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MINISTRY OF HEALTH-ETHIOPIA
የዜጎች ጤና ለሃገር ብልጽግና!
HEALTHIER CITIZENS FOR PROSPEROUS NATION!

Intensive Care Unit Nutritional Support and therapy Guideline

December, 2022

Foreword

Ethiopia's Ministry of Health has been leading a sector wide reform effort aimed at significantly improving the quality and accessibility of health services at all levels of the country's decentralized health system. As part of this reform, the Ministry has recognized the importance of strengthening the critical care services by improving the nutritional support and therapy for patients admitted in the intensive care unit (ICU).

Access to appropriate nutritional support and therapy is an essential part of intensive care unit. All patients admitted to ICU should have access to the appropriate nutritional support they deserve. The main challenges the country is facing with regard to ICU service includes: poor feeding practice of patient admitted to ICU, poor budget allocation, shortage of trained staffs & lack of guidelines for nutritional support and therapy.

Taking this in to consideration the Ministry of Health, Ethiopia (MOH) has prepared nutritional support and therapy guideline.

This guiding document aims to provide insight on: how to assess and manage nutritional status of critical ill patient, and also to guide health professionals when to initiate and how to progress in the administration of adequate provision of nutrients to critical ill patient.

Finally, I wish to extend my heartily gratitude for all individuals and institutions that have contributed to the realization of this document.

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Abbreviations

AKI	Acute Renal Failure
ARDS	Acute respiratory distress syndrome
BMI	Body Mass Index
BDA	British Dietetic Association
BSA	Body surface area
BTF	Blenderised Tube Feeding
CBC	Complete blood count
ABG	Arterial blood gas
CLD	Chronic liver disease
CVAD	Central Venous Access Device
DHA	Docosa-hexaeonic Acid
EN	Enteral Nutrition
EPA	Eicosapentaenoic Acid
EBM	Expressed (mother's) Breast Milk
GRV	Gastric Residual Volume
ICU	Intensive Care Unit
IMD	Inherited metabolic disorder
JJ	Jejunostomy
MST	Malnutrition Screening Tool
MUAC	Mid upper arm circumference
MNA	Mini Nutritional Assessment
MUST	Malnutrition Universal Screening Tool
NDT	Nasoduodenal tube
NJT	Nasojejunal tube
NGT	Nasogastric Tube

NRS	Nutritional Risk Screening
NSC	Nutritional Steering Committees
NST	Nutritional Support Team
NCP	Nutrition Care Processes
NRI	Nutrition Risk Index
OGT	Orogastric Tube
PEG	Percutaneous Endoscopic Gastrostomy
PEJ	Percutaneous Endoscopic Gastrostomy with jejunal extension
PN	Parenteral Nutrition
RIG	Radiologically placed gastrostomy
RNI	Recommended nutrient intake
REE	Resting Energy Expenditure
SGA	Subjective Global Assessment
SNAQ	Short Nutritional Assessment Questionnaire
TOF	Trans-Esophageal Feeding Tube
TSP	Teaspoon
WHO	World Health Organization

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1. INTRODUCTION

*"***Nutrition** is the biochemical & physiological process by which human uses food to support its life. It includes ingestion, absorption, assimilation biosynthesis, catabolism &excretion.

Malnutrition is a disorder in body composition in which inadequate macronutrient (protein, carbohydrate, and fat) or micronutrient (vitamins, minerals, and trace elements) intake results in decreased body mass, reduced organ mass, and most important, decreased organ function. Although malnutrition is most frequently associated with a risk for immune dysfunction-related infection, wound healing/facial dehiscence, and breakdown of surgical anastomoses, it can affect virtually all organ systems when severe. Skeletal muscle wasting, decreased myocardial mass, diastolic cardiac dysfunction and decreased sensitivity to inotropic agents, respiratory insufficiency/need for prolonged mechanical ventilation, renal cortical atrophy, and loss of gastrointestinal absorptive/barrier functions have all been associated with malnutrition. Malnutrition can occur as a result of combined protein-calorie deficiency (marasmus), predominantly protein deficiency (kwashiorkor), and deficiencies in specific micronutrients, as well as altered metabolism arising from a disease state such as sepsis, burns, or trauma. Critically ill patients may be affected by a combination of these causes. Malnutrition is thought to be present in as many as 25% to 50% of patients on hospital admission and may affect an additional 25% to 30% of patients during their hospital stay. Malnutrition becomes particularly important in critically ill patients, in whom the combination of bed rest and catabolic illnesses, such as sepsis, multiple trauma, burns, pancreatitis, and acute respiratory distress syndrome (ARDS), hasten the malnutrition, loss of lean body mass, and organ system dysfunction. These problems can be prevented by having nutritional support and therapy which is an integral part of care among critically ill patients.

2. RATIONALE

Among sub-Saharan African country Ethiopia is now double burden by both communicable and non-communicable disease due to epidemiologic transition. Additionally, Ethiopia is the second populous nation in Africa which demanded optimal health care system and service. Currently nationwide in Ethiopia there are 53 intensive care units (ICU) and 23 more are under development with estimated bed capacity of 620 beds. Most of the ICUs are general which provide all the services across diverse population groups among the service nutritional support is the cornerstone for the rapid recovery of critically ill patients in the ICU. Despite the undeniable importance of having a well-established protocol on nutritional support and therapy there is little to no guidelines on nutritional support and therapy in Ethiopia.

Therefore, this guideline provides an insight on: how to assess nutritional status of an ICU patient, how to define the amount of energy to provide and the route to choose. It will also guide health professionals when to initiate and how to progress in the administration of adequate provision of nutrients. Furthermore, the guideline will help different institutions to develop their own protocol on nutritional support and therapy.

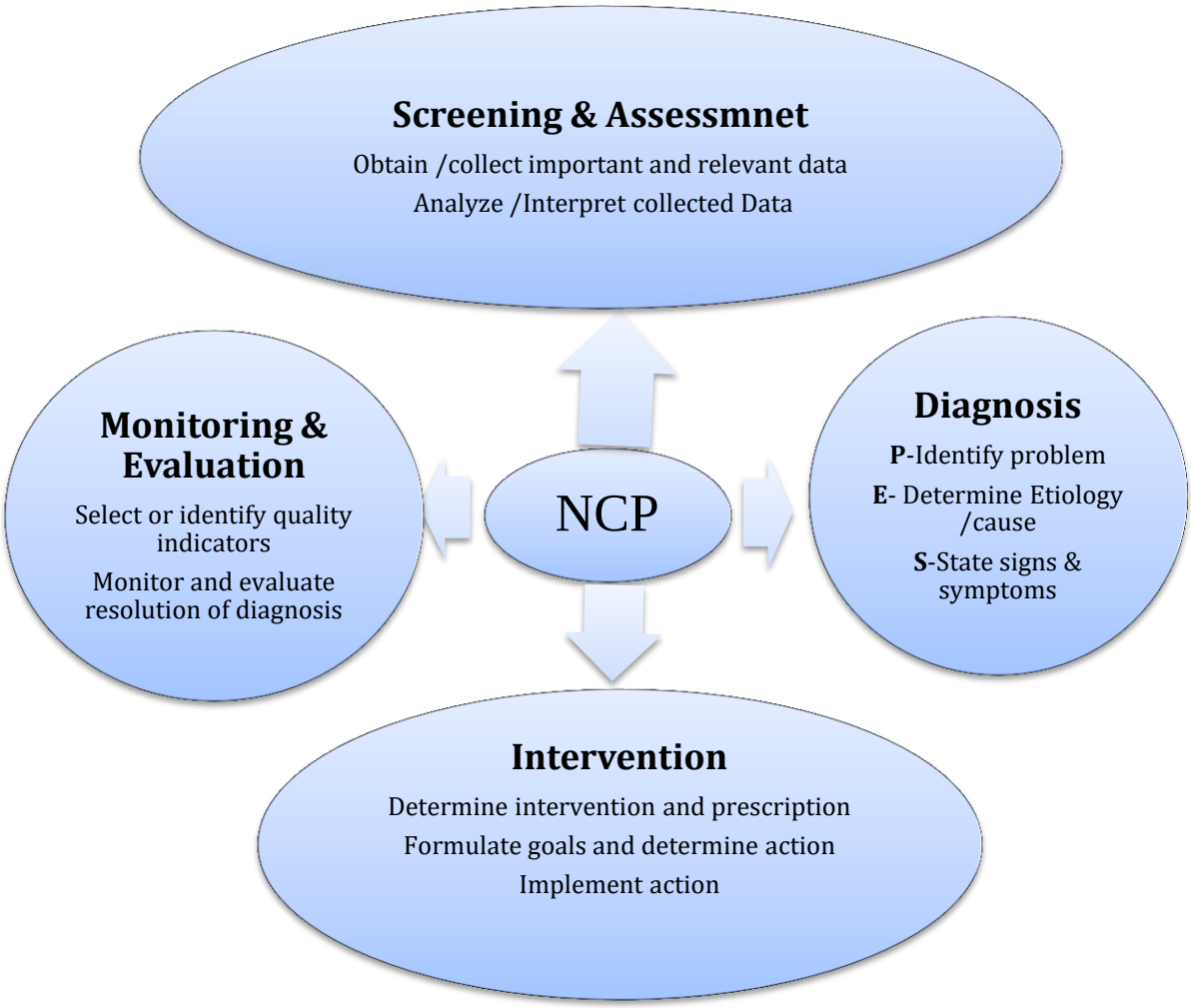
3. OBJECTIVES

This guideline is aimed to provide guidance and suggest practical strategies for the implementation of a quality nutritional support and therapy for critically ill patients. This guideline will also assist health care providers in the prevention, treatment and monitoring of both macro- and micronutrient deficiencies.

4. NUTRITIONAL CARE PROCESSES (NCP)

Nutritional care processes is a systemic method that dietetic and nutritional professionals use to provide nutritional care. Use of the NCP does not mean that all clients get the same care.

Figure 1: The four steps of Nutritional Care Processes (NCP) Model



5. NUTRITIONAL SUPPORT TEAM IN THE ICU

The overall Nutritional service is the responsibility of the nutritionist, dietician, trained nurse or physician reporting to the ICU Director. A nutritional support team (NST) is a multidisciplinary team consulted to manage patients with complex nutritional needs (enteral and parenteral) which serves the primary responsibility of assuring that the patients receive optimal nutritional support. The core members of a nutritional support team are a physician, a dietitian, a nurse and pharmacist. The team can have different tasks such as,

1. Providing standard of care for nutritional support and therapy for critically ill patients
2. Developing clinical nutritional guidelines
3. Monitoring and evaluation of nutritional therapy
4. Development and interpretation of screening tools
5. Consultant for advice on (par) enteral nutrition
6. Counseling and supervising any possible food -drug interaction
7. Support ongoing research and project on critical patient nutrition

Table 1: Specific tasks ICU nutritional support team in ICU

Physicians	Nurses	Dietitian /Nutritionist	Pharmacist
Initiate and manage nutritional therapy	Assess the adequacy of access for nutritional therapy	Identify timing of nutritional support	Logistics support on (par) enteral nutrition
Monitor the effect of nutrition and act accordingly	Notify any Signs and symptoms of fluid volume overload or dehydration	Choose appropriate access route	Consult on drugs/medication and interaction with (routes of) parenteral nutrition
Follow-up the patients has received the order nutritional therapy	Research on (par) enteral nutrition and highly complex nutritional therapy	• Assessment of the patient's nutritional requirements • Educate and advocate about nutritional therapy • Adjustments to the nutritional care plan and change accordingly • Development of screening tools	

Figure 2: Members of nutritional support team

6. ICU FEEDING PREPARATION ROOM

Arranging ICU feeding preparation room is necessary to prevent the ingestion of contaminated liquid feedings that could result in illness either through infection or intoxication. **Therefore, the following points should be considered.**

- Kitchen must be near to Intensive care unit
- Well, furnished with ceramic floor and roof (must be washable)
- All enteral feedings must be prepared in a specific location that encourages the use of aseptic technique and ensures the delivery of safe enteral feedings.
- A hand washing facility must be in close proximity to the enteral feeding preparation area.
- Hands must be washed or an alcohol hand rub applied to the hands prior to preparing formula.
- Tools
    - Heavy duty blender/Stick blender
    - Airtight storage containers
    - Ice cube trays for freezing individual portions
    - Adequate refrigeration /freezer space
    - Dry measuring cups
    - Liquid measuring cups
    - Digital scales
    - Measuring spoons /stainless steel, plastic, wooden
    - Mixing Bowls
    - Slotted Spoons
    - Hanging Scales
    - Room thermometer
    - Jars with measuring marks

Preparation and Handling Procedure

- Gather supplies
- Check manufacturer's expiration date before using of any packed food (E.g. Nido), fresh vegetables, fruits and beans
- Wash hands before preparing enteral feeding and apply an alcohol hand rub to the hands and wear gloves between each activity
- Cover open cans securely with a clean cover before refrigerating
- Use aseptic no-touch technique when measuring and placing feeding tube.

- Medications may be added at the bedside or at feeding time.

- Clean blender thoroughly with dishwashing soap (blender blade and “O” ring should be removed from base and cleaned separately) and allow to completely dry before storage.

7 ADULT NUTRITIONAL THERAPY

7.1 Nutritional Assessment and Screening

Nutritional status screening, assessment and monitoring is essential in the critically ill patient to reduce morbidity and mortality and to decrease hospitalization costs. Nutritional status assessment of the critically ill patient is performed to classify nutritional status, identify nutritional risk and to serve as a baseline for monitoring nutritional support adequacy. Identification of nutritional risk indicates the need for nutritional support to maintain body functions and to facilitate recovery.

Screening versus Assessment

Screening:

- The first step in assessing Nutritional status for all patients within 24 hours of admission
- Quick simple tool to select and prioritize those who'd benefit from immediate care.
- The purpose is to predict the probability of a better or worse outcome due to nutrition
- Parameters used include:
    - Weight
    - Height
    - Conditions that increase nutritional risk
    - History of dietary intake
    - Comorbid conditions
    - Functions of gastrointestinal tract (GI)
    - Disease severity
    - Routine laboratory data

Various tools are used for screening such as the Malnutrition Universal Screening Tool (MUST), Subjective Global Assessment (SGA), Mini Nutritional Assessment (MNA), (Malnutrition Screening Tool (MST), Nutritional Risks Screening 2002 (NRS-2002), Nutritional Risk Index (NRI) and the Short Nutritional Assessment Questionnaire (SNAQ). When choosing a screening tool, factors that should be taken into consideration include the patient population, available resources such as staff and the level of training of the staff. It is also important to consider whether these tools were validated, for which populations and for which type of care setting in order to make an appropriate selection. In the context of our country the Subjective Global Assessment screening tool, is the preferred tool based on simplicity, accessibility, and less resources needed. (**See SGA Form at adult section Annex 1)**

Assessment:

- Nutritional assessment is the systematic process of collecting and interpreting information in order to make decisions about the nature of nutritional related health issues that affect an individual (British Dietetic Association (BDA),2012).
- A comprehensive analysis of a person's Nutritional status that uses components of nutritional Assessment includes; Anthropometric, Biochemical, Clinical Assessment, Dietary Assessment (ABCD).
- Nutritional assessment in critically ill patients is very difficult.

Four Components of Nutritional Assessment

Nutritional assessments, which involve an evaluation of objective and subjective data, are used to determine an individual's nutritional status or growth patterns. Assessing an individual's nutritional status involves anthropometric, biochemical data, clinical data and dietary data.

Anthropometric

- It measures the current nutritional status
- Objective measurements that help determine amount of muscle and percentage of body fat

Includes:

- Body Weight : 10% loss is considered Significant
  20% loss considered Critical
  30% loss considered Lethal
- Mid-Arm Circumference
- Skinfold thickness
- Head-Circumference
- Head-Chest Ratio

Nutritional indices: Body mass index (BMI)

BMI=Weight in Kg/Height in m^2

It is an independent predictor of mortality in seriously ill patients.

Biochemical Data

- Assess nutritional status through laboratory testing or biochemical data

Includes:

- Hemoglobin
- Albumin
- Transferrin

- Pre-albumin
- Lymphocyte count

Obtained from:

- Blood sample
- Urine
- Stool
- Hair and nail samples
- Hydration level, underling medical conditions and metabolic processes, like extreme stress, can affect the outcome of biochemical data so, it is important to consider laboratory results as part of a whole.

Clinical Data

- It is simplest and most practical method.

Obtained from:

- Individual's medical history
- Includes; any diseases or illness, prior diagnostic procedures or current treatments and medications. Some diseases or treatment procedures may increase specific nutrient needs or contribute to malabsorption, which increase the risk of developing a nutritional deficiency. It is also important to determine whether an individual is taking any vitamins, minerals or herbal supplements, which can affect nutritional status.
- Nutritional History
- General physical examination
- Loss of subcutaneous fat (chest and triceps)
- Oedema
- Ascites

Dietary Data

- It can be assessed by 24 hours dietary recall
- Food frequencies
- Food daily technique
- Observed food consumption

7.2 Nutritional Requirement

The amount of each nutrient needed in the human body are different for each nutrient and also vary between individuals; age, gender, level of physical activity, stage of health. To measure energy requirements needs sophisticated equipment. Requirements are most often calculated using formulae.

Careful balances of Macro –nutrients (Protein, lipids and carbohydrates) provide the energy requirements whilst Micro-nutrients (Vitamins and Minerals) are required in a very small amount to maintain health.

Calculation of Energy & Nutrient requirement

Though there are several formulae and methods available to calculate the energy & nitrogen requirement for nutritional support, they are not validated for the use in critical care patient and they are cumbersome to use.

Neither for people who are not severely ill or injured, nor at risk of re-feeding syndrome the suggested nutritional prescription for total intake should provide the following.

Table 2: Calculation of Energy & Nutrient requirement

Energy	In practice, a pragmatic estimation of energy requirements: • 20-30 kcal/kg/day 10% added energy needs for every degree above >37C • 25Kcal /Kg/24 hr. post elective surgery • 35Kcal/Kg/24 hr. polytrauma, Sepsis and Burns
Protein	• **Provide 10-15% of total calories** Daily Requirements • 8-1.2 g/Kg – Normal metabolism • 1.2-1.6 g/kg/day –Hyper catabolism Nitrogen balance 2/3rd of nitrogen derived from protein is excreted in the urine. Because protein is 16% Nitrogen, in each gram of urinary nitrogen represent 6.25gm of degraded proteins. • Nitrogen Balance = (protein intake (g) /day /6.25) – (urinary Nitrogen g/day) + (skin & stool loss g/day) • Skin & stool loss = 2- 4 g/day • Urinary Nitrogen = (urinary urea (g/24hrs) / 2.14) + 2 to 4g. • (*Urinary Nitrogen should be measured in a 24hr urine collection*

	but in emergency a 4 hour collection may suffice. Exact determination of the duration and volume of the urine collection is crucial for accurate calculation of Nitrogen balance) • Positive Nitrogen Balance; provide enough non-protein calories • calories Negative Nitrogen Balance; insufficient intake of non-protein • The goal of nitrogen balance is to maintain a positive balance of 4-6gms.
Fluids	Baseline Fluid/water Requirement for adults = 30-35 ml/kg/hr. Addition must be made for Fever (300-500ml/24hr) for 1^{0}C above normal and for other losses.
Daily Requirements for Electrolyte	
Sodium	*500mg (22mEq/Kg)*
Potassium	*2gm (51mE1/Kg)*
Chloride	*750mg(21mEq/Kg)*
Calcium	*1200mg(30mEq/Kg)*
Magnesium	*420mg(17mEq/Kg)*
Phosphorus	*700mg (23mEq/Kg)*
Daily Requirement for Trace Elements	
Iodine	*150mcg*
Iron	*18mg*
Manganese	*2.3mg*
Selenium	*55mcg*
Zinc	*11mg*
Fluoride	*4mg*
Copper	*0.9mg*
Chromium	*30mcg*
Daily Requirement of Vitamins	
Thiamin B_1	*1.2mg*
Riboflavin B_2	*1.3mg*
Pantothenic acid B_5	*5mg*

Niacin B_3	*16mg*
Pyridoxine B_6	*1.7mg*
Biotin B_7	*30mcg*
Folic Acid B_9	*400mcg*
Cyanocobalamine B_{12}	*2.4mcg*
Ascorbic Acid C	*90mg*
Fat soluble Vitamins	
Retinoic Acid A	*900mcg*
Ergocalciferol D	*15mg*
Alpha-tocopherol E	*15mg*
Phytomenadione K	*120mcg*

- Consider energy provision from propofol, dextrose infusions etc. when calculations are done.

Calculation of Energy Requirement

1. Indirect calorimetry: less practical in ICUs
2. Harris Benedict formulae (may be less accurate in ICU patients): Resting energy expenditure (REE)

Men	**66.5 + (13.7 x W) + (5 x H) - (6.8 x A) kcal/day**
Women	**655 + (9.6 x W) + (1.7 x H) - (4.7 x A) kcal/day**

W- Weight in kg H- height in cm

A- Age in years

REE needs to be multiplied by the stress level

						Stress			
	Surgery	Starvation	Trauma	Sepsis	Severe Burn	**Mild**	**Moderate**	**Severe**	Fever
Multiplication Factor	**1.2**	**0.85**	**1.35**	**1.6**	**2.1**	**1.2**	**1.4**	**1.6**	**1.1**

3. In ventilated critically ill patients: **Faisy equation**

Energy Expenditure (kJ/day) = (8 x W) + (15 x H) + (32 x MV) + (94 x BT) - 4834

MV = Minute Ventilation in l/min

BT = Body Temperature in centigrade

1 kcal = 4.184KJ

Types of feeding

There are many commercially prepared feeds available and some hospitals prepare their own either using commercially prepared dried feed or by following a recipe with normal food stuffs as ingredients and then blending them to a consistency that will pass through a feeding tube. Hospital-prepared feeds Recipes (Blenderised) vary according to country and available ingredients but can include hard-boiled eggs, milk powder, soya, maize oil, rice, squashes, flour, sugar and fruit. These hospital-prepared feeds are much cheaper than commercially prepared feeds but can block tubes and some recipes have been shown to give unpredictable levels of both macro- and micronutrients. In addition, they may contain contaminated ingredients and are not sterile. As a result, they must not be used for post pyloric feeding or in patients with achlorhydria. These feeds should only be used where commercial feeds are either not available or not affordable

1. **Blenderized tube feeding**

Blenderized tube feeding (BTF) is defined as the use of blended naturally made foods and liquids given directly via the feeding tube.

The following examples work well in blenderized tube feedings:

- Grains: cooked cereals, boiled white or brown rice, cooked quinoa, oats, regular or whole grain bread
- Fruits: avocado, applesauce, peach, pear, banana, papaya, Commercial pureed baby food can be used for variety.
- Vegetables: white potato, sweet potato, carrots, spinach, well-cooked broccoli.
- Protein: chicken, beef, legumes, Tofu, peanut butter, cooked eggs, canned tuna or other fish without bones, meat, milk, or yogurt
- Milk or milk substitute: cow's milk, soy milk, almond milk, rice milk, yogurt, non-fat milk powder 15

Benefits

- Exposure to real foods and tastes
- The ability to adhere to dietary restrictions or preferences (dairy free, vegetarian, etc.)
- Possible improvement in gastro-intestinal (GI) symptoms like reflux or constipation
- A possible cost savings with buying food ingredients in bulk versus paying out of pocket for expensive commercial formulas.

Disadvantages

- Difficulty moving through a feeding pump or tubing
- If water is added to the blenderized feed to help thin out the consistency, this can increase the total volume of the feed, but the added volume does not guarantee adequate nutrition (calories, protein, and micronutrients) and usually leads to a larger volume per feed or more feeds per day to ensure adequate nutritional intake.

Factor not Consider Blenderized Tube Feeding

- If the patient can't tolerate or gastrointestinal issues.

2. Enteral Nutrition (EN) formulas

Enteral Nutrition (EN) formulas are designed to meet the basic macro- and micronutrient requirements of individuals who cannot meet nutritional needs orally, specialty EN products have been developed to exhibit pharmacologic properties, such as immune-enhancing formulas containing arginine, glutamine, nucleotides, and ω-3(Omega 3) fatty acids. With the vast number of products available, rising costs of healthcare, and the drive toward evidence-based practice, it is imperative that clinicians carefully consider research regarding use of specialty formulas, paying close attention to the quality, patient population, clinical end points, and cost to patient and/or facility. In Ethiopia currently in governmental hospitals Enteral feed formulas not in use instead Blendrised feed is used but in same private hospitals used.

Type of formulas

1. **Standard (Appropriate for most ICU patients)**
   - Polymeric intact nutrients
   - +/- soluble and/or insoluble fiber
   - Non-fiber containing
2. **Elemental /semi elemental**
   - Hydrolized Formula
   - Contains partially (semi) or completely hydrolyzed or “pre-digested” Nutrients
3. **Immune modulating**

- Contain supplemental nutrients to support metabolically stressed patients

- Arginine, Glutamin, Nuclic acid, Omega 3 fatty acids

- Not recommended for routine use in Medical ICU

- Best in surgical, trauma, Burn or head/neck, Cancer patients

    - Also appropriate for large wounds (stage 3, 4 Pressure ulcers)

    - Must provide at least 60-80 % of total caloric and protein needs in order to gain benefit of immune enhancing nutrients (don't use tickle feed) Can come in standard or semi- elemental formulations

4. Disease specific formulations

- Diabetes/glucose Intolerance

- Renal

- Hepatic etc...

7.3 Route of Nutritional Support

Nutritional support can be given through one of three routes:

1. Oral

- If the patient can eat then they should be encouraged to do so

2 Enteral

- Enteral nutritional support refers to the introduction of a nutritionally complete liquid formula directly into the stomach or small intestine via designed tube.
- Enteral nutritional should be considered when an individual is not safe for oral intake (for example in dysphagia or reduced level of consciousness) or when oral intake is not adequate to meet their nutritional requirements.
- It Maintain gut integrity, Prevent gut stasis, Maintain gut mass, Maintain gut associated lymphoid tissue, Prevent stress ulceration.

Methods of enteral feeding

i. Nasogastric

- This is the most common method of feeding in Intensive Care.
- Tubes used via this route in adults can vary from fine-bore tubes (e.g. 6Fr–12Fr) designed specifically for feeding to the Ryles type tubes, usually 12Fr–16Fr, used for aspiration.
- In adults these tubes are usually 90–100 cm long.
- Potential problems include malposition, difficulty swallowing or coughing, discomfort, sinusitis and nasal tissue erosion.
- Insertion can be difficult in intubated patients as the tube can catch on the piriform sinuses or the arytenoid cartilages. This can be minimized by either ipsilateral lateral neck compression or by turning the head (if it is safe to do so) 900 to the side towards the nostril being used for insertion.
- The insertion of a nasal tube is contra-indicated in a patient with a base of skull fracture due to the risk of intracranial penetration.
- The exit site of a feeding tube should be marked at the time of initial placement. Observe for a change in the external tube length during feeding
- A head-of-bed elevation of 30 to 45o is recommended during feeding, unless contra-indicated
- Use sterile water for flushing tubes or for enteral water infusion. Flush feeding tubes regularly.

Confirming nasogastric tube position

- Aspiration of gastric content along with auscultatory method should be used but not confirmatory
- Radiographic confirmation of correct positioning of any blindly-placed tube should be obtained prior to its initial use for administration of feed or medications

ii. Oro-gastric tubes

Should be considered in intubated patients to reduce sinusitis (a risk factor for ventilator-associated pneumonia)

iii. Post-pyloric feeding

- Post-pyloric feeding is recommended for patients at high risk of aspiration, those undergoing major intra-abdominal surgery and patients who are intolerant of gastric feeding.
- A nasojejunal tube should be over 150cm long to ensure correct placement.
- These tubes are prone to blockage owing to their length.
- Should only be used for drug administration in exceptional circumstances because of the lack of evidence relating to drug adsorption from this site.
- There are also tubes that have a gastric aspiration port in addition to the jejunal feeding port. This allows for continuous jejunal feeding while the stomach is decompressed.

iv. Enterostomy

- Gastrostomy or jejunostomy and can be placed via the abdominal wall, endoscopically, radiologically or surgically.
- Once inserted they are well tolerated, however there are risks associated with insertion, displacement and infection (including peritonitis).
- Benefits for those who require nutritional support for over 4 weeks.

Table 3: Summary table: Site of delivery of enteral feeding

SITE	ACCESS	INDICATIONS	ADVANTAGES	DISADVANTAGES
Gastric	• Nasogastric tube (NGT) • Orogastric tube(OGT) • Trans-Oesophageal feeding tube (TOF) • Percutaneous Endoscopic Gastrostomy(PEG) • Surgical or radiologically placed gastrostomy(RIG)	Patients with normal emptying of gastric and duodenal contents	• Large reservoir capacity of stomach • Maintains normal gut functions and signals • Gastric acid kills bacteria • Most cost effective • Easiest to insert • Can give bolus feeds	Increased risk of oesophageal reflux and/or pulmonary aspiration
Duodenum	Nasoduodenal tube (NDT)	Patients who have impaired gastric emptying or who are at risk of oesophageal reflux	May reduce risk of oesophageal reflux and/or pulmonary aspiration	Potential gastrointestinal intolerance (bloating, cramping, diarrhea) Risk of displacement/ migration back in to stomach
Jejunum	Nasojejunal tube(NJT) Surgical jejunostomy(JJ) Percutaneous Endoscopic Gastrostomy with jejunal extension (PEJ)	Impaired gastric emptying or risk of oesophageal reflux Post upper GI surgery (jejunal feeding bypasses the surgical site)	Reduces risk of oesophageal reflux and/or pulmonary aspiration	Potential gastrointestinal intolerance(bloating, cramping, diarrhea) Risk of displacement/ migration back in to stomach

3. Parenteral Nutrition

- Consider parenteral nutrition when enteral feeding is not possible or adequate
- A reasonable trigger time of 72 hours for commencing PN in ICU, could be used where EN has failed or is contraindicated. When used to supplement insufficient enteral feeding, late parenteral nutrition (day 8) was associated with improved outcomes compared with early PN initiation in one study

The use of femoral vein for PN is relatively contraindicated, since this is associated with a high risk of contamination at the exit site, and a high risk of venous thrombosis.

7.4 Timing for Initiation of Nutritional Support

- Early enteral feeding (within 24-48 hours of admission have benefits for ICU patients
- Nutritional supplementation is necessary if they are unable to resume oral nutrition or if their oral intake is insufficient for more than 3–4 days
- Current evidence suggests that early institution of enteral feed in unstable patients also increases intestinal blood flow and improves intestinal function, and may protect against bowel-related complications
- Oral feeding may not be feasible and hence enteral nutritional support should be attempted after placement of a nasogastric (or in some cases nasojejunal) tube.

Feed rate guidelines

a. 15-50ml/hr. for starting rates and 10-50ml/hr. for the amount to increase the rate each 4-24 hours.
b. Aiming for target feed volumes per 24 hours has also been advocated to improve nutritional adequacy

Table 4: Mode of Delivery and Feed rate

Mode of Delivery	Start Rate	Increase By	Comments
Nasogastric	40-50mL/h	10-50mL/h every 4 hours	Maximum bolus might be the volume of a small glass of milk (150mL) for a smaller/older person or a milk shake (400- 600 mL) for a bigger/younger person. Maximum continuous rate might be up to one cup (250mL) every hour.
Nasoduodenal or nasojejunal	20-30mL/h	10-30mL/h	Continuous feeding at a controlled rate is usually needed due to lack of reservoir capacity in the

		every 4-8 hours	small bowel. Feeds may be tolerated at rates as high as 100-120mL/h.
Gastrostomy / PEG	As for nasogastric	As for nasogastric	Feeds are usually commenced 12-24 hours after insertion of the tube, but there is no evidence to support delaying feeds for more than 3-4 hours after PEG placement.
Jejunostomy	As for nasojejunal	As for nasojejunal	Usually within 24-48 hours of insertion; this depends on the surgical procedure.

7.5 Nutritional therapy in special conditions

1. Acute Respiratory Failure

- Energy and protein requirement estimation done based on weight and clinical condition.
- Avoid providing energy in excess of requirement, as this will increase the amount of CO2 produced
- The use of high fat/ low carbohydrate formula may be of benefit to control excessive production of CO2 however this is only significant in patients who were overfed.
- The provision of energy dense, reduced volume enteral feed preparation may help avoid the complications associated with respiratory failure, like pulmonary oedema and renal failure. A feed providing 1.5 – 2 kcal/ml will be useful to provide adequate energy to fluid restricted patients.

2. Renal Failure

- In patients with Acute Renal Failure (AKI) it is recommended that patients be fed based on estimated requirement of:
- Energy at 25 – 30kcal/kg/d
- Protein 1.2 – 2g/kg/d
- NB. Use usual body weight or Ideal body weight to estimated nutritional requirement. Standard electrolyte is recommended but may use feeds with adjusted electrolytes if significant electrolyte imbalance develop. (Feed lower in potassium and phosphate). In patients receiving frequent dialysis or CRRT, protein should be increased to 2.5g/kg/d. Protein should not be restricted to delay going to dialysis.

3. Hepatic Failure

- Malnutrition and heightened deterioration in nutritional status is common in patients with chronic liver disease often directly related to the extent of liver dysfunction, and contributes to increased morbidity and mortality. Portal hypertension, impaired protein synthesis and the consequent ascites and oedema makes the usual anthropometric information unreliable.
- The primary reason for malnutrition in chronic liver disease is poor oral intake as a result of metabolic and functional GI factors.
- The energy expenditure and requirement of patients with CLD varies and is difficult to predict with a simple calculation. Indirect Calorimetry is still the preferred method of assessing the energy expenditure in patients.
- However, in the absence of IC, methods used for the general ICU patient is suggested with the stipulation that dry weight or usual weight be used in the predictive equation.
- Protein should not be restricted in patients with CLD or those with encephalopathy.

4. Acute Pancreatitis

- Initial assessment of disease severity is suggested as condition may change quickly necessitating change in management and nutritional support.
- In patients with mild acute pancreatitis, it is recommended to advance to oral diet as tolerated, and only start nutritional support if this is not achieved in 7 days.
- In patient with moderate – severe acute pancreatitis, it is recommended to put naso-oro enteric tubes, and start on trophic feeding advancing to calculated goal, once fluid resuscitation is achieved (24-48hrs).
- In patients with severe acute pancreatitis, standard polymeric formula/feed is recommended.
- EN or jejunal route is recommended.
- The use of prebiotics is recommended to be included in EN if available.
- In patients with severe acute pancreatitis in whom EN is not possible or tolerance could not be achieved, PN is recommended to be started 1 week from the onset of pancreatitis.

5. Surgical patients Trauma/ Traumatic brain injury

- Nutritional care in the trauma patient should be handled the same way as other critically ill patients in ICU. Early enteral feeding (24-48hr) with high protein containing polymeric feed should be started as soon as patients have been haemodynamically stabilized.
- Depending on the extent and type of injury and management (use of paralytics or coma inducing agents) energy requirement may reach 100-200% of REE.
- Protein requirement in the range of 1.5 – 2.5g/kg/day since there may be large protein losses.

- Immune modulating agents like arginine and FO are should be considered if available.

6. Open Abdomen

- In the absence of bowel injury, early EN (24-48hrs) after stabilization is recommended.
- An additional 15-30g protein should be added per liter of exudates in patients with OA.
- Energy needs should be determined similar to other critically ill patients in ICU.

7. Burn

- Patients with Burn injury exhibit prolonged hyper metabolic state. It is recommended to use Indirect Calorimetry to estimate the Energy Requirement in Burn patients. In the absence of IC, the Toronto predictive equation is recommended.

<table>
<tr><td rowspan="2">Harris Benedict Equation</td><td colspan="3">Gives Resting metabolic rate estimate, can be adjusted by adding activity and stress factor. Multiply by 1.5 for general burn</td></tr>
<tr><td>Men: 66.5 + 13.8(weight in kg) + 5(height in cm) – 6.76(age in years)</td><td>Women: 65.5 + 9.6(weight in kg) + 1.85(height in cm) – 4.68(age in years)</td><td></td></tr>
<tr><td rowspan="2">Toronto Formula</td><td colspan="3">Useful in acute stages, needs to be adjusted with changing parameters</td></tr>
<tr><td colspan="3">−4343 + 10.5(TBSA) + 0.23(calorie intake in last 24h) + 0.84(Harris Benedict estimation without adjustment) + 114(temperature) – 4.5(number of post burn days)</td></tr>
</table>

- EN should be started on patients with burn who have functional gut but cannot meet their requirement with oral intake, if they have functional gut.
- PN should only be provided if EN is not tolerated or feasible.
- Early initiation of EN is recommended: within 4-6hours
- It is recommended to give a feed composition with high carbohydrate, not exceeding 7g/kg/d low fat, and preferable higher Omega 3 Fatty acid composition – 15% energy
- High protein – 1.5 – 2 g/kg/d. With higher amount of vitamins and minerals.

8. Sepsis

- Early initiation of EN is recommended (within 24-48 hours) of the diagnosis of Septic shock, as soon as resuscitation has been done and patient is hemodynamically stable.
- Early PN supplemental to EN or, full PN is not recommended in the acute phase regardless of the nutritional risk score.

- Early trophic feeding (EN) of 10-20kcal/hr. for up to 500kcal/d is recommended early, which can be increased gradually as tolerated to 80% of calculated target goal in 24-48hrs.
- Protein requirement is recommended at 1.2 – 2g/kg/day.
- No recommendations are currently available for Selenium, Zinc antioxidant or immune modulating formulas (containing Arginine, glutamine, EPA, DHA or Nucleic acids).

9. Post-operative patients after Major Surgery

- It is recommended that nutritional risk score be performed for all patients after major surgery and visceral protein (albumin, prealbumin, transferrin etc.) should not be used as indicators of nutritional status.
- EN should be provided if feasible within 24 hours of major surgery (over PN or Standard Therapy), in the absence of obstruction, bowel discontinuity, risk of bowel ischemia, or ongoing peritonitis. Individually tailored feeding is may be feasible in the presence of high output fistula, severe malabsorption, shock or severe sepsis if patient is made stable for 24 - 36hrs.
- Formulas containing immune modulating ingredients (arginine, EPA, DHA) are recommended if available.
- In patients with major upper GI surgery, EN is not feasible. PN should be started if the duration of treatment is anticipated to be longer than 7 days unless the nutritional risk is deemed to be severe. Postoperatively, patients can be advance to solid foods orally as tolerated, and do not have to start with clear liquids necessarily.

10. Critically ill cardiothoracic patient

- Circulatory and cardiogenic shock as well as medical interventions used in managing the cardiac patient compromises the circulation to the gastrointestinal system, which may lead to reduction of blood and oxygen delivery to the intestines.
- The compromised perfusion can also affect other organs, like the kidneys, resulting in acute kidney injury, necessitating renal replacement therapy.
- Energy and protein provision is recommended via EN early in these patients within 24 – 48 hours.
- Feeding can be started at 20ml/hr. in patients with circulatory failure, and 30ml/hr. in those without. Feeding can be advanced every 12 – 24 hours to target requirement. A minimal amount of 500ml/d is suggested in the first few days, and should reach at least 50 – 65% of goal in the first week. If EN cannot meet requirement then PN should be considered to supplement energy requirement.
- Fluid restriction is common in the above patients, so the use of high energy formulas providing 1.5 – 2kcal/ml should be considered.

- Feeding should be increased slowly, within 3 – 5 days to target volume and energy content, while closely monitoring hemodynamic status and tolerance.

- Feeding should be held if hemodynamic instability is noted, and resuscitation should be attempted until stability is achieved.

11. Low dose EN should be administered

- In patients receiving therapeutic hypothermia and increasing the dose after rewarming;

- In patients with intra-abdominal hypertension without abdominal compartment syndrome, whereas temporary reduction or discontinuation of EN should be considered when intra-abdominal pressure values further increase under EN; and

- In patients with acute liver failure:- when it is acute

7.6 Nutritional Care Plan

Nutritional Care Plan is a detailed plan of interventions/actions to support a person to achieve their nutritional goals. It is a living document which can be updated as required to meet the individual change in nutrient needs, appetite and ability to access food etc.

Figure 3: Nutritional flow sheet pathway

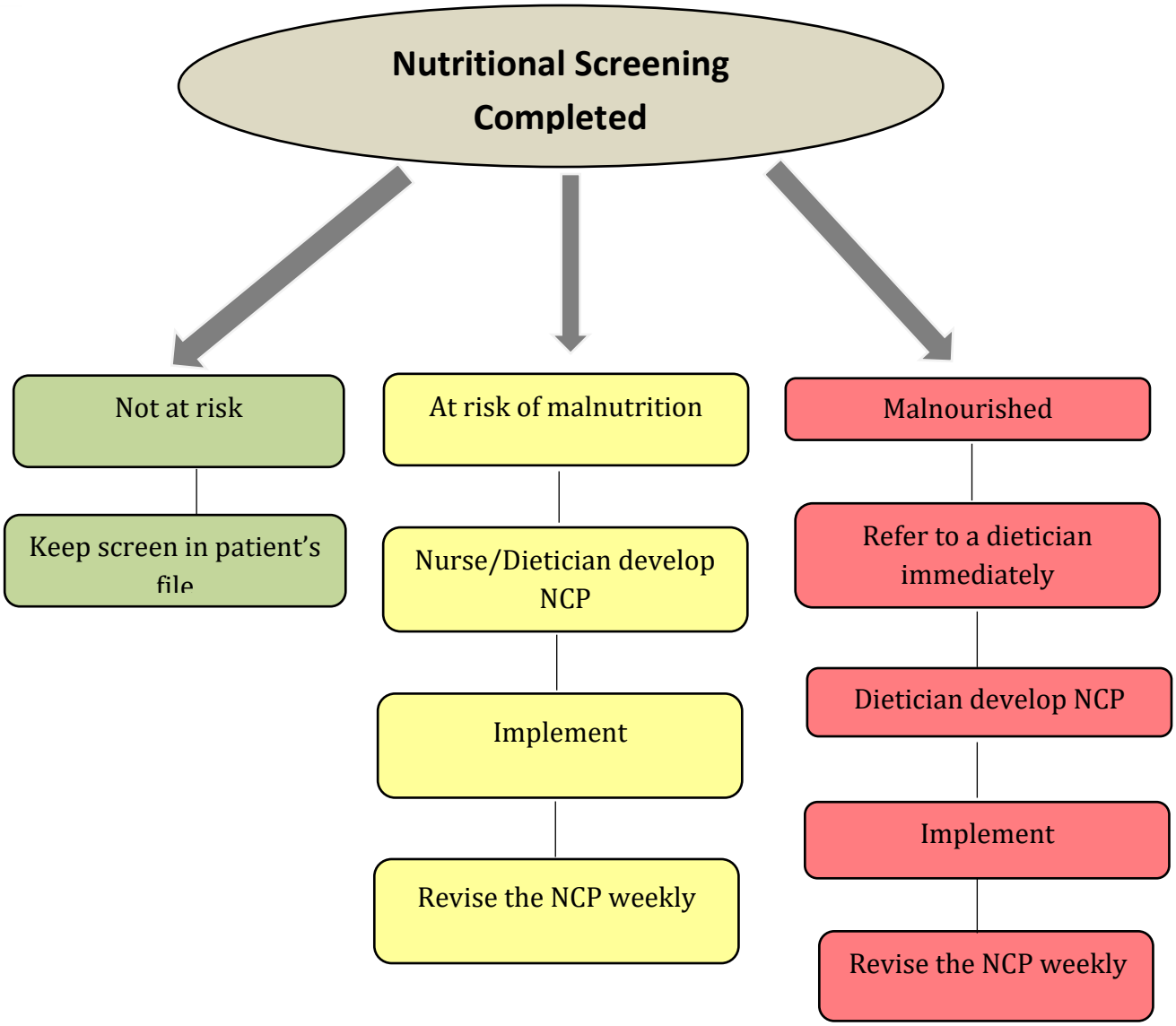


Figure 4: Flow sheet for nutritional support

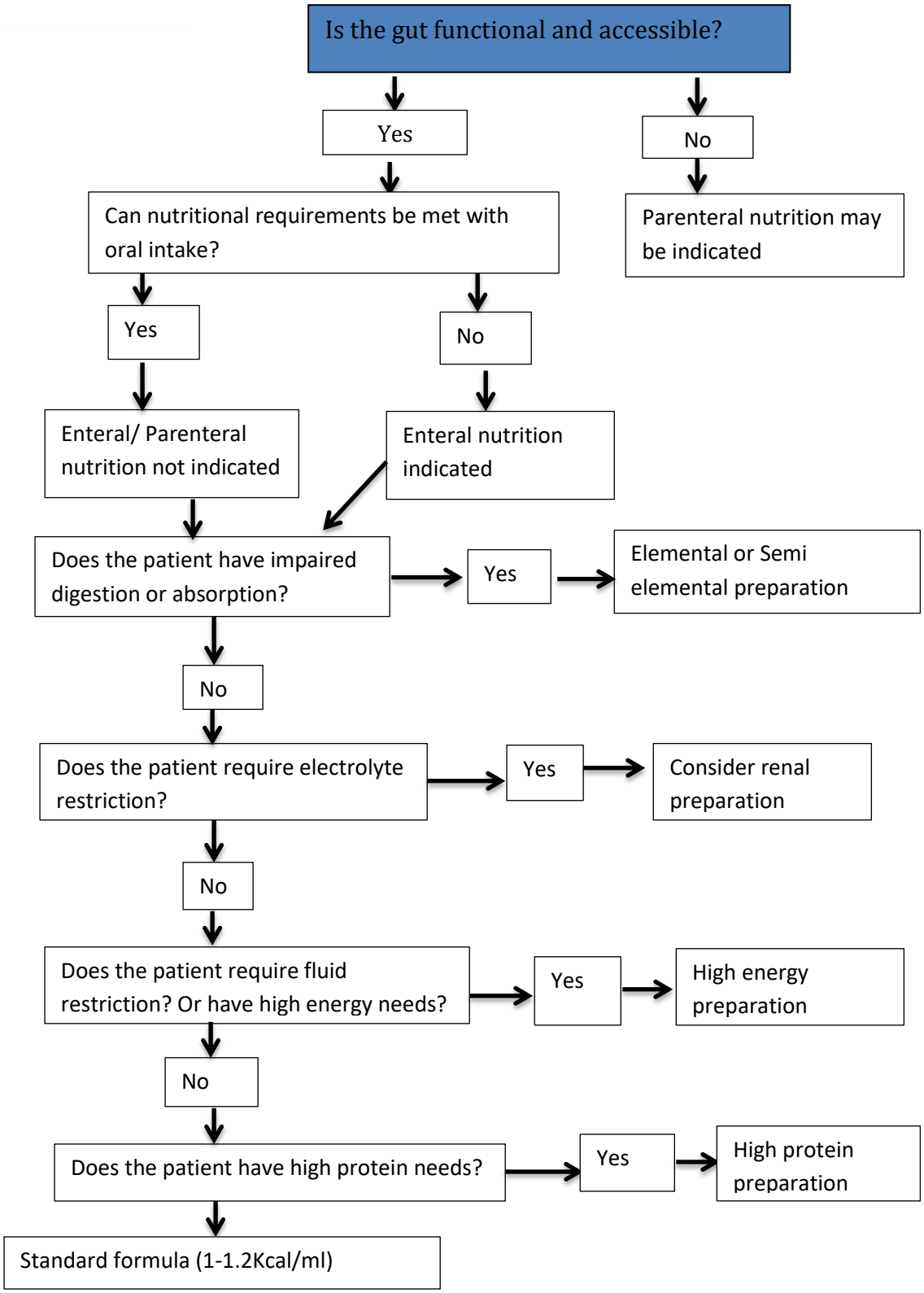
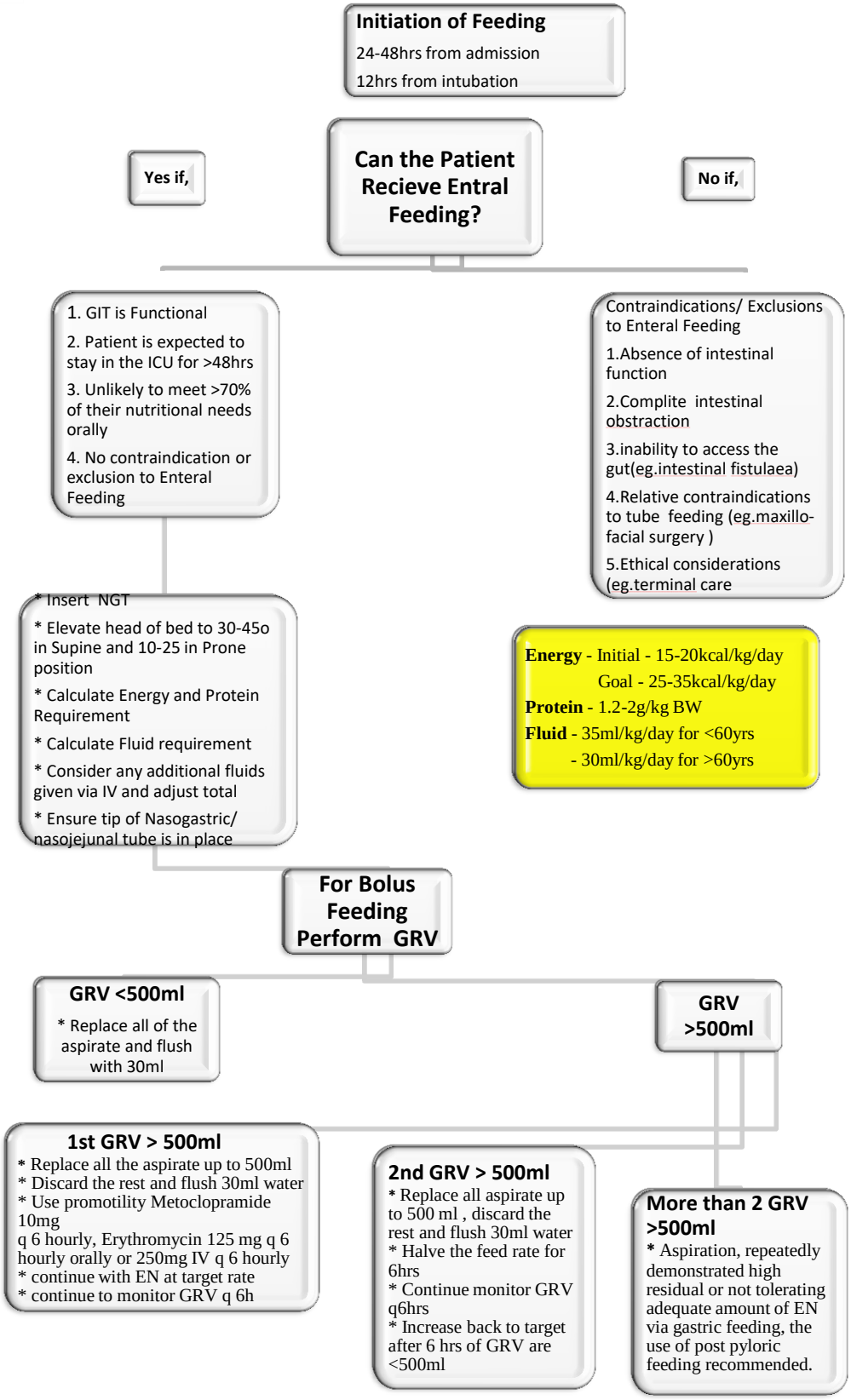


Figure 5: Summary of enteral feeding, time of initiation, rate and GRV



N.B. In addition to the GRV value it is important to consider other clinical signs of feeding intolerance like abdominal distention, excess gas, abdominal pain etc.

7.7 Complications during Nutritional Support and therapy

7.7.1 Drug nutrient interaction

The effect of nutrients on drugs is equally important. Food may delay drug absorption, alter drug metabolism by enzyme induction or inhibition, or alter the rate of drug excretion and drug response.

Drug Ingestion: Common side effects of many medications administered orally or parenterally are nausea and vomiting, resulting in decreased food intake by creating a feeling of fullness. Some drugs, like amphetamines, cholinergic agents, expectorants, narcotic analgesics penicillamine; streptomycin, potassium chloride, vitamin B complex liquids, and some chemotherapies decrease food intake.

Drug Absorption: Drug absorption is governed by its physical form, particle size, gastrointestinal pH, and solubility in fats. Nutrient absorption, on the other hand, depends upon an intact enzyme system and gastrointestinal secretions. The small intestine is the major site for drug and nutrient interactions. Drugs causing mal absorption induce diarrhea, steatorrhea, and weight loss. Abdominal pain, flatulence, and nutrient deficits may also occur.

Drug Metabolism: Nutritional imbalances are known to affect the metabolism of drugs. If any nutrient is lacking; normal drug metabolism can be affected. The toxicity of the drug may be increased or decreased by the metabolic alteration.

Drug Excretion: The effect of drug on re-absorption or transport nutrient affects nutrient excretion. It may also alter the kidney's ability to concentrate. Foods affect drug excretion by changing urine pH and causing the precipitation of certain drugs. Retention of salt and fluids is another undesirable effect associated with drug-nutrient interactions.

7.7.2 Allergies, intolerances, and restrictive food practices

It is easy to forget that tube feed formulae can contain many of the food components that the patient may be avoiding in their oral diet. While they are receiving tube feeding, some patients may be willing to relax some of their habitual food restrictions if these are for life style or

religious reasons. Allergies and intolerances, however, may cause difficulties in the choice of tube feeding formula.

Allergies

- Egg protein allergy
- Soy protein allergy
- Milk protein allergy
- Coeliac disease (Gluten allergy)

Intolerances

- Lactose
- Glutamates
- Amines
- Salicyates

7.7.3 Re- feeding syndrome

Re feeding syndrome refers to biochemical and clinical symptoms and abnormalities caused by shifts in electrolyte and fluid balance in malnourished patients upon recommencement of both enteral and parenteral feeding. It occurs in the setting of prolonged starvation followed by provision of nutritional supplementation by any route.

Table 5: Important symptoms and clinical sequelae of RFS

CVS	**Neurologic**	**MSS**	**RS**
Tachycardia, Arrhythmias Hypotension, Congestive heart failure Shock, Edema Sudden death	Anorexia, Tetany Delirium, Seizures Coma	Weakness, Myalgia Rhabdomyolysis Osteomalacia	Tachypnea, Dyspnea, respiratory failure Diaphragm muscle weakness
GIS	**Metabolic**	**Hematologic**	**Renal and hepatic**
Maldigestion and malabsorption, Vomiting, Constipation, Abdominal pain	Hyperglycemia Metabolic alkalosis Metabolic acidosis Respiratory alkalosis Insulin resistance	Thrombocytopenia Hemolysis Anemia Leukocyte dysfunction Decreased 2,3-DPG	Acute tubular necrosis Acute liver failure

Risk factors for re feeding syndrome

Any malnourished patient from decreased intake, decreased absorption and increased catabolism is at risk of developing re feeding syndrome during initiation of feeding.

Features of the re feeding syndrome

- *Hypophosphatemia*
- *Hypokalemia*
- *Hypomagnesaemia*
- Abnormal Glucose and Lipid Metabolisms
- *Thiamine Deficiency*

Summary of Management of re feeding syndrome

- ***Workup:*** Serum electrolyte, Liver function test, Renal function test, Blood sugar, Thiamine level, Stool, CBC, ABG
- Recognize patients at risk
- Provide adequate electrolytes, vitamin
- Cautious fluid resuscitation to avoid fluid overload
- Cautious and gradual energy restoration
- Monitoring of critical laboratory indicators
- ***Treat electrolyte abnormalities + Acid Base Disturbance***
    - Hypophosphatemia
    - Hypokalemia (<3.5mmol/L) – replace IV or PO
    - Hypomagnesaemia (<0.7mmol/L) – replace IV or PO
    - Hypernatremia – don't correct rapidly unless symptomatic (less than 10mmol/L/day)
    - Hyperglycemia – monitor -> insulin if required
    - Vitamin B6 (pyridoxine) – 1.7mg/day
    - Vitamin B12 (cobalamin) – IM in Folate – 400mcg/day
    - Fat soluble vitamins – DEKA – can be replaced via feed
    - Micronutrient: Selenium – 100-400mcg/day LD -> 20-70mcg/day, Zinc – 10-30mg/day, Iron – no loading dose required -> 10mg/day PO

7.7.4 Gastrointestinal tract complication

Diarrhea: - is perhaps the most common complication in EN, occurring within a wide range (2–63%), depending on how it is defined. Diarrhea is not an inherent complication of EN; it can be prevented if EN is appropriately used.

The following issues should be addressed if patient on feeding developed diarrhea:

- Review patient's EN prescription

- Exclude infectious diarrhea through stool culture
- Review medication profile, searching for diarrhea inducing drugs, in particular prolonged use of antibiotics

If diarrhea persists, the following options to be considered:

- Decrease delivery rate,
- Change to EN formula with a source of soluble fiber, if mal absorption is suspected,
- Change to oligomer or monomeric diets.
- Despite the above measures the problem persists, parenteral nutrition should be considered.

Nausea and vomiting

Approximately 20% of patients on EN experience nausea and vomiting, the latter greatly increasing the risk of aspiration pneumonia. Although multi-factorial, delayed gastric emptying is the most common cause of vomiting. Warning signs, in a conscious patient include abdominal discomfort and/or a sense of bloating.

If delayed gastric emptying is suspected

- Consider reducing sedating medication,
- Switching to a low fat formula,
- Reducing the rate of delivery
- Reduce administering prokinetic drugs.

Constipation

- Constipation can result from inactivity, decreased bowel motility, decreased water intake, impaction and lack of dietary fiber.
- Poor bowel motility and dehydration may cause impaction and abdominal distension. Constipation should be clearly differentiated from bowel obstruction.
- Adequate hydration and the use of insoluble fiber containing formulas usually resolve the problem.
- Persisting situations may require stool softeners or bowel stimulants.

Aspiration

Pulmonary aspiration is extremely serious and may be a life-threatening complication, with an incidence of 1–4%. Symptoms include dyspnea, tachypnea, wheezing, tachycardia, agitation and cyanosis.

Risk factors for aspiration include:

- Decreased level of consciousness
- Diminished gag reflex
- Neurological impairment
- Incompetent lower esophageal sphincter

- GI reflux
- Supine position
- Use of large bore feeding tubes
- Large gastric residues.
- In order to reduce the risk of aspiration, periodic assessment of gastric residual and keeping the head of the bed elevated and maintaining a semi recumbent position.

7.7.5 Tube related complications

Tube mal position could cause bleeding and tracheal, parenchymal or GI tract perforation. These complications can be minimized, through the use of trained staff and adequate post placement monitoring.

Tube clogging

Common causes of obstruction:

- Inadequate flushing of tube after feeding of formula.
- Intact protein and viscous products.
- Administering medication, which may fragment and precipitate to tube kinking.
- Tube diameter and tube type (jejunostomy vs. gastrostomy)
- Quality of nursing care,
- Duration of tube placement.

For further reading refer to the Pediatrics section

7.8 Monitoring Nutritional Therapy

- Effective monitoring is vital to reduce the incidence of complications, reduce electrolyte and metabolic abnormalities and ensure adequate nutrition is delivered.
- The frequency of monitoring and parameters measured will be dependent on the diagnosis and underlying clinical condition of the patient; duration and tolerance of enteral feeding; and rationale for feeding.
- Monitoring should be done by health care professionals, however patients on long term enteral feeding and their care givers should be educated to monitor parameters such as bowels, weight and nutritional intake; identify potential problems; and report concerns to the relevant health care professional as needed.
- In the monitoring process, the goals of nutritional support should also be regularly reviewed.

Table 6: Parameters for monitoring patients on enteral feeding

Monitoring Parameter	Frequency of Monitoring	Rationale
Fluid balance charts	Twice a Day	Help assess hydration status To compare feed given with feed prescribed To assess fluid volume prescribed with volume given
Weight/BMI	Twice weekly or more frequently if hydration concern	To assess changes on hydration and body composition overtime
Bowel Movement	Twice a day	To monitor bowel function and tolerance of enteral feed
Nausea and vomiting	Daily	Monitor tolerance of feed
Gastric residual volume	4-6 hour where clinically indicated in acute setting	To assess gastric emptying and ascertain appropriateness of increasing feed rate
Feeding tube position	NG tubes before each feed, fluid or medication administration	To confirm gastric position and prevent feed aspiration To ensure feeding tube has not migrated from/into stomach
Feeding tube insertion site	Daily	To check for infections/soreness/leakage Check for nasal erosion with nasal placed tubes
Gastrostomy rotation	Daily	To prevent buried bumper syndrome

Gastrostomy progression	Weekly	To prevent tube displacement
General clinical condition	Daily	To ensure feed is tolerated and that feeding and feeding route remain appropriate
Oral Health	Daily	To optimize oral hygiene and reduce risk of aspiration pneumonia

B. Anthropometry

Measure	**Application**	**Interpretation**	**Ideal Frequency of Monitoring**
Weight	Unstable fluid balance (including large output)	• Whether fluid input is meeting needs • Whether it should be restricted or increased	Baseline then daily
	Patients in first 2weeks of tube Feeding	• Whether fluid input is meeting needs	Baseline and then second- daily
	Patients in first 3- 6 weeks of tube feeding	• Whether energy input is meeting needs • Interpret in the light of fluid changes	Baseline and then weekly
	Continuation of long term tube Feeding	• Whether energy input is appropriate	Baseline and then monthly
Mid-arm circumference	Long term tube feeding	• Whether energy and protein input are appropriate • Interpret in the light of changes in patient's activity level • Acute changes in fluid balance may confound this measure in trauma and critical illness	Baseline and then monthly. (Serial measures are more informative than comparing single measures to percentile charts.)

C. Biochemistry Monitoring

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Sodium	Major extracellular electrolyte	Increased in dehydration, re feeding syndrome, Decreased in Over hydration, SIADH, and salt-wasting conditions.	Daily in the acute setting Monthly if possible, for long term feeding
Potassium	• Major intracellular electrolyte • Influences fluid balance	Increased in dehydration, renal failure, or when K+ shifts out of the cell Decreased by losses (vomiting, diarrhea) or when K+ shifts into cell	Daily in the acute setting Monthly, if possible, for long term feeding
Magnesium	• Intracellular electrolyte • Co factor for enzymes • Required in muscle and nerve function	Increased in renal failure Decreased by some diuretics and malnutrition	Daily in the acute setting Monthly, if possible, in long term feeding
Urea	• End product of protein metabolism, formed by liver to detoxify ammonia	Increased i in renal failure, dehydration, high protein intake Decreased with reduced muscle turnover or severe liver dysfunction .	Daily, in the acute setting. Monthly, if possible, in long term feeding
Creatinine	1. produced by body muscle 2. excreted in urine	Increased in renal failure, fever, large meat meal, large muscle mass Decreased with loss of muscle, low protein in take	Daily, in the acute setting. Monthly, if possible, in long term feeding.

D. Liver enzymes

Measure	Description	Interpretation	Ideal Frequency of Monitoring
AST, ALT	Released in cell damage ALT in liver cell AST in liver, muscle and red blood cells	Increased in liver damage	Daily in the acute setting Monthly if possible, for long term feeding
ALP, GGT	Increased liver production during biliary obstruction	Increased in biliary obstruction GGT only: drugs, alcohol, obesity ALP only: bone, growth, fractures	Daily in the acute setting Monthly ,if possible, for long term feeding
Bilirubin	breakdown product of haem molecules	Increased in internal bleeding or hemolysis, liver dysfunction, or biliary obstruction. Decreased in over feeding.	Daily in the acute setting Monthly, if possible, in long term feeding

E. Iron studies

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Hemoglobin (Hb)	Iron containing portion of the RBC	Decreased Acute phase and in all types of anemia	Daily in the acute setting Monthly, if possible, in long term feeding
Serum iron	Free iron in the serum	Decreased in iron deficiency	Not very sensitive or specific
Hematocrit	Volume of red cells in relation to the total volume of blood	Increased with dehydration Decreased in anemia and other blood abnormalities.	To assist in interpretation of abnormal iron studies. .
Mean corpuscular volume (MCV)	Reflects RBC size, to classify type of anemia	Increased in macrocytic anemia Decreased in microcytic anemia	To assist in interpretation of abnormal iron studies.

F. Lipid studies

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Triglycerides	Storage form of fat in the body.	INCREASED in overfeeding, glucose intolerance, hypothyroidism, and pancreatitis. DECREASED in mal-absorption or very low-fat intake, hyperthyroidism.	As needed
Cholesterol	Made in the liver, needed for production of hormones, bile acid and vitamin D.	INCREASED in acute phase and sepsis. DECREASED with malnutrition, liver disease, hyperthyroidism	As needed

G. Vitamins, minerals, and trace elements

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Fat-soluble vitamins	Vitamin A (retinol and carotenoids, essential for vision, growth, iron metabolism.	DECREASED in fat malabsorption	Usually test Vitamins A and D to exclude fat malabsorption.
	Vitamin D (activeformis1,25-dihydroxy vitamin D	Decreased in lack of sun exposure	Usually test serum level of precursor form (25-hydroxyvitaminD)
Vitamin B12	Cyanocobalamin; acts as cofactor in fat metabolism	INCREASED in acute phase and sepsis DECREASED malabsorption	checksB12level, levels are low in deficiency.
Folate	Involved in coenzymes of many metabolic process.	DECREASED infolate deficiency, and in smokers. May be	Erythrocyte (not serum) folate is best test.

Note: blood levels may not reflect total body stores, due to varying distribution of vitamins/minerals in body tissues. Requirements may be increased in illness.

H. Serum proteins

None of these indicators reflects simple nutritional status in a hospital patient. Note the effect of the acute phase process on all of these indicators. Acute phase markers (such as C- reactive protein, see below) may be useful in quantifying this.

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Albumin	A non-specific carrier protein plays important role in controlling fluid distribution between tissue compartments.	Increased in dehydration or when IV albumin is given. Decreased in acute phase, liver failure, protein malnutrition	Strong prognostic indicator, because it is a measure of disease severity. Cannot be used to assess nutritional status in acute phase situation.
Total protein	Total of serum proteins.	DECREASED in acute phase	Severe acute phase may cause a decrease in alb
C-reactive protein (CRP)	An acute phase protein – a non- specific marker of infection and inflammation.	Increased very rapidly in acute phase	Helps in interpretation of other indicators, by quantifying acute phase situation.

I. Monitoring of nutritional support

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Feeding tolerance	Gastric aspirates Abdominal distension or discomfort Bowel activity	Hospital flow sheet or fluid balance charts, medical record documentation.	Daily in acute care situation; 2-3times weekly instable hospital patients; weekly–monthly in long term care
Feed delivered	Is the patient received the prescribed amount of formula?	Hospital flow sheet or fluid balance charts Medical record documentation	Daily in acute care situation; 2-3times weekly instable hospital patients; weekly–monthly in long term care.
Care of feeding equipment	Regular tube flushing PEG site care	Hospital flow sheet/ care plans; medical record documentation.	Daily in acute care situation;2-3times weekly instable hospital patients; weekly–monthly in long term care.

Patient positioning	Patient head and shoulder must be elevated30-45°above chest level	Observation	Continuous in acute care situation; at least every shift in stable patients.

J. Adequacy of nutrition support

Measure	Description	Interpretation	Ideal Frequency of Monitoring
Nutritional input	Is the patient receiving/tolerating the prescribed amount of formula? is the formula appropriate for the patient's needs? *Is the patient receiving adequate fluid	Hospital flow sheet or fluid balance charts Medical record documentation Food charts/observation Patient report of intake Free water input should match fluid output in a stable patient.	Daily in acute care situation; 2-3times weekly instable hospital patients; weekly–monthly in long term care.
Review of requirements	• Have requirements changed (due to new infections or surgery, or improvement in condition, or change in activity level)? • Is feeding regimen still appropriate?	Patient weight monitoring Biochem/ haem Medical record documentation Medication chart and Drug- Nutrient Interaction manual	Weekly in acute care situation; monthly in stable hospital patients. 1-6 times per year in long term care.

8. PEDIATRICS NUTRITIONAL SUPPORT AND THERAPY IN ICU

8.1 Pediatrics Nutritional screening and assessment

- Nutritional screening and/or assessment of critically ill children should be conducted within the first 24 to 48 hours and then daily or weekly depending on child condition and should include routine anthropometric measurements.
- Assessment of malnutrition involves accurate measurements of anthropometric variables such as weight and length/height, which are plotted on population growth curves against which an individual child is compared.

8.1.1 Pediatric Anthropometric Criteria

Anthropometric measurement: weight, length/height, Head Circumference, mid-upper arm circumference, and determination of indices like, weight for Height or length (WFH/ WFL), and body mass index (BMI) should be checked. These values are then used to classify children's nutritional status as compared to children of the same age from healthy population.

Table 7: Pediatric Malnutrition Classification with WHO Z Score BMI/ WFL

Z-score	**Growth indicators**			
	Length/height or-Age	Weight-forage	Weight-for length/ height	BMI-for-age
Above 3	Very tall	Normal	Obese	Obese
Above 2			Overweight	Overweight
Above 1			Possible risk of overweight	Possible risk of overweight
0 (median)				
Below - 1				
Below - 2	Stunted	Underweight	Wasted	Wasted
Below - 3	Severely underweight	Severely underweight	Severely wasted	Severely wasted

8.1.1 Mid-upper arm circumference (MUAC) measurement

Mid–upper arm circumference (MUAC) has been suggested as a proxy for weight and HC as a proxy for height. In the patients with fluid shifts and edema, MUAC may be a better indicator than weight-for-height for classification of acute malnutrition. MUAC changes little during the early years. It is simple and accurate, and it predicts malnutrition-related mortality with reasonable specificity and sensitivity. (Table 2)

Table 8: Mid upper arm circumference classification of malnutrition

Color	Nutritional status	MUAC (cm)	
Red	Severe	<11.5cm	<115 mm
Yellow	Moderate	11.5-12.4 cm	115-124 mm
Green	Healthy	>12.5 cm	>125 mm

NB: MUAC used for (6 to 59 month) and/ or length above 65 cm

NB: Fluctuations in weight due to changes in fluid status, fluid management, and conditions that may lead to volume overload and edema are common critically ill children and should be taken into consideration when evaluating weight changes.

Those children who are at high risk for higher energy demands need to be identified for further nutritional assessment and intervention even if anthropometric measurement falls within normal nutritional status. These may include:

- Those who have mild or moderate malnutrition, or overweight, or obese
- Children with > 10% weight gain or loss during their PICU stay
- Children who failed to take less than 50% of the usual dietary intake for at least 3 days.
- Those children in need of escalating respiratory support or requiring mechanical ventilator support for more than 7 days or who failed to wean off ventilator.
- Children suspected to be severely hyper metabolic (status epilepticus, hyperthermia, systemic inflammatory response syndrome etc.)
- Children with hypometabolic (hypothermia, hypothyroidism, pentobarbital or midazolam, etc.).
- Children with planned major surgery/procedure.

In addition to further assessment of children' clinical condition, biochemical information of laboratory results, and further assessment of past and present nutritional intake, environmental

and functional information are required to determine not just nutritional status, but nutritional diagnosis in addition to providing relevant data for nutritional intervention and monitoring.

Summary: Assessment

Screen: by determining, W/A, MUAC, weight for length/height, BMI based on guidelines

ASSESS: (children at medium or high risk) by performing Anthropometric, Biochemical, Clinical, Dietary (detailed) Environmental and Functional assessment

Nutritional Therapy

Once the assessment is done, the relevant nutritional diagnosis that is amenable to nutritional intervention is identified, and therefore the relevant intervention is planned.

Estimating Pediatrics nutritional requirements necessitates accurate estimation of energy expenditure**.**

Goals of Nutrition Care

To meet 50% of energy requirements by 48 hours and 100% by days 3-5 based on Schofield formula, depending on course of the disease.

8.2 Energy requirement estimation

To estimate energy expenditure, age and weight- based factorial method for energy requirement can be used (Table below) for healthy children.

Table 9 Age and weight- based energy requirement and see also Annex

Normal energy requirement for age based on weight	
Age/Size	Energy requirements per day
Premature neonates	120-150kcal/kg
Neonates	100-120kcal/kg
<10kg	100kcal/kg
10-20kg	1000kcal+ 50kcal/kg over 10kg
>20kg	1500kcal + 20kcal/kg over 20kg

NB: *depending on the disease type the energy demand is different. Eg; Sedated and mechanically ventilated children may experience a significant reduction in energy expenditure. Inaddition, growth impairment during the inflammatory response due to an inhibition of growth hormone's anabolic role, also contributes to hypo metabolism. Conversly sepsis, trauma and high temperature increases energy expenditure and therefore higher energy requirement than the normals energy requirement (table 4) should be considered for these infants and children.*

Alternatively, a predictive equation/formula can be used to estimate the resting energy expenditure (REE) e.g., Scofield formula (**Error! Reference source not found.**), onto which should be added additional energy for physical activity, or disease and stress factor (Table 8).

Table 10: Adjustment factors for Estimated Resting Energy Expenditure (REE)

Fever: increases by 10% for each 1oC above 37 (up to max of 40oC)
Sepsis: increases by 9% regardless of temperature
Surgery: increases by 6% if patient has had surgery or trauma
Burns: increase by 100% if any size over 30% (or use Toronto formula)

Calorie Requirements Changes throughout the phases of critical illness:

Acute Phase

- In this phase, the first 24 to 72hr of critical illness, energy intake should be less or limited to the requirement of vital organ support (sedation, mechanical ventilation, vasopressors, fluid resuscitation)

- Calorie intake should not exceed resting energy expenditure (as calculated by Schofield equation appendix 6

Stable Phases

- The stable phase is where physiological control has been achieved, but the stress response is not completely resolved although the child is stable and there is a process of stability or weaning of vital organ support
- Calorie intake should be increased to account for the energy debt (deficit acquired during the acute phase) growth and mobilization.

Recovery

- Recovery may not occur in PICU, but involves clinical mobilization, with normalization of neuro-endocrine, immunologic and metabolic alterations returning to anabolism.
- During this phase there will be the re-accumulation of protein and fat stores, which may require a period of intensive nutritional rehabilitation. Energy and nutrient delivery may need to be adjusted based on evaluation of nutritional and clinical conditions and progress.

Macronutrient requirement

Protein

- Protein around 1.5 g/kg/day on day 1 (range 1.2 to 2.0 g/kg/day for ICU patients) with gradual increase over the following few days based on assessment.
- Use 2g/kg/day if severely catabolic e.g. severe sepsis/burns/trauma
- Protein provides 4 kcal/g
- Calorie provided by protein should be around 15 -20 % of Estimated Energy requirement.
- Protein energy should never be less than 10% of REE.

Lipid

- Provides 9 kcal/g
- Calories from lipid should be limited to a maximum of 40% of total calories, give the remaining energy requirements as carbohydrate.

Carbohydrate:

- Provides 4 kcal/gm.
- Calories from carbohydrate should be 40- 60 % depending on the underlining disease.
- In PN, glucose delivery rate should not exceed 6-8mg/kg/min (starting at 4mg/kg/min) in preterm, to <12mg/kg/min in term infants. In critically ill children, delivery should be cautious and may be limited to 5mg/kg/min.

Micronutrient requirement

Micronutrients (vitamins and minerals) are required in very small amounts to maintain health but not to provide energy.

- **Iron deficiency:** Anemia is a common complication of pediatric critical illness; close to 75% of children that are admitted to the pediatric intensive care unit (PICU) are anemic at some point during their stay. In sick patient's supplementation of iron has disadvantage because it will worsen the infection. If hemoglobin is less than 7mg/dl, a transfusion is indicated. Supplement 200 µg/kg/ per day may be required at the stage of recovery is hemoglobin level is still < 10mg/dl.
- **Vitamin D:** The prevalence of vitamin D deficiency in intensive care units' ranges typically between 40 and 70%.
  The daily requirement of 1000 IU (10 – 25mcg) of Vitamin D supplementation has to be given to critically ill patients. Monitoring Vitamin D may be essential.
- **Vitamin A:** Vitamin A supplementation is necessary for critically ill patients. Recommendations support supplementing with 100.000 IU **Vitamin A**
- **Zinc**: supplementation of 2 – 4 mg/kg/d is recommended for preterm - term infants respectively.

Fluid and Electrolyte Requirements

Daily assessment of weight, urinary osmolality, and fluid balance is used to estimate hydration status. Considerations should also be given to underlying diseases eg. burn, fever and environmental conditions like (room temperature, radiant warm, and phototherapy) which may increase the requirement for fluid allowances.

Table 11: Electrolyte dosing guideline

	Preterm Neonates	**Infants/Children**	**Adolescents and Children >50 kg**
Sodium	2–5 mEq/kg	2–5 mEq/kg	1–2 mEq/kg
Potassium	2–4 mEq/kg	2–4 mEq/kg	1–2 mEq/kg
Calcium	2–4 mEq/kg	0.5–4 mEq/kg	10–20 mEq
Phosphorus	1–2 mmol/kg	0.5–2 mmol/kg	10–40 mmol
Magnesium	0.3–0.5 mEq/kg	0.3–0.5 mEq/kg	10–30 mEq

Source: Reprinted from (Mirtallo et al., 2004)

Table 12: Fluid requirement estimation: Holliday–Segar Fluid Calculation

Weight	Fluid requirement per weight
1–10 kg	100 mL/kg
>10 to 20 kg	1000 mL for the first 10 kg, plus 50 ml/kg over 10 kg
>20 to 80 kg	1500 mL for the first 20 kg, plus 20 mL/kg over 20 kg up to 2400 mL/day

NB - *Fluid should be increased in febrile patients, diabetic insipidus, burn, radiant warmer, and phototherapy. It may have to be decreased in renal disease, cardiac disease and humidified ventilated patients. Most ICU patients require 60 to 70% of the Holliday–Segar Fluid calculated amount because of syndrome of inappropriate secretion. Always consider fluid given through drugs, through nutrtion etc. and individualize.*

Example 1

Abebe, 5 yrs. old, 18kg, 109cm sustained car accident with Severe Traumatic Brain Injury (TBI) with intra cranial hypertension. The patient is intubated and on sedation also on neuro blocking agents.

- When and how would you feed this patient?

Based on recent guidelines

Abebe, 5 yrs. old, 18kg, 109cm

- Early enteral nutrition (within 24-48hr) with stepwise increase over a few days
- In the first phase of this child fluid and calorie requirement is decreased because of sedation, neuromuscular blocking agent and intubation.
- Fluid may be decreased 18kg: 10kg x 100ml then 8kg x 50ml = total 1400ml/d, but may need to be reduced to 60-70% of requirement, + IV fluid given may further reduce it… = 840ml/d – any additional fluid given via IV or medication (will need to be discussed with med. Team).
- Target Calorie requirement is based on (Table 7) = 1400kcal/d but we need 50% of this in the initial phase i.e. 800kcal/d.

Summary: Determination of Energy, Fluid and Nutritional requirement should be based on:

- Actual weight of child especially if weight is out of range of standard for age!
- Consideration of additional requirement or adjustment for stress e.g., fever, sepsis, trauma or oedema etc.
- Determination of micronutrient requirement, for immediate or later use and monitor micronutrient status to ensure requirement is adjusted to status.
- Continued monitoring and evaluation outcome as requirement may change with changing clinical and anthropometric status.

8.3 Routes Nutritional support

Nutritional support can be given through:

- Enteral - via a tube directly into gastrointestinal tract
- Parenteral - intravenous (via either peripheral or central vein)

Enteral feeding

- Is oral, nasogastric, orogastric, gastrostomy, Nasojejunal, Nasojejunal or Jejunostomy
- Enteral feeding is far cheaper, more physiological, reduce the risk of peptic ulceration, minimize mucosal atrophy (food in the gut lumen is a potent stimulus for mucosal cell growth) and may reduce translocation of bacteria from the intestinal lumen.
- Start feeding early (within 24 hours of admission or surgery) has been shown to reduce septic complications, length of hospital stays and readmission rates in patients after both upper and lower gastrointestinal surgery.
- Aspirate regularly before feeding to ensure that gastric residual volume is less than 200ml Volumes above this greatly increase the risk of reflux and subsequent pulmonary aspiration and feeding rates should be reduced accordingly.

Nasogastric

- This is the most common method of feeding in Intensive Care. The size will vary depending on the age of the child and will range from 6fr (neonates) – 10fr (> 5yrs old). The insertion of a nasal tube is contra-indicated in a patient with a base of skull fracture due to the risk of intracranial penetration. Potential problems include malposition, difficulty swallowing or coughing, discomfort, sinusitis and nasal tissue erosion.
- Confirm tube position - both clinically and radiographically if possible. Otherwise, it is easy to administer feed directly into the lungs.
- Secure tube well- there should always be a high index of suspicion that the tube may have become dislodged.
- The patient should be sat up to an angle of at least 30o to minimize the risk of reflux and subsequent aspiration of gastric contents. This can still occur around a cuffed tracheal tube.
- Enteral feeding does not appear to increase, and may in fact decrease, the incidence of anastomotic breakdown

Oro-gastric tubes

This method may be suitable for in intubated and premature and small neonates. It is not suitable for awake patients however should be considered in intubated. Patients to reduce sinusitis (a risk factor for ventilator-associated pneumonia).

Enterostomy

Gastrostomy or jejunostomy tubes can be placed at the time of surgery or as a separate procedure by endoscopic procedure and have significant benefits for those who require nutritional support for over 4 weeks. Once inserted they are well tolerated.

Post-pyloric feeding: Nasojejunal or Jejunostomy

A nasojejunal tube should be over 120cm long to ensure correct placement. Feeding directly into small bowel avoids the problem of gastroparesis. The small bowel recovers normal function 4-8 hours post laparotomy. Post-pyloric feeding is recommended for patients at high risk of aspiration, those undergoing major intra-abdominal surgery and patients who are intolerant of gastric feeding on monitoring evidenced by intractable vomiting or excessive gastric residual volume (GRV) interfering with successful feeding.

NB: NGT feedings are indicated for infants and children who are not able to take in enough calories by mouth (< 50% of daily requirement). Gastrostomy or Jejunostomy feeding indicated if Oral or Nasogastric feeding is not possible or there is a risk of aspiration. Parenteral feeding is indicated if the GIT is not functioning, or all other methods fail to improve the nutritional status of the patients.

Timing and advancement

- A bedside feeding protocol should be available, with a stepwise algorithm including a bedside support guide to detect and manage intolerance and optimal rate increase.
- Early initiation of EN (within 24hrs) if there is no contraindication, or within 48hrs is recommended. Nutritional support given should not exceed the measured or estimated **basal metabolic rate**.
- Aim to give 2/3rd of target requirement to be given by the first week of the commencement of critical illness in the absence of any contraindications.

Modes of Delivery

The use of a stepwise algorithmic approach to advance EN in children admitted to the PICU is suggested to guide the detection and management of EN intolerance and the optimal rate of increase in EN delivery. Start feeding early within 24 to 48 hours of admission or surgery.

- Start enteral feeding at a rate of 0.5ml/kg/h start, and increase by 0.5ml/kg/h every 4-6 hrs. until target.

- Target oriented 40% of calculated target on Day 1Advance by + 20% on day 2 and add 20% every day Until 100% on Day 4

Delivery

Nasogastric and Gastrostomy feeds may be delivered as bolus or continuous, starting with low volume and gradually increasing depending on tolerance. (Table 11)

Post-pyloric and parenteral feeding should ideally be delivered as continuous infusions, starting with a lower rate and increased gradually in line with the monitoring protocol in place. The volume and rate of increase varies depending on the age and weight of the child. (Table 13)

Table 13: Rate/Volume, increment and maximum feeding guideline for Bolus and Continous feeding in infants and children

Age	Initiation	Advance	Suggested tolerance volumes
Bolus Feedings			
0-12mths	10-15ml/kg every 2-3 hr	10-30ml/feed	20-30ml/kg every 4-5 hrs
1-6yr	5-10ml/kg every 2-3hr	30-45ml/feed	15-20ml/kg every 4-5 hrs
>7 yr	90-120ml/kg every 3-4 hr	60-90ml/feed	330-480ml/kg every 4-5 hrs
Continous feedings			
0-12mths	1-2ml/kg/hr	1-2ml/kg every 2-8 hrs	6ml/kg/h
1-6 yrs	1ml/kg/hr	1ml/kg every 2-8 hrs	1-5ml/kg/hr
>7 yrs	25ml/kg/hr	25ml/kg every 2-8 hrs	100-150ml/kg/hr

Trophic Feedings

- Trophic feedings (also called "minimal" or "priming" enteral feedings) are small amounts of feeds started in newborn infants, especially in premature babies, in order to stimulate the development of the immature gastrointestinal tract of the preterm infant and to ensure gut function is maintained when partial or full enteral feeding is delayed, and parenteral nutrition is the main source of nutrients.
- These feeds do not provide significant energy or nutrients for estimated needs. Feeding should be started from right after birth to up to 24-48 hours within birth. Delaying initiation of feeding beyond this has not been demonstrated to delay development of Necrotizing Entero-Colitis (NEC) in premature or VLBW babies.

- The feeds are usually colostrum and human milk; these have unique properties that cannot be duplicated. These include nutrients, enzymes, growth factors, hormones, and immunological, anti-infective and anti-inflammatory properties.
- These feeds are of small volume ranging from 10 to 24 mL/kg/day and not intended for providing adequate calories. Although trophic feeding does not provide sufficient calories for growth, it is beneficial as it exerts a trophic effect on the gut mucosa.
- Trophic feeding can gradually be increased to provide full requirement, or it can be continued alongside alternative feeding periods (parenteral nutrition or on fluid maintenance) until it is suitable to transfer to the next logical feeding mode (enteral or oral).

8.4 Choices of feeds

8.4.1 Blenderized tube feeding

Blenderized tube feeds are feeds made up of available food ingredients including liquids which are mixed and blended to a consistency which can be given via enteral feeding tubes. Attention should be paid to carefully slenderizing all the ingredients, straining to avoid blockade of tubes, and meticulous hygiene and safety procedures should be employed to avoid microbial contamination and complications thereof.

8.4.2 Infant formula

1st (before 6month) or 2nd stage infant formulas (after 6 month) (can be used as a regular formula or as concentrated formula to provide higher calorie per ml. **Error! Reference source not found.**

8.4.3 Commercial enteral feeding formula appropriate for age

Enteral Formulations

Critically ill children who require nutritional support should be given commercially prepared polymeric feeds as the first-choice formula if available.

Polymeric feeds (standard feeds providing 0.7 – 1kcal/ml) with or without fiber

Indication of fortification:

- Preterm baby in need of more calorie
- Fluid-restricted patient, increased caloric needs
- In need of micronutrients supplementation

Expressed (mother's) Breast Milk (EBM) (67kcal/100ml)

- + proprietary fortifier
- +Infant formula powder used as fortifier

Infant formula +/- added fortification with

- +Formula **Error! Reference source not found.**
- Carbohydrates – Corn flour/ sugar or other
- Fat – vegetable oil/ coconut oil
- Protein – skimmed milk powder/ or other milk powder/ soya powder

Low molecular weight formula

1. Partially hydrolyzed formulas designed for allergies contain partially hydrolyzed, low molecular weight peptide chains which may be absorbed better.

High Energy

2. Higher fat containing formulas or formulations suitable for children with reduced volume tolerance, or fluid restriction usually providing 1.5 – 2 kcal/ml.

Fiber containing

3. Any of the above formulas (except elemental) can be prepared to provide additional fiber.

Disease specific formulas

4. For children with metabolic diseases who cannot tolerate certain macronutrients/ or amino acids

   e.g. Lactose/Galactose free for galactosemia e.g. Soy-based formula
   MCT based for Chylothorax/ or Short bowel syndrome
   Phenylalanine free for PKU

8.4.4 Parenteral

Parenteral nutrition is most often given via a **central vein** as the solutions are usually hypertonic. Preparations for peripheral use are available; however, they have to be isotonic which means that very large volumes would have to be given to provide adequate nutritional support. Parenteral nutrition provides liquid nutrients, including carbohydrates, proteins, fats, vitamins, minerals and electrolytes.

People whose digestive systems either cannot absorb or can't tolerate adequate food eaten by mouth use parenteral nutrition. Parenteral nutrition could be given to supplement enteral nutrition or can be used by itself.

Indications for PN include:

- In younger children when periods of starvation extend more than 2–3 days and in older
- children for periods more than 5–7 days
- Gastrointestinal disorders (short bowel syndromes, malabsorption, intractable diarrhea,
- bowel obstruction, protracted vomiting, inflammatory bowel disease and meconium ileus)
- Congenital anomalies (gastroschisis, bowel atresia, volvulus and meconium ileus)
- Radiation therapy to the gastrointestinal tract
- Chemotherapy resulting in gastrointestinal dysfunction
- Severe respiratory distress syndrome in children and RDS in premature babies
- Very low-birth-weight babies who are incapable of feeding and require PN during the first
- 24 hours of birth

DEVELOPING THE PN GOAL REGIMEN

Diet-induced thermogenesis reflects the amount of energy needed for food digestion and absorption and usually accounts for about 10%–20% of daily energy needs. Generally parenteral energy requirements are approximately 10%–20% less than enteral requirements for this reason.

Table 14: Energy requirements (kcal/kg/d) for parenteral nutrition in different phases of disease

Age	2016	2016	2016	2005
	Acute Phase/1st day	Stable phase	Recovery	Requirement
Preterm	45-55*		90-120	110-120
0-1y	445-50	60-65	75-85	90-100
1-7y	40-45	55-60	65-75	75-90
7-12y	**30-40**	**40-55**	**55-65**	**60-75**
12-18y	20-30	25-40	30-55	30-60

In summary, to calculate and establish parenteral nutrition in infants, it is to:

1. Determine the stage of recovery phase calculate daily energy requirement based on weight

2. Calculate the protein requirement (8.2 Energy requirement estimation)

3. Determine the amount of feed that would closely fit the calculated requirement

4. If central, calculate the rate of feed per hour/rate of drops per hour that would ultimately give the total volume in 24hr (Table 13)

5. Recalculate requirement the next day based on weight, previous monitoring results and stage of critical illness (8.5 Monitoring guideline)

Table 15 : Guideline on initiation and advancement of parenteral nutrition

Age	Initiation and Advancement	Protein (g/kg/day)	Dextrose (GIR)	Fat (g/kg/day)
Premature infant	Initial	1.5 to 3	5 to 7 mg/kg/minute	1 to 2
	Daily increase	1	1 to 2.5 mg/kg/minute or 1% to 2.5% increments	0.5 to 1
	Goal	3 to 4	8 to 12 mg/kg/minute (max: 14 to 18 mg/kg/minute)	3 to 3.5
Term infant <1 year	Initial	1 to 3	6 to 9 mg/kg/minute	1 to 2
	Daily increase	1	1 to 2 mg/kg/minute or 2.5% to 5% increments	0.5 to 1
	Goal	2 to 3	12 mg/kg/minute (max: 14 to 18 mg/kg/minute)	3
Children 1 to 10 years	Initial	1 to 2	10%	1 to 2
	Daily increase	1	1 to 2 mg/kg/minute or 5% increments	0.5 to 1
	Goal	1.5 to 3	8 to 10 mg/kg/minute	2 to 3
>10 years	Initial	0.8 to 1.5	3.5 mg/kg/minute or 10%	1
	Daily increase	1	1 to 2 mg/kg/minute or 5% increments	1
	Goal	0.8 to 2.5	5 to 6 mg/kg/minute	1 to 2.5
Rate of advancement may be limited by metabolic tolerance (eg, hyperglycemia, azotemia, hypertriglyceridemia)				
Timely intervention in premature infants is essential with initiation of dextrose as soon as possible after birth, amino acids within the first 12 hours, and fat emulsion within 24 to 48 hours of life.				

8.5 Monitoring guideline

Anthropometry

Weight should be monitored daily at the after initiation and can be done weekly to monthly after stabilization.

Height can be monitored weekly or monthly depending on the length of time the infant/child is on parenteral nutrition. Alternative **weekly to monthly** monitoring anthropometry of **MUAC** can also be used to monitor adequacy of nutrition for long-term nutritional adequacy.

Table 16: Guide for biochemical monitoring

	Urea/Cr/e-		**Ca/ PO4**	**Mg**	**Triglyceride**	**Glucose**	**Trace Se, Zn, Cu, Mn, and FSV**
First week or unstable	Daily or 2x/week	Daily or 2x/week	Daily	2x/week	2x/week	U: 6hrly B: 6-8hrly	
Stable	2x/week	Weekly	2/week	2x/week	2x/week	U: daily B: daily	Monthly aft >3wk on PN

8.6 Transitioning from Parenteral to Enteral or Enteral to oral feeding

Transition from parenteral to enteral nutrition

- Once PN is started, all efforts must be made to start enteral nutrition.
- Small trophic feeds should be established and gradually increased till the gut normalizes.
- A combination of PN and enteral nutrition is helpful in such cases (e.g., short bowel syndrome, or large fistulae) to best cover nutritional needs.
- Once nutritional demands are met by enteral route, slowly PN can be tapered and stopped.

Enteral to oral feeding

- Enteral tube feeding should be stopped once the patient has recovered swallowing, gastrointestinal, or general function to a level that permits an adequate oral intake, up to 50% of requirement.

Stopping tube feeding

A tube feed may be stopped When nutritional assessment by a dietitian/ medical personal confirms that the patient is able to orally ingest at least 80% of his/her nutritional requirements for 3 consecutive days**.**

Please note

It is imperative that both the dietitian and medical team be informed and/or involved in the decision before any feeding tube is removed. The patient's weight and height need to be recorded on the day that the tube is removed and regular follow- ups scheduled to monitor progress.

- A return of appetite.
- When the patient has a nasogastric tube for decompression, secretions will diminish.
- The patient should not have vomiting.
- Sometimes an X-ray of the gastrointestinal tract is necessary to assess the adequacy of the GI tract, for example to check if there are signs of paralytic ileus.

When the patient is ready for the transition to enteral feeding, an oral diet or tube-feeding is initiated. When the patient is able to eat, an oral diet is preferred. Usually, a clear liquid diet is initiated and, if tolerated well, is advanced to a full liquid diet and finally to solid food. Monitor the oral intake of fluids and food to ensure an adequate intake of nutrients before discontinuing

parenteral nutrition. When the oral intake is increasing, the amount of PN can slowly be tapered.

8.7 Problems during Enteral Feeding

Underfeeding

The causes are inaccurate estimation of energy expenditure, delayed in detection of deteriorating nutritional status and failure to deliver the prescribed nutrients

Overfeeding: the cause is overestimation of energy expenditure and inaccuracy of weight measurement.

Complications of Overfeeding

- Hyperglycemia (may increase infection)
- Hepatic complications: fatty liver, intrahepatic cholestasis
- Pulmonary function alteration because of fluid overload
- Mechanical ventilation delay
- Increased endogenous CO2 production
- Electrolyte abnormalities: PO4, K, Mg Volume overload,

Management: Prevent Overfeeding by reassessing and reviewing feed and requirement.

Difficulty in advancing feeds:

Patients who have hypo perfused gut may have difficulty in tolerating rapid advances in feeds, e.g. premature neonate with necrotizing enterocolitis who is on improving and child recovering from severe shock. Trophic feeds (1–2 mL/h for 24–48 hours) may be useful to maintain gut integrity and function or consider parenteral feeding.

8.8 Complications of Enteral Nutrition

The complications are divided into Mechanical complications, gastrointestinal complications, and Metabolic complications.

Mechanical complications

The naso-enteral tube may cause a problem of clogging or missing the tube itself or causing perforation. Therefore, ensuring tube is in position is essential before every feeding or manipulation of tube. Gastrostomy and enterostomy tubes may also cause similar complications and local irritation. Stoma-related complications may result in an enlarged stoma site due to a large wall incision, leakage of nutrients or gastric juice, and enterocutaneous fistula after removal.

Table 17: Mechanical Complications of Enteral Nutrition

Complication	Cause	Prevention
Tube blockage	Failure to regularly irrigate tube Medication administration via tube Fiber rich diet/ poorly blended or unstrained feed	Flush tube with water after every feed Use larger size tube
Pulmonary aspiration	Reduction in protective reflexes Migration of tip of tube to Esophagus	Post pyloric feeding Head end elevation Monitor GRV and adjust
Poor or shifted tube position	Incorrect placement of tube Migration: coughing/vomiting/retching	Correct tube placement Check tube placement before feeding
Accidental tube withdrawal	Agitated patient, inadequate sedation or analgesia or inappropriate fixation	Correct tube fixation Sedate or provide adequate analgesics

Infectious complications

- Catheter-related infections remain the main cause of sepsis in patients receiving PN.
- Factors that correlate with catheter-related infections include prolonged catheterization,
- A considerably higher rate of infection is found in children with short bowel syndrome; Use of chlorhexidine-impregnated dressings has been shown to reduce pediatric catheter infections.
- Wound infection such as purulent discharge, cellulitis, and peristomal abscess or local and systemic septicemia associated with feeding devices can occur

- Prevention and treatment through antibiotics and dressings in sterile conditions are important before and after the procedure.
- Bacterial contamination is not known precisely, but often sepsis may occur, and up to 35% to 50% of cases have been reported in pediatric hospitals.
- Coagulase-negative staphylococci, streptococci, and gram-negative bacilli cause infections.
- Infection can occur due to insufficient hand washing or lack of awareness of hygiene, and repeated use of food storage containers.
- Reducing exposure time to contamination, such as through feeding hang time or minimizing time to exposure after opening the formula, may also be effective for infection control.

Gastrointestinal complications

Gastrointestinal complications include abdominal discomfort, bloating, and cramping. Excessive infusion rate, slow gastric emptying, constipation, and psychological factors can cause nausea and vomiting, and dislodged tubes and intolerance of bolus feeds can lead to regurgitation or aspiration. Diarrhea may also occur due to multifactorial reasons.

Abdominal distension:

- If there is mild increase in abdominal girth with no symptoms like management is observe. Usually, the cause is due to air swallowing which resolves.
- If associated with vomiting, absent bowel sounds or no passage of stools, then initially smaller-volume feeds can be tried.

Impaired gastric motility: could be one cause of distention. It is caused by multiple factors: ongoing illness, osmolality of the formula, fat content and medications (such as opioids, benzodiazepines, analgesics, sedatives and anesthetics).

- Management: decrease flow of feeding also treats underlying cause stop drugs, treat hypokalemia etc.

Diarrhea in PICU:

Causes of diarrhea

- Could be when on enteral feeds: – Fast increase in the volume of feeds or fast feeding when the tube is post-pyloric
- Low-fiber-containing diet or high-osmolality diet
- Contaminated food
- Drugs such as antibiotics, laxatives, magnesium, antihypertensive and proton pump inhibitors

- Excessive bacterial growth in small bowel – Clostridium difficile infection
- Lactase deficiency both primary and secondary
- Poor fat absorption due to pancreatic dysfunction, hepatic disease or celiac disease
- Management: depends on the cause e.g., low osmolarity feed, lactose free feeding or using yogurt, antibiotic or probiotic etc.

Clostridium difficile diarrhea

- It is usually seen in patients who are receiving or have received antibiotics for the previous 3 weeks.
- Diagnosis is confirmed by stool culture that grows the treatment includes starting oral or intravenous vancomycin or addition of metronidazole orally or intravenously.
- Broad-spectrum antibiotics should be stopped.
- Strict hand-washing precautions and isolation of patient are recommended.
- If immediate infection control steps are not enforced, outbreaks in PICU can be devastating.
- For established cases recently fecal transplant has shown to be quite promising.

Redness in the anal area after starting feeds: This is usually due to high-osmolality feeds, fungal infection, or lactose intolerance.

Metabolic complication

Although metabolic complications are not common occurrences in EN, patients with chronic nutritional imbalance or cardiac, liver, or renal problems require more attention. Careful attention should be paid to the possibility of refeeding syndrome during abrupt feeding of high-energy nutrition in patients with chronic nutritional imbalances.

When excessive amounts of carbohydrates are supplied, phosphorus, magnesium, and potassium move into the cells due to sudden increase in insulin secretion. As hypophosphatemia can lead to heart failure, arrhythmia, and death, the initial supply volume or calories should be at ＜75% of the requirement.

Re-feeding syndrome

Definition: Re-feeding is the process of reintroducing food after malnourishment or starvation. Re-feeding syndrome is a serious and potentially fatal condition that can occur during re-feeding. It's caused by sudden shifts in the electrolytes that help the body metabolize food.

- Reintroduction of feeds needs to be handled with care in management of severely malnourished patients. During starvation, the body becomes deficient in many electrolytes including phosphate and potassium. However, due to intracellular

contraction the serum concentration of these electrolytes remains stable. Commencement of feeding results in shifts in fluids and electrolytes can lead to life-threatening complications.

- Upon reintroduction of nutrition, insulin levels increase resulting in intracellular transport of potassium, phosphate, and magnesium causing profound hypophosphatemia (the hallmark of refeeding syndrome) which can have profound physiologic effects.
- The probability for refeeding syndrome should be considered whenever nutritional support is instituted orally, enterally or parenterally in high-risk patients.
- To prevent refeeding syndrome, once recognized, nutritional therapy should proceed slowly, and electrolytes checked frequently.

Circumstances where the risk of refeeding syndrome occurring may be high in the following patients:

- where the child has <70%–80% weight for height
- following rapid weight loss (including in obese patients)
- after prolonged intravenous fluid therapy devoid of glucose
- when there has been minimal intake for 7–10 days
- where there are pre-existing low levels of serum potassium, phosphate or magnesium before the introduction of nutrition

Management of re-feeding syndrome: Initial monitoring of electrolytes and correction is recommended before starting feeding. Feeds should be started slowly (5-10kcal/kg/d – 40kcal/kg/d) in high risk small infants to older children. Progress of feeding should not be attempted without correction of electrolytes. Targeted feed can be reached within 3 – 5 days of commencement of feeding.

Table 18: Metabolic complications of enteral nutrition

Complication	Probable cause	Prevention/treatment
Hyperglycemia	Metabolic stress	Check infusion rate; monitor glycosuria and glycaemia
Dehydration	High osmolality diet, inadequate liquid intake	Monitor electrolytes, urea, hematocrit. Check protein intake, increase liquid intake
Hypokalemia	Anabolism and intake shortage; losses through diarrhea, digestive juices or diuretic use	Frequent monitoring of potassium
Hyperkalemia	Renal insufficiency; metabolic acidosis	Check potassium intake, treat underlying cause
Hypernatremia	Hypertonic formulas;	Consider formula change;

	inadequate liquid intake	increase liquid intake
Hypophosphatasemia	Refeeding of the severely malnourished; use of antacids	Frequent monitoring of phosphate
Hypercapnia	Hypercaloric diet with high level of carbohydrates in patients with respiratory insufficiency	Decrease proportion of lipids as caloric source

Drug-nutrient interactions

- Unexpected interactions may occur when drugs are administered via enteral feeding tubes.
- Administration of the drug through the intestinal tract, other possible routes should be considered and the administration of coated or slowly degrading drugs through the tube should be avoided.
- If the tube is the only route for drug administration, drugs should be administered in portions; pills should be mixed with water and gelatin capsules should be dissolved in warm water before administration.

Summary: Complications

Carefully monitor and manage complications before stopping feeding.

8.9 Nutritional therapy in specific diseases

The energy and protein requirements of infants and children with the most frequently encountered specific diseases are summarized below.

Cardiac diseases, congenital heart diseases, and cardiac surgery

- Energy requirement prior to surgery is reported to be near normal to high. (100 – 120kcal/kg/d). If, however growth is faltering, energy requirement (and therefore intake) should be adjusted based on assessment.
- Protein should provide 9-12% of energy (1.5g/kg/d).
- Micronutrient intake should be according to the recommendation for healthy children unless indicated by assessment.

Post-surgery energy requirement

- As low as 60 – 75kcal/kg/d, this may also be limited by the restriction on fluid required during the first few days after surgery.
- Energy (and therefore protein and other micronutrients) will be increased once fluid has started to be liberalized. Once out of the acute phase post - surgery energy requirement should be calculated based on daily requirement of 120 - 150kcal/kg/d, with protein around 2.5 – 4g/kg/d depending on the level of faltering growth observed on assessment.
- For this, a high energy feed (Feed providing 1.2 – 1.5 kcal/ml) may be required.
- Sodium intake should not exceed the recommendation for age. (Table 19)
- Regular anthropometric assessment and weight chart to monitor their growth is essential in determining the energy requirement and adjustment necessary.
- If an infant continues to falter in growth despite high energy and protein intake, assessment of Sodium, Magnesium and Zinc and their adequacy should be assessed as low levels may be limiting factors in adequate growth for infants and children.

Renal Diseases

- The aim of nutritional management is to help control acute symptoms, maintain fluid, electrolyte and acid base balance and ensure growth and development.
- Adequate energy should be provided and protein restriction to below recommended nutrient intake (RNI) should only be considered where the serum Urea > 40mmol/l.
- Minerals (sodium) should be limited within 3 – 6mmol/kg/d (depending on whether the condition is salt losing or salt sparing. Consider sodium content of some medications).

- Uremic diet consists of low protein, high caloric content, and low phosphate and potassium. Depending on the GFR, protein needs to be restricted. If the GFR < 25, then protein should be 0.6–0.7 g/kg/day (**Error! Reference source not found.**)

Table 19: Recommendations on Na,Ca and vitamin D consumption in children with chronic renal failure

Age	Range Target daily intake of Sodium	Calcium	Vitamin D
0–6 months	<1g	400 mg/d	340-400 IU
7–12 months	1g	500 mg/d	400 IU
1–3 years	2g	600mg/d	400 IU
4–6 years	3g	700mg/d	400IU
7–10 years	5g	800mg/d	400IU
11–14 years	6g	1000mg/d	400IU

To convert grams of salt to milligrams of sodium: divide the salt figure in grams by 2.5 and then multiply by 1000, e.g., 6g salt ÷ 2.5 = 2.4×1000 = 2400mg sodium = 100mmol sodium.

To convert grams of salt to milligrams of sodium: divide the salt figure in grams by 2.5 and then multiply by 1000, e.g., 6g salt ÷ 2.5 = 2.4×1000 = 2400mg sodium = 100mmol sodium.

Burn Injury

Thermal injury results in a marked change in metabolism that is reported to last up to 12 months or longer depending on the severity of the original injury. Initially there is a reduction in metabolic rate that lasts 3–5 days then this is followed by the hypermetabolic 'flow phase' that is associated with physiological, endocrine and immunological changes.

To enable this estimation of increased requirement, information on burn surface area quantification, should be used with nutritional assessment methods. **Error! Reference source not found.**

Goal of Nutritional Management is:

- to promote optimal wound healing and rapid recovery from burn injuries,
- to decrease complications, like of infections during the treatment period
- to attain and maintain normal nutritional status and minimize metabolic disturbances during the treatment process

Nutritional Management

- Provide nutrition via enteral route within 6–18 hours post-burn injury and severe burn injuries often require nasogastric feeding.
- Ensuring adequate energy and protein as well as fluid intake with the inclusion of micronutrients is essential. The hypermetabolic response associated with severe burn injury results in high calorie requirements. Provision of those nutrients known to be associated with healing and immune function. The provision of high energy feeds concentrated to provide 1.5 – 2kcal/ml may be necessary to accommodate the high energy requirements
- Protein requirement 2–3g protein/kg/day
- Aggressive protein delivery, providing approximately 20% of calories from protein, has been associated with improved mortality and morbidity.
- Particularly vitamin A, C and E, some B vitamins and zinc, is especially important. Supplementation with various additives, including fish oil and arginine also beneficial.
- Minimize hyperglycemia and hypertriglyceridemia
- Maintain weight within 5–10% of pre-burn weight
- Diarrhea is commonly encountered and is usually non-infectious and multifactorial. Factors associated with decreased incidence of diarrhea include

Table 20: Formulas for energy requirements

Hildreth/Galveston equations 28	
Infants <1 year	2100kcal (8.8MJ)/m2 TBSA+1000kcal (4.2MJ)/m2BSA
Children <12 years	1800kcal (7.5MJ)/m2 TBSA+1300kcal (5.4MJ)/m2BSA
Children >12 years	1500kcal (6.3MJ)/m2 TBSA+1500kcal (6.3 MJ)/m2BSA
Curreri Junior equations [29]	
Infants <1 year	RDA+15kcal (0.063MJ)/m2BSA
Children 1–3 years	RDA+25kcal (0.105MJ)/m2BSA
Children 4–15 years	RDA+40kcal (0.167MJ)/m2BSA
Scofield equation [30]	
Girls 3–10 years	(16.97×wt)+(161.8×ht)+371.2
Boys 3–10 years	(19.6×wt)+(103.3×ht)+414.9
Girls 10–18 years	(8.365×wt)+(465×ht)+200
Boys 10–18 years	(16.25×wt)+(137.2×ht)+515.5

TBSA, total body surface area; BSA, burn surface area; RDA, recommended dietary allowance; wt., weight in kg; ht., height in cm.

Mosteller formula an estimate of body surface area and burn surface area

Total body surface area = √[(weight kg) × (height cm) /3600]

Total fluid requirement for first 24 hours

2000 ml /m^2 BSA + 5000 ml /m^2 BSAB (Body Surface Area Burned).

Example: A young girl with a mixed thickness scald

A girl aged 2 years and 11 months old has sustained a 12% mixed thickness scald (7% full thickness, 5% partial thickness) to the lower legs and feet as a result of being placed in a bath of hot water.

On admission her Weight = 12.85kg (25th centile). Estimated height = 92cm (25th centile)

Blood results are within the normal range, and there is no history of iron deficiency anemia.

The child had a reasonable intake of food prior to her injury, Anthropometric measurements and biochemical results are all currently in the normal range. Sedation and pain management is likely to reduce dietary intake in the early stage of management.

Calculating requirements

1. Determine Total body surface area (TBSA)

   weight ×height / 3600=12.85 * 92 / 3600 = **0.57 m^2**
2. Calculate Burn surface area (BSA)==12% ×**0.57m^2** = 0.068 m^2
3. Calculate requirements using the **Hildreth/Galveston equation:**

   Energy: 1800kcal (7.5MJ)/m2 TBSA+1300kcal (5.4MJ)/m2 BSA= **1114kcal** (4.6MJ)

   Protein: 2–3g protein/kg== 26–39g protein

   Fluid: 1140mL

Requirements using the Schofield equation: (kcal/day) in infants from 0–3 years

Female BMR = 16.25 ×Wt. + 1023.2×Ht−413.5

= (16.25×12.85) + (1023.2×0.92) −413.5

= (208.8+941.3) − 413.5

= 737kcal

Chronic and acute liver failure

- There is a high risk of malnutrition in CLD. It is strongly linked to morbidity and mortality. Malnutrition may be due to malabsorption, reduced intake, increased requirements and altered metabolism.
- Management is focused on avoiding hypoglycemia, avoiding the build-up of toxic by-products of metabolism and maintaining nutritional status.

- A protein restriction is not recommended for hepatic encephalopathy due to its impact on nutritional status and the risk of increasing ammonia production through catabolism.
- Maintaining glucose levels is essential. Frequent feeding including overnight feeding is recommended to avoid going long periods without food as hypoglycemia and protein catabolism is more likely during these periods.

Table 21: Calorie and protein requirement in chronic liver failure

Age	Calorie	Protein
Infants	120–150kcal/kg (*500–630kJ/kg*)	3–4g/kg
Older children	130%–150% EAR for age	3–4g/kg

- In severe Acute liver failure protein may need to be limited to 1.5g/kg;
- If inherited metabolic disorder (IMD) suspected start at 0.8–1g/kg and increase according to metabolic team and may need to avoid specific amino acids.
- In encephalopathy, protein content is reduced to less than 0.5 g/kg/day.

NUTRITION IN CHILDREN WITH MALIGNANCY

- One of the main objectives in this field is the early detection of children with pre-existing malnutrition and a high risk of substrate depletion before cancer therapies
- Early initiation of enteral feeds by means of nasogastric feeding or gastrostomy and/or nasojejunal feeding has lots of advantages in such patients.
- Parenteral nutrition can be started but infectious complications may be a limiting factor considering most children are immunocompromised.

SHORT GUT SYNDROME

- This occurs when < 200 cm small bowel is viable. Extensive loss of the intestine causes severely compromised absorption ability.
- In jejunal resection, ileal adaptation occurs and ileum is able to absorb proteins and carbohydrates, vitamins and minerals. However, the high acid output from the stomach leads to small bowel injury, enzymatic digestion suffers and diarrhea occurs due to large osmotic load to ileum.
- In ileal resection, the capacity to absorb water and electrolytes is lost; continued loss of bile salts leads to steatorrhea, fat malabsorption and loss of fat-soluble vitamins. If ileal valve is lost, diarrhea worsens and more nutrient loss occurs because of less transit time.

Management

- Early establishment of enteral feeds so that bowel function is optimised and early adaptation occurs. This often requires a combination therapy wherein PN needs to be supplemented.
- If enteral nutrition cannot be established and if the patient is fully PN dependent, then there is high risk of hepatic failure. Small bowel transplant is only option in some cases.
- Neonates, particularly those with ostomies, may have high stool output, which is associated with excessive losses of zinc, magnesium, sodium, bicarbonate and potassium. These losses must be monitored. Total-body sodium depletion has been shown to be associated with failure to thrive, despite the administration of adequate amounts of calories.
- Stool or ostomy volume should be 45 mL/kg/day, and a major obstacle to advancing feeds may be high stool output. The cause of this high output may include infections, malabsorption or rapid transit as well as bile acid irritation of the colonic epithelium
- Measurement of stool pH, reducing substances and qualitative fecal fats should be obtained and may pinpoint the etiology of high stool output. Stool pH less than or equal to 5.5 and an elevated reducing substance level (>0.5%) indicate carbohydrate malabsorption. Formulas with sucrose as the carbohydrate do not yield a positive reducing substance test despite carbohydrate malabsorption.
- Elevation in fecal fats suggests fat malabsorption, which may require modification of a child's enteral diet (i.e. increase the percentage of MCTs).
- An increase in stool a1-antitrypsin indicates a protein malabsorption, although this is less commonly encountered
- Excessive use of bile acid binders, however, such as cholestyramine, may result in depletion of the circulating bile acid pool, and thereby further limit fatty acid absorption.
- Because many infants with short bowel syndrome may have concomitant dysmotility, other causes should be ruled out first (i.e. infectious, bacterial overgrowth, bile acid irritation and potentially correctable malabsorption)

ANNEXES 1: Adult

Annex 1.1: Subjective Global Assessment Form

Medical History

Patient name:_____ Date:_____ /_____ /_____

NUTRIENT INTAKE

1. ☐ No change; adequate
2. Inadequate; duration of inadequate intake____
   ☐ Suboptimal solid diet ☐ Full fluids or only oral nutrition supplements ☐ Minimal intake, clear fluids or starvation
3. **Nutrient Intake in past 2 weeks***
   ☐ Adequate ☐ Improved but not adequate ☐ No improvement or inadequate____

WEIGHT

Usual weight_____ **Current weight**_____

1. **Non fluid weight change past 6 months** Weight loss (kg)_____
   ☐ <5% loss or weight stability ☐ 5-10% loss without stabilization or increase ☐ >10% loss and ongoing
   If above not known, has there been a subjective loss of weight during the past six months?
   ☐ None or mild ☐ Moderate ☐ Severe
2. **Weight change past 2 weeks*** Amount (if known)_____
   ☐ Increased ☐ No change ☐ Decreased

SYMPTOMS (Experiencing symptoms affecting oral intake)

1. ☐ Pain on eating ☐ Anorexia ☐ Vomiting ☐ Nausea ☐ Dysphagia ☐ Diarrhea
   ☐ Dental problems ☐ Feels full quickly ☐ Constipation
2. ☐ None ☐ Intermittent/mild/few ☐ Constant/severe/multiple
3. **Symptoms in the past 2 weeks***
   ☐ Resolution of symptoms ☐ Improving ☐ No change or worsened

FUNCTIONAL CAPACITY (Fatigue and progressive loss of function)

1. No dysfunction
2. Reduced capacity; duration of change_____
   ☐ Difficulty with ambulation/normal activities ☐ Bed/chair-ridden
3. **Functional Capacity in the past 2 weeks***
   ☐ Improved ☐ No change ☐ Decrease

METABOLIC REQUIREMENT

High metabolic requirement ☐ No ☐ Yes

PHYSICAL EXAMINATION

Loss of body fat	☐ No	☐ Mild/Moderate	☐ Severe
Loss of muscle mass	☐ No	☐ Mild/Moderate	☐ Severe
Presence of edema/ascites	☐ No	☐ Mild/Moderate	☐ Severe

SGA RATING

☐ **A** Well-nourished Normal ☐ **B** Mildly/moderately malnourished Some progressive nutritional loss ☐ **C** Severely malnourished Evidence of wasting and progressive symptoms

CONTRIBUTING FACTOR

☐ **CACHEXIA** - (Fat and muscle wasting due to disease and inflammation) ☐ **SARCOPENIA** (Reduced muscle mass and strength)

Annex1.2: Subjective Global Assessment Guidance for Body Composition

SUBCUTANEOUS FAT

Physical examination	Normal	Mild/Moderate	Severe
Under the eyes	Slightly bulging area	Somewhat hollow look, Slightly dark circles,	Hollowed look, depression, dark circles
Triceps	Large space between fingers	Some depth to fat tissue, but not ample. Loose fitting skin.	Very little space between fingers, or fingers touch
Ribs, lower back, sides of trunk	Chest is full; ribs do not show. Slight to no protrusion of the iliac crest	Ribs obvious, but indentations are not marked. Iliac Crest somewhat prominent	Indentation between ribs very obvious. Iliac crest very prominent

MUSCLE WASTING

Physical examination	Normal	Mild/Moderate	Severe
Temple	Well-defined muscle	Slight depression	Hollowing, depression
Clavicle	Not visible in males; may be visible but not prominent in females	Some protrusion; may not be all the way along	Protruding/prominent bone
Shoulder	Rounded	No square look; acromion process may protrude slightly	Square look; bones prominent
Scapula/ribs	Bones not prominent; no significant depressions	Mild depressions or bone may show slightly; not all areas	Bones prominent; significant depressions
Quadriceps	Well defined	Depression/atrophy medially	Prominent knee, Severe depression medially
Interosseous muscle between thumb and forefinger (back of hand)**	Muscle protrudes; could be flat in females	Slightly depressed	Flat or depressed area

FLUID RETENTION

Physical examination	Normal	Mild/Moderate	Severe
Edema	None	Pitting edema of extremities / pitting to knees, possible sacral edema if bedridden	Pitting beyond knees, sacral edema if bedridden, may also have generalized edema
Ascites	Absent	Present (may only be present on imaging)	

A. **Well-nourished** no decrease in food/nutrient intake; < 5% weight loss; no/minimal symptoms affecting food intake; no deficit in function; no deficit in fat or muscle mass **OR** *an individual with criteria for SGA B or C but with recent adequate food intake; non-fluid weight gain; significant

recent improvement in symptoms allowing adequate oral intake; significant recent improvement in function; and chronic deficit in fat and muscle mass but with recent clinical improvement in function.

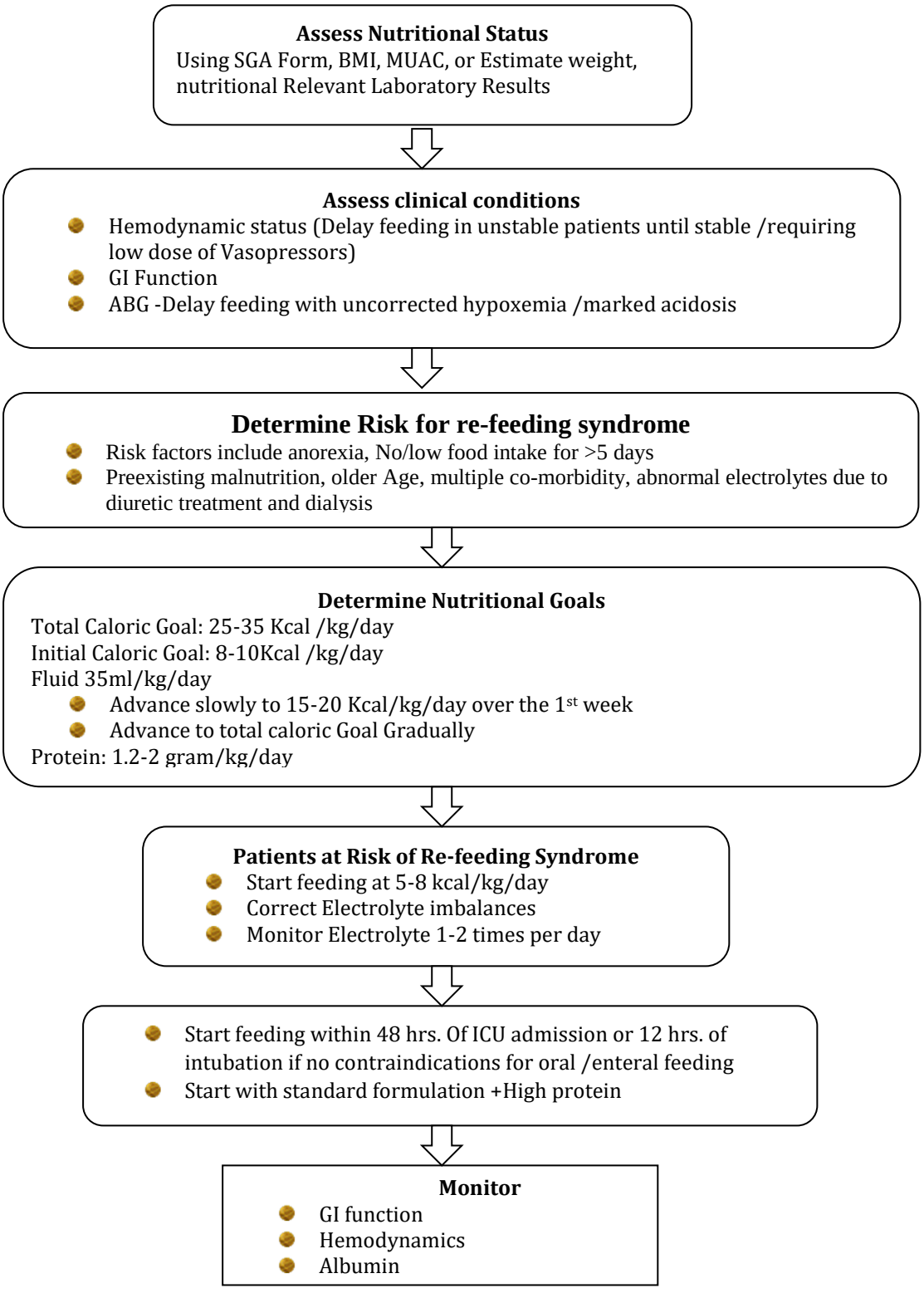
B. **Mildly/moderately malnourished** definite decrease in food/nutrient intake; 5% - 10% weight loss without stabilization or gain; mild/some symptoms affecting food intake; moderate functional deficit or recent deterioration; mild/moderate loss of fat and/or muscle mass **OR** *an individual meeting criteria for SGA C but with improvement (but not adequate) of oral intake, recent stabilization of weight, decrease in symptoms affecting oral intake, and stabilization of functional status.

C. **Severely malnourished** severe deficit in food/nutrient intake; > 10% weight loss which is on-going; significant symptoms affecting food/ nutrient intake; severe functional deficit **OR** *recent significant deterioration obvious signs of fat and/or muscle loss.

Cachexia – If there is an underlying predisposing disorder (e.g. malignancy) and there is evidence of reduced muscle and fat and no or limited improvement with optimal nutrient intake, this is consistent with cachexia.

Sarcopenia – If there is an underlying disorder (e.g. aging) and there is evidence of reduced muscle and strength and no or limited improvement with optimal nutrient intake.

Annex 1.3: Assessment of Nutritional Status Flow diagram



Annex 1.4: Summary of Recommended Macronutrient requirements for use in ICU

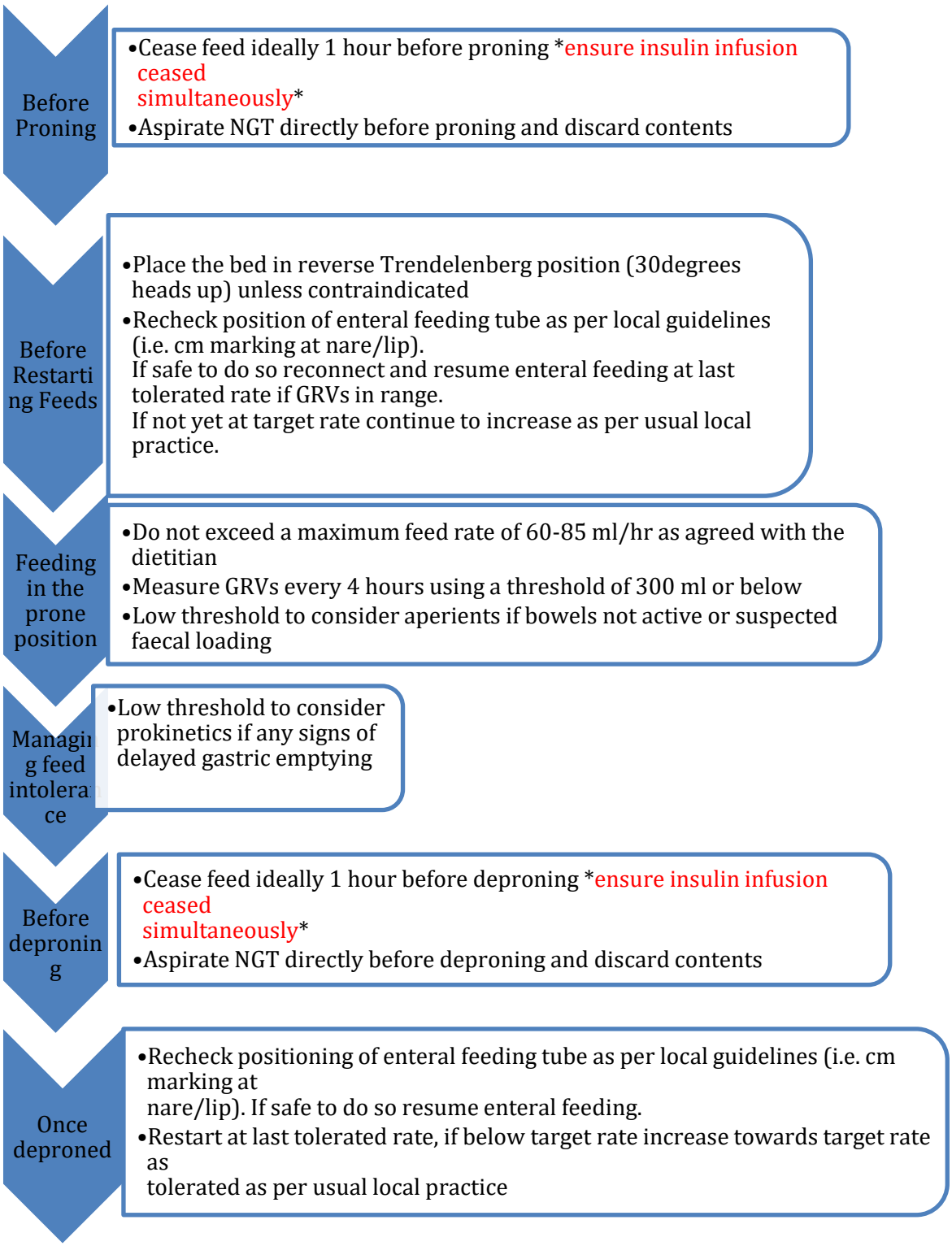
Nutrient	Recommendation *(Per kg recommendations infer per kg per 24 hours.)*	Guideline Source
Energy	Individualize Use validated equations, in the absence of indirect calorimeter	**PENG 2007** **NSIG 2010**
	Use 25-30kcal/kg, or predictive equations, or indirect calorimetry.	**ASPEN 2009**
	20-25kcal/kg in acute phase of critical illness. 25-30kcal/kg in recovery phase.	**ESPEN 2006**
	25kcal/kg	**ESPEN 2009**
	Consider hypo caloric feeding in critically ill obese (BMI >30kg/m^2), e.g. 60-70% of target energy requirements, or 11- 14kcal/kg actual body weight, or 22-25kcal/kg ideal body weight.	**ASPEN 2009**
Protein	1.3-1.5g protein/kg.	**ESPEN 2009**
	1.2-2.0g protein/kg if BMI<30kg/m^2. 2g/kg ideal weight if BMI 30-40kg/m^2. 2.5g/kg ideal weight if BMI >40kg/m^2.	**ASPEN 2009**
	Caution with excess nitrogen in severely ill.	**NICE 2006**
Glucose	Minimum 2g/kg	**ESPEN 2009**
	Maximal glucose oxidation rate is 4-7 mg/kg/minute/24hours. Ideally keep to ≤5mg/kg/minute/24hours.	**ESPEN 2009**
	3-5 (maximum 7) g/kg.	**ESPEN 2006**
Fat/lipid	0.7-1.5g/kg.	**ESPEN 2009**
	0.8-1g/kg in sepsis/SIRS.	**PENG 2007**
	Consider lipid source.	**CPG 2009**

Annex 1.5. Micronutrient Supplementation in ICU

Additional Micronutrient supplementation	Source of Recommendation
Supplemental combined vitamins and trace elements should be considered in critically ill patients receiving nutrition support.	• Canadian Clinical Practice (CPG) Guidelines 2009 • American Society for Parenteral and Enteral Nutrition (ASPEN) Guidelines 2009

Additional studies to delineate optimal dosage, route and combination of micronutrients are needed.

Annex 1.6. Flow Sheet of Best Practice Recommendations for Enteral Feeding In the Prone Position



Annex 1.7. Nutritional care Plan sheet in critical care

Initial Nutritional Care Plan Sheet						
Date:				Time:		
WARD/UNIT	☐ MICU	☐ SICU	☐ ICU	BED NO:		
Patient's Name:			Age:	Sex:	MRN:	
Dietitian /Nutritionist/ Physician Name:						
Nutritional Assessment						
Current wt.:				Dosing body wt. (for obese patients):		
SGA rating:	☐ A	☐ B	☐ C	MUAC: cm	BMI kg/m^2	
	Initial	Calories: kcal /day		Protein: g/day	Fluid: ml/day	
Nutritional goal	Total	Calories: kcal /day		Protein: g/day	Fluid: ml/day	
	Other specific nutrients need Specify:					
Patient Condition						
Medical Diagnosis						
Medication	-		-		-	
Allergy/Sensitivity	☐ None	☐ Milk	☐Egg	☐ Gluten	☐ Peanuts	☐ Other Specify ……
Hemodynamic status	☐Stable			☐ Unstable		
Vasopressor (dose)	☐ None			☐ Increasing/ High		Decreasing/ Low
GI function	☐ Normal	☐ Vomiting		☐ Diarrhea		☐ Abdominal distension
	☐ GI bleeding	☐ Obstruction		☐ Ischemia		
Respiratory support	☐ Nasal cannula	☐ Face mask		☐ HFO/NIV		☐ Invasive ventilation
Electrolytes	Na:	K:		PO4:	Mg:	
Risk for refeeding syndrome	☐At risk			☐ None		
Initial Order						
☐ Start feeding				☐ Delay feeding		

1. Start feeding on *[Date]* *[Time]*			
2. Access/Route	☐ Oral	☐ NGT	☐ OGT
3. Method	☐ Bolus	☐ Gravity	☐ Pump

4.Option of Blendrised Tube Feedings Options For Adult & pediatric 6 month - 5years	Volume and Rate / Time of feeding	Freq.*(_ x day)*
☐ Standard with Milk 1kcal/ml		
☐ Standard without Milk 1kcal/ml		
☐ High energy 1.5kcal/ml		
☐ Grule with Milk 1kcal/ml		
☐ Grule without Milk 1kcal/ml		
☐ Oatmeal with milk 0.9kcal/ml		
☐ Bombay (For High Protein 0.9kcal/ml		
☐ Milk with Roasted Barley 1kcal/ml(hypo volume)		
☐ Bombay (egg and 1.2kcal/ml (hypo volume)		
☐ Oats with banana and peanut butter 1.4kcal/ml (Milk free)		
☐ Banana & white flour with Milk: Oral feeding		
☐ Porridges for pediatric: Oral feeding		
Other Specify ……		

Monitoring

Parameter	Frequency	Parameter	Frequency
Calorie received		Serum K, Mg, PO4	
Protein received		Serum Albumin	
GRV		Input (IV, PO) & Output	

Dosing weight = IBW + 0.4 (Current BW - IBW)

IBW (males)= 50 + (0.91 × [ht. (cm) – 152.4])	IBW (females) = 45.5 + (0.91 × [ht. (cm)– 152.4])

Annex 1.8: Nutritional Care Order Sheet – Revised Orders				
UNIT	□ MICU	□ SICU	□PICU	BED NO:
Patient's Name:	Age:		Sex:	MRN:
Revised Order				
Nutritional Goal	Calories: kcal/day/		Protein: g/day	
	Fluid: ml/day			
Date:	Time:	Name of Dietitian / Nutritionist /Physician: …….		
1. Access/Route	□ Oral	□□□ NGT	□OGT	
2. Method	□Bolus□□	□Gravity□		
3. Volume and Rate/Timing			Freq. *(x day)*	
4.Option of Blendrised Tube Feedings Options For Adult& pediatric 6 month- 5years				
□ Standard with Milk 1kcal/ml				
□ Standard without Milk 1kcal/ml				
□ High energy 1.5kcal/ml				
□ Grule with Milk 1kcal/ml				
□ Grule without Milk 1kcal/ml				
□ Oatmeal with milk 0.9kcal/ml				
□ Bombay (For High Protein 0.9kcal/ml				
□ Milk with Roasted Barley 1kcal/ml(hypo volume)				
□ Bombay(egg and 1.2kcal/ml (hypo volume)				
□ Oats with banana and peanut butter 1.4kcal/ml (Milk free)				
□ Banana & white flour with Milk: Oral feeding				

□ Porridges for pediatric: Oral feeding			
Other Specify ……			
Monitoring			
Parameter	**Frequency**	**Parameter**	**Frequency**
Calorie received		Serum K, Mg, PO4	
Protein received		Serum Albumin	
GRV		Input (IV, PO) &Output	
Revised Order			
Date:	Time:	Dietitian/Nutritionist / Physician Sign ……	

Annex 1.9: Nursing Tube feedings Follow-up Sheet

Adult & Pediatrics Nursing Enteral (Home/hospital Blendrised /commercially prepared /Parenteral) Tube feedings Follow-up Sheet															
Patient's Name:			Age:	Sex:	*AMICU ☐ *PSICU ☐ *ASICU ☐ *PMICU ☐		Bed no:		MRN:						Relevant Laboratory result
Date	Time of Feeding													Total	
	Formulation(Code)														Na+ K+
	Ordered Amount														Mg++ PO4-
	Amount given/ml														Alb.
	Water Given (in ml)														
	GRV														
	Formulation(Code)														Na+ K+ Mg++
	Ordered Amount														PO4-
	Amount given														Alb.
	Water Given (in ml)														
	GRV														
	Formulation(Code)														Na+ K+ Mg++
	Ordered Amount														PO4-
	Amount given														Alb.
	Water Given (in ml)														
	GRV														
	Formulation(Code)														Na+ K+ Mg++
	Ordered Amount														PO4-
	Amount given														Alb.
	Water Given (in ml)														

	GRV														
	Formulation(Code)														Na+ K+ Mg++
	Ordered Amount														PO4-
	Amount given														Alb.
	Water Given (in ml)														
	GRV														

Annex 1.10: Blenderised Tube feeding Menus (English Version)

1. Standard with Milk 1kcal/ml

==========

Ingredient	Amount	Energy	Carbohydrate
Roasted Barley whole meal	222 g	709.9 kcal	142.8 g
Cow's milk partially skimmed boiled	1100 g	544.2 kcal	54.9 g
Chicken egg fresh cooked	120 g	178.4 kcal	0.8 g
Avocado fresh	150 g	325.9 kcal	0.6 g
Drinking water	400 g	0.0 kcal	0.0 g
Sugar	60 g	243.4 kcal	59.9 g

Meal analysis: Energy 2001.8 kcal Carbohydrate 258.9 g
Protein 77.7gm Total Volume 2000 ml

Result

==========

Nutrient content	Analyzed value	Recommended value/day	Percentage fulfillment
Energy	2001.8 kcal	2036.3 kcal	98 %
Water	1598.5 g	2700.0 g	59 %
Protein	77.7 g (16%)	60.1 g (12 %)	129 %
Fat	70.8 g (31%)	69.1 g (< 30 %)	102 %
carbohydrate.	258.9 g (53%)	290.7 g (> 55 %)	89 %
dietary fiber	26.7 g	30.0 g	89 %
Alcohol	0.0 g	-	-
PUFA	8.0 g	10.0 g	80 %
Cholesterol	524.4 mg	-	-
Vit. A	499.4 µg	800.0 µg	62 %
Carotene	0.2 mg	-	-
Vit. E (eq.)	6.2 mg	12.0 mg	52 %
Vit. B1	1.4 mg	1.0 mg	142 %
Vit. B2	2.7 mg	1.2 mg	225 %
Vit. B6	2.7 mg	1.2 mg	222 %
tot. fol. acid	285.9 µg	400.0 µg	71 %
Vit. C	25.1 mg	100.0 mg	25 %
sodium	697.1 mg	2000.0 mg	35 %

potassium	3540.8 mg	3500.0 mg	101 %
calcium	1526.8 mg	1000.0 mg	153 %
magnesium	444.6 mg	310.0 mg	143 %
Se	0.0 µg	-	-
phosphorus	2132.8 mg	700.0 mg	305 %
iron	9.8 mg	15.0 mg	65 %
zinc	12.7 mg	7.0 mg	182 %
arginine	3.4 g	-	-
glutamic acid	15.2 g	-	-
Vit. B12	2.4 µg	3.0 µg	80 %

2. Standard without Milk 1kcal/ml

Ingredient	Amount	Energy	Carbohydrate
Barley whole meal	300 g	959.4 kcal	192.9 g
Banana fresh	350 g	332.9 kcal	74.9 g
Lentils ripe tinned cooked drained	300 g	83.9 kcal	13.4 g
Drinking water	950 g	0.0 kcal	0.0 g
Safflower oil	60 g	528.0 kcal	0.0 g
Table salt	4 g	0.0 kcal	0.0 g
Soya bean flour (excess oil removed) bitter principle	65 g	127.9 kcal	0.4 g

Meal analysis: Energy 2032.1 kcal Carbohydrate 281.6 g

Protein 69.3gm Total Volume 2029ml

Result

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Nutrient content	Analyzed value	Recommended value/day	Percentage fulfillment
Energy	2032.1 kcal	2036.3 kcal	100 %
Water	1522.2 g	2600.0 g	59%
Protein	69.3 g (14%)	60.1g (12 %)	115 %
Fat	67.8 g (30%)	69.1g (< 30 %)	98 %
Carbohydrate.	281.6 g (56%)	290.7g (> 55 %)	97 %
Dietary fiber	57.2 g	30.0 g	191 %
Alcohol	0.0 g	-	-
PUFA	48.3 g	10.0 g	483 %
Cholesterol	0.0 mg	-	-

Vit. A	138.6 µg	1000.0 µg	14 %
Carotene	0.8 mg	-	-
Vit. E (eq.)	30.0 mg	14.0 mg	215 %
Vit. B1	2.3 mg	1.2 mg	191 %
Vit. B2	1.0 mg	1.4 mg	70 %
Vit. B6	3.3 mg	1.5 mg	220 %
tot. fol. acid	492.0 µg	400.0 µg	123 %
Vit. C	42.1 mg	100.0 mg	42 %
Sodium	1814.8 mg	2000.0 mg	91 %
Potassium	4327.3 mg	3500.0 mg	124 %
Calcium	373.3 mg	1000.0 mg	37 %
Magnesium	710.3 mg	350.0 mg	203 %
Se	0.0 µg	-	-
Phosphorus	1679.5 mg	700.0 mg	240 %
Iron	20.2 mg	10.0 mg	202 %
Zinc	12.0 mg	10.0 mg	120 %
Arginine	4.4 g	-	-
Glutamic acid	14.3 g	-	-
Vit. B12	0.0 µg	3.0 µg	0 %

3. High energy 1.5kcal/ml

Ingredients	Amount	Energy	Carbohydrate
Chicken egg fresh cooked	180 g	267.6 kcal	1.2g
Banana fresh	200 g	190.2 kcal	42.8 g
Oats whole grain	100 g	353.3 kcal	59.8 g
Cow's milk partially skimmed boiled	800 g	395.8 kcal	39.9 g
Sugar	45 g	182.5 kcal	44.9 g
Pumpkin seed fresh	40 g	224.1 kcal	5.7g
Sunflower seed oil	45 g	396.0 kcal	0.0g
Gingerbread	10 g	30.5kcal	6.7g
Table salt	2 g	0.0 kcal	0.0g

Meal analysis: Energy 2040 kcal Carbohydrate 228.0 g
Protein 76g Total Volume=1422ml

Result

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Nutrient content	Analyzed value	Recommended value/day	Percentage fulfillment
Energy	2030.7 kcal	2036.3 kcal	100 %
Water	1020.5 g	2700.0 g	38 %
Protein	76.0g (15%)	60.1 g (12 %)	126 %
Fat	88.7g (39%)	69.1 g (< 30 %)	128 %
Carbohydrate.	228.0g (46%)	290.7 g (> 55 %)	78 %
Dietary fiber	14.0 g	30.0 g	47 %
Alcohol	0.2 g	-	-
PUFA	34.0 g	10.0 g	340 %

Cholesterol	736.9 mg	-	-
Vit. A	707.0 µg	800.0 µg	88 %
Carotene	0.6 mg	-	-
Vit. E (eq.)	25.7 mg	12.0 mg	214 %
Vit. B1	1.0 mg	1.0 mg	103 %
Vit. B2	2.2 mg	1.2 mg	179 %
Vit. B6	2.3 mg	1.2 mg	193 %
tot. fol. acid	213.9 µg	400.0 µg	53 %
Vit. C	28.4 mg	100.0 mg	28 %
Sodium	1386.9 mg	2000.0 mg	69 %
Potassium	2915.5 mg	3500.0 mg	83 %
Calcium	1213.3 mg	1000.0 mg	121 %
Magnesium	486.0 mg	310.0 mg	157 %
Se	0.0 µg	-	-
Phosphorus	1939.2 mg	700.0 mg	277 %
Iron	16.0 mg	15.0 mg	106 %
Zinc	13.8 mg	7.0 mg	197 %
Arginine	4.6 g	-	-
glutamic acid	13.3 g	-	-
Vit. B12	3.6 µg	3.0 µg	120

4. Gruel with Milk 1kcal/ml

Ingredients	**Amount**	**Energy**	**Carbohydrate**
Barley whole meal	300 g	959.4 kcal	192.9 g
Cow's milk partially skimmed boiled	1500 g	742.1 kcal	74.8 g
Sugar	15 g	60.8 kcal	15.0 g
Table salt	4 g	0.0 kcal	0.0 g
Safflower oil	36 g	316.8 kcal	0.0 g
Drinking water	150 g	0.0 kcal	0.0 g

Meal analysis: Energy 2079.1 kcal Carbohydrate 282.7 gm
Protein 81.4 gm Total Volume 2000 ml

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Result

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Nutrient content	**Analyzed value**	**Recommended value/day**	**Percentage fulfillment**
Energy	2079.1 kcal	2036.3 kcal	102 %
Water	1519.0 g	2700.0 g	56 %
Protein	81.4 g (16%)	60.1 g (12 %)	135 %
Fat	66.6 g (28%)	69.1 g (< 30 %)	96 %
Carbohydrate.	282.7 g (56%)	290.7 g (> 55 %)	97 %
Dietary fiber	29.4 g	30.0 g	98 %
Alcohol	0.0 g	-	-
PUFA	30.5 g	10.0 g	305 %
Cholesterol	90.0 mg	-	-

Vit. A	195.0 µg	800.0 µg	24 %
Carotene	0.1 mg	-	-
Vit. E (eq.)	18.5 mg	12.0 mg	154 %
Vit. B1	1.6 mg	1.0 mg	165 %
Vit. B2	3.0 mg	1.2 mg	251 %
Vit. B6	2.4 mg	1.2 mg	197 %
tot. fol. acid	240.0 µg	400.0 µg	60 %
Vit. C	7.6 mg	100.0 mg	8 %
Sodium	2374.5 mg	2000.0 mg	119 %
Potassium	3627.8 mg	3500.0 mg	104 %
Calcium	1961.7 mg	1000.0 mg	196 %
Magnesium	528.3 mg	310.0 mg	170 %
Se	0.0 µg	-	-
Phosphorus	2487.0 mg	700.0 mg	355 %
Iron	9.2 mg	15.0 mg	62 %
Zinc	13.9 mg	7.0 mg	198 %
Arginine	3.2 g	-	-
Glutamic acid	17.8 g	-	-
Vit. B12	0.0 µg	3.0 µg	0 %

5. Gruel without Milk 1kcal/ml

Ingredients	Amount	Energy	Carbohydrate
Barley whole meal	450 g	1439.1 kcal	289.4 g
Peanut butter	60 g	358.7 kcal	7.3 g
Sugar	50 g	202.8 kcal	49.9 g
Table salt	5 g	0.0 kcal	0.0 g
Safflower oil	30 g	264.0 kcal	0.0 g
Drinking water	1500 g	0.0 kcal	0.0 g

Meal analysis: Energy 2264.5 kcal Carbohydrate 346.6 gm. Protein 59.9 gm.

Total Volume 2000ml

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Result

Nutrient analyzed recommended percentage content value value/day fulfillment

Nutrient content	Analyzed value	Recommended value/day	Percentage fulfillment
energy	2264.5 kcal	2036.3 kcal	111%
water	1551.9 g	2700.0 g	57 %
protein	59.9 g (11%)	60.1 g (12 %)	100 %
fat	69.3 g (27%)	69.1 g (< 30 %)	100 %
Carbohydrate.	346.6 g (62%)	290.7 g (> 55 %)	119 %
dietary fiber	48.7 g	30.0 g	162 %
alcohol	0.0 g	-	-
PUFA	34.0 g	10.0 g	340 %
cholesterol	0.0 mg	-	-
Vit. A	0.0 µg	800.0 µg	0 %
carotene	0.0 mg	-	-
Vit. E (eq.)	20.5 mg	12.0 mg	170 %
Vit. B1	2.0 mg	1.0 mg	203 %
Vit. B2	0.9 mg	1.2 mg	73 %
Vit. B6	2.9 mg	1.2 mg	239 %
tot. fol. acid	324.3 µg	400.0 µg	81 %
Vit. C	0.0 mg	100.0 mg	0 %
sodium	2179.5 mg	2000.0 mg	109 %
potassium	2455.5 mg	3500.0 mg	70 %
calcium	292.0 mg	1000.0 mg	29 %
magnesium	642.0 mg	310.0 mg	207 %
Se	0.0 µg	-	-
phosphorus	1763.7 mg	700.0 mg	252 %
iron	14.1 mg	15.0 mg	94 %
zinc	14.7 mg	7.0 mg	210 %
arginine	4.1 g	-	-
glutamic acid	14.1 g	-	-
Vit. B12	0.0 µg	3.0 µg	0 %

Annex 1.11: Amharic Version

የተፈጨ ምግብ ዝርዝር በመመገቢያ ቱቦ ለሚመገቡ አዋቂ ታካሚዎች

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1. በሶ በአቮካዶ እና በወተት 1ኪሎ ካሎሪ/ ሚ. ሊትር

ግብአት	ልኬት	መጠን/ግ	ሀይል	ካርቦሀይድሬት
የበሶዱቄት	(14.8 የሾርባማንኪያ)	222 g	709.9 kcal	142.8 g
የተፈላ ወተት/	(01 ሊትር እና			
ፓስቸራይዝድ	100ሚሊ.ሊትር)	1100 g	544.2 kcal	54.9 g
የተቀቀለ እንቁላል	(02 መካከለኛ)	120 g	178.4 kcal	0.8 g
አቮካዶ	(01 መካከለኛ)	150 g	325.9 kcal	0.6 g
ውሃ	(400ሚሊ. ሊትር)	400 g	0.0 kcal	0.0 g
ስኳር	(04 አነስተኛ የሾርባ ማንኪያ)	60 g	243.4 kcal	59.9 g

ምግብ ምርመራ: ሀይል 2001.8 kcal ካርቦሀይድሬት 258.9 g

ገንቢ 77.7gm አጠቃላይ መጠን 2000 ml

2. በሶ በሙዝ ያለ ወተት 1ኪሎ ካሎሪ/ ሚ. ሊትር

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ግብአት	ልኬት	መጠን/ግ	ሀይል	ካርቦሀይድሬት
የበሶ ዱቄት	20 የሾርባማንኪያ)	300 g	959.4 kcal	192.9 g
ሙዝ	(3 1/2 መካከለኛ)	350 g	332.9 kcal	74.9 g
የተቀቀለ ምስር ክክ	(6 1/2 የቡናሲኒ)	300 g	83.9 kcal	13.4 g
ውሃ	(950 ሚ.ሊትር)	950 g	0.0 kcal	0.0 g
ፈሳሽ ዘይት	(4 የሾርባማንኪያ)	60 g	528.0 kcal	0.0 g
ጨው	(1የሻይ.ማንኪያድርበብ)	4 g	0.0 kcal	0.0 g
የአኩሪ አተር ዱቄት	(41/2 የሾርባማንኪያ)	65 g	127.9 kcal	0.4 g

ምግብ ምርመራ: ሀይል 2032.1 ካሎሪ ካርቦሃይድሬት 281.6 ግራም

ገንቢ 69.3 ግራም አጠቃላይ መጠን 2029 ሚ.ሊትር

3. ኦትስ በወተት እና እንቁላል ከፍተኛ ሃይል ሰጪ1.4 ኪሎ ካሎሪ/ ሚ. ሊትር

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ግብአት	ልኬት	መጠን/ግ	ሀይል	ካርቦሀይድሬት
የተቀቀለእንቁላል	(3 መካከለኛ)	180 g	267.6 kcal	1.2 g
ሙዝ	(3 መካከለኛ)	200 g	190.2 kcal	42.8 g
ኦትስየበሰለ	(4 የሾርባ ማንኪያ)	100 g	353.3 kcal	59.8 g
የተፈላ ወተት/ ፓስቸራይዝድ	(800 ሚ. ሊትር)	800 g	395.8 kcal	39.9 g
ስኳር	(3 የሾርባ ማንኪያ)	45 g	182.5 kcal	44.9 g
ዱባየተፈጨ	(3 የሾርባ ማንኪያ)	40 g	224.1 kcal	5.7 g
ዘይትፈሳሽ	(3የሾርባ ማንኪያ)	45 g	396.0 kcal	0.0 g
ዝንጅብል	(1የሾርባ ማንኪያ)	10 g	30.5 kcal	6.7 g
Table salt		2 g	0.0 kcal	0.0 g

ምግብ ምርመራ: ሀይል 2040 ካሎሪ ካርቦሃይድሬት 228 ግራም

ገንቢ 76 ግራም አጠቃላይ መጠን 1422 ሚ.ሊትር

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4. አጥሚት በወተት 1ኪሎ ካሎሪ/ ሚ. ሊትር

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ግብአት	ልኬት	መጠን/ግ	ሀይል	ካርቦሀይድሬት
አጃ/ገብስዱቄት	20የሾርባማንኪያ	300 g	959.4 kcal	192.9 g
የተፈላወተት/ ፓስቸራይዝድ	11/2 ሊትር	1500 g	742.1 kcal	74.8 g
ስኳር	1የሾርባማ	15 g	60.8 kcal	15.0 g
ጨው	1የሻይማ	4 g	0.0 kcal	0.0 g
ዘይት	2 ½ የሾርባ.ማ	36 g	316.8 kcal	0.0 g
ውሃ	150ሚ/ሊትር	150 g	0.0 kcal	0.0 g

ምግብ ምርመራ: ሀይል 20479 ካሎሪ ካርቦሃይድሬት 282.7 ግራም

ገንቢ 81.4 ግራም አጠቃላይ መጠን 2000 ሚ.ሊትር

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5. አጥሚት በለውዝ ቅቤ ያለ ወተት 1ኪሎካሎሪ/ ሚ. ሊትር

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ግብአት	ልኬት	መጠን/ግ	ሀይል	ካርቦሀይድሬት
የገብስ/የአጃ/የስንዴ ዱቄት	15የቡናሲኒ	450 g	1439.1 kcal	289.4 g
ለውዝቅቤ	1የሾርባ.ማሙሉ	60 g	358.7 kcal	7.3 g
ስኳር	4የሾርባ.ማ	50 g	202.8 kcal	49.9 g
ጨው	1የሻይ.ማ	5 g	0.0 kcal	0.0 g
ፈሳሽ ዘይት	2የሾርባ.ማ	30 g	264.0 kcal	0.0 g
ውሃ	1.5ሊትር	1500 g	0.0 kcal	0.0 g

ምግብ ምርመራ: ሀይል 2264.5 ካሎሪ ካርቦሃይድሬት 346.6 ግራም ገንቢ 59.9 ግራም አጠቃላይ መጠን 2000 ሚ.ሊትር

አማራጭ የተፈጨ ምግብ ዝርዝር አማርኛ

1.አጥሚት በወተት (2ሊትር የሚሆን

Flour with milk0.9kcal/ml) 0.9kcal/ml

ግብዓት	**መጠን**
ፉርኖ ዱቄት	200ግ
ወተት2%	1500 ሚሊ
ስኳር	2 የሾርባማንኪያ
ዘይት	2 የሾርባ ማንኪያ
ጨው	2 ግ
ጠቅላላ ይዘት/መጠን	2000ml
ሀይል	1800 kcal
ፕሮቲን	68 g
አዘገጃጀት	ግብዓቶቹ ሁሉ ተቀላቅለው፣ ውሃ እየጨመሩ፣ እስኪበስል ማማሰል፣ ከበሰለ በኋላ መጠኑ 2 ሊትር እስኪሆን የፈላ ውሃ ጨምሮ ማሟላት

Recipes	
Regular flour	200 gm.
Milk 2%	1500 ml
Sugar	2 BTSP
Oil	2 BTSP
Salt	2 gm.
Total volume	2000ml
Energy	1800 kcal
Protein	68 g

መብሰል የሚያስፈልገው። ከመሰጠቱ 3 ሰዓት በፊት ታዞ መሰራት አለበት

- ይህ፣ በትእዛዝ የሚሰራ ነው። ከተሰራ በኋላ ከ4 ሰዓት በላይ ውጭ መቀመጥ የለበትም።

2.ቦንቤ (2ሊትር የሚሆን ከፍተኛ ፕሮቲን ለሚያስፈልገው) 0.9kcal

Bombay for High Protein 0.9kcal/ml

ግብዓት	**መጠን**
ወተት	1200ሚ.ሊ
ሙዝ	6 አነስተኛ
የተቀቀለእንቁላል	6 እንቁላል
ዘይት	6 የሻይማንኪያ
Total volume	2000ml
Energy	1800 kcal
Protein	**92 g**
አዘገጃጀት	እንቁላሉን በቅድሚያ በአግባቡ በመቀቀል ሁሉንም ግብአቶች ወደ ምግብ መፍጫ ጨምሮ በደንብ እስኪልም ድረስ መፍጨት

Recipes	**Amount**
Milk	1200 ml
Banana	6 small
Boiled Egg	6
Oil	6 TSP
Total Volume	2000ml
Energy	1800 kcal
Total Protein	92gm

- ይህ ግብዓቶቹ አስቀድመው ተዘጋጅተው፣ በንጹህ ቦታ ተቀምጠው፣ በሚፈለግበት ጊዜ ለማዘጋጀት ይቻላል።

3.ወተት በበሶ (1ሊትር, የ1/2 ቀን/12 ሰዓት የሚበቃ) 1kcal/ml Milk with Roasted Barley (for 12hrs)

ግብዓት	መጠን
በሶዱቄት	100ግ (5የሾርባማንኪያ)
ዱቄትወተት	100ግ (5ስፍርየሾርባማንኪያ)
ዘይት	1 የሾርባማንኪያ
ዉሃ	800ሚ.ሊ (1 ሊትር)
ጨው	1.5 ግራም
Total volume	1000ml
Energy	970 kcal
Protein	35.8 g
አዘገጃጀት	በሶ ዱቄቱ፣ ወተት ዱቄት፣ ውሃ አንድ ላይ ጨምሮ፣ በመፍጫ በደንብ መፍጨት፣ ከዚያም በደረቅ ማጥለያ ማጥለል/ ካስፈለገ ውሃ መጨመር

Recipes	Amount
Roasted Barley	**100gm (5 tablespoon)**
Powder Milk	**100gm(5 tablespoon)**
Oil	**1 BTSP**
Water	**800ml (1Lit)**
Salt	1.5
Total volume	1000ml
Energy	970 kcal
Protein	35.8 g

- ይህን ግብዓቶቹ አስቀድመው ተዘጋጅተው፣ በንጹህ ቦታ ተቀምጠው፣ በሚፈለግበት ጊዜ ለማዘጋጀት ይቻላል።

4. **ቦንቤ (1 ½-ሊትር የሚሆን በትንሽ መጠን <u>ከፍተኛ ጉልበት</u> የሚሰጥ)1.2kcal/ml Bombay (Small amount high calorie) 1.2kcal/ml**

ግብዓት	መጠን
ወተት	1000ሚ.ሊ
ሙዝ	2አነስተኛ
የተቀቀለ እንቁላል/ ተልጦ	3እንቁላል
ዘይት	4የሻይማንኪያ
የለውዝቅቤ	60 ግ (2የሾርባማንኪያ)
በሶ	20 ግ / 2 የሾርባ ማንኪያ
ጨው	2 ግራም
ውሃ	100 ሚል ተጨማሪ ካስፈለገ
Total volume	1300ml
Energy	1500 kcal
Protein	76g
አዘገጃጀት	በመፍጫ/ ሁሉንም ግብዓቶች (ከውሃ በስተቀር) ጨምሮ መፍጨት፣ ውሃ እንደቅጥነቱ እያዩ መጨመር

Recipes	Amount
Milk	1000 ml
Banana	2small
Boiled Egg	3
Oil	4 TSP
Peanut butter	60 gm(2 BTSp)
Roasted Barley	20 gm (2 BTSP)
Salt	2 gm
Water	100 ml if needed
Total Volume	1300ml
Energy	1500 kcal
Total Protein	76g

- ይህ ግብዓቶቹ አስቀድመው ተዘጋጅተው፣ በንጹህ ቦታ ተቀምጠው፣ በሚፈለግበት ጊዜ ለማዘጋጀት ይቻላል።

5. ኦትስ (ከወተት ነጻ) 1.4kcal/ ml

ግብዓት	መጠን
ኦትስ	240 ግ(16 የሾርባ ማንኪያ)/ 8 የቡናሲኒ
ሙዝ	4 አነስተኛ
ዘይት	1 የሾርባ ማንኪያ
የለውዝቅቤ	120 ግ (4 የሾርባ ማንኪያ)
ጨው	
ውሃ	1000ሚ.ሊ
Total volume	1440ml
Energy	2064 kcal
Protein	64 g
አዘገጃጀት	አጃው ከውሃ ጋር ተጥዶ ከበሰለ በኋላ፣ ሙዝ + አቮሎኒ ቅቤና ዘይት ተጨምሮ በመፍጫ ይፈጫል፣ ይህም በማጥለያ አልፎ ይቀመጣል

Oats (milk free) 1.4Kcal/ml

Recipes	Amount
Oats	240gm (16BTSP) / 8 arabic coffe cup
Banana	4 small
Oil	1 (BTSP)
Peanut butter	120 gm(4 BTSP)
Salt	
Water	1000ml
Total Volume	1440ml
Energy	2064 kcal
Total Protein	64gm

- ይህን ግብዓቶቹ አስቀድመው ተዘጋጅተው፣ በንጹህ ቦታ ተቀምጠው፣ በሚፈለግበት ጊዜ ለማዘጋጀት ይቻላል።

ANNEX 2: PEDIATRICS

Annex 2.1: Analysis of the food record

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Food	Amount	energy	carbohydr.
Wheat flour fine Type 550	10 g	33.7 kcal	7.1 g
Infant formula, MEAD JOHNSON, ENFAMIL, with iron, powder 5 g	26.0 kcal	2.8 g	
Milk, reduced fat, fluid, 2% milk fat, without added vitamin A and vitamin D	20 g	10.0 kcal	1.0 g
Seeds, sesame butter, paste	2 g	11.7 kcal	0.5 g
Avocado fresh	10 g	21.7 kcal	0.0 g
Cod liver oil	.2 g	1.8 kcal	0.0 g
Meal analysis: energy 105.0 kcal (100 %), carbohydrate 11.4 g (100 %)			

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Result

Nutrient	analysed	recommended	percentage
content	**value**	**value/day**	fulfilment
energy	**105.0 kcal**	**2036.3 kcal**	5 %
water	**26.4 g**	**2700.0 g**	1 %
protein	**2.7 g(11%)**	**60.1 g(12 %)**	5 %
fat	**5.4 g(46%)**	**69.1 g(< 30 %)**	8 %
carbohydr.	**11.4 g (44%)**	**290.7 g (> 55 %)**	4 %
dietary fiber	**0.8 g**	**30.0 g**	3 %
alcohol	**0.0 g**	**-**	-
PUFA	**1.1 g**	**10.0 g**	11 %
cholesterol	**4.2 mg**	**-**	-
Vit. A	90.4 µg	800.0 µg	11 %
carotene	**0.0 mg**	**-**	-
Vit. E (eq.)	**0.2 mg**	**12.0 mg**	2 %

Vit. B1	**0.1 mg**	**1.0 mg**	5 %
Vit. B2	**0.1 mg**	**1.2 mg**	8 %
Vit. B6	**0.1 mg**	**1.2 mg**	9 %
tot. fol.acid	**11.8 µg**	**400.0 µg**	3 %
Vit. C	**4.4 mg**	**100.0 mg**	4 %
sodium	17.2 mg	2000.0 mg	1 %
potassium	**130.5 mg**	**3500.0 mg**	4 %
calcium	**65.8 mg**	**1000.0 mg**	7 %
magnesium	**15.4 mg**	**310.0 mg**	5 %
phosphorus	**60.2 mg**	**700.0 mg**	9 %
iron	**1.1 mg**	**15.0 mg**	7 %
zinc	0.7 mg	7.0 mg	9 %
Vitamin D / needs to be checked			

Annex 2.2: Nutritional guidelines for the child with chronic kidney disease.

Age	Energy (per kg body weight per day) kcal	Protein (per kg body weight per day)(g)
Conservative management		
Infants	10–135	2.5–3.0
Preterm	96–120	2.1
0–2 months	72–96	1.5–1.6
3–12 months	78–82	1.1
1–3 years		
		If GFR < 25protein 0.6-0.7g/kg/day
Children/adolescents	Minimum of EAR for chronological	
4 years to puberty	age (use height age if	1.0–1.1
Pubertal	<2nd centile for height)	0.9–1.0
Post-pubertal		0.8–0.9
Peritoneal dialysis (APD/CAPD)		
Infants	110–135	3.0–4.0
Preterm	96–120	2.4
0–2 months	72–96	1.9
3–12 months	78–82	1.4
1–3 years		
Children/adolescents	minimum of EAR for chronological	1.3
4 years to puberty	age (use height age if <2nd centile	1.2
Pubertal	for height)	1.0–1.2
Post-pubertal		
Haemodialysis		
Infants		
Preterm	110–135	3.0
0–2 months	96–120	2.2
3–12 months	72–96	1.7
1–3 years	78–82	1.2
Children/adolescents		
4 years to puberty	minimum of EAR for chronological	1.1
Pubertal	age (use height age if <2nd centile	1.1
Post-pubertal	for height)	1.1

Annex 2.3: Analysis of the food record Amharic version

1.የሕጻናት የቆርቆሮ ወተት

(እስከ 1 ዓመት ለሚሞላው ልጅ፣ ወይም 10ኪሎ እና ከዛ በታች ለሆነ ልጅ መሰጠት ይችላል።

	1					
	ለ67 ካሎሪ / 100 ሚል	89 ካሎሪ/ 100ሚል	100 ካሎሪ / 100ሚል	1000ሚል ለመስራት		
ዱቄት	3 የራሱ ማንኪያ + እስከ 100ሚል ውሃ	4 ማንኪያ እስከ 100ሚል	2 ጊዜ፣ 1ኛ + 1 ማንኪያ ለ200ሚል			
ወተት	20ሚል					
የሕጻናት ወተት ዱቄት	1 ማንኪያ (5ግ)					
የተፈጨ ሰሊጥ	2 ግ					
አቮካዶ	10 ግ					
የአሳ ዘይት	0፤2 ሚል					
	+ ውሃ					

❖150 ሚል/ ለ1 ኪሎ መሰረት ተሰልቶ

2. አጥሚት (ከ1 ዓመት በታች ላለ ልጅ መስጠት ይችላል)

	ለ100 ሚል	**300 ሚል ለመስራት**	**500 ሚል ለመስራት**	**1000ሚል ለመስራት**
ዱቄት	10ግ			
ወተት	20ሚል			
የሕጻናት ወተት ዱቄት	1 ማንኪያ (5ግ)			
የተፈጨ ሰሊጥ	2 ግ			
አቮካዶ	10 ግ			
የአሳ ዘይት	0፤2 ሚል			
	+ ውሃ			

አጥሚት ውስጥ መጨመር ያለባቸው፣በቀን

	< 1 ዓመት								
ኣሳዘይት	1 ሚል								
ጨው	210 እስከ 380 ሚግ								

ይህ፣በልጁ የክብደት መጠን ተሰልቶ፣ የቀኑ መጠን በተለያየ የምግብ ሰዓት መሰጠት ይችላል ተጨማሪ

1. ኢንፋንትሪኒ (ከ1 ዓመት በታች ለሆኑ)
2. ፔዲያሹር (ከ1 ዓመት በላይ ለሆኑ)
3. የአዋቂዎች አጥሚትና፣ አልሚ ምግቦች፣ ከ10 ዓመት በላይ፣ ወይም ኪሎ በላይ ለሆኑ

Pediatric Resting Energy Estimation Equation: Schofield's Equation
Scofield's Equation for estimating the Basal Metabolic Rate (Kcal/day) of Children

Age	**Boys**	**Girls**
0-3 year	59.5 x (weight in kg) – 30	58.3 x (weight in kg) - 31
3 – 10 year	22.7 x (weight in kg) + 504	20.3 x (weight in kg) + 486
10 – 18 year	17.7 x (weight in kg) + 658	13.4 x (weight in kg) + 692

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