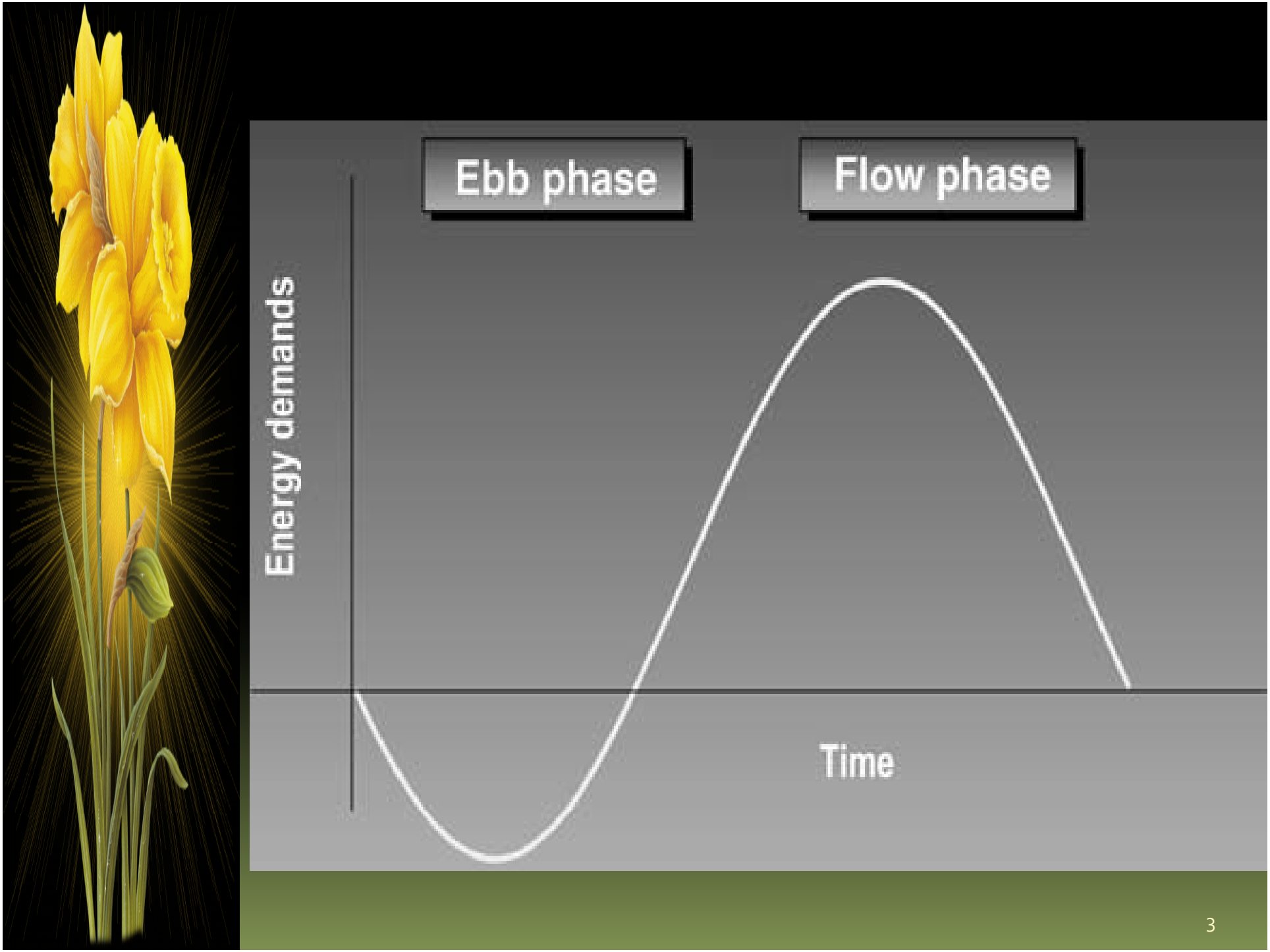
ENTERAL NUTRITION IN THE CRITICALLY ILL

- Ebb phase
- Flow phase
  - acute response (catabolic)
  - adoptive response (anabolic)


Ebb phase
Flow phase
Energy demands
Time

Metabolic Response to Stress (catabolic phase)

- Glucose and Protein Metabolism
- Fluid and Electrolyte Response
- Endocrine Response
- Inflammatory and Immunologic Response

systemic inflammatory response syndrome

- The severity of hypermetabolic phenomena thereafter might lead to the systemic inflammatory response syndrome (SIRS), the amplified generalized body response.

- **SIRS** describes the widespread inflammation

DX of SIRS

the presence of two or more of the following

- T > 38.5° C or < 36° C
- Heart rate > 90 /min
- Respiratory rate > 20 breaths/min (tachypnea) or $Paco_2$ < 32 mm Hg (hyperventilation)
- WBC > 12,000/mm3 or < 4000/mm3 Bandemia (the presence of more than 10% bands (immature neutrophils)

MODS

- A common complication of SIRS is the development of **multiple organ dysfunction syndrome (MODS).**

MODS

- Lung failure (PO_2/FiO_2)
- (kidney failure) Serum creatinine
- (Hematologic failure) Platelet count
- (Central nervous system failure) Glasgow coma score
- Liver failure (Serum bilirubin)
- myocardial failure

Hypotheses of SIRS or MODS

- Excessive production of proinflammatory cytokines and other mediators of inflammation.
- The gut hypothesis: disruption of the gut barrier function

COMPLICATIONS OF MALNUTRITION

- Increased susceptibility to infection
- Poor wound healing
- Increased frequency of decubitus ulcers
- Overgrowth of bacteria in the GI
- Abnormal nutrient losses through the stool
- increased morbidity and mortality

When is EN indicated in ICU patients?

- All patients who are not expected to be on a full oral diet within 3 days.
- within the first 24-48 hours following admission.

- EN decreases infectious complications
- Preservation of gut immune function
- Reduction of inflammation

Contraindications

- Hemodynamically unstable and have not had their intravascular volume fully resuscitated, since such patients may be predisposed to bowel ischemia
- Persistent Ileus
- Gastrointestinal ischemia
- Bilious or persistent vomiting
- Mechanical obstruction

When to Use Parenteral Nutrition

- In the patient who was previously healthy prior to critical illness with no evidence of protein calorie malnutrition, use of PN should be reserved and initiated only after the first 7 days of hospitalization (when EN is not available).

When to Use Parenteral Nutrition

- If there is evidence of protein-calorie malnutrition on admission and EN is not feasible, it is appropriate to initiate PN as soon as possible following admission and adequate resuscitation.

How much? initial phase

- During the acute and initial phase of critical illness: **20–25** kcal/kg BW/day

How much? Anabolic phase

- 25–30 total kcal/kgBW/day
- BMI ≥30: AIBW (Uptodate)

- If unable to meet energy requirements (100% of target goal calories) after 7-10 days by the enteral route alone, consider initiating supplemental PN.

- Initiating supplemental PN prior to this 7-10 day period in the patient already receiving EN does not improve outcome and may be detrimental to the patient.

Protein

- 1.2-2 g/Kg ABW
- Even higher in burn or multi-trauma

Protein

- ClassI &II: ≥2.0 g/kg IBW
- Class III: ≥2.5 g/kg IBW

Which route?

- There is no significant difference in the efficacy of jejunal versus gastric feeding in critically ill patients.

Monitoring Tolerance and Adequacy of EN

- Evidence of bowel motility (resolution of clinical ileus) is not required in order to initiate EN in the ICU.

Monitoring Tolerance and Adequacy of EN

Patients should be monitored for tolerance of EN:

- Pain and/ or distention
- Physical exam
- Passage of flatus and Stool
- Abdominal radiographs

Monitoring Tolerance and Adequacy of EN

- Inappropriate cessation of EN should be avoided.
- Holding EN for gastric residual volumes <500 mL in the absence of other signs of intolerance should be avoided.

Monitoring Tolerance and Adequacy of EN

- The time period that a patient is made NPO prior to, during, and immediately following the time of diagnostic tests or procedures should be minimized to prevent inadequate delivery of nutrients and prolonged periods of ileus.

- Ileus may be propagated by NPO status.

Risk of aspiration

- HOB position
- 30° - 45°

Risk of aspiration

- For high-risk patients or those shown to be intolerant to gastric feeding, delivery of EN should be switched to continuous infusion.

Risk of aspiration

- Prokinetic drugs (metoclopramide and erythromycin)

Risk of aspiration

- Diverting the level of feeding by post-pyloric tube placement should be considered.

Risk of aspiration

- Use of chlorhexidine mouthwash twice a day should be considered to reduce risk of ventilator-associated pneumonia.

Formulations

- For most critically ill patients: high protein formulation

Formulations

- patients who require volume restriction may benefit from concentrated enteral nutrition

Formulations

- patients who do not tolerate a standard formulation may benefit from predigested enteral nutrition.

Formulations

- patients with renal failure complicated by severe fluid and electrolyte abnormalities may benefit from concentrated, electrolyte-restricted (ie, renal) enteral nutrition.

Immune-modulating formula

arginine, glutamine, nucleic acid, ω-3 fatty acids, and antioxidants

- In elective upper GI surgical patients
- Patients with a mild sepsis (APACHE II<15)
- **head and neck cancer,**

Immune-modulating formula

- To receive optimal therapeutic benefit from the immune-modulating formulations, at least 50%-65% of goal energy requirement should be delivered.

Mechanism

Arginine

- Myeloid suppressor cells (specialized immune cell)
- Regulation of availability of arginine, necessary for normal T lymphocyte function.

Mechanism

Arginine

- ↑Myeloid suppressor cells →severe arginine deficiency → ↓ nitric oxide production → negatively affect microcirculation.
- Immune-modulating diets containing arginine and ω-3 fatty acids appear to overcome the regulatory effect of myeloid suppressor cells.

Mechanism

- **RNA nucleotides→**

- ↑ Total lymphocyte count
- ↑ lymphocyte proliferation
- ↑ Thymus function

Mechanism

ω-3 fatty acids (EPA) and (DHA)

- displace ω-6 fatty acids from the cell membranes of immune cells:

- ↓systemic inflammation through the production of alternative
- biologically less active prostaglandins and leukotrienes.

- Down-regulate expression of nuclear factor-kappa B **(NFkB)**, intracellular adhesion molecule 1 **(ICAM-1)**, and **E-selectin**, which in effect decreases neutrophil attachment and transepithelial migration to modulate systemic and local inflammation.

Mechanism

ω-3 fatty acids (EPA) and (DHA)

- Stabilize the myocardium and lower the incidence
- ↓ Cardiac arrhythmias,
- ↓ ARDS
- ↓ Sepsis

Mechanism

Glutamine:

- Conditionally essential amino acid
- Antioxidant defenses
- Precursor for nucleotide synthesis
- Fuel source for rapidly dividing cells such as GI epithelium
- Immune function
- Production of heat shock proteins
- Nitrogen retention

- Addition of agents such as selenium, ascorbic acid (vitamin C), and vitamin E provides further antioxidant protection.

Immune-modulating formula

Glutamine:

- **Burn**
- **Trauma**
- **Mixed ICU patients**

2 or 3 divided doses to provide 0.3-0.5 g/kg/d.

Immune-modulating formula

ARDS

- EN enriched with ω-3 fatty acids, borage oil and antioxidants.