Nutrition in Burns and Wound Healing

University of Utah Burn Center

Caran Graves MS, RD, CNSC

University of Utah
Disclosures

Not really, but…

I ask lots of questions
I’m a skeptic by nature
I am not an ‘early adopter’
I believe in food first
Objectives

• Nutrition-related risk factors in developing and healing wounds
• Nutrients involved in wound healing
• Limitations in current nutritional recommendations in wound healing.
• Interventions for providing adequate nutrition in wound healing
New terminology → Pressure Injury

Overview of types of wounds
Review hypermetabolic response
Discuss nutrient needs
Case studies
How to meet nutrient needs
What to monitor
Caveats

Quality of evidence
- Theoretical vs. proven
- Retrospective studies
- Small samples
- Over-generalization
- Grading/strength

Not covered
- Cell biology
- Metabolic pathways
- Healing phases & stages
- Study details
## Types of wounds

<table>
<thead>
<tr>
<th>Cause</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical</td>
<td>Acute</td>
</tr>
<tr>
<td>Crush</td>
<td>Chronic</td>
</tr>
<tr>
<td>Pressure</td>
<td>Infection/disease process</td>
</tr>
<tr>
<td>Stasis (includes DM/CVD)</td>
<td>Clean/dirty</td>
</tr>
<tr>
<td>Other (TEN/NF/frostbite)</td>
<td></td>
</tr>
</tbody>
</table>

**Warning**
Possibly unsettling photos to follow
Types of wounds

Surgical incision

Pressure Injury stage 4
www.studywithclpna.com

Venous stasis
www.veinsveinsviens.com

Pressure Injury Stage 4+
www.health.qld.gov.au

Necrotizing fasciitis
researchgate.net

Frostbite
Dr. Katie Russell
## Wound evaluation

<table>
<thead>
<tr>
<th></th>
<th>Burn</th>
<th>Pressure Ulcer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^{st}) / 1</td>
<td>Red, moist, blanches</td>
<td>Not open, red Does not blanch</td>
</tr>
<tr>
<td>2(^{nd}) / 2</td>
<td>Blister</td>
<td>Breaks open, ulcer May blister</td>
</tr>
<tr>
<td>3(^{rd}) / 3</td>
<td>White/waxy, leathery Dark/charred</td>
<td>Crater, fat may show</td>
</tr>
<tr>
<td>Stage 4</td>
<td></td>
<td>Muscle &amp; bone</td>
</tr>
</tbody>
</table>
Case study—Burn

29 yo man
80 kg
178 cm
83% burn
(smelter explosion)
Intubated and sedated
Case study—Necrotizing faciitis

56 yo woman
100 kg
167 cm
BMI 35
Pressure ulcer $\rightarrow$ necrotizing faciitis
Hx: Diabetes
Hyperlipidemia
Alcohol/Tobacco
Pressure ulcer risk factors
(getting and keeping)

• Wound conditions
  – Pressure
  – Moisture

• Weight
  – Overweight $\rightarrow$ increased pressure
  – Underweight $\rightarrow$ too little ‘padding’
  – Weight loss (large, unplanned)

• Malnutrition
  – Increased incidence with malnutrition
  – Starvation/undernutrition delays wound healing

• Poor intake

Common Tools
Braden
Norton
Waterlow
## Nutritional response

<table>
<thead>
<tr>
<th></th>
<th>Burn</th>
<th>Acute (e.g. hatchet)</th>
<th>Chronic (e.g. stasis ulcer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic</td>
<td>+/-</td>
<td>+/-</td>
<td>+</td>
</tr>
<tr>
<td>inflammation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time frame</td>
<td>Weeks-months</td>
<td>Days-weeks</td>
<td>Months</td>
</tr>
<tr>
<td>Calories</td>
<td>↑/↑↑↑</td>
<td>↑ short term</td>
<td>↑</td>
</tr>
<tr>
<td>Protein</td>
<td>↑/↑↑↑</td>
<td>↑ short term</td>
<td>↑</td>
</tr>
</tbody>
</table>
Assessment
(Basically the same as always)

- Anthropometrics—height, usual weight and loss
- Diet history
  - Malnutrition
  - Pt preferences
- Biochemical
  - No albumin/pre-albumin
  - Electrolytes & glucose
- Co-morbidities/pre-existing conditions
- Type and size of wound
- Treatment plan
Estimating Caloric Requirements

25 yo male, 183 cm

<table>
<thead>
<tr>
<th></th>
<th>80 kg</th>
<th>120 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harris-Benedict</td>
<td>Basal = 1,915 x 1.5 = 2,872</td>
<td>2467</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3700</td>
</tr>
<tr>
<td>Curreri</td>
<td>4,400</td>
<td>6300</td>
</tr>
<tr>
<td>Mifflin – St. Jeor</td>
<td>1850</td>
<td>2224</td>
</tr>
<tr>
<td>30-35 kcal/kg</td>
<td>2400-2800</td>
<td>3600-4200</td>
</tr>
</tbody>
</table>
## Energy Requirements

### Pressure ulcers

<table>
<thead>
<tr>
<th>30-35 kcal/kg/d</th>
<th>Prevention and treatment of pressure ulcers: Clinical practice guidelines 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;30 improved</td>
<td>Yamamoto et al 2009</td>
</tr>
<tr>
<td>&lt;20 poor healing</td>
<td></td>
</tr>
<tr>
<td>29-38 kcal/kg (BEE x 1.1 x 1.3-1.5)</td>
<td>Ohura et al 2011</td>
</tr>
<tr>
<td>1.25-1.6 g/kg/d protein</td>
<td></td>
</tr>
</tbody>
</table>

Prevention and treatment of pressure ulcers 2014; Yamamoto Wounds 2009; Ohura Wound Repair Regen 2011
Energy Requirements

56 yo woman, 167 cm 100 kg

- 30-35a
- >30 improved
- 29-38 kcal/kg
  \((\text{BEE} \times 1.1 \times 1.3-1.5)^c\)

<table>
<thead>
<tr>
<th>Method</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30-35</td>
<td>3000-3500</td>
</tr>
<tr>
<td>29-38</td>
<td>2900-3800</td>
</tr>
<tr>
<td>(\text{BEE} \times \text{XX})</td>
<td>2400-2700</td>
</tr>
</tbody>
</table>

\(a\) Prevention and treatment of pressure ulcers: Clinical practice guidelines 2014; \(b\) Yamamoto et al 2009; \(c\) Ohura et al 2011
Protein Needs

• Protein needed for wound healing
• Goal
  – 1.25 – 1.5 g/kg/d pressure ulcers
  – 1.25 – 2 g/kg/d (burn)
• “Remains unclear” (but none is obviously bad)
• Monitor BUN & UUN

Cochrane Database 2014; Lee Adv Skin Wound Care 2006; Wolfe Ann Surg 1983
Protein Needs
(types)

• Collagen

• Arginine
  – Stimulates collagen synthesis
  – Often given with other nutrients

• Glutamine
  – Cellular fuel
  – Burns: increased wound healing

• “No clear evidence”

Leigh J Wound Care 2012; Doley Nutr Clin Pract 2010;
Other Nutrients

Carbohydrate
• Needed for energy
• “Stress Diabetes”
• Monitor for excess intake
• Maximum glucose load about 4-5 mg/kg/min (7 g/kg/d) during stress

Fat
• Calorie source
• Essential Fatty Acids
• Non-CHO calories

Fiber
• May not be appropriate in critically ill

~2000 kcal for 80 kg
Vitamins

- Based largely on theory
  - Vitamin function
  - Difficult to assess
  - Needed “if deficient”
- Multivitamin
  - Common
  - Safe
  - Relatively inexpensive

- Vitamin A
  - Immune function
  - Epithelialization
  - Collagen formation

- Vitamin C
  - Collagen formation
  - Antioxidant
  - Avoid mega-doses

Might help; Shouldn’t hurt

Graves J Burn Car Res 2009
Minerals

- Based largely on theory
  - Mineral function
  - Difficult to assess
  - Needed “if deficient”
- Mineral supplementation
  - Less common
  - Variable doses & routes

- Zinc
  - Difficult to assess
  - Affects other minerals
  - Needed “if deficient”

Nutrition Continuum of Care

Curative → Assertive care

Rehab → Restorative care

Maintenance → Supportive care

Palliative → Comfort care

From: Everything you always wanted to know about nutrition but didn’t ask.
Nancy Collins PhD (Nutrition411.com)
Consult Order

Evaluation and recommendation:
Pt with poor intake and pressure ulcer
Consult Order

Evaluation and recommendation:
Pt with poor intake and pressure ulcer

Diet order: Renal
Cardiac
No sugar
Fluid restriction
Goals

• Wound healing
  -- Remove cause
  -- Positioning
  -- Wound care

• Adequate nutrition
  – Repletion vs. maintenance

• Balance nutritional needs
  – Glucose
  – Weight
  – Other diet and lifestyle concerns
What’s the goal?

Fat mass and lean body mass with caloric delivery

Total body weight and caloric delivery indexed to measured REE

...total body weight at higher caloric intakes was maintained by the addition of fat mass in the face of lean body mass loss.

Hart Ann Surg 2002; Demling ePlasty 2009
## Summary of Pressure Ulcer Recommendations

Prevention and treatment of pressure ulcers: Clinical practice guidelines 2014

<table>
<thead>
<tr>
<th></th>
<th>Strength</th>
<th>Recommendation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screening</strong></td>
<td>C</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td><strong>Nutrition Assessment</strong></td>
<td>C</td>
<td>+</td>
<td>Weight history, feeding and intake</td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>B/C</td>
<td>+/+++</td>
<td>Individualize/30-35 kcal/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adjust based on weight (obese/underweight)</td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td>C (A for burn)</td>
<td>+</td>
<td>+ N2 balance 1.25-1.5 g/kg/d</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td></td>
<td>Supplements for poor po</td>
</tr>
<tr>
<td><strong>Vitamin/mineral</strong></td>
<td>C (generally)</td>
<td>++</td>
<td>MVI</td>
</tr>
<tr>
<td></td>
<td>B (if deficient)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>Recommendation</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>++</td>
<td>Draining wounds “adequate” Monitor for dehydration</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>+</td>
<td>“Modify/liberalize” “Balanced” “Healthy”</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>++</td>
<td>Can be used</td>
<td></td>
</tr>
<tr>
<td>C (burn grade A/B)</td>
<td>+</td>
<td>If oral intake inadequate</td>
<td></td>
</tr>
</tbody>
</table>

“Individualize as tolerated” Noreen Schvaneveldt RD
### Special Populations

#### Pressure ulcers

<table>
<thead>
<tr>
<th>Population</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bariatric</td>
<td>No nutrition-specific recommendations</td>
</tr>
<tr>
<td>Critical illness</td>
<td>“additional nutrition interventions are not recommended for routine use” due to insufficient evidence</td>
</tr>
<tr>
<td>Older adults</td>
<td>No nutrition-specific recommendations</td>
</tr>
<tr>
<td>Palliative Care</td>
<td>Risk assessment (including nutrition)</td>
</tr>
<tr>
<td></td>
<td>“compatible with …condition and wishes”</td>
</tr>
<tr>
<td>Palliative Care</td>
<td>Offer protein supplements when healing is the goal</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>“paucity of research”</td>
</tr>
<tr>
<td>Spinal Cord Injury</td>
<td>No nutrition-specific recommendations</td>
</tr>
<tr>
<td>Spinal Cord Injury</td>
<td>Oral, enteral or parenteral as needed for those at risk or w/ malnutrition &amp; wound</td>
</tr>
</tbody>
</table>
How?

Oral--recommended
• What diet?
  – Is it adequate?
  – How many restrictions?
  – Liberalize liberally
• How much is eaten?

Supplements
• Calories?
• Protein?
• Vitamins?
• Minerals?
• Specialty

Enteral Nutrition
• Total vs. supplemental
• What formula?
“The daily intake of food was selected from the following list: “

Dried milk
Brown bread
Digestive biscuits
Fresh butter
Steak (served as stew)
Dried apples (served as stew)

Dried tomato soup (served as soup)
Dried egg (served as custard)
Tea
Sugar
Marmelade
Orange Juice

From: Cuthbertson Biochem J. 1930
Ultimate Nutrition Support Study
(thought experiment only)  Thought author: Dr. Mark Oltermann

Medical Outcomes

Severity of illness

<table>
<thead>
<tr>
<th>Severity of illness</th>
<th>Oral</th>
<th>EN/PN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ultimate Nutrition Support Study
(thought experiment only)  Thought author: Dr. Mark Oltermann

Patient Satisfaction

Severity of illness

Worse → Better

Low  Moderate  Severe

Oral  EN/PN
Monitoring

- Wound healing
- I & O
- Weight?
- Labs?
- Calorie counts

- How will you use it?
- Will it affect care?
- Is it practical?
- What is the cost?
  - time
  - pain
  - money

How much is a ‘bite’?
Monitoring: Glucose control

• Critical Care
  – Decreased mortality
  – Decreased morbidity
  – Insulin protocols

• Benefits of insulin/metformin
  – Directly increases anabolism

How tight?
- 80-110 mg/dl
- <180 mg/dl

Insulin vs. carbohydrate restriction

Van der Berge N Engl J Med 2001;
NICE-SUGAR 2009
Case study: burn

29 yo man; 80 kg; 178 cm; 83% burn (smelter explosion)

Hospital course
Calorimetry: 1440 – 4100 kcal
(day 4 hypothermic, day 23)
UUN max: 39 g N2 out
= >250 g protein
Enteral + IV
Home on po intake
Case Study: Necrotizing Faciitis

56 yo woman; 100 kg; 167 cm; pressure ulcer → necrotizing faciitis

**Hospital course**

- Calorimetry: 1700- 3200+ kcal
- Diverting colostomy with wound dehiscence
- PN & EN nutrition
- Permissive underfeeding + added protein
- Normal HgbA1c and cholesterol at discharge
- Home on po intake
Questions/Comments
Selected References


• Demling Eplasty Nutrition, anabolism, and the wound healing process: an overview. 2009:9:e9


• Langer G, Fink A. Dietary supplementation for preventing and treating pressure ulcers. Cochrane Database 2014
Selected References

• Lee et al. Adv Skin Wound Care 2006;19:92-6
• Leigh et al. The effect of different doses of an arginine-containing supplement on the healing of pressure ulcers. Wound Care 2006;19:92-96
• Prevention and treatment of pressure ulcers: Clinical practice guidelines 2014
• Streechmiller JK. Understanding the role of nutrition and wound healing Nutr Clin Pract 2010;25:50-60
• Wild et al. Basics in nutrition and wound healing. Nutrition 2010;26:862
• Wolfe et al. Response of protein and urea kinetics in burn patients to different levels of protein intake. Ann Surg 1983
• Yamamoto T et al. Evaluation of nutrition in the healing of pressure ulcers: are the EPUAP nutritional guidelines sufficient to heal wounds? Wounds. 2009 21;6:153-7