

INFLUENCE OF MACRONUTRIENTS INTAKE ON NITROGEN BALANCE IN CRITICALLY ILL PATIENTS

Safdar Ali Khan, Maryam Zahid, Shahab Naqvi, Muzaffar Kirmani, Sabeen khurshid Zaidi, Hafsa Khalil

Armed Forces Institute of Cardiology/National Institute of Heart Diseases Rawalpindi

ABSTRACT

Objective: To assess the frequency of positive nitrogen balance in cardiac surgical intensive care unit and correlating with critical illness and to find out the relationship between carbohydrates, protein and fat intake and nitrogen balance.

Study Design: Descriptive cross sectional study.

Place and Duration of Study: This study was conducted at AFIC/NIHD Rawalpindi from 1st July 2014 to Dec 2014.

Patient and Methods: Patients selected through purposive convenient sampling from adult intensive care unit of Armed Forces Institute of Cardiology & National Institute of Heart Diseases, Rawalpindi who had undergone any cardiac surgery (CABG or valve replacement). Demographic, clinical and nutritional data was collected. Nitrogen balance was obtained by subtracting nitrogen intake with nitrogen output.

Results: Out of 46 patients 33% of the patients have nitrogen balance within -2 to +2 (normal range) and 13% of the patients had more than +2 nitrogen balance. Thirty nine patients had SOFA score of <13 of when 49% of the patients had nitrogen balance -2 to +2 and >2 whereas 71% of the patients had with SOFA scores >13 were having negative nitrogen balance. Among patients with nitrogen balance -2 to +2 and > 2, 13 consumed calories > 60% , 81% consumed proteins > 60%, 43% consumed carbohydrates > 60% and 57% consumed fats > 60%

Conclusion: According to our study majority of the patients falling in group of nitrogen positive negative balance -2 to +2 (normal range) and >2 were consuming good protein, moderate fat and carbohydrate intake, and had < 50% of the mortality.

Keywords: Cardiac surgery, Intensive care, Nitrogen balance.

INTRODUCTION

The prevalence of protein energy malnutrition in patients in intensive care units is high. This is related to the severity of the metabolic derangements linked to the severity of the disease that induces an acute malnutrition, which is potentially worsened by inadequate nutrient supply¹.

The metabolic response to critical illness or injury has classically been discussed in two phases, the ebb and flow. In the first few hours to a couple of days after injury, the ebb phase is marked by hypometabolism and increases in the activity of the sympathetic nervous system. The flow phase of critical illness is characterized by hypermetabolism, proteolysis, gluconeogenesis and lipolysis. The excessive

protein catabolism occurs in critical illness which can results in negative nitrogen balance. Urinary nitrogen excretion can exceed 15-20 g/day. Nitrogen balance studies are commonly used in the critical care setting to determine the protein turnover and whether the patient is in a state of anabolism or catabolism². The amount of nitrogen in the diet and the amount of nitrogen excreted in the urine plus the small amount of nitrogen lost through the GI tract determines the overall nitrogen balance of the individual. A positive nitrogen balance means the body's structural proteins are rebuilding. A net negative balance occurs when the rate of protein breakdown exceeds the rate of protein synthesis³.

The combination of glucose with nitrogen containing nutrients improves nitrogen balance and allows more calories to be utilized for the restoration of nitrogen balance than would be the case if either nutrient group were used alone⁴.

Correspondence: Dr Safdar Ali Khan, Consultant Cardiac Anaesthesiologist, AFIC/NIHD, Rawalpindi
Email: sak1958@hotmail.com

PATIENTS AND METHOD

A cross sectional study was performed in the Intensive care unit of AFIC-NIHD. Demographic, clinical and nutritional characteristics were collected from patient records. Patients older than 18 years who were hospitalized in the ICU for at least 5 days, and who had undergone any cardiac surgery (CABG or valve replacement) were included. Patients who received Enteral or parenteral nutrition (TPN) or progressed to oral feeding were included in the research.

Patients with no urine output and creatinine clearance < 50 were also excluded⁵. Patients on Continuous renal replacement therapy/dialysis were also excluded. The extent of patients organ failure was determined by using severity organ failure assessment (SOFA) scoring system⁹.

Mean weight 68 kg (35-99 kg), mean height 165 cm (145-186) and mean age 54(19-74 yrs). Post operative days on which urine sample for urea urinary nitrogen test was collected ranged from 5-69. 32 patients were operated for CABG, 5 for AVR, 7 for DVR, and for 2 MVR. Energy and protein requirements were estimated individually. Caloric, protein, carbohydrates and fats targets were 25-30 kcal/kg per day, 1.2-2 g/kg per day⁶, 3-5 g/kg⁷ and 0.7-1.5 g/kg¹² per day respectively.

Samples of 24 h urinary output were collected and analysed to obtain 24 h urinary urea-N excretion. The sample was analyzed using Hitachi 912 analyzer. To this value 2 g N (for N in faeces, skin and miscellaneous) was added to obtain total N loss⁸. This was recalculated to protein equivalents (Proteineq) by multiplying by 6.25.

$$\frac{\text{Protein intake (gm)} - (\text{UUN} + 2 \text{ gm})}{6.25}$$

Patients were grouped according to the nitrogen balance, Sequential Organ Failure Assessment (SOFA) scores and adequacy of protein, carbohydrate and fat intake. Patients who received $\geq 60\%$ of their caloric or protein requirements and patients who received <60% of their caloric or protein requirements were grouped separately. This cutoff point was based

on the goal of nutritional support recommended by ASPEN for critically ill patients during the first week of ICU stay¹⁰ and the similarity to Tsai et al¹¹. To facilitate comparisons. Patients whose mortality was $\geq 50\%$ were grouped into SOFA B, and patients whose mortality was <50% comprised the SOFA A group.

Data was analyzed using IBM SPSS Statistics 19 (statistical package for social sciences). Descriptive data are reported as means and standard deviations (SD), medians and interquartile ranges (IQR) or as frequencies (%) as appropriate. Correlations were considered statistically significant at $p < 0.05$.

RESULTS

Total 46 patients were included in this study. Mean carbohydrate intake was 164 g and Std. Deviation ± 90.8 . mean protein intake was 63 g and Std. Deviation was ± 26.9 . Mean fat intake was 44.6 g and Std. Deviation 21.5. mean caloric intake 1336 kcal and Std. Deviation ± 425 . Mean sofa was 9 and std. Deviation ± 2.96 .

56%(n=26) of the the total patients have caloric intake more than 60% of the requirements i.e. (25-30/kg/d). Where have (n=20)44% have less than 60% of the requirements. 50%(n=23) of the the total patients have protein intake more than 60% of the requirements i.e. (1.2-2 g/kg/ d). Where have 50%(n=23) have less than 60% of the requirements. Where as 39%(n=18) of the the total patients have carbohydrates intake more than 60% of the requirements i.e. (3-5 g/kg/d). where have 61%(n=28) have less than 60% of the requirements. 46%(n=21) of the the total patients have fat intake less than 60% of the requirements i.e. (0.7-1.5g/kg). whereas have 54%(n=25) have more than 60% of the requirements.

In our study 50%(n=23) of the patients with SOFA scores >13 were having negative nitrogen balance more than -10.1 whereas other 50%(n=23) have nitrogen balance between -2 to -10. 60% of the patient's caloric intake less than 60% were having negative nitrogen balance. Patients among Nitrogen balance -2 - + 2 and more than + 2, 72%(n=23) of the patients

consumed proteins more 60% (1.3-1.5 g). 33%(n=15) of the patient having nitrogen balance -2 - +2 and > +2, carbohydrate intake is

more than -10.1 whereas other 50% have nitrogen balance between -2 to -10.

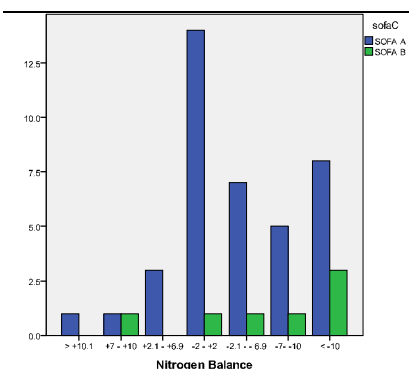


Table-1(a): Relationship between nitrogen balance and (SOFA) score.

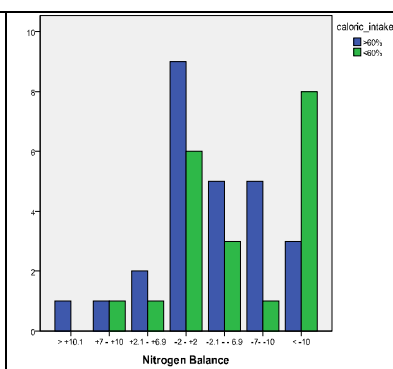


Table-1(b): Relationship between nitrogen balance and caloric intake.

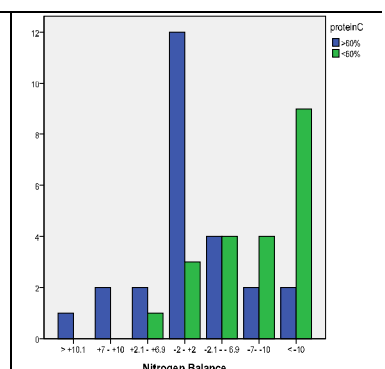


Table-1(c): Relationship between nitrogen balance and protein intake.

more than 60% of the requirements where as 77%(n=35) of the patients having nitrogen balance less -2.1 were consuming carbohydrates less than 60% of the total requirements. Patients among Nitrogen balance -2 - +2 and more than + 2, 81%(n=37) of the patients consumed proteins more 60% (1.3-1.5 g). 74% of the patients consuming protein intake less than 60% were having negative nitrogen balance. 64% of the patients having nitrogen balance less -2.1 were consuming fats less than 60% of the total requirements. 57% of the patients having fat intake more than 60% of the requirement were having nitrogen balance -2 - +2 and > +2. Relationship between nitrogen balance and severity organ failure assessment (SOFA) scoring system, calories and proteins is shown in Fig-1(a,b,c).

DISCUSSION

Out of 46 patients 36% of the patients have nitrogen balance within -2 - +2 and 13% of the patients have more than +2 nitrogen balance. Patients with higher APACHE II scores in the early feeding group experienced more nitrogen loss and worsened NB. We observed no differences in protein intake between both feeding groups but significantly higher 24-h UUN losses in more severely ill early feeders. This implies that levels of stress are higher among these patients¹³. Similarly in our study patient 50% of the patients with SOFA scores >13 were having negative nitrogen balance

In a meta-analysis of 91 cohorts and 1107 patients in whom nitrogen balance was measured, Kreyman et al¹⁶ observed that proteolysis (measured using urea nitrogen) is exponentially related to clinical severity and that EE and is greatly increased in critically ill patients (1.2 to 3.1 g.kg-1.d-1). The intensity of protein loss tends to exceed the EE to the extent of the hypercatabolism of the patient. Two observational studies found clinical improvement when patients received protein intake In our research 33% of the patient having nitrogen balance -2 - +2 and > +2, carbohydrate intake is more than 60% of the requirements where as 78% of the patients having nitrogen balance less -2.1 were consuming carbohydrates less than 60% of the total requirements close to 1.5 g/kg/d.^{14, 15} In our study patients among Nitrogen balance -2 - +2 and more than + 2, 72% of the patients consumed proteins more 60% (1.3-1.5 g).

Studies have confirmed the inhibitory effect of carbohydrate in nitrogen loss¹⁷. It has been suggested that dietary carbohydrates inhibit urinary nitrogen losses by an insulin mediated action but not all researches has demonstrated an nitrogen sparing effect of dietary carbohydrates¹⁸.

Protein sparing effect of fats may be due to a reduction of amino acid oxidation through an effect of free fatty acid oxidation in liver,

whereby the increase in NAD/NADH inhibits branched chained keto acid dehydrogenase¹⁹. In our study 64% of the patients having nitrogen balance less -2.1 were consuming fats less than 60% of the total requirements

CONCLUSION

According to our study majority of the patient falling in group of nitrogen balance -2 - +2 and >2 were consuming good protein, moderate fat and carbohydrate intake, and were having less than 50% of the mortality . Whereas majority of the patient with mortality >50% and reduced protein intake fall in group of nitrogen balance more than -2.1.

Conflict of Interest

This study has no conflict of interest to declare by any author.

REFERENCES

- Ronco C, Bellomo R, Kellum J. *Critical Care Nephrology: Expert Consult - Online and Print*: Elsevier Health Sciences; 2008.
- Shikora SA, Parental ASF, Nutrition E, Martindale RG, Schwaitzberg SD. *Nutritional Considerations in the Intensive Care Unit: Science, Rationale and Practice*: Kendall/Hunt Pub.; 2002.
- Criner GJ, Barnette RE, D'Alonzo GE. *Critical Care Study Guide: Text and Review*: Springer; 2010.
- M Phadke, S Menon, M Gore. *Study Of Nitrogen Balance In Thermally Injured Patients. The Internet Journal of Emergency and Intensive Care Medicine*. 2007 Volume 11 Number 1.
- Lawrence PF, Bell RM, Dayton MT. *Essentials of General Surgery*: Wolters Kluwer Health; 2012.
- McClave SA, Martindale RG, Vanek VW, et al. *Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient*:: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). *JPEN J Parenter Enteral Nutr* 2009;33(3):277-316.
- Surviving Sepsis Campaign. *International guidelines for management of severe sepsis and septic shock 2008*. *Crit Care Med*. 2008;36:296-327.
- Gropper S, Smith J. *Advanced Nutrition and Human Metabolism*: Cengage Learning; 2012
- Smith FG, Yeung J. *Core Topics in Critical Care Medicine*: Cambridge University Press; 2010.
- McClave SA, Martindale RG, Vanek VW, McCarthy M, Roberts P, Taylor B, Ochoa JB, Napolitano L, Cresci G; A.S.P.E.N. Board of Directors; American College of Critical Care Medicine; Society of Critical Care Medicine. *Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient*: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). *JPEN J Parenter Enteral Nutr*. 2009;33(3):277-316.
- Tsai JR, Chang WT, Sheu CC, Wu YJ, Sheu YH, Liu PL, et al. *Inadequate energy delivery during early critical illness correlates with increased risk of mortality in patients who survive at least seven days: a retrospective study*. *Clin Nutr*. 2011;30(2):209-14.
- Singer P, Berger MM, Van den Berghe G, et al. *ESPEN Guidelines on Parenteral Nutrition: intensive care*. *Clin Nutr* 2009;28:387-400.
- Huang HH, Hsu CW, Kang SP, Liu MY, Chang SJ. *Association between illness severity and timing of initial enteral feeding in critically ill patients: a retrospective observational study*. *Nutrition journal*. 2012;11:30
- Weijs, P.J., Stapel, S.N., de Groot, S.D., Driessen, R.H., de Jong, E., Girbes, A.R. et al. *Optimal protein and energy nutrition decreases mortality in mechanically ventilated, critically ill patients: a prospective observational cohort study*. *J Parenter Enteral Nutr*. 2012; 36: 60-68
- Allingstrup, M.J., Esmailzadeh, N., Wilkens Knudsen, A., Espersen, K., Hartvig Jensen, T., Wiis, J. et al. *Provision of protein and energy in relation to measured requirements in intensive care patients*. *Clin Nutr*. 2012; 31: 462-468
- Kreyman G, DeLegge MH, Luft G, Hise ME, Zaloga GP. *The ratio of energy expenditure to nitrogen loss in diverse patient groups--a systematic review*. *Clin Nutr*. 2012;31(2):168-75.
- M Phadke, S Menon, M Gore. *Study Of Nitrogen Balance In Thermally Injured Patients. The Internet Journal of Emergency and Intensive Care Medicine*. 2007 Volume 11 Number 1
- Nissen S. *Modern Methods in Protein Nutrition and Metabolism*: Elsevier Science; 2012.
- Allen LH, Prentice A, Caballero B. *Encyclopedia of Human Nutrition*: Elsevier Science; 2012.