Trace Elements

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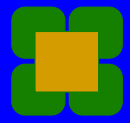
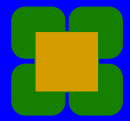


Learning Objectives:

- Describe the signs and symptoms of trace element abnormalities
- Discuss how to monitor for trace element abnormalities
- List ways to treat trace element abnormalities

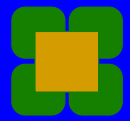


Trace Elements

- **Trace Elements: those elements that constitute less than 0.01% of the total body weight of a human**

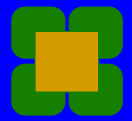
Rombeau/Caldwell. Clinical Nutrition: Parenteral Nutrition, 2nd edition, 1993

- chromium, copper, iron, manganese, selenium, zinc



Trace Elements Injection

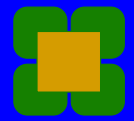
	MTE -4 reg	MTE -4 conc	MTE -5 reg	MTE -5 conc	A.S.P.E.N. 1998
Chromium (mcg)	4	10	4	10	10 -15
Copper (mg)	0.4	1	0.4	1	0.3 - 0.5
Manganese (mcg)	100	500	100	500	60 - 100
Zinc (mg)	1	5	1	5	2.5 - 4
Selenium (mcg)			20	60	60 - 100



Trace Elements - Case #1

21 year old male with past medical history significant for acrodermatitis enteropathica who presented with:

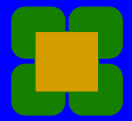
* 2-3 week history of fatigue
* 1 day PTA: fever (Tmax = 105 degrees F), chills and sore throat
* No N,V, D, abd pain, weight loss, loss of appetite, cough, night sweats



Trace Elements - Case #1

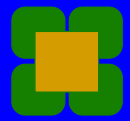
Acrodermatitis enteropathica is a disease caused by malabsorption of dietary zinc. The syndrome includes severe skin lesions, intractable diarrhea and immunodeficiency.

This syndrome can be effectively treated with large oral doses of zinc.



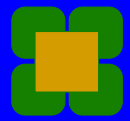
Trace Elements - Case #1

- ZINC deficiency:
  - dermatitis
  - hypogeusia
  - alopecia
  - diarrhea
  - apathy and depression



Trace Elements - Case #1

- Labs:
  - WBC 1.6
  - Hemoglobin 8.5
  - Hematocrit 26.6
  - Platelets 213
  - MCV was WNL
- BMP was WNL
- Cultures: urine, blood and throat were negative.



Trace Elements - Case #1

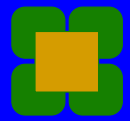
MEDICATIONS:

Zinc supplements to treat acrodermatitis enteropathica.

* Zinc 600 mg po daily x 5 years

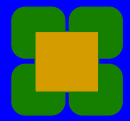
Trace Elements - Case #1: Questions?

- Is his condition secondary to his prolonged use of zinc (zinc toxicity)?
- What could be the cause of his anemia?
- What lab tests would you request?



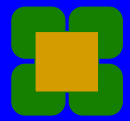
Trace Elements - Case #1

- Laboratory orders placed for:
  - anemia panel
  - trace element levels



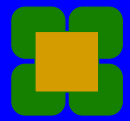
Trace Elements: Case #1

- Serum zinc = 145 (normal 50-150)
- Serum copper = <15 (normal 70-140)
- Serum iron = 5 (normal 30-140)
- Ferritin = 444 (WNL)
- Folate = 8.2 (WNL)
- B12 = 223 (WNL)



Trace Elements - Case #1

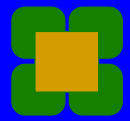
- COPPER deficiency:
  - neutropenia
  - anemia
  - osteoporosis
  - decreased hair and skin pigmentation
  - dermatitis
  - anorexia
  - diarrhea



Trace Elements - Case #1

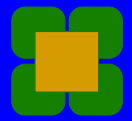
DIAGNOSIS: Copper deficiency

Oral zinc interferes with the absorption of dietary copper.



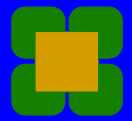
Trace Elements - Case #1

- Discharged home on a megamineral supplement ii tablets daily, which contained 30 mg zinc and 2 mg copper / tablet.
- Follow-up visit 2 months after discharge found patient with no complaints
- Repeat labs:
  - copper = 54
  - iron studies normal
  - hemoglobin normal



Trace Elements - Case #1: Take Home Message

- Zinc excess can result in copper deficiency.
- Copper deficiency can result in severe anemia.
- Monitor levels when prescribing trace elements.



RUN DATE: 07/12/04
RUN TIME: 1204
RUN USER: HLBLTC

Mercy Medical Center LAB **LIVE**
SPECIMEN INQUIRY

PATIENT: [redacted]
REQ DR: Seidner,Douglas

ACCT #: HQ2028403463 LOC: H.ELS U #: H000017645
AGE/SX: 81/M ROOM: REG: 06/28/04
DOB: 12/30/22 BED: DIS:
STATUS: REG REF TLOC:

SPEC #: 0628:I000Z0R COLL: 06/28/04-1000 STATUS: COMP REQ #: 01682118
RECD: 06/28/04-1441 SUBM DR: Seidner,Douglas

ENTERED: 06/28/04-1444 OTHR DR: Personal-Touch Home Care
ORDERED: COFFEE
COMMENTS: PLEASE FAX RESULTS

Test	Result	Flag	Reference
COFFEE	<0.05		0 <0.05

Result Units: IU/mL class

Levels of Specific IgE mRAST		
IU/mL	Class	Description of Class
<0.05	0	No detectable Specific IgE
0.05 - 0.07	0/I	Equivocal binding of Specific IgE Antibody
0.08 - 0.15	I	Increasing Levels of Specific IgE Antibody
0.16 - 0.50	II	
0.51 - 2.50	III	
2.51 -12.50	IV	
12.51 -62.50	V	
62.51 - >100	VI	

TESTING PERFORMED BY LABORATORY CORPORATION OF AMERICA, 6370 WILCOX ROAD, DUBLIN, OH 43106-1296.

SPEC #: 0628:CG00165R COLL: 06/28/04-1000 STATUS: COMP REQ #: 01682118
RECD: 06/28/04-1441 SUBM DR: Seidner,Douglas

ENTERED: 06/28/04-1444 OTHR DR: Personal-Touch Home Care
ORDERED: PT
COMMENTS: PLEASE FAX RESULTS
QUERIES: Patient's Anticoagulant? UNKNOWN

Test	Result	Flag	Reference
PT INR	1.2	H	0.8-1.1

Recommended PT INR therapeutic range for long term and prophylactic therapy is 2.0 - 3.0. For heart valve and shunt patients the range is 2.5 - 3.5.

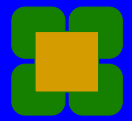
** CONTINUED ON NEXT PAGE **

Trace Elements - Case #2

The patient is a 46 year old male vegetarian with no previous history of smoking, alcohol or drug abuse, ischemic heart disease, DM, stroke or hypertension.

He developed “dilated cardiomyopathy” while on home PN.

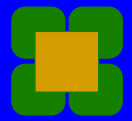
Yusef et al, JPEN 26:63-66, 2002.



Trace Elements - Case #2

Prior to admission, was on home PN for 3 months for pancreatitis and thrombotic bowel infarction with intestinal resection.

PN contained amino acids, dextrose, fat, sodium, potassium, chloride, acetate, phosphate, calcium, magnesium, MVI, trace elements, famotidine and insulin; 2400 ml / day over 24 hours.

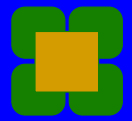


Trace Elements - Case #2

After 3 months of home PN, patient was admitted with catheter sepsis.

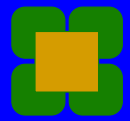
During the admission, patient developed tachycardia and a third heart sound.

Chest x-ray showed enlarged heart.
TEE showed dilated ventricles with depressed function, normal valves and no pericardial effusion.



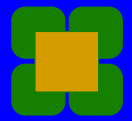
Trace Elements - Case #2

- ECG showed left anterior fascicular block with no evidence of ischemia.
- Thyroid function was normal.
- Tests for syphilis, vasculitic disorders and HIV were normal.



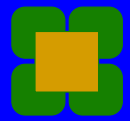
Trace Elements - Case #2

- What is the likely cause of his heart condition (see title of this slide)?
- What test(s) would you perform to validate your suspicions?
- What would you expect the results of that test(s) to be?



Trace Elements - Case #2

- Basic metabolic panel was WNL.
- Treatment with diuretics, digoxin, ACE inhibitors and beta blockers resulted in little improvement.
- Folate, homocysteine, copper, chromium, zinc and vitamins B1, B6 and B12 levels were all WNL.

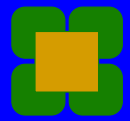


Trace Elements - Case #2

Patient had “undetectable blood selenium level”.

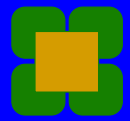
-Had no selenium in PN

-Vegetarian



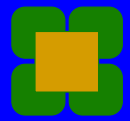
Trace Elements - Case #2

- SELENIUM deficiency:
  - muscle weakness
  - muscle pain
  - cardiomyopathy



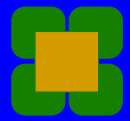
Trace Elements - Case #2

- Selenium-containing foods
  - brazil nuts
  - sea foods
  - kidneys
  - liver
  - meat
  - poultry



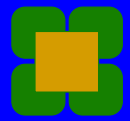
Trace Elements - Case #2

Treated with 150 mcg selenium / day in TPN with marked improvement of CHF symptoms over several weeks.



Trace Elements - Case #2
Take Home Message

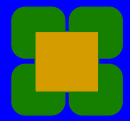
- Selenium deficiency can result in cardiomyopathy.
- Selenium is required in long-term PN.
- Monitor levels when prescribing trace elements in long-term PN.



Trace Elements - Case #3

The patient is a 72 y/o male with a history of metastatic renal cell cancer, status post right nephrectomy, splenectomy and pancreatectomy with resultant type 1 diabetes mellitus. Patient uses blood glucose monitor.

Admitted with left upper quadrant abscess secondary to an enterogastric fistula. Made NPO and discharged home on PN.



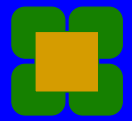
Trace Elements - Case #3

At discharge:

height = 188 cm, weight = 94.5 kg

PN contained 2700 total calories with 140 gm protein and was infused over 14 hours and tapered off over the last hour. Non-protein calorie distribution was 60% dextrose and 40% fat.

The PN contained 377 gm dextrose and required 180 units of insulin.

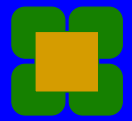


Trace Elements - Case #3

Laboratory:

At discharge, patient was stable, afebrile and most laboratory values were within normal limits except glucose was elevated (280 mg/dL) and transferrin (169 mg/dL) was just below normal.

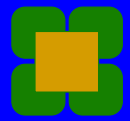
Prior to discharge, serum zinc, copper, chromium, selenium and whole blood manganese were measured.



Trace Elements - Case #3

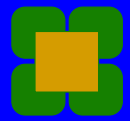
Questions?

- What may be the cause of glucose intolerance in a malnourished patient?
- How would you treat this?



Trace Elements - Case #3

- CHROMIUM deficiency:
  - glucose intolerance
  - peripheral neuropathy

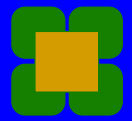


Trace Elements - Case #3

His chromium level was 0.6 (normal 5-11).

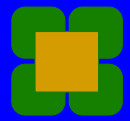
Extra chromium (60 mcg) was added to his PN just prior to discharge.

Five days after discharge, the patient began complaining of chronic symptomatic post-infusion hypoglycemia (lab blood glucose = 19 mg/dL, fingerstick glucose = 50).



Trace Elements - Case #3 Questions?

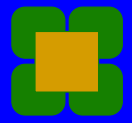
- What may be happening to cause the hypoglycemia?
- What would you do to treat this problem?



Trace Elements - Case #3

Fingerstick Measurements

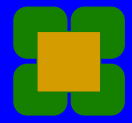
PM	AM
197	119
182	114
182	123



Trace Elements - Case #3

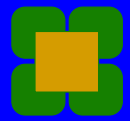
Treatment plan:

- Decrease insulin from 180 units to 150 units to 100 units over 7 days.
- Change taper down from 1 hour to 2 hours.
- Patient readmitted for takedown of enterogastric fistula
- Discharged on enteral nutrition



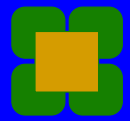
Trace Elements - Case #3
Take Home Message

- Chromium deficiency can cause hyperglycemia.
- Chromium repletion can result in hypoglycemia in patients receiving insulin.
- Monitor levels when prescribing trace elements in long-term PN.



Monitoring Trace Elements in Long Term PN

- Baseline serum zinc, copper, chromium, selenium and whole blood manganese
- Repeat every 3 months until stable
- Recheck every 6 months

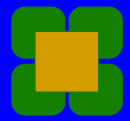


Common findings:

- Low chromium
- High manganese
- Low selenium
- Low zinc
- Low iron
- Low copper

Trace Elements

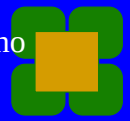
- MANGANESE toxicity:
  - manganese accumulation in the brain
  - deposits in the basal ganglia
  - neurologic symptoms (like Parkinson's disease)



Dr. Lyn Howard - Nutrition Week 2007

- Dr. Howard has studied TE tissue levels in HPN patient cadavers and found standard MTE mix to be inadequate.
- Dr. Howard reports plasma levels inadequate to measure TEs.

Howard L, Ashley C, Lyon D et al. Autopsy Tissue Trace Elements in 8 Long-Term Parenteral Nutrition Patients Who Received the Current U.S. Food and Drug Administration Formulation,
JPEN 31:388-396, 2007.

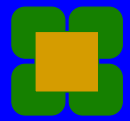


Dr. Lyn Howard - Nutrition Week 2007
HPN cadavers, 2 controls: (6 > 60 y/o, 2 <38 y/o)

	Heart	Muscle	Liver	Kidney
Cr	↑	↑	↑	↑
Zn	–	–	↑	–
Cu	– ↓	–	↑	↑ ↓
Mn	↑	↑	↑	–
Se	–	– ↓	–	– ↓

Dr. Lyn Howard's recommendations: Nutrition Week 2007

- **zinc 12 mg/day** - they add 3 mg + 3-5 mg/L enteric loss
- **copper 0.3-0.5 mg** - they add 1.4 mg
- **manganese 50 mcg/day (as a contaminant)** - - they add 700 mcg
- **chromium to be studied** - they add 14 mcg
- **selenium 85-100 mcg/day** - they add 85 mcg



Trace Elements

- Trace element monitoring can effectively prevent complications due to trace element abnormalities.

Webinar Audience Sample Question and Answers

- **Q:** In patients with fistulas or Crohn's Disease, would you suggest extra individual Trace Elements?
- **A:** Absolutely, We would use individual injections in addition to the cocktail to correct deficiencies.
- **Q**: What is your recommendation for Trace monitoring and repletion in the acute care setting?
- **A**: The amount needed depends on the duration that the person is on PN. Deficiencies develop with time and the body can rely on it's own body stores short term.
- **Q:** Will a child on lifelong PN develop osteopenia and what should they be concerned about?
- **A**: Bone disease is associated with Long-term PN. The reasons are many including; calcium and/or Vitamin D deficiency, medications, aluminum in the PN solution. All long-term patients should have their Calcium, Vitamin D and bone density measured.

Webinar Audience Sample Question and Answers

- **Q:** Are blood levels of Trace Elements always accurate?
- **A**: No. Tissue levels are more accurate but, blood levels are the easiest measure available.
- **Q**: Should we be concerned with Aluminum toxicity?
- **A**: Aluminum is a contaminant of PN solutions and can be harmful. Your pharmacy should be using products that contain the lowest possible amounts of aluminum. Manufacturers of IV solutions are required to measure and report the aluminum content of their products.
- **Q**: Will the current Trace Element cocktails be reformulated to better meet patient needs?
- **A**: We need FDA approval and none of the manufacturers are interested in making these products.