

IN THE NAME OF GOD

NUTRITION IN ICU

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KUMS



2 TYPES OF ICU

- I. **Medical ICU** :This offers critical care to patients to treat a wide range of medical conditions like respiratory failure, sepsis, organ failure, and neurological emergencies.
- II. **Surgical ICU**: This is offered to patients who undergo major surgeries.The main idea of this ICU is to manage surgical complications, pain control, and wound care.
- III. **Cardiac ICU**: This unit specialises in caring for patients with severe cardiac conditions, including heart attacks, congestive heart failure, arrhythmias, and those recovering from cardiac surgeries.The equipment offers continuous cardiac monitoring, and advanced cardiovascular support to prevent further complications.
- IV. **Neonatal ICU**: This Unit is dedicated to the care of critically ill newborn infants. It offers support to patients suffering from respiratory distress, temperature regulation, and nutrition focusing on overall growth.
- V. **Pediatric ICU** : This unit focuses on providing intensive care to critically ill children.The unit offers special care to respiratory distress, trauma, severe infections, and congenital abnormalities, with a focus on age-appropriate care and emotional support.

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A. Nutritional Assessment

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INTRODUCTION

- Critically ill patients ⇒ high risk for malnutrition
- Malnutrition has been correlated with **prolonged hospital stays, nutrition-related complications** and **other adverse outcomes.**
- Proper nutrition treatment may ↓ the morbidity, mortality, and cost associated with malnutrition.

NUTRITION ASSESSMENT

A comprehensive evaluation of nutrition status:

Medical history, dietary history, physical examination, anthropometric measurements, and laboratory data

- Using a single indicators :
 - ❖ Serum albumin level
 - ❖ weight
 - ❖ Triceps skinfold (TSF) thickness
- ➡ Fails to recognize the multitude of factors that influence nutrition status.

6 ESPEN

(European Society for Parenteral and Enteral Nutrition)

APACHE II score

SOFA score

NRS2002

7 **A.S.P.E.N. GUIDELINES**

(AMERICAN SOCIETY FOR PARENTERAL AND ENTERAL NUTRITION)

Nutrition Risk Index (NRI)

Prognostic Nutrition Index (PNI)

Prognostic Inflammatory and Nutritional Index (PINI)

Subjective global assessment (SGA)

Nutritional Risk Screening (NRS-2002)

Initial screening

	Answer	
• Is BMI < 20.5?	Yes	No
• Has the patient lost weight within the last 3 months?	Yes	No
• Has the patient had a reduced dietary intake in the last week?	Yes	No
• Is the patient severely ill ? (e.g. ICU)	Yes	No

→ If „No“ to all questions, re-screened at weekly intervals.

→ If „Yes“ to any question, the final screening is performed.



Nutritional Risk Screening (NRS-2002)

Final Screening I (Impaired nutritional status)

Absent	Score 0	= Normal nutritional status
Mild	Score 1	Wt loss >5% in 3 months or Food intake below 50-75% normal requirement in preceeding week
Moderate	Score 2	Wt loss >5% in 2 months or BMI 18.5 – 20.5 + impaired general condition or Food intake 25-50% normal requirement in preceeding week
Severe	Score 3	Wt loss >5% in 1 mo (>15% in 3 mo) or BMI <18.5 + impaired general condition or Food intake 0-25% normal requirement in preceeding week

Nutritional Risk Screening (NRS-2002)

Final screening II (Severity of disease)

Absent	Score 0	Normal nutritional requirements
Mild	Score 1	Hip fracture, chronic patients, in particular with acute complications: cirrhosis, COPD, <i>chronic hemodialysis, diabetes, oncology</i>
Moderate	Score 2	Major abdominal surgery, stroke. <i>Severe pneumonia, hematologic malignancy</i>
Severe	Score 3	Head injury, bone marrow transplantation, <i>Intensive care patients (APACHE>10).</i>

Nutritional risk screening

ESPEN – NRS 2002

- **Impaired nutritional status**
weight loss % over time, food intake, BMI (Score 0-3)
- **Severity of disease**
mild to severe (Score 0-3)
- **Age over 70 years add 1 point**



**If the total score is 3 or more
nutritional support is indicated**

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Energy and macronutrient requirements in ICU patient:



13 DETERMINING ENERGY NEEDS IN ICU PATIENT:

- Indirect calorimetry (IC)

In the absence of IC:

- A simplistic weight-based equation (25–30 kcal/kg/d)

14 PROTEIN REQUIREMENT:

- Protein is most important macronutrient for:
- Healing wounds
- Supporting immune function
- Maintaining lean body mass

- **Weight-based equations:** 1.2–2.0 g/kg actual body weight per day.
- Be higher in burn or multiple trauma patients.

- Serum protein markers: (albumin, prealbumin, transferrin, CRP) are **not validated** for determining adequacy of protein provision.
- CHO ? FAT??

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B. Initiate EN

16 BENEFIT OF EARLY EN IN CRITICALLY ILL ADULT PATIENTS

- **Early EN** be initiated within **24–48 hours** who is unable to maintain volitional intake.
- ✓ EN supports:
 - Integrity of the gut by maintaining **tight junctions**
 - Maintaining **villous height**
 - Stimulating **blood flow?**
 - Release of **trophic endogenous agents** (eg, cholecystokinin, gastrin, bombesin, and bile salts)

• با افزایش جریان خون اسید معده شسته شده و احتمال GI bleeding کمتر. بهمین دلیل در ICU بیماران رانیتیدین و پنتوپرازول استفاده می نمایند.

EN supports

gut-associated lymphoid tissue (GALT)

mucosal-associated lymphoid tissue at distant sites such as the lungs, liver, and kidneys.

18 PREFERRED LEVEL OF INFUSION OF EN WITHIN THE GI

✓ In most critically ill patients: EN in the **stomach**.

be **diverted lower for** :

- At high risk for **aspiration**
- **Intolerance** to gastric EN

But advantage of EN in the stomach:

- Higher volume
 - Use of polymeric formula (we don't have monomeric formula in Iran)
 - With out endoscopy
- Thus we use EN in the stomach in Iran

C. Dosing of EN

20 TROPHIC EN OVER THE FIRST WEEK OF HOSPITALIZATION FOR:

1. acute respiratory distress syndrome (ARDS)
2. acute lung injury (ALI)
3. have a duration of mechanical ventilation ≥ 72 hours

Initial trophic EN: (defined as 10–20 kcal/h or up to 500 kcal/d)

For: Prevent mucosal atrophy and maintain gut integrity

2 | full EN (as close as possible to target nutrition goals) beginning in the first week of hospitalization for:

1. Patients who are at high nutrition risk (eg, NRS 2002 ≥ 5 or NUTRIC score ≥ 5 , without interleukin 6) : High-risk patients (**burn** and **bone marrow transplant** patients)
2. Severely malnourished

- ✓ **Efforts to provide $>80\%$ of goal energy / protein within 48–72 hours**
- ✓ **Advanced toward goal : over 24–48 hours**
- ✓ **Monitoring for refeeding syndrome** (تشخیص رفیدینگ با فسفر و سپس افت سدیم و پتاسیم و منیزیم)

D. Monitoring Tolerance and Adequacy of EN

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- (NPO) should be minimized to limit propagation of **ileus** and to prevent **inadequate nutrient** delivery.

24 GI INTOLERANCE DEFINITION

- Vomiting
- Abdominal **distention**,
- Complaints of discomfort
- High **NG output**, high **GRV**
- Diarrhea
- Reduced passage of **flatus** and **stool**
- Abnormal **abdominal radiographs**

25 SHOULD GRVS BE USED AS A MARKER FOR ASPIRATION TO MONITOR ICU PATIENTS RECEIVING EN?

- GRVs not be used as part of routine care to monitor ICU patients receiving EN.
- GRVs do **not correlate** with incidences of pneumonia, regurgitation, or aspiration.
- If GRVs are still utilized, holding EN for GRVs <500 mL in the absence of other signs of intolerance should be **avoided**.

26 PATIENTS AT HIGH RISK FOR ASPIRATION

- Mechanical ventilation
- Age >70 years
- Reduced level of consciousness
- Inadequate nurse : patient ratio,
- Supine positioning
- Neurologic deficits
- Gastroesophageal reflux
- Transport out of the ICU
- Use of **bolus** intermittent EN

• در سن بالا بدلیل عدم کارایی مناسب دیافراگم احتمال اسپیراسیون است.

• در کاهش سطح هوشیاری هم رفلکس های طبیعی کاهش می یابد.

-
- Use of **postpyloric enteral**
 - Switched to **continuous infusion**
 - Agents to promote motility, such as **prokinetic medications** (metoclopramide or erythromycin)
 - The head of the bed should be elevated **30°–45°**
 - **Use of chlorhexidine mouthwash twice a day**

- اریترومایسین محل اثرش روده است و قویتر است. اندانسترون محل اثرش مغز است در کموتراپی بیشتر اثر دارد یا در بیماران با ترومای سر.
- متوکلوپرامید منع مصرف در Cr بالا . اما هر دو بر ریتم قلبی اثر دارند و در بیماران قلبی هر دو ممنوع هستند.
- عارضه مصرف طولانی پلازین انقباضاتی شبیه تشنج است پس در بیماران با حملات تشنج منع مصرف طولانی دارد.

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- Diarrhea associated with EN???
 - EN not be automatically interrupted for diarrhea
 - Feeds be continued while evaluating the etiology of diarrhea

E. Selection of Appropriate Enteral Formulation



30 WHICH FORMULA FOR INITIATING EN IN THE CRITICALLY ILL PATIENT?

- A **standard polymeric** isotonic or near isotonic **1- to 1.5-kcal/mL formula** is appropriate and will be well tolerated.

3 |

- **No clear benefit** for the routine use of specialty formulas in a general ICU setting, including:

- Diabetes
- (pulmonary, renal, hepatic),
- Semi elemental
- Elemental
- Immune modulating (Arg-EPA-DHA- glutamine-nucleic acid): **no outcome benefits** over standard EN formulas in a MICU setting

Consideration for these formulations should be reserved for patients with **TBI (thromatic brain injury) and **perioperative** patients in the **SICU**.**



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- The **rationale for pulmonary formulas** (high fat to carbohydrate to reduce respiratory quotient) has been shown to be **erroneous** (effect seen only with **overfeeding**), and their high content of **omega-6** fatty acid may drive inflammatory processes.

33 FORMULATIONS CONTAINING SOLUBLE FIBER OR SMALL PEPTIDES

- A commercial **mixed fiber** formula **not be used routinely**
- **Avoiding** both soluble and insoluble fiber: in **bowel ischemia** or severe dysmotility.
- **Small peptide** formulations : in **persistent diarrhea**

F. Antioxidants and trace minerals



ANTIOXIDANTS AND TRACE MINERALS

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- Antioxidant vitamins (including vitamins E and C)
 - Trace minerals (including selenium, zinc, and copper)
 - Especially in **burns, trauma**, and critical illness requiring **mechanical ventilation**

Renal function should be considered when supplementing vitamins and trace elements



36 ENTERAL GLUTAMINE

- supplemental enteral glutamine **not** be added to an EN regimen **routinely** in critically ill patients.

G. When to Use PN

38 PATIENT AT LOW NUTRITION RISK

At low nutrition risk (eg, NRS 2002 ≤ 3 or NUTRIC score ≤ 5): (پرنترال انحصاری) exclusive PN be **withheld over the first 7 days**

if

- Early EN is not feasible.
- Patient cannot maintain volitional intake

Patients with **short bowel** should **continue their PN**

39 PATIENT AT HIGH NUTRITION RISK?

- (eg, **NRS 2002 ≥ 5 or NUTRIC score ≥ 5**) or **severely malnourished**,
- (پرنترال انحصاری) Initiating exclusive PN **as soon as possible**
if
- EN is not feasible

40 OPTIMAL TIMING FOR INITIATING **SUPPLEMENTAL PN**

In patients at either low or high nutrition risk:

use of supplemental PN be considered after 7–10 days

if

- **Unable to meet >60% of energy and protein** requirements by the enteral route alone.

H. When Indicated, **Maximize Efficacy of PN**

When Indicated, **Maximize Efficacy of PN**

1- USING TPN over the first week of hospitalization in the ICU

- Hypocaloric PN dosing (≤ 20 kcal/ kg/d or 80% of estimated energy needs)
- With adequate protein (≥ 1.2 g protein/kg/d)

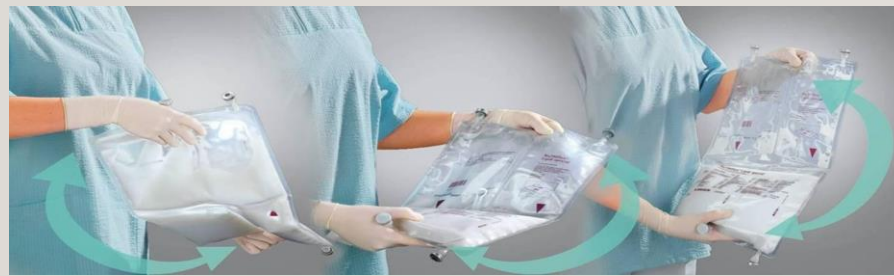
• TPN از ¼ مقدار هدف شروع می شود. و در دوز های پوکالریک آن با کمتر از 20 کالری در کیلوگرم یا 80 درصد کالری هدف شروع می شود.

2- USING SMOF LIPID

Alternative (SMOF [soybean oil, MCT, olive oil, and fish oil emulsion], MCT, OO, and FO) IVFEs may provide outcome benefit over soy-based IVFEs during the first week.

concern for essential fatty acid deficiency: max **100 g/wk** (often divided into 2 doses/wk)

- Is there an advantage to using **premixed PN** versus compounded PN admixtures? **NO**
has no advantage in terms of clinical outcomes.



THE DESIRED TARGET BLOOD GLUCOSE RANGE IN ADULT ICU PATIENTS

- Target blood glucose range : **140 or 150–180** mg/dL for the **general ICU population**.
- Ranges for specific patient populations (postcardiovascular surgery, head trauma, . . .) may differ and are beyond the scope of this guideline.
- **BG \geq 150 mg/dL : triggers initiation of insulin** therapy for most patients with the diagnoses of ischemic stroke, intraparenchymal hemorrhage, aneurysmal subarachnoid hemorrhage, or **TBI**.

• چک قند خون والکترولیت‌ها برای شروع پرنترال ضروری است.

• قند خون نرمال اینجا 140-180 است.

• بیماران با جراحی قلب و ترومای سر گایدلاین متفاوت است اسپین می گوید 100-150 نرمال است برای اینها و قبل 180 باید انسولین دهند و زیر 100 هیپوگلیسمی است.

I. Pulmonary Failure




Pulmonary Failure

1. **Risk for Fluid accumulation, pulmonary edema, and renal failure** for patients with acute respiratory failure : **fluid restricted energy-dense EN formulations (1.5–2 kcal/mL)**
2. Optimal carbohydrate/fat ratio for pulmonary failure: specialty high-fat/low-carbohydrate formulations **not be used** in ICU patients with acute respiratory failure.
3. **Avoid total energy provision** that exceeds energy requirements, as **CO₂ production increases significantly with lipogenesis.**
4. **Rapid infusion of IVFE** : should be avoided in patients with severe pulmonary failure.
5. Serum phosphate concentrations should be monitored closely in patients with acute respiratory failure.
 - Moderate hypophosphatemia serum phosphorus concentrations ≤ 2.2 mg/dL and severe hypophosphatemia < 1.5 g/dL.

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Renal Failure

ACUTE KIDNEY INJURY (AKI), ENERGY AND PROTEIN

- ICU patients with acute renal failure (ARF) or AKI : **standard enteral formulation.**
 - **Protein (1.2–2 g/kg actual or usual body weight per day)**
 - **Protein should not be restricted in patients with renal insufficiency as a means to avoid or delay initiating dialysis therapy.**
 - **Energy (25–30 kcal/kg/d).**
 - **Ideal body weight for obese** critically ill patients.
 - If significant **electrolyte abnormalities** develop, a specialty **formulation designed for renal failure** (with appropriate electrolyte profile) may be considered.
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In adult critically ill patients with AKI receiving **hemodialysis or CRRT:**

- Increased protein, **up to a maximum of 2.5 g/kg/d.**

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Hepatic Failure



51 Hepatic Failure

Cirrhosis and hepatic failure: dry weight or usual weight be used instead of actual weight.

- **Avoid restricting protein** in patients with liver failure due to complications of ascites, intravascular volume depletion, edema, portal hypertension, and hypoalbuminemia.
- Using the same recommendations as for other critically ill patients
- **Standard enteral formulations** be used in ICU patients with acute and chronic liver disease.
- There is **no evidence** of further benefit of branched-chain amino acid (**BCAA**) formulations on coma grade in the ICU patient with **encephalopathy** who is already receiving first-line therapy with luminal-acting antibiotics and lactulose.

Acute Pancreatitis



Mild acute pancreatitis

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- ✓ Not providing specialized nutrition therapy to patients with mild acute pancreatitis.
- ✓ Advancing to an **oral diet** as tolerated.

Moderate to severe acute pancreatitis (پانکراتیت حاد متوسط تا شدید)

- ✓ **EN started at a trophic rate** and advanced to goal **within 24–48 hours of admission**
- ✓ initiate EN in the patient with **severe acute pancreatitis**: standard polymeric formula
- ✓ Route of feeding in pancreatitis: **gastric or jejunal route**, as there is **no difference**.

Moderately severe acute pancreatitis (پانکراتیت حاد نسبتاً شدید)

Is defined by transient organ failure lasting <48 hours and local complications: pain, nausea, vomiting, and normalization of pancreatic enzymes

STRATEGIES IN **INTOLERANCE TO EN** IN SEVERE ACUTE PANCREATITIS?

- Diverting the level of infusion of **EN more distally in the GI tract** (قسمتهای پایینتر از پیلور)
- Changing from a standard polymeric formula to **small peptides and MCTs**
- **Fat-free elemental formulation**
- Switching from **bolus to continuous** infusion

When EN is not feasible use of PN should be considered **after 1 week** from the onset of the pancreatitis episode.

M. Surgical Subsets (Trauma &TBI & Open abdomen (OA))

56 TRAUMA

Similar to other critically ill patients with:

- **Early** enteral feeding & **high protein polymeric diet** If the patient is **hemodynamically stable**.
- Energy goals should be in the range of **20–35** kcal/kg/d
- Immune-modulating formulations containing **arginine** and **FO** be **considered in patients with severe trauma**.

Traumatic Brain Injury

TBI



58 TBI

- **Early enteral feeding** be initiated in the immediate posttrauma period (within 24–48 hours of injury) once the **patient is hemodynamically stable**.
- **Energy expenditure can range from 100%–200%** of baseline-predicted REE.
- Protein requirements : **1.5–2.5 g/kg/d**
- Energy approximately **25 kcal/kg/d**.
- Suggested use of either **arginine-containing** immune-modulating formulations or **EPA/DHA supplement** with standard enteral formula in patients with TBI.

59 OPEN ABDOMEN (OA)

- Providing an additional 15–30 g of protein per liter of exudate lost for patients with OA.


• (پروتئین مانند سایر بیماران ICU بعلاوه ۱۵-۳۰ گره پروتئین اضافی به ازای هر لیتر ترشحات از دست رفته)

- Energy needs should be determined **as for other ICU patients.**

60 SEPSIS

- **Initiating EN within 24-48 hours** of resuscitation or when hemodynamic stability is reached.
- **Not using** exclusive PN or supplemental PN in conjunction with EN early in the acute phase of severe sepsis or septic shock, regardless of patients' degree of nutrition risk.

protein / energy requirements for septic patients in the acute phase of management:

- **Trophic feeding** (defined as 10–20 kcal/h or up to 500 kcal/d) for the initial phase of sepsis
 - Advancing as tolerated after 24–48 hours **to >80% of target energy goal over the first week.**
 - **1.2–2 g protein/kg/d.**
 - Immune-modulating formulas **not be used routinely** in patients with **severe sepsis.**
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6 | MICRONUTRIENT SUPPLEMENTATION IN SEPSIS

- We **cannot make a recommendation** regarding **selenium, zinc,** and **antioxidant** supplementation in sepsis at this time due to conflicting studies.
- Specifically, plasma selenium has been shown to be depressed in sepsis.
- The recommended optimal acute selenium dose for critically ill patients may range between 500–750 mcg/d, 1–3 weeks depending on severity of disease

62 POSTOPERATIVE MAJOR SURGERY (SICU ADMISSION EXPECTED)

- **Routine use** of an immune-modulating formula (containing both arginine and fish oils) in the SICU for the postoperative patient who requires EN therapy.
- For the patient who has undergone major upper GI surgery and EN is not feasible and **duration of therapy is anticipated to be ≥ 7 days** PN should be initiated.
- Upon advancing the diet postoperatively, patients be **allowed solid food as tolerated** and that **clear liquids are not required as the first meal.**

63 CHRONICALLY CRITICALLY ILL

- Chronically critically ill patients (defined as those with persistent organ dysfunction requiring **ICU LOS >21 days**) be managed with **aggressive high-protein EN therapy** and, when feasible, that a **resistance exercise program be used**.

Q. Obesity in Critical Illness



OBESITY IN CRITICAL ILLNESS

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- Early EN start within 24–48 hours of admission to the ICU for obese patients who cannot sustain volitional intake.
 - **High protein hypocaloric** feeding in the care of obese ICU patients.

The nutrition assessment in the obese ICU patient should focus on:

- Determining **actual, usual, and ideal** weight.
- **BMI** should be calculated, **Class of obesity** identified, and, if possible, **waist circumference** measured.
- **Use of adjusted body weight is not recommended**

Protein:

2.0 g/kg ideal body weight: BMI = 30–40

up to 2.5 g/kg ideal body weight : BMI ≥40.

Energy:

11–14 kcal/kg actual body weight :BMI =30–50

22–25 kcal/kg ideal body weight : BMI >50.



66 OBESITY IN CRITICAL ILLNESS

- Biomarkers of metabolic syndrome should be evaluated, which include:

serum glucose,

triglyceride,

and cholesterol concentrations

Attention to blood pressure

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- An assessment of the level of inflammation should be done by looking at :
 - CRP
 - Erythrocyte sedimentation rate
 - Evidence of SIRS (The Systemic Inflammatory Response Syndrome)

SIRS criteria:

1. Body temperature over 38 degrees Celsius or under 36 degrees C.
2. Heart rate greater than 90 beats per minute.
3. Respiratory rate greater than 20 breaths per minute or partial pressure of CO₂ less than 32 mmHg.
4. Leukocyte (white blood cell) count greater than 12,000

obese ICU patient with a history of bariatric surgery or other mal absorptive condition:

- supplemental thiamine prior to initiating dextrose-containing IV fluids or nutrition therapy.
- calcium
- thiamin
- vitamin B12
- fat soluble vitamins (A, D, E, K)
- folate
- trace minerals **iron, selenium, zinc, and copper**

• حتما در شروع تزریق دکستروز وریدی باید تیامین IV شود.

Thank you

