

# **LAB RATS TO THE RESCUE:**

## **Inpatient Cases in Lab Medicine**

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# CENSUS

**Mr. Weakness**

**Mr. Farmer**

**Mr. Drowsy**

**Mr. Stressed**

**Mrs. Carrot**

**Mrs. Delirium**

**Mr. Diesel**



# Mr. Weakness

## PMH

Obesity  
Hyperlipidemia  
Osteoarthritis

## PSH:

Total Hip Arthroplasty  
Total Knee Arthroplasty

## SOCIAL HISTORY:

Married. Neversmoker. No ETOH.

## MEDS:

Ibuprofen, Metoprolol, ASA, Simvastatin

## ROS:

Progressive weakness, GERD, Joint Pain

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# LABS

Lab	Admission	Day 2	Day 3
Hemoglobin	11.2	9.5	8.9
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	42
AST	52	-	-
ALT	55	-	-
UA	Negative	-	-
TSH	1.8	-	-



# Your review of vitals...

**Normal saline running 100cc/hr since admission**

**Weight is up 3kg**

**Fluid balance is +2.7L**



# LABS

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Hemoglobin	11.2	9.5	8.9
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AST	52	-	-
ALT	55	-	-
UA	Negative	-	-
TSH	1.8	-	-



# 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**

*Jeffrey 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*





# MR. FARMER

## PMH

Never been to doctor.

## PSH:

## SOCIAL HISTORY:

Married. Neversmoker. No ETOH.

## MEDS:

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.



	ADMIT LABS	DAY 2
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	5.6
Sodium	144	141



	ADMIT LABS	DAY 2
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	5.6
Sodium	144	141
CK	---	11,526



# 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

Traumatic	Nontraumatic Exertional	Nontraumatic Nonexertional
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



# MR. DROWSY

## PMH

Severe Right Heart Failure  
Severe Coronary Artery Disease  
OSA (CPAP Noncompliance)  
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.





Lab	Value
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



Lab	Value
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
Anemia	160



# 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)



# MR STRESSED

## PMH

Hyperlipidemia  
Peptic Ulcer x2

## PSH:

None.

## SOCIAL HISTORY:

Single. Practicing Lawyer. Smokes 1ppd x 30 years. Drinks w/ dinner.

## MEDS:

Tylenol as needed

## ROS:

Unknown.

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Lab	Value
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





# ALCOHOL

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



# 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

\*\*\*\*Type A vs Type B\*\*\*\*



# Mrs. Carrot

## PMH

St. Jude Aortic Valve  
OSA  
Atrial Fibrillation  
HTN

## PSH:

Right Total Hip Arthroplasty  
Aortic Valve Replacement  
Varicose Veins

## SOCIAL HISTORY:

Married. Neversmoker. No ETOH.

## MEDS:

Warfarin, Metoprolol, HCTZ, and Melatonin

## ROS:

Admitted from ER for weakness and dyspnea



# LABS

Lab	On discharge from Cardiac Surgery	Admit Labs
Hemoglobin	12.7	9.6
MCV	87	88
Platelets	206	259
Sodium	141	138
Potassium	4.8	5.9
Bicarbonate	25	28
Creatinine	1.0	0.9
BUN	20	21
AST	79	251
ALT	86	----
Bilirubin	1.2	3.8
INR	2.6	3.3



Lab	Discharge from CV Surgery	Admit Labs
Hemoglobin	12.7	9.6
MCV	87	88
Platelets	206	259
Sodium	141	138
Potassium	4.8	5.9
Bicarbonate	25	28
Creatinine	1.0	0.9
BUN	20	21
AST	79	251
ALT	86	----
Bilirubin	1.2	3.8
INR	2.6	3.3
Haptoglobin	--	3
LDH	--	980
Peripheral Smear	--	Schistocytes, Helmet Cells



# Hemolysis

## Up

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

## Down

- Hemoglobin
- Haptoglobin

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# BILIRUBIN

0.1-1.0mg/dL

## HYPERBILIRUBINEMIA

- Cholelithiasis (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 Reactant????***



# Acute Phase Reactants

Positive	Negative
Fibrinogen Haptoglobin CRP Ferritin Ceruloplasmin Alpha 1 Antitrypsin Complement Factors	Albumin Transferrin



# 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
Ca <sup>2+</sup>	1.11



# 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



# MR. DIESEL

## PMH

BPH  
Hyperlipidemia  
Sleep Apnea

## PSH:

Bilateral Carpal Tunnel Release  
Tonsillectomy  
Right Total Knee Arthroplasty

## SOCIAL HISTORY:

Single. Lives in Iowa. Truck driver. Smokes 3ppd x 30 years.  
Weekend alcohol binges. Minimal exercise.

## MEDS:

Flomax, Lipitor, Nicotrol Inhalers, Viagra.

## ROS:

Weakness, cough, constipation, weight loss, insomnia, and polyuria.

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# ADMIT LABS

Hgb-18.7

WBC-14K

Platelets 649K

Sodium 121

Potassium 4.8

Bicarbonate 38

AST 75

ALT 43

TSH 1.6

INR 1.0

ALKPHOS 523

Bilirubin 1.0

Albumin 1.9

Calcium 10.0

ESR 140

Glucose 240

Amylase 26

Creatinine 0.8

BUN 18

HgbA1C 9.0

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# What should we order next?

- A. EKG, Troponin, and TTE
- B. Chest CT
- C. Hematology Consult
- D. Abdominal US and GI Consult
- E. Hydrate with 2L and repeat labs





# ADMIT LABS

Hgb-18.7

WBC-14K

Platelets 649K

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Potassium 4.8

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ESR 140

Glucose 240

Amylase 26

Creatinine 0.8

BUN 18

HgbA1C 9.0

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# 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

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# CALCIUM

8.9-10.1mg/dL

## HYPERCALCEMIA

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

## HYPOCALCEMIA

- Severe Pancreatitis
- Renal Failure
- Vitamin D Deficiency
- Hypoparathyroidism
- Pseudo (Hypoalbuminemia) \*\*\*\*  $\text{Corrected Ca} = \text{Calcium} + 0.8 \times (4.0 - \text{Albumin})$  \*\*\*\*
- 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

## C REACTIVE PROTEIN

<8.0mg/dL

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

## SED RATE

0-29mm/1hour

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



# In Summary

**Mr. Weakness**

**Mr. Farmer**

**Mr. Drowsy**

**Mr. Stressed**

**Mrs. Carrot**

**Mrs. Delirium**

**Mr. Diesel**



# References

## **Clinician's Guide to Laboratory Medicine**

Desai, Samir MD 2009

## **Henry's Clinical Diagnosis and Management by Laboratory Methods**

21<sup>st</sup> Edition. McPherson, Richard, Pincus, Matthew. 2007

## **Hospital Medicine Secrets**

Glasheen, Jeffrey MD 2007

**UpToDate**





# Questions????

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