Bedside Assessment of Nutritional Status of Patients

Shah Md. Keramat Ali and Md. Muazzem Hossain, Institute of Nutrition and Food Science
University of Dhaka. Bangladesh.

Introduction

Many of our hospitalized patients are suffering from malnutrition. The risk of death and severity of the disease of these patients are high. It was demonstrated that a relatively high degree of previously unrecognised malnourished children and adults are admitted to the hospital [1 & 2]. A 50% prevalence of protein energy malnutrition was found in Surgical patients.[3] Clinical studies have demonstrated a higher prevalence of morbidity and mortality in malnourished patients. It has come to realization that new therapeutic agents and sophisticated technologies available for the treatment of complex medical and surgical problems are not effective unless the adequate nutrition is maintained. Because energy, protein and other nutrients as well as oxygen, fluid and electrolytes are essential to support metabolism.

Nutritional screening will identify those who are at increased risk for malnutrition. Moreover the screening will help physician to workout the dosage, duration and frequency of treatment. This will also help to assess the prognosis of disease of the malnourished individuals.

Factors that appear and/or increase malnutrition

1. Abnormal weight patterns
a. Children's weight for height outside the normal range b. Adults 20% above or 10% below desirable weight
c. Recently 10% weight loss

2. Any condition characterised by insufficient intake of energy and nutrients.
a. Impaired ability to chew, swallow, taste or smell food b. Diet with multiple restriction in types of food and/or levels of nutrients; for example, clear liquid, extremely low protein diets. c. Nothing by months, or use of intragastric feedings for more than 10 days or more. d. Patients cannot eat or food supply stopped 3 days or more. e. Two weeks or more stay in the Hospital.

3. Admission into the Hospital for surgery, any bleeding disease, burning or wound in 6 months age.

4. Increased nutritional needs.
a. Pregnancy, malabsorption, diarrhoea, postoperative states, fever, sepsis, etc.
b. Continued external losses of bodily constitutents, draining wounds, chronic haemorrhage, chronic dialysis, cancer.

5. Drug therapy that interferes with nutrient utilization.

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6. Conditions characterized by abnormal levels of haemoglobin, haematocrit, lymphocytes, serum albumin, serum transferrin, cholesterol, blood urea nitrogen, etc.

Nutritional history of the patients should be collected immediately after the admission into the hospitals with special attention to food intake or food habit of previous 6 months, liking and disliking of foods, economic conditions, present caloric requirement including attention to food aversions, intolerances, allergies, and any difficulty with chewing and swallowing or any nausea, vomiting, bloating, diarrhoea, or steatorrhoea. When patients are hospitalised teaching on nutrition and disease can be effectively given as they are very close to the physician, dietitian and nurse. On admission into the hospital- the following criteria should be known:

1. Present illness, chief complaints, especially those relating to nutrition. 2. Digestion: anorexia, vomiting, distension, cramps. 3. Food likes and dislikes, food intolerance, food allergies. 4. Attitudes towards food, food and nutrition beliefs. 5. Previous dietary restrictions, reasons for, type, how long, responses to, modified diet.

Methods of determination of the nutritional status of the patients are-

(A) Anthropometric measurements.

(1) Weight (2) Height (3) Skinfold thickness (4) Arm muscle circumference (5) Arm muscle area

(B) Biochemical measurements.

(1) Haemoglobin (2) Haematacrit (3) Serum transferrin (4) Albumin (5) Total lymphocyte (6) 24-hours Nitrogen excretion (7) Skin test reactivity to common recall antigens.

(C) Additional measurement

(1) 24-hours Urinary creatinine excretion (2) Thyroxin binding protein (3) Rational binding protein.
(4) Lymphocyte response to phytohaemoglutinin (5) Total iron binding capacity.

Height and Weight : The height and weight of each patient should be obtained on admission and recorded in the history sheets. If the patient is unable to stand, a chair or bed scale can be used to obtain the weight. In many instances adults patients are able to report their heights within fair degree of accuracy. There are two way by which weight should be obtained:--

(I) Percentage of standard weight (2) Standard weight, or ideal weight

Weight can be measured properly in the following manner:

I. Use a beam balance scale, not a spring scale, whenever possible. 2. Periodically calibrate the scale for accuracy, using know one in. 3. The patient should be weighed in light clothing without shoes. 4. Record weight to the nearest 1/2 lb or 0.2 kg for adults and 25 lb or 0.1 kg for infant.

Height is a more technically difficult measurement to make than body weight, but it is more or less constant from day to day, so interpretation is easier.

Height can be measured properly in the following manner:

1. The person/patient should be barefoot or weaning only socks or stockings.

2. The patients feet should be together with the heels against the wall or measuring board.

3. The patient should be erect, neither shimped nor stretching, looking straight ahead, without tipping the head up or down. The top of the ear and outer corner of the eye should be in a line parallel to the floor called the Frankfort plane.

4. A horizontal bar, a rectangular block of wood, or the top of the stationmeter then should be lowered to touch the sclap
5. Read the height to the nearest inch or 0.5 cm.

In 1969 Metropolitan Life Insurance Co. established standard weight for height without shoes. Ideal adult weight (kg) for Height, are shown in Table 1.

Table I *Ideal weight (kg) for height, Adults.*

	Male			Female		
cm.	Small Frame	Medium Frame	Large Frame	Small Frame	Medium Frame	Large Frame
142				41.8	45.0	49.5
143				42.3	45.3	49.8
144				42.8	45.6	50.1
145				43.2	45.9	50.5
146				43.7	46.6	51.2
147				44.1	47.3	51.8
148				45.6	47.7	52.3
149				45.5	48.6	52.8
150				45.5	48.6	53.2
151				46.2	49.3	54.0
152				46.3	50.0	55.5
153				47.8	50.5	55.5
154				47.8	51.0	55.5
155	50.0	53.6	58.2	48.2	51.4	55.9
156	50.7	54.3	58.8	48.9	52.3	56.8
157	51.4	55.0	59.5	49.5	53.2	57.7
158	51.8	55.5	60.0	50.0	53.6	58.3
159	52.2	56.0	60.5	50.5	54.0	58.9
160	52.7	56.4	60.9	50.9	54.5	59.5
161	53.3	56.8	61.5	51.5	55.3	60.1
162	53.7	57.3	62.1	52.1	56.1	60.7
163	54.1	57.7	62.7	52.7	56.8	61.4
164	55.0	58.5	63.4	53.6	57.7	62.3
165	55.9	59.5	64.1	54.5	58.6	63.2
166	56.5	60.1	64.8	55.1	59.2	63.8
167	57.1	60.7	65.5	55.7	59.8	64.4
168	57.7	61.4	66.4	56.4	60.5	65.0
169	58.6	62.3	67.6	57.3	61.4	65.9
170	59.5	63.2	68.6	58.2	62.2	66.8
171	60.1	63.8	69.2	58.8	62.8	67.4
172	60.7	64.4	69.8	59.4	63.4	68.0
173	61.4	65.0	70.5	60.0	64.1	68.6
174	62.3	65.9	71.4	60.9	65.0	69.8
175	63.2	66.8	72.3	61.8	65.9	70.9
176	63.8	67.5	72.9	62.4	66.5	71.7
177	64.4	68.5	73.5	63.0	67.1	72.5
178	65.0	69.0	74.1	63.6	67.7	73.2
179	65.9	69.9	75.3	64.5	68.6	74.1
180	66.8	70.9	76.4	65.5	69.5	70.0
181	67.4	71.7	77.1	66.1	70.1	75.6
182	68.0	72.5	77.8	66.7	70.7	76.2
183	68.6	73.2	78.6	67.3	71.4	76.8
184	69.8	74.1	79.8			
185	70.9	75.0	80.9			
186	71.5	75.8	81.7			
187	72.1	76.6	82.5			
188	72.7	77.3	83.2			
189	73.3	78.0	83.8			
190	73.9	78.7	84.4			
191	74.5	79.5	85.0			

Body Frame Size: Body frame may be small, medium, or large. To determine ideal body weight-body frame size is needed. Frame size is calculated from the height to wrist circumference ratio. The wrist circumference is measured with a flexible steel tape just distal to the styloid process at the wrist crease on the right arm[4] . The formula for calculated body frame size is :

$$\text{Frame (r)} = \frac{\text{Height (cm)}}{\text{Wrist circumference (cm)}}$$

Frame size can be estimated as follows :

	Males	Females
Small	r > 10.4	r > 11.0
Midium	r = 9.6–10.4	r > 10.1–11.0
Large	r < 9.6	r < 10.1

Body size may also be estimated by the following method. The person/patient's right arm is extended forward perpendicular to the body with the arm bent the angle at the elbow form 90° with the fingers pointed up and the palm turned away from the body. The greatest breadth across the elbow joint is measured with a sliding caliper along the axis of the upper arm, on the two prominent bones on either side of the elbow. This is recorded as the elbow breadth.

In 1983 Metropolitan Life Insurance Co. established the following table, which gives the elbow breadth measurements for medium framed men and women of varies height. Measurement lower than those listed indicate a small frame size and higher measurement indicate a large frame size.

Table II *Body frame Size in relation to height.*

Men		Women	
Ht. in 2.5cm. Heels	Elbow Breadth in cm.	Ht. in 2.5cm.Heels	Elbow Breadth in cm.
155--157.5	6.25--9.19	145--147.5	5.63--6.25
160--167.5	6.56--7.19	150--157.5	5.63--6.25
177.5	6.88--7.5	160--167.5	5.94--6.56
180--187.5	6.88--7.8	170--177.5	5.94--6.56
190	7.19--8.13	180	6.25--6.88

Source: Metropolitan Life Insurance Co., 1983.

Following methods also may be used to determine the ideal body weight: According to American Diabetes Association (9).

For Male : First five feet (150 cm) height-weight is 106 lbs (48.1 kg): for additional each inch (2.5 cm), weight to be added is 6 lbs (2.72 kg).

For Female : First 5 feet(150 cm) height, weight is 100 lbs (45.45 kg): for additional each inch (2.54 cm) weight to be added is 5 lbs (2. 27 kg).

Example.

(A) A 25 year old male doctor's Ht. is 5' and 7" what is his ideal wt. ? Ans.

For male

1st. 5 ft. Ht. = Wt. is 106 lbs. and additional each inch Ht. = Wt. is 6 lbs.

Ht. - 5'7" then = (106 + 7 X 6) lbs
= (106 + 42) = 148 lbs.

(B) A 25 years old female doctor's Ht. is 5 feet 2 inch find the ideal body wt.

Ans. For female 1st 5' Ht.= Wt. is 100 lbs.

Additional each inch=Wt. is 5 lbs.

5'2" Ht. = (100 + 2 X 5) lbs.
= (100 + 10) lbs = 110 lbs.

Because of the different body size at the same age,from the ideal body wt. deduct 10% for small and add 10% for large body frame.

II. Body Mass Index(BMI).

Ideal body weight also can be measured from body mass index (BMI). For calculating BMI, body weight should be in kg and height should be in meter. This index

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

A BMI greater than 27 is obesity in either sex. For male BMI is 20-25 and for female 19-23. Ideal BMI for male is 22.1 and for female is 20.6.

So, Ideal body weight calculated from the above equation- $Ht.^2$ (in meter) multiply by body mass index.

Ideal body wt. (IBW) = $Ht.^2$ (Meter) X BMI.

Further-

Percent body meass index (PBMI) is calculated as follows [5].

$$PBMI = \frac{BMI}{\text{Standard BMI}} \times 100$$

Standard BMI = 22.1 for male and 20.6 for female.

PBMI 80 = Malnutrition

PBMI = 80-120 = Normal.

PBMI 121- 13= obese

PBMI 140 = severe obese (very obese)

Previous 3 months if there is 10% weight loss then malnutrition arise and when 30% weight loss than standard weight-then patient's condition is serious.

Example.

(A) A male ht. is 1.6m. What is ideal Wt. ?
Ans. Ideal weight = Ht^2 X BMI

$= 1.6^2 \times 22.1 = 56.58kg$
Lower Wt. = $(1.6^2 \times 20) = 51.0kg$. Higher Wt. = $(1.6^2 \times 25) = 64.0kg$.

(B) In the same way, the Ht. of a female is 1.45m. What is her idealWt. ?

Ans. Ideal wt. = $(1.45)^2 \times 20.6 = 43.3$ Kg.
Lower Wt. = $(1.45)^2 \times 19 = 40.0kg$
Higher Wt. = $(1.45)^2 \times 23 = 48.3kg$

Skin Fold Thickness:

Skinfold thickness is a measurement to determine the subcutaneous fat present in the body. The measurement is usually taken over the triceps or biceps muscle, below the scapula (subscapular) or above the iliacrest (suprailiac), although other sites can be used. It is generally agreed that the triceps measurement is the most useful method.

(a) Triceps skinfold thickness (TSF):

By TSF we determine the body fat store. At the dorsal midpoint of the arms hanging relaxed, the TSF is measured to the nearest 10th of a millimeter with a Lange skinfold Caliper having a pressure of $10g/mm^2$ of contact surface area. If the patient lie in the bed the measurement can be taken with the forearms comfortably folded across the chest[4] (Grant 1980). The skinfold thickness is grasped between the left index point and the thumb immediately above the dorsal midpoint and should include skin and subcutaneous fat but not muscle.

Standard Triceps skinfold thickness are given in the following Table.

Table III. *Standard Triceps Skinfold.*

Triceps Skinfold in mm.	Standard	90% of std.	80% of std.	70% of std.	60% of std.
Male	11	10	9	8	7
Female	19	17	15	13	11

Accordiding to Bistrain[6] :
80% triceps skinfold thicknessmeans small amount of fat loss
70% ,, ,, ,, mildy fat loss
60% ,, ,, ,, severely fat loss

(b) From Biceps, Triceps, Subscapular thickness, we determine the body density and fat percentage of the body weight.

Table IV *(a) Body density and total fat percentage from skinfold thickness.*

	ADULT			
Total skinfold thickness in mm.	Body density		Total fat in the body	
	Male	Female	Male	Femal
25	1.07	1.05	12.0	18.0
30	1.06	1.05	13.5	20.5
35	1.06	1.04	13.5	23.0
40	1.05	1.04	17.0	24.5
50	1.05	1.03	20.0	28.0
55	1.05	1.03	21.0	29.5
60	1.04	1.02	22.0	30.5
65	1.04	1.02	23.0	32.0
70	1.04	1.02	24.0	33.0
75	1.04	1.02	25.0	34.0
80	1.04	1.02	25.5	35.0
85	1.03	1.01	26.5	36.0
90	1.03	1.01	27.0	36.5
95	1.03	1.01	28.0	37.0
100	1.03	1.01	28.5	38.0

Table IV *(b). For children (13-15 years)*

Total skinfold Thickness in mm.	Total fat in kg.	
	Boys	Girls
15	9.0	12.5
20	12.5	10.0
25	15.5	19.9
30	17.5	19.4
35	19.5	23.5
40	21.5	25.0
45	23.0	27.0
50	24.0	28.5
55	25.5	29.5
60	26.5	30.5
65	27.5	32.5
70	28.5	33.0
75	29.5	34.0

Arm Muscle circumference (AMC)

AMC is used to estimate muscle mass, bone size, and subcutaneous fat. AMC is measured at the mid point of the back of the upper right arm between the acrominal process of the scapula and the olecranon of the ulna. The

subject's forearm is positioned against his or her body perpendicular to the upper arm, the midpoint is measured with a flexible steel tape.

The arm muscle circumference can be calculated from the arm circumference and tricep skinfold (TSP) using the following equation. AMC (in mm) = Arm Circumference (mm)–0.314(0.314 is the value of pie)(π) X triceps skinfold thickness (mm).

Example.A man whose TSF is 11, Arm circumference is 170 mm, calculate the AMC

AMC = AC – 0. 314 X TSF = 270 – (0. 314 X 11) = 266.5

Table V *Standard Arm Muscle Circumference :*

Sex	Standard	90% of std.	80% of std.	70% of std.	60% of std.
Male	270	243	216	189	102
Female	130	192	170	149	128

80% of standard means small protein destruction

70% of Std. means mildy protein destruction
60% of Std. means severely protein destruction

Note : Weight must be taken 3 times per week and other anthropometric measurement taken within 21-30 days.

Biological Measurements

By measurement of serum albumin, serum transferrin we determine the availability of protein (amino acids and nitrogen) which support the metabolic activity of liver cells and the cells of the gastrointestinal tract, pancreas, and other visceral tissues with a high degree of mitotic activity. The total lymphocyte count and recall antigen testing are also indicating the visceral protein status.

I Serum albumin

In 1979 Blackburn states that when serum albumin level is 3.0 gm-3.5 gm per deciliter, which is associated with mild visceral protein depletion, and 2.1 gm-3.0 gm per deciliter is associated with severe protein depletion.

In 1980 Grant states that when serum albumin level is 2.8 gm-2.5 gm per deciliter indicating mild protein depletion and 2.1 gm-2. 7gm per deciliter indicating moderate protein depletion.

Because of the slow repletion of serum albumin the recommended interval for the follow-up of serum albumin in every 10-14 days.

It was shown that serum albumin usually depressed during stress-surgical, septic, or traumatic state. In the chronically ill patient-severely depressed level occur in those with advanced hepatic cirrhosis, renal failure, and cardiac failure.

II Haemoglobin (Hb)

An healthy human body contain approximate 4.0 gm (<5.0 gms) iron. Approximately 70% of this iron found in the haemoglobin. There is a normal level of haemoglobin (Hb) in the body. The level of Hb is decreased due to deficiency of iron.

Men had haemoglobin levels of 11.9. per dl. at 1 year age. The levels increased to 15.8 gm/dl at 18 to 19 years and remained relatively constant until the later ages, declining only slightly to 15.3 gm/dl at 65-74 years.

According to WHO[7] Hb levels at different ages and different stage of life:

Table VI *Haemoglobin level at different Stages.*

Age	Hb/dl blood
Upto 6 years	11 gm.
6 -- 14 years	12 gm.
Audult, Male	13 gm.
Audult, Female (non preg.)	12 gm.
Pregnant Women	11 gm.

When the Hb. levels is lower than this level then nutritional anaemia may be diagnosed.

III Serum transferrin

Serum transferring may be measured directly in the laboratory or calculate from the total iron-binding capacity (TIBC). The equation is:
Serum transferring = (O.8 X TIBC) – 43

The normal concentration of serum transferring is 250 mg-300 mg/dl (Grant, 1980).

In 1980, Grant also states that when the serum transferrin value is 150 mg/dl that indicates mild visceral protein depletion and when 100 mg-150 gm/dl that indicate moderate depletion and when any value<100 mg/dl indicate severe depletion.

Through thyroid-binding prealbumin and retinol-binding protein (RBP) also assess the protein status. Because retinol binding protein has a half-life of 10 hours, is probably the most sensitive indicator of visceral protein depletion[4]

IV 24-hours Nitrogen excretion (N_2 balance)

Approximately 85% of the intake nitrogen is excreted through urine daily. Nitrogen balance can be estimated from the nitrogen intake compared to the urinary urea nitrogen excretion for 24 hours.

Nitrogen can also be excrete through feces. For this reason to cover other daily nitrogen losses from the body a factor of 2 gm of nitrogen is added to the value for urea nitrogen.

The equation used to calculate nitrogen balance is:

$$\text{Nitrogen intake (gm)} = \frac{\text{Protein intake (gm)}}{6.25}$$

$$\pm \text{ Nitrogen Balance} = \frac{\text{Nitrogen intake (gm)}}{\text{Urinary urea nitrogen (gm)} + 2\text{gm}}$$

These are many disease which affect the nitrogen balance-such as protein urea, enteropathy, excessive dirainage from gastrointestinal fistula or abscesses.

V 24-hours Creatinine Excretion Analysis

Nutritional status of the patients may be determined by 24 hrs. creatinine excretion analysis. When skeletal muscle depletion is high then excretion of creatinine through urine fall. A healthy man and woman with normal kidney function excretes 23 mg and 18 mg creatinine per kg of body weight respectively.

In 1980, Grant introduced creatinine excretion index (CEI), using the equation:[4]

$$\text{Creatinine excretion index (CEI)} = \frac{\text{Actual 24-hr. creatinine excretion}}{\text{Predicted 24 hr. creatinine}}$$

By creatinine height index (CHI), we determine the lean body mass from the 24 hr creatinine:

$$\text{CHI} = \frac{\text{Actual urinary excretion X 100}}{\text{Ideal urinary excretion}}$$

Creatinine excretion value decline with age, and CHI declined by 20% by age 65-74 year.

The CHI in mild body cell mass depletion is 90% of normal, moderate is 60% to 90% and severe in 60%. The recommended follow-up assessment of CHI is in every 21 to 30 days.

VI Total lymphocyte count

Total lymphocyte count are also used to evaluate cellular immunity i.e. determine the nutritional status of the patients. Patients with PEM have low lymphocyte counts.

The normal total lymphocyte count is 2500 mm^3. The value for total lymphocytes in mm^3 can be derived by multiplying the total leucocyte count by the percentage of lymphocyte.

When total lymphocyte count between 1200-2000 mm^3 that indicates mild depression of immuno system; 800-1200 mm^3 indicating moderate and 800 mm^3 or less severe depression of the immune system these means that the nutritional status of the patients are mildly, moderately and severely malnourished.

VII Skin test with recall antigens

Skin tests with recall antigens are used to evaluate cellular immunity. Mumps, candids and streptokinase-streptodornase (SK-SD) etc. antigens are administered intradermally-if the induration is 5 mm or more in 24-28 hrs. after injections that means the nutritional status is good. In PEM no skin test reactivity.

Therefore it is shown that an immune competent person has a response (less than 5 mm induration at the site of intection) to two or more recall antigens-that means nutritional status of the patients in good.

A moderately malnourished patient responds to only one antigen, whereas a severely malnourished patient has no response to any antigens.

Depressed skin test reactivity has been observed when serum albumin is less than 3.0 g/dl or the percentage of ideal body is less than 85%.

VIII Haematocrit level

By the determination of haematocrit level of blood,nutritional status of the patients can be determined. The normal haematocrit[8] are shown in the following Table:

Table VI *Haematocrit level*

Age	Less than acceptable		
	Deficit	low	Acceptable
6 -- 23 months	28	28--30	31
2 -- 5 years	30	30--33	34
3 -- 12 years	30	30--35	36
13 -- 16 years	37	37--39	40
13 -- 16 years Females	31	31--35	36
16 yrs. Male	37	37--43	44
16 yrs, Female	31	31--37	38
Pregnant, 2nd. Trimester	30	30--34	35
Pregnant, 3rd. Trimester	30	30--32	33

Abbreviated Assessment Methods

Many investigators recommended abbreviated assessment-method to screen high risk patients.

(i) Patient's recent unintentional body wt. loss of 10 lbs or more, serum albumin level less than 3.4 g per deciliter, negative reaction to skin test antigens-which indicates nutritional depletion i.e. malnutrition. (ii) Patients serum albumin level less than 3 gm/dl, serum transferring level less than 250 mg/dl and no reaction to three antigens (i.e.-ve reactivity of skin test) which means patient's suffer from malnutrition. (iii) Serum level less than normal level and lower total lymphocyte counts[15] associated with increased morbidity and mortality.

So, when patients are admitted into hospital, the above test should be done routinely to check morbidity and mortality.

Discussion

Nutritional states assessment methods described in the text are specifically suitable for specific patients. While assessing the nutritional status special care should be taken for easy, quick, cheap methods. This will benifit the treatment schedule and will hasten recovery.

Summary

Therapeutic agents available for treatment of patient becomes highly effective if nutritional status of patient is adequately maintained.

Nutritional history of the patient should be obtained immediately after admission into the hospital. Weight, height, skinfold thickness, arm muscle circumference, are muscle area, haemoglobin, haematocrit, serum transferrin, sr. albumin, total lymphocyle, 24 hour nitrogen excretion and skin test reactivity to common recall antigens should be measured. Additional measurement like estimation of the patients 24 hours energy and nutrient intake during hospitalisation, 24 hours urinary creatinine excretion, thyroxinbinding protein, retinol binding protein, lymphocyte response to phytohaemoglutinine and total iron binding capacity are important.

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