- Temp

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Modified Early Warning Score

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Score	3	2	1	0	1	2	3
Temp	< 32	< 35	< 36	36 - 38.4	38.5 - 38.9	39 - 40.9	≥ 41
HR	< 40	40 - 44	45 - 50	51 - 100	101 - 110	111 - 129	≥ 130
RR	≤ 7	8	9	10 -14	15 - 20	21 - 29	≥ 30
SBP	≤ 70	71 - 80	81 - 100	101 - 160	161 - 180	181 - 199	≥ 200
Mental Status Change**	Unresponsive, coma	Stupor, responds to noxious stimuli	Lethargic, responds to voice or tap	Alert, calm, cooperative	Mildly agitated, confused, anxious	Very agitated, requires restraints	Extremely agitated and danger to self or others
Latest WBC	< 1*	1 - 2.9*		3 - 14.9	15 - 19.9	20 - 39.9	≥ 40

https://journals.lww.com/ccejournal/pages/articleviewer.aspx?year=2021&issue=05000&article=00025&type=Fulltext

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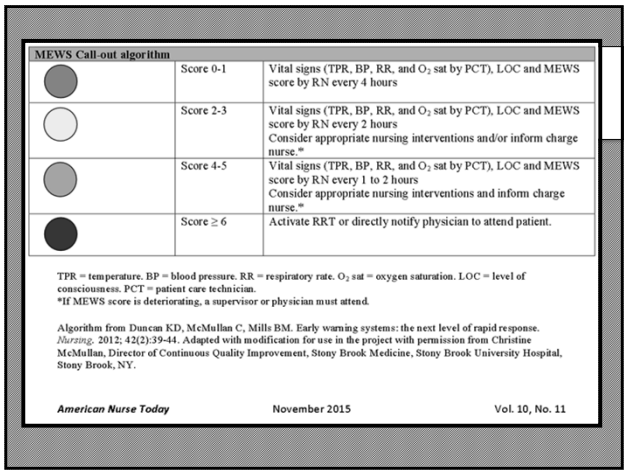

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Royal College of Physicians

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National Early Warning Score (NEWS)*

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Level of Consciousness				A			V, P, or U

https://openanesthesiajournal.com/VOLUME/12/PAGE/26/FULLTEXT/

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Risk Factors

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- ICU admission (nosocomial infection)
  - Presence of plastic:
    - Central venous access
    - Urinary catheter
    - ETT
    - NGT
  - Wounds/surgical site
- Bacteremia
- Advanced age (>65)
- Immunosuppression
- Cancer
- PNA
- Previous hospitalization
- SARS-CoV-2
- DM/obesity

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Clinical Presentation

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- Sxs infectious source
- SBP < 90/MAP < 70
- Temp > 38.3/< 36 [100.94/96.8]
- HR > 90
- RR > 20
- Sxs end-organ function ~ mottled, < cap refill
- Altered mental state d/t hypoperfusion
- Absent BS d/t hypoperfusion

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Sepsis: Immediate Eval & Management

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- Optimize oxygen delivery/cont pulse ox
  - Intubation: support > WOB/airway protection in altered NS
- Venous access ~ do not delay for central access
  - Fluid resuscitation
  - Optimize tissue perfusion ~ vasopressors as needed
- Investigation

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Sepsis?????????

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- CBC ~ WBC, LFTs, Bun/Cr, coags
- Serum lactate ~ > 2 indicates severity of response
- BCs ~ prior to antimicrobial therapy
- ABGs ~ acidosis, hypxemia, hypercarbia
- Imaging ~ chest (PNA), abdomen (acute abd)
- Procalcitonin ~ value w/ antibiotics

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Pharmacotherapy of Sepsis

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- IV fluids
  - Rx tissue hypoperfusion
- Vasoactive agents
- Antimicrobials
- Corticosteroids
  - Lower level evidence IF hemodynamically stable w/ fluids
- Glycemic control

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Initial Resuscitative Therapy

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- Restore perfusion
  - Hypovolemia typical ~ severe possibly
  - Aggressive fluid resuscitation (LR or NS) ~ 30 ml/kg
  - Started w/in 1 hour; complete in 3
  - Well-defined bolus (500)
    - Evaluate response
    - Assess presence/absence of pulm edema
    - Goal: BP & tissue perfusion OK

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IV Fluids

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- 20-30ml/kg
- Dynamic fluid responsiveness
  - SVV, PPV, SLR
- LR vs NS vs albumin

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Antimicrobials

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- Source ID
- W/in 1 hour of sepsis dx
- Broad spectrum until culture data
- IVP rapid admin
- Potential for weight-adjusted dosing
  - distribution

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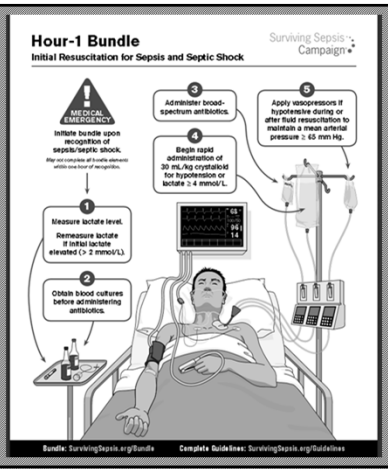

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Perianesthesia Challenges

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- Transitions of care
- Disposition of perioperative patients
  - Variabilities d/t postoperative condition
- Hand-off communication
  - MD-MD
  - RN-RN
  - MD-RN
- Inpatient change in patient condition
  - Early warning systems
  - Not visible to PACU ? or in use or conflicting d/t anes response
- Hemodynamic changes r/t anesthesia

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Sepsis in the PACU?

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Presenting w/ infection- known or suspected
- Surgical intervention
- ED or emergent
- Pre-op labs
  - WBC, lactate, ABG
  - ? Part of hand-off? What is hand-off and by whom?

Hypotension/tachycardia
- d/t anesthetic effects or ????
- Hemodynamic instability/escalation of vasopressors ~ unlikely anesthetic related

- Alteration in MS: anes related or ????
- Alteration in oxygenation

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Oxygenation

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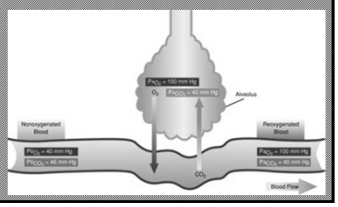
- Environment: RA/supplemental
- Conducting airways
- Dead end: alveolus
- Alveolar capillary membrane
- Bound to hgb
- LV-aorta-systemic circulation
- Cellular function



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Inadequate Oxygenation

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- Inadequate supply of O_2 in environment
- Inadequate delivery of O_2 to the tissues
- Cellular inability to utilize available O_2
- Sepsis guidelines
  - Risk of acute hypoxic failure
  - High flow O2 (HFNC)
  - NIV
  - MV

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Assessments for Alterations in Oxygenation

- RR/BS
- Saturation
- *Mental status changes*
- Skin color: cyanosis, pallor, mottling
- **Capillary refill time**
- Increasing oxygen requirements
- ABG/VBG
- Lactate levels

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Mixed Venous Blood Gas

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- Represents an aggregate of venous effluent from all tissues and organs in the body
- Drawn from the distal port of a PA catheter/central line/PIV
- Measures pH, PvO2, SvO2, PvCO2

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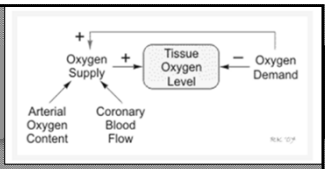
VBG



- PvO_2 40
  - Indicator of the balance between oxygen supply & demand
  - < d/t:
    - decreased arterial oxygen content (< hgb, SaO_2, PaO_2)
    - < CO
    - > tissue oxygen demand
  - >>- O_2 not used

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SvO_2

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- SvO_2 is the saturation of hgb with oxygen in the mixed venous blood
- Normal value is 60-80%, with an average of 75%
- Reflects the balance between oxygen supply and demand
- Indicates that 25% of all oxygen delivered is used by the tissues

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Lactate

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- Produced when body breaks down carbs for energy when O_2 levels <
- Nl: ≤ 2 mmol/L
- Evidence of cellular stress r/t refractory <<<< BP
  - > d/t impaired tissue oxygenation
    - Aerobic to anaerobic metabolism
    - Decreased O_2 delivery
    - Defect in mitochondrial O_2 utilization
- Often used as a predictor for survival

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PACU Oxygenation Assessment

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- Pulse ox, color, mentation, VS, BS
- Chest x-ray (dx)
- ABG
- VBG
  - Is the delivery sufficient to meet demand
  - PvO_2
  - Maximize oxygenation

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Postoperative Hypotentsion

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- Anesthesia – related
  - Spinal
  - GA
  - MAC
- Return of vasomotor tone
  - Spinal- sympathetic blockade ~ T8-10
  - ~ 30 mins post PACU (generally)
  - Normalization of HR, BP
    - Excluding pain, agitation, delirium, bleeding
  - Wean phenylephrine if present to off

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Persistent Hypotension

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- Postoperative complication/association
  - Bleeding: drain output, distention
  - << BP assoc. w/ >>> HR
  - <<< u/o
  - Labs- but most often H/H, not WBC
- Resolution/identification
- Still searching for a cause???
  - Infectious presentation???
  - WBC/ABG/lactate

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Persistent Hypotension

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- Consistency in BP management
- Consideration of A-line
- Ensure mean BP > 65
- Volume ~ response to fluid
- Neo initially
  - Titration guidelines
  - Excalation ~ consideration of norepi
  - Higher level of care

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Case Study

- 78 yo male s/p I&D L hip
- ED admit, prior THR
- GEA, arrived on 0.5 mcg/kg neo
- VS: 110/88, 100, spont resps ~ 16, sats ok
- BP: NIBP RUE; LUE traumatic amp distal to elbow
- RN moved BP to LE
- 160/80 146/88 110/80 *Neo off*

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Case Study

- Transfer to floor
- Arrived unresponsive, no BP
- Met call – to ICU
- Review:
  - ED: lactate 6, WBC > 20,000
  - Hypotensive requiring vasopressor support
  - Fluid bolus given in ED
  - No ED handoff to PACU
  - MUCH closer observation required post neo off
  - Possible higher level of care warranted

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PACU Management

- Hypotension
  - NIBP: cuff accuracy, compare bilat
  - ? Need a-line
  - A-line "hygiene"
  - R/O: pain, agitation, delirium, full bladder
  - MAP goal per DOS, clinical severity

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Mean Arterial Pressure

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- Mean systemic filling pressure
- > MAP=
  - Increased tissue blood flow
  - Tissue perfusion
  - MAP < 60 a/w decreased organ perfusion
  - Goal MAP > 65

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Monitoring Blood Pressure

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- Direct: invasive arterial line
  - Reflection of "pressure"
  - Represents the "force" on arterial wall
  - Values obtained via hemodynamic monitoring:
    - Electronic system- monitor
    - Fluid filled tubing
  - Accuracy
    - Priming
    - Zeroing/leveling/air-fluid interface
    - Dynamic response testing

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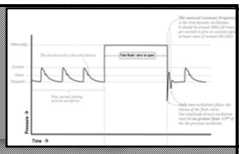
Monitoring ABP



- Essential to have accurate measurement to guide Rx
  - resuscitation
- Level air-fluid interface correctly
- Perform dynamic wave test
- Ensure fluid system bubble-free

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Phlebostatic Axis

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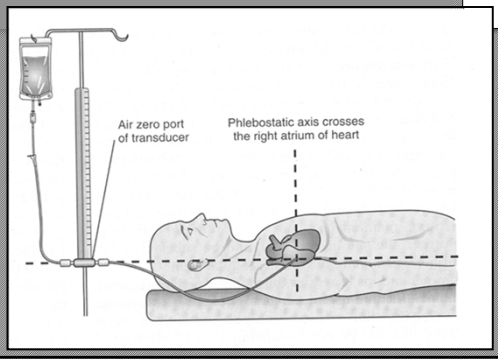

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How Do You Level?

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Hemodynamic Instability

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- Unexplained tachycardia
- Hypotension
  - Less than 30 pts of baseline
  - Mean < 65
- Oliguria
- Sxs of poor perfusion
  - Pallor
  - Lactic acidosis
  - End-organ dysfunction

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Shock

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- Clinical presentation of circulatory failure
- Life threatening condition
  - Low blood perfusion
    - Lack of oxygen to tissues
      - Cellular injury and cellular death
- Clinical sxs:
  - < BP
  - Rapid heart rate
  - Poor end organ function

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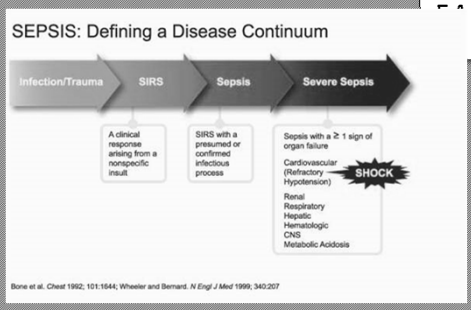

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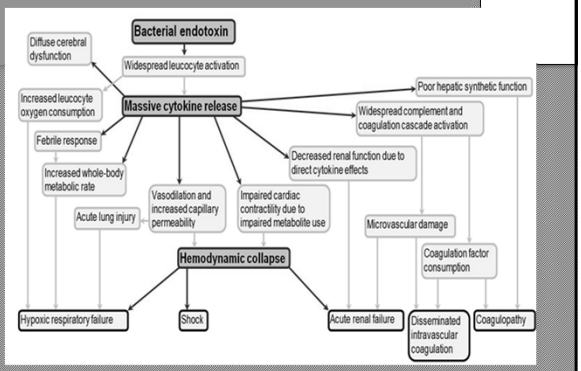
Septic Shock



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Sepsis???

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- Hypotension not responding to fluids
- Initiation of vasopressors
  - Escalation
- Poor oxygenation- low sats, > O_2 requirements
- *Infectious source*
- Pre-disposition: elderly, DM, other

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Case Study

84 yo gentleman postop hip pinning
- Assisted living
- Fall from standing
- CAD, DM, otherwise "healthy"

Post spinal, arrives hypotensive, neo

Spinal wearing off, still neo

IV fluid w/ transient response

Labs (routine): WBC 28,000

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Case Study

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- > WBC- indicative of infection (unk)
- < BP on pressors
- Baseline MS??

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Case Study

- Worsening sats, < BS
- Lactate 6
- Minimal u/o
- 24 post-op- + UTI
- ICU

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Case Study

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- Elderly female brought to ED by family w/ hand injury
  - T 101 [38.3]
  - HR 120 BP 105/58
  - Serosanguinous drainage from several sites on hand
    - Redness extends to elbow
  - Labs
    - Lactate 4.6
    - WBC 20.9 w/ 20% bands
  - Antis ordered
- OR for ? necrotizing fasciitis

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Case Study

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- OR for emergent I&D
- GEA, 18ga peripheral IV
- Initial VS: HR 125 BP 150/100
- << BP on induction- quick response to neo
- Neo duration of case- unknown amt
- Wide excision of necrotic tissue, no evidence of gas, clean margins, left open
- *Are you worried?*

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Case Study

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- Extubated @ end

- Post-op
  - Arrival VS- SVT, BP < 100, minimal response
  - Reintubated
  - PA line
  - Neo
    - then vasopressin, levo
- Ischemic stroke, MI, CMO 7 days later

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Case Study

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- 37 yo male, chief c/o severe acute abd pain, vomiting, unable to void since prev day, 10/10 pain; ED @ 7:50 AM, Thurs
- PMHx sig for: obesity, + smoker, HTN, > chol, DM
- Dx: acute appendicitis, planned appy for later that day
- OR @ 20:10, approx 12 hours later

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Case Study

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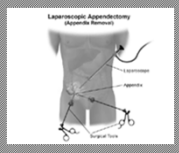
- OR: lap appy (perforated) w/ GA, min EBL, 1600 mls fluid. Toradol at end
- PACU @ 22:10
  - HR 108
  - BP 140/70
  - RR 16
  - T: 104.9
  - Sat 98%, 4L O2



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Case Study

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TIME	BP	HR	RR
22:17	157/71	124	42
22:32	112/64	116	33
22:52*	95/52	132	35
23:12*	86/44	129	36
23:42	81/42	130	30
00:05*	66/41	127	30
00:10	103/72	128	31

* Call to Anesthesia- "give IV fluids until BP up"

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Case Study

TIME	BP	HR	RR
00:50	93/88	111	32
01:20*	58/27	123	35
01:35	59/88	139	38

*Patient restless. Abd distended. "Can't breathe"
3 hours after arrival to PACU
Anesthesia notified again. Call 2nd anesthesia provider

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Case Study

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- Abg: 7:47/24/95/17
- Decision to intubate
- Return to OR w/ CRNA for intubation
- Code called @ 02:20 AM [PEA arrest]: 4 hours after arrival to PACU
- Resuscitated
- 03:25: 6.75/58; creatinine: 2.3
- 04:12 AM- re-exploration
  - EBL 1000
  - IV: 3000
  - u/o: 25 ml

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Case Study

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- Back to PACU awaiting ICU bed
  - Vasopressin, neo
  - Intubated and sedated
- POD # 2: creatinine 6.2
  - Return to OR for vas cath
- D/c to home 23 days following ED admission
  - Inpt rehab denied d/t insurance
  - On-going dialysis as outpt
  - Pt never returned to work, divorced, debt

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Case Review

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- Preoperative presentation
  - Emergent
  - Delay to OR
  - Anueric/oliguria
- Intraoperative course
  - Perforation
- Initial VS stable except temp
  - 30 mins after arrival BP ~ 30 points < arrival
  - HR 130's

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Final Thoughts

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- Sepsis *common* life-threatening condition
  - ~ High mortality
- Surgical patients NOT exempt
  - But presentation @ odds w/ p-op complications
  - Hemodynamic instability- observe, ? higher LOC
- Timely ID essential ~ appropriate management
- Hand-off- ED nursing/anesthesia
- Protocolized approach
- A-line hygiene

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Question

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Sepsis is best defined as:

a. systemic response to infection
b. white blood cell count < 100K
c. hypertension > 150 systolic
d. lactate <1

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Question

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Septic shock is best described as:

a. hypotension despite fluid resuscitation
b. lactate < 2
c. heart rate > 100
d. anemia with hgb < 7

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Question

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Elevated serum lactate levels may be indicative of:

a) fever
b) inflammatory systemic response
c) solid end-organ dysfunction
d) appropriate host response in the setting of sepsis

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THANK YOU!!!

IT HAS BEEN AN HONOR!!!

maureen.f.mclaughlin@lahey.org

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