LAB RATS TO THE RESCUE:
Inpatient Cases in Lab Medicine

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Objectives

- Interpret abnormal lab values commonly found in hospitalized patients
- Determine a differential diagnosis for specific lab abnormalities
- Develop a strategic approach to ordering labs in hospitalized patients

no disclosures

CENSUS

Mr. Weakness

Mr. Farmer

Mr. Drowsy

Mr. Stressed

Mrs. Carrot

Mrs. Delirium

Mr. Diesel

Lets start rounding…

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
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BUN	28	35	42
AST	52	-	-
ALT	55	-	-
UA	Negative	-	-
TSH	1.8	-	-

Now what?

A. EGD
B. Colonoscopy
C. Peripheral Smear
D. CT Abdomen
E. Stop IVF and give Furosemide
F. Transfer to SNF for continued PT/OT

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

EGD = Ulcer
What next?

A. Transfuse 1 unit of PRBCs

B. Transfuse 2 units of PRBCs

C. Iron supplementation

D. Monitor closely

E. 1gram of IV SoluMedrol, 30mg of Toradol, place PEG and inject live H. Pylori cultures into stomach.

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

So you don't transfuse…

How much blood does a healthy bone marrow typically make in one day?

A. 10mL

B. 50mL

C. 100mL

D. 350mL

So say you did transfuse…

Which of the following theoretically would not increase after transfusion?

A. Potassium

B. Bilirubin

C. White Blood Cells

D. Platelets

E. Risk of TRALI/TACO

Did you say risk of taco?

Risks of Transfusion?

Our next patient is waiting…

MR. FARMER

PMH **PSH:**

Never been to doctor.

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

What next?

A. Check Creatinine Kinase
B. Obtain PSA and place Foley
C. Renal US
D. Check Hemoglobin A1C
E. Urine electrolytes and calculate FeNa

	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 Prolonged Immobilization	Marked exertion Hyperthermia	Drugs Toxins Infections

CREATININE

0.6-1.1mg/dL

ELEVATED

-Renal disease

-Drugs (Cimetidine, Trimethoprim)

DECREASED

-Minimal muscle mass

Next up on the list…

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

How do you wake this guy up and get a big hug from his wife?

A. Lactulose and Rifaximin
B. Intravenous levothyroxine
C. 1gram IV of methylprednisolone
D. Narcan and Flumazenil
E. 2mg of Ativan and EEG
F. Extra Loud Rap Music

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)

Moving along…

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.

OUR LOVELY ER EVAL

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)

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

Next step?

A. CT Abdomen and Pelvis

B. LP then Ceftriaxone, Vancomycin, Acyclovir

C. IV Ativan

D. CT Head

E. Liver Biopsy

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

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

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

Next patient please…

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

Now What?

A. Abdominal CT

B. Call GI Bleed Team

C. FFP and Vitamin K

D. Peripheral Smear

E. Right Upper Quadrant US

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

-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 Reactant????

Which of the following is an inverse acute phase reactant?

A. Fibrinogen

B. CRP

C. Ferritin

D. Albumin

E. Ceruloplasmin

Acute Phase Reactants

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

What should we order next?

A. Liver Ultrasound
B. EKG and Troponin
C. Tylenol Level
D. Head CT
E. Muscle Biopsy
F. Psych Eval for Husband

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

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 intoxification
-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

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

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UpToDate

Questions????

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