

LAB RATS TO THE RESCUE:

Inpatient Cases in Lab Medicine

Andy Herber, PA-C
Assistant Professor of Medicine
Mayo College of Medicine
Mayo Clinic
Rochester, MN



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



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

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	-	-



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

•



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.



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. Neversmoker. 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
Ammonia	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.

•



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
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



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

•



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 ²⁺	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.

•



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

•



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

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

•



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 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**

21st Edition. McPherson, Richard, Pincus, Matthew. 2007

Hospital Medicine Secrets

Glasheen, Jeffrey MD 2007

UpToDate



Questions????

Herber.Andrew@mayo.edu

