Journal of Aging Research & Clinical Practice©
Volume 2, Number 4, 2013

USEFULNESS OF CLINICO-BIOLOGICAL INDICES IN THE ASSESSMENT OF MALNUTRITION AND ITS RELATED MORTALITY AND COMPLICATIONS RISKS IN ELDERLY PATIENTS

J. Abroug[1], O. Harzallah[1], M. Mahjoub[2], R. Klii[1], A. Sriha[4], F. Neffati[3], I. Hellara[3], S. El Mhamdi[4], A. Hamzaoui[1], H. Mribeh[5], H. Gamra[2], M.F. Najjar[3], M. Soussi Soltani[4], A. Kamel[6], I. Khochtali[1], S. Mahjoub[1]

Abstract: *Background:* To date, no standard is currently available for the assessment of malnutrition and its complications. Many tools are available but most of them are partially or not validated. *Objectives:* In this work we aimed to evaluate the nutritional state of elderly people meaning the MNA test and to assess the prognosis and mortality risk related to malnutrition in elderly patients. *Methods:* 662 patients (mean age: 73 years, sex ratio: 0.6) older than 65 years were included in this study. They were recruited either from primary (438 outpatients) than from tertiary healthcare centers (224 inpatients). Patient's nutritional state was evaluated by anthropometric parameters, by biological tests (albumin, transthyretin, orosomucoide and crp) and by MNA form. Prognostic indices (GNRI and PRI) were calculated for each patient in order to assess malnutrition related mortality and complications risks. *Results:* According to MNA test, 6.65% patients (44/662) were malnourished. Among these patients, albumin, transthyretrine and orosomucoide levels were decreased in respectively 52%, 62% and 89% of cases. The mean GNRI in malnourished elderly patients was 104 +/- 20. According to this index, malnutrition related risk of mortality and complications was major in 25%, moderate in 14.3% and low in 14.5% of cases. The PINI was on average at 33+/- 10. The malnutrition related-risk was appraised by PINI as low in 6.5%, moderate in 12.7% and high in 7% of cases and the vital prognosis was engaged in 35% of malnourished patients. *Conclusion:* Our study showed that clinico-biological indices are a good tool for the assessment of nutritional status and malnutrition's complications in elderly patients.

Key words: Malnutrition, elderly patients, clinic-biological indices, prognosis.

Introduction

Malnutrition in elderly patients is particularly frequent and represents a real worldwide public health problem.

Many factors could explain the high prevalence of malnutrition in elderly people: physiological changes related to ageing, the decrease of food intake, intercurrent diseases, polymedication and psycho-sociological factors.

As reported by recent European and American epidemiological studies (1, 2), the prevalence of malnutrition is clearly higher in hospitalized (30 – 65%) than in ambulatory (4 – 10%) or institutionalized patients (15 - 38%).

Malnutrition screening in elderly people is quite difficult: many clinical and biological tools are available but most of them are partially or not validated. According to the French "Haute Autorité de Santé" (HAS), malnutrition in an elderly patient is defined as a body mass index (BMI) below 21 kg/m2, a weight loss more than 5% in one month or than 10% in 6 months, an albumin level below 35 g/l or a mini nutritional assessment (MNA) score below 17 (3).

The MNA is a clinical form especially designed by Guigoz and Vellas in 1998, to screen malnutrition in the elderly (4).

Severe malnutrition is defined by the presence of at least one of these criteria: a weight loss more than 10% in a month or than 15% in 6 months, a body mass index below 18 kg/m2 or an albuminemia below 30 g/l (3).

A severe undernourishment is associated in elderly people to a significant increase in morbidities and overall mortality (5, 6). Geriatric Nutritional Risk Index (GNRI)

1. Internal Medicine and Endocrinology department. Fattouma Bourguiba University Hospital Monastir; 2. Cardiology A department. Fattouma Bourguiba University Hospital Monastir; 3. Biochemistry department. Fattouma Bourguiba University Hospital Monastir; 4. Preventive Medicine and Epidemiology Department. Fattouma Bourguiba University Hospital Monastir; 5. Pulmonology department. Fattouma Bourguiba University Hospital Monastir

Corresponding Author: Olfa Harzallah MD, Internal Medicine and Endocrinology department. Fattouma Bourguiba University Hospital Monastir, Tunisia. E-mail : harzallaholfa@yahoo.fr, tel : (00216) 23280348, Fax: 00 216 73 460 678

Received July 3, 2013
Accepted for publication July 8, 2013

and Prognostic Inflammatory Nutritional Index (PINI) are clinic-biological prognostic indices used to appreciate mortality and complications risks related to malnutrition in elderly (7, 8).

In this work, we aimed first to evaluate the nutritional state of elderly people meaning the MNA test, second to appreciate the prognosis and mortality risk related to malnutrition in elderly patients and finally to study the correlation between malnutrition related prognosis and biological parameters.

Methods

We prospectively enrolled, from February 2008 to August 2010, 662 elderly patients.

Patients older than 65 years were included in this study. They were recruited either from primary (438 outpatients) than from tertiary healthcare centers (224 inpatients).

Tertiary healthcare centers were 3 university departments randomly selected:internal medicine, cardiology and pulmonology departments.

Demographic and clinical data were, first, collected for each patient. Then, patient's nutritional state was evaluated by anthropometric parameters, by biological tests and by MNA form. Finally prognostic indices (GNRI and PRI) were calculated for each patient in order to assess malnutrition related mortality and complications.

Evaluation of nutritional state

Anthropometric parameters

Weight, BMI and calf circumference were determined for each patient.

Calf circumference is measured perpendicularly to the leg axis at its widest point. A calf width below 31 cm signs a decrease in the muscular mass.

MNA test

The MNA test, validated by Guigoz et al (4), in order to identify patients having or at risk of malnutrition in elderly patients, comprises a short (MNA-SF) and a complete form (MNA). The complete form is filled only if the MNA-SF score is ≤11.

The MNA test includes 18 items focusing on four 4 distinct topics: an anthropometric evaluation, a global evaluation dealing with daily life conditions of elderly patient, a dietetic evaluation and a patient subjective auto-evaluation of his nutritional state. The MNA score maximum points is 30. The malnutrition risk is stratified according to MNA score as follows: MNA ≥ 24 points: Absence of malnutrition. 17 ≤ MNA ≤ 23.5 points: risk of malnutrition. <17 points: Malnutrition.

Biological tests

Albumin, transthyretin, orosomucoide and CRP levels were measured for malnourished patients (MNA complete form ≤ 17).

Nutritional state of patients was classified:

- According to albumin level as follows:
  . Albumin > 35 g/l: normal
  . 30 <albumin<35 g/l: Malnutrition
  . < 30 g/l: severe malnutrition
- According to transthyretrin level as follows:
  . > 180 mg/l : normal
  . 150 < transthyretrin < 180 mg/l : malnutrition
  . 110 < transthyretrin < 150 mg/l : moderate malnutrition
  . < 110 mg/l : severe malnutrition
- According to orosomucoide :
  . > 2.2 mg/l: normal
  . 2 < orosomucoide < 2.2 mg/l: malnutrition
  . < 2 mg/l : severe malnutrition

Evaluation of malnutrition complications and morbi-mortality

Complications and morbi-mortality risks related to malnutrition were assessed, in our patients, meaning two clinico-biological indices: the Geriatric Nutritional Risk Index (GNRI) and the Prognostic Inflammatory Nutritional Index (PINI).

The GNRI is calculated according to the following formula: GNRI = [1,519 x albumin (g/l) + 41.7 x present weight/ ideal weight*] (9)

*Ideal weight was calculated from the Lorentz equations as follows:

. For men: H* – 100 - [(H – 150)/4] (10)

. For women: H* – 100 - [(H – 150)/2.5] (11)

*H: height

Nutrition-related risk (complications and mortality) was stratified according to GNRI as follows:

- GNRI < 82 : Major
- 82 < GNRI < 92 : Moderate
- 92 < GNRI < 98 : Low
- GNRI > 98 : Absent

The PINI index is calculated as follows (12): [CRP×Orosomucoide) / (Albumin ×Transtthyretin]

Malnutrition risk and complications are predicted, according to PINI, as follows:

- PINI < 1 : no risk
- 1 < PINI < 10 : low risk
- 11 < PINI < 20 : moderate risk
- 21 < PINI < 30 : high risk
- PINI > 30 : vital risk

Statistical analysis

Univariate analysis was conducted using Student's t-tests for continuous variables and $\chi 2$ for categorical variables.

Relationships among parameters were determined using Pearson correlation analysis.

The p-value less than 0.05, was considered to be significant. Our study's data were collected and analyzed using the 17th version of Statistical Package for the Social Sciences (SPSS) Software.

Ethical approval

This study was approved by the Human Research Ethics Committee of our institution. All patients were enrolled after they gave an informed and written consent.

Results

662 patients (mean age: 73 years, sex ratio: 0.6) were prospectively included in this study. Their mean weight was 71 kg (26 – 150 kg). The BMI was below 21 kg/m2 in 8% of them (53/662) and nearly the third of patients (30%) had a calf circumference under 31 cm. The mean MNA-SF score was 11.6 points (3 – 15 points). The complete form was filled (MNA-SF ≤ 11 points) in only the third of patients (223/662) and the corresponding score was below or equal to 17 points in 44 patients. So, malnutrition was diagnosed in 44/662 patients according to the MNA score. Their main demographic and clinical characteristics are summarized in table 1.

Table 1
Baseline characteristics of malnourished patients (according to the MNA score)

Characteristic	Frequency (%) n =44
Mean age (years)	77 ± 7.5
Sex ratio	0.7 (18/26)
Marital status	
Married	25.6
Single	74.4
Healthcare structure	
Primary (outpatients)	25
Tertiary (inpatients)	75
Previous medical history	
Yes	75
No	25
BMI	
< 21 kg/m²	25
< 18 kg/m²	6.8
Calf circumference	
<31 cm	59
≥ 31 cm	41

The mean age of malnourished patients was 77 +/- 7.5 years. Females were more represented (60% cases). Malnourished patients were single in ¾ of cases. Inpatients seem to be three times more exposed to malnutrition than outpatients.

According to the MNA, 14.7% inpatients and 2.5% outpatients were malnourished.

A BMI below 21 kg/m2 was found in ¼ of patients and only 6.8% of patients had a BMI below 18 kg/m2. The muscular mass was decreased in 59% of patients as attested by a calf circumference below 31 cm.

Biological dosages were performed in malnourished patients (44 patients). Their results are illustrated in table 2.

According to albumin, transthyretrine and to orosomucoide levels, the 44 patients were considered as malnourished in respectively 52%, 62 and 89% of patients.

Malnutrition was appraised as severe in 18%, 27% and 80% of cases respectively by albumin, transthyretrin and orosomucoide levels.

The C-reactive protein was higher than 50 mg/l in 27% of malnourished patients.

Results of the evaluation of malnutrition related-risks by GNRI and PINI indices are represented in table 3.

The mean GNRI in malnourished elderly patients was 104 +/- 20. According to this index, malnutrition related risk of mortality and complications was major in 25%, moderate in 14.3% and low in 14.5% of cases.

The PINI was on average at 33+/- 10. The malnutrition related-risk was appraised by PINI as low in 6.5%, moderate in 12.7% and high in 7% of cases. According to this index, the vital prognosis was engaged in 35% of malnourished patients.

Analysis of correlation between malnutrition clinical indices and biochemical parameters is represented on table 4.

PINI was significantly correlated to all biochemical parameters (albumin, Transthyretin, Orosomucoide and CRP) whereas GNRI was significantly correlated only to albumin and transthyretin.

Discussion

Malnutrition screening in elderly people is quite difficult: many clinical and biological tools are available but most of them are partially or not validated (13). So, to date, no standard is currently available for the assessment of malnutrition.

Both the European Society of Parenteral and Enteral Nutrition (ESPEN) guidelines and the French Programme National Nutrition Santé (PNNS) recommend the use of the Mini Nutritional Assessment (MNA) to detect the risk of malnutrition among elderly subjects (14, 15). The MNA is based on a questionnaire and doesn't use any biological indicators. A MNA score below 17 points

Table 2
Evaluation of patient's nutritional status according to biological parameters

	Mean levels +/- SD	Patient's nutritional state according to biological parameters	(% of patients)
Albumin (g/l)	35.61± 7.13	Normal (> 35 g/l)	48
		Malnutrition (30 g/l <albumin<35g/l)	34
		Severe malnutrition (albumin <30g/l)	18
Transthyretin (mg/l)	150 ± 65	Normal (> 180 mg/l)	38
		Malnutrition (150 < transthyretrin < 180 mg/l)	14
		Moderate malnutrition (110 < transthyretrin < 150 mg/l)	21
		Severe malnutrition (< 110 mg/l)	27
Orosomucoid (mg/l)	1,52 ± 0,52	Normal (> 2.2 mg/l)	11
		Malnutrition (2 < orosomucoide < 2.2 mg/l)	9
		Severe malnutrition (<2 mg/l)	80
CRP (mg/l)	62,36 ± 56,6	Severe inflammation (>50 mg/l)	27%

indicates a malnutrition state in elderly people (4).

Protein-energy malnutrition (PEM) is a common disorder in the elderly. Despite the obvious increase of the prevalence of elderly people in Tunisia, Tunisian studies evaluating nutritional state in elderly patients are lacking (16).

Table 3
Assessment of nutrition related risks meaning GNRI and PINI indices

	Mean +/- SD	Nutrition-related risk	Frequency (%)
GNRI	104 +/- 20	GNRI < 82 : Major	25
		82 < GNRI < 92 : Moderate	14.3
		92 < GNRI < 98 : Low	14.5
		>98 : no risk	46.2
PINI	33+/-10	<1 : no risk	38.7
		1 <PINI < 10 : low	6.5
		11 <PINI < 20 : moderate	12.7
		21 < PINI <30 : major	7
		>30 : vital risk	35

In our work, we found 7% of malnourished patients (44/662 patients). According to international studies, the prevalence of PEM varies significantly from 20 to 78% (17, 18, 19). These variations are due to diversity of clinical and/or biological methods used to define and assess malnutrition. The prevalence of malnutrition also differs if patients are hospitalized (30 – 65%), institutionalized (15 - 38%) or ambulatory (4 – 10%) (20, 21, 22).

Our population's study was mixed from 438 outpatients and (¾) and 224 (¼) inpatients and as previous studies, frequency of malnutrition was higher in inpatients (14.7%) than in outpatients (2.5%).

A Tunisian study, realized in 2007 in a tertiary Universitary hospital, found respectively 82.9% and 43.8% of malnutrition among elderly in-and outpatients (16).

Our patients had a BMI below 21 kg/m2 in 25% of cases. So, according to the French HAS, ¼ of our patients were malnourished. Malnutrition, according to the HAS, is defined either by a BMI < 21kg/ m2 or by a weight loss more than 5% in one month or than 10% in 6 months, an albumin level below 35 g/l or a mini nutritional assessment (MNA) score below 17 (3).

Table 4
Results of correlation study between prognostic indices and biochemical parameters

	Albumin (g/l)	Transthyretin (mg/l)	Orosomucoide (mg/l)	CRP (mg/l)
PINI	P < 0.0001	P = 0.023	P <0.0001	P < 0.0001
	r = 0.77	r = 0.83	r = 0.7	r = 0.71
GNRI	P <0.0001	P <0.0001	P = 0.46	P = 0.38
	r = 0.74	r = 0.51	r = -0.15	r = - 0.17

The MNA score was below 17 in 6.65% of patients. In more than the half of them (52%), the albumin level was below 35 g/l.

As stated above, malnutrition frequency seems to vary largely with the definition adopted.

In our patients, the MNA-SF was on average at 7 ±2. It was below 11 in the third of our patients (223/662) and in ¾ of Ranhoff's patients (23). Patients of Ranhoff, with a MNA-SF below 11, were frequent than ours probably because they were all hospitalized in contrary to our patients which ¾ of them were outpatients.

Nearly the half of Ranhoff's patients had a BMI < 23 Kg/m2. Ronhoff and al showed that sensitivity of MNA-SF and of BMI in malnutrition assessment in elderly hospitalized patients are respectively at 100% and 86% whereas their specificity were only at 36% and 71% (23). They finally recommend performing a MNA test in patients having a BMI below 23 Kg/m2. According to the definition of French HAS, malnutrition was severe in 6.8% of our patients which had a BMI below 18 kg/m2. However, the French HAS also defines malnutrition as a weight loss more than 10% in a month or than 15% in 6 months or an albuminemia below 30 g/l. Among the malnourished 44 patients –according to MNA test-, 18% had an albumin level below 30 g/l.

Serum albumin is the most commonly used biochemical marker since it can predict mortality in older people. However albumin is not only affected by nutritional state but also by other factors, such as inflammation, infection, hydration status etc … (24)

CRP was increased in only 27% of patients diagnosed as malnourished according to MNA. TTR and orosomucoide were respectively decreased in 62% and 89% of them. According to albumin and TTR, malnutrition was severe respectively in 18 and 27 % of elderly patients whereas orosomucoide allowed the diagnosis of severe malnutrition in 80% of cases (39/44).

No standard single biochemical marker is currently available for the assessment of malnutrition and its related risks in the elderly. That's why clinic-biological tool's use is recommended. These scores represent an objective way to assess nutritional state, to diagnose malnutrition and to depict patients with a poor prognosis (25-27).

The Prognostic Inflammatory Nutritional Index (PINI) is a prognostic index based on 4 biochemical parameters: CRP, orosomucoide, albumin and transtthyretin. PINI score predicts malnutrition related mortality in elderly people.

PINI index was first used in children (28) then in intensive care patients (29) and it is now more and more widely used: oncology (30, 31), haemodialysis (32) and acute respiratory failure patients (33).

The mean PINI score, calculated in the 44 malnourished patients, was at 33±10. According to this index, 36% of patients had a low malnutrition related mortality risk. This risk was moderate to high in 14% of cases and the vital prognosis was engaged in nearly the quarter (23%) of malnourished patients.

In our work, there was a correlation between this index and albumin, TTR and orosomucoide levels. Walsh, also found a correlation between the PINI and albumin, CRP and TTR levels in intensive care patients (34). In Devoto G work, there was a positive correlation between the PINI and TTR in patients hospitalized for malnutrition management (35).

Concerning the Geriatric Nutritional Risk Index (GNRI), it was on average at 104 ± 20 in our patients. According to this index, complications and mortality risks related to malnutrition were major, moderate and low in respectively 11.5%, 35% and 53.5% of cases.

The complications taken into account by the GNRI are infections and bedsores. GNRI also, as PINI, predict malnutrition related mortality in elderly patients (7, 36).

Malnutrition prognostic indices (PINI and GNRI) were correlated to albumin, TTR and to MNA test. Malnutrition related complications and mortality are well established.

In addition to the risk of increase in hospitalization's duration, malnutrition seems to be an additional and independent risk factor of nosocomial infections. It is well known that nosocomial infections are a negative indicator of healthcare quality.

Therefore, Raynard suggests that malnutrition screening and assessment could be a very interesting healthcare quality indicator (37). Hence, powerful screening, assessment and prognostic malnutrition indices seem mandatory.

Conclusion

As known, there isn't any standard biochemical marker for malnutrition screening and related risks evaluation. Our study showed that clinico-biological indices are a good tool for the assessment of nutritional status and malnutrition's complications in elderly patients. MNA test is a rapid way for screening undernourishment in elderly in and outpatients. Severity of malnutrition, its complication's risk and related mortality can be evaluated by PINI and GNRI.

References

1. Pirlich M, Lochs H. Nutrition in the elderly. Best Pract Res Clin Gastroenterol. 2001; 15(6): 869- 84
2. Blanquer M, Gareia-Alvarez A, Ribas-Barba L. How to find information on national food and nutrient consumption surveys across Europe: systematic litterature review and questionnaires to selected country experts are both good strategies. Br J Nutr.2009; 101(S2): S37-5
3. Haute Autorité de Santé (HAS): Recommandations professionnelles. Stratégie de prise en charge en cas de dénutrition protéino-énergétique chez la personne âgée. Médecine des maladies métaboliques. 2007; 12(67): 7
4. Vellas B, Guigoz Y, Garry PJ et al. The mini nutritional assessment (MNA) and the use in grading the nutritional state of elderly patients. Nutrition 1999; 15(2) : 116-22
5. Chapman IM. Nutritional disorders in the elderly. Med Clin North Am. 2006; 90: 887–907
6. Potter JF, Schafer DF, Bohi RL. In hospital mortality as a function of body mass index; an age dependant variable. J Gerontol. 1988;43: M59–M63
7. Bouillanne O, Morineau G, Dupont C. Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr 2005;82:777–83
8. Kudlackova M, Andel M, Hajkova H et al. Acute phase proteins and prognostic inflammatory and nutritional index (PINI) in moderately burned children aged up to 3 years. Burns 1990; 16 (1): 53- 6.
9. Pablo AM, Izaga MA, Alday LA. Assessment of nutritional status on hospital admission: nutritional scores. Eur J Clin Nutr 2003;57:824 –31
10. Füllöp T, Hermann F, Rapin H. Prognostic role of albumin and prealbumin levels in elderly patients at admission to a geriatric hospital. Arch Gerontol Geriatr 1991;12:31–9
11. Sullivan DH, Bopp MM, Roberson PK. Protein-energy undernutrition and life-threatening complications among the hospitalized elderly. J Gen Intern Med 2002;17:923–32
12. Carriere I, Dupuy AM, La croux A et al. Biomarkers of inflammation and malnutrition associated with early death in healthy elderly. J Am Geriatr Soc 2008; 56: 840-6
13. Harris D, Haboubi N. Malnutrition screening in the elderly population J R Soc Med 2005;98:411– 4
14. Kondrup J, Allison SP, Elia M et al. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003;22:415–21
15. Hasselmann M, Alix E. Tools and procedures for screening for malnutrition and its associated in risks in hospital. Nutr Clin Metabol 2003; 17: 218 –26
16. Lamloum H, Boukhis I, Ben Ghorbel I et al. Evaluation du statut nutritionnel d'une population âgée hospitalisée. Rev Med Int. 2007 (28) S83–S160: CA118
17. Sullivan DH, Bopp MM, Roberson PK. Protein-energy undernutrition and life-threatening complications among the hospitalized elderly. J Gen Intern Med 2002;17:923–32
18. Pablo AM, Izaga MA, Alday LA. Assessment of nutritional status on hospital admission: nutritional scores. Eur J Clin Nutr 2003; 57:824 –31
19. PerssonMD, Brismar KE, Katzarski KS et al. Nutritional status using mini nutritional assessment and subjective global assessment predict mortality in

geriatric patients. J Am Geriatr Soc 2002;50:1996 –2002
20. Leistra E, Neelemaat F, Evers AM. Prevalence of undernutrition in Dutch hospital outpatients. Eur J Int Med 2009; 20: 509-13
21. Neelmaat F, Kruizenga HM, De Vet HC. Malnutrition screening in hospital outpatients. Can the SNAQ malnutrition screening tool also be applied in this population ? Clin Nutr 2008; 27 : 439-46
22. Fanello S, Foucault S, Delbos V et al. Evaluation of nutritional status in hospitalized aged patients. Santé Publique 2000; 12 : 83 – 90
23. Ranhoff AH, Gjoen AU, Mowé M. Screening for malnutrition in elderly acute medical patients: the usefulness of MNA-SF. J Nutr Health Aging 2005; 9 (4): 221-5
24. Ballmer PE. Causes and mechanisms of hypoalbuminaemia. Clin Nutr 2001;20:271–3.
25. Bernard M, Aussel C, Cynober L. Markers of malnutrition or markers of the complications related to the malnutrition? Nutr Clin & Metab. 2007, (21): 52- 9
26. Tanvir A, Nadim H. Assessment and management of nutrition in older people and its importance to health. Clinical Interventions in Aging, 2010; 5: 207- 16
27. Persson MD, Brismar KE, Katzarski KS et al. Nutritional status using mini nutritional assessment and subjective global assessment predict mortality in geriatric patients. J Am Geriatr Soc. 2002, 50: 1996–2002.
28. Kudlackova M, Andel M, Hajkova H and al. Acute phase proteins and prognostic inflammatory and nutritional index (PINI) in moderately burned children aged up to 3 years. Burns 1990, 16 (1): 53-6
29. Denis L, Quinonez M. Nutritional assessment in intensive care unit. Nutr Clin & Metab. 2008, 22: 20-6
30. Nelson KA, Walsh D. The cancer anorexia-cachexia syndrome: a surgery of Prognostic Inflammatory and Nutritional Index (PINI) in advanced disease. J Pain Symptom Manage. 2002 Oct. 24 (4):424-8
31. Dupire S, Wemeau M, Debarri H et al. Prognostic value of PINI index in patients with multiple myeloma. Eur J Haematol. 2012; 88 (4): 306-13
32. Dessi M, Noce A, Agnoli A et al. The usefulness of the prognostic inflammatory and nutritional index (PINI) in haemodialysis population. Nutr Metab Cardiovasc Dis. 2009; 19 (11) : 811-5
33. Schlomasscher P, Hasselmann M, Meyer N et al. The prognostic value of nutritional and inflammatory indices in critically ill patients with acute respiratory failure. Clin Chem Lab Med. 2002 Dec; 40 (12): 1339-43
34. Walsh D, Mahmoud F, Barna B. Assessment of nutritional status and prognosis in advanced cancer: interleukin-6, C-reactive protein, and the prognostic and inflammatory nutritional index. Support Care Cancer. 2003; 11 (7): 494-5
35. Devoto G, Gallo F, Marchello C et al. Prealbumin serum concentrations as a useful tool in the assessment of malnutrition in hospitalized patients. Clin Chem. 2006; 52 (12): 2281-5
36. Park JH, Kim SB, Shin HS et al. Geriatric Nutritional Risk Index May Be a Significant Predictor of Mortality in Korean Hemodialysis Patients: A Single Center Study. Therapeutic Apheresis and Dialysis. 2012; 16 (2): 121-6
37. Raynard B. Organisation du dépistage de la dénutrition à l'hôpital Macesciverit te salutant (ceux qui vont maigrir te saluent). Nutr Clin & Metabo. 2006; 20: S22-S7