Sepsis Survival for Patients and Nurses

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ACNP-BC, CCRN

Many aspects of sepsis care have not changed

WHAT IS *NOT* NEW?

Severe Sepsis: What Do We Know?

"Except on few occasions, the patient appears to die from the body's response to infection rather than from it."

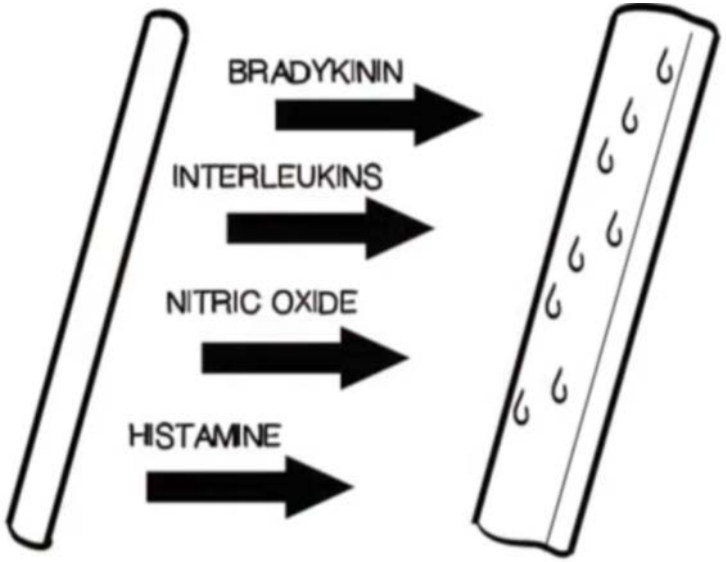
— Sir William Osler, 1904
"The Evolution of Modern Medicine"

NYPL/Science Source/Science Photo Library

Figure: Sir William Osler at the bedside of a patient


Healthy volunteer

Pathophysiology: Early Sepsis



- ***Myocardial Depression (early)→Hyperdynamic (late)***
- Vasodilation (bigger tank)
- Capillary Leak (relative hypovolemia)

Stroke Volume (SV)

Pathophysiology: Sepsis

- Increased O_2 demand, decreased supply, cellular dysoxia
- Ultimately sepsis is a perfusion problem
- Code Stroke, Code STEMI… Code Sepsis!

Sepsis: “Relative” Hypovolemia

↑HR
CO = HR x SV
↓SV

↑SVR
MAP = CO x SVR
↓CO

- Treatment:
  - Crystalloids
    - NS
    - LR
    - Albumin

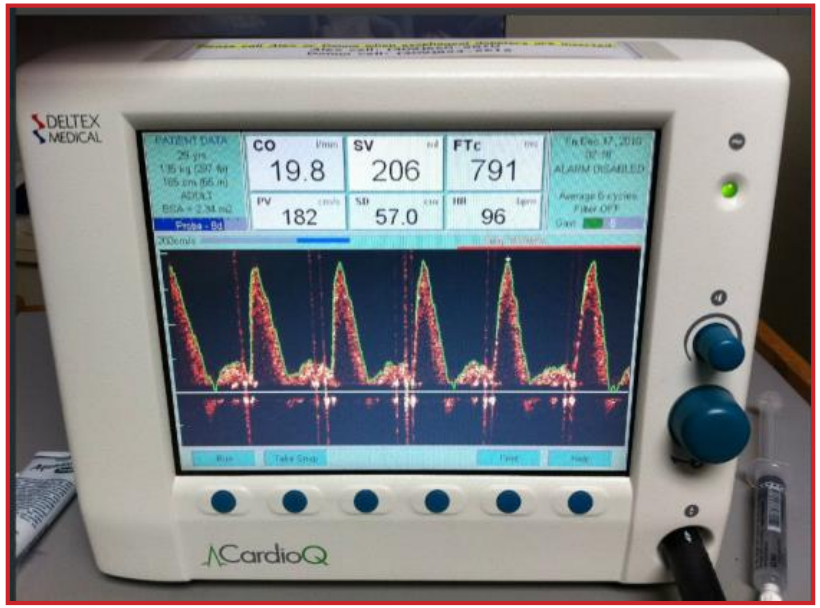
***** Fill the tank before you press on the accelerator *****

CO SVR

“Teeter-Totter” Relationship

Pathophysiology: Late Sepsis

- The only shock state that is hyperdynamic in late stages
  - Septic shock in 39 y.o. male w/ history of lupus
  - BP: 68/39
  - Central venous pressure: 15
  - Levophed 30 mcg/min
  - Phenylephrine 200 mcg/min
  - Vasopressin 0.04 u/min



“Sepsis-Dose” Fluid Challenge in HF & ARF

ORIGINAL ARTICLE

Multicenter Implementation of a Treatment Bundle for Patients with Sepsis and Intermediate Lactate Values

Vincent X. Liu[1,2], John W. Morehouse[2], Gregory P. Marelich[2], Jay Soule[2], Thomas Russell[2], Melinda Skeath[3], Carmen Adams[3], Gabriel J. Escobar[1,2], and Alan Whippy[2]

[1]Kaiser Permanente Division of Research, Oakland, California; [2]The Permanente Medical Group, Oakland, California; and [3]Kaiser Foundation Hospitals and Health Plan, Oakland, California

Abstract

Rationale: Treatments for patients with sepsis with intermediate lactate values (≥2 and <4 mmol/L) are poorly defined.

Objectives: To evaluate multicenter implementation of a treatment bundle (including timed intervals for antibiotics, repeat lactate testing, and intravenous fluids) for hemodynamically stable patients with sepsis and intermediate lactate values in the emergency department.

Methods: We evaluated patients in annual intervals before and after bundle implementation in March 2013. We evaluated bundle compliance and compared outcome measures across groups with multivariable logistic regression. Because of their perceived risk for iatrogenic fluid overload, we also evaluated patients with a history of heart failure and/or chronic kidney disease.

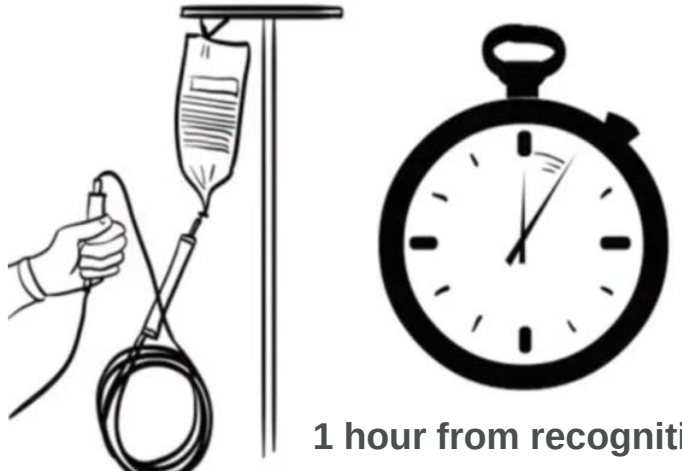
Measurements and Main Results: We identified 18,122 patients with sepsis and intermediate lactate values, including 36.1% treated after implementation. Full bundle compliance increased from 32.2% in 2011 to 44.9% after bundle implementation ($P < 0.01$). Hospital mortality was 8.8% in 2011, 9.3% in 2012, and 7.9% in 2013 ($P = 0.02$). Treatment after bundle implementation was associated with an adjusted hospital mortality odds ratio of 0.81 (95% confidence interval, 0.66–0.99; $P = 0.04$). Decreased hospital mortality was observed primarily in patients with a heart failure and/or kidney disease history ($P < 0.01$) compared with patients without this history ($P > 0.40$). This corresponded to notable changes in the volume of fluid resuscitation in patients with heart failure and/or kidney disease after implementation.

Conclusions: Multicenter implementation of a treatment bundle for patients with sepsis and intermediate lactate values improved bundle compliance and was associated with decreased hospital mortality. These decreases were mediated by improved mortality and increased fluid administration among patients with a history of heart failure and/or chronic kidney disease.

Keywords: hospital mortality; quality improvement; resuscitation; sepsis

Literature Review: SSC Guidelines

- "…the optimal fluid management of septic shock is unknown and currently is empirical."[1]
- 2008 to 2012 to 2016 SSC Sepsis Guidelines[2]
  - Initial fluid challenge increased from 20 mL/kg to 30 mL/kg
  - "Sepsis dose" initial fluid challenge
  - **77% compliance in post-intervention group**



1 hour from recognition

1. Micek S, McEvoy C, McKenzie M, et al. *Crit Care*. 2013;17(5):R246.
2. Surviving Sepsis Campaign. survivingsepsis.org/Guidelines/Pages/default.aspx. Accessed 5/8/17.

The Bundle Has Not Changed

The Society of Critical Care Medicine has created a website:

Surviving Sepsis Campaign

On the Bundles tab of this website, a PDF with updated Bundles is referenced.

Surviving Sepsis Campaign Bundles

The PDF was revised 4/2015 by the SSC Executive Committee. It is now under revision consideration byt the SSC Steering Committee based on the release of the fourth edition of the International Guidelines for Management of Sever Sepsis and Septic Shock: 2016.

Key Points from the PDF:

1. Treatment guidelines were revised 4/2015 by the SSC Executive Committee
2. Bundles have been updated in response to new evidence
3. The 6-hour SSC bundle has been updated
4. The 3-hour SSC bundle remains unchanged

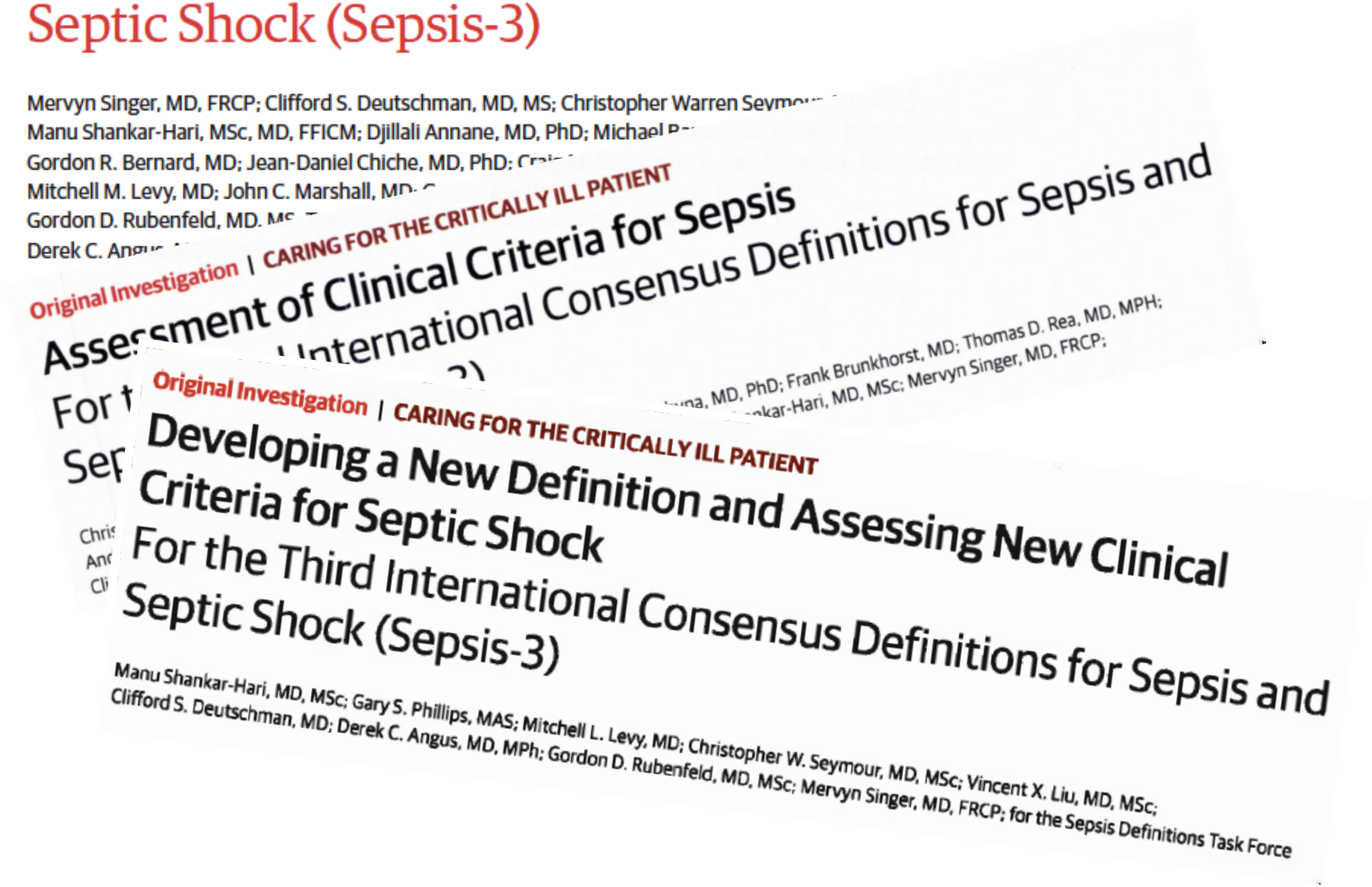
Some aspects of sepsis identification and treatment are evolving

WHAT *IS* NEW?

Special Communication | CARING FOR THE CRITICALLY ILL PATIENT

The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3)

Mervyn Singer, MD, FRCP; Clifford S. Deutschman, MD, MS; Christopher Warren Seymour
Manu Shankar-Hari, MSc, MD, FFICM; Djillali Annane, MD, PhD; Michael
Gordon R. Bernard, MD; Jean-Daniel Chiche, MD, PhD;
Mitchell M. Levy, MD; John C. Marshall, MD;
Gordon D. Rubenfeld, MD, MS;
Derek C. Angus



Sepsis/Severe Sepsis

- Confusing
  - Most people say “sepsis” when they mean “severe sepsis”
  - What the initial two task forces called “sepsis” is what most people call “infection”

Sepsis Definitions

New definitions aligned with clinical use

- Infection:
  - Routine infection without organ dysfunction
- Sepsis:
  - Infection progresses to (“infection-induced”) organ dysfunction
- Septic Shock:
  - Sepsis requiring vasopressors ***AND*** lactate > 2 mmol/L

2016 SSC Guidelines

On the Guidelines tab of the SSC website, a PowerPoint of the Campaign Guidelines Presentation is linked:

Slide #23 lists the members of the Expert Panel

Initial Resuscitation Recommendations Have Changed From 2012

2012 RECOMMENDATIONS	2016 RECOMMENDATIONS
A. INITIAL RESUSCITATION 1. Protocolized, quantitative resuscitation of patients with sepsisinduced tissue hypoperfusion (defined in this document ashypotension persisting after initial fluid challenge or blood lactate concentration ≥ 4 mmol/L). Goals during the first 6 hours of resuscitation: a. Central venous pressure 8–12 mm Hg b. Mean arterial pressure ≥ 65 mm Hg c. Urine output ≥ 0.5 mL/kg/hr d. Central venous (superior vena cava) or mixed venous oxygen saturation 70% or 65%, respectively (grade 1C). 2. In patients with elevated lactate levels,targeting resuscitation to normalize lactate (grade 2C).	**A. INITIAL RESUSCITATION** 1. Sepsis and septic shock are medical emergencies, and we recommend that treatment and resuscitation begin immediately (BPS). 2. We recommend that, in the resuscitation from sepsis-induced hypoperfusion, at least 30 mL/kg of IV crystalloid fluid be given within the first 3 hours (strong recommendation, low quality of evidence). 3. We recommend that, following initial fluid resuscitation, additional fluids be guided by frequent reassessment of hemodynamic status (BPS). Remarks: Reassessment should include a thorough clinical examination and evaluation of available physiologic variables (heart rate, blood pressure, arterial oxygen saturation, respiratory rate, temperature, urine output, and others as available) as well as other noninvasive or invasive monitoring,as available. 4. We recommend further hemodynamic assessment (such as assessing cardiac function) to determine the type of shock if the clinical examination does not lead to a clear diagnosis (BPS). 5. We suggest that dynamic over static variables be used to predict fluid responsiveness, where available (weak recommendation, low quality of evidence). 6. We recommend an initial target mean arterial pressure of 65 mmHg in patients with septic shock requiring vasopressors (strong recommendation, moderate quality of evidence). 7. We suggest guiding resuscitation to normalize lactate in patients with elevated lactate levels as a marker of tissue hypoperfusion (weak recommendation, low quality of evidence).

Rhodes A, Evans LE, Alhazzani W. *Intensive Care Med*. 2017;43(3):304-77.

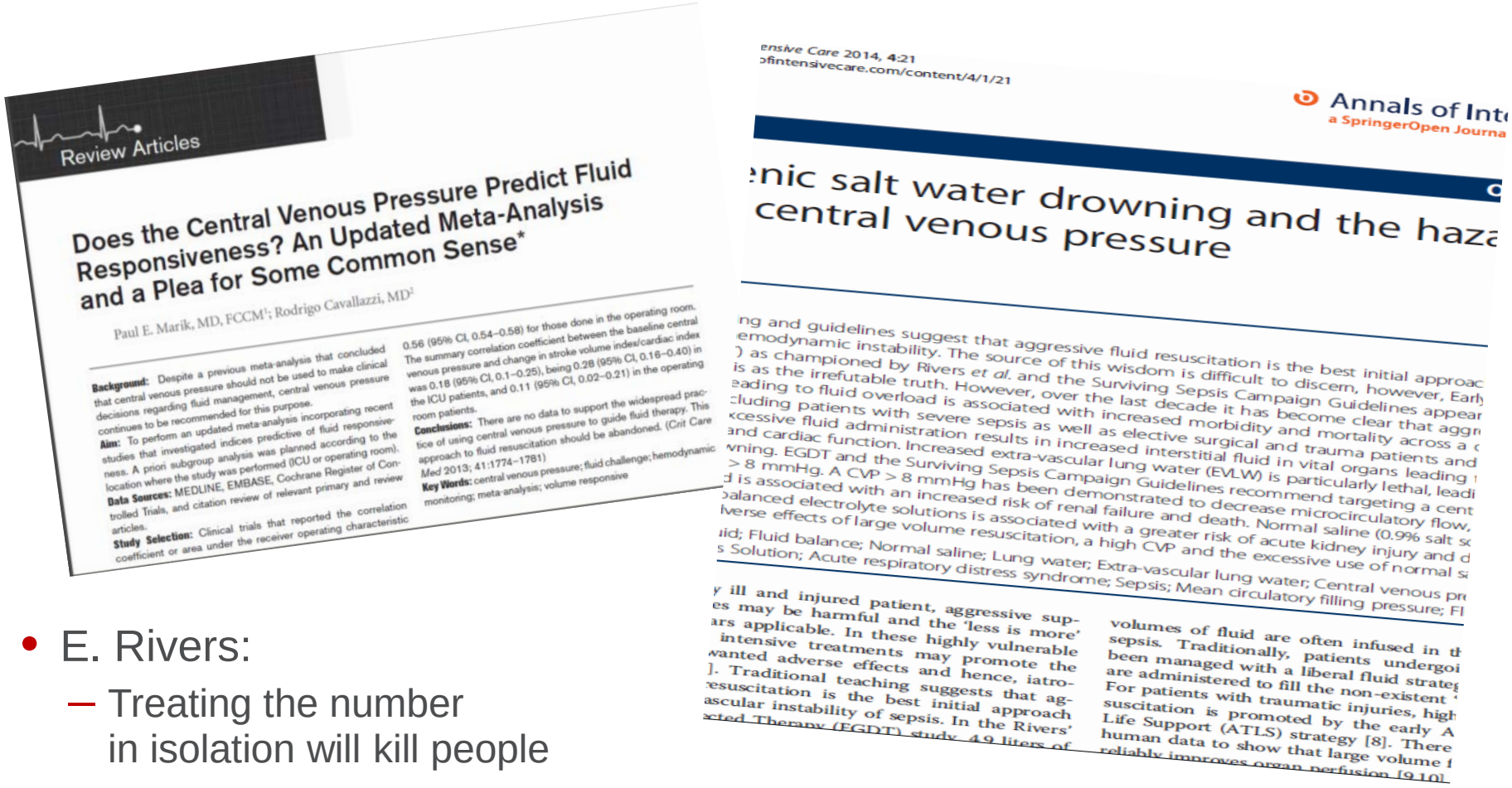
Limitations of Physical Assessment and Static Variables

- Can you determine hypovolemia just by examination?
  - Not studied/included in sepsis trials
- Cap refill, cold extremities, etc. indices are the result (not predictive of hypovolemia)
  - Only tells you “point in time”
  - Secondary parameters that can be slow to change, misleading, and only indirect correlations with changes in cardiac output

Transitioning from Pressure-based Parameters to Flow-based Parameters

STATIC PARAMETERS

Limitations of the CVP



Review Articles

Does the Central Venous Pressure Predict Fluid Responsiveness? An Updated Meta-Analysis and a Plea for Some Common Sense*

Paul E. Marik, MD, FCCM[1]; Rodrigo Cavallazzi, MD[2]

Background: Despite a previous meta-analysis that concluded that central venous pressure should not be used to make clinical decisions regarding fluid management, central venous pressure continues to be recommended for this purpose.

Aim: To perform an updated meta-analysis incorporating recent studies that investigated indices predictive of fluid responsiveness. A priori subgroup analysis was planned according to the location where the study was performed (ICU or operating room).

Data Sources: MEDLINE, EMBASE, Cochrane Register of Controlled Trials, and citation review of relevant primary and review articles.

Study Selection: Clinical trials that reported the correlation coefficient or area under the receiver operating characteristic 0.56 (95% CI, 0.54–0.58) for those done in the operating room. The summary correlation coefficient between the baseline central venous pressure and change in stroke volume index/cardiac index was 0.18 (95% CI, 0.1–0.25), being 0.28 (95% CI, 0.16–0.40) in the ICU patients, and 0.11 (95% CI, 0.02–0.21) in the operating room patients.

Conclusions: There are no data to support the widespread practice of using central venous pressure to guide fluid therapy. This approach to fluid resuscitation should be abandoned. (*Crit Care Med* 2013; 41:1774–1781)

Key Words: central venous pressure; fluid challenge; hemodynamic monitoring; meta-analysis; volume responsive

ensive Care 2014, 4:21
ofintensivecare.com/content/4/1/21

Annals of Int
a SpringerOpen Journa

enic salt water drowning and the haza
central venous pressure

ng and guidelines suggest that aggressive fluid resuscitation is the best initial approac
emodynamic instability. The source of this wisdom is difficult to discern, however, Earl
) as championed by Rivers *et al.* and the Surviving Sepsis Campaign Guidelines appear
is as the irrefutable truth. However, over the last decade it has become clear that aggr
eading to fluid overload is associated with increased morbidity and mortality across a
cluding patients with severe sepsis as well as elective surgical and trauma patients and
xcessive fluid administration results in increased interstitial fluid in vital organs leading
and cardiac function. Increased extra-vascular lung water (EVLW) is particularly lethal, leadi
vning. EGDT and the Surviving Sepsis Campaign Guidelines recommend targeting a cent
> 8 mmHg. A CVP > 8 mmHg has been demonstrated to decrease microcirculatory flow,
d is associated with an increased risk of renal failure and death. Normal saline (0.9% salt s
balanced electrolyte solutions is associated with a greater risk of acute kidney injury and d
lverse effects of large volume resuscitation, a high CVP and the excessive use of normal s

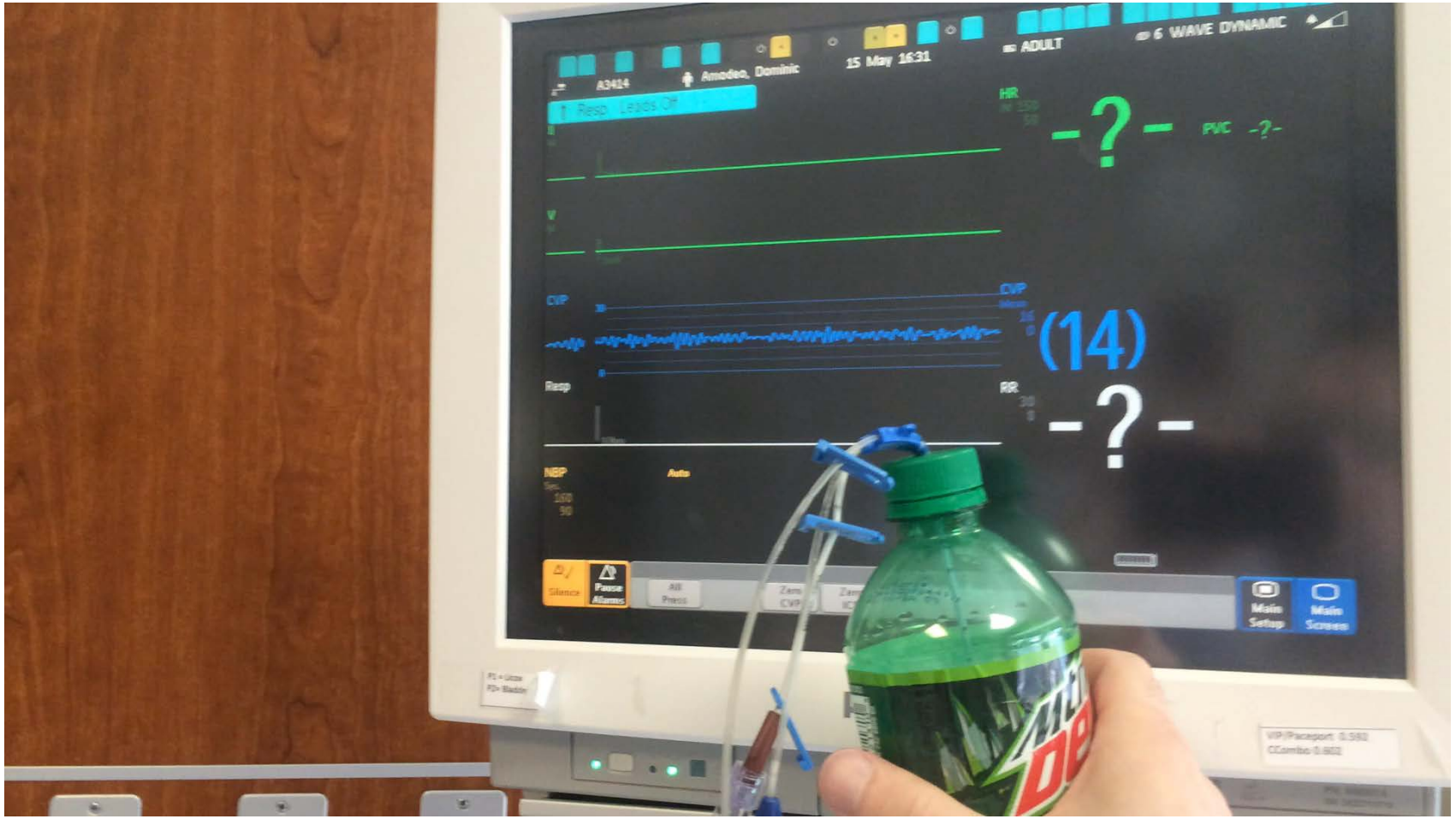
iid; Fluid balance; Normal saline; Lung water; Extra-vascular lung water; Central venous pr
s Solution; Acute respiratory distress syndrome; Sepsis; Mean circulatory filling pressure; FI

y ill and injured patient, aggressive sup-
es may be harmful and the 'less is more'
ars applicable. In these highly vulnerable
intensive treatments may promote the
wanted adverse effects and hence, iatro-
]. Traditional teaching suggests that ag-
esuscitation is the best initial approach
ascular instability of sepsis. In the Rivers'
acted Therapy (EGDT) study, 4.9 liters of

volumes of fluid are often infused in t
sepsis. Traditionally, patients undergoi
been managed with a liberal fluid strate
are administered to fill the non-existent
For patients with traumatic injuries, high
suscitation is promoted by the early A
Life Support (ATLS) strategy [8]. There
human data to show that large volume
reliably improves organ perfusion [9,10].

- E. Rivers:
  - Treating the number in isolation will kill people
  - CVP used in his control group
  - Post-mortem CVP → SV will still = Zero

Limitations of the CVP



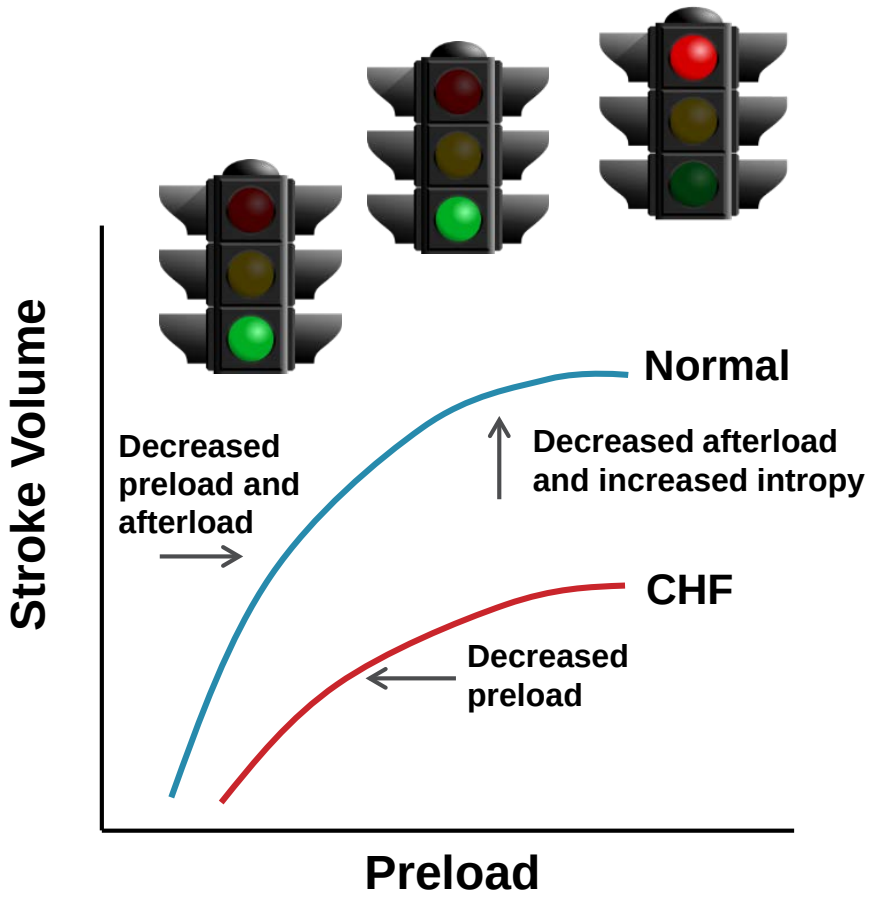
Reporting to provider

Stroke Volume, Stroke Volume Variation, Cardiac Output

DYNAMIC PARAMETERS

SVO Algorithm

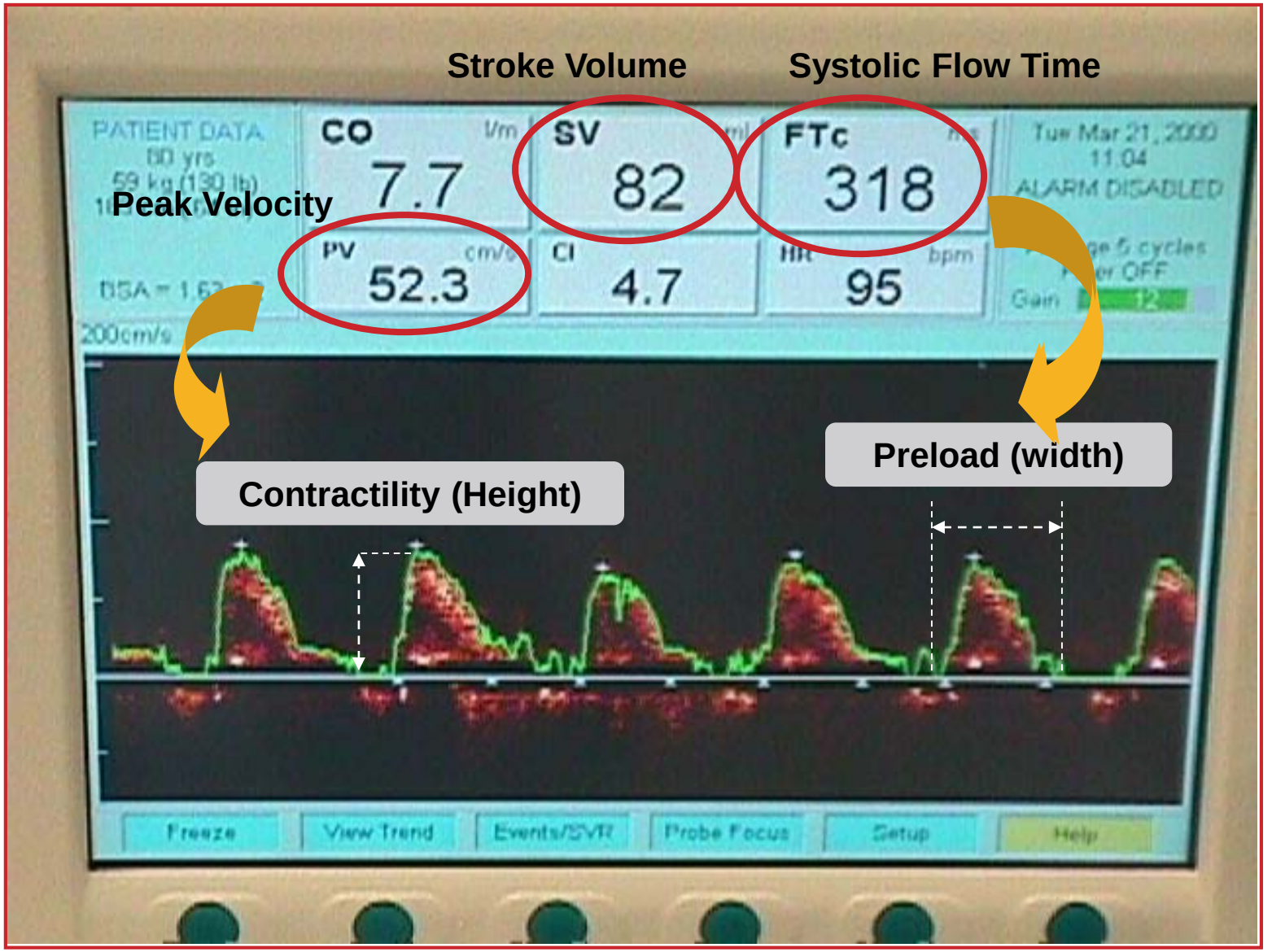
- Administer fluid challenges as long as SV improves by ≥ 10%



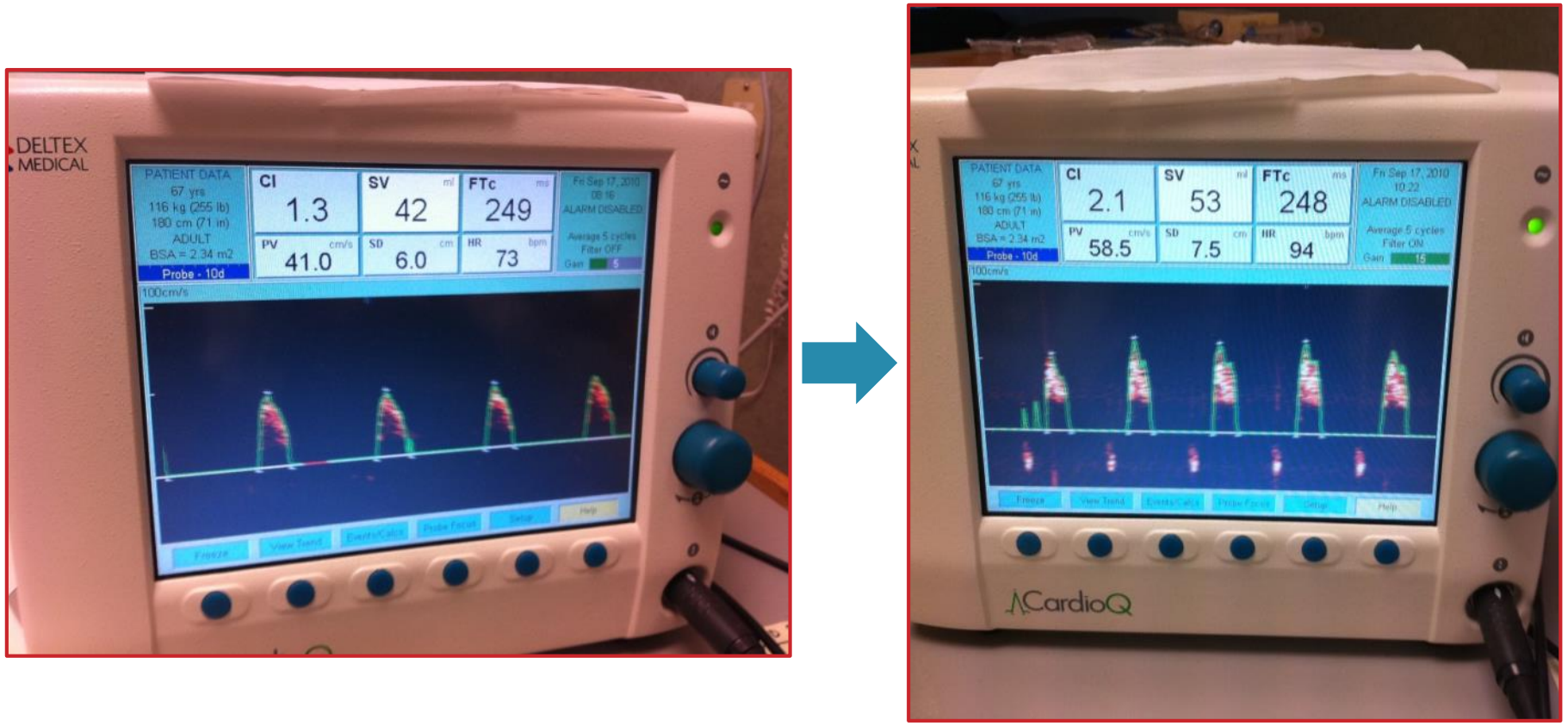
Reference Ranges

- SV reference range = 50-100 mL
- SVV = < 13%
- C.I. = 2.8-4.2
- C.O. = 4-8 L/min
- FTc = 330-360 ms
- PV = 50-100 cm/s
- SvO2 = > 70%
- SvO2 = 60-80%
- SVR = 900-1600
- CVP = 2-8 mmHg

Example of a Real Screen



Should Levophed Continue to be the First-line Vasopressor? When Should Dobutamine be Considered?



"What's the max dose of this pressor?"

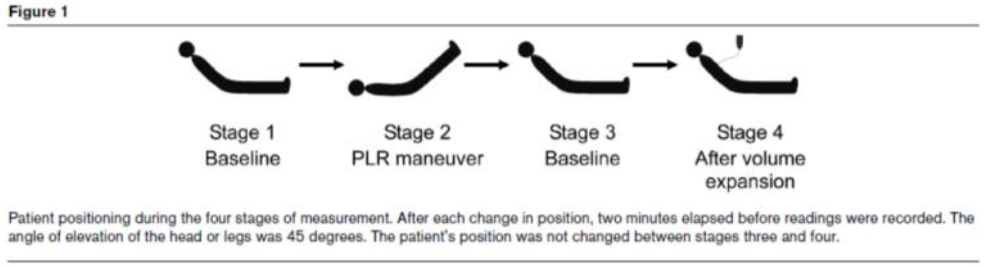
Predictive Value of SV:
Fluid Administration *According to Response*

Moving Forward:
Practical Applications

PASSIVE LEG RAISE

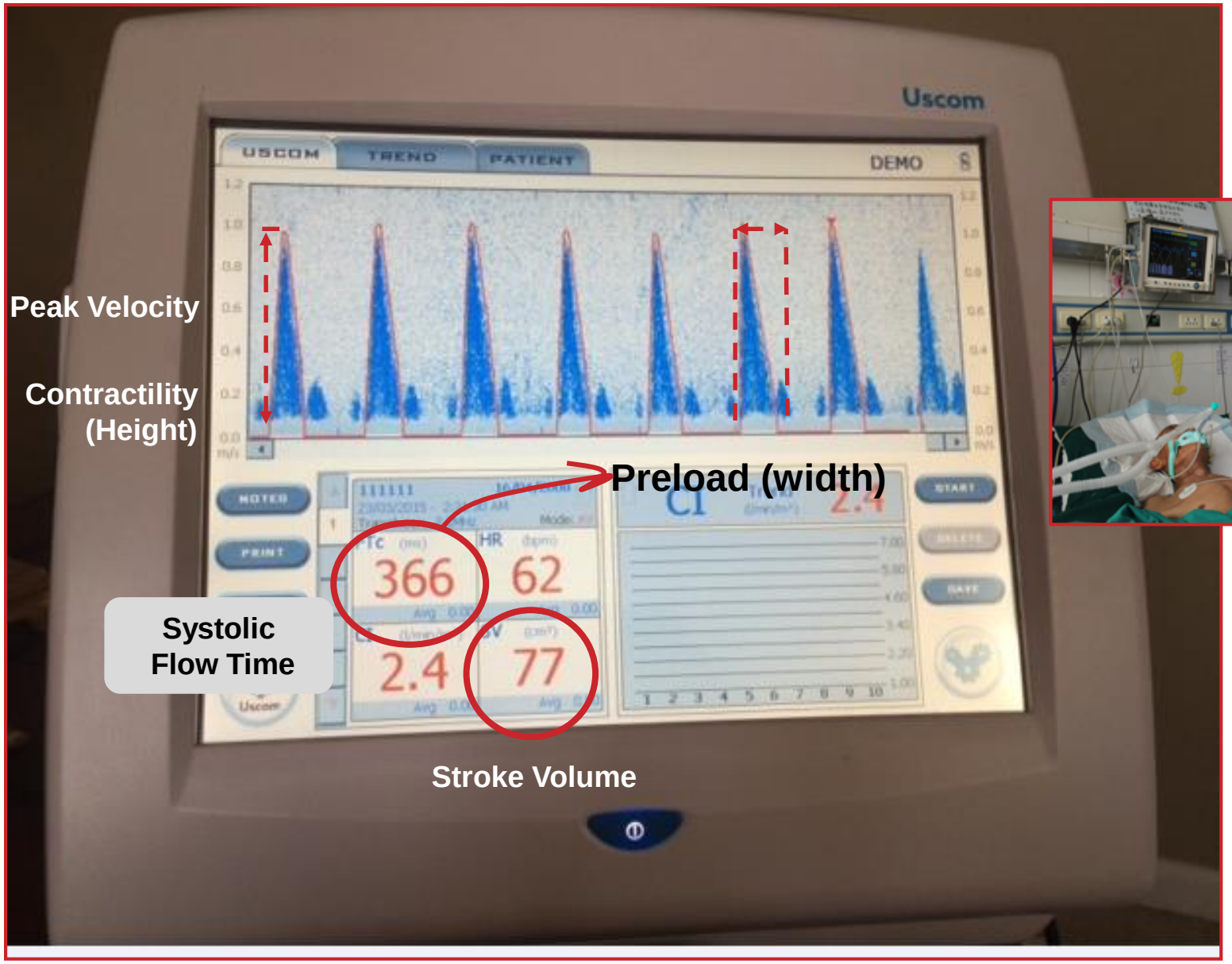
Passive Leg Raise (PLR) *

- Kollef study (N = 102; fluid challenges in 89 patients)
  - 62% sepsis
  - 67% ventilator
  - 59% vasopressors
  - **"A SV ↑ induced by PLR of ≥ 15% predicted volume responsiveness with sensitivity 81%, specificity of 93%"**
  - Positive Predictive Value 91%
  - Negative Predictive Value 85%
  - 46.1% of patients were volume responsive



Thiel SW, Kollef MH, Isakow W. *Crit Care*. 2009;13(4):R111.

PLR – Bed Functionality


Uscom
USCOM
TREND
PATIENT
DEMO
Peak Velocity
Contractility (Height)
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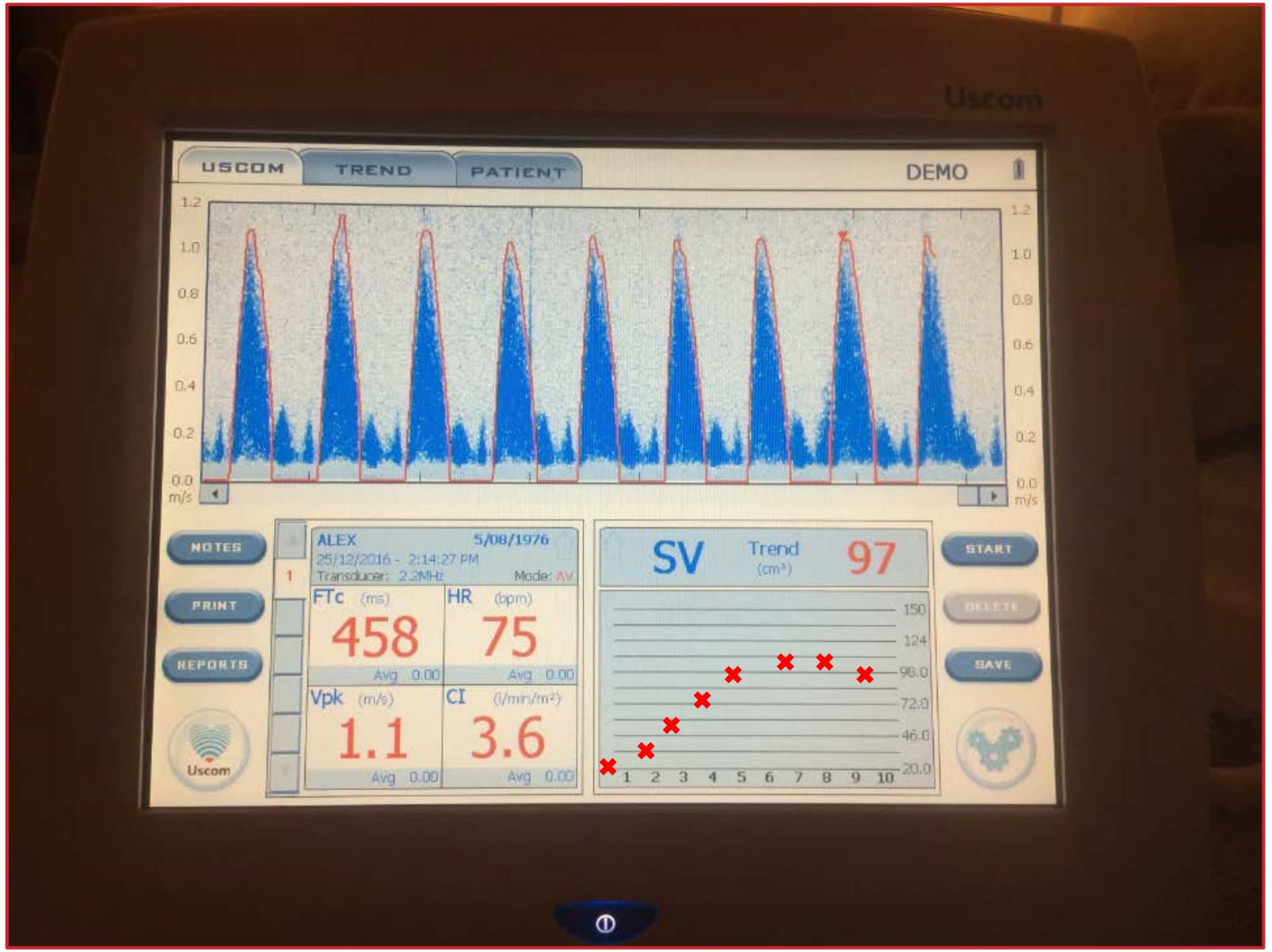
Systolic Flow Time
Stroke Volume
366
62
2.4
77
START
NOTES
PRINT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Transducer: 2.2MHz
Mode: AV
FTc (ms)
458
Avg 0.00
HR (bpm)
75
Avg 0.00
Vpk (m/s)
1.1
Avg 0.00
CI (l/min/m²)
3.6
Avg 0.00
SV
Trend (cm³)
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46.0
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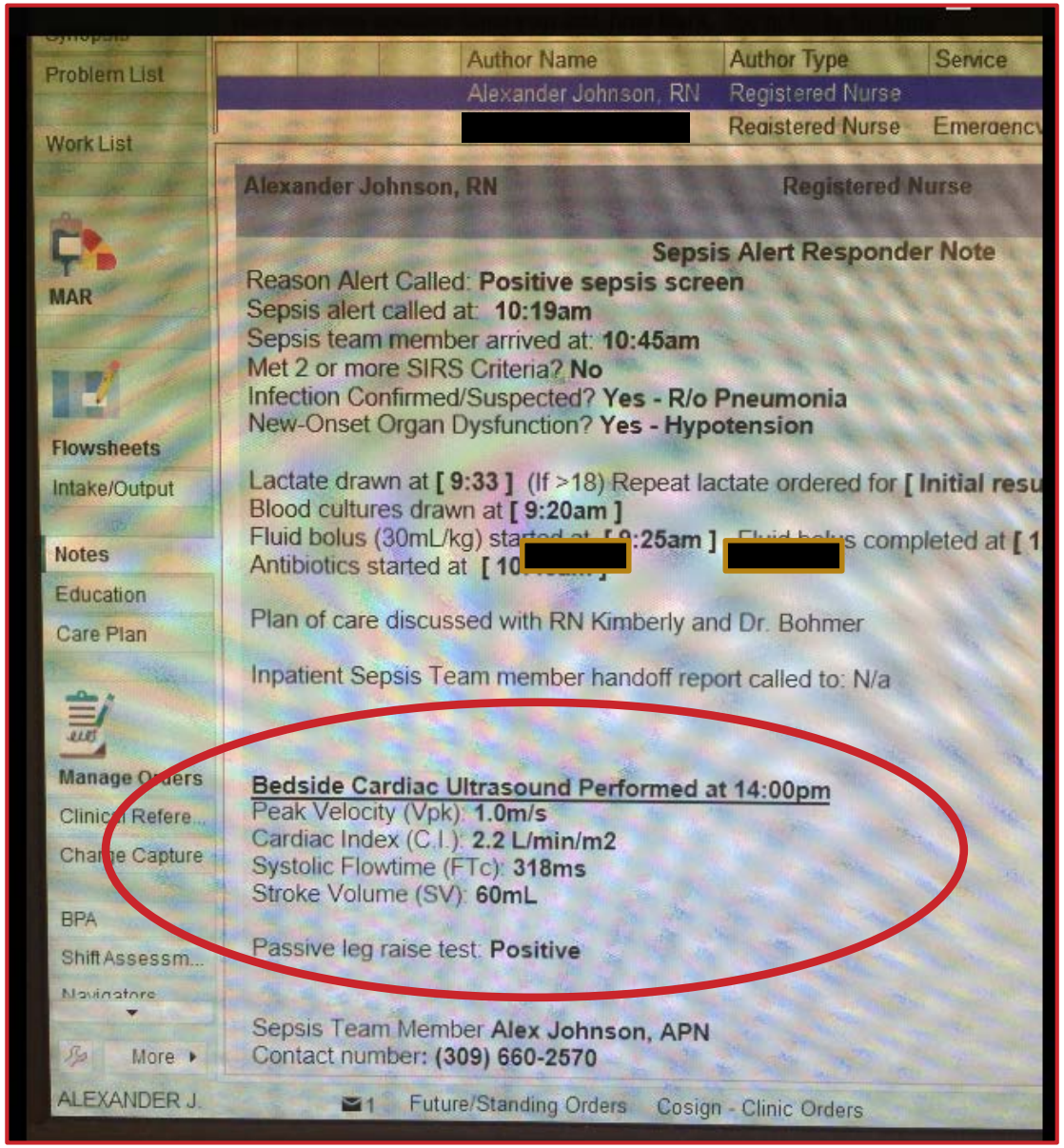
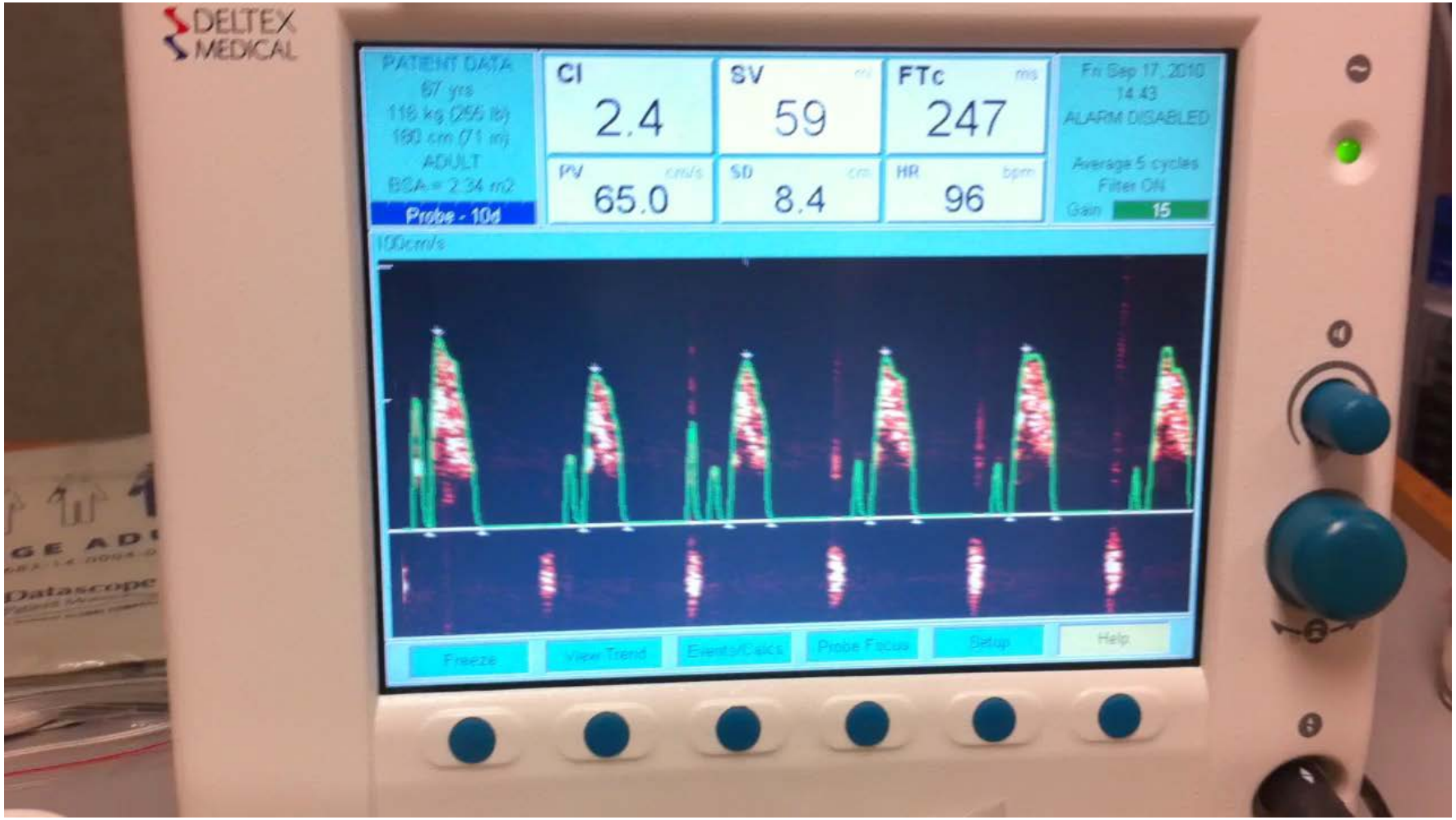
START
DELETE
SAVE


Problem List
Work List
MAR
Flowsheets
Intake/Output
Notes
Education
Care Plan
Manage Orders
Clinical Refere...
Charge Capture
BPA
Shift Assessm...
Navigators
More
ALEXANDER J.
Author Name
Author Type
Service
Alexander Johnson, RN
Registered Nurse
[redacted]
Registered Nurse
Emergency
Alexander Johnson, RN
Registered Nurse
Sepsis Alert Responder Note
Reason Alert Called: Positive sepsis screen
Sepsis alert called at: 10:19am
Sepsis team member arrived at: 10:45am
Met 2 or more SIRS Criteria? No
Infection Confirmed/Suspected? Yes - R/o Pneumonia
New-Onset Organ Dysfunction? Yes - Hypotension
Lactate drawn at [9:33] (If >18) Repeat lactate ordered for [Initial resu
Blood cultures drawn at [9:20am]
Fluid bolus (30mL/kg) started at [9:25am] Fluid bolus completed at [1
Antibiotics started at [10[redacted]]
Plan of care discussed with RN Kimberly and Dr. Bohmer
Inpatient Sepsis Team member handoff report called to: N/a
Bedside Cardiac Ultrasound Performed at 14:00pm
Peak Velocity (Vpk): 1.0m/s
Cardiac Index (C.I.): 2.2 L/min/m2
Systolic Flowtime (FTc): 318ms
Stroke Volume (SV): 60mL
Passive leg raise test: Positive
Sepsis Team Member Alex Johnson, APN
Contact number: (309) 660-2570
1
Future/Standing Orders
Cosign - Clinic Orders

Passive Leg Raise



What is next?

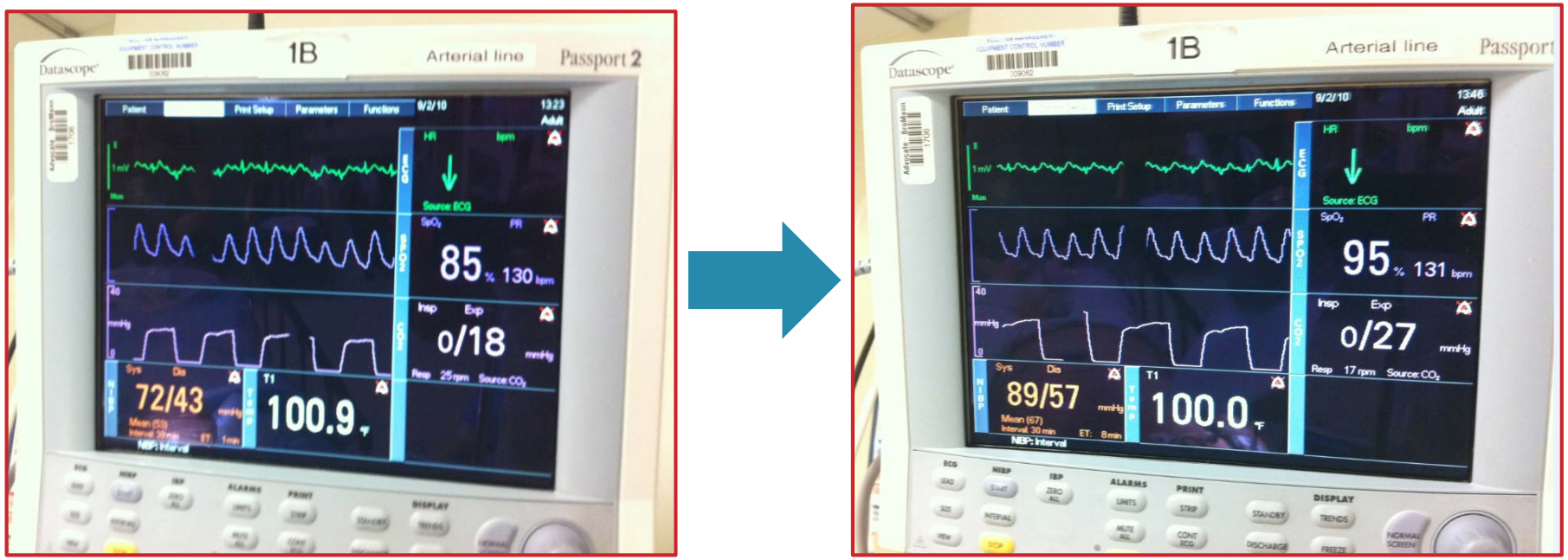
CAPNOGRAPHY

Capnography: PLR-induced Changes in $EtCO_2$

- $EtCO_2$ for predicting volume responsiveness by PLR test
- Monnet et al. (2013) (N = 65)
- "A PLR-induced increase in $EtCO_2$ ≥ 5% predicted a fluid-induced increase in cardiac index (CI) ≥ 15% with sensitivity of 71% and specificity of 100%"
- $EtCO_2$ and CI predictive ability not different

Monnet X, Bataille A, Magalhaes E, et al. *Intensive Care Med*. 2013;39(1):93-100.

Pre to Post-Fluid Challenge Capnogram



Case Studies

Conclusion

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Get to Know Merit Medical