Nutrition In Wounds And Tissue Regeneration

SPECIFIC NUTRIENTS IN WOUND HEALING

S. Klek (*PL*)
Nutrition in wounds and tissue regeneration

Stanislaw Klek

Stanley Dudrick’s Memorial Hospital Skawina, Poland
Polish Society for Enteral, Parenteral Nutrition and Metabolism
Conflict of interest

Speaker’s honoraria: Baxter, B Braun, Fresenius Kabi, Nestle, Nutricia, Shire, Vipharm

Advisory Boards: Baxter, Braun, Fresenius, Nestle, Nutricia, Tracheron

Main/ co-author: ESPEN guidelines in Surgery, ESPEN guidelines in Gastroenterology,

ESPEN definition of malnutrition, Acute Intestinal Failure Position Paper, ESPEN

Guidelines on HPN
Enteral/parenteral diets

Macro- and micronutrients

- Water
- Carbohydrates
- Lipids
- Proteins
- Vitamins
- Minerals
- Trace elements
Pharmaco (immuno)nutrition

Some nutrients may serve as pharmacologic agents:
- Glutamine
- Arginine
- Omega-3 fatty acids
- Nucleotides
- Selenium, Zinc, Copper
- Vitamins (C, E)
ENTERAL ARGinine

% Fistula

Control
ARG-OM3
Wypadek koło Mądrzechowa (zdjęcia)

Dodano: 8 maja 2014, 22:36    Autor: Andrzej Gurbą


Galeria: Wypadek w Mądrzechowie

Courtesy of Marcin Gendwill, MD
1st chronic care facility

Neurosurgery unit

2nd chronic care unit

May Jun Jul Aug Sep Oct Nov Dec Jan

Courtesy of Marcin Gendwill, MD
Pressure ulcers

Courtesy of Marcin Gendwill, MD
Tracheostomy, PEG, urinary cath

Courtesy of Marcin Gendwill, MD
Nutritional support

- Enteral nutrition via PEG: 500 – 1000 ml / day (Arginine-enriched diet)
- + 1500 ml water/ day
- Increase over 1000 ml/ day impossible – diarrhoea

Courtesy of Marcin Gendwill, MD
After 4 months

Courtesy of Marcin Gendwill, MD
Discharged home on 29th Jan 2015

- On the 5th of March, 2015, he came for a check-up by car

- He was driving that car!
Arginine

Ochoa JB, Zhu X, Makarenkova V et al.
Arginine levels in Plasma and in T cells hours after Injury – Ochoa Lab.

JPEN 2012

Plasma

Intracellular
Myeloid Cells accumulate near T lymphocytes after Injury

Makarenkova, Ochoa – Journal of Immunology 2006

Control 12 Hrs. after Injury
Myeloid Cells

Classic

TH1

M1

iNOS

Nitric Oxide

IL-6, LPS

Alternative

TH2

M2

Arginase

Ornithine
Physical Injury ↑↑ susceptibility to Infection

Zhu, Ochoa, Ann Surg 2013

Reproduced by injecting Myeloid cells

Or By Injecting Arginase
Effect of Arginase Blockade on Infection

Arginase blockade (Nor- Noha)

ST = Injury

CFU/Spleen (log10 scale)

P < 0.001
Supplementing with 9 g of l-arginine has been shown to promote wound healing (most of authors: approx. 20 g/day)

An average dietary intake provides about 4 g l-arginine per day
GLUTAMINE
Parenteral glutamine supplementation may be considered in patients who cannot be fed adequately enterally and, therefore, require exclusive PN (0) (BM, HE).

Consensus Conference: Grade of recommendation B consensus (76% agreement) downgraded by the working group during the finalization process according to the recent PRCT [257] (with 100% agreement within the working group members).
Early glutamine-enriched enteral feeding facilitates colonic anastomosis healing: light microscopic and immunohistochemical evaluation.

Güven A, Pehlivan M, Gökpinar I, Gürleyik E, Cam M

Problems related to colonic anastomosis healing constitute the major morbidity in colorectal surgery. Patients without appropriate nutritional support are at higher risk of postsurgical complications, mainly due to reduced wound healing. Therefore, we investigated the effect of early and late postoperative total enteral nutrition (TEN) and glutamine addition on colon anastomosis healing using light microscopy and immunohistochemistry (IGF-I immunolabelling). In this study, 40 Wistar-albino rats underwent distal left colonic transection and anastomosis. The rats were then divided into four groups given different diets: delayed total enteral nutrition (dTEN; beginning 3 days postoperatively), delayed TEN with added glutamine (dTEN+Glutamine), early TEN (eTEN; beginning within 6h postoperatively), and early TEN with added glutamine (eTEN+Glutamine). Colon segments, including the anastomosis, were excised 7 days postoperatively and evaluated histopathologically for inflammation, mucosal healing, submucosal-muscular layer repair, the amounts of necrosis and vascularisation and immunohistochemically for IGF-I labelling. The inflammation and necrosis scores in the dTEN and dTEN+Glutamine groups were significantly greater than in the eTEN and eTEN+Glutamine groups. The IGF-I immunoreactivity increased in the eTEN, eTEN+Glutamine, and dTEN+Glutamine groups compared to dTEN (p<0.05).

We concluded that early TEN and glutamine enrichment in the postoperative period improve anastomosis healing via IGF-I.
Surgery: Glutamine

Complications’ rate

Wang et al., JPEN, 2010

Length of stay
Supplementing with 0.3-0.5 g of glutamine has been shown to be effective.

An average dietary intake provides about 5-9 g glutamine per day.
GLUTAMINE IN
SURGICAL PATIENTS:
there is always a 'but’...

In adults who eat healthy food, who do not have any factor that can affect wound healing negatively and who do not have large tissue loss at critical level, Gln and Arg support would not be required to accelerate secondary wound healing.

Kesici U et al, Int Wound J, 2013
OMEGA-3-PUFAs
Postoperative parenteral nutrition including omega-3-fatty acids should be considered only in patients who cannot be adequately fed enterally and, therefore, require parenteral nutrition (BM, HE).
Randomized control trials

Parenteral fish oil as a pharmacological agent to modulate post-operative immune response: A randomized, double-blind, and controlled clinical trial in patients with gastrointestinal cancer

Raquel Susana Matos de Miranda Torrinhas\textsuperscript{a,b,c}, Raquel Santana\textsuperscript{d}, Thais Garcia\textsuperscript{e}, Maria Fernanda Cury-Boaventura\textsuperscript{d}, Maria Mirtes Sales\textsuperscript{d}, Rui Curi\textsuperscript{d}, Dan Linetzky Wainzberg\textsuperscript{a,b}

Table 3

Inter-group changes in the mean of the difference in variation of immunological markers from patients with gastrointestinal cancer who were pre-operatively treated for 3 days with a peripheral infusion of a fish oil parenteral lipid emulsion (FO) that was rich in omega-3 fatty acids, or a control parenteral lipid emulsion (MCT/LCT) that was rich in medium-chain triglycerides. Data are expressed as mean ± standard deviation and analyzed by the Wilcoxon test.

<table>
<thead>
<tr>
<th>Immunological marker</th>
<th>Group</th>
<th>T1–T0</th>
<th>P value</th>
<th>T2–T0</th>
<th>P value</th>
<th>T3–T0</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interleukin-6</td>
<td>FO</td>
<td>-0.05 ± 0.30</td>
<td>\textless 0.0001\textsuperscript{*}</td>
<td>0.09 ± 0.52</td>
<td>0.029\textsuperscript{*}</td>
<td>0.22 ± 0.60</td>
<td>0.202</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>0.15 ± 0.26</td>
<td>1.29 ± 1.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interleukin-10</td>
<td>FO</td>
<td>-0.005 ± 0.05</td>
<td>0.019\textsuperscript{*}</td>
<td>0.75 ± 0.32</td>
<td>\textless 0.0001\textsuperscript{*}</td>
<td>-0.07 ± 0.13</td>
<td>\textless 0.0001\textsuperscript{*}</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>-0.01 ± 0.03</td>
<td>-0.10 ± 0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxidative burst</td>
<td>FO</td>
<td>-0.08 ± 0.65</td>
<td>0.632</td>
<td>-0.96 ± 0.70</td>
<td>0.028\textsuperscript{*}</td>
<td>-0.20 ± 0.64</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>0.11 ± 0.78</td>
<td>-1.16 ± 0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage HLA-DR (Mϕ)</td>
<td>FO</td>
<td>2.67 ± 15.94</td>
<td>0.464</td>
<td>-2.31 ± 7.83</td>
<td>0.046\textsuperscript{*}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>-8.11 ± 31.20</td>
<td>-15.86 ± 18.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage CD32 (Mϕ)</td>
<td>FO</td>
<td>1.17 ± 12.28</td>
<td>0.253</td>
<td>0.19 ± 12.48</td>
<td>0.025\textsuperscript{*}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>-4.96 ± 7.84</td>
<td>-15.11 ± 16.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity CD32 (Nϕ)</td>
<td>FO</td>
<td>-0.14 ± 99.87</td>
<td>0.200</td>
<td>65.00 ± 138.84</td>
<td>0.010\textsuperscript{*}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MCT/LCT</td>
<td>-1.23 ± 35.68</td>
<td>20.26 ± 91.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mϕ = Monocytes; Nϕ = Neutrophils.
Surgery: Omega-3-PUFAs

Complications’ rate

LOS

Chen et al., JPEN, 2010
Supplementing with 0.1-0.2 g/kg/d of omega-3-PUFAs has been shown to be effective.
Early studies also suggested that ω-3 fatty acids have a detrimental effect on wound healing. Rats fed diets enriched with ω-3 fatty acids had significantly decreased wound tensile strength 30 days after injury, even though the levels of collagen were similar; it was postulated that the quality and crosslinking of the collagen fibers were compromised by the ω-3 fatty acid supplementation.

Chow A, Barbul A. Adv Wound Care, 2014
Arginine + Omega-3-PUFAs

**Complications’ rate**

*Marik et Zaloga, JPEN, 2010*
Nucleotides
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Number of patients (n)</th>
<th>Study Groups</th>
<th>Type of Diet</th>
<th>Patients Characteristics</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senkal 1997</td>
<td>154</td>
<td>IMEN vs isocaloric</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>17/77 vs 24/77 (p&lt;0.05), shortening of hospital stay</td>
</tr>
<tr>
<td>Daly 1992</td>
<td>85</td>
<td>IMEN vs isocaloric</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>11 vs 33%, shortening of hospital stay by 5 days</td>
</tr>
<tr>
<td>Heslin 1997</td>
<td>195</td>
<td>IMEN vs isocaloric</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>No differences</td>
</tr>
<tr>
<td>Daly 1995</td>
<td>60</td>
<td>Postoperative IMEN, outpatients MEN, standard postoperative and outpatients</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>Reduction of complications rate (10 vs 43%), shortening of hospital stay by 6 days</td>
</tr>
<tr>
<td>Braga 2002</td>
<td>150</td>
<td>Pre- and postoperative IMEN &amp; standard EN</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>Reduction of complications rate</td>
</tr>
<tr>
<td>Braga 1996</td>
<td>60</td>
<td>Standard EN, IMEN, TPN</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>No reduction of complications</td>
</tr>
<tr>
<td>Braga 1999</td>
<td>206</td>
<td>IMEN vs standard EN</td>
<td>Impact</td>
<td>Operated on for upper GI cancer</td>
<td>Well nourished and malnourished 14 vs 30% (p=0.009)</td>
</tr>
</tbody>
</table>
ERAS and Immunodiets

A Multicenter Randomized Clinical Trial (SONVI Study)

Pedro Moya, MD, PhD, Leticia Soriano-Irigaray, PharmD, Jose Manuel Ramirez, MD, PhD, Alessandro Garcea, MD, Olga Blasco, MD, Francisco Javier Blanco, MD, PhD, Carlo Brugotti, MD, Elena Miranda, MD, and Antonio Arroyo, MD, PhD

TABLE 7. Complications According to Clavien–Dindo Classification

<table>
<thead>
<tr>
<th>Clavien-Dindo Classification</th>
<th>Without Perioperative Immunonutrition N = 122</th>
<th>With Perioperative Immunonutrition N = 122</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No complication</td>
<td>64.80%</td>
<td>77.00%</td>
<td>0.144</td>
</tr>
<tr>
<td>Clavien-Dindo I</td>
<td>12.30%</td>
<td>5.70%</td>
<td></td>
</tr>
<tr>
<td>Clavien-Dindo II</td>
<td>13.10%</td>
<td>7.40%</td>
<td></td>
</tr>
<tr>
<td>Clavien-Dindo III</td>
<td>3.30%</td>
<td>4.90%</td>
<td></td>
</tr>
<tr>
<td>Clavien-Dindo IV</td>
<td>6.60%</td>
<td>4.90%</td>
<td></td>
</tr>
</tbody>
</table>
**Nutrition Screening Checklist**

**Screening for Malnutrition**

- Is BMI less than 19?  
  - Yes  
  - No  

- Has the patient had unintentional weight loss of over 5 pounds in the last 3 months?  
  - Yes  
  - No  

- Has the patient had a poor appetite – eating less than half of meals or fewer than two meals per day?  
  - Yes  
  - No  

- Is the patient unable to take food orally (ex: dysphagia, vomiting)?  
  - Yes  
  - No  

**Lab Tests for Risk Stratification**

- Is the patient having inpatient surgery?  
  - Yes  
  - No  

  - Check albumin level to assess complication risk after surgery  

**Supplementation**

- Is the patient having complex surgery (example: GI anastomosis)?  
  - Yes  
  - No  

  - Give evidence-based immune modulating supplementation  

---

**Optimizing Nutrition Prior to Surgery**

Nutritional status is a major determinant of type of surgery, especially for high-risk patients. Surgery is an initiative in Washington State identifying and improving evidence-based patients have better outcomes.

The Strong for Surgery nutrition initiative screening of patients prior to surgery to decrease risk for malnutrition. Good nutrition is important to help patients heal better.

The Strong for Surgery Nutrition Check separate components:

- Screening for Malnutrition: Four specific questions determine the patient's current nutrition status. A Body Mass Index (BMI) less than 19 indicates a patient is at risk for malnutrition. At-risk patients will be referred to the dietitian for further evaluation and management.

- Lab Tests for Risk Stratification: If yes, check albumin level to assess complication risk after surgery.

- Supplementation: If yes, give evidence-based immune modulating supplementation.
Is Impact different?

- increased amount of arginine
- no glutamine
- omega-3-PUFAs
- nucleotides
MICRONUTRIENTS
In those patients after surgery who are unable to be fed via the enteral route, and in whom total or near total parenteral nutrition is required, a full range of vitamins and trace elements should be supplemented on a daily basis.
ESPEN: Vitamin Recommendations for Patients With Major Burns

MAJOR BURN

- Patients with major burns have increased vitamin requirements
- Supplementation of vitamins B₁ (thiamine), C (ascorbic acid), D and E is strongly suggested
Enhancement of Re-epithelialization with Topical Zinc Oxide in Porcine Partial-Thickness Wounds

MAGNUS S. ÅGREN, M.Sc., MILOS CHYAVIT, M.D., and LENNART FRANZÉN, M.D.
Department of Pathology, Faculty of Health Sciences, S-60166 Linköping, Sweden, and Department of Surgery, University of Arizona, College of Medicine, Tucson, Arizona 85724

TABLE 1
Zinc Contents of the Dressings and the Effect of Zinc in Gauze and in Collagen Sponge on Re-epithelialization

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Zinc content*</th>
<th>Epithelialization % of initial wound areab</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>µg/cm²</td>
<td>48 hr</td>
</tr>
<tr>
<td>Gauze</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+PVP</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>+ZnSO₄ + PVP</td>
<td>6.6</td>
<td>31.5 ± 2.6 (32)*</td>
</tr>
<tr>
<td>+ZnSO₄ + PVP</td>
<td>65</td>
<td>25.8 ± 2.4 (25)</td>
</tr>
<tr>
<td>+ZnO + PVP</td>
<td>630</td>
<td>33.2 ± 1.6 (32)</td>
</tr>
<tr>
<td>+ZnO + PVP</td>
<td>250</td>
<td>22.1 ± 4.1 (16)*</td>
</tr>
<tr>
<td>Collagen sponge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+PVP</td>
<td>6.2</td>
<td>42.0 ± 6.4 (13)*</td>
</tr>
<tr>
<td>+ZnSO₄ + PVP</td>
<td>130</td>
<td>21.8 ± 1.5 (25)</td>
</tr>
<tr>
<td>+ZnO + PVP</td>
<td>510</td>
<td>17.0 ± 0.9 (32)</td>
</tr>
</tbody>
</table>

* Determined in triplicates and given as the total available elemental zinc.

b X ± SEM.

* Contained 5 mg PVP/g as determined gravimetrically.

* Number of sections assessed.

* ND, not determined.

* P < 0.05 compared to respective control treatment (gauze + PVP and collagen sponge + PVP, respectively) at each time point.
Zinc and wound healing

FIG. 1. The appearance of the upper dermis in wounds treated for 48 hr with gauze + (a) PVP; (b) zinc sulfate (65 μg zinc/cm²) + PVP; and (c) zinc sulfate (629 μg zinc/cm²) + PVP. Arrows indicate the edge of epithelium resurfacing the wounds. Note less inflammation in zinc sulfate treated wound (b) compared with control treated wound (a). A more pronounced inflammatory reaction was, however, seen with the highest zinc sulfate dosage and some parts of these wounds showed a very dense infiltrate of leukocytes (c). Hematoxylin-eosin, 215X.
Local supplementation with zinc, copper, and selenium combined may therefore stimulate distinct, non-overlapping pathways during wound healing.
Zinc, Copper, and Selenium Tissue Levels and Their Relation to Subcutaneous Abscess, Minor Surgery, and Wound Healing in Humans

Ursula Mirantuckiški - Alicia Martin - Lars N. Jørgensen - Barry Sampson - Magnus S. Ågren
The recommended intake of zinc for non-healing pressure ulcers is 15mg/day. With larger non-healing wounds, 25-50mg daily can be used, but this should be limited to 14 days, as excess zinc can interfere with wound healing.

Dietary zinc sources include red meat, fish and shellfish, milk products, poultry and eggs.
Annals of Internal Medicine

A Nutritional Formula Enriched With Arginine, Zinc, and Antioxidants for the Healing of Pressure Ulcers

A Randomized Trial

Emanuele Cereda, MD, PhD; Catherine Klerys, MD, MSc; Marcella Serioli, RD; Aldo Crespi, MD; and Federico D’Andrea, MD, for the OligoElement Sore Trial Study Group*

Background: Trials on specific nutritional supplements for the treatment of pressure ulcers (PUs) have been small, inconsistent in their formulations, or unsuccessful in controlling for total supplement calorie or protein content.

Objective: To evaluate whether supplementation with arginine, zinc, and antioxidants within a high-calorie, high-protein formula improves PU healing.

Design: Multicenter, randomized, controlled, blinded trial. (ClinicalTrials.gov: NCT01107197)

Setting: Long-term care and home care services.

Patients: 200 adult malnourished patients with stage II, III, and IV PUs.

Interventions: An energy-dense, protein-rich oral formula enriched with arginine, zinc, and antioxidants (400 mL/d) or an equal volume of an isocaloric, isonitrogenous formula for 8 weeks.

Measurements: The primary end point was the percentage of change in PU area at 8 weeks. Secondary end points included complete healing, reduction in the PU area of 40% or greater, incidence of wound infections, the total number of dressings at 8 weeks, and the percentage of change in area at 4 weeks.

Results: Supplementation with the enriched formula (n = 101) resulted in a greater reduction in PU area (mean reduction, 60.9% [95% CI, 54.3% to 67.5%]) than with the control formula (n = 99) (45.2% [CI, 38.4% to 52.0%]) (adjusted mean difference, 18.7% [CI, 5.7% to 31.8%]; P = 0.017). A more frequent reduction in area of 40% or greater at 8 weeks was also seen (odds ratio, 1.98 [CI, 1.12 to 3.48]; P = 0.018). No difference was found in terms of the other secondary end points.

Limitation: Participation was restricted to patients who were malnourished, were able to drink oral supplements, and were living in long-term care institutions or receiving home care services.

Conclusion: Among malnourished patients with PU, 8 weeks of supplementation with an oral nutritional formula enriched with arginine, zinc, and antioxidants improved PU healing.

Primary Funding Source: Azienda Ospedaliera Universitaria Maggiore della Carità.


For author affiliations, see end of text.

* For a list of members of the OligoElement Sore Trial Study Group, see Appendix 1 (available at www.annals.org).
Selenium added unripe carica papaya pulp extracts enhance wound repair through TGF-β1 and VEGF-a signalling pathway

Abdulaziz Bidem Nafiu and Mohammad Tanvir Rahman®
Vitamin C promotes wound healing through novel pleiotropic mechanisms

Bassem M Mohammed¹,², Bernard J Fisher³, Donatas Kraskauskas⁴, Susan Ward⁴, Jennifer S Wayne⁵, Donald F Brophy⁴, Alpha A Fowler Ill³, Dorne R Yager⁴ & Ramesh Natarajan³

Key Messages

• healing wounds are often characterised by low/inadequate VitC levels
• VitC supplementation may be essential for timely termination of the inflammatory phase of wound healing
• adequate circulating VitC promotes fibroblast migration, matrix deposition and neovascularisation in healing wounds via modulation of the transcript levels of HO-1, TGFβ, CTGF and VEGF
• VitC facilitates wound healing by pleiotropic mechanisms that extend beyond its known role in collagen metabolism
- Recommended vitamin C supplementation for deficient patients is 60-200mg daily. Doses over 200mg a day are not necessary as tissue saturation occurs at this point.

- Vitamin C is found mostly in fruit and vegetables, especially oranges, grapefruit, tomatoes, and leafy vegetables. Fruit juices with added vitamin C are also a good source, although often they contain only small amounts of vitamin C.

- Vitamin E – not really needed
Vitamin D Ameliorates Impaired Wound Healing in Streptozotocin-Induced Diabetic Mice by Suppressing Endoplasmic Reticulum Stress

Yi Feng Yuan, Sushant K. Das, and Mao Quan Li

(a)
- Vitamin A is found in milk, cheese, eggs, fish, dark green vegetables, oranges, red fruits and vegetables

- **The recommended dose in cases of vitamin A deficiency is 700-3000 IU** – the higher range being for males

- **Recommended iron intake for the general population is 8mg/day** and for females aged 19-50 years this increases to 18mg/day

- **The best sources of iron in the diet are red meat, offal, fish, eggs, wholemeal bread, dark green leafy vegetables, dried fruits, nuts and yeast extracts.**
What to do in the real life?
Wound eats like hell!
Large abdominal wall defects =

wound bags and suction drainage

Protein loss > 35 g/l/day
### Differences between enteral and parenteral feeding solutions (after: Mette Berger)

<table>
<thead>
<tr>
<th>Carbohydrates</th>
<th>Proteins</th>
<th>Lipids</th>
<th>Micronutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enteral</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Maltodextrines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Full blend of polymeric proteins, including glutamine 8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mix of fatty acids with variable proportions of n-6, n-9 and n-3 fatty acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• TE + Vitamins in DRI doses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parenteral</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Glucose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Amino acids, incomplete blend, in particular, no glutamine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Triglycerides with various combinations of n-6, n-9 and n-3 fatty acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• NONE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tailor your intervention!
Chow A, Barbul A. Adv Wound Care, 2014
Chow A, Barbul A. Adv Wound Care, 2014
Not too short!

Short-term (3 days) preoperative supplementation of an immunoenriched diet does not improve clinical outcome in well-nourished patients undergoing abdominal cancer surgery.
- 108 patients included in the study
- No differences in LOS or morbidity/mortality

Giger-Pabst U. et al., Nutrition, 2013
Short-term pre-operative infusion of FO alone improves the post-operative immune response of gastrointestinal cancer patients without significantly changing post-operative infections or length of ICU and hospital stay.
Short-term effects of supplementary feeding with enteral nutrition via jejunostomy catheter on post-gastrectomy gastric cancer patients.

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Abstract
BACKGROUND: Most gastric cancer patients who undergo gastrectomy develop malnutrition. It is, therefore, crucial to establish an effective means to provide nutrition for these patients. To perform home enteral nutrition (EN) to ensure adequate nutritional intake in gastric cancer patients, we placed a jejunostomy catheter during gastric surgery. Most patients showed improved nutritional status.

METHODS: Twenty-nine inpatients at our hospital underwent radical gastrectomy and jejunostomy from December 2002 to December 2007 and were designated as the jejunostomy group, and 32 matched patients without a jejunostomy tube were designated as the tube-free group. The jejunostomy group was treated with EN from 72 hours to 3 months postoperatively. The tube-free group did not receive EN. Data including preoperative and postoperative body weight, body mass index (BMI), nutrition risk screening (NRS) score, Karnofsky performance score (KPS), and laboratory biochemical indicators were documented respectively and compared.

RESULTS: Compared with preoperative week 1, both groups showed decreased body weight and BMI at 3 months postoperatively. The weight loss in the jejunostomy group (2.1 ± 3.3 kg) was significantly less than that in the tube-free group (3.9 ± 3.1 kg). Similarly, BMI decreased by (2.4 ± 1.0) kg/m² in the jejunostomy group, which was significantly less than in the tube-free group (3.2 ± 0.9) kg/m². The number of patients with postoperative NRS ≥ 3 was decreased in the jejunostomy group, but was increased in the tube-free group, and this difference was significant. There were no significant differences between the two groups in total lymphocyte count, hemoglobin, albumin and prealbumin, and adverse drug effects.

CONCLUSIONS: Short-term (3 months) EN supplementation via jejunostomy tube can reduce the risk of malnutrition and weight loss, and improve tolerance of chemotherapy. Tube feeding is reliable for achieving these goals because it is not important whether or not the patients have appetite.
The recommended intake of zinc for non-healing pressure ulcers is 15mg/day. With larger non-healing wounds, 25-50mg daily can be used, but this should be limited to 14 days, as excess zinc can interfere with wound healing.

Dietary zinc sources include red meat, fish and shellfish, milk products, poultry and eggs.
A

SEN  Post EIN  Pre EIN  Peri EIN

Worse  post infectious complications  Best

B

SEN  Pre EIN  Peri EIN  Post EIN

Worse  post noninfectious complications  Best

C

SEN  Pre EIN  Post EIN  Peri EIN

Worse  length of post hospitalization  Best
Special nutrients: take home messages

• Special nutrients may facilitate wound healing

• The accurate importance and mechanisms of action of these nutrients have still not been fully understood

• We have to be careful about the dose, timing and the length of intervention
Have a good time in Krakow!

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