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The author has no financial interest in any of the named products in this presentation.
Nutrition and the Elderly Eye

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Learning Objectives

1. Which has the highest caloric density (calories/gram): carbohydrates, fats, protein, or alcohol?

2. Which is the main difference in micronutrients found in the AREDS and AREDS II formulas for dry AMD?

3. Which two micronutrients are useful in blood glucose control for diabetics?

4. Deficiencies in which micronutrients can mimic dementia in senior patients?

5. Which are the nutritional treatments for gyrate atrophy and retinitis pigmentosa?
Why Study Nutrition, Vision and the Elderly?

- According to Cafferty, older adults are particularly prone to nutritional problems because of the frequency of poverty, loneliness, neglect, and mental disabilities

- “37-40% of...community-dwelling individuals older than 65 years have inadequate nutritional intake”
Macro- vs. Micro-Nutrients

- Micronutrients are vitamins, minerals and other trace nutrients needed for survival.
- Macronutrients are chemical compounds from which we get calories, such as:
  - Carbohydrates
  - Fats
  - Protein
  - Even alcohol!

Caloric Density of Macronutrients

- Carbohydrates are 4 calories/gram
- Fats are 9 calories/gram
- Protein is 4 calories/gram
- For completeness sake, alcohol is 7 calories/gram

http://www.bodycorestrength.com/calorie-facts/
Under-nutrition and Older Patients

- Under-nutrition is defined as the loss of more than 10 pounds (4.5 kg) or 7.5% of body weight in six months, or
- Loss of 4-5% of body weight in one year
- In one 4-year study of veterans, the annual incidence of involuntary weight loss was 13%
- Over a two-year follow-up period, their increased risk of death was 28%
- Still, studies have shown that slight under-nutrition increases longevity, in blue zones like Okinawa and Loma Linda, CA

An Okinawan reaching 110 years of age has typically had a diet consistently averaging no more than one calorie per gram of food and has a BMI of 20.4

http://en.wikipedia.org/wiki/Ryukyu_Islands
Even Protein Has a Dark Side

- “A study of more than 400,000 participants by Harvard School of Public Health (HSPH) researchers finds a strong association between the consumption of red meat, particularly when the meat is processed, and an increased risk of type 2 diabetes that strokes more than one of four senior citizens.

- The study also shows that replacing red meat with healthier proteins, such as low-fat dairy, nuts, or whole grains, can significantly lower the risk.”

Aging Effects on Nutritional Requirements

- According to Cafferty, 87% of older Americans have diabetes, hypertension (shown here), dyslipidemia or a combination.

- 34% of women and 44% of men in the US are overweight, and an additional 27% of women and 34% of men are obese.

- Older patients do not require as many calories per day to maintain their weight if they are sedentary.

http://webeye.ophth.uiowa.edu/eyeforum/atlas/pages/hypertensive-retinopathy.html
Prevalence of Obesity in North America
also see Semba, figure 4-5, page 231

http://eaves.ca/2008/07/08/fatness-index-canada-vs-united-states/
Micronutrient Deficiencies in Older Patients

Vitamins and minerals that are proven deficient in senior citizens:

- Calcium
- Vitamin D
- Vitamin $B_6$ (Pyridoxine)
- Vitamin $B_9$ (Folate)
- Vitamin $B_{12}$ (Cobalamin)

http://www.webmd.com/osteoporosis/ss/slideshow-osteoporosis-overview
Calcium Deficiency in Older Patients
(quotting the Linus Pauling Institute)

- The RDA for protein is about 50 grams/day for adults; however, the average intake of protein in the U.S. tends to be higher (65-110 grams per day)

- As dietary protein intake increases, the urinary excretion of calcium also increases

- High protein consumption can and does cause kidney stones and osteoporosis in our older patients

http://lpi.oregonstate.edu/infocenter/minerals/calcium/
http://en.wikipedia.org/wiki/Kidney_stone
Calcium-Rich Beyond Dairy

- Patients may need less calcium if they consume less protein.

- Calcium-rich foods that are not high in protein include bok choy, kale, broccoli, and spinach, but seniors need **1200 mg/day** (after age 51 for women, 71 for men) according to the LPI.

- The US and Canada are leading consumers of dairy products, but also lead the world in osteoporosis rates.

Vitamin D Deficiency in Older Patients

- Vitamin D helps calcium deposition in bone, but is actually a **steroid hormone** that can lead to chronic inflammatory disease when deficient.
- This diagram shows calcium regulation in the human body.
- The role of vitamin D is shown in orange.
- Unless you go to tanning booths, you should supplement vitamin D or you increase the risk of disease.

Vitamin D

- Vitamin D may be useful in chronic inflammatory diseases like multiple sclerosis and probably uveitis in senior citizens.
- Unless you are a lifeguard at the beach, you are not getting enough from the sun.
- A blood test can and should be performed to determine vitamin D levels in your patients (and you!)

http://www.lifetimeeyecare.ca/vitamin-d-myopia/
Vitamin B\textsubscript{6} (Pyridoxine) Deficiency in Older Patients

- B\textsubscript{6} deficiency can lead to \textbf{dry eyes}, immune system and cognitive dysfunction, kidney stones, and excess homocysteine, a risk factor in heart disease.
- Food sources include fortified cereals, bananas, baked potatoes, spinach, hazelnuts, and vegetable juice, among others.

Pacific University Ocular Disease Digital Collection
Vitamin B₆ (Pyridoxine)

- Other neurologic symptoms noted in severe vitamin B₆ deficiency include irritability, depression, and confusion; additional symptoms include inflammation of the tongue, sores or ulcers of the mouth, and ulcers of the skin at the corners of the mouth, according to the LPI.

- Senior citizens need at least 2 mg/day, more than other adults, and over half of our seniors over age 60 aren’t getting enough.

- More sources are shown here: [http://healthplusrx.com/vitamin-b6-3/](http://healthplusrx.com/vitamin-b6-3/)
DDX: Gyrate Atrophy

- Gyrate atrophy is characterized by areas of chorioretinal atrophy that start in the midperiphery and progress to the posterior pole.

- GA “is a rare autosomal recessive inherited disease, characterized by progressive chorioretinal atrophy that results in progressive deterioration of peripheral and night vision and leading to blindness.”

- Dietary restriction may slow the progression.

Wright 3, Figure 13-17
Vitamin B$_6$ and Gyrate Atrophy

- Mutation of an enzyme and increased blood ornithine levels causes this degeneration of the retina
- Patient symptoms include night blindness and high myopia, in addition to this scalloped appearance of the retina
- 300-500 mg of pyridoxine QD PO results in a 30-50% decrease in plasma ornithine levels and may save sight
- See Eperjesi, page 79 and the link above for “Gyrate atrophy of the choroid and retina with hyper-ornithinemia responsive to vitamin B6: a case report”

http://www.jmedicalcasereports.com/content/1/1/27
Gyrate Atrophy
Fluorescein Angiography

http://www.jmedicalcasereports.com/content/1/1/27
Semba on Gyrate Atrophy

Table 2
Clinical and Laboratory Findings in Gyrate Atrophy

• Progressive myopia
• Reduced peripheral vision
• Night blindness
• Chorioretinal atrophy
• Other: straight sparse hair, general muscle weakness
• Elevated plasma ornithine
Folate Deficiency in Older Patients

- Folic acid is added to bread and pasta because deficiency during pregnancy can cause neural tube defects in the unborn child.
- As a rule, foods rich in folic acid that help babies’ brains to develop, and also help senior citizens to continue to think clearly, as well as protecting other vital organs.

http://en.wikipedia.org/wiki/Neural_tube
Folate and Cognitive Impairment

- Folate reduces the risk of some forms of cancer and heart disease.
- Vitamin B₉ may also prevent progression of cognitive impairment in Alzheimer dementia (!).
- Besides fortified grains, many of these foods are naturally rich in vitamin B₉.
- In a sense, these prevent secondary glaucomas!

Dietary sources of folate, some of them (cereals) fortified.
Vitamin B\textsubscript{12} (Cobalamin) Deficiency in Older Patients

- B12 is only found in animal products and supplements
- We need only micrograms, but deficiency causes pernicious anemia, memory loss, dementia and visual field defects
- Often, patients with pernicious anemia are missing intrinsic factor in their stomachs, and need IM injection to get B\textsubscript{12}

http://www.webstersdictionaryencyclopedia.com/Vitamins/Vitamin.php
Vitamin B$_{12}$ (Cobalamin)

- Vitamin B$_{12}$ deficiency is estimated to affect **10-15% of individuals over the age of 60**, according to the LPI.

- It can also cause optic neuropathy and visual field defects, as seen here in this case from *Review of Optometry* from 2007.

- Shown here is a 69 YOWM with bitemporal field loss secondary to B$_{12}$ deficiency.

$B_{12}$ Deficiency OCT

Possible Deficiencies in Older Patients

Insufficient or conflicting data on deficiency:

- Biotin (vitamin B$_7$)
- Niacin (vitamin B$_3$, deficiency causes pellegra (shown here)
- Pantothenic Acid (vitamin B$_5$)
- Vitamin E
- Vitamin K

http://www.sciencephoto.com/media/260894/enlarge
Biotin (B₇) in Older Patients

- Biotin helps the integument, so you find it in shampoo, skin, and fingernail products.
- Presently, there is no indication that older adults have an increased requirement for biotin, according to the LPI.
- However, there are applications to controlling blood glucose in diabetes.

http://suppversity.blogspot.com/2012/01/biotin-ameliorates-skeletal-muscle.html
Biotin and Diabetes

- Biotin can be used to help control blood glucose in diabetics.

- Reductions in blood glucose levels were found in insulin-dependent (Type 1) diabetics after one week of supplementation with 16 mg of biotin daily.

- In Type II NIDDM, after one month of biotin supplementation (9 mg/day), fasting blood glucose levels decreased by an average of 45% (LPI).

http://suppversity.blogspot.com/2012/01/biotin-ameliorates-skeletal-muscle.html
Chromium and Diabetes
Niacin (B₃) in Older Patients

- Niacin deficiency is known as pellagra, and niacin is used for hypercholesterolemia, by prescription and under the PCP’s care.
- Patients can get the so-called “Niacin Flush” from taking too much vitamin B₃ orally.
- There is a “flush-free” version of niacin available, but it may not be as effective.
- It is also available by Rx.

Niacin (B₃)

- Niaspan is the brand name for prescription Niacin
- Dietary surveys indicate that 15 to 25% of older adults do not consume enough niacin in their diets to meet the RDA
- Dietary intake of niacin decreases between the ages of 60 and 90 years
- 20 mg QD recommended by the Linus Pauling Institute at Oregon State
Pantothenic Acid (B₅) in Older Patients

- Pantothenic acid plays a role in metabolizing carbohydrates, fats and proteins, and aids in hair and skin care, as well as lowering cholesterol and triglyceride levels.

- Thus, vitamin B₅ aids in the prevention of obesity and diabetic wound healing.

- Presently there is little evidence that older adults differ in their intake or requirement for pantothenic acid (LPI).

Vitamin E in Older Patients

- Vitamin E is a fat-soluble antioxidant that works as an anticoagulant in the bloodstream
- 400 mg of vitamin E are found in both the AREDS I and II formulae, which have been shown to slow the progression of dry AMD
- 30 IU of synthetic vitamin E is 90% of the RDA (LPI)
Vitamin K in Older Patients

- Vitamin K is a necessary clotting factor in the blood and mineralization of bone
- Because older adults are at increased risk of osteoporosis and hip fracture, at least 1 cup of dark green leafy vegetables/day is recommended
- Green leafy vegetables can cancel the effects of blood thinners like Warfarin

http://www.bristol-labs.co.uk/lib/pictures/products/Warfarin.jpg
Micronutrient Adequacies in Older Patients

According to Rosenbloom, these are found in adequate levels in the average senior citizen:

- Copper
- Iron
- Vitamin C?
- Selenium
- Zinc
Copper in Older Patients

- 2 mg of copper were found in the AREDS I formula only because the 80 mg of zinc could deplete copper stores in the body.
- Copper is found in most nuts, including sunflower seeds, hazelnuts, peanuts, and the cashews shown here growing beneath the highly-perishable cashew apple.
- It’s also found in filtering organs (liver, oysters, clams).
Chelated Copper

- Copper’s functions are still being discovered, but are known to play a role in cardiac function, osteoporosis, and immune system function.
- Use chelated copper (like picolinate) for best bioavailability.
- Copper may not be necessary if the patient isn’t taking over 40 mg of zinc/day.

Iron in Older Patients

- Iron-deficiency anemia is a common condition, especially in women, and can lead to retinal hemorrhages (shown here).
- But a recent study in an elderly population found that high iron stores were much more common than iron deficiency, according to the LPI.
- Vitamin C catalyzes absorption of non-heme iron.

http://www.revoptom.com/content/s/93/c/15632/
Chelated Iron for Anemia

- Mainly used to treat deficiency anemia, the chelated forms (such as iron citrate) are much more absorbable than the non-chelated forms (such as iron sulfate).

- Older adults should not generally take nutritional supplements containing iron unless they have been diagnosed with iron deficiency.

- Moreover, it is extremely important to determine the underlying cause of the iron deficiency, rather than simply treating it with iron supplements (says the LPI).

http://www.flickr.com/photos/drshivam/4225004903/
Vitamin C in Older Patients

- 500 mg of vitamin C are found in both AREDS I and II formulas, which have been shown to slow the progression of dry AMD.

- Low vitamin C among British pensioners has been found to be strongly predictive of death (Cafferty, page 339).

- The principal antioxidant, vitamin C protects against heart disease, stroke, cancer and may even slow cataract development and diabetes.

[http://lpi.oregonstate.edu/infocenter/vitamins/vitaminC/index.html#cataracts](http://lpi.oregonstate.edu/infocenter/vitamins/vitaminC/index.html#cataracts)
Vitamin C and Iron Absorption

- “Vitamin C strongly enhances the absorption of non-heme iron by reducing dietary ferric iron (Fe$^{3+}$) to ferrous iron (Fe$^{2+}$) and forming an absorbable, iron-ascorbic acid complex.

- Plants, dairy products, meat, and iron salts added to foods and supplements are all sources of nonheme iron.”

- In nature, they come in combination with other minerals, and are sometimes sold that way.

https://online.epocrates.com
Selenium and the Elderly Eye

- Selenium is essential in the function of our immune systems, including preventing everything from viral infection to cancer.

- “There appears to be a unique interaction between selenium and HIV that causes AIDS.

- Selenium is a trace element that is essential in small amounts, but like all essential elements, it is toxic at high levels.”

http://lpi.oregonstate.edu/infocenter/minerals/selenium/
Zinc in Older Patients

- Zinc is vital for photoreceptor renewal, and is found in higher concentration in the posterior segment of the eye than all other parts of the body combined.

- “Although the requirement for zinc is not known to be higher for older adults, their average zinc intake tends to be considerably less than the RDA.

- A reduced capacity to absorb zinc, increased likelihood of disease states that alter zinc utilization, and increased use of drugs that increase zinc excretion may all contribute to an increased risk of mild zinc deficiency in older adults” (LPI).

Table 2
Zinc Concentrations in Human Tissues

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Zinc ((\mu g/g) dry weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choroid</td>
<td>472</td>
</tr>
<tr>
<td>Retina</td>
<td>464</td>
</tr>
<tr>
<td>Ciliary body</td>
<td>227</td>
</tr>
<tr>
<td>Optic nerve</td>
<td>170</td>
</tr>
<tr>
<td>Hair</td>
<td>150</td>
</tr>
<tr>
<td>Pancreas</td>
<td>135</td>
</tr>
<tr>
<td>Bone</td>
<td>100</td>
</tr>
<tr>
<td>Liver</td>
<td>58</td>
</tr>
<tr>
<td>Kidney</td>
<td>55</td>
</tr>
<tr>
<td>Skeletal muscle</td>
<td>51</td>
</tr>
<tr>
<td>Cornea</td>
<td>41</td>
</tr>
<tr>
<td>Skin</td>
<td>32</td>
</tr>
<tr>
<td>Heart</td>
<td>23</td>
</tr>
<tr>
<td>Lens</td>
<td>21</td>
</tr>
<tr>
<td>Plasma</td>
<td>1</td>
</tr>
</tbody>
</table>

Based on refs. 37, 54, 56.

Semba, Table 8-2, page 358
Zinc and AMD Progression

- 80 mg of zinc was in AREDS I, reduced to 40 mg in AREDS II, and has been shown to slow the progress of dry AMD

- “Because the consequences of mild zinc deficiency, such as impaired immune system function, are particularly relevant to the health of older adults, patients should pay particular attention to maintaining adequate zinc intake”, says the LPI

Semba, Figure 8-1
Micronutrient Excesses in Older Patients

According to Rosenbloom, these may be in excess:

- Chromium?
- Magnesium??
- Vitamin A???

And our discussion would not be complete without:

- Omega-3 Fatty Acids
- Lutein
- Zeaxanthin

http://en.wikipedia.org/wiki/Broccoli
Chromium in Older Patients

- Chromium’s main function is glucose metabolism, and can be used to help control blood glucose in diabetics.
- You can find the highest concentration of chromium in broccoli (lightly cooked).
- This may be offset if your older patients drink too much grape juice (or wine).
- Chromium can be used safely even in gestational diabetes.

Magnesium in Older Patients

- Patients with alcoholism are generally magnesium deficient, but there is evidence that the elderly generally excrete more than they take in.
- The main side effect from too much magnesium is diarrhea – Rx 300 mg QD
- Magnesium can be used to prevent recurrence of migraine headaches in those who suffer from them.

Vitamin A in Older Patients

- 15 mg of vitamin A are found in the AREDS I formula, but was removed for AREDS II because of smokers getting lung cancer with beta carotene.

- Vitamin A plays a major role in rhodopsin function, **dark adaptation and night vision**

- Rx 15000 IU QD of vitamin A palmitate for **Retinitis Pigmentosa**

- Combine with amber lenses for best effects to slow RP

[http://www.viteyes.co.uk/acatalog/Viteyes_Advanced.html](http://www.viteyes.co.uk/acatalog/Viteyes_Advanced.html)
Omega-3 Fatty Acids: DHA and EPA

http://www.theratears.com/nutrition.php
Lutein (10 mg) in AMD
45 YO Fundus shown here!

http://en.wikipedia.org/wiki/Kale

Pacific University Ocular Disease Digital Collection
Zeaxanthin (2 mg) in Older Patients

http://en.wikipedia.org/wiki/Wolfberry

http://www.eyefoods.com/
Parting Thought: The Anti-Inflammatory Food Pyramid

- Besides micronutrient imbalances, our senior citizens need to be concerned about chronic inflammation.
- An anti-inflammatory diet may be the best way to keep these diseases from causing morbidity and early mortality.
- Here’s one diet proposed by Andrew Weil, MD.

Take-Home Pearls

1. Wound healing is assisted by vitamin C and pantothenic acid (vitamin $B_5$)

2. Vitamin C, as well as thiamine (vitamin $B_1$) and riboflavin (vitamin $B_2$), have been shown to be preventative in cataract development

3. Magnesium and riboflavin have been shown to prevent migraines

4. Vitamin E is an anticoagulant, but vitamin K counteracts anti-coagulants

5. Biotin (vitamin B7) and the mineral chromium help regulate blood sugar levels in Type II diabetes
Thank you!

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Readings and References

- This lecture was inspired by Rosenbloom & Morgan’s *Vision and Aging* (2007). See chapter 17 entitled “Nutrition and Older Adults” by Barbara Cafferty.


- The Linus Pauling Institute (LPI) Micronutrient Info Center: [http://lpi.oregonstate.edu/](http://lpi.oregonstate.edu/)