

# Evaluation of Nutrition in PICU

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# Introduction

- Between 24 - 53% of children admitted to (PICUs) suffer from acute or chronic malnutrition at the time of admission and a large number of them undergo a deterioration of nutritional status during hospitalization .
- Malnourished hospitalized patients usually encounter several complications such as infections, prolonged length of hospital stay, poor outcome , and increased mortality.
- Early nutritional assessment and consequently early intervention can prevent or reduce the complications of malnutrition.

## Introduction..

- PICU patients are at increased risk of malnutrition because of altered metabolism.
- These changes include increased basal metabolic rate and enhanced protein catabolism.
- The metabolic response to stress in these patients causes the amino acids of lean tissues to mobilize in order to support accelerated demand for protein synthesis.
- Supporting the hypermetabolism and consequent high demands for energy, protein, and other nutrients through an early and appropriate nutritional intervention is critical.

# *1 Rationale for nutritional assessment of critically ill children*

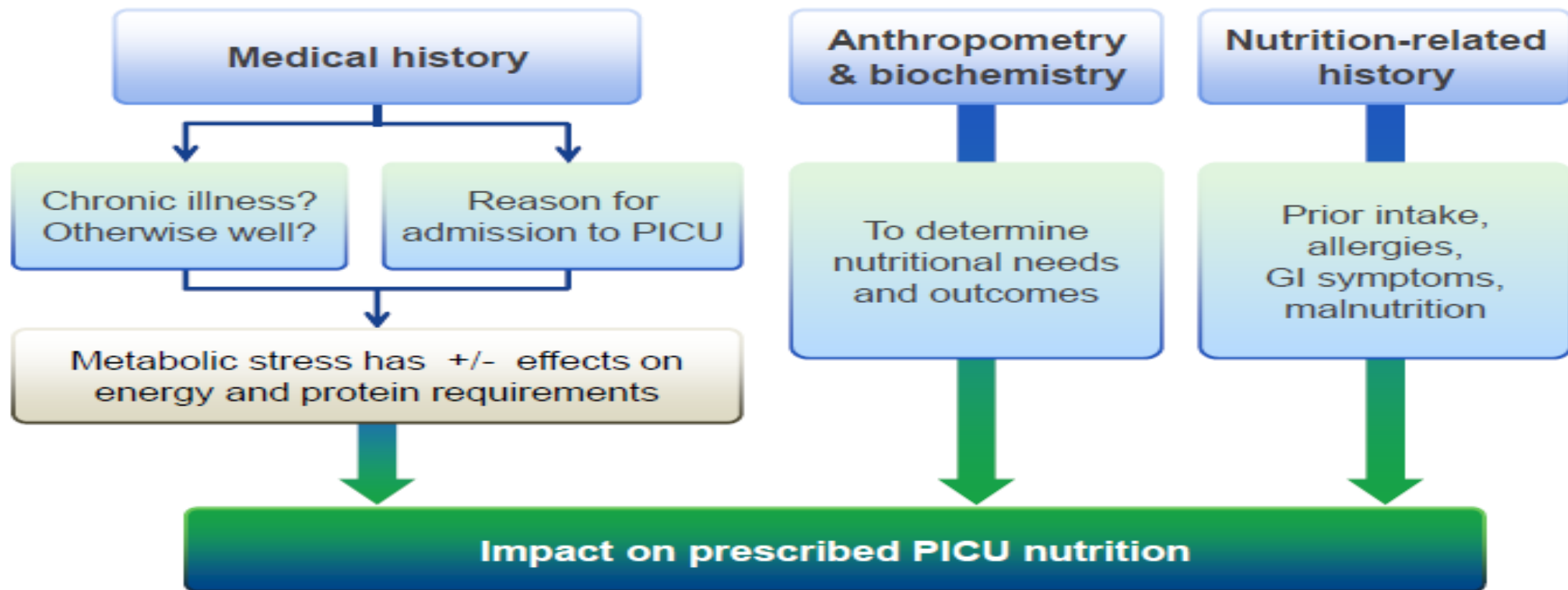
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*The Asia Pacific – Middle East Consensus Working Group on  
Nutrition Therapy in the Paediatric Critical Care Environment*

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# How to conduct accurate nutritional assessments?





# Conditions that may cause metabolic stress

## Moderate metabolic stress

- Routine surgery
- Laparoscopic surgery
- Exploratory surgery
- Fracture
- Infection
- Pressure sore/ulcer

## Severe metabolic stress

- Major organ surgery
- Major bowel resection
- Trauma
- Multiple injuries/fractures/burns/pressure sores
- Multi-organ failure
- Severe sepsis
- Severe inflammation
- Chronic illness with acute deterioration
- Current treatment for malignancy
- Acquired immunodeficiency syndrome with secondary infection

# 2 *Physical examination, anthropometry and nutritional history*

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# Nutritional assessment parameters: Anthropometry

## Anthropometry\*

- Growth (dynamic changes)
  - Weight
  - Length/height
- Weight for length or height
- Body mass index (BMI)
- Head circumference
- Triceps skinfold thickness

**Growth and anthropometry must be compared to charts for specific age groups** (Refer to slide 13 for more details)

for specific age groups (Refer to slide 13 for more details)

*\*Children with Down's syndrome or known genetic disorders may differ from normal populations in these aspects*

Abad-Jorge A. *ICAN: Infant, Child, & Adolescent Nutrition* 2013;5:221-230.



# Watch points when measuring weight

1

Weight should be accurately measured, wherever possible, rather than estimated

2

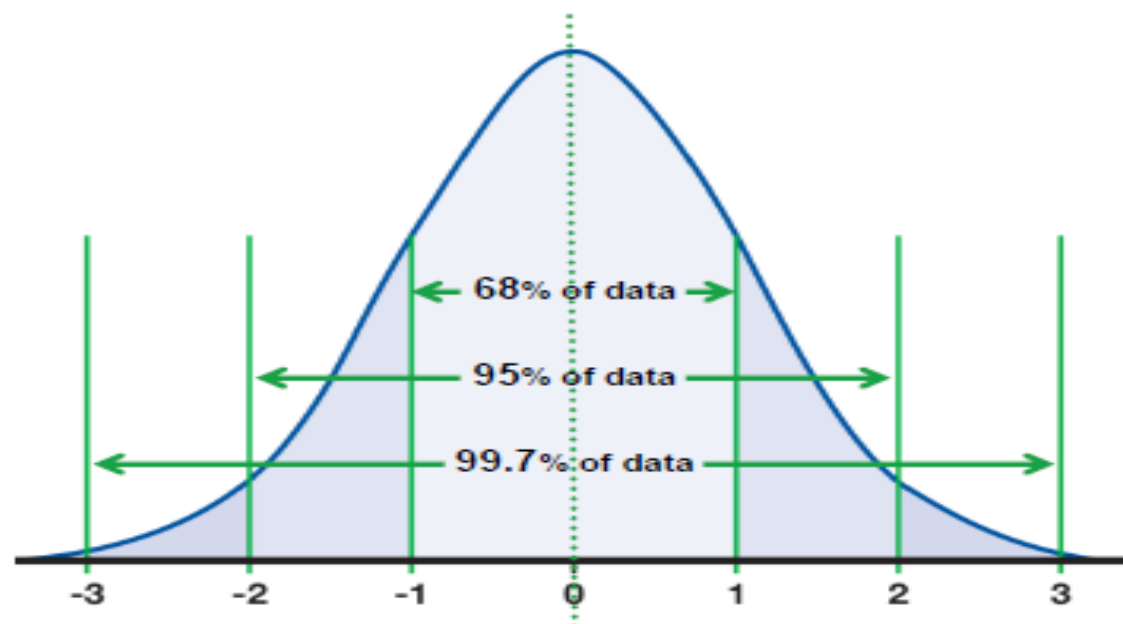
Always use the same standardised tool/chart when taking serial anthropometric measurements of a patient

*Energy requirements calculated from predictive equations depend on weight*

# Anthropometry: Recommendations for PICU

- Weight and height/length should be measured in all children on admission to PICU
- Head circumference should be measured in all children aged <3 years
- Use CDC/WHO reference standards unless robust local data are available
- Use **z-scores** rather than percentiles:
  - z-score enables comparison of a child's weight/height with the average weight/height for children of the same age
  - z-score of 0 is equivalent to median, normal range is +2 to -2

# Definition of z-score



**z-scores** describe how far (in standard deviation units) a child's weight is from the median weight of a child of the same height in the reference data

$$\text{z-score} = \frac{\text{individual value} - \text{population mean}}{\text{population SD}}$$

A **z-score** of 0 is equivalent to the median; the normal range is +2 to -2.

# Measuring weight and height/length

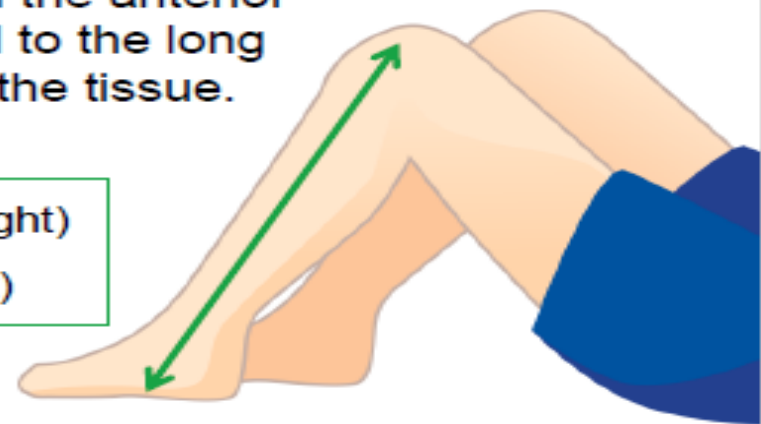
- WHO's instructions on how to measure a child's **weight** and **height** can be found here:  
[http://www.who.int/childgrowth/training/jobaid\\_weighing\\_measuring.pdf?ua=1](http://www.who.int/childgrowth/training/jobaid_weighing_measuring.pdf?ua=1)
- Knee-to-heel height can be used to estimate standing height in patients who are too ill to stand, or too large to be held while standing on a scale:

## Estimating height from knee height

While lying supine, both the knee and ankle of the patient are held at a 90-degree angles. One blade of a sliding Mediform caliper is placed under the heel of the foot, and the other blade is placed on the anterior surface of the thigh. The shaft of the caliper is held parallel to the long axis of the lower leg, and pressure is applied to compress the tissue. Height (in cm) is then calculated from the formula below:

**Females:** Height in cm =  $84.88 - (0.24 \times \text{age}) + (1.83 \times \text{knee height})$

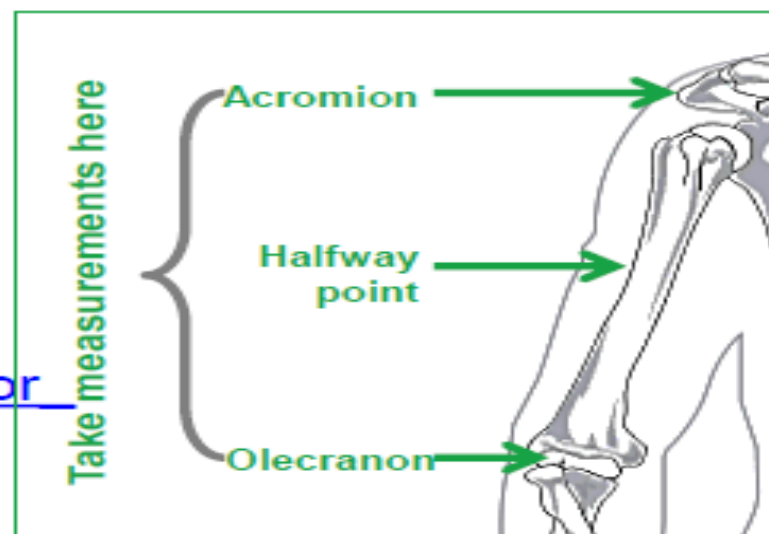
**Males:** Height in cm =  $64.19 - (0.04 \times \text{age}) + (2.02 \times \text{knee height})$





# Measuring skinfold thickness

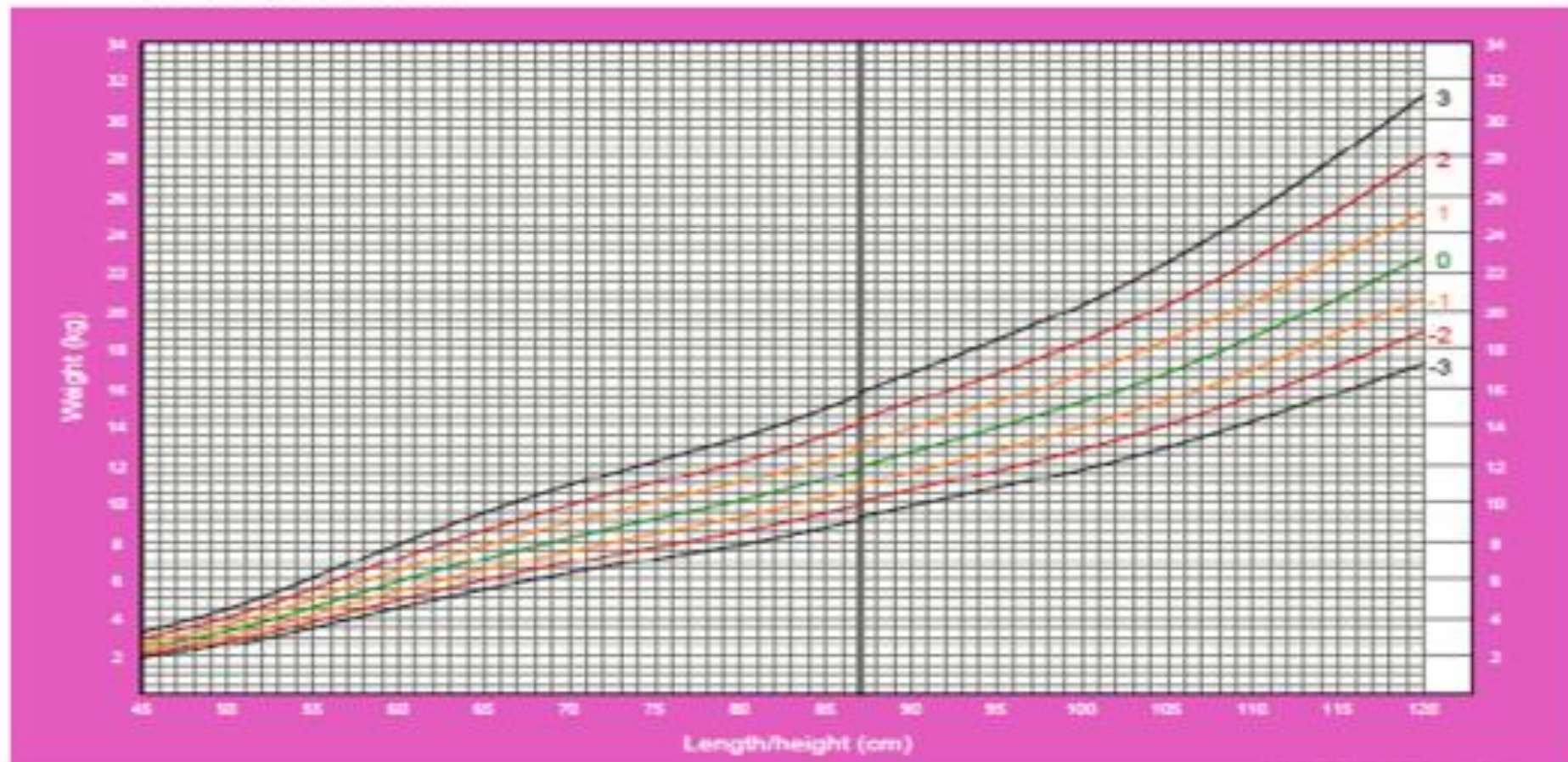
- Skinfold thickness measurements show changes in total body fat
- Triceps skin fold thickness is the easiest to measure:
  - Using the thumb and index finger, grasp and pull the skinfold with subcutaneous fat so that it is separate from the muscle
  - Place the calipers around the skinfold
  - Record the measurement in millimetres (mm)
  - Compare with z-scores in a WHO standardised chart, available at:  
[http://www.who.int/childgrowth/standards/tsf\\_for\\_age/en/](http://www.who.int/childgrowth/standards/tsf_for_age/en/)



## پیوست ۱۱: نمودار وزن برای قد دختران زیر ۵ سال

### Weight-for-length/height GIRLS

Birth to 5 years (z-scores)



WHO Child Growth Standards



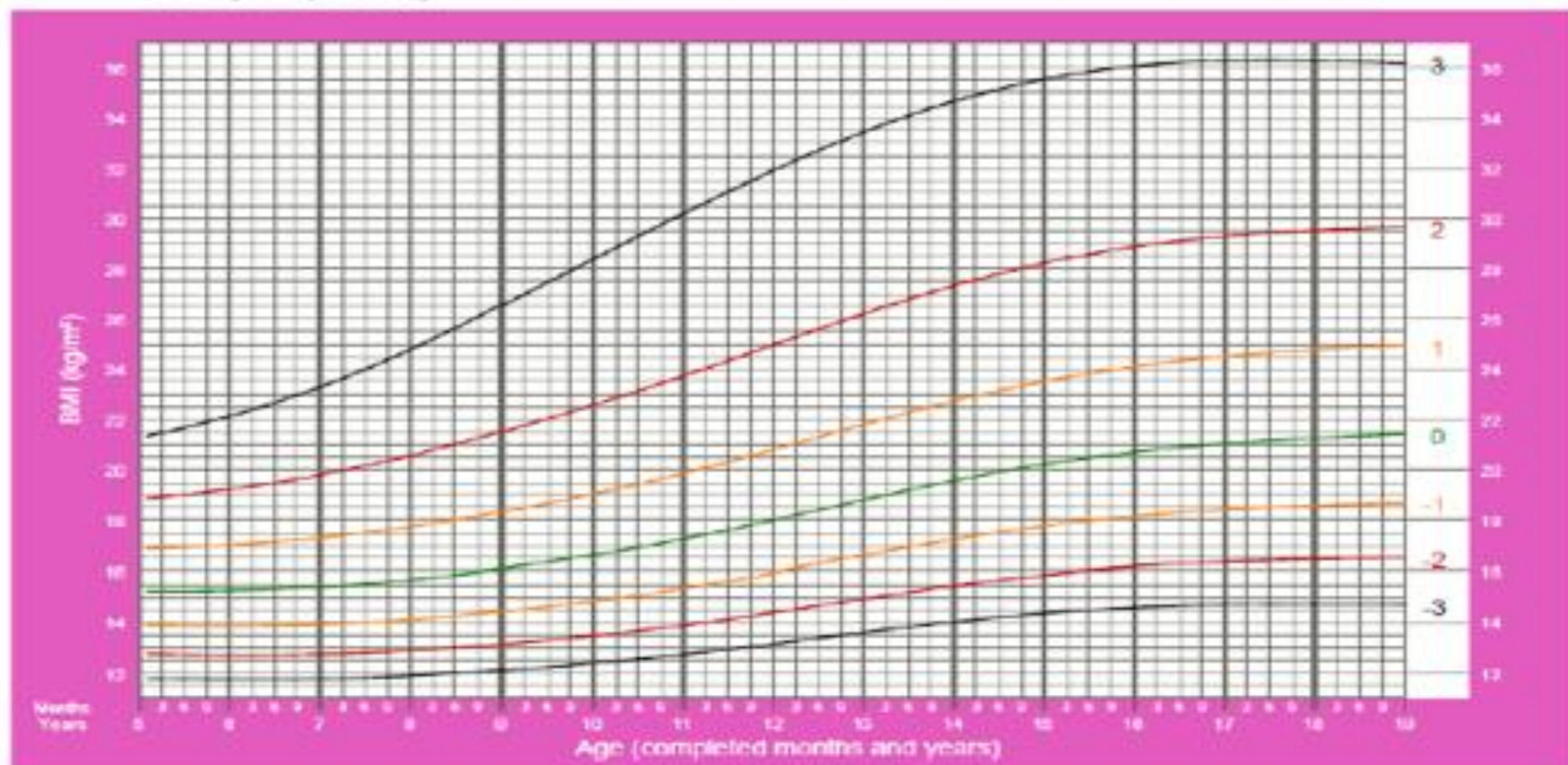
## پیوست ۱۲: نمودار نمایه توده بدنی برای سن دختران ۵ تا ۱۹ سال

### BMI-for-age GIRLS

5 to 19 years (z-scores)

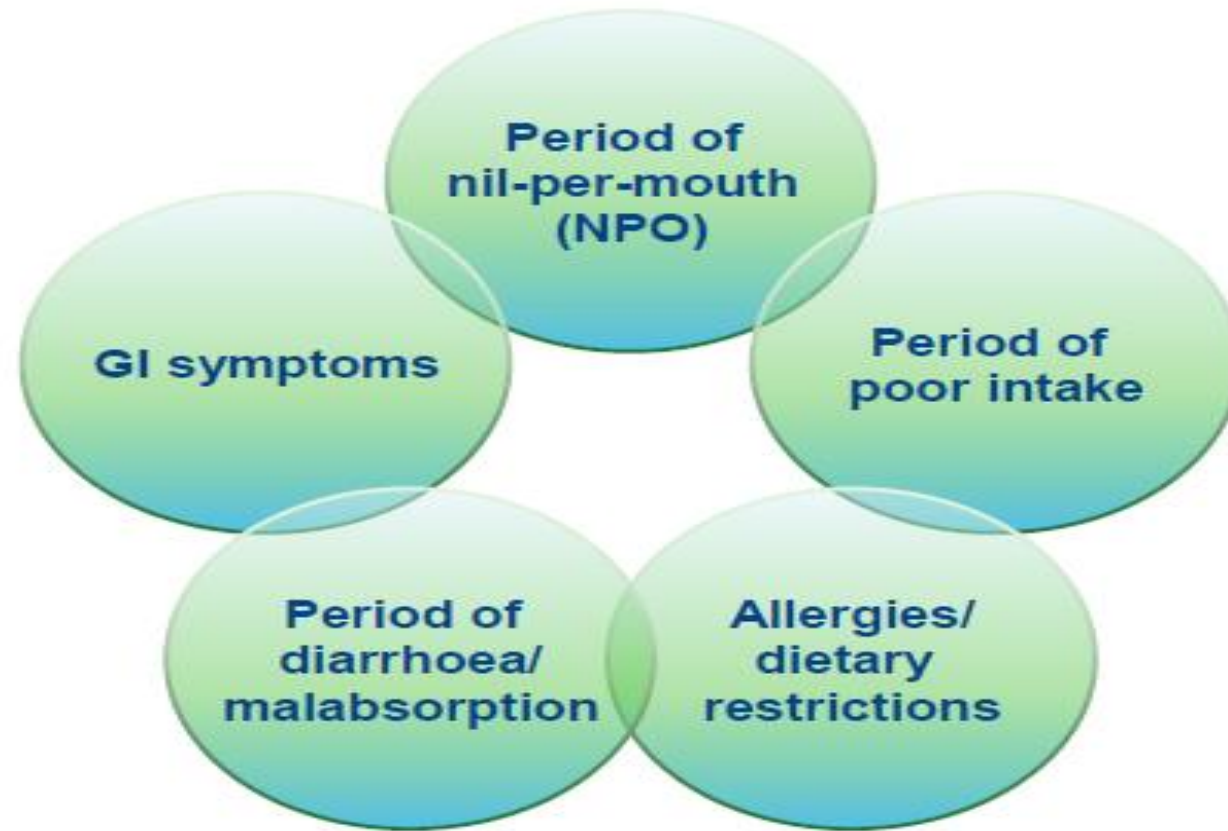


World Health  
Organization



2007 WHO Reference

# Nutritional assessment parameters: Taking a nutritional history





# Nutrition-focused physical examination

| Parameter                       | Examination  |
|---------------------------------|--|
| Overall appearance              | Check for oedema, muscle wasting, decreased subcutaneous fat, growth failure <sup>1</sup>  |
| Extremities, muscles, and bones | Check for peripheral oedema, subcutaneous fat loss, muscle wasting, muscle tone <sup>2</sup>   |
| Digestive system                | Check for compromised swallow function, decreased appetite, abdominal distention/pain, ascites, nausea, vomiting, reflux, diarrhoea <sup>2</sup> |
| Head and eyes                   | Check for sunken eyes, loss of hair, temporal wasting <sup>2</sup>   |
| Skin                            | Check for dry, scaly skin, dermatitis, wound healing issues <sup>2</sup>   |
| Vital signs                     | Check or access information on blood pressure, heart rate, respiratory rate, temperature <sup>2</sup>  |

# Nutritional assessment parameters: Biochemical/ laboratory measures

**Basic metabolic panel**

**Hepatic panel – particularly for infants and children on PN**

**Serum triglycerides – for patients on intravenous lipids**

**Pre-albumin as a measure of disease acuity (along with CRP)**

**Nutritional anaemia profile**

# Timing of nutritional assessments

- Should be conducted within the first **24–48 hours** of admission to the PICU
- Once nutrition goals are achieved, **reassess** nutritional requirements and evaluate the effects of critical illness and the response to nutrition therapy regularly
  - **At least weekly** for weight
  - **Every 2–4 weeks** for height/length, and head circumference in <3 year-olds
- **Serial assessments** are valuable
  - Changes in nutritional status during the course of critical illness may not be accurately detected with a single assessment

# 3 *Malnutrition screening and assessment tools*

*Developed by*

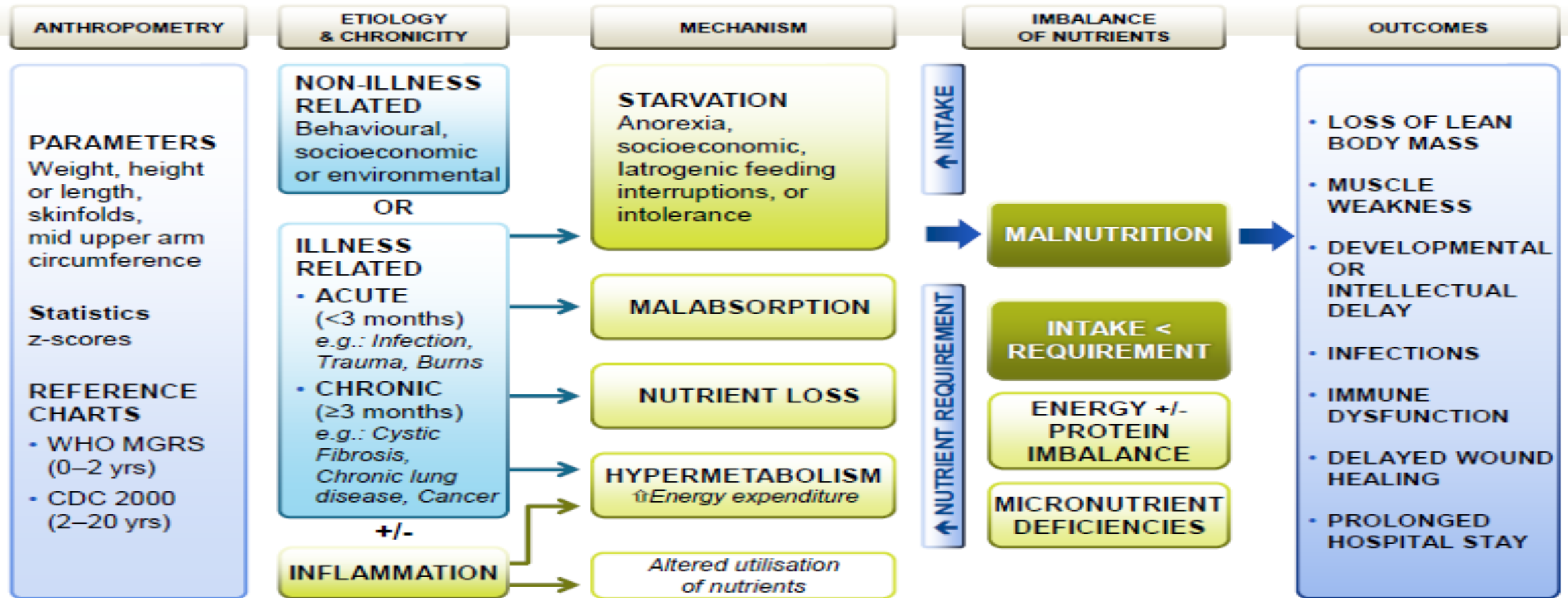
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# Conceptual definition of paediatric malnutrition



# Definition of paediatric malnutrition

| Chronology                             | Suggested criteria<br>Severity of malnutrition is based on anthropometric markers |
|--|---|
| <b>Acute</b><br>(<3 months duration)   | Mild malnutrition or at-risk of malnutrition<br>(z-score <-1)                     |
| <b>Chronic</b><br>(3 months or longer) | Moderate (z-score between -2 and -3)  |
|  | Severe (z-score <-3)  |

# Malnutrition screening tools

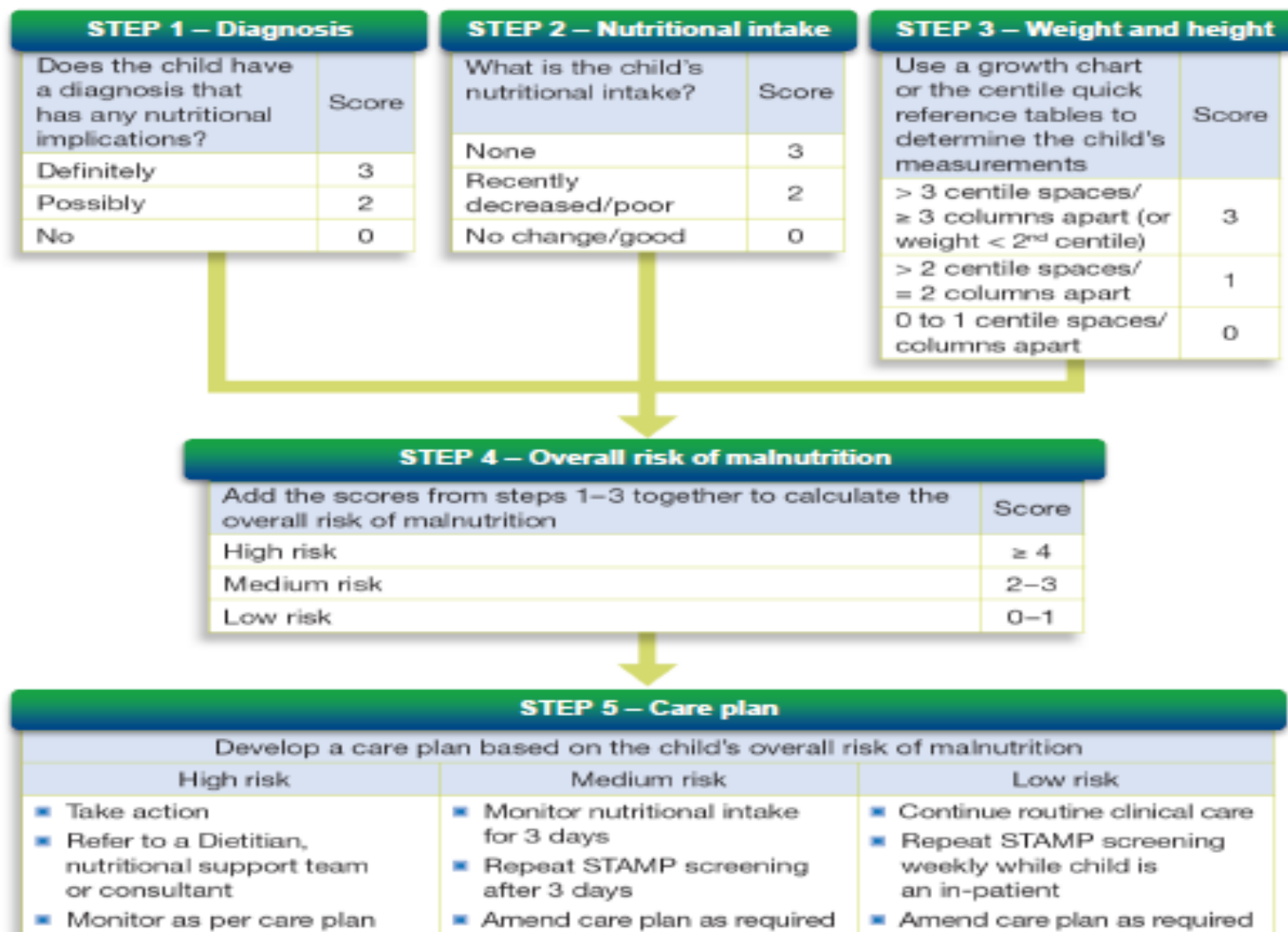
| Tool  | Comments on variables assessed                |
|---|---|
| Screening Tool for the Assessment of Malnutrition in Paediatrics <sup>1</sup> (STAMP) | Anthropometry, BMI, cutoffs                   |
| Paediatric Yorkhill Malnutrition Score <sup>2</sup> (PYMS)                            |   |
| Simple paediatric nutrition screening tool <sup>3</sup> (PNST)                        | Four basic questions, no anthropometry        |
| STRONGkids nutritional screening tool <sup>4</sup>                                    | Four basic questions <u>and</u> anthropometry |

1. <http://www.stampscreeningtool.org/stamp.html>; 2. <http://www.vdito.be/documenten%20nodig%20voor%20website/pymschart.pdf>; 3. White M, et al. *J Parenter Enteral Nutr* 2014; 4. Hulst JM, et al. *Clin Nutr* 2010;29:106-111

# STAMP

## 5 SIMPLE STEPS

- 1 Diagnosis
- 2 Nutritional intake
- 3 Weight and height
- 4 Overall risk of malnutrition
- 5 Care plan





# Simple paediatric nutrition screening tool (PNST)

**Performed as part of  
routine admission  
process by nurses**

**Simple**

**Quick**

**Cheap**

**Avoids anthropometric  
measures and reference  
to standards**

**Applies to all  
in-patients and ages**

**Takes limited  
printing space**

# Simple paediatric nutrition screening tool (PNST)

## 4 simple questions for nutritional screening:

- |   |   |         |
|---|---|---------|
| 1 | Has the child unintentionally lost weight lately?             | Yes/ No |
| 2 | Has the child had poor weight gain over the last few months?  | Yes/ No |
| 3 | Has the child been eating/feeding less in the last few weeks? | Yes/ No |
| 4 | Is the child obviously underweight/ significantly overweight? | Yes/ No |

If answer is **yes** for any of the two above – implement the following actions:

- Strict food intake record
- Weigh twice weekly
- Refer to dietician

**Two affirmative responses are a predictor of nutrition risk**



# 4 Serum biomarkers

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# Interpreting serum biomarkers

| Measure (half-life)    | Clinical use   | Limitations and comments  |
|------------------------|--|---|
| Albumin (15–20 days)   | <ul style="list-style-type: none"><li>• Valuable as a prognostic indicator of disease severity</li><li>• Useful for long-term assessments</li></ul>  | <ul style="list-style-type: none"><li>• Affected by albumin infusion, dehydration, sepsis, trauma, inflammatory reaction or liver disease</li><li>• Cannot be used to assess nutritional status in acute phase</li></ul>  |
| Pre-albumin (2–3 days) | <ul style="list-style-type: none"><li>• Shorter half-life makes it an earlier indicator of clinical improvement</li><li>• Sensitive in evaluating acute changes in protein and energy adequacy</li></ul> | <ul style="list-style-type: none"><li>• Influenced by liver, renal and inflammatory disease</li><li>• Decreased in acute phase, liver failure, protein malnutrition, hyperparathyroidism, significant hyperglycaemia.</li><li>• Increased in renal failure, steroid therapy, non-Hodgkin's lymphoma, head injury.</li></ul> |



# Interpreting serum biomarkers

| Measure (half-life)             | Clinical use  | Limitations and comments   |
|---------------------------------|---|--|
| Retinol binding protein (12 hr) | <ul style="list-style-type: none"> <li>Short half-life, sensitive indicator of patient's condition</li> </ul>   | <ul style="list-style-type: none"> <li>May fluctuate too much to be a useful measure</li> <li>Decreased in acute phase, liver failure, protein malnutrition</li> <li>Increased in renal failure, vitamin A deficiency</li> </ul>   |
| Transferrin (8–10 days)         | <ul style="list-style-type: none"> <li>More sensitive than albumin in reflecting protein depletion</li> <li>Decreases rapidly with protein energy malnutrition</li> </ul> | <ul style="list-style-type: none"> <li>Involved with iron transport, so levels are influenced by iron status</li> <li>Decreased in acute phase, anaemia, overhydration, chronic infection, acute catabolic states, kwashiorkor</li> <li>Increased in iron deficiency, dehydration, chronic blood loss, hypoxia, hepatitis</li> </ul> |

Dieticians Association of Australia. 2011; Available at: <http://daa.asn.au/wp-content/uploads/2011/10/Parenteral-nutrition-manual-September-2011.pdf>.; Banh L. *Practical Gastroenterology*; October 2006:46, available at: <http://www.medicines.virginia.edu/clinical/departments/medicine/divisions/digestive-health/clinical-care/nutrition-support-team/nutrition-articles/BanhArticle.pdf>. Goday PS, Mehta NM. *Pediatric Critical Care Nutrition*. McGraw-Hill Education. 2014.

# Indicators of protein status

| Measure                    | Interpretation   | Remarks  |
|----------------------------|--|--|
| Urinary nitrogen excretion | <ul style="list-style-type: none"><li>• Marker of protein metabolism</li><li>• Positive nitrogen balance (input &gt; output) indicates anabolism</li><li>• Negative nitrogen balance indicates lean tissue loss. (Will be negative in acute phase)</li></ul> | <ul style="list-style-type: none"><li>• Test 24-hour urine collection for urea or total nitrogen content</li><li>• <b>Nitrogen input</b> (g) = protein intake (g) ÷ 6.25</li><li>• <b>Nitrogen output</b> = 24-hour urinary urea + insensible losses</li></ul> |
| Total serum protein        | <ul style="list-style-type: none"><li>• Decreased in acute phase, or any other situation where albumin is decreased</li></ul>  | <ul style="list-style-type: none"><li>• Decreases with loss of visceral and somatic protein stores</li></ul>   |

# Summary: Recommendations on interpreting serum biomarkers

- Serum biomarkers should **be used/interpreted with caution** as indicators of nutritional status
- It is preferable to **evaluate changes in serial serum biomarker measurements over time** to indicate changes in the patient's status, rather than using absolute values
- Serum biomarkers are recommended always to be **interpreted in the context of other factors (nature of illness, other comorbidities, anthropometry)**, and not in isolation
- A true biomarker for nutritional status is still not available!



# Module summary

- Accurate anthropometric and nutritional assessments must be carried out within 24–48 hours of admission to the PICU, to enable the correct prescription of optimal nutrition
  - Use z-scores and plot weight, height (and head circumference for children <3 years) on WHO or CDC growth charts for age
  - Use a malnutrition screening tool to determine whether the patient is malnourished, or at risk of malnutrition
  - Regular reassessments of nutritional status must be carried out during nutrition therapy
- Serum biomarkers should be interpreted in the context of other factors as indicators of nutritional status
- Nurses, dieticians and physicians all play a role in the assessment of the child's nutritional status

# ارزیابی تغذیه ای ( Nutritional Assessment) بیماران بستری در NICU/PICU در قالب شیفت های NICU و PICU ویژه پرستار

| ارزیابی تغذیه ای Nutritional Assessment |  |                       |                    |            |       |                  |     |         |
|---|--|-----------------------|--------------------|------------|-------|------------------|-----|---------|
| مقدار تغذیه<br>شده<br>(CC)              | مقدار مورد<br>نیاز طی ۲۴<br>ساعت<br>(CC) | نوع فرموله<br>و تغذیه | سرعت و طریقه گوارش |            |       | روش دریافت تغذیه |     |         |
|   |  |                       | Intermittent       | Continuous | Bolus | PO               | NPO |         |
|   |  |                       |                    |            |       |                  |     | صبح     |
|   |  |                       |                    |            |       |                  |     | عصر     |
|   |  |                       |                    |            |       |                  |     | شب      |
|   |  |                       |                    |            |       |                  |     | اقدامات |

۷- این شیفت به صورت پشت و رو چاپ شود.

# Interpretation of Z scores for growth parameters

| Z-score    | Growth indicators             |                                   |   |   |
|------------|-------------------------------|-----------------------------------|---|---|
|            | Height* for age               | Weight for age                    | Weight for height*                        | BMI for age                               |
| Above 3    | Very tall <sup>¶</sup>        | Δ                                 | Obese                                     | Obese                                     |
| Above 2    |                               | Δ                                 | Overweight                                | Overweight                                |
| Above 1    |                               | Δ                                 | Possible risk for overweight <sup>⊕</sup> | Possible risk for overweight <sup>⊕</sup> |
| 0 (median) |                               |                                   |   |   |
| Below -1   |                               |                                   |   |   |
| Below -2   | Stunted <sup>§</sup>          | Underweight                       | Wasted                                    | Wasted                                    |
| Below -3   | Severely stunted <sup>§</sup> | Severely underweight <sup>‡</sup> | Severely wasted                           | Severely wasted                           |







## Interpretation of Z-scores for growth parameters

| Z-score    | Growth indicators |                       |                               |                               |
|------------|-------------------|-----------------------|-------------------------------|-------------------------------|
|            | Height* for age   | Weight for age        | Weight for height*            | BMI for age                   |
| Above 3    | Very tall¶        | Δ                     | Obese                         | Obese                         |
| Above 2    |                   | Δ                     | Overweight                    | Overweight                    |
| Above 1    |                   | Δ                     | Possible risk for overweight◊ | Possible risk for overweight◊ |
| 0 (median) |                   |                       |                               |                               |
| Below -1   |                   |                       |                               |                               |
| Below -2   | Stunted§          | Underweight           | Wasted                        | Wasted                        |
| Below -3   | Severely stunted§ | Severely underweight✕ | Severely wasted               | Severely wasted               |

BMI: body mass index; IMCI: Integrated Management of Childhood Illness.

\* Length (recumbent) is generally measured for children younger than 2 years of age, and height (standing) is measured for those 2 years and older.

¶ A child in this range is very tall. Tallness is rarely a problem, unless it is so excessive that it may indicate an endocrine disorder such as a growth hormone-producing tumor. Refer a child in this range for assessment if you suspect an endocrine disorder (eg, if parents of normal height have a child who is excessively tall for his or her age).

Δ A child whose weight-for-age falls into this range may have a growth problem, but this is better assessed from a weight-for-length/height or BMI-for-age.

◊ A plotted point above 1 shows possible risk. A trend towards the 2 Z-score line shows definite risk.

§ It is possible for a stunted or severely stunted child to become overweight.

✕ This is referred to as very low weight in IMCI training modules<sup>[1]</sup>.