Nutrition in the Surgical Patient

Annastasia King'ori

Introduction:

The Nutrition Care Process consists of four distinct but interrelated steps: Assessment, Diagnosis, Intervention and Evaluation.

All patients undergoing surgery need a nutrition work up pre- and post-operatively. Normally, well-nourished patients can survive without specific nutritional support for several days when they undergo an elective surgical procedure. However, numerous factors including a prolonged disease process, investigations, treatment, and postoperative complications, may lead to decline in nutritional status of a patient. Because only a small percentage of the population in low resource areas has access to affordable surgical care, there are few indicators to assess perioperative nutrition intervention in these areas. However, we know that malnutrition is a common risk factor among the poor.

Malnutrition is common among hospitalized patients, particularly among patients suffering from acute and chronic life-threatening conditions. Such people often need surgical intervention. There is a great need to consider nutrition support as a component of surgical care both pre- and post-operatively. This helps to address any form of malnutrition, optimizes the patients' nutritional status, and improves outcomes.

Some reasons for the development of undernutrition among hospitalized patients include limited awareness, knowledge, and training of staff at all levels. The overall problem is worsened by the following factors, that contribute to the development of malnutrition:

- The broad perception that the provision of food and nutrition is of low priority
- The alignment of nutrition with patient service rather than medical services
- The difficult in responding to patient preferences, or clinician requests for certain types of food resources
- Repeated fasting and skipping of meals associated with surgical and medical interventions

The patient's nutrition status is therefore a major determinant of outcomes for any type of surgery. Surgeons and surgical teams should have basic skills in nutrition screening and assessment of patients prior to a surgical procedure, to determine those at greatest risk for malnutrition development.

Importance of Pre-operative Management

Malnutrition is a modifiable risk factor. It can be tamed pre-operatively through nutritional support. Preoperative nutrition support optimizes patient nutrition status, preparing the patient for increased metabolic demands due to surgical injury.

Under normal conditions, fatty acids are mobilized in states of starvation, in a process called ketosis. Infection and injury inhibit this response and instead cause the mobilization of muscle protein. This process leads to generalized muscle weakness, edema, and weight loss. Severe malnutrition can weaken the respiratory muscle, making the patient unable to cough effectively which promotes chest infection and atelectasis. The immune response to infection also becomes down-regulated and T-cell, B-cell and macrophage function deteriorates.

Nutrition assessment includes collecting information about the patient's medical history, clinical and biochemical characteristics, dietary practices, current medication(s), and food security situation, and taking anthropometric measurements. There is no single standard for identifying either nutrition risk or nutrition status. Any assessment should be valid, simple, easy to interpret and sensitive so that it can be widely and consistently implemented by non-specialists.

Often simple questions about the patients' practices and any dietary changes reported can give insight into the overall nutrition status in relation to the planned surgery. Those patients identified to be either at risk, or frankly malnourished, should be forwarded to a clinical nutritionist or dietitian for nutrition optimization prior to surgery. Preoperative patients found to be at risk or with malnutrition are scheduled on individualized treatment plans that may include therapeutic diets (e.g., F_{75}, F_{100}, and "Ready to Use Therapeutic Food-" RUTF), fortified foods, oral nutrition supplements ("Ready to Use Supplemental Food-" RUSF, commercial supplements like ENSURE), modified home or Kitchen diets addressing their specific needs e.g., full liquid diet, and/or parenteral nutrition.

Postoperatively, management is continued in order to maintain the patient's nutrition status,

support wound healing and improve the immune function. Ideally, clinical nutritionists and dietitians continue to participate in the postoperative care, providing guidelines that allow systematic screening and assessments, as well as patient-based interventions that are discussed below.

Assessment 1: History

Nutrition screening involves the search for known risk factors such as those listed below. Its purpose is to identify individuals who are at risk of becoming malnourished or who are malnourished. For nutrition screening to be effective, it must use existing staff, be simple and inexpensive, and be initiated early before surgery. Known risk factors include:

- Involuntary loss or gain before hospital admission of more than: 10 % of the usual body weight within 6 months, or 5 % of the usual body weight in the past 1 month.
- A weight of 20 % over or under ideal body weight.
- Presence of chronic disease
- Disease-induced increased metabolic requirements.
- Alterations to the normal diet required as a result of recent surgery, illness or trauma
- Receiving artificial nutrition support as a result of recent surgery, illness or trauma
- Inadequate nutritional intake, including not receiving food or nutrition products due to impaired ability to ingest or absorb food adequately for greater than 7 days

A comprehensive dietary assessment should be done by a clinical nutritionist or dietitian and includes multiple components such as dietary intake, ability to chew and swallow, food intolerances, ability to digest and absorb food, and ability to comply with nutritional interventions. Decreased dietary intake may result from poor appetite, unavailability of food, or inappropriate diet. Available dietary history tools include 24-hour recall, diet history, food diaries, or food frequency questionnaires. Assessment of behavioral characteristics is important to assess the patient chewing and swallowing ability, especially in cases of stroke, dementia, or upper gastrointestinal obstruction. A patient may also have a history of impaired digestion and absorption e.g., in the presence of pancreatic disease, inflammatory bowel disease, or intestinal resection. There may be increased nutritional requirements in patients due to chronic disease, sepsis, burns, or multiple surgical procedures.

Another important component of dietary assessment is determining the patient's feeding practices. This is important to determine their dietary diversity, nutrient interactions, and to address any inappropriate dietary practices, such as skipping meals and unhealthy food regimens like fad diets, that may have adverse effects on nutritional status.

While conducting nutrition screening, take caution with accepting the patient's verbally reported weight. Most often, such a verbal report is unreliable. A full nutritional assessment considers both the measurement of body composition (specifically fat and muscle stores,) and the effects of nutritional status on physiological function. Assessment is more indicated when there is a prolonged disease process that led to weight loss, for example, esophageal carcinoma, high-stress disease, major burns, major surgery, sepsis, severe pancreatitis, and postoperative complications.

Assessment 2: Physical Examination

Monitoring weight loss is a useful means of nutritional assessment. 10% weight loss indicates mild malnutrition, while 30% loss is an alarming situation. Obvious clinical features of malnutrition are thin, lean wasted appearance, bilateral pitting edema, sunken eyes, easy shedding of body hairs, voice weakness, and enlargement of salivary glands. Midarm circumference for muscle mass should be assessed when the patient requires long-term nutritional support. Body mass index (BMI) gives information about the change in body weight. It is calculated by weight in kg/height in M^2. Normal BMI is 18.5-25. These and other values are calculated as described below, and then summarized using an anthropometric table like the one at the end of this section.

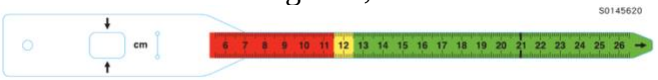
<u>Mid-Upper Arm Circumference</u>

This measurement, commonly shortened as MUAC, is used as a screening tool for acute

malnutrition. MUAC is recommended for use with children between six months and 5 years of age, pregnant and lactating women, and in adults with clinical signs of undernutrition. A separate tape is used for adults. The major determinants of MUAC, arm muscle and subcutaneous fat, are both important determinants of survival in starvation.

Other indices, such as weight and height-based ones, are more often confounded by bipedal or nutritional oedema, periorbital oedema, or ascites. For this reason, MUAC is a more sensitive index of tissue atrophy than low body weight alone. It is also relatively independent of height and body shape.

The right procedure should be employed when carrying out this assessment. First, measure the distance between the tip of the shoulder and the tip of the elbow and find the midpoint. Then, wrap the tape around the arm at this location as shown below. Take the correct reading here, to the nearest 1mm.



MUAC tape, showing measurements for Severe (Red) Yellow (Moderate) and Green (Not Present) Acute Malnutrition. Source: UNICEF Technical Bulletin No. 13 Revision 2 https://www.unicef.org/supply/media/1421/file/mid-upper-arm-circumference-measuring-tapes-technical-bulletin.pdf

Using the MUAC tape to determine the midpoint between the acromion and the ulna.

Using the MUAC tape to determine the circumference at the mid-humerus. Note that this child's measurement displays severe malnutrition.

Height

The patient's height is needed for calculating body mass index. If height cannot be measured or is unknown, the following measurements can be used to calculate height: ulna length, knee height, or demispan (do not use if the patient has severe or obvious curvature of the spine.) For patients who are bed-bound, those with severe disabilities and those with kyphosis or scoliosis, it is preferable to use ulna length to estimate height.

These values are measured as shown below, then the derived height values are used to calculate the body mass index. This value is then used in the anthropometric tables provided in the following section, **Diagnosis**.

Measuring knee height, the distance from the bottom of the patient's foot (resting on the floor) to the top of thigh above the lower leg.

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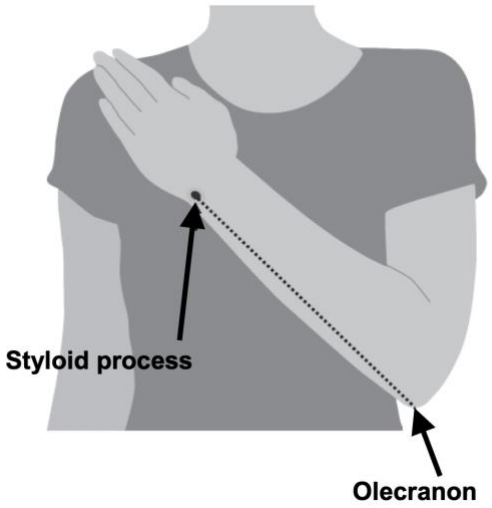
Estimating Patient Height From Knee Height:
Females
Height in cm = 84.88 - (0.24 X age) + (1.83 X knee height)
Males
Height in cm= 64.19 - (0.04 X age) + (2.02 X knee height)

Measuring the demispan, the distance between the suprasternal notch and the base of the space between the middle and ring fingers.

Estimating Patient Height from Demispan:
Females
Height in cm = (1.35 x demispan (cm)) + 60.1
Males
Height in cm = (1.40 x demispan (cm)) + 57.8



Ulna length, measured from the tip of the olecranon to the ulnar styloid process. Source: https://www.uhs.nhs.uk/Media/Southampton-Clinical-Research/Procedures/BRCProcedures/Procedure-for-adult-ulna-length.pdf

HEIGHT (m)	Men(<65 years)	1.94	1.93	1.91	1.89	1.87	1.85	1.84	1.82	1.80	1.78	1.76	1.75	1.73	1.71
	Men(>65 years)	1.87	1.86	1.84	1.82	1.81	1.79	1.78	1.76	1.75	1.73	1.71	1.70	1.68	1.67
	Ulna length(cm)	32.0	31.5	31.0	30.5	30.0	29.5	29.0	28.5	28.0	27.5	27.0	26.5	26.0	25.5
HEIGHT (m)	Women(<65 years)	1.84	1.83	1.81	1.80	1.79	1.77	1.76	1.75	1.73	1.72	1.70	1.69	1.68	1.66
	Women(>65 years)	1.84	1.83	1.81	1.79	1.78	1.76	1.75	1.73	1.71	1.70	1.68	1.66	1.65	1.63
HEIGHT (m)	Men(<65 years)	1.69	1.67	1.66	1.64	1.62	1.60	1.58	1.57	1.55	1.53	1.51	1.49	1.48	1.46
	Men(>65 years)	1.65	1.63	1.62	1.60	1.59	1.57	1.56	1.54	1.52	1.51	1.49	1.48	1.46	1.45
	Ulna length(cm)	25.0	24.5	24.0	23.5	23.0	22.5	22.0	21.5	21.0	20.5	20.0	19.5	19.0	18.5
HEIGHT (m)	Women(<65 years)	1.65	1.63	1.62	1.61	1.59	1.58	1.56	1.55	1.54	1.52	1.51	1.50	1.48	1.47
	Women(>65 years)	1.61	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.48	1.47	1.45	1.44	1.42	1.40

Table for estimating patient height from ulna length. Source: https://www.uhs.nhs.uk/Media/Southampton-Clinical-Research/Procedures/BRCProcedures/Procedure-for-adult-ulna-length.pdf

Weight, Z-Score

In children, the Z-score is a comparison of weight vs. age, based on standard growth curves. One example is shown here and all the curves are reproduced at the end of this chapter. They are published for general use by the World Health Organization- https://www.who.int/tools/child-growth-standards/standards/weight-for-age

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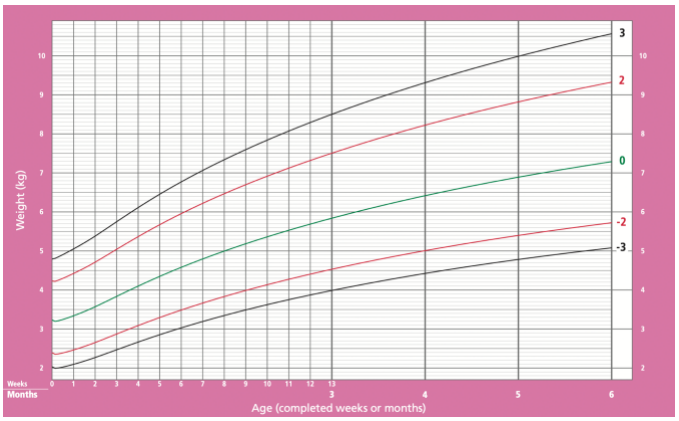


One example of a weight for age curve, this one for girls aged 0-6 months. This graph is used to derive Z-score (Black, Red and Green numbers on Right.) Source: WHO, website above.

Calf Circumference

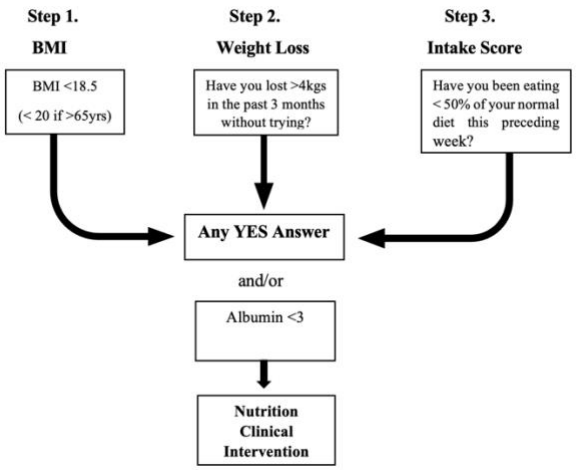
Calf circumference measurement is useful in assessing the nutritional state of hospitalized elderly people. The cut off of 30.5cm in adults provides a good diagnostic capacity.

Calf circumference is measured at the widest point of the calf. Note that in this patient, wasting of the temporalis muscle is visible. This is another potential indicator of severe malnutrition.

Blood Testing

Blood tests are not absolutely necessary, and the interpretation may give a confusing picture. Generally, testing will reveal low serum proteins, low lymphocyte count, and delayed hypersensitivity reaction. As below, laboratory testing is best used to supplement history and physical examination data, rather than independently in isolation.

The flow chart below can work as a screening tool to aid in nutrition screening and diagnosis for preoperative patients:



Diagnosis:

These anthropometric values and historical data can be entered into tables like the one below to determine the patient's degree of malnutrition:

INDICATOR	Severe Acute Malnutrition (SAM)	Moderate Acute Malnutrition (MAM)	At Risk
Infants less than 6 months			
W/L	W/L < - 3 Z-score	Static weight or losing weight at home	Static weight or losing weight at home
Oedema	Oedema Present	Oedema Absent	Oedema Absent
Other signs	Too weak to suckle or feed	Poor feeding	Poor feeding
Children 6 months to 10 years			
W/H Z-Scores	< -3 Z-Score	Between -3 to < -2 Z-Score	Between -2 to -1 Z-Score
MUAC (6-59 months)	<11.5 cm	11.5 to 12.4cm	12.5-13.4cm
Oedema	Oedema Present	Oedema Absent	Oedema Absent
Adolescent (10 years to 18 years)			
MUAC	< 16cm	N/A	N/A
Oedema	Oedema Present	Oedema Absent	Oedema absent
Adults (older than 18 years)			
MUAC	<16cm irrespective of clinical signs	16-18.5cm with no relevant clinical signs. Few relevant social criteria e.g. critical household food insecurity	N/A
MUAC	16-18.5cm plus one of the following: 1) Oedema 2) Inability to stand 3)Apparent dehydration	N/A	N/A
BMI	<16	16-17	17-18.5
Oedema	Oedema Present	Oedema Absent	Oedema Absent
Pregnant & lactating women			
MUAC	No available criteria	< 21cm	

Anthropometric criteria for acute malnutrition. Source: Kenya National Clinical Nutrition and Dietetics Reference Manual, 1st Edition
http://guidelines.health.go.ke/#/category/12/179/meta

The Ministry of Health, Kenya has developed a nutrition risk screening tool that can be used in a hospital as shown in the table below. Like the above table, it uses a combination of history and examination findings. It is a simple nutrition screening procedure that can help to distinguish between patients not at nutritional risk and those who require a more detailed nutrition assessment.

Indicator	Yes (☑)	No (☑)
Significant decrease in body weight • 5% weight loss in 30 days. • 10% weight loss in 6 months.	☐	☐
1. Low body weight • 20% or more below ideal body weight or BMI of 18.5 or less • Request for assistance with gaining/maintaining weight.	☐	☐
2. Significant increase in weight; physical diagnosis of obesity • Obesity: 20% or more above ideal body weight or BMI of 25 or greater. • Request for assistance with weight control.	☐	☐
3. Abnormal body composition measures e.g. • MUAC below 22 for adults. • MUAC below 11.5 children	☐	☐
4. Medical or psychiatric diagnosis related to nutritional therapy e.g. nephritic syndrome, diabetes, cardiovascular, hepatic, pancreatic, gastric etc.	☐	☐
5. Chronic decrease in food intake	☐	☐
6. Chewing and/or swallowing difficulties.	☐	☐
7. Pregnancy	☐	☐
8. Abnormal laboratory values pertinent to nutritional status e.g. HB, Albumin, blood glucose etc.	☐	☐
9. Enteral or parenteral nutrition	☐	☐

Nutrition screening tool for preoperative patients who will be hospitalized. Source: Kenya National Clinical Nutrition and Dietetics Reference Manual, 1st Edition
http://guidelines.health.go.ke/#/category/12/179/meta

Ideally, nutritional screening using techniques such as those above should be quick and simple. They should be done for every preoperative patient who needs them within the first 24-48 hours of the patient entering the hospital. More intensive assessments should be done for those identified to be at nutritional risk. The surgeon should assess every patient for this history and physical findings described here and attempt to make a diagnosis and implement intervention and monitoring as appropriate.

Intervention:

Nutrition therapy refers to provision of nutrition or nutrients. This can be done in the following manners:

- Orally: Regular diet or therapeutic diet (fortified food, oral nutritional supplements)
- Enteral nutrition: Tube feeds via nasogastric tube, nasojejunal tube, or surgical gastrostomy or jejunostomy access.
- Parenteral nutrition: Intravenous provision of nutrients, into central or peripheral veins.

Medical nutrition therapy is a subset of nutritional therapy that encompasses oral nutritional supplements, enteral tube feeding (enteral nutrition) and parenteral nutrition. Nutrition therapies are individualized and targeted nutrition care measures, using diet or medical nutrition approaches. Dietary education or counseling can be part of nutrition therapy, especially when dietary modifications are required.

For a surgical patient, the indications for nutritional therapy are prevention and treatment of catabolism, and malnutrition. This mainly affects the perioperative maintenance of the nutritional state, in order to prevent postoperative complications.

Nutritional therapy starts as a nutritional risk becomes obvious. Criteria for the success of the intervention are the "outcome" parameters of mortality, morbidity, and length of hospital stay, while taking into consideration economic implications. The improvement of nutritional status and functional recovery including quality of life are most important nutritional goals in the late postoperative period.

Nutrition therapy may be indicated even in patients without obvious disease-related malnutrition, if it is anticipated that the patient will be unable to eat or cannot maintain appropriate oral intake for a longer period perioperatively. In these situations, nutrition therapy may be initiated without delay. One example of this is placing a jejunostomy feeding tube during an esophageal or gastric resection.

We strongly recommend that you do not wait until severe disease-related malnutrition has developed, but start nutrition therapy as soon as a nutritional risk becomes apparent. Most nutritional care protocols for the surgical patient usually include a detailed nutritional and medical history as described above. It is important to document clear and accurate assessment of nutritional and clinical outcome whenever possible.

Adequate energy and protein intakes are needed to limit catabolic process. However, many

patients are not able to consume enough to meet their needs before or after the surgery. Some signs and symptoms of the condition i.e.; nausea, pain, medications, dry mouth and multiple fasting potentially reduce appetite and intake. The stress from trauma and surgery creates a catabolic state, increasing protein and energy requirements and utilization. Fat, protein and glycogen from the body reserves are redistributed to visceral organs leading to negative nitrogen and energy balance. This is defined as negative balance of 100g of nitrogen and 10,000kcals of energy within a few days. Nutrition intervention is achieved through accurate estimation of energy requirements and provision of available food.

Energy Requirements:

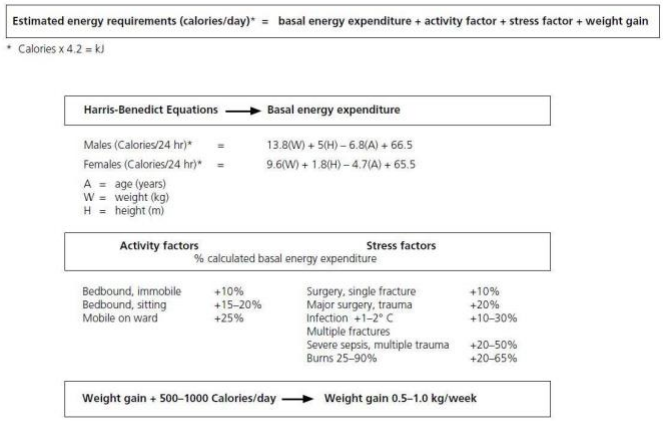
The standard approach used is to estimate energy requirements from the basal energy expenditure accompanied by the stress factors. Energy is provided by carbohydrate and fat, while protein is used to compete with the metabolic response of the body to trauma.

In sepsis, there will be increased protein breakdown. The body utilizes lipid more easily than glucose, therefore sepsis is associated with hyperglycaemia (septic diabetes.)

Typical adult surgical patients need 1800 to 2500kcal/day. The average daily requirement, in seriously ill patients, is 25 - 30 kcal/kg/day. Regarding protein requirement, 6.25 gm of protein provides 1 gm of nitrogen. Daily nitrogen requirement is 0.2 grams/kg.

Typically, energy is given to the patient in the following distributions: carbohydrate 50%, fat 35%, protein 15%. One gram of carbohydrate provides 4kcal, 1gram of protein provide 4kcal, while 1gm of fat provide 9 kcal. These energy sources must be delivered in combination with fluid, electrolytes, vitamins and trace elements. Fluid requirement is typically 30-35ml/kg/day. Major electrolytes like Na, K, and Cl requirement are 1.0 mmol/kg/day each. Zinc, Magnesium, and Phosphorus are the main trace elements required in daily diet.

The Harris-Benedict Equation is a common method for calculating energy requirements. The figure below summarizes the daily requirement for patients:



The Harris Benedict equation for calculation of daily energy requirements among patients receiving surgical care.

Enteral Feeding:

The preferred route is oral/enteral rather than parenteral, because it preserves intestinal structure and the role of the intestine in immune function. Nonuse of enteral feeding is related to villous and cellular atrophy leading to bacterial translocation and migration into systemic circulation. This may start or worsen systemic inflammatory response syndrome.

Enteral nutrition is used in patients with a normal functioning gastrointestinal tract. It may be given orally or via nasogastric, nasoduodenal, or naso-jejunal tube feeding, or surgically placed feeding tubes depending on the patient's condition.

Types of Enteral Feeds

i. Polymeric diet: A high molecular weight diet that is used in normal functioning gastrointestinal tract. It is composed of intact proteins, starch and long chain fatty acids.
ii. Elemental diet: A low molecular diet that is composed of amino acids, oligosaccharides and medium chain triglycerides. These products require minimal digestion and are easily absorbed. These diets are helpful in patient with pancreatitis, inflammatory bowel disease, and distal intestinal fistulas.
iii. Disease specific diet: These diets are specially prepared for renal, hepatic or pulmonary dysfunction patients. These are expensive. One example is Glucena®, a special formulation for patients with diabetes.

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Feeding Infusion:

Feeding infusion starts with a small volume of diluted formula initially. Concentration is gradually increased based on the patient's tolerance. Enough water should be provided to avoid osmotic dehydration. Tube feeding residual should be checked every 4 to 8 hours. More than 100ml residue requires holding the feeding for 2 hours. The feeding tube should be flushed routinely with 25 to 100 ml of water to prevent clogging. Feeds directly into the jejunum should be given as continuous infusion rather than "bolus" as the small intestine has no reservoir capacity.

Complication of Enteral Feeding

The most frequently seen complications are cramping, distension, vomiting and diarrhea. These may be managed by altering the fluid dilution or rate of administration. Mechanical problems include tube displacements, malposition, intra peritoneal leakage and intestinal obstruction. Other complications are dehydration, electrolyte imbalances and changes in blood sugar level. Aspiration can be a lethal complication. Therefore, if the stomach is being fed directly, the patient should have their head elevated at 45 degrees, during feeding. For recently placed nasogastric tubes, position of the tube should be confirmed prior to use.

Parenteral Feeding:

Parenteral nutrition is indicated when there is failure of enteral feeding. Enteral feeding will not be possible in the presence of proximal intestinal fistulas, intestinal obstruction, acute inflammatory bowel disease, inoperable malignancy, hepatic and renal failure, post chemotherapy or radiotherapy mucositis, malabsorption syndromes, prolonged ileus, pancreatitis, hypercatabolic states like burn, trauma, or major surgery.

Remember to address the overall picture when considering parenteral nutrition. A patient with malignant inoperable intestinal obstruction is better served by an honest discussion with the family followed by comfort care, rather than the provision of an expensive therapy such as intravenous nutrition.

Parenteral nutrition can be administered peripherally via superficial veins or centrally via a central vein. Peripheral Vein Nutrition is used as temporary nutritional support, when the anticipated period of starvation is less than 14 days. It is actually less complicated than central nutrition. Isotonic solution composed of amino acids, 5-10% dextrose and fat emulsion are commonly used. Phlebitis is the main problem resulting from use of a hyperosmolar solution. If osmolality exceeds 600 mmols, which is almost equal to a 10% glucose solution, it may cause line failure. Therefore, the full caloric requirement cannot be delivered by the peripheral veins. Regular change of the IV cannula is needed to avoid phlebitis. This can be controlled by using a long peripheral line such as a peripherally inserted central catheter (PICC) line.

Central Vein Nutrition requires insertion of a catheter into a central vein (subclavian, internal jugular vein) under aseptic conditions. Central vein nutrition, unlike peripheral nutrition, allows provision of full nutritional support for a long term period. Hyperosmolar solutions like 25-50% dextrose can be given by this route. It therefore allows minimized volume while optimizing calorie delivery. Precise and independent calories can be given, allowing the patient to achieve an anabolic state. However, as this is not a physiologically normal activity, it has some potentially severe adverse consequences:

- Gastrointestinal mucosal atrophy
- Hormonal imbalances
- Hyper- or hypo-glycemia
- Changes in hepatic metabolism

TPN is contraindicated in the presence of severe hepatic failure with encephalopathy, severe glucose intolerance, and extreme fluid restriction in renal failure patients. It should be avoided if experienced personnel (dietician, pharmacist, trained nurse, physician) are not available.

Parenteral Feeding Solutions:

The available feeding solution is delivered in one bag to be given over 24 hours. It includes solutions containing all nutrients including, glucose, fat, amino acids, vitamins, trace elements, mineral, electrolytes in required amount of fluid. The main advantage of using one single bag that contains all the ingredients are decreased risk of infection,

decreased manipulation, cost saving and time saving. Complete data regarding the patient's requirements is provided to the pharmacist by a nutritionist, to prepare a fresh infusion bag for 24 hours infusion. Individual solutions of glucose (5%, 10%, 25% dextrose), fat (10%, 20% lipids,) and amino acids are not usually available in resource-limited settings.

Conclusion:

In resource limited areas, the most available nutrition support is oral and enteral nutrition because of low cost and low risk of complication. This can be used in the provision of calories, protein, electrolytes, vitamins, minerals, trace elements, and fluids via an intestinal route. There are a wide range of hospital made oral nutrition supplements that can be delivered via this route depending on the nature/location of the condition. These include: (yogurt, milk shakes for high protein, juices for minerals and vitamins) formulas (clear liquids for gut assessment after procedures, soft liquid, thick fluids for individuals with dysphagia), and other types (high protein, high fiber, high calorie formulas.)

Diet-based prescriptions are strictly individualized. Requirements are determined as per the patient's physiological, functional, and nutrition status, and age. Some hospitals made oral supplements that can provide up to 300kcals and 12 g of proteins and a full range of vitamins and minerals. In general, high protein oral supplements are most suitable for patients with wounds and those with malignancy.

Post-operatively, surgeons normally indicate the format of nutrition support the patient will tolerate and what type to request for their patients. In consultation with the surgeon, the nutritionist then determines the patient's requirements, and schedules a feeding regimen.

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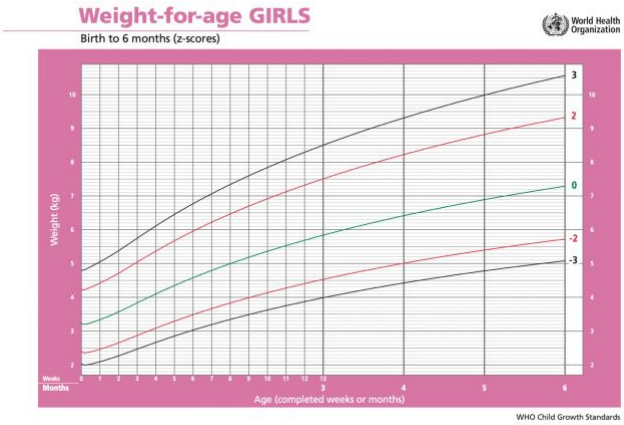

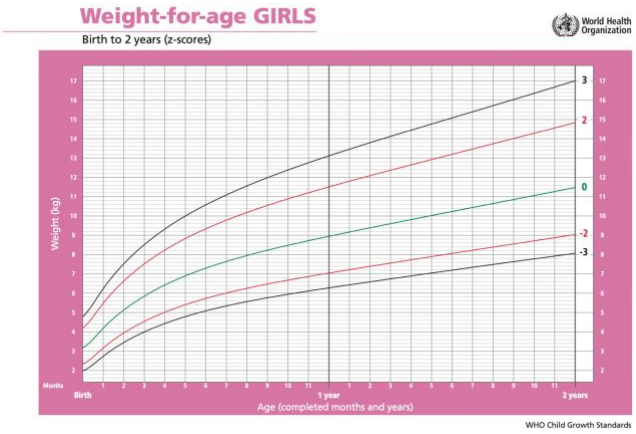

OPEN MANUAL OF SURGERY IN RESOURCE-LIMITED SETTINGS
www.vumc.org/global-surgical-atlas

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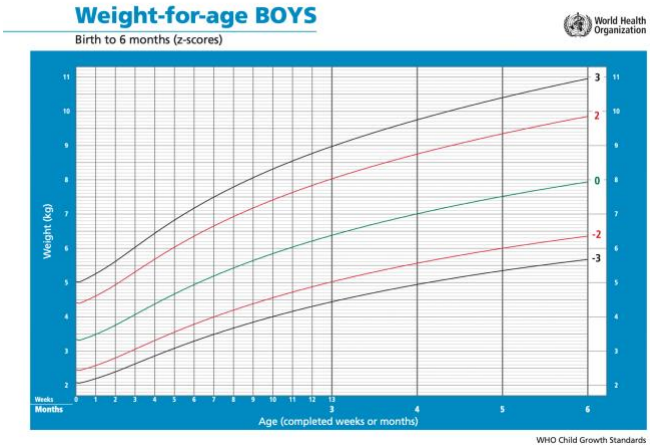

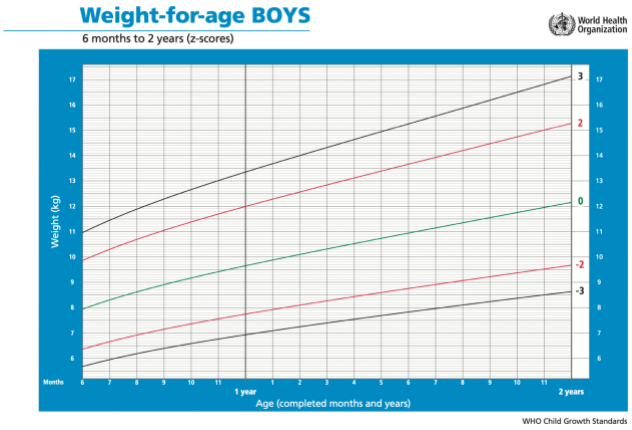

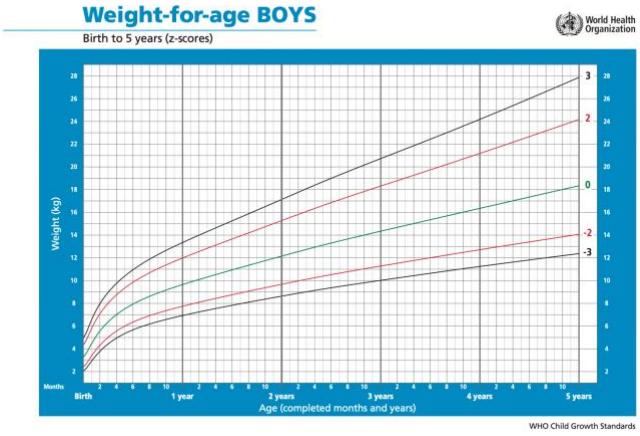

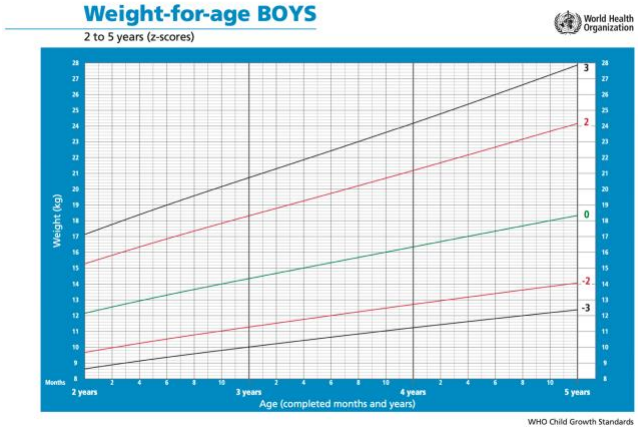

All graphs source: World Health Organization
https://www.who.int/tools/child-growth-standards/standards/weight-for-age

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www.vumc.org/global-surgical-atlas