NUTRITION IN BURN INJURY

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Banjarmasin: 15 Juli 2023

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4. THE ROLE OF MACRONUTRIENTS IN BURN INJURY
5. THE ROLE OF MICRONUTRIENTS IN BURN INJURY
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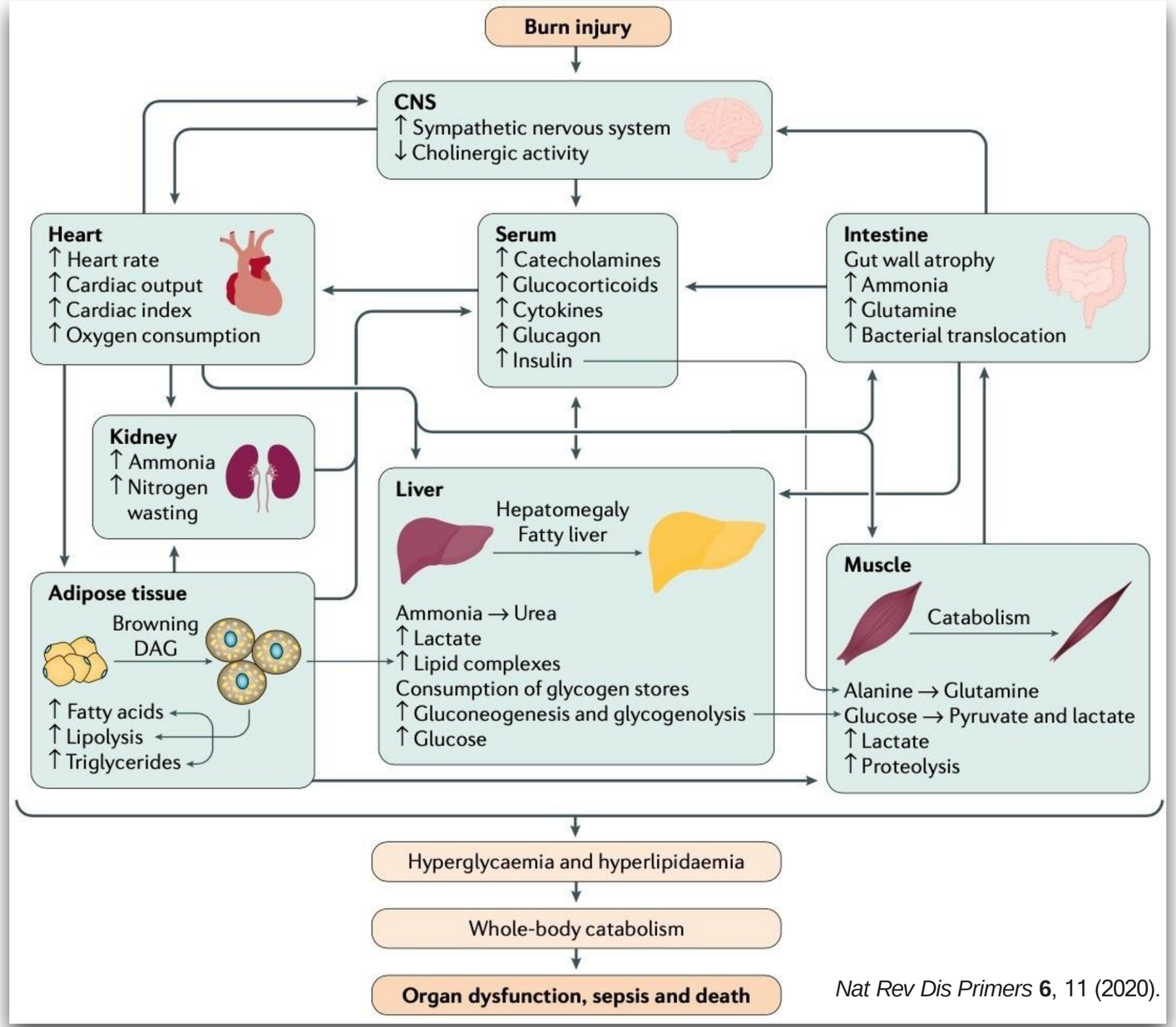
1. INTRODUCTION

- A major burn leads: **Hypermetabolism** and **nutrient losses** → high risk for **organ injury** and **mortality**
- Inflammatory response is triggered by the **initial trauma** → reinitiated several times by **debridement**, **septic** complications, **sleep deprivation**, or by exposure to a **cold environment.**
- The general framework of nutritional support is based on **management** of the **hypercatabolic** state, **glycemic control**, **micronutrients supplementation**, and adequate provision of **energy** and **protein**, with **prompt feeding initiation** via a **tolerable** and **effective** route → EN



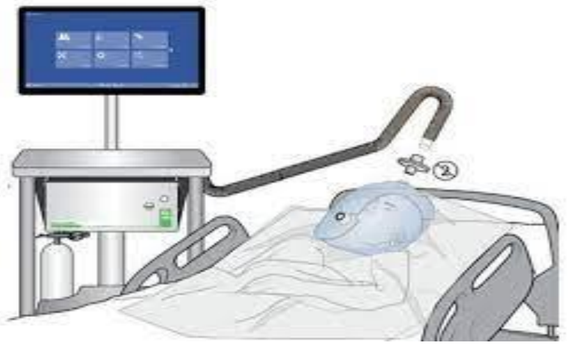
Nat Rev Dis Primers **6**, 11 (2020).

2. METABOLIC CHANGES IN BURN INJURY

- BURN INJURY → CNS: ↑Sympathetic nervous system
- INFLAMMATION RESPONSE → HYPERMETABOLISM
- LIVER: UREA↑& GLUCONEOGENESIS↑
- MUSCLE: CATABOLISM
- INTESTINE: HYPOXIA
- KIDNEY: NITROGEN LOSS

3. ENERGY REQUIREMENT

Indirect calorimetry (IC) measures accurate energy expenditure and is considered the **current gold standard** test. Due to the cost factor and technical issues related to its maintenance, It is not available in all burn care centers

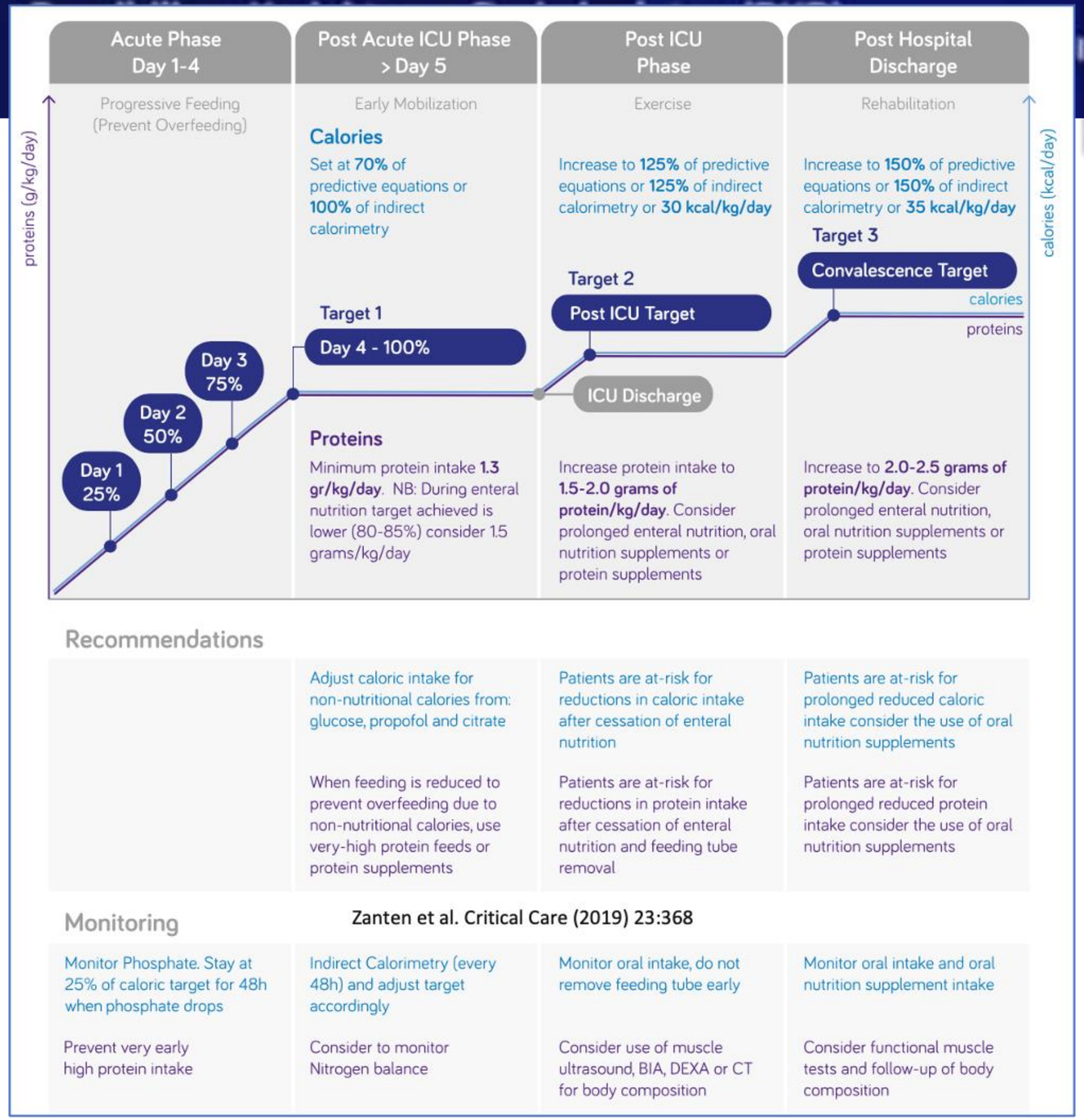


Equations to estimate energy requirements.

Toronto	EE = −4343 + (10.5 x %BSA burn) + (0.23 x CI) + (0.84 x EREE) + (114 x *T* °C) − (4.5 x days post injury)
Harris-Benedict	TEE = EREE x activity factor x stress factor[a] where EREE = *M* = 66.5 + (13.8 x weight) + (5.0 x height) − (6.8 x age) *F* = 655.1 + (9.6 x weight) + (1.8 x height) − (4.7 x age)

EREE = Harris-Benedict estimated REE; BSA = body surface area; TEE = total energy expenditure; CI = caloric intake during the previous day.

[a] Major surgery: 1.0–1.2, skeletal trauma: 1.2–1.5, major burn: 1.4–1.8.



MEDICAL NUTRITION THERAPY

- ACUTE PHASE DAY 1 - 4 :
  - Monitor Phosphate
  - Protein and Calorie intake → Start low go slow
- POST ACUTE PHASE > DAY 5 :
  - When feeding is reduced to prevent overfeeding
  - → Protein supplementation
  - Monitor Nitrogen Balance

- ESPEN and SCCM/ASPEN guidelines: early initiation of EN[1]
  - ESPEN: within 12 h from injury,
  - SCCM/ASPEN: within 6 h from injury
- TPN is a second choice for nutritional support in burns, but may prove life saving to prevent or correct undernutrition due to insufficient energy delivery by the enteral route

1. j.clnu.2020.04.023
2. Clinical Nutrition 38 (2019) 48-79
3. e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism 4 (2009) e308-e312

Acute Phase | Post Acute ICU Phase | Post ICU | Post Hospital

Early enteral administration of nutrients can improve splanchnic perfusion (animal trials), blunt the hypermetabolic response, stimulate intestinal IgA production and maintain intestinal mucosal integrity.

Delayed gastric emptying is sometimes observed in burned patients, as a result of heavy sedation and analgesia, which these patients require. In severe cases, post-pyloric feeding solves these problems allowing nutritional support to be continued during long surgical procedures, thereby avoiding energy deficits.

Patients affected with greater than 20% burn injury and/or inhalation injuries need close observation and may require enteral feeding.

Slow constant gastric or post-pyloric infusion is better tolerated than bolus administration. Gastric suction can be continued simultaneously with nasojejunal feeding

If nutritional requirements are not met using the enteral route, parenteral supplementary feeding may be given. The two techniques are complementary

MEDICAL NUTRITION THERAPY

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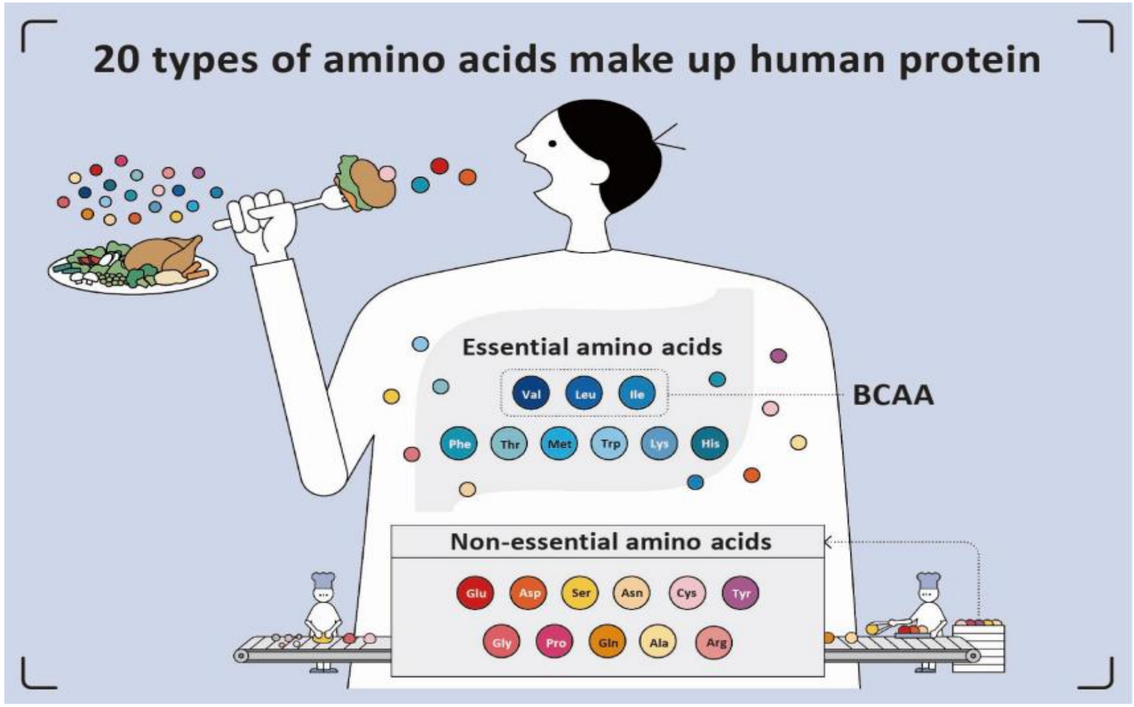
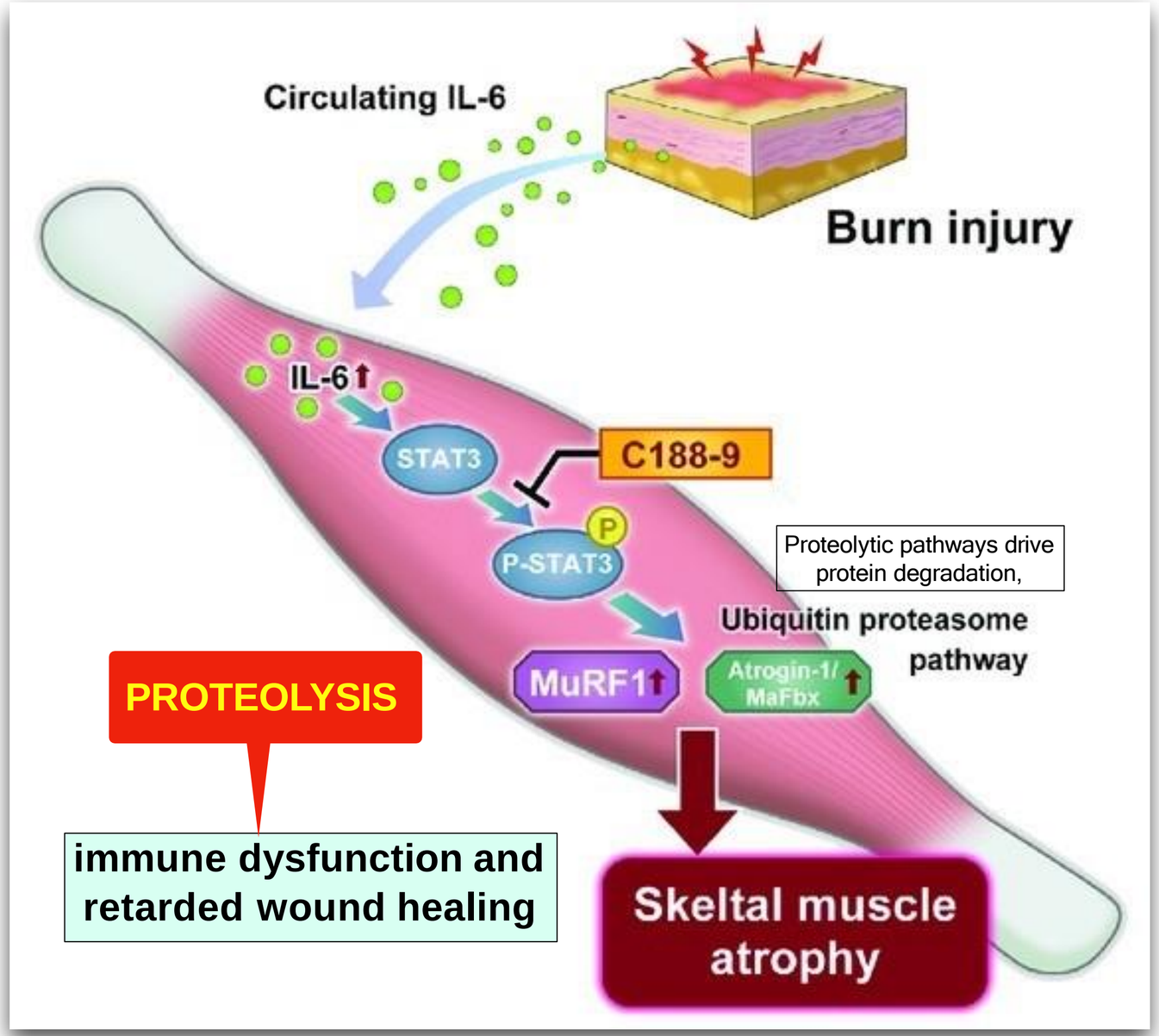
3. THE ROLE OF MACRONUTRIENTS IN BURN INJURY

Proteins	Adults protein needs 1.5–2.0 g/kg; children need 1.5–3 g/kg/day. They are higher than in critical patients due to other conditions Glutamine or ornithine alpha-ketoglutarate is ideal
Glucose levels and glycemic control	Carbohydrate sources make up for 60% of total energy intake (limit to below 5 mg/kg/min in adults and children) Continuous intravenous infusion of insulin keeps glucose levels under 8 mmol/L (and over 4.5 mmol/L)
Lipids	Fat energy sources form <35% of total energy and monitor total fat delivery

ROLE OF PROTEIN

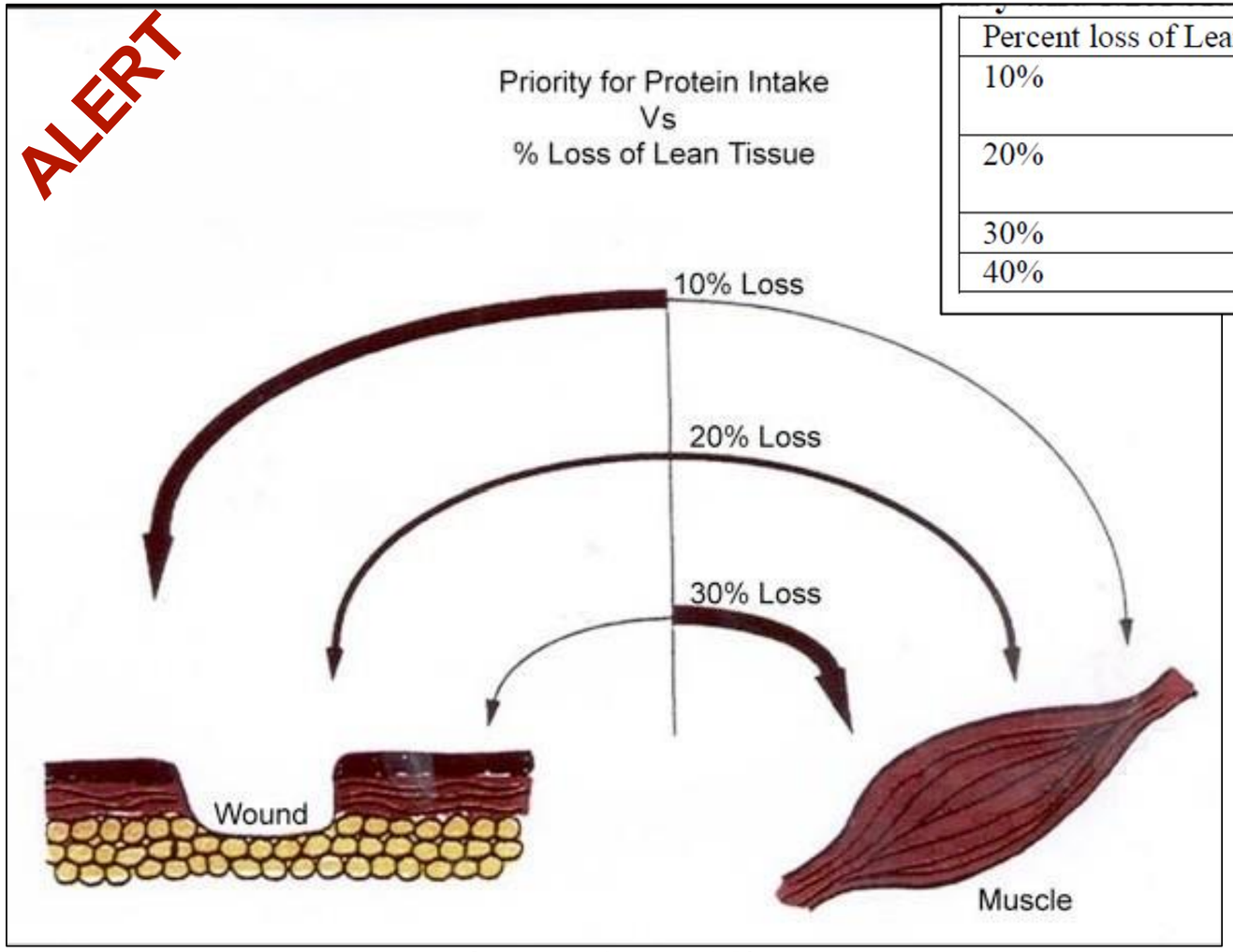




1. PROTEIN FOR MUSCLE WASTING

- **PROTEOLYSIS** is the metabolic hallmark of the **HYPERMETABOLIC RESPONSE**
- As much as **150 g/d** atau **1,5 kg/ 10 d** of skeletal muscle is lost per day in the absence of adequate nutritional support.
- **Nutrition therapy REDUCES the effects of hypercatabolic state**

2. PROTEIN FOR WOUND CLOSURE



Loss of LBM and Wound Closure

Percent loss of Lean mass	Complications	Mortality
10%	Impaired immunity Increased infection	10%
20%	Decreased wound healing, Weakness, infection	30%
30%	Too week, Pressure ulcer, Pneumonia	50%
40%	Death commonly due to pneumonia	100%

- **Glycogen stores** are rapidly depleted in this hypermetabolic state, and the body soon begins to **oxidize its own proteins** to generate ATP.
- TARGET: **NPC:N ratio** is 120 to 150:1.
  - In stable NPC : N = 150 : 1 - 200 : 1

3. PROTEIN FOR HEALTHY GUT

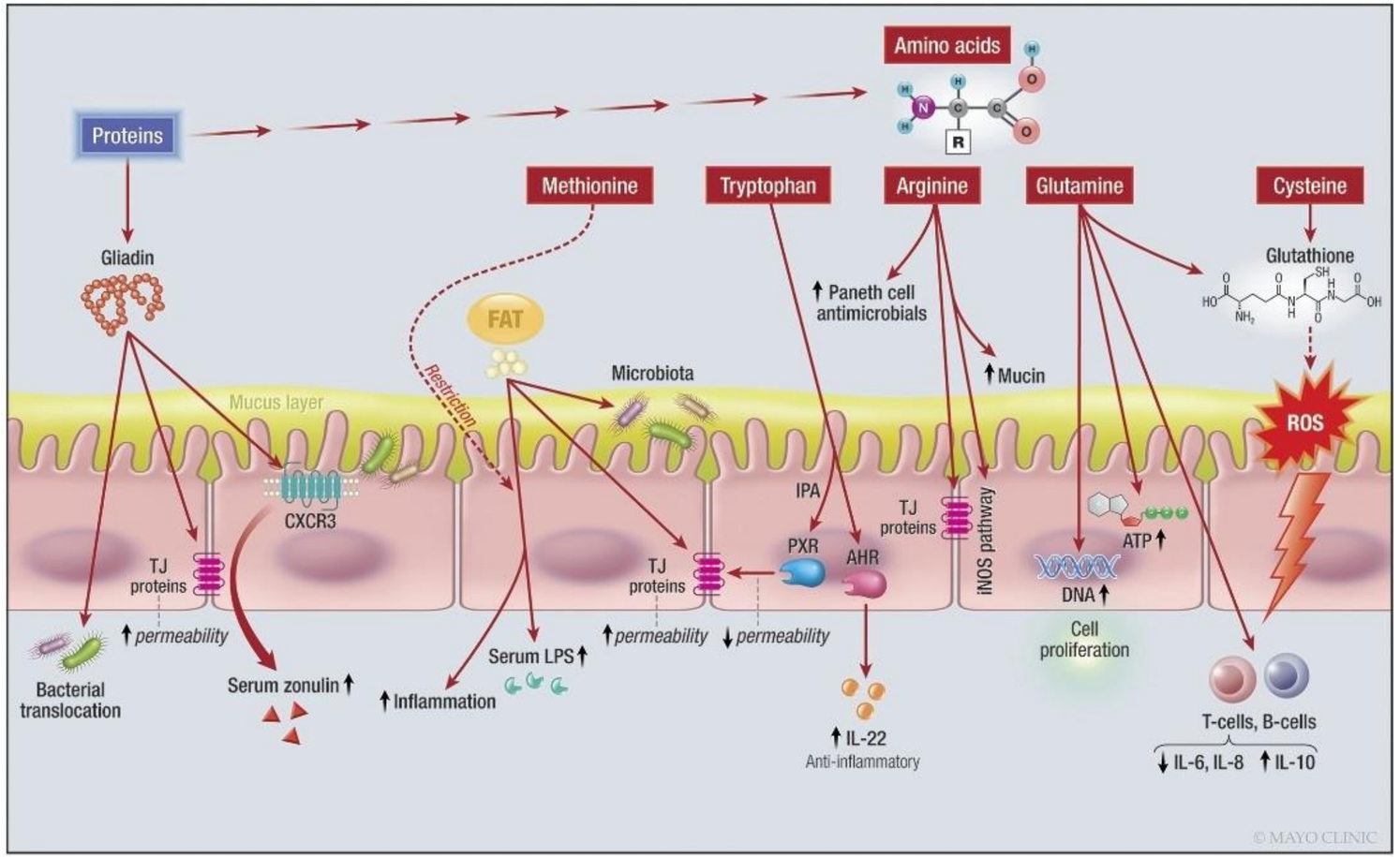


Fig. 3. Effects of fat, proteins and amino acids on the intestinal barrier. Note the effect of amino acids on different intracellular signaling pathways and enzymes, and the effect of gliadin on CXCR3 and TJ proteins. IL-22, interleukin-22, LPS, lipopolysaccharides, TJ, tight junction, ATP, adenosine triphosphate, DNA, deoxyribonucleic acid, CXCR3, chemokine receptor CXCR3; ROS, reactive oxygen species; iNOS, inducible nitric oxide synthase; PXR, pregnane X receptor; AHR, aryl hydrocarbon receptor. One sided arrow shows activation, while dashed arrow shows inhibitory effects.

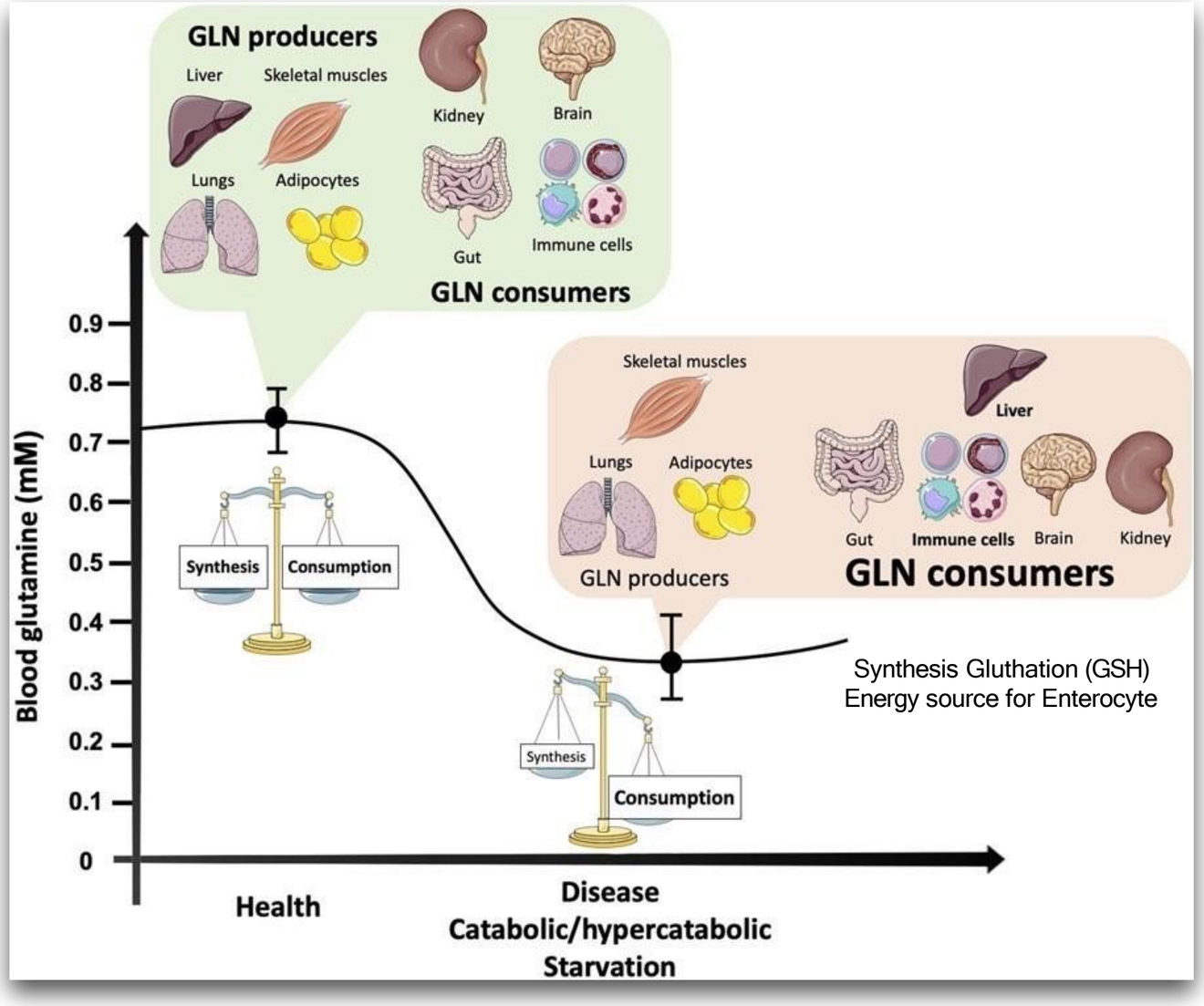
ADEQUATE **PROTEIN** INTAKE → **GLUTAMINE**:

- Antioxidant (Glutathion)
- Cell proliferation
- Substrat for enterocytes (ATP)
- Immune function: activated T-cells and B-cells → ↓IL-6, IL-8; ↑IL-10.

GLUTAMINE

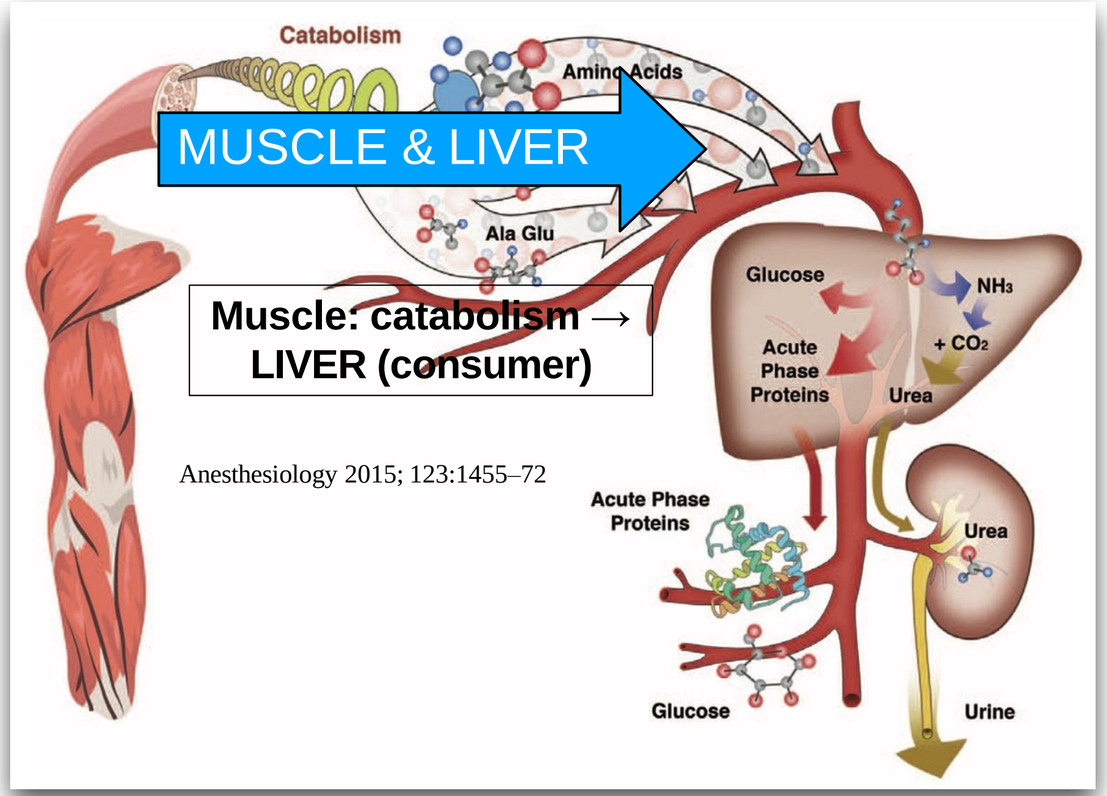
- Glutamine is conditionally **essential** AA. favorite substrate for **lymphocytes** and **enterocytes**.
- Component of proteins, representing around **8% of all amino acids**.
- Glutamine in mixed protein contains approximately **12 %** of **GLN**.
- Normal concentration glutamine **420–700 µmol/l**
- Plasma GLN levels have repeatedly been shown to be **low** during critical illness, and low values to be associated with **poor outcome**.
- Analysis of burn exudates shows that **GLN is lost** in larger amounts than any other amino acid (JPEN. vol. 46,4 (2022): 782-788)

P. Singer et al. / Clinical Nutrition 38 (2019) 48-79



Synthesis Gluthation (GSH)
Energy source for Enterocyte

GLUTAMINE METABOLISM



Anesthesiology 2015; 123:1455–72

https://doi.org/10.1017/S0029665122002749


Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/burns
ELSEVIER
BURNS

Glutamine relieves the hypermetabolic response and reduces organ damage in severe burn patients: A multicenter, randomized controlled clinical trial☆

Zi En Wang[a,b,1], Jian Jun Zheng[a,1], Jin Bin Feng[c], Dan Wu[b], Sen Su[b], Yong Jun Yang[b], Yan Wei[b], Zhao Hong Chen[a], Xi Peng[a,b,d,e,]*

1. GLUTAMINE FOR HYPERMETABOLIC RESPONSE

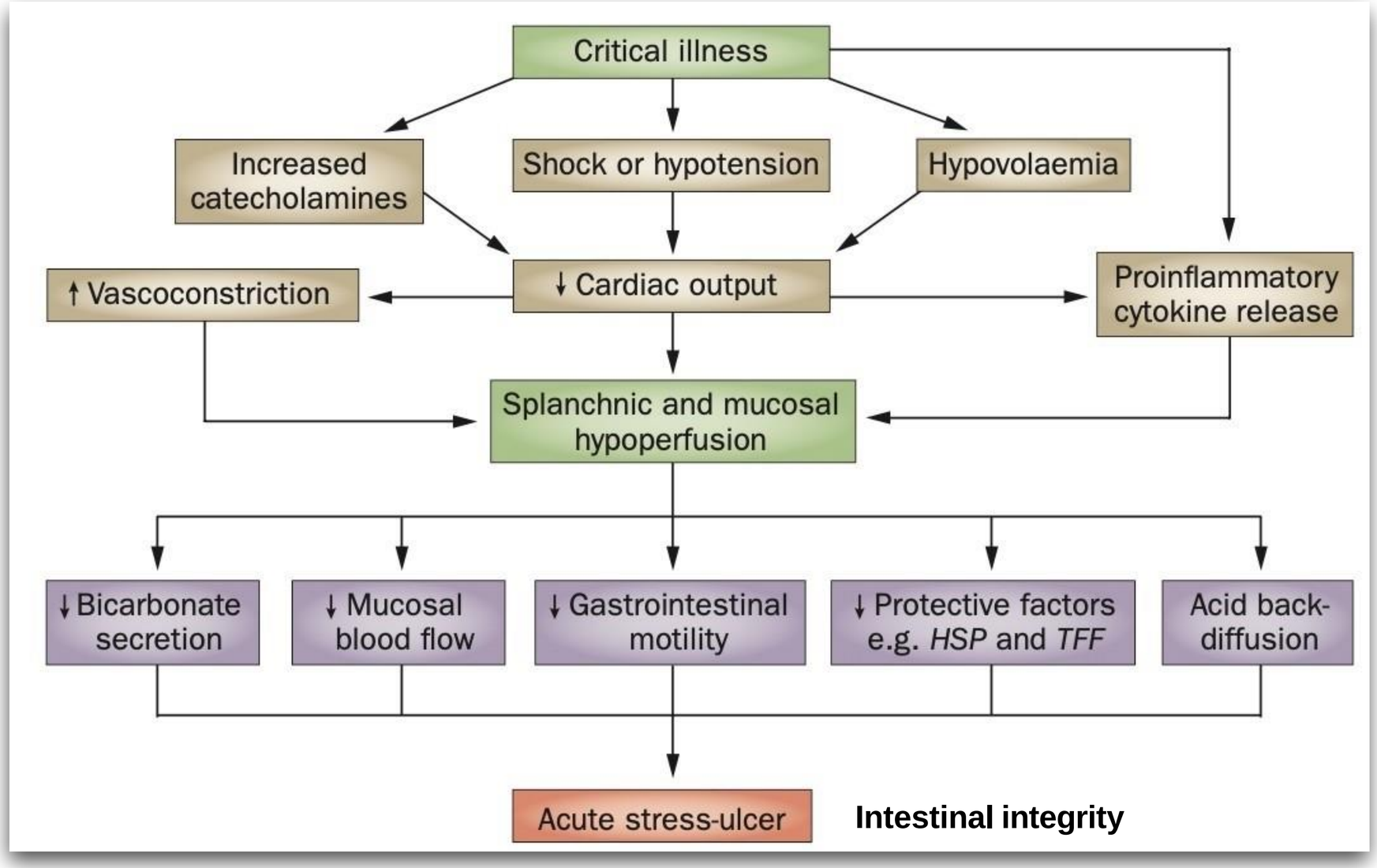
Conclusions:

Glutamine moderately alleviates the hypermetabolic response and reduces organ damage after severe burns.

Therefore, the early application of glutamine, which is effective and safe, should be used as an active intervention as early as possible.

- POPULATION: 55 adult burn patients with a total burn surface area (TBSA) of 30-70%.
- INTERVENTION: **Glutamine** via the **parenteral route.** Specifically, **alanyl glutamine injection diluted with 5% dextrose at a ratio of 1:5** was administered iv at a dose of **0.5 g/kg**. The treatments were given for **14 days** to each group.
- C: Isonitrogenous and isocaloric nutritional support were via a compound AA injection.
- O: The levels of **REE**, serum **catecholamines**, **glucagon**, **lactate** and Homeostasis model assessment (**HOMA**) **were significantly lower** than control ($p < 0.05$ or 0.01).

burns 48 (2022) 1606–1617



J. Crit. Care 20, 35–45 (2005)

GUT DYSFUNCTION

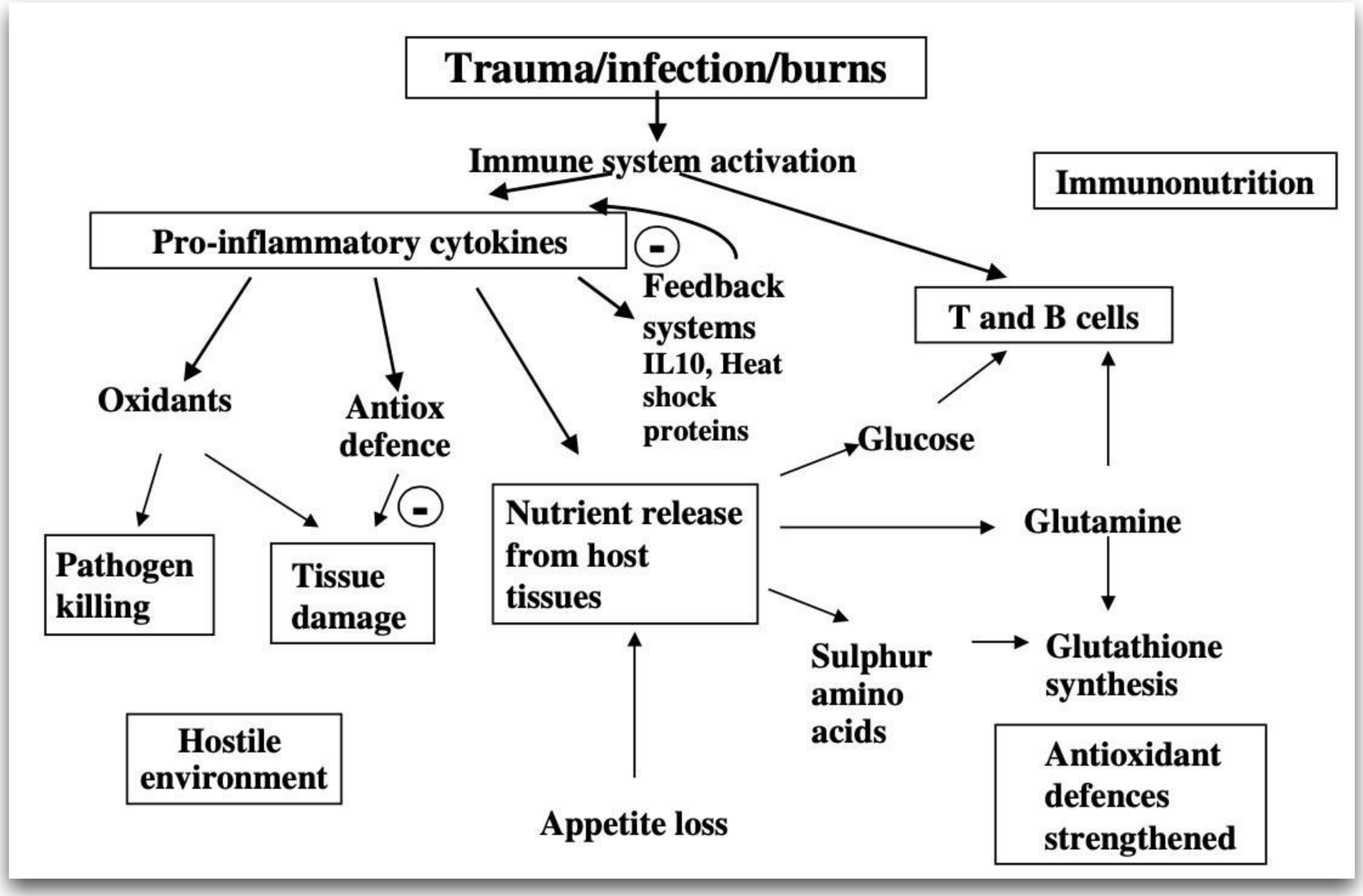
Bacteria and toxins present in the blood circulation triggering:

- Inflammatory response → **Hypermetabolism**
- Infection → **Hypermetabolism**
- Organ injury

2. ROLE OF GLUTAMINE IN GUT INTEGRITY

- Gastrointestinal dysfunction plays a key role in the driving **sepsis**, ongoing **infection**, and even distant organ failure.
- As **enterocytes** prefer GLN as a substrate, GLN may be vital for the normal immunologic function and structure of the gut.
- GLN deficiency leads to **loss** of intestinal epithelial barrier function.
- Supplementation with GLN attenuates **mucosal atrophy** in the gut during parenteral nutrition (PN).

Nutr Clin Pract. 2019;00:1–7



The influence of metabolic changes during the inflammatory response on anti-oxidant status and immune function.

3. GLUTAMINE AS A IMMUNONUTRIENT

- **T cells** can helping B lymphocytes to eliminate invading pathogens.
- **B cells** create antibodies.

4. ROLE OF GLUTAMINE IN INFECTION

Glutamine administration reduces Gram-negative bacteremia in severely burned patients: A prospective, randomized, double-blind trial versus isonitrogenous control

Wischmeyer, Paul E. MD; Lynch, James BS; Liedel, Jennifer MD; Wolfson, Rachel MD; Riehm, Jacob; Gottlieb, Lawrence MD; Kahana, Madelyn MD

Author Information

Critical Care Medicine 29(11):p 2075-2080, November 2001.

- **26** severe burn patients.
- The incidence of **Gram-negative** bacteremia was significantly **reduced** in the glutamine-supplemented group (8%) vs. control (43%).
- **C-reactive protein** was also significantly reduced at 14 days after burn injury in the glutamine group ($p < .01$).
- Glutamine's beneficial effects may be a result of improved **gut integrity or immune function.**

ORIGINAL ARTICLE

Intisari Sains Medis 2021, Volume 12, Number 1: 187-191
P-ISSN: 2503-3638, E-ISSN: 2089-9084

INTISARI SAINS MEDIS

Published by Intisari Sains Medis

Correlation of glutamine and serial absolute neutrophil count as a parameter of infection in major burn trauma patients at Sanglah General Hospital, Bali, Indonesia

CrossMark

Shita Diwyani Sudarsa[1*], Agus Roy Rusly Hariantana Hamid[2], Agustinus I Wayan Harimawan[3], Ni Nyoman Sri Budayanti[4]

- **56** major burn patients. **Analytical study** with a cross-sectional design to see the relationship between **glutamine administration and the serial absolute neutrophil count levels**.
- **Conclusion**: glutamine administration was significantly associated with **decreased the serial absolute neutrophil count**.


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Enteral Glutamine for Treatment of Burn Injuries

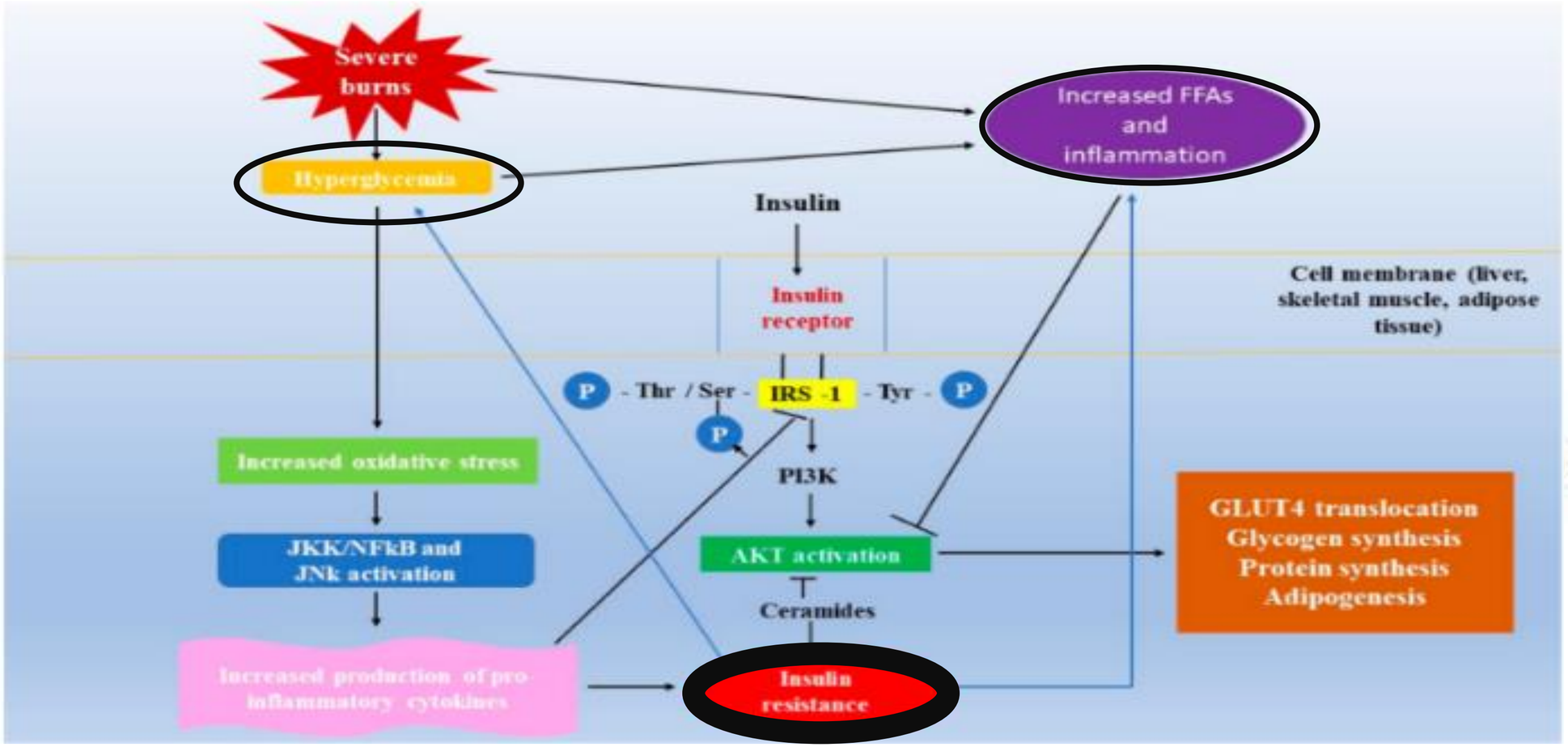
RE-ENERGIZE ClinicalTrials

The RE-ENERGIZE study is the first major international multicenter study of the role of GLN in burns.

- P: **1200** patients with severe burn injury. In a double-blind, randomized, placebo-controlled trial
- INTERVENTION: **Glutamine 0.5 g/kgBB/d**, were given every 4 hours through a **feeding tube** or three or four times a day by mouth until 7 days after the last skin grafting procedure, discharge from the acute care unit, or **3 months after admission**, whichever came first.
- O: In patients with severe burns, supplemental glutamine did not reduce the **time to discharge alive from the hospital.**
- **shown consistent GLN deficiency in burn-injured patients**

N Engl J Med 2022;387:1001-10.

ROLE OF CARBOHYDRATES&LIPIDS



Int. J. Mol. Sci. 2021, 22, 5159

Administration of glucose, even in large amounts, fails to suppress endogenous glucose production, gluconeogenesis, and protein breakdown

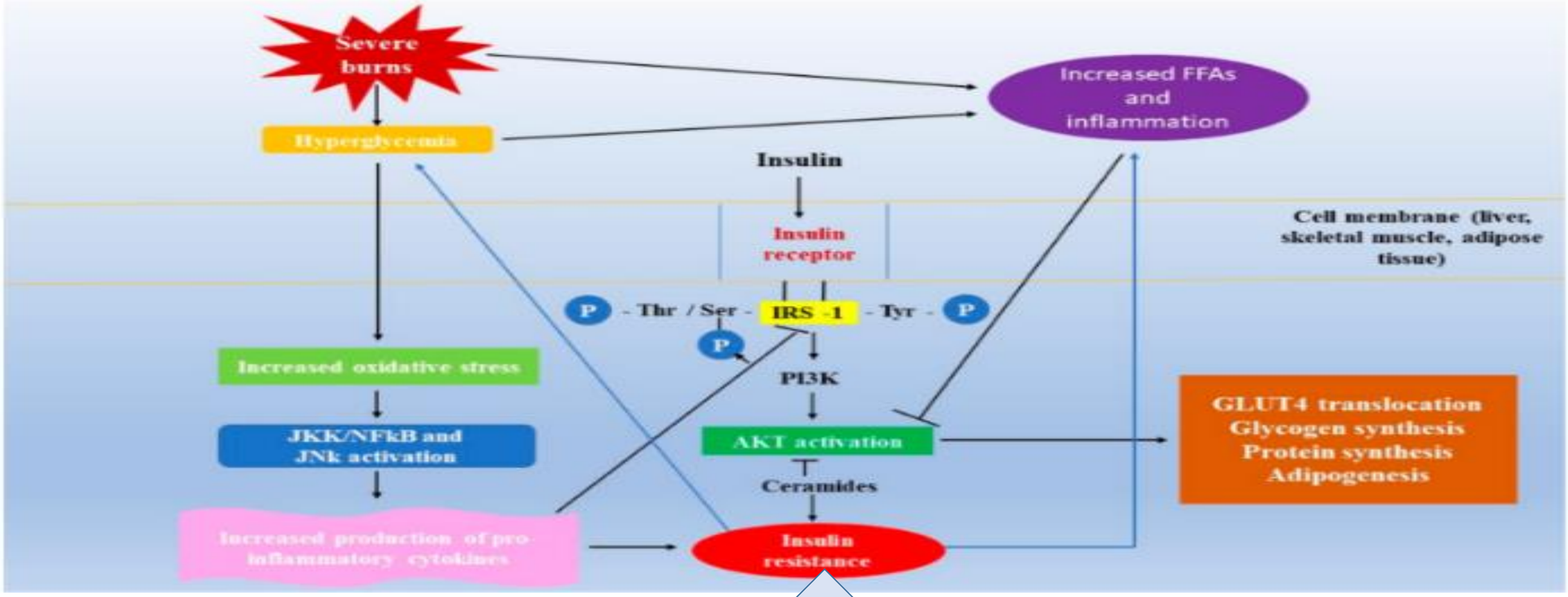
Fatty liver from increased de novo lipogenesis is commonly observed in major burns. It probably results from hypercaloric feeding with excessive amounts of carbohydrate

Avoid giving glucose at a rate in excess of 5 g/kg/day, and to use glucose–lipid mixtures for patients without lipid intolerance, due to the above mentioned maximal oxidizing capacity of glucose.
Lipid 30-35%

Tight glycaemic control <8 mmol using insulin, reduces mortality in critically ill surgical patients

Insulin may have other beneficial effects as well, e.g. decreased protein catabolism and improved muscle protein synthesis

e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism 4 (2009) e308–e312



Insulin Therapy
Fenofibrate
Glucagon-Like Peptide-1 (GLP-1) and Analogs
Metformin
Sitagliptin
Recombinant Human Growth Hormone (rhGH)
Beta Blockers

Int. J. Mol. Sci. 2021, 22, 5159

4. THE ROLE OF MICRONUTRIENTS IN BURN INJURY

- Vitamins A and E are involved in tissue repair.
- Fat-soluble vitamins D and K are stored in adipose tissue and are slowly depleted during prolonged diseases: there are no reports of deficiencies specific to burns.
- Water-soluble vitamins of the B complex are not stored in appreciable amounts and are rapidly depleted. Their requirements are increased, due to changes in carbohydrate metabolism (vitamin B_1).
- Vitamin C is important in collagen synthesis and also has an antioxidant effect. A total daily intake of 1–2 g is therefore recommended. According to recent studies, even this quantity may be insufficient during the early phase after burns, when the use of mega-doses may achieve a capillary leak stabilising effect.
- Copper, selenium and zinc are lost in large amounts through cutaneous exudates: depletion of body stores must be anticipated by early substitution in patients with major burns. Copper is of special importance in burns as collagen is dependent on it for maturation. Selenium is essential for glutathione peroxidase activity and zinc for immunity and cell replications.

e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism 4 (2009) e308–e312

The effect of dietary intake of antioxidant micronutrients on burn wound healing: a study in a tertiary health institution in a developing country

Article *In* Burns & Trauma · August 2015

Methods: Questionnaires were administered to 40 burn patients at Komfo Anokye Teaching Hospital (Ghana) from January 1, 2014 to May 30, 2014. The data taken include anthropometric measurements and dietary assessment. Their nutrient intakes were assessed with the Nutrient Analysis Template. The average intakes were compared to the recommended daily allowance. Assessment of recovery was based on records of wound healing assessments and infection rates from the health practitioners.

Results: A cross-sectional study of 40 patients revealed an average total burn surface area (TBSA) of 31.4 %, where 70.0, 35.0, 75.0, 52.5, 12.5 and 32.5 % patients were deficient in vitamins A, C and E, zinc, copper and selenium, respectively and adequate amounts of vitamin C intake were related with significantly better wound healing progress. Positive wound healing outcomes were observed for patients with adequate vitamins A and E and zinc intake. Less infection presented among patients with adequate amount of vitamins A and C and zinc, but this was not observed for patients with adequate vitamin E, copper and selenium.

CONCLUSIONS

Indication	Initiate nutrition within 12 h by enteral route
Route	Enteral method is preferred and parenteral is rarely indicated The two techniques are complementary
Energy needs/equations for calculation	Gold standard is indirect calorimetry. For adults Toronto equation and for children Schofield equations are alternatives, if IC is not available
Proteins	Adults protein needs 1.5–2.0 g/kg; children need 1.5–3 g/kg/day. They are higher than in critical patients due to other conditions Glutamine or ornithine alpha-ketoglutarate is ideal
Glucose levels and glycemic control	Carbohydrate sources make up for 60% of total energy intake (limit to below 5 mg/kg/min in adults and children) Continuous intravenous infusion of insulin keeps glucose levels under 8 mmol/L (and over 4.5 mmol/L)
Lipids	Fat energy sources form <35% of total energy and monitor total fat delivery
Micronutrients	Adults and children need zinc, copper, and selenium; vitamin B1, C, D, and E


thank you