NMDF121

Session 11
WATER SOLUBLE VITAMINS PART 1

Naturopathic Medicine Department
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Topic Summary

• Water Soluble Vitamins

• Introduction to Water Soluble Vitamins

• Vitamin C
  • Structure and requirements
  • Functions and metabolism
  • Therapeutic uses
Water Soluble Vitamins: Introduction

“Vitamins can be defined as essential organic compounds required in very small amounts (micronutrients) that are involved in fundamental functions of the body such as growth, maintenance of health, and metabolism.”

(Groff and Gropper, 2000)
Water Soluble Vitamins: Introduction

- Vitamins
  - differ from carbohydrate, fat and protein in structure, function and food contents
  - similar to the energy-yielding nutrients in that they are vital to life, organic and available from foods.

Both deficiencies and excesses of supplemental vitamins can affect health!
Water Soluble Vitamins: Properties

- Absorbed into portal blood
- Not stored long in body except vitamin B12
- Excreted in urine
- Easily destroyed during food storage or preparation
Water Soluble Vitamins: Preparation

• The organic nature of vitamins means they can be destroyed by exposure to light, oxidation, cooking and storage.

• Preventative measures should be taken
  • Refrigeration
  • Cut fruits and vegetables should be stored in closed containers
  • Avoid high temperatures and long cooking times
  • Steam as opposed to boil
Water Soluble Vitamins

Vitamin C (Ascorbic Acid)

Energy releasing
- Thiamin (B1)
- Riboflavin (B2)
- Niacin (B3)
- Pantothenic Acid (B5)
- Biotin
- Vitamin B6

Hematopoietic
- Folic Acid
- Vitamin B12
- Vitamin B6
- Pantothenic Acid

B-complex Vitamins

Other
- Vitamin B6
- Thiamin (B1)
- Folic Acid
- Vitamin B12
- Niacin (B3)

Adapted from Groff and Gropper, 2000
Water Soluble Vitamins

• Deficiency is likely in:
  • Anorexia
  • Malignancy or other chronic disease
  • Coeliac sprue (or other small intestine disease)
  • Postsurgical patients receiving inadequate prolonged nutritional support
  • Drugs which antagonise vitamin absorption or metabolism
  • Poor dietary habits

(Garrow et al, 1998)
Review Questions

1. List the water soluble vitamins.

2. What are the general characteristics of water soluble vitamins?

3. How can we minimise their degradation in foods?

4. In which conditions are water soluble vitamins likely to become deficient?
Vitamin C

http://commons.wikimedia.org/wiki/File:VitaminC.png
## Vitamin C

<table>
<thead>
<tr>
<th>Food</th>
<th>Amount</th>
<th>Vitamin C (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackcurrants</td>
<td>1 cup</td>
<td>202</td>
</tr>
<tr>
<td>Red pepper (raw)</td>
<td>1 cup, sliced</td>
<td>174</td>
</tr>
<tr>
<td>Orange juice, commercial</td>
<td>1 cup</td>
<td>124</td>
</tr>
<tr>
<td>Grapefruit juice</td>
<td>1 cup</td>
<td>94</td>
</tr>
<tr>
<td>Papaya</td>
<td>1 cup</td>
<td>86</td>
</tr>
<tr>
<td>Strawberries/ Green Pepper</td>
<td>1 cup</td>
<td>82</td>
</tr>
<tr>
<td>Kiwi fruit, peeled</td>
<td>1 medium</td>
<td>74</td>
</tr>
<tr>
<td>Oranges</td>
<td>1 fruit</td>
<td>68</td>
</tr>
<tr>
<td>Broccoli, boiled</td>
<td>½ cup</td>
<td>58</td>
</tr>
</tbody>
</table>

(Adapted from Reavley, N. *Vitamins etc.* p135)
Vitamin C

- The human being is one of the few mammals unable to synthesise Vitamin C.
- Absorption decreases with intake
- Oxidation prior to absorption
  - Absorption of dehydroascorbate is thought to occur to a greater extent than absorption of ascorbate.
Vitamin C: Functions

• Antioxidant
  – Regenerates vitamin E
  – Regenerated by niacin, GSH

• Collagen synthesis
  – with Fe, proline, lysine, glycine

• Carnitine synthesis
  – from lysine

• Neurotransmitter synthesis
  – Tyrosine → dopamine → noradrenalin
  – Tryptophan → serotonin

(Li and Schellhorn 2007)
Vitamin C: Functions

• Hormone synthesis
  • Sex steroid, thyroid releasing, adrenal

• Fe, Cu, Cr bioavailability
  • Non-heme iron absorption

• Supports immune function
  • Antibody and interferon production
  • Prostaglandin metabolism
  • White blood cell ‘oxidative burst’

(Li and Schellhorn 2007)
Vitamin C: Functions

• Diminishes histamine release
  • Natural antihistamine

• Regulates cholesterol metabolism
  • Conversion of cholesterol to bile acids

• Drug and heavy metal metabolism
  • Cortisone, aspirin, insulin
  • Lead, mercury, arsenic

Rolfes, Pinna & Whitney 2009
Factors Increasing Demand

• Increased physical stress
  • Allergies, infection, burns, surgery, chronic illness

• Increased oxidative stress
  • Drugs, chemicals, radiation, heavy metals

• Chronic drug use
  • Aspirin, OCP, smoking, PPIs

Rolfes, Pinna & Whitney 2009
Factors Increasing Demand

- Certain life stages
  - Elderly
  - Pregnancy and lactation
  - Growth and development
- Athletes
- Acute or chronic inflammatory illness
Vitamin C: Deficiency Disease

• Scurvy
  – Bleeding Gums
  – Easy bruising
  – Loose and decaying teeth
  – Joint pain
  – Impaired wound healing

http://upload.wikimedia.org/wikipedia/commons/1/1a/Scorbutic_tongue.jpg
Vitamin C: Deficiency Symptoms

- Capillary fragility (Gibson 2005)
- Fatigue, weakness, irritability (Leggot 1986)
- Splinter hemorrhages near distal ends of nails (Heimburger 2006)
- Perifollicular hyperkeratosis on the lateral aspects of the upper arms and the thighs (Ryan 1996)
- Ruptured small blood vessels – petechiae (Shenkin 2006)
- Joint pain, bone and connective tissue disorders (Gibson 2005)
- Poor wound healing (Shenkin 2006)
- Bleeding gums and loosened teeth (Leggot 1986)
Vitamin C: Deficiency Symptoms

- Anaemia – small cell type
- Frequent infections
- Muscle degeneration and pain
- Hysteria and depression
- Rough, brown scaly and dry skin
- Blotchy bruises

Rolfes, Pinna & Whitney 2009
Vitamin C - Deficiency Symptoms

Scorbutic gums. Unlike other lesions of the mouth, scurvy presents a symmetrical appearance without infection.

Pinpoint hemorrhages. Small red spots appear in the skin, indicating spontaneous bleeding internally.

Rolfes, Pinna & Whitney 2009
Toxicity Symptoms

• Diarrhoea
  • Indicates tissue fluids have been saturated with ascorbic acid
  • >5-10g/day

• Hemolysis
  • In people with an inherited disease of enzyme deficiency
  • Occurred with doses of at least 6g
Toxicity Symptoms

• Enhances aluminum and iron absorption
  • Caution in hemochromatosis, thalassemia major, sickle cell disease (Shils et al, 2005)

• Very high intake increases oxalate and urate excretion
  • May promote the development of kidney stones

• Rebound scurvy
  • The body gets accustomed to long-term high doses, then issues occur when this regime is discontinued

(Peckenpaugh 2010)
### RDI

#### Therapeutic Range

- 250-10,000mg divided into multiple doses

<table>
<thead>
<tr>
<th>Age</th>
<th>EAR</th>
<th>RDI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-30 yr</td>
<td>30 mg/day</td>
<td>45 mg/day</td>
</tr>
<tr>
<td>31-50 yr</td>
<td>30 mg/day</td>
<td>45 mg/day</td>
</tr>
<tr>
<td>51-70 yr</td>
<td>30 mg/day</td>
<td>45 mg/day</td>
</tr>
<tr>
<td>&gt;70 yr</td>
<td>30 mg/day</td>
<td>45 mg/day</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-30 yr</td>
<td>30 mg/day</td>
<td>45 mg/day</td>
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<tr>
<td>&gt;70 yr</td>
<td>30 mg/day</td>
<td>45 mg/day</td>
</tr>
</tbody>
</table>
## Tolerable Upper Intake Levels (ULs) for Vitamin C

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Pregnancy</th>
<th>Lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12 months</td>
<td>Not possible to establish*</td>
<td>Not possible to establish*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–3 years</td>
<td>400 mg</td>
<td>400 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4–8 years</td>
<td>650 mg</td>
<td>650 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9–13 years</td>
<td>1,200 mg</td>
<td>1,200 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14–18 years</td>
<td>1,800 mg</td>
<td>1,800 mg</td>
<td>1,800 mg</td>
<td>1,800 mg</td>
</tr>
<tr>
<td>19+ years</td>
<td>2,000 mg</td>
<td>2,000 mg</td>
<td>2,000 mg</td>
<td>2,000 mg</td>
</tr>
</tbody>
</table>

*Formula and food should be the only sources of vitamin C for infants.*

(Jacob 2002)
Absorption

• Oral vitamin C produces tissue and plasma concentrations that the body tightly controls.
• Approximately 70%–90% of vitamin C is absorbed at moderate intakes of 30–180 mg/day.
• Doses above 1 g/day, tissue absorption falls to less than 50% and absorbed, unmetabolized ascorbic acid is excreted in the urine

(Jacob 2002)
Activity

- View the following presentation on Linus Pauling: High dose vitamin C is a cure for cancer, aids, heart disease!’ (19mins)

http://www.youtube.com/watch?v=OfuXHJh3LMY

- In small groups discuss your views about this video
- Present your groups views to the class group
- Online students should discuss their views in the relevant weekly forum
Activity

• Considering what we have so far learned about vitamin C answer the following question – ‘How much vitamin C, if any, should healthy people be taking, and how much is too much in diseased states?’

➢ Discuss your thoughts initially in small groups then present findings to the class

➢ Online students should discuss their thoughts in the relevant weekly forum
Therapeutic Uses

• Antioxidant
  • Cardiovascular disease (Nakamura et al, 2006)
  • Smokers (Bruno et al, 2006)
  • Atherosclerosis (May 2013)
  • Heavy metal toxicity (Peckenpaugh 2010)
  • Hypoxia (Sureda et al, 2004)
  • Oxidative stress in athletes (Mastaloudis et al, 2004)
  • Cancer (Peckenpaugh 2010)
Therapeutic Uses

- Immune modulation
  - Hepatitis C (Murakami et al, 2006)
  - Asthma (Fogarty et al, 2006)
  - Infections (Douglas et al, 2004)
  - Frequent colds and flus (Rolfes 2009)
  - Allergic disorders (Johanna 2013)
Supplemental Forms

• Ascorbic Acid
  • Pure Vitamin C
  • Cheap but may cause gastric irritation
  • Low pH/acidic

• Calcium or Magnesium Ascorbate
  • Mineral bound non-acid form of vitamin C
  • May exacerbate effects of low stomach acid when taken in close proximity to meals

• Research has found no difference in plasma or urinary excretion levels with either form
  
  (Johnson 1996)
Assessment of Nurtriture

- Plasma and serum vitamin C
  - Respond to dietary intakes
  - Used to assess recent intake

- White blood cell vitamin C
  - Reflect body stores
  - Difficult to perform
Review Questions

1. What products does vitamin C assist in synthesising in the body?

2. What signs might a person with a vitamin C deficiency display?

3. Which factors increase the demands for vitamin C?

4. What are the main researched conditions for the therapeutic use of vitamin C?
Activity

• Consider your vitamin C intake from the previous 2 diet diaries you have entered into your diet analysis programme and answer the following questions –

1. Are there any notable differences between the 24-hour and 3 day average intake?
2. Which foods in your diet have the highest levels of vitamin C?
3. In which instances would you recommend increased intakes from the RDI? Think specific and patient related and also from a more general context
4. Is there any specific dietary recommendations you would make to optimise your intake? Include specific food choices and quantities to reach your target.
References

References


• May and Harrison 2013. Role of vitamin C in the function of the vascular endothelium. Antioxid Redox Signal. Epub ahead of print

• Peckenpaugh 2010 Nutrition Essentials and Diet Therapy. Saunders, Missouri, USA.


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