Optimal nutrition in critically ill children

Nutritional assessment of critically ill children

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

Supported by
Nestlé Nutrition Institute
Learning objectives

- To understand the need for accurate nutritional and anthropometric assessment of critically ill children
- To be able to take a thorough nutrition-focused medical history of a child admitted to the PICU
- To understand which anthropometric assessments are required to help determine the nutritional status of the child, and how to obtain thorough, accurate measurements
- To be able to determine whether the child is at risk of malnutrition, or is already malnourished
- To be able to interpret baseline serum biomarkers
Overview

1. Rationale for nutritional assessment of critically ill children
2. Physical examination, anthropometry and nutritional history
3. Malnutrition screening and assessment tools
4. Serum biomarkers
5. Nutritional assessment: Roles and responsibilities
6. Test your knowledge
1 Rationale for nutritional assessment of critically ill children
How to conduct accurate nutritional assessments?

Medical history
- Chronic illness?
- Otherwise well?
- Reason for admission to PICU

Anthropometry & biochemistry
- To determine nutritional needs and outcomes

Nutrition-related history
- Prior intake, allergies, GI symptoms, malnutrition

Impact on prescribed PICU nutrition

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

Secker DJ, Jeejeebhoy KN. *J Acad Nutr Diet* 2012;112:424-431 e426.
2 Physical examination, anthropometry and nutritional history
Nutritional assessment parameters: Anthropometry

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

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


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

http://www.who.int/childgrowth/training/jobaid_weighing_measuring.pdf?ua=1
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.

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

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

Calculation of z-score

• The values corresponding to specific z-scores (-2, -1.5, -1, -0.5, 0, 0.5, 1, 1.5, 2) are contained in 8 excel data files representing the 8 different growth curves
  – Infants: weight-for-age; length-for-age; weight-for-recumbent length; head circumference-for-age
  – Older children: weight-for-stature; weight-for-age; stature-for-age; BMI-for-age

• These are available on CDC website: http://www.cdc.gov/growthcharts/zscore.htm
Example of WHO growth chart: Length for age z-scores (girls <2 yrs)

http://www.who.int/childgrowth/standards/cht_lfa_girls_z_0_2.pdf?ua=1
## Charts for anthropometry

<table>
<thead>
<tr>
<th>Age of PICU patient</th>
<th>Charts and growth standards</th>
<th>Website</th>
</tr>
</thead>
</table>
| <2 years (length, weight)* | • WHO length for age and z-scores  
• CDC growth charts (download for girls vs. boys, weight or length) | [http://www.who.int/childgrowth/standards/height_for_age/en/](http://www.who.int/childgrowth/standards/height_for_age/en/)  
[http://www.cdc.gov/growthcharts/clinical_charts.htm](http://www.cdc.gov/growthcharts/clinical_charts.htm) |
| <3 years (head circumference)* | • WHO head circumference for age  
• CDC growth charts (download for girls vs. boys, head circumference) | [http://www.who.int/childgrowth/standards/hc_for_age/en/](http://www.who.int/childgrowth/standards/hc_for_age/en/)  
[http://www.cdc.gov/growthcharts/clinical_charts.htm](http://www.cdc.gov/growthcharts/clinical_charts.htm) |
| 2–20 years (length, weight, BMI)* | • CDC weight/height for age, BMI  
• WHO standards | [http://www.cdc.gov/growthcharts/clinical_charts.htm](http://www.cdc.gov/growthcharts/clinical_charts.htm)  

*Both WHO and CDC charts can be used. However, WHO used cross-sectional and longitudinal data that was more robust in patients aged less than 2 years, and their charts are more reflective of children in Asian regions. For children aged 2–5 years, the data collected by CDC and WHO are similar.*
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

• 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 X age) + (1.83 X knee height)

**Males**: Height in cm = 64.19 – (0.04 X age) + (2.02 X 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)
Nutritional assessment parameters: Taking a nutritional history

- Period of nil-per-mouth (NPO)
- GI symptoms
- Period of poor intake
- Period of diarrhoea/malabsorption
- Allergies/dietary restrictions

# Nutrition-focused physical examination

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall appearance</td>
<td>Check for oedema, muscle wasting, decreased subcutaneous fat, growth failure¹</td>
</tr>
<tr>
<td>Extremities, muscles, and bones</td>
<td>Check for peripheral oedema, subcutaneous fat loss, muscle wasting, muscle tone²</td>
</tr>
<tr>
<td>Digestive system</td>
<td>Check for compromised swallow function, decreased appetite, abdominal distention/pain, ascites, nausea, vomiting, reflux, diarrhoea²</td>
</tr>
<tr>
<td>Head and eyes</td>
<td>Check for sunken eyes, loss of hair, temporal wasting²</td>
</tr>
<tr>
<td>Skin</td>
<td>Check for dry, scaly skin, dermatitis, wound healing issues²</td>
</tr>
<tr>
<td>Vital signs</td>
<td>Check or access information on blood pressure, heart rate, respiratory rate, temperature²</td>
</tr>
</tbody>
</table>

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

PN=Parenteral nutrition; CRP=C-reactive protein
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

Malnutrition screening and assessment tools
Conceptual definition of paediatric malnutrition

**ANTHROPOMETRY**
- Weight, height or length, skinfolds, mid upper arm circumference

**ETIOLOGY & CHRONICITY**
- **NON-ILLNESS RELATED**
  - Behavioural, socioeconomic or environmental
- **ILLNESS RELATED**
  - **ACUTE** (<3 months)
    - e.g.: Infection, Trauma, Burns
  - **CHRONIC** (≥3 months)
    - e.g.: Cystic Fibrosis, Chronic lung disease, Cancer

**MECHANISM**
- **STARVATION**
  - Anorexia, socioeconomic, iatrogenic feeding interruptions, or intolerance
- **MALABSORPTION**
- **HYPERMETABOLISM**
  - Energy expenditure
- **INFLAMMATION**
  - Altered utilisation of nutrients

**IMBALANCE OF NUTRIENTS**
- **MALNUTRITION**
  - Energy +/− Protein imbalance
  - Micronutrient deficiencies

**OUTCOMES**
- **LOS OF LEAN BODY MASS**
- **MUSCLE WEAKNESS**
- **DEVELOPMENTAL OR INTELLECTUAL DELAY**
- **INFECTIONS**
- **IMMUNE DYSFUNCTION**
- **DELAYED WOUND HEALING**
- **PROLONGED HOSPITAL STAY**

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Assess several markers to predict protein-energy malnutrition or risk of nutrition-related complications:

- Insufficient food and nutrition
- Reduced intake compared with nutrition requirements
- Weight loss over time
- Loss of muscle mass
- Loss of fat mass
- Fluid accumulation

# Definition of paediatric malnutrition

<table>
<thead>
<tr>
<th>Chronology</th>
<th>Suggested criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute</strong></td>
<td></td>
</tr>
<tr>
<td>(&lt;3 months duration)</td>
<td>Mild malnutrition or at-risk of malnutrition (z-score &lt;-1)</td>
</tr>
<tr>
<td><strong>Chronic</strong></td>
<td></td>
</tr>
<tr>
<td>(3 months or longer)</td>
<td>Moderate (z-score between -2 and -3)</td>
</tr>
<tr>
<td></td>
<td>Severe (z-score &lt;-3)</td>
</tr>
</tbody>
</table>

Severity of malnutrition is based on anthropometric markers.

# Malnutrition screening tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Comments on variables assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening Tool for the Assessment of Malnutrition in Paediatrics¹ (STAMP)</td>
<td>Anthropometry, BMI, cutoffs</td>
</tr>
<tr>
<td>Paediatric Yorkhill Malnutrition Score² (PYMS)</td>
<td>Four basic questions, no anthropometry</td>
</tr>
<tr>
<td>Simple paediatric nutrition screening tool³ (PNST)</td>
<td>Four basic questions and anthropometry</td>
</tr>
<tr>
<td>STRONGkids nutritional screening tool⁴</td>
<td></td>
</tr>
</tbody>
</table>

STAMP: Screening tool for the assessment of malnutrition in paediatrics

Developed by dieticians in a children’s hospital in the UK

A 5-step tool validated for hospitalised children aged 2–16 years

Available at www.stampscreeningtool.org

Has been validated in a PICU of a Shanghai hospital

# STAMP

## 5 SIMPLE STEPS

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

### STEP 1 – Diagnosis

<table>
<thead>
<tr>
<th>Does the child have a diagnosis that has any nutritional implications?</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely</td>
<td>3</td>
</tr>
<tr>
<td>Possibly</td>
<td>2</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
</tbody>
</table>

### STEP 2 – Nutritional intake

<table>
<thead>
<tr>
<th>What is the child’s nutritional intake?</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>3</td>
</tr>
<tr>
<td>Recently decreased/poor</td>
<td>2</td>
</tr>
<tr>
<td>No change/good</td>
<td>0</td>
</tr>
</tbody>
</table>

### STEP 3 – Weight and height

Use a growth chart or the centile quick reference tables to determine the child’s measurements:

- > 3 centile spaces/≥ 3 columns apart (or weight < 2nd centile) = 3
- > 2 centile spaces/≥ 2 columns apart = 1
- 0 to 1 centile spaces/columns apart = 0

### STEP 4 – Overall risk of malnutrition

Add the scores from steps 1–3 together to calculate the overall risk of malnutrition:

- High risk: ≥ 4
- Medium risk: 2–3
- Low risk: 0–1

### STEP 5 – Care plan

Develop a care plan based on the child’s overall risk of malnutrition:

<table>
<thead>
<tr>
<th>High risk</th>
<th>Medium risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take action</td>
<td>Monitor nutritional intake for 3 days</td>
<td>Continue routine clinical care</td>
</tr>
<tr>
<td>Refer to a Dietitian, nutritional support team or consultant</td>
<td>Repeat STAMP screening after 3 days</td>
<td>Repeat STAMP screening weekly while child is an in-patient</td>
</tr>
<tr>
<td>Monitor as per care plan</td>
<td>Amend care plan as required</td>
<td>Amend care plan as required</td>
</tr>
</tbody>
</table>

[www.stampscreeningtool.org](http://www.stampscreeningtool.org)
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:**

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Yes/ No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Has the child unintentionally lost weight lately?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Has the child had poor weight gain over the last few months?</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Has the child been eating/feeding less in the last few weeks?</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Is the child obviously underweight/significantly overweight?</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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Assessment for malnutrition: Paediatric Subjective Global Nutritional Assessment (SGNA)

1. Take a nutrition-focused medical history
   - Linear growth
   - Weight relative to length/height
   - Changes in body weight
   - Adequacy of dietary intake
   - Persistent GI symptoms
   - Muscle function impairment
   - Metabolic demands based on underlying co-morbidities, nature of critical illness
   
   Use historical measurements from medical records or caregivers

2. Perform nutrition-focused medical examination

3. Assign overall SGNA rating
   - Normal
   - Moderate
   - Severe

Secker DJ, Jeejeebhoy KN. *J Acad Nutr Diet* 2012;112:424-431 e426.
Serum biomarkers
## Interpreting serum biomarkers

<table>
<thead>
<tr>
<th>Measure (half-life)</th>
<th>Clinical use</th>
<th>Limitations and comments</th>
</tr>
</thead>
</table>
| Albumin (15–20 days) | • Valuable as a prognostic indicator of disease severity  
• Useful for long-term assessments | • Affected by albumin infusion, dehydration, sepsis, trauma, inflammatory reaction or liver disease  
• Cannot be used to assess nutritional status in acute phase |
| Pre-albumin (2–3 days) | • Shorter half-life makes it an earlier indicator of clinical improvement  
• Sensitive in evaluating acute changes in protein and energy adequacy | • Influenced by liver, renal and inflammatory disease  
• Decreased in acute phase, liver failure, protein malnutrition, hyperparathyroidism, significant hyperglycaemia.  
• Increased in renal failure, steroid therapy, non-Hodgkin’s lymphoma, head injury. |

## Interpreting serum biomarkers

<table>
<thead>
<tr>
<th>Measure (half-life)</th>
<th>Clinical use</th>
<th>Limitations and comments</th>
</tr>
</thead>
</table>
| Retinol binding protein (12 hr) | • Short half-life, sensitive indicator of patient’s condition | • May fluctuate too much to be a useful measure  
• Decreased in acute phase, liver failure, protein malnutrition  
• Increased in renal failure, vitamin A deficiency |
| Transferrin (8–10 days) | • More sensitive than albumin in reflecting protein depletion  
• Decreases rapidly with protein energy malnutrition | • Involved with iron transport, so levels are influenced by iron status  
• Decreased in acute phase, anaemia, overhydration, chronic infection, acute catabolic states, kwashiorkor  
• Increased in iron deficiency, dehydration, chronic blood loss, hypoxia, hepatitis |
**Indicators of protein status**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Interpretation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary nitrogen excretion</td>
<td>• Marker of protein metabolism</td>
<td>• Test 24-hour urine collection for urea or total nitrogen content</td>
</tr>
<tr>
<td></td>
<td>• Positive nitrogen balance (input &gt; output) indicates anabolism</td>
<td>• <strong>Nitrogen input</strong> (g) = protein intake (g) ÷ 6.25</td>
</tr>
<tr>
<td></td>
<td>• Negative nitrogen balance indicates lean tissue loss. (Will be negative in acute phase)</td>
<td>• <strong>Nitrogen output</strong> = 24-hour urinary urea + insensible losses</td>
</tr>
<tr>
<td>Total serum protein</td>
<td>• Decreased in acute phase, or any other situation where albumin is decreased</td>
<td>• Decreases with loss of visceral and somatic protein stores</td>
</tr>
</tbody>
</table>
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!
Nutritional assessment: Roles and responsibilities
Nutritional screening: Who does what?
(Recommendations from algorithm developed in US)

I. Nursing staff/diet technicians:

- **Weight, length and body mass index (BMI)** – to be documented
- Complete **Nutrition Assessment** within 24 hours of admission
  - Repeat weight as ordered or at least once a week and length monthly
- Flag patients who meet criteria for malnutrition
  - Weight-for-age (WAZ), weight-for-height (WH) or BMI – z scores (<-2 or >+2)

Nutritional screening: Who does what? (Recommendations from algorithm developed in US)

II. Dietician/consulting physician:

- Consult on patients meeting criteria for malnutrition
- Anthropometry
- Recommend **Energy** (kcals/day) & **Protein** (grams/day) goals
- Assess volume goal daily
- Recommend route of administration
- Recommend formula
- Repeat assessment and recommendation weekly (at minimum)
- Review criteria for Indirect Calorimetry and discuss with team
- Document assessment in electronic medical records

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.
Test your knowledge
1. Which one of these statements regarding nutritional assessment is NOT correct?

A. Weight and length/height should be measured in all children on admission to the PICU

B. Use z-scores rather than percentiles

C. Always use local weight/height/head circumference standards to ensure accuracy

D. Head circumference should be measured in all children aged <3 years

E. Weight should be accurately measured, wherever possible, rather than estimated
1. Which one of these statements regarding nutritional assessment is NOT correct?

Answer:

• C. Always use local weight/height/head circumference standards to ensure accuracy.

• This statement is not correct because locally developed growth charts are less acceptable for use. Growth charts based on large databases (such as those developed by the WHO and CDC) are the most accurate.
2. Which of these parameters must be evaluated as part of the nutritional assessment? *(Select all that apply)*

A. Period of poor intake/nil-per-mouth

B. Period of diarrhoea

C. Patient’s head circumference for age <3 year old

D. Patient’s age

E. All of above
2. Which of these parameters must be evaluated as part of the nutritional assessment?

Answer:

E. All of above
3. When should a nutritional assessment be conducted on a newly admitted PICU patient?

A. On admission
B. Within 24–48 hours of admission
C. Within 72 hours of admission
D. Within 7 days of admission
3. When should a nutritional assessment be conducted on a newly admitted PICU patient?

Answer:

B. Within 24–48 hours of admission

The Asia Pacific – Middle East Consensus Working Group on Nutrition Therapy in the Paediatric Critical Care Environment recommends that accurate nutritional assessments of the patient must be carried out within 24–48 hours of admission to the PICU, to enable the correct prescription and initiation of nutritional therapy. Conducting the assessment at 7 days and even within 72 hours are not soon enough. However, it may not be possible or practical to conduct nutritional assessments immediately on admission, if the appropriate staff are not available at that time, or if the patient requires urgent treatment.
Test your knowledge

4. Once the patient's nutritional goals have been achieved, how often thereafter should they be weighed?

A. At least weekly
B. Every day
C. Every 12 hours
D. Every 48 hours
E. Once a month
4. Once the patient’s nutritional goals have been achieved, how often thereafter should they be weighed?

• Answer:
  
  A. At least weekly

The Asia Pacific – Middle East Consensus Working Group on Nutrition Therapy in the Paediatric Critical Care Environment recommends that regular reassessment will show how the patient is responding to the prescribed nutrition, so that any required modifications to the feed can be made timeously. The group recommended that weight should be measured at least weekly during the PICU stay.
Test your knowledge

5. Which of the scores below indicates that the patient has malnutrition?

A. Weight z-score = 1.1
B. Weight z-score = 0.5
C. Weight z-score = -2.5
D. Weight z-score = 1.9
E. Weight z-score = -0.9
5. Which of these scores below indicates that the patient has malnutrition?

• Answer:
  C. Weight z-score = -2.5

• Recommendations for recognising and defining malnutrition in paediatric patients according to z-scores have been developed by a multidisciplinary task force appointed by the American Society of Parenteral and Enteral Nutrition (A.S.P.E.N.). A weight z-score of ≤-1 indicates that the patient has mild malnutrition or is at risk of malnutrition. A weight z-score of between -2 and -3 indicates that the child has moderate malnutrition.
Test your knowledge

Which of these statements with regards to use of serum biomarkers in nutritional assessment is true?

A. Serum biomarkers are a sensitive indicator of nutritional status
B. Serum biomarkers should be interpreted with caution, and always in the context of other factors
C. Albumin is a suitable marker for determining acute nutritional status
D. Nutritional assessment of a patient is incomplete without serum biomarker values obtained on admission to PICU
6. Which of these statements with regards to use of serum biomarkers in nutritional assessment is true?

Answer:

B. Serum biomarkers should be interpreted with caution, and always in the context of other factors.

Serum biomarkers can be affected by many variables. Therefore, they rarely offer a direct measure of a patient’s nutritional status and should be interpreted in the context of other factors such as nature of illness, other comorbidities, and anthropometry. The Asia Pacific – Middle East Consensus Working Group on Nutrition Therapy in the Paediatric Critical Care Environment recommends that is preferable to evaluate changes in serial serum biomarker measurements over time to indicate changes in the patient’s status, rather than basing conclusions on absolute values taken at one time point.
Test your knowledge

A positive nitrogen balance indicates:

A. Catabolism
B. Anabolism
C. Acute phase
D. Lean tissue loss
6. A positive nitrogen balance indicates:

- Answer:
  B. Anabolism

- Nitrogen balance is the most direct measurement of the patient’s protein status, and is obtained by comparing nitrogen input and output. A 24-hour urine collection is tested for urea (or, preferably, total nitrogen) content. A positive nitrogen balance (when the nitrogen input is greater than the output) indicates anabolism (synthesis). A negative nitrogen balance, usually observed during the acute phase, indicates catabolism (breakdown) and lean tissue loss.