136 0.396 89.0 30.6 343

### Secrets of the CBC . . . What's the diff??

Kathleen M. Vollman MSN, RN, CCNS, FCCM, FCNS, FAAN Clinical Nurse Specialist / Educator / Consultant ADVANCING NURSING kvollman@comcast.net Northville, Michigan www.vollman.com

Kathleen Vollman

### **Disclosures for Kathleen Vollman**

- Consultant-Michigan Hospital Association Keystone Center
- Subject matter expert HRET: CAUTI, CLABSI, HAPI, Sepsis, Safety culture for HRET
- Consultant and speaker bureau:
  - Stryker Sage
  - Potrero Medical
  - Beckman Coulter
- Baxter Healthcare Advisory Board



### Objectives

- Explain the consequences of severe infection and sepsis if gone unrecognized early, particularly important in patient presenting with vague signs and symptoms.
- Identify how the components of the CBC with Diff can help you understand your patient's condition
- Differentiate the use of the WBC vs. the Monocyte in the type of infection & its recognition
- Understand the practical utility of MDW across patient presentations through case examples



### Sepsis is a Public Health Problem

Affects >1.7 million Americans per year

## Sepsis occurs in just **10% of U.S.**

#### hospital patients,

but it contributes to as many as half of all hospital deaths

**3rd leading cause** of death in the US

#### \$41.5 billion spent on

sepsis inpatient care and skilled nursing for Medicare beneficiaries in 2018

#### ) 1-week mortality

for Medicare beneficiaries with sepsis is **18% vs 4.1%** with no sepsis

**87%** of all adult sepsis cases begin outside the hospital

700 people die each day from sepsis in the U.S.



One every 2 minutes

Rhee C, et al. JAMA. 2017;318(13):1241-1249. Angus DC, et al.. Crit Care Med 2001;29:1303-10. Buchman TG, et al. Crit Care Med. 2020;48(3):276-288. Novosad SA, et al. CDC Morbidity and Mortality Weekly Report., 2016;65(33):864-869 Buchman TG, et al. Crit Care Med. 2020;48(3):276-288

### Value Based Purchasing Domains



Total Performance Score

Each domain is 25%





### Value Based Purchasing

- SEP 1 a measure in the Safety Domain
- A One of 6 measures in the safety domain
  - $\triangle$  CAUTI
  - $\triangle$  CLABSI
  - $\triangle$  CDI
  - $\triangle$  MRSA
  - $\triangle$  SEP-1
  - $\triangle$  SSI



#### VBP 2026: Safety Domain

#### **Healthcare-Associated Infections**

Ja	Baseline Period n. 1, 2022–Dec. 31, 2	2022	Performance Period Jan. 1, 2024–Dec. 31, 2024		
	Measure ID	Measure Name	Achievement Threshold	Benchmark	
t	CAUTI	Catheter-Associated Urinary Tract Infection	0.615	0.000	0
Ļ	CDI	Clostridium difficile Infection	0.423	0.000	Ľ
t	CLABSI	Central Line-Associated Bloodstream Infection	0.760	0.000	ç
t	MRSA	Methicillin-Resistant Staphylococcus <i>aureus</i>	0.793	0.000	
ţ	SSI	Colon Surgery Abdominal Hysterectomy	0.747 0.763	0.000 0.000	
	Sepsis	Severe Sepsis & Septic Shock	0.597482	0.843620	

Safety

### Hospital Sepsis Core Elements Program (CDC)



#### Hospital Sepsis Program Core Élements



**Hospital Leadership** Commitment

Dedicating the necessary human, financial, and information technology resources.



Accountability Appointing a leader or co-leaders responsible for program goals and outcomes.



Multi-Professional Expertise Engaging key partners throughout the hospital and healthcare system.



Action

Implementing structures and processes to improve the identification of, management of, and recovery from sepsis.



Tracking

Measuring sepsis epidemiology, management, and outcomes to assess the impact of sepsis initiatives and progress toward program goals



Reporting

Providing information on sepsis management and outcomes to relevant partners.



Providing sepsis education to healthcare professionals, patients, and family/caregivers.

https://www.cdc.gov/sepsis/core-elements.html



### Sepsis (Severe Sepsis) and septic shock are medical emergencies, and we recommend that treatment and resuscitation begin immediately

2021 Surviving Sepsis Guidelines Best Practice Statement

Evans L, Rhodes A, Alhazzani W, et al Crit Care Medicine.;49(11):e1063-e1143.

### SSC Guidelines: Screening



2021

- 2016: We recommend that hospitals and hospital systems have a performance improvement program for sepsis, including sepsis screening for acutely ill, highrisk patients (BPS).
- 2012: We recommend routine screening of potentially infected seriously ill patients for severe sepsis to increase the early identification of sepsis and allow implementation of early sepsis therapy (1C)

#### SCREENING AND EARLY TREATMENT

#### Recommendation

1. For hospitals and health systems, we **recommend** using a performance improvement program for sepsis, including sepsis screening for acutely ill, high-risk patients and standard operating procedures for treatment.

Strong recommendation, moderate quality of evidence for screening. Strong recommendation, very low-quality evidence for standard operating procedures.

#### **B%** FOR EVERY HOUR DELAYED

Mortality from sepsis increases by as much as 8% for every hour that treatment is delayed.<sup>1</sup> Adverse effects on secondary end points (LOS, AKI, ALI, and organ injury assessed by SOFA Score) increases with increasing delays. <sup>2-3</sup>

1.Kumar, Anand, et al. Critical Care Medicine, vol. 34, no. 6, 2006, pp. 1589-1596 2.Zhang. Crit Care Med. 2015:43:21332140 3.Bagshaw. Intensive Care Med. 2009;35:871881

Mortality from sepsis increases by as much as 8% for every hour that treatment is delayed.<sup>1</sup> Adverse effects on secondary end points (LOS, AKI, ALI, and organ injury assessed by SOFA Score) increases with increasing delays.<sup>2-3</sup>



### Timing Is Important And Mortality Is High



Episode Severity	# patients	1 <sup>st</sup> lactate mmol/L	Time to 1 <sup>st</sup> lactate, h	Time to Abx, h	Hospital Mortality, %	# Dead
Sepsis	12,122 (35%)	1.3 (1.0-1.5)	1.1 (0.6-2.6)	2.3	3.9%	473
Severe Sepsis	18,210 (52%)	2.2 (1.5-2.7)	0.9 (0.6-2.0)	2.1*	8.8%	1602
Septic Shock	4,668 (13%)	4.6 (4.0-5.9)	0.8 (0.5-1.7)	1.7	26.0%	1213

V. Liu et al., Am J Respir Crit Care Med 2017;196:856-863.

#### Failure To Recognize Sepsis Early Contributes To Adverse Outcomes





Vague symptoms of infection: fatigue, weakness, and abdominal pain without fever, without explicit symptoms Explicit symptoms of infection: ever, chills, or rigors, cough with productive sputum, dysuria, reported skin redness or concern for soft-tissue infection, or referral for specific infection diagnosis Early Detection is the Key

### Detection of infection is typically delayed by

# 8 HRS+ in approximately 30% of cases

presenting to the Emergency Department.



### **Action: Priority Steps**

- Implementing a standardized process to screen for sepsis: Early administration of sepsis treatment is lifesaving
- Developing and maintaining a hospital guideline or a standardized care pathway for management of sepsis
- A Hospital order sets for management of sepsis
- Structures and processes to facilitate prompt delivery of antimicrobials
- Structures and processes to support effective hospital hand-offs in patients with sepsis
- A Rapid response teams trained in sepsis recognition and care





Providing sepsis education to healthcare professionals, patients, and family/caregivers.

What's In A Complete Blood Count With Differential & How Can it Help You?

#### What's in a complete blood count with differential?



#### RBC

- Number of red blood cells
- Average size of red blood cells
- Hgb concentration
- RBC morphology
- 44% of Blood volume



#### WBC

- Number of white blood cells
- Together with platelets 1% of blood volume



#### DIFFERENTIAL

- Types of white cells: # & %
- Any immature cells?



- Number of platelets
- Average size of platelets
- 1% of blood volume



### Question



# When you check the CBC with Diff, which values do you routinely examine?

- 1. HGB & HCT
- 2. HGB, HCT and WBC
- 3. HGB, HCT & WBC, platelets
- 4. RBC count, HGB, HCT, WBC & neutrophils
- 5. HGB, HCT, WBC, neutrophils & platelets



### **Red Blood Cells**

- Called erythrocytes
- Bi-concave disc
- Special protein-Hemoglobin
- Hgb contains iron which gives the cell its red color
- Male: 4.35 to 5.65 cells/L
- Female: 3.92 to 5.13 cells/L
- What is the Rule of Three or H&H check
  - Multiple the RBC x 3, and the result should equal the HGB +/-3. Then multiply the HGB x 3 and the result should equal the HCT +/-3.



### Hemoglobin & Hematocrit

#### \Lambda Hemoglobin

- △ A protein (globin) that contains iron (Heme) inside red blood cells that carries oxygen from the lungs to tissues and organs in the body and carries carbon dioxide back to the lungs.
- $\triangle$  Male: 13.2 to 16.6 grams/dL
- $\triangle$  Female: 11.6 to 15 grams/dL

#### \Lambda Hematocrit

- △ The ratio of the volume of red blood cells to the total volume of blood as determined by separation of red blood cells from the plasma. It depends on the number and size of red blood cells.
- $\bigtriangleup$  It may be used to check for conditions such as anemia, dehydration, malnutrition, and leukemia.
- △ **Male:** 38.3% to 48.6%
- △ **Female:** 35.5% to 44.9%

#### More than just HCT and HGB

#### MCV: Mean Corpuscular Volume

Average red cell size Can help diagnose bone marrow health and anemia

#### MCH: Mean Corpuscular Hemoglobin

Average amount in each of your red blood cells of hemoglobin
Low levels: iron deficient anemias
High levels: macrocytic anemia (B12 deficiency)



#### MCHC: Mean Corpuscular Hemoglobin Concentration

Low levels: challenge with carrying oxygen High levels: autoimmune hemolytic anemia

#### **RDW: Red Cell Distribution Width**

If there is a greater variation in red cell size the RDW increases May help dx anemias

#### **Platelets** Forms a clot with fibrin to stop blood loss

The cells colored green in this image are platelets (PLTs), also called thrombocytes. They are actually fragments of a large cell called a megakaryocyte. PLTs are smaller than the other cells and appear to have tentacles. They also do not have a nucleus.



- Male: 135 to 317 /L
- Female: 157 to 371 /L

#### **Additional Platelet Information**



- MPV: Mean Platelet Volume
  - Average size of platelets
  - ↓Looks at bone marrow function.
     If someone loses blood and bone marrow is healthy it will send out large young platelets and the MPV will increase.
- PDW: Platelet Distribution Width.
  - Marker of platelet function & activation

### What's the Diff?

#### Secrets of the WBC's in Helping to Identify Infection





### White Blood Count

- Measures the amount of white blood cells
- Normal WBC: 4.5 to  $11.0 \times 10^9/L$ 
  - (varies with age and sex)
- Low WBC: Leukopenia
  - Viral infections, endocrine disorders, drugs and radiation
- High WBC: Leukocytosis
  - Bacterial infections
  - Acute inflammatory Conditions
  - Leukemia



#### What causes infections?



Fungus

#### WBC's are involved in fighting all of these infections







#### Types of white Blood Cells





### Neutrophils

- First responder of immune cells to infection or tissue damage
- Most abundant WBC, make up 50-70% of total WBC's
- Immature neutrophil is called a band
- Bands: 10% or less
- Neutrophils: 1.8 7.7 k/uL

## What's A "Left Shift"

### Left Shift

 Increase of neutrophil consumption which is equal to increase in production in the bone marrow





#### Lymphocytes

- Responsible for immune response, infection fighters
- Include T cells (regulates other immune cells and attacks virus infected cells and tumors) and B cells (makes antibodies)
- 20-45% of the total WBC's
- Lymphocytes: 1.4 to 5.7 k/uL
- If elevated-infection, cancer of the blood or lymphatic system or autoimmune disorder
- If low, higher risk for infection



### Eosinophils

- Released in allergic reactions, asthma, viral infections, and histamine response. Also see elevation with parasitic infections.
- Eosinophils: 0 to 1 k/uL
- Low with intoxication from alcohol or excessive cortisol production
- 1-3% of WBC's



#### Basophils

- Defend the body from allergens, pathogens & parasites-contain histamine & heparin
- Low levels caused by allergic reaction, infections and overactive thyroidplacing basophils in overdrive
- High levels sign of blood disorders, autoimmune dx or infection leading to inflammation
- 1% of WBC's, smallest and least understood.



#### Monocytes

- Early part of the body's first line of defense against infection
- Monocytes:
  - phagocytize pathogens
  - display inflammatory characteristics
  - present antigens to lymphocytes
- When they move into tissue and ingest pathogens they are called MACROPHAGES
- Monocytes: 0 to .8 k/uL
- Elevated levels link to infectious dx & immune disorders
- Low levels more susceptible to infection
- 3-11% of the total WBC's
- Largest size WBC



### **Polling Question**

What biomarkers do you currently use for screening and potential diagnosis of sepsis in the ED

- 1. Lactic acid
- 2. PCT
- 3. CRP
- 4. MDW



### Role of Current Biomarkers for Sepsis



#### Understand Overall Accuracy of Biomarkers



#### 1 - Specificity

Area under the curve: Value between .5 and 1.0

- .5 indicates no discrimination, 1.0 is perfect discrimination
- Reflects overall
  accuracy and
  separation
  performance of the
  biomarker
- Can be used to compare different biomarkers

#### PCT CRP 1.0 1.0 1.0 Lactate NLCR \* 0.8 0.8 AUC = 0.57 - 0.710.8 3-marker AUC = 0.56 - 0.68 П 4-marker \*\*\* 0.6 0.6 0.6 Ŧ AUC AUC ΓT AUC 0.4 0.4 0.4 0.2 0.2 0.2 0.0 0.0 0.0 Severe Bacterial Sepsis / **Bacterial Infection Bacterial Sepsis** Septic Shock

#### Limited Utility Of Conventional "Sepsis Biomarkers"

1500 patients admitted to the ED with sepsis

\* Neutrophil-lymphocyte count ratio (NLCR) \*\* CRP+Lactate+NLCR

\*\*\* CRP+Lactate+NLCR+PCT



### What Is The Right Tool For Early ID of Sepsis?

Lactate Is Useful, But You Need To Suspect Sepsis

Measuring Point of Care Lactate in Emergency Department Patients With Suspected Sepsis				
Sepsis Severity	Specificity			
Lactate >2mmol/I Normal				
All Sepsis	34	82		
Severe Sepsis & Septic Shock	64	94		
Septic Shock	53	72		
Lactate >4mmol/I Abnormal				
All Sepsis	7	98		
Severe Sepsis & Septic Shock	13	99		
Septic Shock	27	97		

### **Triage Information - Guess How Many?**

- 1. What % of SEPTIC patients **initially present** to ED with 2+ SIRS criteria? (Crouser et al, JICM)
  - a. 87% b. 67%
  - **C.** 27%



2. What % of SEPTIC patients initially present to ED with hypotension or altered mental status? (Crouser et al, JICM)

- a. 56% Hypotension and 52% Altered mental status
- **b.** 36% Hypotension and 32% Altered mental status
- C. 16% Hypotension and 12% Altered mental status

3. What % of SEPTIC SHOCK patients initially present to ED with hypotension or altered mental status? (Filbin et al)

- a. 82% Hypotension and 84% Altered mental status
- **b.** 32% Hypotension and 34% Altered mental status
- C. 22% Hypotension and 24% Altered mental status

#### MDW- Monocyte Distribution Width A Pragmatic Screening Tool for Sepsis



#### **MDW Severity Of Infection Marker**

To assist clinically with patient assessment: higher mdw values equate to higher relative risk of severe infection



Considered with other signs and symptoms, MDW cut-off value of **20.0** effectively **differentiates sepsis from non-septic presentations**, including non-infectious systemic inflammatory response

Distribution of MDW Values

#### Numerous Studies Over Past 5 Years 2021 2017 2019 2020 Hausfater et al. Crit Care (2021) 25:227 **≋**CHEST Critical Care Original Research Critical Care https://doi.org/10.1186/s13054-021-03622-5 Crouser et al. Journal of Intensive Care (2020) 8:33 https://doi.org/10.1186/s40560-020-00446-3 Journal of Intensive Care Improved Early Detection of Sepsis in the CrossMark RESEARCH **Open Access** ED With a Novel Monocyte Distribution RESEARCH **Open Access** Width Biomarker Monocyte distribution width (MDW) Elliott D. Crouser, MD; Joseph E. Parrillo, MD; Christopher Seymour, MD; Derek C. Angus, MD, MPH; Monocyte distribution width enhances performance as an early sepsis indicator Keri Bicking, PharmD; Liliana Tejidor, PhD; Robert Magari, PhD; Diana Careaga, BS; JoAnna Williams, MD; Check for updates Douglas R. Closser, MD; Michael Samoszuk, MD; Luke Herren, BA; Emily Robart, BS; and Fernando Chaves, MD early sepsis detection in the emergency in the emergency department: comparison department beyond SIRS and gSOFA with CRP and procalcitonin in a multicenter Critical Care Medicine Elliott D. Crouser<sup>1\*</sup>, Joseph E. Parrillo<sup>2</sup>, Greg S. Martin<sup>3</sup>, David T. Huang<sup>4</sup>, Pierre Hausfater<sup>5</sup>, Ilya Grigorov<sup>6</sup>, international European prospective study Diana Careaga<sup>7</sup>, Tiffany Osborn<sup>8</sup>, Mohamad Hasan<sup>7</sup> and Liliana Teiidor Pierre Hausfater<sup>1,2,3\*</sup>, Neus Robert Boter<sup>4,5</sup>, Cristian Morales Indiano<sup>5,7</sup>, Marta Cancella de Abreu<sup>1,2</sup>, Societyof Critical Care Medicine Adria Mendoza Marin<sup>4,5</sup>, Julie Pernet<sup>1</sup>, Dolores Ouesada<sup>5,8</sup>, Iris Castro<sup>9</sup>, Diana Careaga<sup>9</sup>, Michel Arock<sup>6</sup>, DE GRUYTER Clin Chem Lab Med 2020: aor Liliana Teiidor<sup>9</sup> and Laetitia Vellv<sup>1,2</sup> Monocyte Distribution Width: A Novel Indicator of Luisa Agnello, Giulia Bivona, Matteo Vidali, Concetta Scazzone, Rosaria Vincenza Giglio, Giorgia Iacolino, Alessandro Iacona, Silvia Mancuso, Anna Maria Ciaccio, Bruna Lo Sasso Sepsis-2 and Sepsis-3 in High-Risk Emergency and Marcello Ciaccio\* PERFORMANCE OF MONOCYTE DISTRIBUTION WIDTH (MDW) FOR THE **Department Patients\*** Monocyte distribution width (MDW) as a **IDENTIFICATION OF COVID-19** screening tool for sepsis in the Emergency ales<sup>1</sup>, N. Robert<sup>1</sup>, A. Mendoza<sup>1</sup>, G. <u>Rocamora</u><sup>1</sup>, A. Leis<sup>1</sup>, M.D. Quesada<sup>1</sup>, I. Castro<sup>2</sup>, D. Careaga<sup>2</sup>, R. Magari<sup>2</sup>, L. Tejidor<sup>2</sup> Elliott D. Crouser, MD1; Joseph E. Parrillo, MD2; Christopher W. Seymour, MD3; Derek C. Angus, MD, MPH3; Keri Bicking, PharmD2; Vincent G. Esguerra, MD1; Department Octavia M. Peck-Palmer, PhD4; Robert T. Magari, PhD5; Mark W. Julian, MS1; Jennifer M. Kleven, MD<sup>2</sup>; Paarth J. Raj, DO<sup>2</sup>; Gabrielle Procopio, PharmD<sup>2</sup>; Diana Careaga, BS5; Liliana Tejidor, PhD5 www.nature.com/scientificreports DE GRUYTER Clin Chem Lab Med 2021: aop Monocyte Distribution Width (MDW) as novel inflammatory Elisa Piva, Jenny Zuin, Michela Pelloso, Francesca Tosato, Paola Fogar and Mario Plebani\* marker with prognostic significance Monocyte distribution width (MDW) parameter as

a sepsis indicator in intensive care units

RESEARCH ARTICLE

in COVID-19 patients

Monocyte distribution width compared with C-reactive protein and procalcitonin for early sepsis detection in the emergency department PLOS ONE

Giovanni Riva<sup>1,603</sup>, Sara Castellano<sup>2,8</sup>, Vincenzo Nasillo<sup>1,8</sup>, Anna Maria Ottomano<sup>1</sup>



A la Woo<sup>1</sup>, Dong Kyu Oh<sup>1</sup>, Chan-Jeoung Park<sup>2</sup>\*, San

1 Department of Pulmonary and Critical Care Medicine, Asan Medical Center, University of Ulsan Golege of Medicine, Seoul, Republic of Korea, 2 Department of Laboratory Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Republic of Korea

# MDW: Regulatory-cleared Marker for Detection of Severe Infection and Sepsis in ED

#### N=2158 | 3 Large EDs in US:

Hackensack University Medical Center; Ohio State University Wexner; Medical Center University of Pittsburgh

#### **Receiver-Operator Curves for Sepsis-2 Detection**





#### Distribution of MDW Values for Various Sub-populations



#### MDW Results Replicated in EU

#### N=1517 | 2 Large EDs in France and Spain

Performances of MDW, WBC, PCT, CRP alone or in combination, for baseline measurement in the ED vs. Sepsis-2 & Sepsis-3

Parameters	SEPSIS-2		SEPSIS-3		
	AUC	CI 95%	AUC	CI 95%	
MDW	0.81	[0.78-0.84]	0.82	[0.79-0.85]	
WBC	0.76	[0.72-0.79]	0.65	[0.60-0.70]	
MDW+WBC	0.86	[0.84-0.88]	0.83	[0.79-0.86]	
PCT	0.78	[0.75-0.81]	0.84	[0.81-0.87]	
CRP	0.85	[0.83-0.87]	0.85	[0.82-0.87]	
MDW+WBC+PCT	0.86	[0.84-0.89]	0.83	[0.80-0.86]	
MDW+WBC+CRP	0.87	[0.85-0.89]	0.85	[0.82-0.87]	

Hausfater et al. Crit Care (2021) 25:227 https://doi.org/10.1186/s13054-021-03622-5	Critical Care
RESEARCH	Open Access
Monocyte distribution width performance as an early sepsi in the emergency departmen with CRP and procalcitonin in international European prosp	(MDW) is indicator t: comparison a multicenter ective study
Pierre Hausfater <sup>1,2,3*</sup> •, Neus Robert Boter <sup>4,5</sup> , Cristian Morales Indian Adria Mendoza Marin <sup>4,5</sup> , Julie Pernet <sup>1</sup> , Dolores Quesada <sup>5,8</sup> , Iris Castro Liliana Tejidor <sup>9</sup> and Laetitia Velly <sup>1,2</sup>	o <sup>57</sup> , Marta Cancella de Abreu <sup>1,2</sup> , º, Diana Careaga <sup>9</sup> , Michel Arock <sup>6</sup> ,

#### Distribution of MDW Values for Various Sub-populations



### Mitigate Diagnostic Uncertainty

MDW IS AVAILABLE EARLY IN-PATIENT ASSESSMENT TO HELP DETERMINE PATIENT ACUITY AND RISK OF SEPSIS Enhances WBC interpretation – helps to identify patients at risk



MDW FDA-cleared cut off value of 20  $\rm K_2 EDTA$  - NPV 92%, PPV 36%

#### Can MDW Help to Tag More Patients with Sepsis Time Zero?

example

SEPSIS SCREENING/STANDING ORDERS

Does the patient have any of the	Pneumonia (Cough, Shortness of Breath)	Value	Time	Nurse
following documented or	UTI (Urinary Pain/ Frequency), Indwelling device(foley or central line)			
suspected infections?	Wound Infection (Cellulitus, Decubitus Ulcer, Purulent Drainage)			
	Abdominal Pain/Distention/Firmness			
Please circle any that apply	Stiff neck			
	Recent Surgery			
S	Currently on Antibiotics, Antibiotics or reports of infection within last 30 days.			
Screen within 30 minutes of	Does the patient meet 2 or more of the following SIRS?			
presentation to the ED	<ul> <li>Temperature &gt;100.4 or &lt;96.8</li> </ul>			
	<ul> <li>Heart rate &gt; 90 bpm</li> </ul>			
Date/Time	<ul> <li>Respiratory rate &gt;20 bpm</li> </ul>			
<u></u>	<ul> <li>WBC &gt;12,000 or &lt;4,000 or &gt;10% bands</li> </ul>			
	o MDW >20			
	TIME ZERO FOR SEPSIS			
Do not delay antibiotic administration if	Lab draw for CBCD, CMP, UA, lactate level STAT			
unable to obtain timely blood cultures	Blood cultures (x2) STAT			
	> CXR			
***MAY GIVE ANTIBIOTICS IM ONLY IF	Administer a broad- spectrum antibiotic STAT			
YOU CAN NOT OBTAIN IV—PLEASE	REPEAT Lactate Level in 4 hours if > 2mg/dl (Put order in as soon as you know the results)			
DOCUMENT IV ATTEMPTS***	(Give Antibiotic prior to transport and within 3 hour after arrival to ED)			
	<ul> <li>Zosyn 3.375 gms IV/IM</li> </ul>			
	<ul> <li>Vancomycin IV</li> </ul>			
	• Levaquin 750mg IV			
	• Rocephin 2 gm IV/IM			
	o UnasynIV/IM			
Does the patient have one or more of	<ul> <li>Cardiovascular: Systolic BP &lt;90</li> </ul>			
the following organ dysfunctions?	CNS: Significant mental status change			
SEVERE SEPSIS = Sepsis + one of the	Respiratory: SaO2 90% or increasing O2 needs			
following.	<ul> <li>Renal: Urinary output &lt; 0.5ml/kg/hr or Creatinine &gt;2( must be NEW ONSET)</li> </ul>			
	<ul> <li>Hematologic: Platelets &lt;100,000/mm3 or &gt;400.000/mm3 or INR &gt;1.5</li> </ul>	· · · · · · · · · · · · · · · · · · ·		
	<ul> <li>Hepatic: Liver Function Test &gt;2 times upper limit of normal or bilirubin &gt;2mg/dl</li> </ul>			
	Metabolic: pH < 7.3 or lactate >2 mmol/l			

MDW Customer Protocol Example

### SeptiCyte® Host Response Technology



#### Measures Host Response Signals

- Measures mRNA in White Blood Cells (WBCs)
- Quantifies expression in two WBC genes
- Specific to infection in systemic inflammation
- Independent of type of pathogen causing sepsis (bacterial gram +tive, gram -tve, viral fungal/yeast)
- Not reliant on finding pathogen in blood sample

#### **Clinical Interpretation of Result**

- Reports the likelihood of sepsis
- Independent of severity
- Actionable results in ~100% of suspected sepsis patients

# SeptiCyte RAPID outperforms PCT and lactate, alone and in combination with other clinical variables



Comparison of lactate, PCT and SeptiScore, without or with additional clinical variables, for discrimination of sepsis vs. SIRS. AUC distributions are shown for all 32,767 possible logistic combinations of the following variables: age, race, sex, MAP max, T min, T max, HR min, HR max, WBC min, WBC max, glucose max, lactate, PCT, SeptiScore, # of SIRS criteria

Performance was assessed against consensus RPD.

#### Key:

vertical line, lactate alone; grey distribution, lactate
 combined with other clinical variables except SeptiScore or PCT
 vertical line, PCT alone; blue distribution, PCT combined
 with other clinical variables except SeptiScore;

vertical line, SeptiScore alone; red distribution, SeptiScore combined with other clinical variables

\*Pre-print manuscript "Validation of SeptiCyte RAPID For Sepsis vs SIRS" <u>https://doi.org/10.1101/2022.07.20.22277648</u>



#### Early Rule In/Rule Out Sepsis



For results falling into band 2 or 3 the SeptiScore value can drive the probability up or down in conjunction with the other clinical variables and lab tests

USC University of Southern California



50

# Case Studies—Using the CBC with Diff to Help Rule in or Rule Out Sepsis



This case on their implementation of MDW at this facility and do study is presented for educational purposes only, it may not reflect a typical patient triage process and only applicable to the specific study population.

Statements made in this video are the opinions of the presenter based not represent performance claims made by Beckman Coulter.

For MDW specific performance claims, please refer to UniCel DxH 900 Coulter Cellular Analysis System Early Sepsis Indicator (ESId) Application Addendum PN C42014AC. MDW values greater than 20.0 together with other laboratory findings and clinical information, aids in identifying patients with sepsis or at increased risk of developing sepsis within the first 12 hours of hospital admission.

MDW results greater than 20.0 should be interpreted in association with other clinical information and diagnostic testing as a proportion of patients without sepsis may have an elevated MDW value at baseline. MDW values less than or equal to 20.0 cannot rule out sepsis or the development of sepsis within 12 hours of hospital admission. The Early Sepsis Indicator should not be used as the sole basis to determine the absence of sepsis.

#### **12:30 PM** PATIENT ARRIVES TO ED

A 64-year-old female with a history of asthma and hypothyroidism presents to the ED complaining of SOB, generalized body aches, fatigue and off & on fever started 4 days ago.





#### Denies chest pain, abdominal pain, urinary symptoms

- ✓ 4 days ago, started on 60 mg per day of steroids,
- ✓ 3 days ago, started on nebulized breathing treatment & a Z pack
- ✓ Oxygen saturation in urgent care 88%

#### **Chief Complaint:**

- ✓ SOB and Fatigue
- ✓ Initial Vital Signs: BP 117/62, HR 73, Temp 98.5, RR 16
- ✓ Rales present in the lung, sats 92% at rest
- Tested for COVID & Influenza A



Component	Your Value	Standard Range
WBC Count	Your Value 13.9 K/uL	Standard Range 3.8 - 10.6 K/uL
RBC Count	Your Value 4.15 M/uL	Standard Range 4.15 - 5.55 M/uL
Hemoglobin	Your Value 13.0 g/dL	Standard Range 12.0 - 15.0 g/dL
Hematocrit	Your Value 39.0 %	Standard Range 36 - 46 %
МСV	Your Value 94.0 fl	Standard Range 80 - 100 fl
МСН	Your Value 31.2 pg	Standard Range 26 - 34 pg
мснс	Your Value 33.2 g/dL	Standard Range 31 - 37 g/dL
RDW	Your Value 14.6 %	Standard Range <14.5 %
Platelet Count	Your Value 356 K/uL	Standard Range 150 - 450 K/uL
Neutrophil,%	Your Value 91 %	Standard Range %
Lymphocyte,%	Your Value	Standard Range

My CBC with Diff

Monocyte,%	Your Value 3 %	Standard Range %
Eosinophil,%	Your Value 0%	Standard Range %
Basophil,%	Your Value 0%	Standard Range %
Neutrophil, Absolute	Your Value 12.70 K/uL	Standard Range 1.80 - 7.70 K/uL
Lymphocytes Absolute	Your Value 0.80 K/uL	Standard Range 1.10 - 4.00 K/uL
Monocytes, Absolute	<b>Your Value</b> <b>0.40</b> K/uL	Standard Range 0.00 - 0.80 K/uL
Eosinophils, Absolute	Your Value 0.00 K/uL	Standard Range 0.00 - 0.70 K/uL
Basophils, Absolute	Your Value 0.00 K/uL	Standard Range 0.00 - 0.20 K/uL

BC's drawn; Lactate drawn, Chest x-ray

#### What do you think?



Component	Your Value	Standard Range
Sodium	Your Value 132 mmol/L	Standard Range 135 - 145 mmol/L
Potassium	Your Value 4.5 mmol/L	Standard Range 3.5 - 5.0 mmol/L
Chloride	Your Value 101 mmol/L	Standard Range 98 - 111 mmol/L
Carbon Dioxide	Your Value 22 mmol/L	Standard Range 21 - 35 mmol/L
Anion Gap	Your Value 9	Standard Range 3 - 13
Blood Urea Nitrogen	<b>Your Value</b> 13 mg/dL	Standard Range 10 - 25 mg/dL
Creatinine	Your Value 0.88 mg/dL	Standard Range <1.03 mg/dL
IDMS Standardized.		
Glucose	Your Value 260 mg/dL	Standard Range 60 - 140 mg/dL
If fasting, glucose reference range = 60 to 99	mg/dL	
Calcium	<b>Your Value</b> <b>8.4</b> mg/dL	Standard Range 8.2 - 10.2 mg/dL

### My Chem Panel

#### **11:15 AM** PATIENT ARRIVES TO ED

63 year old brought in by EMS for generalized weakness and fatigue for 1 week



- ✓ Decrease appetite for 2 weeks
- Intermittent nausea
- ✓ Vomited twice yesterday
- ✓ Mild, intermittent abdominal pain
- ✓ Denies change in BM or urination
- ✓ No f/c
- ✓ No cough or sob
- 🗸 No ср

#### PMH:

Prostate cancer

Urinary retention s/p suprapubic catheter

#### 07:08 T: 37.4 BP: 122/81 P: 127 RR: 21 SpO2: 97% (RA)

**Positive Physical Exam Findings:** 

Mildly dry mucous membranes

Mild TTP of the periumbilical region

Tachycardic, irregular rhythm

**07:35** EKG: A fib w/ RVR, rate 130



08:38 Troponin & BNP: Negative

**09:35** UA: WBC 5-10 RBC 10-20 Epithelial cells moderate Leukocyte esterase 2+ Few bacteria

UTI??

- **08:55** CXR: No acute findings
- **10:43** CT abdomen/pelvis: No acute findings

Urine culture after 5 days: No Growth



In the presence of leukocytosis, when MDW is not elevated, significant underlying infection is less likely

DKA

Trauma	63 y/o presents post fall with left hip pain P: 115 RR: 24		WBC: 21.2 MDW: 15.3
Hemorrhage	35 y/o presents post dark brown emesis P: 124 BP: 88/57	Lactate: 5.5	WBC: 22.0 MDW: 16.1

27 y/o w/ h/o IDDM and noncompliance presents<br/>w/ fatigue, vomiting and abdominal painWBC: 19.4<br/>MDW: 17.3P: 133RR: 28Lactate: 4.7

#### **9:30 AM** PATIENT ARRIVES TO ED

A 63-year-old male with a history of coronary artery disease, diabetes, and lung cancer presents to the ED complaining of generalized body aches, fatigue and weakness, which started about one week prior.





- Denies localized weakness or numbness, chest pain, shortness of breath, abdominal pain, headache, or urinary symptoms. His last chemotherapy was the month prior
- ✓ Feeling more tired than usual
- ✓ H/o anemia and thromocytopenia

#### **Chief Complaint:**

✓ Fatigue, generalized weakness



#### 09:35 T: 37.1 BP: 122/73 P: 88 RR: 21 SpO2: 97% (RA) Positive Physical Exam Findings: Mildly dry mucous membranes Hemoccult positive stool



**10:45** Lactate, blood cultures and Abx ordered

**10:50** Head to toe exam: Mild erythema and induration around Portacath

- **11:15** Antibiotic given
- 11:27 Lactate: 3.2
- **11:33** CXR: No acute findings
- 12:55 UA: WBC 0-2 RBC 0 Bacteria None

#### Blood Cultures: Gram-positive cocci in clusters





Head to toe exam reveals possible port infection

 $\sqrt{\text{SIRS}(\text{RR + WBC})}$   $\sqrt{\text{Infection SEPSIS}}$ 

11:27 Lactate: 3,2 Time Zero





## Ring! Ring!

"Hey, this is Meg on 3B. Mr. Boris' C. diff test came back negative and he hasn't had any more loose stools since the test was sent last night. Is it okay to take him out of isolation?"



Kathleen M. Vollman MSN, RN, CCNS, FCCM, FCNS, FAAN Clinical Nurse Specialist / Educator / Consultant ADVANCING NURSING kvollman@comcast.net Northville, Michigan

www.vollman.com

