



School of Continuous  
Professional Development



# LAB RATS TO THE RESCUE:

## A QUICK REVIEW OF LAB MEDICINE

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MINIVAN DRIVER*



*No disclosures.*

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**Mr. Weakness**

**Mr. Farmer**

**Mr. Drowsy**

**Mr. Stressed**

**Mrs. Carrot**

**Mrs. Delirium**

**Mr. Diesel**



***LETS GET STARTED...***



# MR. WEAKNESS

## **PMH**

Obesity  
Hyperlipidemia  
Osteoarthritis

## **PSH:**

Total Hip Arthroplasty  
Total Knee Arthroplasty

## **SOCIAL HISTORY:**

Married. Never smoker. No ETOH.

## **MEDS:**

Ibuprofen, Metoprolol, ASA, Simvastatin

## **ROS:**

Progressive weakness, GERD, Joint Pain

# LABS

Lab	Admission	Day 2	Day 3
Hemoglobin	11.2	9.5	8.6
MCV	87	88	91
Platelets	206	259	214
Sodium	141	138	140
Potassium	4.8	5.2	5.2
Bicarbonate	20	21	23
Creatinine	1.0	0.9	1.1
BUN	28	35	48
AST	52	–	–
ALT	55	–	–
UA	Negative	–	–
TSH	1.8	–	–



## YOUR REVIEW OF VITALS...

- Normal saline running 100cc/hr since admission
- Weight is up
- Fluid balance is +2.7L

# LABS

Lab	Admission	Day 2	Day 3
Hemoglobin	11.2	9.5	8.6
MCV	87	88	91
Platelets	206	259	214
Sodium	141	138	140
Potassium	4.8	5.2	5.2
Bicarbonate	20	21	23
Creatinine	1.0	0.9	1.1
BUN	28	35	48
AST	52	–	–
ALT	55	–	–
UA	Negative	–	–
TSH	1.8	–	–



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# BLOOD UREA NITROGEN

## 6-21MMOL/L

### AZOTEMIA

- Dehydration
- Rapid protein catabolism
- CHF
- Shock
- MI
- High protein diet
- Anabolic effect of systemic corticosteroids

### LOW

- Liver failure
- Malnutrition
- Nephrotic syndrome

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# TRANSFUSE?

## **Transfusion Strategies for Acute Upper Gastrointestinal Bleeding**

*Villanueva, MD et. al.  
The New England Journal of Medicine, 2013*

## ***Liberal or Restrictive Transfusion in High Risk Patients after Hip Surgery***

*Carson, MD et al  
The New England Journal of Medicine, 2011*

## ***Lower versus Higher Hemoglobin Threshold for Transfusion in Septic Shock***

*The New England Journal of Medicine, 2014*

SO SAY YOU DID  
TRANSFUSE...



**OUR NEXT  
PATIENT IS WAITING...**



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# MR. FARMER

<b>PMH</b>	“I hate doctors”
<b>PSH</b>	“I told you, I hate doctors”
<b>SOCIAL HISTORY</b>	Married, Neversmoker, No ETOH
<b>MEDS</b>	None


Transferred from OSH for femur fracture after falling off tractor and being rolled over.

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## ADMIT LABS

Hemoglobin	11.7
WBC	11.2
Platelets	199,000
Creatinine	1.0
Glucose	146
Potassium	4.8
Sodium	144

 Start fentanyl PCA and LR @100cc/hr. Western movie channel. NPO after midnight.



	<b>ADMIT LABS</b>	<b>DAY 2</b>
Hemoglobin	11.7	10.7
WBC	11.2	12.0
Platelets	199,000	159,000
Creatinine	1.0	2.1
Glucose	146	155
Potassium	4.8	5.4
Sodium	144	141

# CREATININE KINASE

38-176U/L

## ELEVATED

- Myocardial Infarction
- Seizure
- Skeletal Muscle Disease  
(Rhabdomyolysis, Polymyositis, Dermatomyositis)
- Medications (antipsychotics, statins, SSRI's, fibrates, ARB's, antivirals, immunosuppressants)
- Strenuous exercise
- Prolonged Immobilization
- Alcohol, Cocaine, LSD
- Malignant Hyperthermia



# Rhabdomyolysis

<b>Traumatic</b>	<b>Nontraumatic Exertional</b>	<b>Nontraumatic Nonexertional</b>
Crush Syndrome	Marked exertion	Drugs
Prolonged Immobilization	Hyperthermia	Toxins
		Infections

# CREATININE

0.6-1.1MG/DL

## ELEVATED

- Renal disease
- Drugs (Cimetidine, Trimethoprim)

## DECREASED

- Minimal muscle mass

**NEXT UP ...**



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# MR. DROWSY

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## PMH

Severe Right Heart Failure  
Severe CAD  
OSA (CPAP noncompliant)  
HTN

## PSH

CABG  
Drug Eluting Stent x3

## SOCIAL HISTORY

Married, Never smoker,  
Occasional alcohol, Minimal exercise

## MEDS

Coreg 25mg BID, Zocor 80mg nightly, Lisinopril 20mg daily, Lasix 80mg BID, Aspirin 325mg daily

\*\*\*\*Transfer from OSH for coma; wife refusing Hospice Care

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<b>Lab</b>	<b>Value</b>
Hemoglobin	10.7
MCV	85
WBC	11,000
Platelets	158,000
Sodium	135
Potassium	3.6
BUN	22
Glucose	90
Calcium	10
AST	88
ALT	103
Alkaline Phosphatase	323
Albumin	3.1
INR	1.7
ABG	Normal
UA	Negative

<b>Lab</b>	<b>Value</b>
Hemoglobin	10.7
MCV	85
WBC	11,000
Platelets	158,000
Sodium	135
Potassium	3.6
BUN	22
Glucose	90
Calcium	10
AST	88
ALT	103
Alkaline Phosphatase	323
Albumin	3.1
INR	1.7
ABG	Normal
<b>Ammonia</b>	<b>160</b>

# AMMONIA

<50ug N/L

## ELEVATED

- Liver congestion/failure
- Urea Cycle Enzyme Dysfunction
- Increased protein intake

# PROTHROMBIN TIME

10-13 Seconds

## ELEVATED

- Iatrogenic (Coumadin)
- Liver failure
- Fat malabsorption
- DIC
- Vitamin K deficiency



# ALKALINE PHOSPHATASE

37-98U/L

## ELEVATED

- Biliary stasis (most common)
- Bone disorders (Paget's, Rickets, Osteomalacia, Fractures, Metastatic Tumor)
- Pregnancy (Typically third trimester)
- Chronic renal failure
- Drugs (Antibiotics, HRT, etc)
- Right Sided Heart Failure
- Ulcerative Colitis
- Hyperparathyroidism
- Post Prandial (Blood Type O and B)



# MOVING ALONG...



# Mr. Stressed



<b>PMH</b>	Hyperlipidemia, PUD x2
<b>PSH</b>	None
<b>SOCIAL HISTORY</b>	Single Practicing lawyer Smokes 1ppd x 30 years Drinks w/ dinner
<b>MEDS</b>	Tylenol as needed
<b>ROS</b>	Unknown

# ER

- Hypertensive 200's (Gave Lopressor)
- Tachycardia 120's (EKG = sinus)
- Hallucinations (Glucose and UA normal, Psych is busy, Security notified)
- Urinary retention for 46 seconds (foley placed)

<b>Lab</b>	<b>Value</b>
Hemoglobin	14.1
MCV	104
WBC	8000
Platelets	47000
ALT	100
AST	259
TSH	1.6
Potassium	4.2
Creatinine	1.0
Bicarbonate	21
Urinalysis	Negative
Alkaline Phosphatase	110
BUN	39
Magnesium	1.2
Sodium	141
Lactate	3.7

Lab	Value
Hemoglobin	14.1
<b>MCV</b>	<b>104</b>
WBC	8000
<b>Platelets</b>	<b>47000</b>
<b>ALT</b>	<b>100</b>
<b>AST</b>	<b>259</b>
TSH	1.6
Potassium	4.2
Creatinine	1.0
Bicarbonate	21
Urinalysis	Negative
Alkaline Phosphatase	110
BUN	39
<b>Magnesium</b>	<b>1.2</b>
Sodium	141
Lactate	3.7

# Alcohol

- MCV goes Up
- Platelets down
- AST/ALT ratio 2:1 and typically less than 300
- Magnesium down



**WAIT... WHAT ABOUT  
THAT ELEVATED  
LACTATE????**



# LACTATE

0.6-2.3mmol/L

## ELEVATED

- Tissue hypoxemia (most common)
- Seizures
- Exercise
- Leukemia
- Liver and kidney disease
- Medications (metformin)
- Short Bowel Syndrome
- Ethanol, Methanol, Salicylates



**NEXT PATIENT  
PLEASE...**





# Mrs. Carrot

<b>PMH</b>	Hyperlipidemia, Aortic Stenosis, Osteoporis
<b>PSH</b>	Mechanical AVR
<b>SOCIAL HISTORY</b>	Married. No alcohol. No smoking.
<b>MEDS</b>	Warfarin, HCTZ, Metoprolol,, Calcium
<b>ROS</b>	Unknown

# LABS

Lab	On Discharge from Cardiac Surgery	Admit Labs
Hemoglobin	8.7	6.7
MCV	87	88
Platelets	206	259
Sodium	141	138
Potassium	4.8	5.9
Bicarbonate	25	28
Creatinine	1.0	1.6
BUN	20	21
AST	39	251
ALT	50	50
Bilirubin	1.2	3.8
INR	2.6	3.3

# LABS

Lab	On Discharge from Cardiac Surgery	Admit Labs
Hemoglobin	8.7	6.7
MCV	87	88
Platelets	206	259
Sodium	141	138
Potassium	4.8	5.9
Bicarbonate	25	28
Creatinine	1.0	1.6
BUN	20	21
AST	39	251
ALT	50	50
Bilirubin	1.2	3.8
INR	2.6	3.3
Haptoglobin	–	3
LDH	–	980
Peripheral Smear	–	Schistocytes, Helmet Cells

# Hemolysis

↑  
INCREASED

- Potassium
- AST
- LDH
- Bilirubin (Indirect)
- Reticulocytes

↓  
DECREASED

- Hemoglobin
- Haptoglobin

# BILIRUBIN

0.1-1.0mg/dL

## HYPERBILIRUBINEMIA

- Choledocholithiasis (most common)
- Liver Disease
- Hemolysis (Indirect)
- Recent transfusion
- Gram Negative Sepsis
- TPN
- Obstruction (Tumor, Mass, Stone)
- Gilberts Disease

# LDH

122-222U/L

## ELEVATED

- Heart Disease (MI)
- Tissue Infarction (Renal, Pulmonary)
- Hemolysis
- Liver Disease (Hepatitis, Cirrhosis, Cholangitis)
- Malignancy (Lymphoma, Myeloma, Leukemia)

\*Present in liver, heart, kidney, RBC, WBC, Lungs, Platelets, skeletal muscle, prostate\*

\*Any cellular damage causes elevation\*



# Haptoglobin

30-200mg/dL

INCREASED

- Inflammation
- Infection
- Malignancy
- Surgery
- Trauma
- Corticosteroids

DECREASED

- Hemolysis
- Liver disease
- Malnutrition
- Estrogens
- Pregnancy



# ACUTE PHASE REACTANTS?



# Acute Phase Reactants

## POSITIVE

- Fibrinogen
- Haptoglobin
- CRP
- Ferritin
- Ceruloplasmin
- Alpha 1 Antitrypsin
- Complement Factors

## NEGATIVE

- Albumin
- Transferrin



**ONLY TWO  
LEFT...**



# Darlene Delirium



Lab	Value
Hemoglobin	11.7
MCV	87
WBC	8000
Platelets	157,000
ALT	48
AST	188
TSH	1.6
Potassium	4.2
Creatinine	1.0
Bicarbonate	21
Urinalysis	Negative
Alkaline Phosphatase	110
BUN	20
Sodium	141

# Liver Enzymes

## ELEVATED

- NASH (Most common cause of ALT elevation)
- Alcohol
- Viral Hepatitis
- Shock Liver
- Drugs
- Muscle Damage (Cardiac, Skeletal)
- Celiac Disease

ALT more specific to the liver

AST/ALT Ratio >2:1 think ETOH (Pyridoxal-5'-phosphate)

ALT and AST >1,000 think Tylenol, Ischemia, or Viral Hepatitis



# FINALLY OUR LAST PATIENT...





# Mr. Diesel

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<b>PMH</b>	BPH, Hyperlipidemia, OSA, Obesity
<b>PSH</b>	Bilateral Carpal Tunnel, tonsillectomy, Right Total Knee
<b>SOCIAL HISTORY</b>	Single, lives in Iowa, truck driver, smokes 3ppd x 30 years; weekend alcohol binges and minimal exercise
<b>MEDS</b>	Flomax, Lipitor, Nicotrol Inhalers, Viagra
<b>ROS</b>	Weakness, cough, constipation, weight loss, insomnia, and polyuria

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## Admit Labs

Hgb	18.7	ALKPHOS	523
WBC	14K	Bilirubin	1.0
Platelets	649K	Albumin	1.9
Sodium	121	Calcium	10.0
Potassium	4.8	ESR	140
Bicarbonate	38	Glucose	240
AST	75	Amylase	26
ALT	43	Creatinine	0.8
TSH	1.6	BUN	18
INR	1.0	HgbA1C	9.0

## Admit Labs

Hgb	18.7	ALKPHOS	523
WBC	14K	Bilirubin	1.0
Platelets	649K	Albumin	1.9
Sodium	121	Calcium	10.0
Potassium	4.8	ESR	140
Bicarbonate	38	Glucose	240
AST	75	Amylase	26
ALT	43	Creatinine	0.8
TSH	1.6	BUN	18
INR	1.0	HgbA1C	9.0

# HYPONATREMIA

135-145mmol/L

## Hypovolemic

- Volume contraction
- Sweating, Diarrhea, or Vomiting
- Diuretics (Thiazides, Loop)
- Cerebral Salt Wasting

## Euvolemic

- SIADH (Head trauma, Seizure, CNS disease, Neoplastic, Meds)
- Adrenal Failure
- Hypothyroidism

## Hypervolemic

- Congestive Heart Failure
- Cirrhosis
- Polydipsia
- Nephrotic Syndrome
- Renal disease

## Pseudo

- Hyperglycemia **\*FOR EVERY 100 ABOVE 100 ADD 1.6\***
- Hypertriglyceridemia
- Paraproteinemia

# ALBUMIN

3.4-4.7g/dL

## **HYPOALBUMINEMIA**

- Inverse Acute Phase Reactant
- Poor nutrition
- Liver disease
- Nephrotic Syndrome
- Burns
- Increased catabolism (Cancer)
- Protein losing Gastropathies

# CALCIUM

8.9-10.1mg/dL

## HYPERCALCEMIA

- Primary Hyperparathyroidism
- Malignancy (PTH peptide, Bone Mets)
- Sarcoidosis
- Drugs (HCTZ, Lithium, Theophylline)
- Vitamin D intoxication
- Hyperthyroidism
- Immobilization

## HYPOCALCEMIA

- Severe Pancreatitis
- Renal Failure
- Vitamin D Deficiency
- Hypoparathyroidism
- Pseudo (Hypoalbuminemia)  
\*\*Corrected Ca = Calcium + 0.8 x (4.0-Albumin)
- Chelation secondary to use of citrate

# PLATELETS

150,000-450,000/L

## THROMBOCYTOSIS

- Infection (most common)
- Post Surgical Status
- Malignancy
- Splenectomy
- Acute blood loss
- Iron deficiency
- Inflammation

## THROMBOCYTOPENIA

- Increased destruction (ITP, SLE, DIC, TTP, HUS, HELLP)
- Decreased production (Aplastic Anemia, ETOH, Viral infections)
- Splenomegaly
- Pseudo (RBC Transfusion)
- Drugs (Heparin, Quinine, Valproic Acid, Sulfonamide)

# INFLAMMATORY MARKERS

## SED RATE

0-29mm/1hour

- Infection
- Trauma
- Infarction
- Inflammation
- Neoplasm
- Obesity
- Monoclonal Gammopathies
- Age

## C REACTIVE PROTEIN

<8.0mg/dL

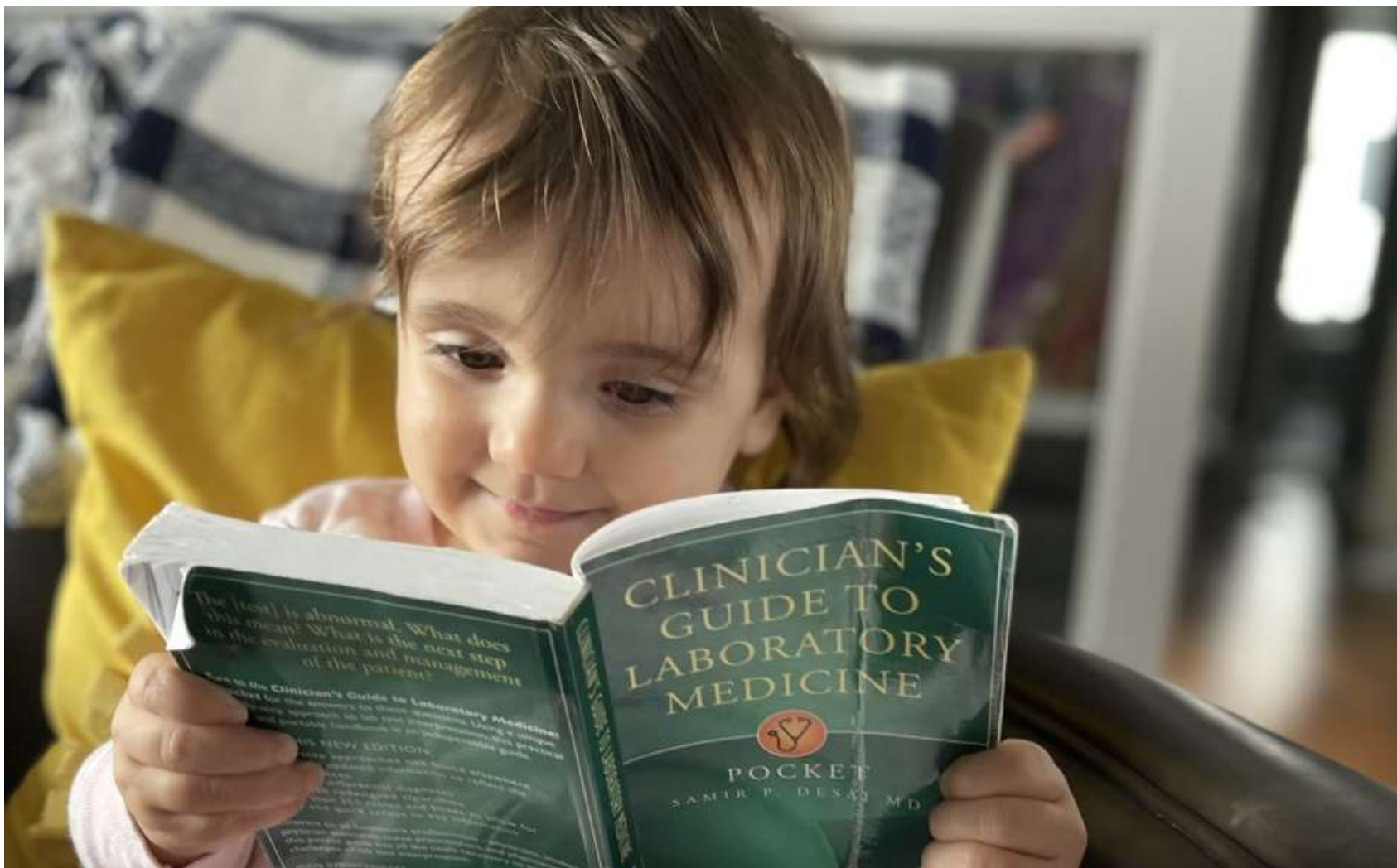
- Infection
- Trauma
- Infarction
- Inflammation
- Neoplasm
- Obesity
- OCP's

## IN SUMMARY

- Mr. Weakness
- Mr. Farmer
- Mr. Drowsy
- Mr. Stressed
- Mrs. Carrot
- Mrs. Delirium
- Mr. Diesel







## References

*Clinician's Guide to Laboratory Medicine 4<sup>th</sup> Edition*

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