Monitoring Critically Ill Patients

Vital basics on vital signs and signs that are vital…

Brandon Masi Parker OMS IV POPPF
DidacticsOnline

Topics:

Vitals

Pulse Oximetry

Blood Gases

End-tidal $C0_2$

Vitals

- Heart rate
- Respiratory rate
- Temp
- Blood pressure

Heart rate

- The autonomic nervous system is the primary regulator of heart rate in healthy pt.
- 50% of critically ill patients will present with normal HR

HR variability

- Heart rate variability (HRV) measurements provide a method for assessing cardiac autonomic function and for predicting cardiac death and sustained ventricular arrhythmias in pts. with CAD.
  - The autonomic nervous system has an important role in the triggering or sustaining of malignant ventricular arrhythmias, particularly after myocardial infarction.
  - Myocardial ischemia → increase afferent cardiac sympathetic firing→ reflexes that increase efferent cardiac sympathetic neural activity while decreasing efferent vagal activity.
    - Release of norepinephrine from sympathetic nerves and high extracellular potassium concentrations in ischemic regions →regional heterogeneity of depolarization and repolarization →reentrant activity and the precipitation of ventricular fibrillation.
  - HR variability is inversely related to the production of many inflammatory markers.

Respiratory rate

- Ensure accuracy
- Insight to respiratory drive
- Insight to metabolic status

- Minute ventilation→ actual ventilation
  - Clinically assess tidal volume

Temperature

- Rectal, vagina, or otic= 37.5 °C (99.5 °F)
- Oral= 36.8 °C (98.2 °F)
- Axillary= 36.5 °C (97.7 °F)

- Oral about 0.4 °C (0.7 °F) lower than rectal
  - influenced by drinking, chewing, smoking, and breathing with the mouth open

Blood pressure

- Aims to represent perfusion of organs

- Commonly measured with MAP and Pulse pressure

Pulse Pressure

- Pulse Pressure: SP-DP
- Low/Narrow:
  - Decreased stroke volume
- High/wide:
  - Increase in SV
    - Physiologic in stress and exercise (increase SV and decrease TPR)
  - A high pulse pressure with bradycardia and an irregular breathing pattern = Cushing's triad

MAP

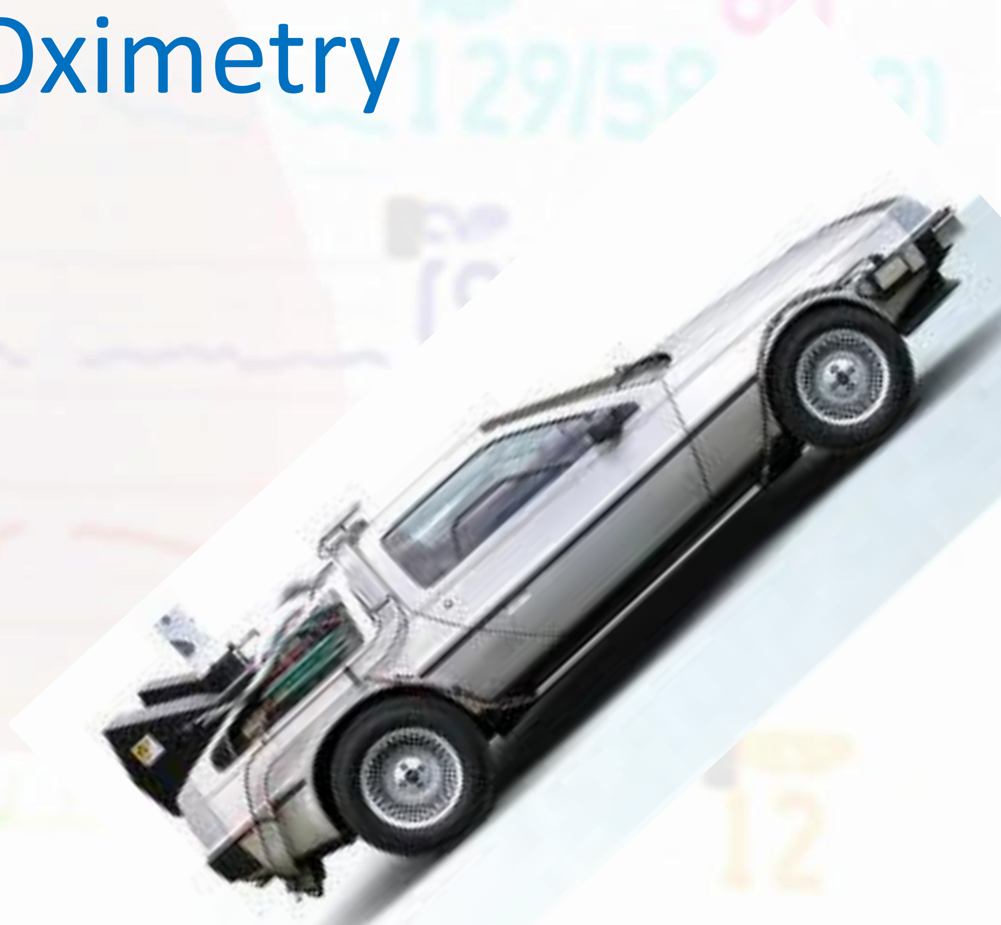
- MAP: (CO x SVR) + CVP
  - DP + 1/3(SP-DP) or DP + 1/3PP
  - 2/3DP + 1/3SP

- Noninvasive can underestimate by 2-12 mmHg
- MAP is unreliable predictor of blood flow and CO

Perfusion

- Cardiac index= CO/BSA
  - Warm toe=sufficient cardiac index and global perfusion
- Cardiac power= MAP x CO

Pulse Oximetry



Pulse ox

- PaO_2: *partial pressure* of O_2 in arterial blood--ABG.

  SaO_2 : *oxygen saturation* is the percentage of hemoglobin molecules which are oxygenated (oxyhemoglobin) in arterial blood.-- pulse ox

PaO_2	**SaO_2**
40	70 (74.9)
50	80 (85)
60	90 (90.6)

Pulse ox calibration

- Finger probes are calibrated in subjects with $Sa0_2$ from 100-75%.
  - Figures are extrapolated below 75% and accuracy suffers.
- Calibrated with normal Hg, Temp and pH which can all effect $Sa0_2$.
  - Pulse ox still considered accurate with very low Hg but questionable with pH and Temp changes.

Pulse ox waveform

- Artifactual changes or a diminished arterial pulse may be evident in this waveform, and repositioning the probe may improve the signal.

- Good waveform=more trust in pulse ox reading.
- Although waveform is real time the saturation figure is not.

Pulse oximetry latency

- Lag time of finger pulse oximeter primarily determined by blood flow and is approx. 30 seconds in a healthy person (Ding).
- With decreased blood flow lag time can increase to over 2 minutes (Mateer).
  - Vasoconstriction/hypothermia/low flow state
  - Very dangerous at steep part of curve

Blood Gases

Blood gas

- Traditionally ventilation and acid base status is assessed via ABG.
- In VBG this can be closely estimated by looking at $PvC0_2$, pH, and $HC0_3$
  - Lactate can also be measured via VBG as long as in blood gas analyzer

VBG as estimate of ABG

- Central/Mixed VBG
  - pH: 0.03-0.05 < ABG
  - $PC0_2$: 4-5 mmHg > ABG
  - $HC0_3$: equivalent
- Peripheral VBG
  - pH: 0.02-0.04 < ABG
  - $PC0_2$: 3-8 mmHg > ABG
  - $HC0_3$: 1-2 meq/L > ABG

Blood gases in shock patients

- ABG- Alkalotic or neutral
  - Low CO_2
  - Little to no interaction with acidotic tissues

- VBG- Acidotic
  - High $C0_2$
  - Little to no interaction with lungs (ventilation)

End-tidal $C0_2$

End-tidal $C0_2$

$ETCO_2 = PaCO_2$

- $ETC0_2$ can predict $PaCO_2$ with an intrinsic and predictable *under*estimation in *healthy* pts.
- In critically ill pts. we can assume:

$PaC0_2 \geq ETC0_2$

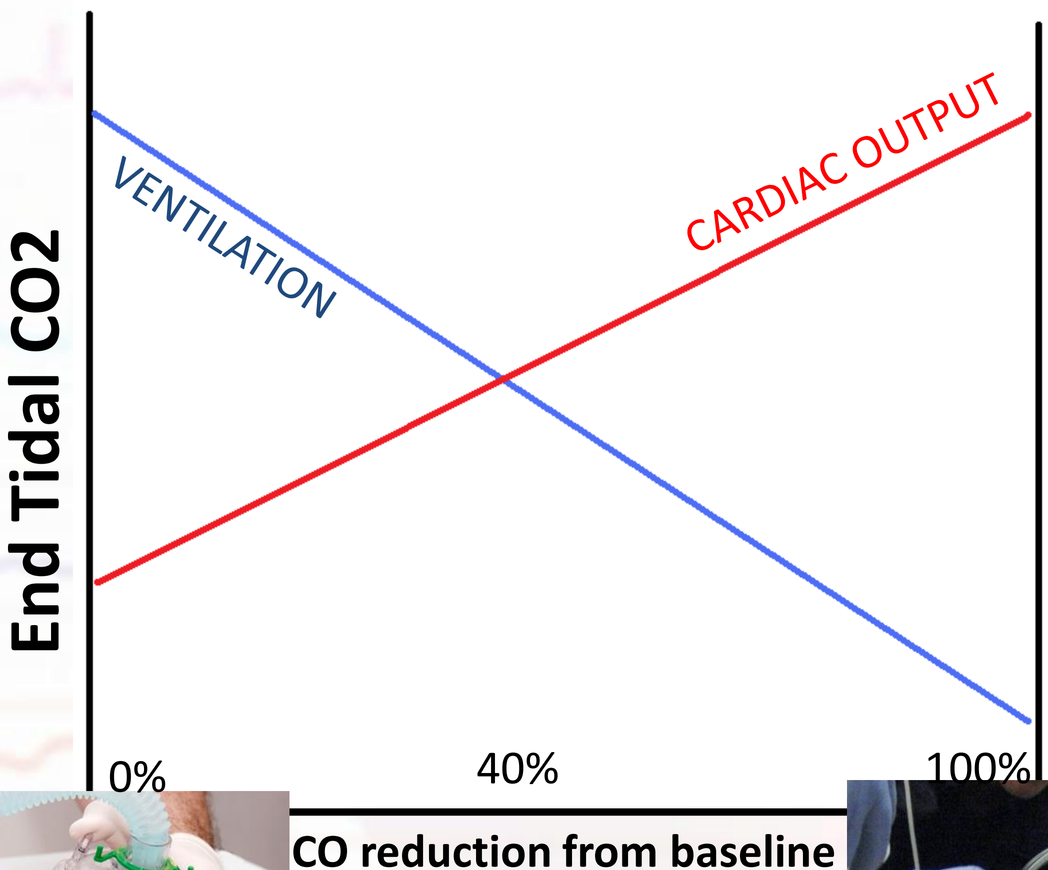
- Gradient between PaC02 and ETC02 is determined by shunt and dead space

End-tidal C0₂

- Parameter measuring ventilation and cardiac output
- In healthy patients it primarily measures ventilation
  - With decreasing CO the measurement becomes more dependent on the perfusion of the lungs and thus measures CO > ventilation

End tidal CO_2

- Measure of ventilation and cardiac output



http://www.sheknows.com/beauty-and-style/

http://airway.jems.com/tag/intubate/

Summary

- Vitals
  - Vital but always in context
- Pulse Oximetry
  - Looking in the past
- Blood Gases
  - VBG ≈ ABG in non-shock patients
- End-tidal C02
  - Measures primarily CO after a significant drop in CO

Resources

- Assali AR, Herz I, Vaturi M, Adler Y, Solodky A, Birnbaum Y, Sclarovsky S. Electrocardiographie criteria for predicting the culprit artery in inferior wall acute myocardial infarction. *Am. J. Cardiol.* 84(1); 87-9
- Ding ZN, Shibata K, Yamamoto K, Kobayashi T, Murakami S. Decreased circulation time in the upper limb reduces the lag time of the finger pulse oximeter response. *Can J Anaesth.* 1992 Jan;39(1):87-9.
- Goldberg AL. Electrocardiogram in the diagnosis of myocardial ischemia and infarction. In: UpToDate, Ganz, LI (Ed , UpToDate, Waltham, MA, 2013.
- Goldberger AL, Stein PK. Evaluation of heart rate variability. In: UpToDate, Ganz, LI (Ed), UpToDate, Waltham, MA, 2013.
- Elert, Glenn (2005). "Temperature of a Healthy Human (Body Temperature)". *The Physics Factbook*. Retrieved 2007-08-22.
- Ellender TJ, Skinner JC. The use of vasopressors and inotropes in the emergency medical treatment of shock. *Emerg Med Clin N Am*. 26 (2008) 759-786
- Jin x, Weil MH, Tang W, Povoas H, Pernat A, Xie J, Bisera J. End-tidal carbon dioxide as a noninvasive indicator of cardiac index during circulatory shock. *Crit Care Med*. 2000 Jul;28(7):2415-9.
- Kelly G (December 2006). "Body temperature variability (Part 1): a review of the history of body temperature and its variability due to site selection, biological rhythms, fitness, and aging". *Altern Med Rev* 11 (4): 278–93. PMID 17176167.
- Levin T, Goldstein JA. Right ventricular myocardial infarction. *UpToDate*
- Mackay MH, Ratner PA, Johnson JL, Humphries KH, Buller CE. Gender differences in symptoms of myocardial ischaemia. *Eur Heart J* 2011;32:3107-3114.
- Mackowiak, P. A.; S. S. Wasserman, M. M. Levine (1992-09-23). "A critical appraisal of 98.6 degrees F, the upper limit of the normal body temperature, and other legacies of Carl Reinhold August Wunderlich". *JAMA* 268 (12): 1578–1580. doi:10.1001/jama.268.12.1578. PMID 1302471. Retrieved 2007-08-22.
- Marino, Paul. The ICU Book, 3rd Edition. *Ovid Technologies, Inc. 2006*
- Mateer, J.R., et al. Continuous pulse oximetry during emergency endotracheal intubation. Ann Emerg Med 1993;22(4):675-9.
- Meyers CM, Weingart SD. Critical Care Monitoring In The Emergency Department. *Emergency Medicine Practice*. 2007;(9)7:1-23.
- Reeder GS, Kennedy HL, Rosenson RS. Overview of the acute management of ST elevation myocardial infarction. *UpToDate*
- Ryan TJ, Reeder GS. Initial evaluation and management of suspected acute coronary syndrome in the emergency department. *UpToDate*
- Prause G, Hetz H, Lauda P, Pojer H, Smolle-Juettner F, Smolle J. A comparison of the end-tidal-CO2 documented by capnometry and the arterial pCO2 in emergency patients. *Resuscitation.* 1997 Oct;35(2):145-8
- Polielinicio SD. Use of inhaled nitric oxide in the treatment of right ventricular myocardial infarction. *Am. J. or Emerg. Med.* 29;473.e3-473.e5
- Spalding MB, Ala-Kokko TI, Kiviluoma K, et al. Inhaled nitric oxide effectively decreases right heart afterload following right heart infarct in pigs. *Scand Cardiovasc J* 2001;35(1):45-9
- Weingart S. Physiology of oxygenation. *Emcrit audio podcast*