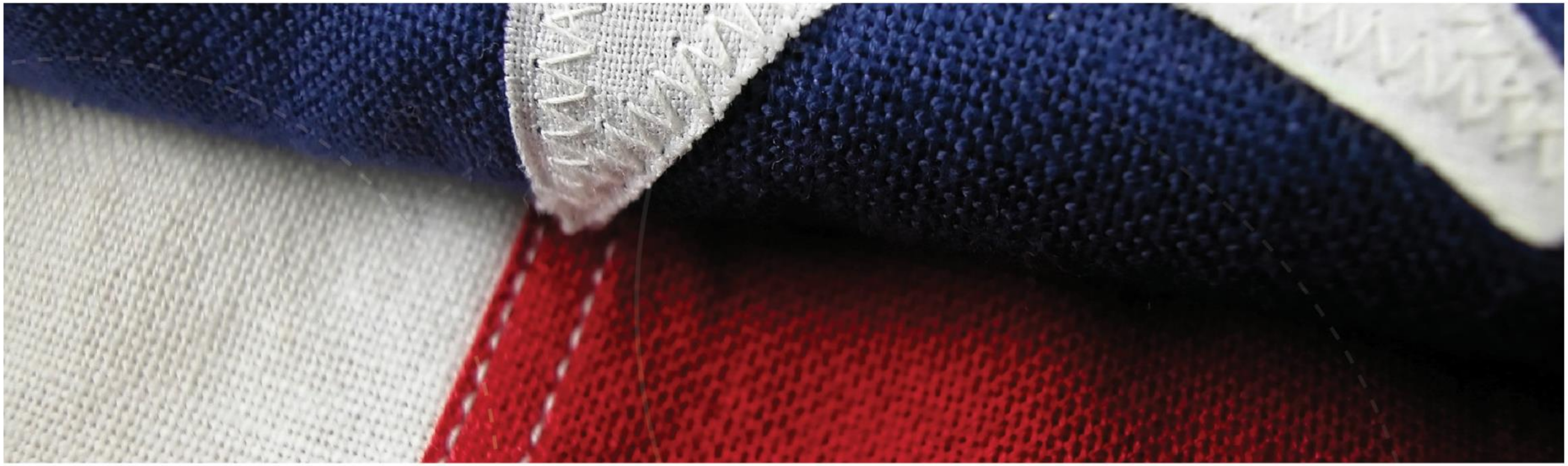

Nutrition Following Traumatic Brain Injury:
Recommendations for Education and Interventions

Jessica Gottenborg MS, RD, LD
Kelli Hall PharmD, BCPS
Deborah Huddleston MD
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Affiliations

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Deborah Huddleston MD: Physical Medicine and Rehabilitation Resident at the University of Minnesota

Diane Mortimer MD, MSN, FAAPMR: Medical Director of Outpatient TBI Rehabilitation at the Minneapolis VA Health Care System.

Objectives

1) Learners will list and discuss two of the most common post-TBI nutritional deficiencies.

2) Learners will discuss current evidence for potential supplementation with vitamin D and other vitamins following TBI.

3) Learners will discuss evidence-based paradigm, including diet, vitamins, and other supplements, to optimize overall nutrition following TBI.

Disclosures

We have no financial disclosures to report.

We are not speaking on behalf of the VA or federal government.

This presentation includes information regarding nutritional supplements which are not evaluated by the FDA.

TBI-Specific Nutritional Issues

TBI effects and sequelae can impact nutritional issues over the short-term and long-term:

- Hypermetabolic state during acute recovery
- Fluid and electrolyte abnormalities, such as sodium abnormalities
- Neurogenic bowel (constipation or diarrhea)
- Associated of gallbladder disease and pancreatitis
- Feeding tube issues, such as malfunction or malposition

TBI-Specific Nutritional Issues

TBI effects and sequelae can impact nutritional issues over the short-term and long-term:

- Behavioral issues surrounding eating
  - impulsivity; acting out
- Memory issues
  - not remembering to eat; forgetting that they already ate
- Altered sense of taste and smell
- Medication issues
  - can increase or decrease appetite
- Swallowing problems

Introduction to Illustrative Case

Mr. B. is a 40 year old man who sustained a severe TBI in a motorcycle crash.

His injury included bilateral frontal bleeds. He was unresponsive for 2 weeks. He spent 3 weeks in the ICU and another 2 weeks in the hospital prior to coming to rehabilitation. During his acute care course, he underwent decompressive cranial surgery, tracheostomy placement and feeding tube placement.

He also required surgery for repair of a right lower limb musculoskeletal injury plus treatment of pneumonia and respiratory failure.

Upon admission to acute rehabilitation, he exhibits signs of agitation.

Nutrition Issues Following TBI

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Calories

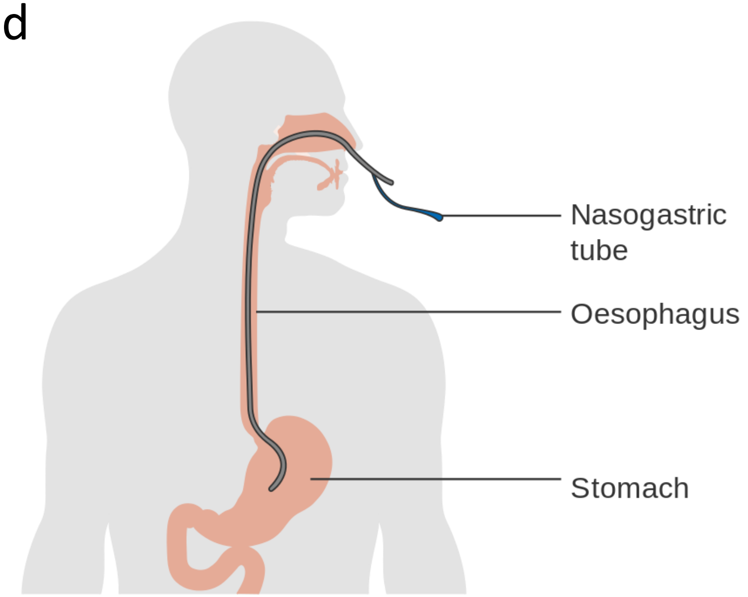
- Hypermetabolic & Hypercatabolic following acute TBI
  - Weeks to months depending on severity of injury

- Inadequate nutrition can lead to muscle wasting & wt loss of 15% per week!!!

- Providing adequate calories is essential
  - Providing excess of a patient's energy needs may result in complications such as hyperglycemia, hepatic steatosis, and pulmonary compromise

Early Feeding

- First 24 hours after injury
- Increased catabolic stress
- The likelihood of death for patients with TBI who were NOT fed within 5 days of injury was DOUBLE that of patients who were fed, and those not fed within 7 days had 4x greater likelihood of death (Hartl et al., 2008).



Estimating Calorie Needs

- Indirect Calorimetry
  - "Gold Standard"
  - Respiratory Quotient
    - CO_2 production; O_2 consumption

- Harris Benedict Equation (HBE)
  - Formula based on height, weight, sex, and age & activity

- Mifflin- St. Joer Equation
  - Recommended by A.S.P.E.N. guidelines but not validated for TBI patients

- Calories per kg body weight
  - 25-30 kcals/kg

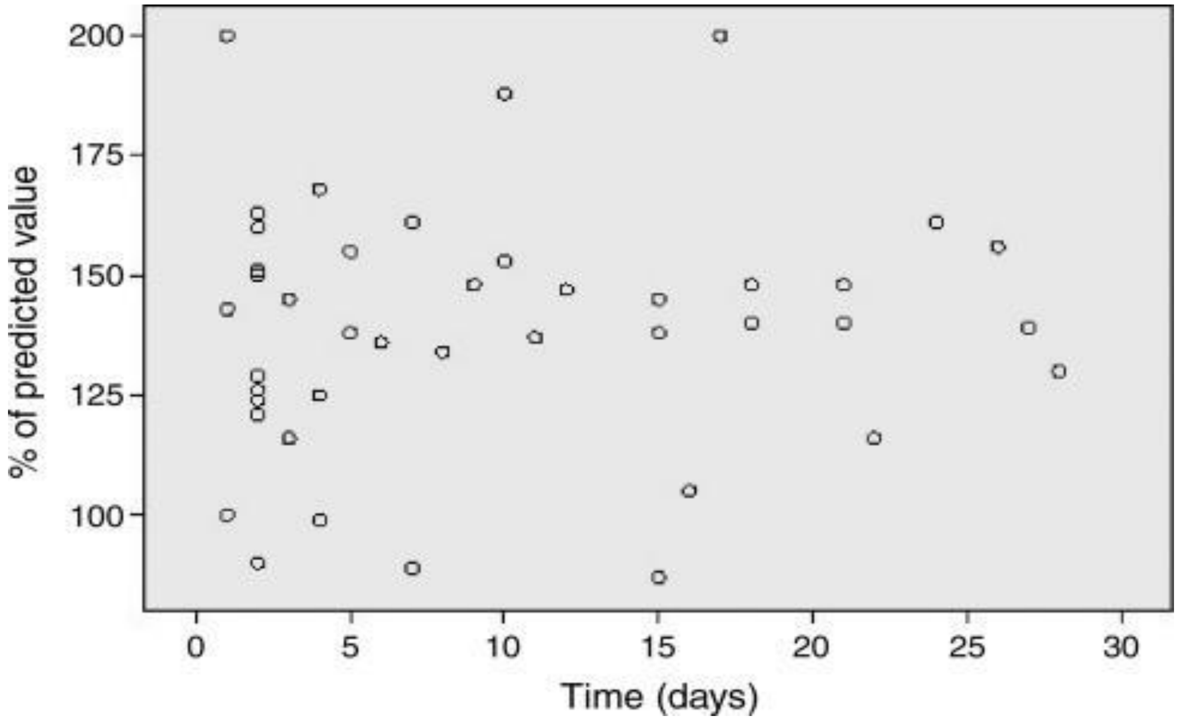
* 2200-3700 kcals/day using above formulas!

Energy Expenditure

- Systematic Review of 24 studies by Foley et al. (Journal of Neurotrauma; December, 2008)
  - Energy needs increased & highly variable
  - Range from 87-200% of predicted value
  - Hyper-metabolism lasts for 30 days post injury

- Conclusion: formulas should not be used to estimate energy requirements for individual patients

Pattern of energy expenditure during first 30 days post-injury



Clinical Judgement

- Weight Loss
  - <10% of UBW not significant
  - Wt loss of up to 40% correlates with mortality!
  - On average, pts lose 15.6 lbs during acute hospitalization despite adequate nutrition support
- 24 hour UUN Test
- Watch for signs of Malnutrition!

Protein

Protein Needs

- 1.5-2.5 grams protein/kg
  - 200 lbs (91 kg) =136-228 gms protein/day

- Is patient receiving adequate protein?!
  - **Pre-albumin NOT a good indicator**
    - Negative Acute Phase Reactant
      - CRP
      - Westergren
      - Liver disease
      - Corticosteriods
      - Nephrotic syndrome

  - 24 hour Urine Urea Nitrogen Test
    - Nitrogen balance = (protein intake)/(6.25) − (UUN excretion + 3–5 g)

Protein Needs

- Positive nitrogen balance not achievable in TBI patients until 2-3 weeks post injury

- STUDY:
  - 1.5 or 2.2 gms protein/kg to patients after TBI
    - 2.2 gms protein/kg: Positive nitrogen balance of +9.2
    - 1.5 gms protein/kg: Negative nitrogen balance of -31.2

Carbohydrates

Glucose

- Monitor glucose levels
  - Hyperglycemia has adverse impact in TBI
    - Increased mortality with blood glucose <60 mg/dL and >160 mg/dL
    - Worsened neurologic outcomes
    - Increase brain injury severity
  - Adjust insulin, tubefeeding or diet order accordingly
  - D5 should be avoided in TBI patients
  - Glucose administration rates should not exceed **3.5 g/kg/day** to avoid complications associated with hyperglycemia

Fat

Fat

- Brain composed of 60% lipids by dry weight
  - DHA one of the most abundant fatty acids found in the brain
  - DHA potentially anti-inflammatory & may prevent or reduce traumatic axonal injury
  - Omega 3's an Essential Fatty Acid (EFA)
- Docosahexaenoic acid (DHA) supplementation
  - Post TBI can promote cell survival and viability
  - Depletion of Omega-3 acids led to worsened motor and memory deficits & supplementation prior to injury lead to improvements in motoric ability & learning.
  - One clinical trial examining fish oil after injury found no improvements in mortality from brain injury
  - Anecdotal cases gave ~20 grams Omega-3 FA's with good outcomes (Lewis, 2016)

FAT– Concerns?

- Omega 3 & bleeding risk?
  - No clinical data to support increased bleeding risk
- Immune Enhancing TF formulas (omega 3's, L-arginine, Glutamine)
  - Mixed studies re: reduced length of stay or infectious complications compared with traditional formulas in patients with TBI
  - Area of research due to theoretical benefits
- EPA vs. DHA ratio
  - Goal of more DHA than EPA in a supplement
  - VA provided omega-3 contains 200 mg DHA & 300 mg EPA
- Heavy metal toxicity
  - www.consumerlabs.com
- Most clinical studies of DHA have used a dose of 2-6 g/d, and no consistent adverse events have been observed in humans consuming 1.0 -7.5g/d of DHA.

Immune Enhancing Nutrition (IEN)

Tubefeeding formulas that contain glutamine, arginine & Omega 3 FA's

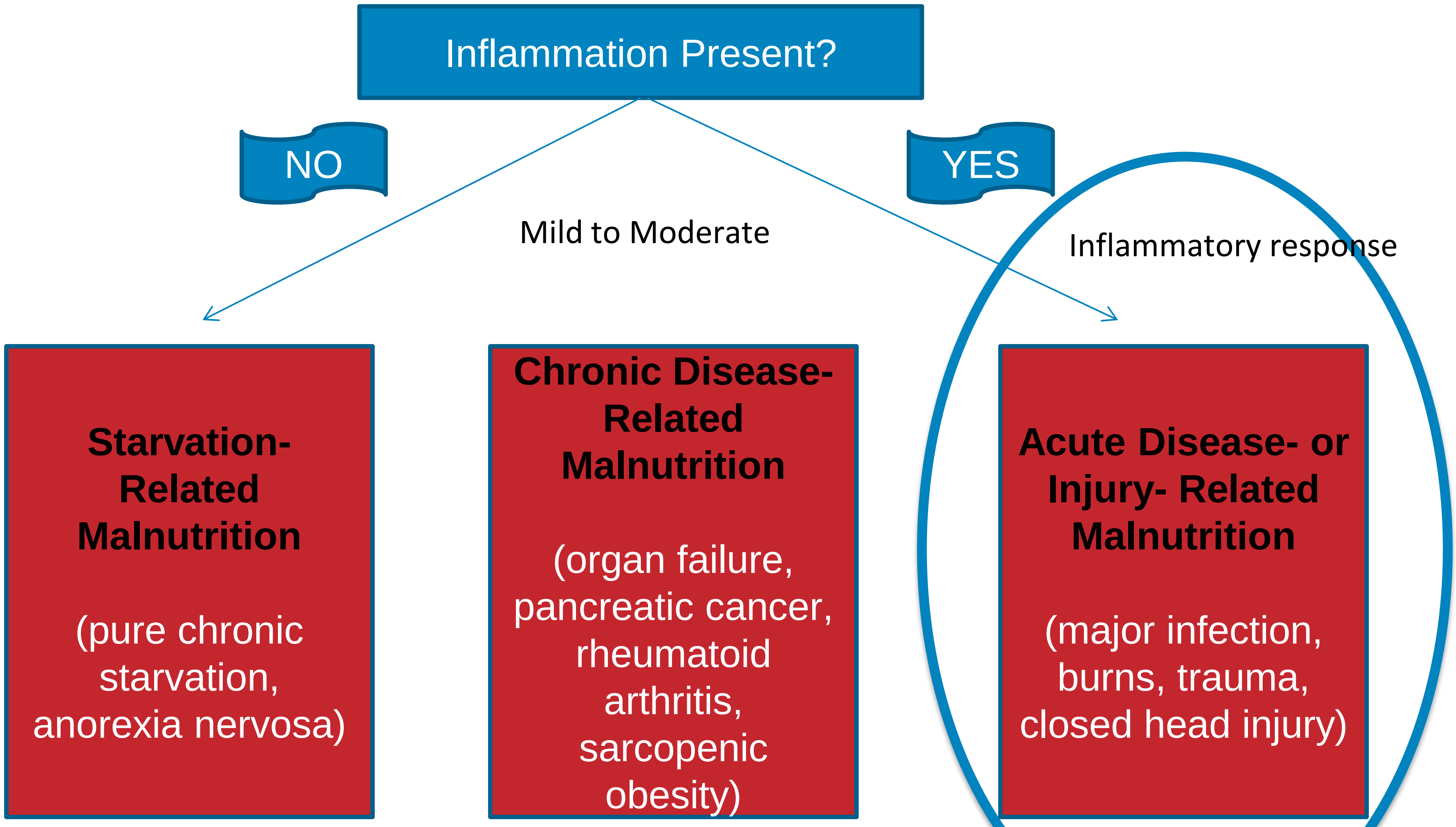
- 2015 study, 240 patients
- 2 groups: IEN vs. standard formula
- Showed pts with TBI who receive IEN more likely to have increased pre-albumin levels perhaps reflecting improved nutrition throughout their hospital stay

RESULTS:

- No change in UTI & pneumonia rates. Similar rates of mortality & LOS
- Some benefit in rates of infections, particularly in bacteremia

Malnutrition Diagnosis

- Pre-albumin NOT an indicator of malnutrition
- New Malnutrition Criteria since 2012
  - 6 General Guidelines (need 2 of 6 for Malnutrition dx)
    - Energy Intake
    - Weight Loss
    - Body Fat Loss
    - Muscle Mass Loss
    - Fluid Accumulation
    - Reduced Grip Strength



White JV, et al. *JPEN*. 2012; 36:275-283.

Severe Malnutrition Diagnosis

Table 4. Characteristics to Diagnose Severe Malnutrition.[4]

Characteristic	Acute Illness or Injury Related Malnutrition	Chronic Disease Related Malnutrition	Social or Environmental Related Malnutrition
Weight loss	>2%/1 week >5%/1 month >7.5%/3 months	>5%/1 month >7.5%/3 months >10%/6 months > 20%/1 year	>5%/1 month >7.5%/3 months >10%/6 months > 20%/1 year
Energy intake	≤50% for ≥5 days	≤75% for ≥1 month	≤50% for ≥1 month
Body fat	Moderate depletion	Severe depletion	Severe depletion
Muscle mass	Moderate depletion	Severe depletion	Severe depletion
Fluid accumulation	Moderate → severe	Severe	Severe
Grip strength	Not recommended in intensive care unit	Reduced for age/gender	Reduced for age/gender

Published in: Ainsley Malone; Cynthia Hamilton; *Nutr Clin Pract* 28, 639-650.
DOI: 10.1177/0884533613508435

Moderate Malnutrition Diagnosis

Table 5. Characteristics to Diagnose Nonsevere (Moderate) Malnutrition.[4]

Characteristic	Acute Illness or Injury Related Malnutrition	Chronic Disease Related Malnutrition	Social or Environmental Related Malnutrition
Weight loss	1%-2%/1 week 5%/1 month 7.5%/3 months	5%/1 month 7.5%/3 months 10%/6 months 20%/1 year	5%/1 month 7.5%/3 months 10%/6 months 20%/1 year
Energy intake	<75% for >7 days	<75% for ≥1 month	<75% for ≥3 months
Body fat	Mild depletion	Mild depletion	Mild depletion
Muscle mass	Mild depletion	Mild depletion	Mild depletion
Fluid accumulation	Mild	Mild	Mild
Grip strength	Not applicable	Not applicable	Not applicable

Table 5. Characteristics to Diagnose Nonsevere (Moderate) Malnutrition.4

Published in: Ainsley Malone; Cynthia Hamilton; *Nutr Clin Pract* 28, 639-650.
DOI: 10.1177/0884533613508435

Case: Mr. B.

Prior to injury:

Worked full-time at an office job.

Ate 2-4 meals per day and did not follow any specific diet.

Did not exercise regularly.

5’9”, UBW of 190-200 lbs per family.

Upon admission to acute rehabilitation:

157 lbs, BMI 23.3; 2 months out from injury (17% wt loss)

Albumin 2.7 g/dL L (3.4-5)
Pre-albumin 25.2 mg/dL (20-40)
CRP 3.76 H

Vitamin D 22 ng/mL L (Above 30)

After discharge: 197 lbs

Longitudinal Weight Changes

- 2014 Study
  - 107 patients (81 males/26 females) age 36 ± 13 yrs, baseline BMI 23
  - Followed for ~38 months
  - In ICU, lost a mean 11 ± 6 kg (24 lbs +/-13 lbs)

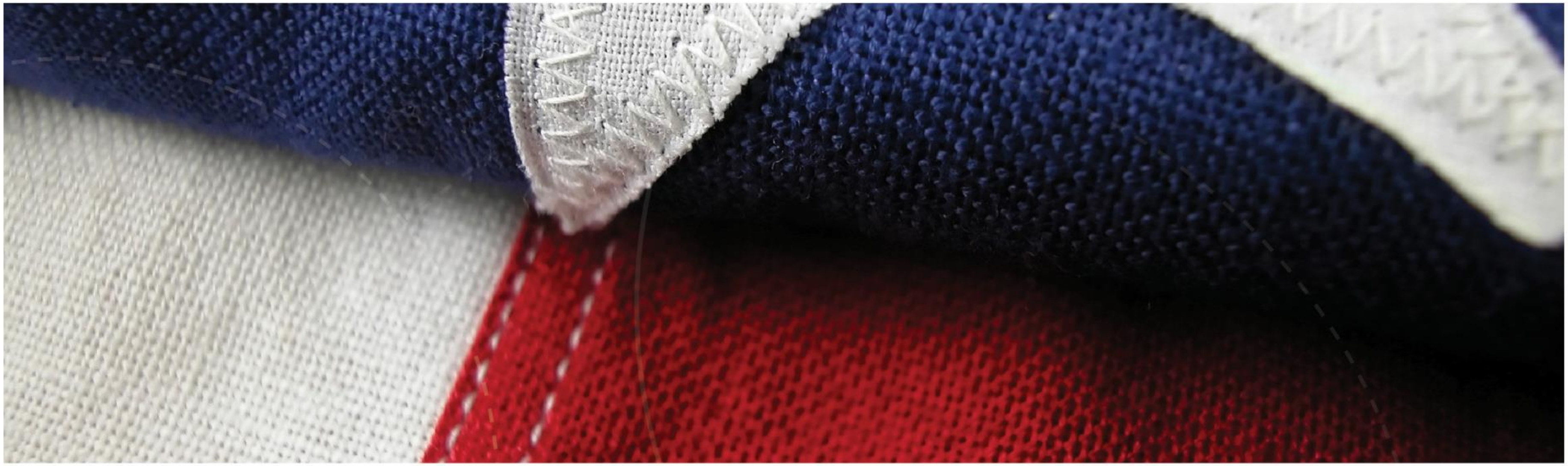
RESULTS:

- Patients categorized in 3 groups: stable (30%), loss (28%) and gain (42%)
  - Factors related to wt gain were hyperphagia, dysexecutive syndrome
  - Factors related to wt loss were hypophagia, higher pre-TBI BMI
- Over a median period of 38 months, **42% of TBI patients gained** & 28% lost weight

Interventions

Patients with brain injury consume larger meals & more calories per day than controls

- Food Journal/Diary
- Limit Access to Food
- Schedule Meals
- Review Medications



Vitamin D Supplementation Following TBI

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Illustrative Case: Mr. B.

Upon admission to acute rehabilitation, the following labs resulted

Vitamin D (Vitamin D-OH, total) was 22 ng/mL (normal is 30)

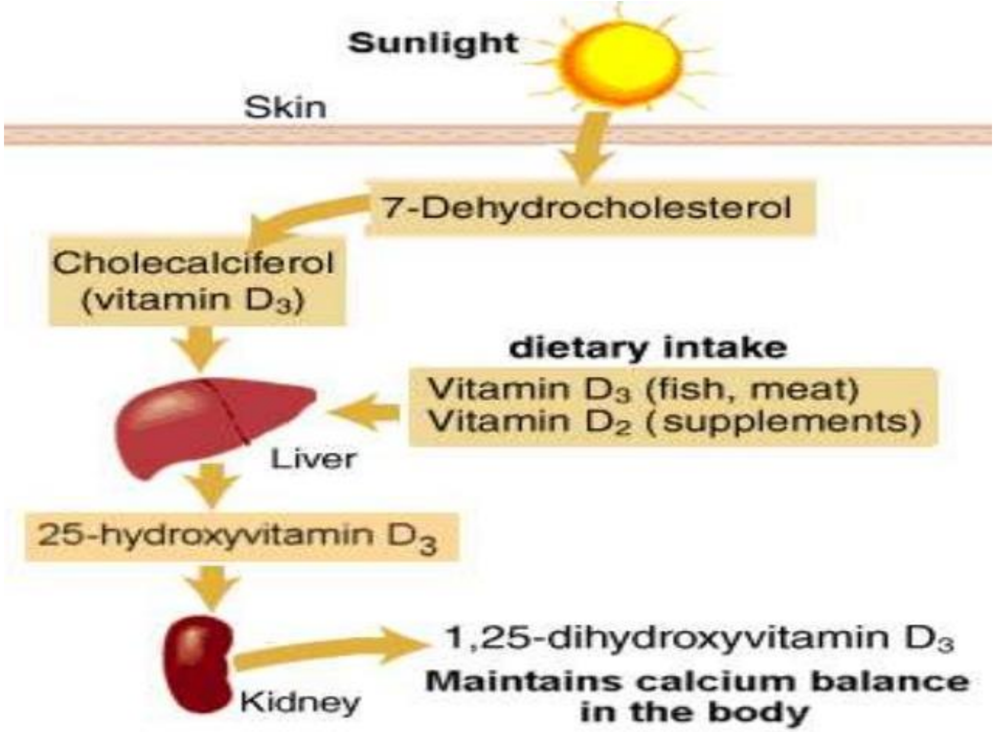
Calcium 8.8	mg/dL	(8.5-10.1)
Phosphorus 2.9	mg/dL	(2.3-4.5)
Albumin 2.7	g/dL	(3.4-5)
Creatinine 0.6	mg/dL	(0.7-1.2)

Vitamin D

- Fat soluble vitamin
- Found in many foods such as fish, egg yolk, fortified foods
- Vitamin D can also be manufactured on the skin through exposure to ultraviolet B rays from sunlight

Vitamin D

Biologically inert and must undergo two hydroxylations for activation:



https://image.slidesharecdn.com/vitd-160819131406/95/vitamin-d-sources-and-merabolism-9-638.jpg?cb=1471612525

Supplementing Vitamin D

Vitamin D deficiency is defined as serum 1,25(OH)D less than 30 ng/ml.

Vitamin D likely has a regulatory role for many physiologic processes.

Vitamin D deficiency has been associated with

- Inflammatory problems
- Autoimmune problems
- Cardiovascular issues
- Neuromuscular problems
- Neurogenerative diseases
- Cancer.

Supplementing Vitamin D

- Population-based studies suggest that Vitamin D deficiency is associated with
  - increased prevalence of Parkinson's Disease
  - dementia
  - Alzheimer disease
  - increased stroke risk in the elderly

- More common in women than men (9.2% vs 6.6%), and pregnancy is known to represent a high-risk for Vitamin D deficiency (Scrimgeour et al).

Supplementing Vitamin D

- Vitamin D has been shown to reduce the inflammatory response post-TBI
  - Lessens the severity of neuronal injury
  - Diminishes neuronal apoptosis
  - Improves functional outcomes
  - Minimizes neuronal calcium influx and excitotoxic glutamate release
  - Increases free radical scavenging
  - Promotes axonogenesis in traumatically injured axons
  - Upregulates neurotrophic growth factors

(Lawrence et al)

Recommended Dietary Allowance for Vitamin D

Age	Male	Female	Pregnancy	Lactation
0-12 months*	400 IU (10 mcg)	400 IU (10 mcg)		
1-13 years	600 IU (15 mcg)	600 IU (15 mcg)		
14-18 years	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)
19-50 years	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)	600 IU (15 mcg)
51-70 years	600 IU (15 mcg)	600 IU (15 mcg)		
>70 years	800 IU (20 mcg)	800 IU (20 mcg)		

* Adequate Intake (AI)

Source: National Institutes of Health Office of Dietary Supplements

Vitamin D Supplements

Active metabolite is 1,25-dihydroxyvitamin D **(calcitriol)**

Available in 2 forms:

1. **Ergocalciferol (Vitamin D2)**

   Vit D deficiency treatment (off-label): 50000unit once weekly for 6-8 weeks to achieve 25(OH)D level>30mg/ml

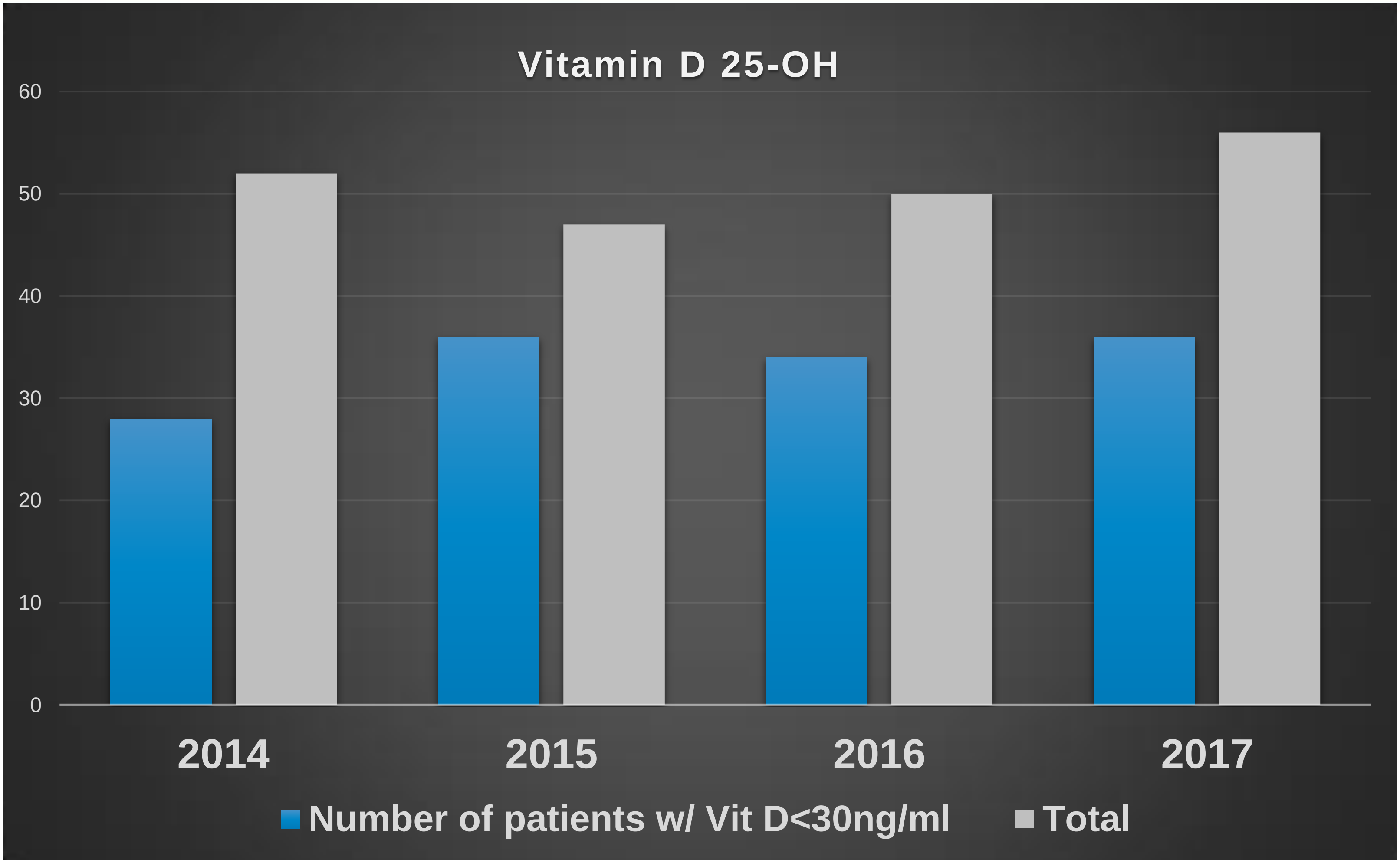
2. **Cholecalciferol (Vitamin D3)**

   Vit D deficiency prevention 1500-2000units daily to maintain 25(OH)D level>30mg/ml

Vitamin D and Brain Injury

Schnieders and Associates recently reported that 65% of patients with varying degrees of TBI were Vitamin D deficient, ie having a serum 25(OH)D level < 30 ng/ml (Scrimgeour et al).

Minneapolis VA Polytrauma Acute Rehab Center



Minneapolis VA Polytrauma Acute Rehab Center

Year	Median Age (years)	Number of Patients with Vit D 25-OH Level less than 30ng/mL	Total Number of patients (Inpatient)	Percentage of patients with Vit D 25-OH Level less than 30ng/mL upon admit	Range of Low Vitamin D 25-OH values (in ng/ml)	Receive treatment with Vit D supplement
2014	48.5	28	52	53.9%	6-29	YES***
2015	57	36	47	76.6%	4-28	YES
2016	49	34	50	68%	7-29	YES
2017	53	36	56	64.3%	6-29	YES

* Data Provided by Anders Westanmo, PharmD, BCPS, Minneapolis VA Pharmacoinformatics Specialist

** Excludes Hemodialysis Patients, Corrected Calcium >10.5mg/dl, CKD stage III and CKD stage IV patients.

*** One patient (24 year old male Veteran) declined treatment per chart review June 2014.

Cautions with Excessive Vitamin D

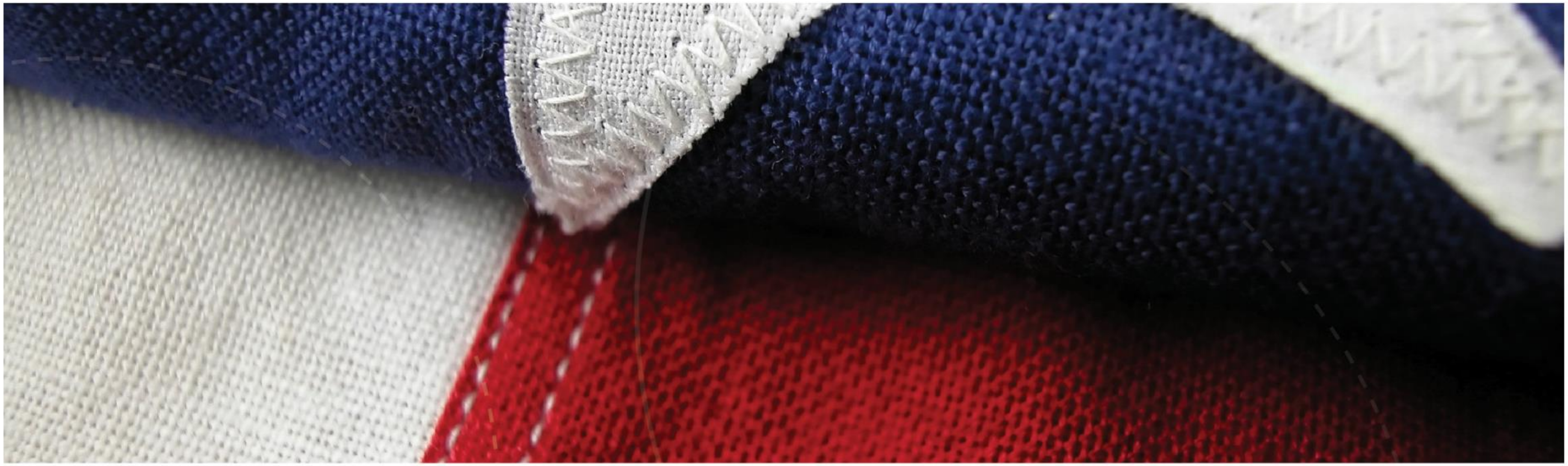
Vitamin D Toxicity

- Serum 25(OH)D levels above 50 ng/ml associated with increase all-cause mortality, greater risk of cancer and cardiovascular events, increase in falls and fractures among elderly population
- Symptoms
  - Anorexia
  - Weight loss
  - Polyuria
  - Heart arrhythmias
  - Hypercalcemia

Cautions with Excessive Vitamin D

Clinical Considerations

- Serum Calcium Level
  - Corrected Serum Ca = measured Ca + [0.8 x (4 - albumin)]
  - Check corrected calcium levels and avoid supplementing if calcium high
  - Serum calcium times phosphorus should not exceed 70 mg^2/dL^2 to avoid ectopic calcification
- Renal issues
- Use caution if there are any parathyroid problems



Other Vitamins and Supplements

Case: Mr. B.

He continued to recover during his acute rehabilitation course.

Two weeks after admission, he was tolerating a regular diet and thin liquids. He was still confused.

His family asked if there were any nutritional supplements that might help his healing.

Sodium

Normal is 135-145 mmol/ L

Goal is individualized and may be high normal in some cases.

Following TBI, it seems important to have normal sodium levels

Interventions include salt tablets and high intake of salt.

Fluid restriction is also an option, but generally not as desirable due to risk of hypotension and fatigue.

In most cases, it seems to make more sense to have a balance of normal fluid intake and increased sodium intake.

Omega-3 Fatty Acids

Growing evidence regarding these

Most commonly administered one is Docosahexanoic acid (DHA)

Theory: DHA shunts prostaglandin production away from arachidonic acid and associated metabolites. This mitigates central inflammatory response and propagation of lipid peroxidation which occur in setting of ischemia and metabolic demand seen after TBI.

Branched Chain Amino Acids

Eg Glutamate, GABA

Important for

protein synthesis

Glucose metabolism

Oxidation of free fatty acids

Cerebral metabolism

Immune function

May have role in maintaining/ repairing learning circuit

Pinheiro JL et al. Traumatic brain injury and branched-chain amino acids. *Journal of Clinical Nutrition and Metabolism. 2018*; 2(1): 1-4.

Progesterone

Hormone that is normally present in the brain

Has role in lipid peroxidation and inhibiting free radical formation

Upregulates antioxidant enzymes like superoxide dismutase

Also acts as neurosteroid

Has been trialed in critical care (IV administration) and longer term

Appears safe but efficacy data remains inconclusive

Ma J et al. Progesterone for acute traumatic brain injury. *Cochrane Database Systematic Review. 2016.* 12.

Vitamin C

An antioxidant

Can be beneficial for wound healing

Vitamin E

Some evidence that Vitamin E can be beneficial for the brain

In Alzheimer's Disease, supplementation has been shown to slow cognitive decline

Given as alpha tocopheral 2000 IU/ day

Dysken MW. Effect of vitamin E and memantine on functional decline in Alzheimer Disease. *JAMA 2014*. 31(1); 33-44.

Illustrative Case: Mr. B.

He recovered to the point where he could be discharged home with his family.

At his follow up appointment in clinic 6 weeks following discharge, he mentioned that his friend told him that probiotics and other supplements could be beneficial.

Green tea/ Caffeine

Stimulants are often used in combination with therapy and behavior plans to allow for optimal daytime function.

Need to monitor sleep and appetite, which can be negatively affected by stimulants

Also, check for interactions with other medications and for contraindications involving a person's health status (eg cardiac issues)

Exercise

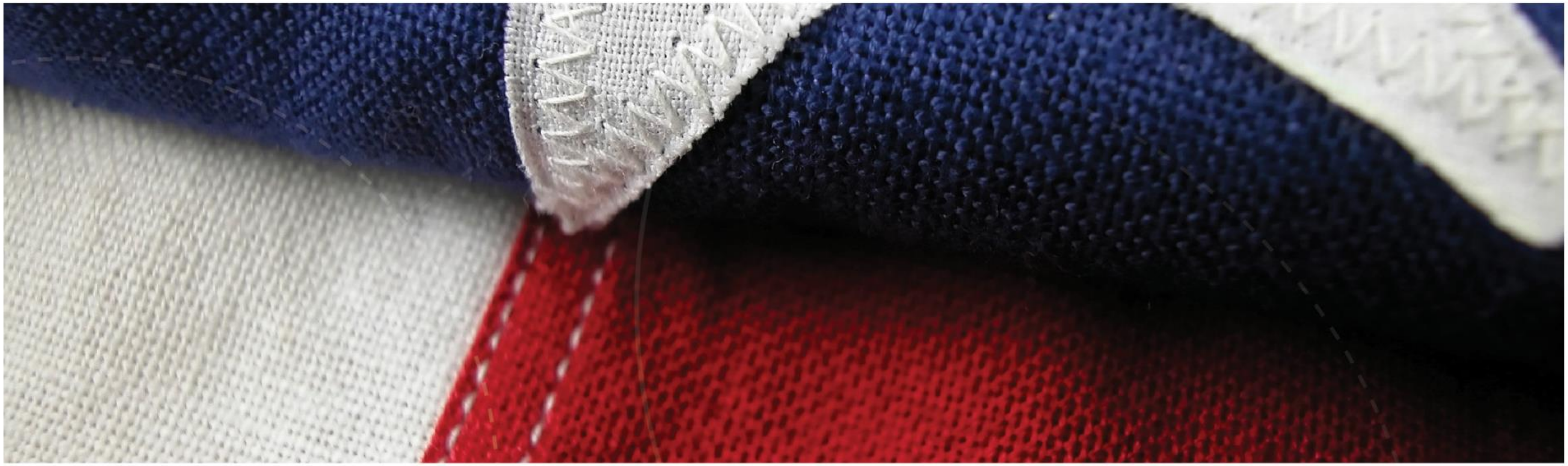
There is ample evidence that exercise is beneficial for the brain.

Many studies have demonstrated better-than-expected cognitive function in older adults who were physically active

Animal studies are demonstrating improved neuronal functioning during and following exercise

It follows that exercise is likely beneficial for the healing brain as well

It is appropriate to recommend an individualized, appropriate exercise program



Food as Medicine in TBI Recovery

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Case: Mr. B.

Eight months later, Mr. B. has returned to work at his office job.

He has essentially resumed his pre-injury routine (with the exception that he is no longer riding a motorcycle).

At his clinic appointment, he reflects on all that he has experienced during the past year. He asks for advice and recommendations about optimizing his overall health going forward. He'd like to start with dietary changes.

Mr. B.

Starts insulin, metformin, glipizide

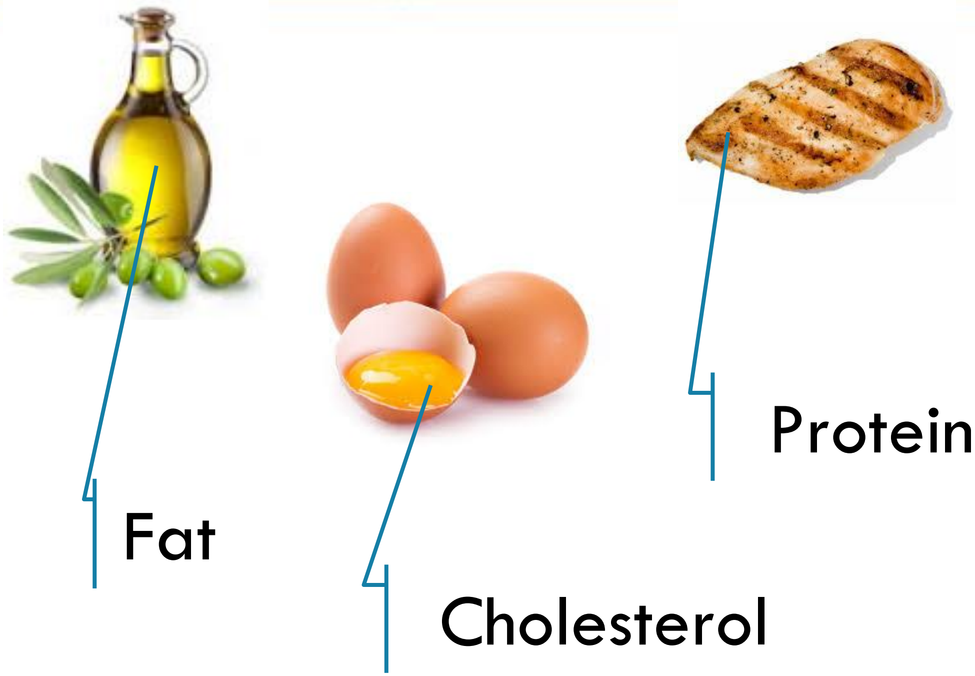
Dietary modifications

JAN FEB MAR APR MAY JUN

Hgb A1c 11.1%
Total Cholesterol 286
BP 136/66

Outline

- Individual dietary components



Fat

- Individual dietary components

Fat

Research

JAMA Internal Medicine | Original Investigation

Association of Specific Dietary Fats With Total and Cause-Specific Mortality

Dong D. Wang, MD, MSc; Yanping Li, PhD; Stephanie E. Chiuve, ScD; Meir J. Stampfer, MD, DrPH; JoAnn E. Manson, MD, DrPH; Eric B. Rimm, ScD; Walter C. Willett, MD, DrPH; Frank B. Hu, MD, PhD

- Nurses' Health Study
  - 121k + female nurses 30-55 yrs in 1976
  - Data collected 1980-2012
- Health Professionals Follow Up Study
  - 52k + male health care professionals 40-75 yrs in 1986
    - Data collected 1986-2012
- Food frequency questionnaire q2-4 yrs
- Participants grouped into quintiles of intake levels for each type of fat

Dietary Fat

Table 2. Associations Between Total and Specific Types of Fat Intake and Total Mortality (Comparison Is Isocaloric Substitution for Total Carbohydrates) (continued)

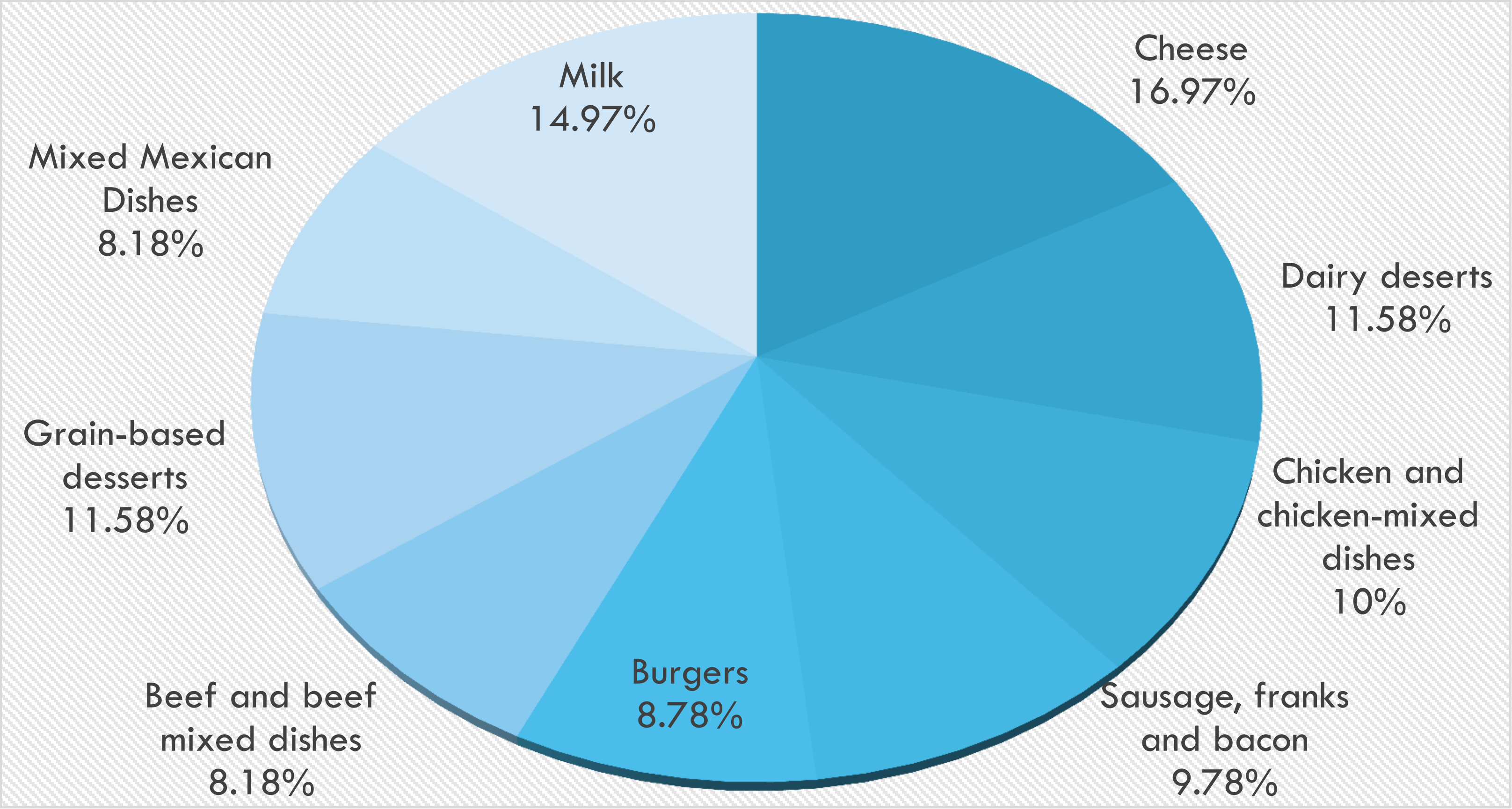
	Quintile of Dietary Fatty Acid Intake					P Value for Trend	HR (95% CI)[a]
	1	2	3	4	5		
Trans-fat intake							
NHS							
Median, % of energy	0.9	1.2	1.5	1.9	2.5	NA	NA
No. of deaths	5747	5158	4268	3099	2042	NA	NA
HPFS							
Median, % of energy	0.7	1.0	1.2	1.4	1.9	NA	NA
No. of deaths	2511	2642	2683	2698	2456	NA	NA
Pooled[b]							
Age-adjusted model	1 [Reference]	1.31 (1.27-1.35)	1.49 (1.44-1.54)	1.63 (1.57-1.69)	1.73 (1.66-1.80)	<.001	2.31 (2.20-2.43)
MV-adjusted model[c]	1 [Reference]	1.11 (1.07-1.15)	1.14 (1.10-1.19)	1.15 (1.10-1.20)	1.13 (1.07-1.18)	<.001	1.16 (1.09-1.24)

Dietary Fat

Polyunsaturated fat intake							
NHS							
Median, % energy	4.2	5.0	5.6	6.3	7.5	NA	NA
No. of deaths	4423	4380	3997	3829	3685	NA	NA
HPFS							
Median, % of energy	4.4	5.2	5.8	6.5	7.7	NA	NA
No. of deaths	2872	2633	2513	2545	2427	NA	NA
Pooled[b]							
Age-adjusted model	1 [Reference]	0.91 (0.88-0.94)	0.85 (0.82-0.88)	0.81 (0.78-0.84)	0.73 (0.70-0.75)	<.001	0.62 (0.59-0.65)
MV-adjusted model[c]	1 [Reference]	0.97 (0.94-1.00)	0.91 (0.87-0.94)	0.87 (0.84-0.91)	0.81 (0.78-0.84)	<.001	0.73 (0.69-0.77)
Monounsaturated fat intake							
NHS							
Median, % of energy	9.4	11.4	12.8	14.4	17.2	NA	NA
No. of deaths	6241	4769	3789	3191	2324	NA	NA
HPFS							
Median, % of energy	8.9	10.8	12.1	13.3	15.3	NA	NA
No. of deaths	2748	2637	2622	2598	2385	NA	NA
Pooled[b]							
Age-adjusted model	1 [Reference]	1.05 (1.02-1.08)	1.10 (1.06-1.14)	1.17 (1.13-1.21)	1.22 (1.17-1.26)	<.001	1.16 (1.13-1.19)
MV-adjusted model[c]	1 [Reference]	0.95 (0.92-0.99)	0.93 (0.89-0.97)	0.93 (0.89-0.98)	0.89 (0.84-0.94)	<.001	0.90 (0.87-0.94)

(continued)

Highest Sources of Saturated Fat in U.S. Diet



Top Food Sources of Saturated Fata among U.S. Population, 2005–2006. NHANES.

Outline

- Individual dietary components

Fat

Cholesterol

Protein

Cholesterol

- Individual dietary components

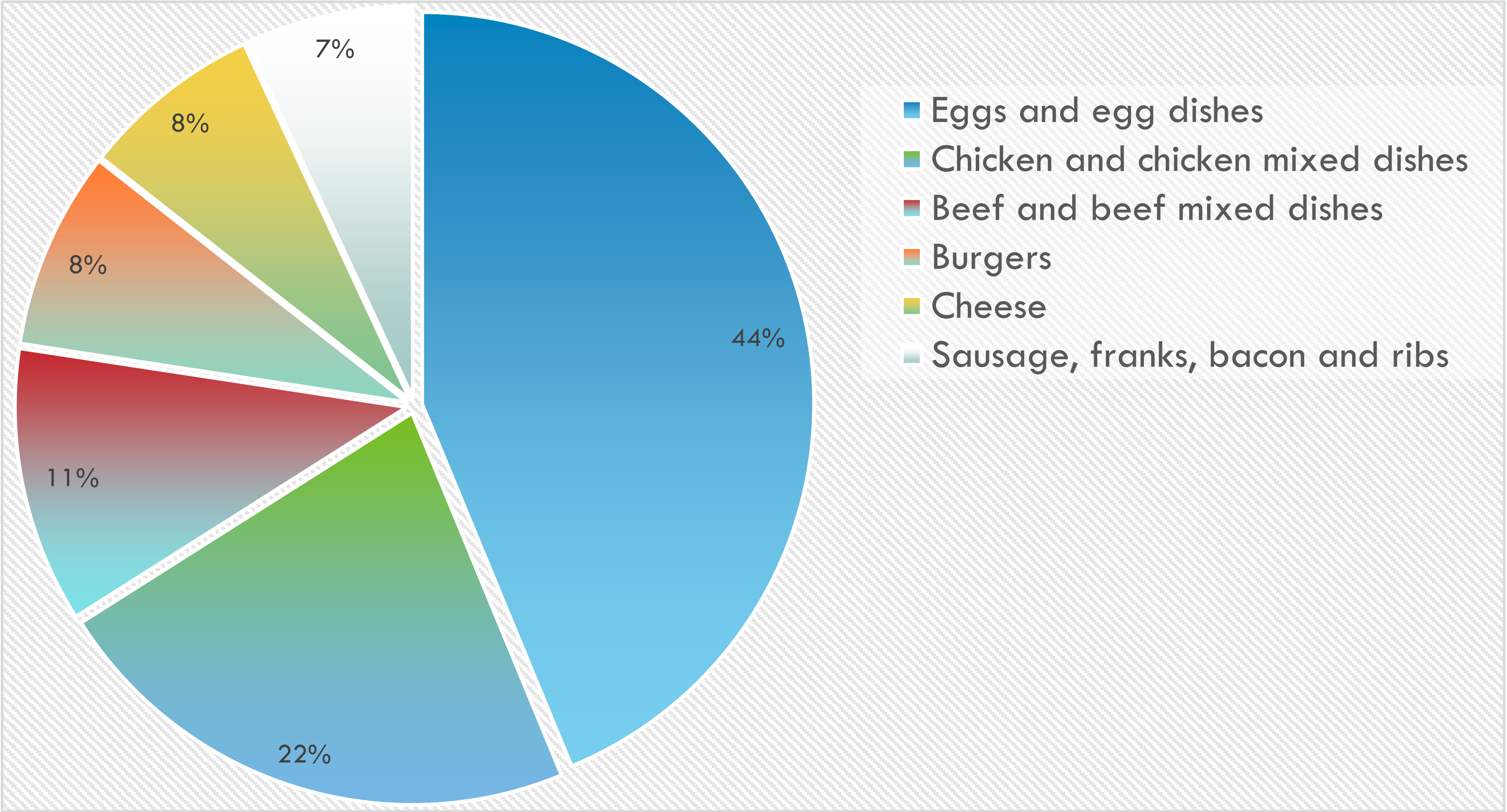
Cholesterol

Blood cholesterol and vascular mortality by age, sex, and blood pressure: a meta-analysis of individual data from 61 prospective studies with 55 000 vascular deaths

*Prospective Studies Collaboration**

- 61 observational studies
- 900k+ adults without previous disease

Dietary Sources of Cholesterol in U.S.



J, Krebs-Smith et al. *Am Diet Assoc* 2010

Outline

- Individual dietary components

Fat

Cholesterol

Protein

Outline

- Individual dietary components

Protein

Dietary Protein

- Heart disease
- All cause mortality
- Diabetes

Research

JAMA Internal Medicine | Original Investigation

Association of Animal and Plant Protein Intake With All-Cause and Cause-Specific Mortality

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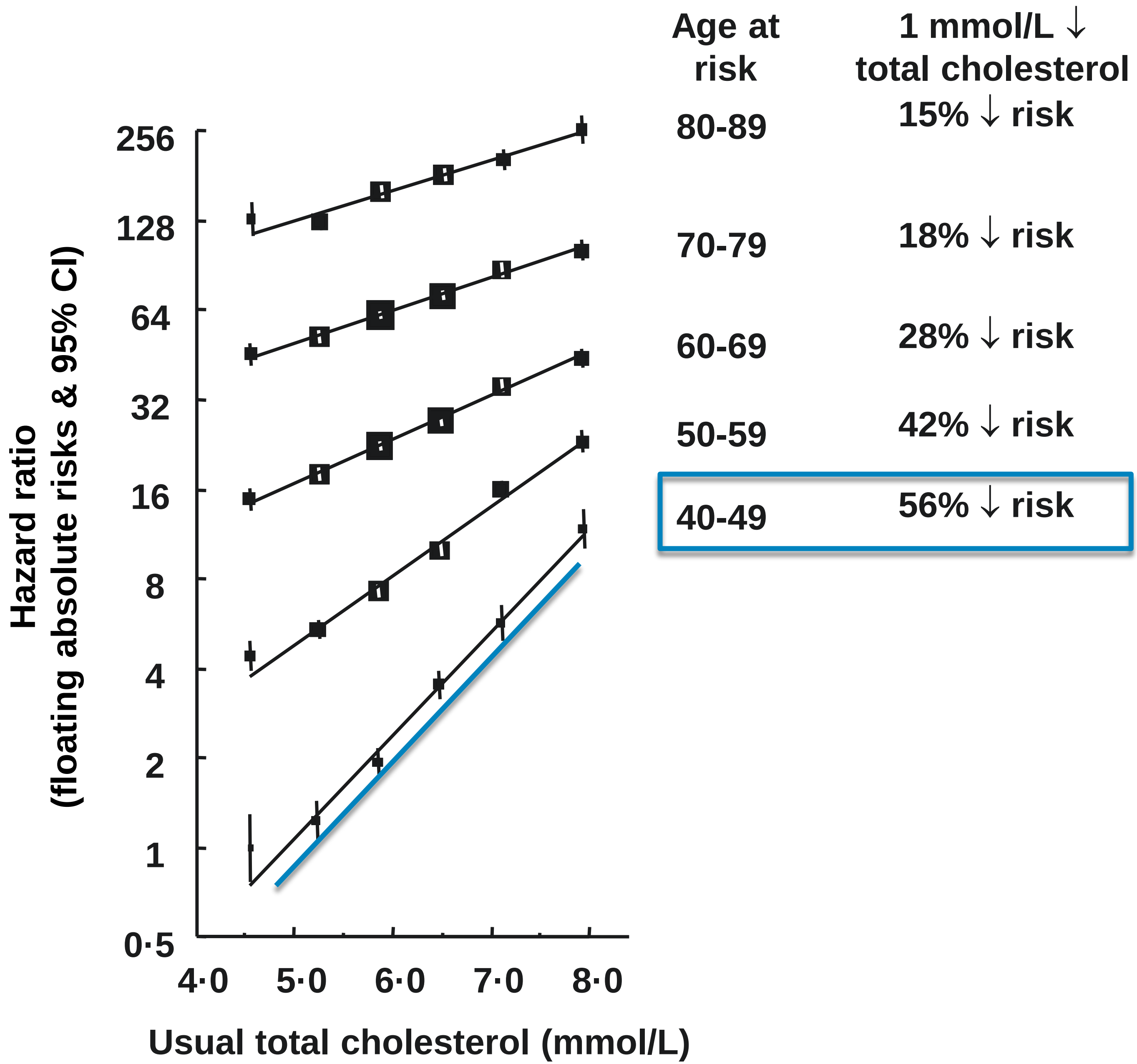
- Nurses’ Health Study
- Health Professionals Follow Up Study
- Food frequency questionnaire q4 yrs

IHD mortality (33 744 deaths) versus usual total cholesterol



The JAMA Network

From: **Association of Animal and Plant Protein Intake With All-Cause and Cause-Specific Mortality**

JAMA Intern Med. 2016;176(10):1453-1463. doi:10.1001/jamainternmed.2016.4182

Table 2. Risk for All-Cause and Cause-Specific Mortality According to Percentage of Energy From Animal and Plant Protein Intake

	Protein Intake Category						
	1	2	3	4	5	HR (95% CI)[a]	*P* Value for Trend
Animal Protein							
Intake category, % of total energy	≤10	>10 to 12	>12 to 15	>15 to 18	>18	NA	NA
Median intake, % of energy	8.9	11	14	16	20	NA	NA
Person-years of follow-up	317 851	544 922	1 171 916	893 047	613 056	NA	NA
All-cause mortality							
No. of deaths	3770	6151	11 909	8401	5884	NA	NA
Age-adjusted HR (95% CI)[b]	1 [Reference]	0.97 (0.93-1.01)	0.97 (0.93-1.00)	0.98 (0.94-1.02)	1.01 (0.96-1.06)	1.03 (1.00-1.06)	.09
Multivariable-adjusted HR (95% CI)[c]	1 [Reference]	1.01 (0.97-1.05)	1.03 (0.99-1.07)	1.03 (0.98-1.07)	1.03 (0.98-1.08)	1.02 (0.98-1.05)	.33
CVD mortality							
No. of deaths	974	1527	2967	1987	1396	NA	NA
Age-adjusted HR (95% CI)[b]	1 [Reference]	0.94 (0.87-1.02)	1.01 (0.94-1.09)	1.07 (0.99-1.17)	1.19 (1.09-1.30)	1.20 (1.12-1.28)	<.001
Multivariable-adjusted HR (95% CI)[c]	1 [Reference]	0.98 (0.90-1.07)	1.05 (0.97-1.14)	1.06 (0.97-1.16)	1.09 (0.99-1.20)	1.08 (1.01-1.16)	.04
Cancer mortality							

Table Title:

Risk for All-Cause and Cause-Specific Mortality According to Percentage of Energy From Animal and Plant Protein Intake

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Table 2. Risk for All-Cause and Cause-Specific Mortality According to Percentage of Energy From Animal and Plant Protein Intake

	Protein Intake Category						
	1	2	3	4	5	HR (95% CI)[a]	*P* Value for Trend
Plant Protein							
Intake category, % of total energy	≤3	>3 to 4	>4 to 5	>5 to 6	>6	NA	NA
Median intake, % of energy	2.6	3.5	4.5	5.4	6.6	NA	NA
Person-years of follow-up	710 592	1 060 873	929 193	550 015	290 118	NA	NA
All-cause mortality							
No. of deaths	6160	9661	10 235	6602	3457	NA	NA
Age-adjusted HR (95% CI)[b]	1 [Reference]	0.92 (0.89-0.96)	0.85 (0.82-0.89)	0.72 (0.69-0.76)	0.67 (0.63-0.70)	0.73 (0.70-0.75)	<.001
Multivariable-adjusted HR (95% CI)[c]	1 [Reference]	0.97 (0.94-1.01)	0.95 (0.91-0.99)	0.91 (0.86-0.96)	0.89 (0.84-0.96)	0.90 (0.86-0.95)	<.001
CVD mortality							
No. of deaths	1260	2126	2638	1811	1016	NA	NA
Age-adjusted HR (95% CI)[b]	1 [Reference]	0.88 (0.82-0.95)	0.78 (0.72-0.85)	0.63 (0.57-0.69)	0.60 (0.53-0.67)	0.67 (0.62-0.72)	<.001
Multivariable-adjusted HR (95% CI)[c]	1 [Reference]	0.93 (0.86-1.01)	0.90 (0.82-0.99)	0.83 (0.74-0.93)	0.85 (0.74-0.97)	0.88 (0.80-0.97)	.007
Cancer mortality							

Dietary Protein & Cardiovascular Health

- Iowa Women's study: cohort study of post-menopausal women
  - Inverse association between plant protein and CVD mortality
  - Substituting plant protein for animal protein resulted in 30% reduction in mortality

Kelemen et al.*Am J Epidemiol*.. 2005

- National Health and Nutrition Examination Survey III
  - Higher protein intake associated with increased all-cause mortality in respondents < 65 yrs.
  - Controlling for animal protein intake eliminated the association

Levine et al. *Cell Metab*. 2014

- The China Study: nationwide study of dietary and lifestyle factors associated with disease mortality in 170 villages in mainland China
  - Consumption of red meat is associated with an increased risk of all-cause mortality and increased risk of CV mortality

Campbell Am. J. Cardiol. 1998

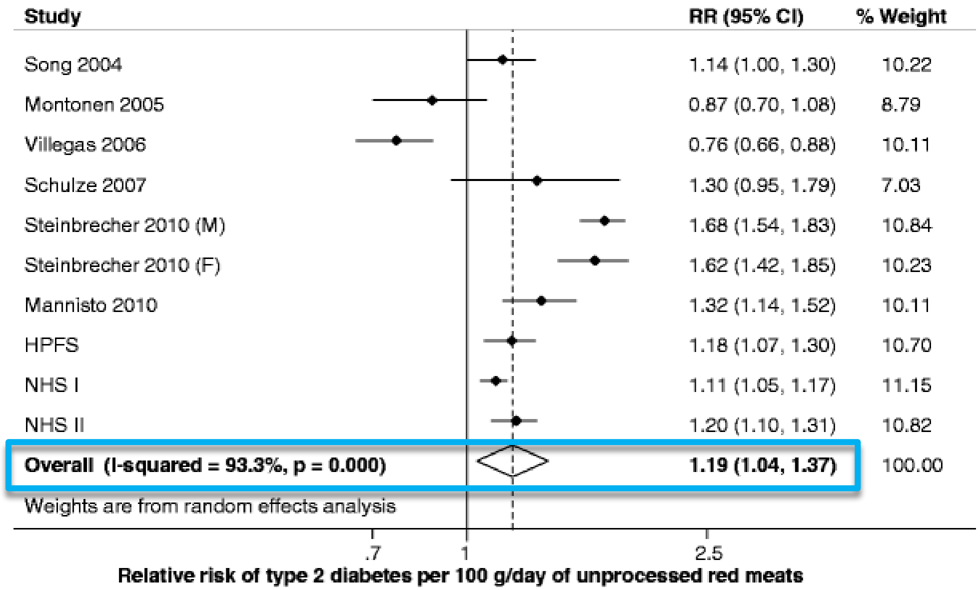
Dietary Protein & DM2

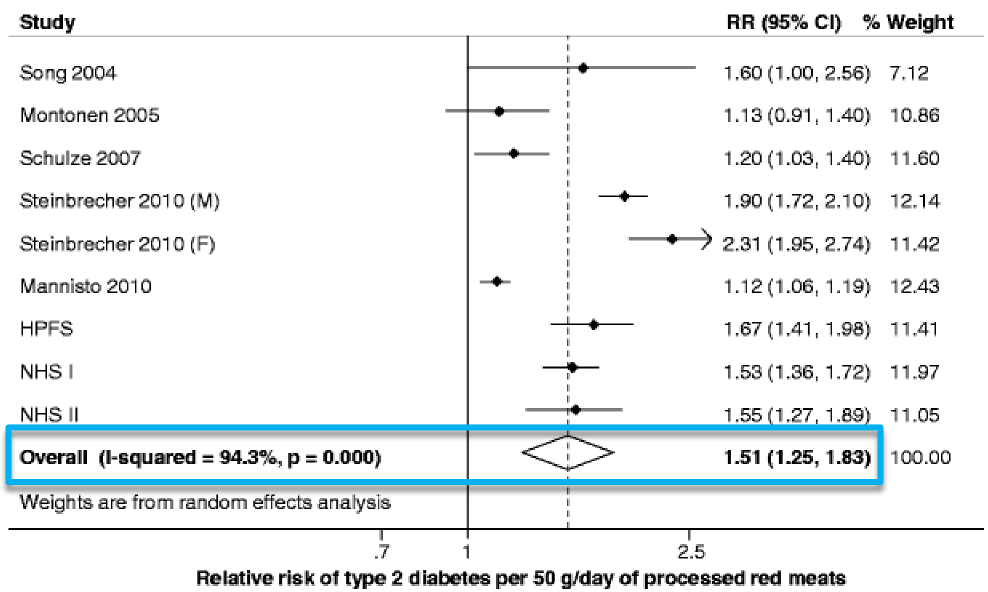
Curr Atheroscler Rep (2012) 14:515–524
DOI 10.1007/s11883-012-0282-8

NUTRITION (BV HOWARD, SECTION EDITOR)

Unprocessed Red and Processed Meats and Risk of Coronary Artery Disease and Type 2 Diabetes – An Updated Review of the Evidence

Renata Micha • Georgios Michas • Dariush Mozaffarian


Study
RR (95% CI)
% Weight
Song 2004
1.14 (1.00, 1.30)
10.22
Montonen 2005
0.87 (0.70, 1.08)
8.79
Villegas 2006
0.76 (0.66, 0.88)
10.11
Schulze 2007
1.30 (0.95, 1.79)
7.03
Steinbrecher 2010 (M)
1.68 (1.54, 1.83)
10.84
Steinbrecher 2010 (F)
1.62 (1.42, 1.85)
10.23
Mannisto 2010
1.32 (1.14, 1.52)
10.11
HPFS
1.18 (1.07, 1.30)
10.70
NHS I
1.11 (1.05, 1.17)
11.15
NHS II
1.20 (1.10, 1.31)
10.82
Overall (I-squared = 93.3%, p = 0.000)
1.19 (1.04, 1.37)
100.00
Weights are from random effects analysis
.7
1
2.5
Relative risk of type 2 diabetes per 100 g/day of unprocessed red meats


Study
RR (95% CI)
% Weight
Song 2004
1.60 (1.00, 2.56)
7.12
Montonen 2005
1.13 (0.91, 1.40)
10.86
Schulze 2007
1.20 (1.03, 1.40)
11.60
Steinbrecher 2010 (M)
1.90 (1.72, 2.10)
12.14
Steinbrecher 2010 (F)
2.31 (1.95, 2.74)
11.42
Mannisto 2010
1.12 (1.06, 1.19)
12.43
HPFS
1.67 (1.41, 1.98)
11.41
NHS I
1.53 (1.36, 1.72)
11.97
NHS II
1.55 (1.27, 1.89)
11.05
Overall (I-squared = 94.3%, p = 0.000)
1.51 (1.25, 1.83)
100.00
Weights are from random effects analysis
.7
1
2.5
Relative risk of type 2 diabetes per 50 g/day of processed red meats

Summary

FAT

- Trans-fats and saturated fats ↑ all-cause mortality
- PUSF and MUSF ↓ all-cause mortality
  - Most of the highest sources of saturated fats in the US diet are from animal products

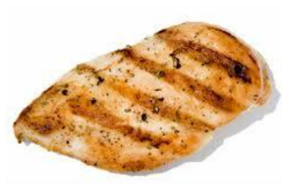
Summary

CHOLESTEROL

- Increased serum cholesterol increases ischemic heart disease mortality
  - All of the highest sources of dietary cholesterol in the US diet are from animal products

Summary

PROTEIN



- For each 10% increment of total energy consumed from animal protein, there is an 8% increase in risk of cardiovascular disease mortality
- For each 3% increment of total energy consumed from plant protein, there is a 12% decreased risk of cardiovascular disease mortality
- Multiple large prospective studies have found increased risk of all-cause and cardiovascular specific mortality with animal protein consumption

Mr. B.

Starts insulin, metformin, glipizide

Dietary modifications

Off insulin, glipizide, 2 anti-hypertensives

Health indices changes maintained

JAN FEB MAR APR MAY JUN

Hgb A1c 11.1%
Total Cholesterol 286
BP 136/66

Hgb A1c 6.3%
Total Cholesterol 136
BP 125/60

Recommendations Could Include:

- Limit saturated fats
- Optimize intake of fats and cholesterol from plant-based sources
- Consider transitioning to plant-based sources of protein

Nutrition Following Traumatic Brain Injury: Summary & Wrap Up

Nutritional issues are important for people who sustain TBIs of all severities.

Nutritional issues following TBI change over the course of recovery.

Common deficiencies include Vitamin D and protein.

Multiple other supplements have been trialed.

There is evidence that plant-based sources of fat, cholesterol and protein may have benefits for health over the long-term.

Interdisciplinary interventions need to be tailored to the individual's needs and status.

Thank You!

Email: Diane.Mortimer@VA.gov

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