Continuous Parenteral Nutrition to Reduce Pneumonia: Its Effects on Severe Head Injury Patients in Hasan Sadikin Hospital Bandung, Indonesia

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Abstract

The aim of this study was to compare the effects of enteral-, standard- and continous-parenteral nutrition therapy to reduce incidence of pneumonia in severe head injury (SHI) patients. We used nutrition therapy as one of the treatments for reducing pneumonia in SHI patients. Twenty one brain-injured patients with peak 24-hour admission Glasgow Coma Scale (GCS) scores of 4-8 were prospectively and randomly assigned to receive continuous total parenteral nutrition (TPNC) for 24 hours nonstop, total parenteral nutrition standard (TPNS) and enteral nutrition (EN) in March-May 2011. Patients were observed up to 14 days post injury. Pneumonia was assessed by using clinical, radiology and laboratory tests with the incidence of pneumonia significantly different among groups ($p<0.05$). The GCS changes over time among groups were significantly different; nutritional assessment parameters such as anthropometry were not significantly different among groups; total lymphocyte count was significantly increased in TPNC group; albumin was significantly increased in 7th and 14th day post injury in TPNC group ($p < 0.05$). Absolute lymphosit count was significantly increased on 7th day and 14th day post injury in TPNC group ($p < 0.05$). Incidence of pneumonia was significantly decreased in TPNC group ($p < 0.05$). Calories and protein given by TPNC within 24 hours nonstop can be administered better in acute SHI patients than by EN via nasogastric routes. Neurological recovery from SHI occurs more rapidly in patients with better and earlier nutritional support, especially in TPNC group.

Keywords: brain injury, nutrition, pneumonia, nutritional assessment

Efek Pemberian Nutrisi Parentral pada Pasien Cedera Kepala Berat dalam Menurunkan Terjadinya Pneumonia di Rumah Sakit Hasan Sadikin, Bandung, Indonesia

Abstrak

Tujuan dari studi ini adalah untuk membandingkan efek dari pemberian terapi enteral-, standard- dan continous-parenteral nutrition untuk mengurangi insidensi pneumonia pada cedera kepala berat (CKB). Kami menggunakan terapi nutrisi ini sebagai salah satu pengobatan pada CKB untuk mencegah pneumonia. Dua puluh satu pasien cedera kepala dengan skor GCS 4-8 yang datang dalam 24 jam setelah kecelakaan secara acak diberikan total parenteral nutrition continous (TPNC) selama 24 jam/nonstop, total parenteral nutrition standard (TPNS) dan nutrisi entral (EN), Maret-Mei 2011. Pasien diikuti hingga 2 minggu setelah cedera. Pneumonia dinilai secara klinis, laboratoris dan radiologis; dengan insidensinya yang sangat berbeda secara signifikan antar perlakuan (p<0,05). Perubahan GCS antar grup berbeda signifikan; parameter pengukuran nutrisi seperti antropometri tidak terdapat perbedaan; total lymphocyte count meningkat secara signifikan pada TPNC grup; albumin meningkat signifikan dalam hari ke 7 dan 14 setelah cedera pada TPNC grup (p<0,05). Absolute lymphocyte count meningkat signifikan pada hari ke 7 dan 14 setelah cedera pada TPNC grup (p<0,05). Insiden pneumonia menurun signifikan pada TPNC grup (p<0,05). Kalori dan protein yang diberikan melalui TPNC dalam 24 jam/nonstop dapat diberikan pada CKB lebih baik dari pemberian dengan EN melalui rute nasogastrik. Penyembuhan neurologis CKB lebih cepat pada pasien dengan dukungan nutrisi yang lebih awal dan lebih baik terutama pada TPNC grup.

***Kata kunci**: cedera kepala, nutrisi, pneumonia, penilaian pemberian nutrisi*

Introduction

Traumatic brain injury remains a highly lethal injury with mortality ranging from 20 to 50%; approximately 52.000 patients die each year from Traumatic Brain Injury (TBI) with 85% of the death happening within the first two weeks. TBI Pharmaceutical trials have failed to demonstrate any efficacy in reducing death.[1-4]

Currently the metabolic status and nutritional needs of TBI patients are less of a priority than maintaining cerebral perfusion. However, TBI research shows hypermetabolic and hypercatabolic state that increases systemic and cerebral energy requirements.[1,5-11] Nutritional treatment providing favorable estimation for caloric and protein requirements that influences the outcome of severe head injury (SHI) remains unresolved. In an earlier prospective randomized study of SHI patients, we found a significantly improved outcome in those receiving total parenteral nutrition (TPN) compared to those receiving enteral nutrition (EN). It may not be a well-controlled study of head injury patients so that the test of our results has not

been published yet. Consequently, we are reporting the results of a prospective randomized study to determine the effect of nutritional support as continuous parenteral nutrition on incidence of pneumonia on SHI patients.

Materials and Methods

Patients, population and cinical therapy

A total of 21 consecutive SHI patients with a Glasgow Coma Scale (GCS) score of 4 to 8 during the first 24 hours after admission were divided into three groups. The first was the total parenteral nutrition continuous group for 24 hours non stop (TPNC), the second was the total parenteral nutrition standard (TPNS) group, which was infused three times a day, and the third was enteral group, which was fed with enteral nutrition six to eight times a day via nasogastric tube. The nutritional data were collected until the patients' death or for 14 days after injury. The major criterion for inclusion was that the primary site of the injury was the brain. Nine patients were excluded for the above reasons, because of extracranial problem and unstable haemodynamic, leaving 21 patients for statistical analysis. Of the 21 patients, 17 had sustained a blunt head injury; 4 had fallen from height. Patients which had remained unconscious or in a state of prolonged use of mechanical ventilation had a tracheostomy performed. Nasogastric tube was initiated. An urinary catheter was inserted in every case. None of the effect of nutritional support as continuous parenteral nutrition on incidence of pneumonia on SHI patients. patients was treated with corticosteroid therapy. Phenytoin was given only if seizures occurred.

For nutritional support, each patient was randomly assigned to an EN or TNPS route and TNPC route for 24 hours nonstop. Nutritional support was initiated as soon as possible on early admission in the TPN group after patients were hemodinamically stable and enteral feeding was started after the presence of bowel sounds. The parenteral nutrition consisted of sterile amino acid, dextrose solutions, multivitamins, trace elements, and intravenous lipid emulsions. Enteral feedings were started in the TPN group as soon as bowel sounds were present, and gastric residual volumes were less than 100 cc every 2 hours. Patients were given metoclopramide, 10 mg/6 hrs to stimulate gastrointestinal motility; feedings were started as soon as the bowel sounds were present and feeding tube was inserted with ascertained placement in the stomach.

Enterally fed patients were given Ensure as standard nutrition in Hasan Sadikin Hospital Bandung via nasogastric tube feedings. Ensure contains 1.5 kilocalories/ml and is comprised of 14.7% protein, 32% fat, and 53.3% carbohydrate. Patients in the EN group who could not tolerate EN feedings by 7th day post injury were given TPN support until EN feedings could be administered. The Harris-

Benedict equation was used to predict basal energy expenditure. Parenteral fed patients were given Aminovel via intravenous abocath continuously for 24 hours nonstop every day during the experiment, Aminovel contains 0.5 Kcal/cc. Every effort was made to achieve a caloric intake of 1.75 (activity factor) x the basal energy expenditure and 1.5–2.5 gram protein/kg body weight/day.

Calorie intake and nitrogen balance

Daily total calorie and protein intake were recorded. Calorie intake was 1.75 x the basal energy expenditure. Daily nitrogen (N) balances were calculated as follows: protein (g) / 6.25 = N gram, N output (g/day) = urea N (g/day) + 4 g (insensible loss) balance = N (g/day) – No output.[1] Serum protein levels and serum albumin levels were evaluated as an indirect measure of protein turnover. Calorie and protein intakes were compared to serum protein levels to determine the effect of nutrient intake on serum protein levels and also albumin anthropometry. The assessment of nutritional status includes measurement of the mid-arm circumference on days 1, 7, and 14 post injury; total acute lymphocyte count was calculated daily as (white blood cell (WBC) count x % lymphocytes)/100.

Anthropometry

The assessment of nutritional status used in this study is the measurement circumference of the mid-arm.

Complications

Incidences of pneumonia were recorded. Pneumonia was defined as an elevated WBC count, elevated temperature, positive sputum culture, and a demonstration of infiltrate on chest x-ray films.

Statistical analysis

Data measured repeatedly over time were evaluated by an analysis of variance.

Result and Discussion

Result

Nine patients were excluded for the above reasons because of extracranial problem and unstable haemodynamic, leaving 21 patients for statistical analysis. Of the remaining 21 patients, 7 were randomly assigned to receive continous parenteral nutrition (TPNC), 7 were randomly assigned to receive standard parenteral nutrition (TPNS) and 7 patients were randomly assigned to receive enteral nutrition (Table 1).

Table 1 presents the primary data of 21 patients with severe head injury. age, sex, CT scan diagnosis, Glasgow Coma Scale (GCS) of 1^{st}, 7^{th}, and 14^{th} day, mid arm circumference (MAC) of 1^{st}, 7^{th}, and 14^{th} day, albumin of 1^{st}, 7^{th}, and 14^{th} day, total protein of 1^{st}, 7^{th}, and 14^{th} day serum osmolarity of 1^{st}, 7^{th}, and 14^{th} day lymphocyte count of 1^{st}, 7^{th}, and 14^{th} day, Blood Gas Analysis of 1^{st}, 7^{th}, and 14^{th} day, pneumonia based on clinical status, pneumonia based on radiology features, proteins, nitrogen urine of 1^{st}, 7^{th}, and

14th day, nitrogen balance of 1st, 7th, and 14th day, and finally the body mass index (BMI).

We found out that there were no significant differences between nutritional groups based upon their demographic features as shown in Table 2. The p values for GCS 1stday 14 height, body weight, and sex, are p=0.709, p=0.561, p=0.413, p=0.601 respectively. Table 3 demonstrates that there was no significant difference between nutritional groups based on factors of death with p value 0.667. Table 4 shows the mean neurological outcome based on the 14th day's GCS. In it, there was a significant GCS difference among nutritional groups on the 14th day with a p value of 0.010. TPN nutritional group had the highest 14th day's GCS, which is 10.86±0.508.

Counting albumin levels could be a marker for neurologic outcome after severe head injury. Table 5 confirms that albumin levels of the 14th day had a significant difference among nutritional groups based upon p value of 0.02. The highest mean albumin levels of 3.867±0.3777 can be found from the TPN nutritional group. Total protein levels can also be a marker for neurologic outcome after severe head injury. Table 6 contains data of protein levels of the 14th day compared among nutritional groups. The p value was 0.066, so there was no significant difference between nutritional groups based upon protein levels.

Table 1. Summary of 21 Patients with Severe Head Injury[a]

Group	Age	Sex	Diagnosis/Head CT Scan	GCS (day)				MAC(day)				Albumin (day)			Total Protein		
TPN Continous				I	VII	XIV	△	I	VII	XIV	△	I	VII	XIV	I	VII	XIV
1	40	M	CC + Severe HI	8	9	10	2	35	34	33	-2	4.2	4.0	4.2	7.4	6.3	7.6
2	17	M	CC + Severe HI	8	8	11	3	37	36	36	-1	3.9	3.9	4.0	6.5	6.0	6.9
3	45	M	SAB + Severe HI	7	9	11	4	39	38	38	-1	3.7	3.9	3.9	6.3	6.4	6.6
4	36	F	SDH min + Severe HI	6	8	10	4	33	32	33	0	3.1	3.5	3.7	5.4	6.0	6.3
5	15	M	CC + Severe HI	7	10	13	6	29	29	29	0	3.6	4.0	3.2	7.1	7.3	7.5
6	27	M	SBF + Severe HI	8	11	12	4	29	29	28	-1	3.2	4.1	4.2	4.9	5.1	6.9
7	36	M	Diffuse + Severe HI	7	8	+	+	32	31	+	+	4.5	4.4	+	6.6	6.4	+
N	7	7	7	7	7	7	7	7	7	6	6	7	7	6	7	7	6
Enteral																	
1	26	M	Diffuse + Severe HI	8	8	8	0	40	39	38	-2	3.7	3.3	3.2	6.5	6.2	6.0
2	19	M	SAB + Severe HI	7	9	10	3	37	35	34	-3	4.2	3.5	3.4	6.9	6.7	6.3
3	33	M	CC + Severe HI	8	10	+	+	45	43	+	+	3.2	3.4	+	6.7	6.5	+
4	21	M	Diffuse + Severe HI	7	9	9	2	59	57	56	-3	3.9	3.6	3.3	6.9	6.7	6.4
5	17	F	IVH + Severe HI	8	8	+	+	52	50	+	+	3.4	3.3	+	5.3	5.1	+
6	23	M	SDH min + Severe HI	6	8	9	3	47	46	45	-2	4.2	4.2	3.8	8.2	7.7	6.9
7	39	M	CC + Severe HI	8	9	9	1	32	32	31	-1	3.4	3.1	3.1	7.1	6.5	6.1
N	7	7	7	7	7	5	5	7	7	5	5	7	7	5	7	7	5

TPN standard																	
1	32	M	SAB + Severe HI	8	8	10	2	32	32	31	-1	4.0	3.6	3.5	7.1	6.8	7.0
2	23	F	SDH min + Severe HI	8	8	9	1	37	37	35	-2	3.7	3.6	3.6	6.9	6.2	6.3
3	42	M	CC + Severe HI	6	7	7	1	39	38	37	-2	3.3	3.3	3.2	6.7	6.4	6.4
4	30	F	SDH min + Severe HI	6	7	8	2	33	31	30	-3	2.5	2.8	3.4	5.1	6.0	6.1
5	14	M	IVH + Severe HI	8	9	10	2	29	28	27	-2	2.9	3.0	3.2	7.0	6.9	6.9
6	21	F	Diffuse + Severe HI	8	8	10	2	29	27	26	-3	3.3	3.2	3.3	4.6	5.1	5.2
7	43	M	Diffuse + Severe HI	5	7	8	3	32	31	31	-1	3.8	3.9	3.8	6.5	6.4	6.2
N	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Total N	21	21	21	21	21	19	19	21	21	18	18	21	21	18	21	21	18

[a] GCS: Glasgow Coma Scale; MAC: mid-arm circumferences; HI: Head injury; CC: Contusio Cerebri; SAB: Sub Arachnoidal Bleeding; SDH: Sub Dural Hematom; IVH: Intra Ventrikuler Hemorrhage; SBF: Skull Base Fracture; (+) Death

Table 1 (continued). Summary of 21 Cases of Nutritional State

	Osmolarity Serum			Lymphocyte Count			BGA			Clinic	Radiology		Nitrogen Urine			Nitrogen Balance				BMI		
Therapy Diet	I	VII	XIV	I	VII	XIV	I	VII	XIV	Pneu-monia +/-	Pneu-monia +/-	Protein (g)	I	VII	XIV	I	VII	XIV	PEE Kcal	H (cm)	W kg	Age (yr)
TPN Continous																						
1	278	286	290	2602	1925	1378	N	N	N	NP	NP	175	23.65	22.98	Z	-0.35	-1.02	Z	1697	169	70	40
2	277	282	298	4800	4210	3365	RA	RA	RA	P	P	170	25.33	20.12	Z	-2.13	3.08	Z	1723	170	68	17
3	289	288	296	2295	2890	2650	RA	RA	N	NP	NP	165	33.47	29.78	Z	-11.7	-5.38	Z	1688	168	66	45
4	285	290	295	4987	4212	3987	N	N	N	NP	NP	162	26.36	24.40	Z	-4.44	-2.84	Z	1445	167	65	36
5	276	290	299	5409	4513	3456	RA	RA	N	NP	NP	175	32.12	28.84	Z	-8.12	-4.84	Z	1735	172	70	15
6	290	289	294	6312	5465	4564	N	N	N	NP	NP	138	35.45	30.27	Z	-17.37	-12.04	Z	1659	159	55	27
7	289	297	+	3060	2987	+	RA	RA	+	+	+	135	27.22	25.48	Z	-9.62	-7.88	Z	1656	160	54	36
N	7	7	6	7	7	6	7	7	6	6	6	7	7	7		7	7		7	7	7	7
Enteral																						
1	288	274	276	3960	1902	900	RA	RA	RA	P	P	175	9.02	10.76	Z	16.88	13.24	Z	1710	169	70	26
2	279	277	278	3762	1671	1243	RA	RA	RA	P	P	172	11.23	12.08	Z	12.29	11.44	Z	1431	171	69	19
3	289	287	+	4686	2062	+	RA	RA	+	+	+	170	9.12	11.45	Z	14.68	12.35	Z	1710	170	68	33
4	276	280	270	7644	2101	1654	RA	RA	RA	P	P	138	13.42	38.76	Z	4.66	-20.68	Z	1714	169	55	21
5	290	286	+	6804	2845	+	N	RA	+	+	+	152	15.60	20.78	Z	4.72	-0.46	Z	1435	169	61	17
6	310	293	280	5412	2574	1324	RA	RA	RA	P	P	175	10.25	12.32	Z	13.75	11.68	Z	1702	167	70	23
7	288	285	281	6510	3622	3421	N	RA	RA	P	P	173	12.40	14.45	Z	11.28	9.23	Z	1678	165	69	39
N	7	7	5	7	7	5	7	7	5	5	5	7	7	7		7	7		7	7	7	7

TPN

1	274	281	289	2312	1821	1265	RA	RA	RA	P	P	165	28.10	25.77	Z	-6,06	-6,32	Z	1724	173	66	32
2	290	278	279	5957	2392	1567	RA	RA	RA	P	P	170	22.36	20.52	Z	0.84	2.68	Z	1412	170	68	23
3	278	288	286	3874	2534	1892	RA	RA	RA	P	P	172	21.90	20.88	Z	1.62	2.64	Z	1140	169	69	42
4	285	285	281	3775	2262	1998	RA	RA	RA	P	P	182	28.81	21.23	Z	-3.68	3.89	Z	1375	168	73	30
5	286	277	276	2997	1743	1313	RA	RA	N	NP	NP	145	17.80	16.06	Z	1.4	3.24	Z	1721	163	58	14
6	290	281	284	3213	630	1543	RA	N	RA	P	P	190	22.22	17.34	Z	4.18	9.06	Z	1409	163	76	21
7	293	279	277	2375	1982	1698	RA	RA	RA	P	P	172	18.23	16.06	Z	5.26	7.46	Z	1650	160	69	43
N	7	7	7	7	7	7	7	7	7	7	7	7	7	7	0	7	7	0	7	7	7	7
Total N	21	21	18	21	21	18	21	21	18	18	18	21	21	21	0	21	21	0	21	21	21	21

[a]AGD: Blood Gas Analysis) RA: Respiratoric Alkalosis; N: Normal; P: Pneumonia; NP: No Pneumonia; +: Death; Z: Out of nitrogen reagent; BMI: Body Mass Index; H: Height; W: Weight

Table 2. Summary of Demographic Features and Significance of Difference between Groups. The demographic features were not significantly different between groups based on GCS 1st day, height, body weight and sex (p>0.05)

Factor	TPN Continous	Enteral	TPN standard	Significance
Cases	7	7	7	
GCS day 1	7.29±0.286	7.43±0.297	7.00±0.486	p = 0.709
Height (cm)	166.43±1.888	168.57±0.751	166.57±1.757	p = 0.561
Weight (kg)	64.0±2.554	66.00±2.182	68.43±2.148	p = 0.413
Age (y)	30.86±4.350	25.43±3.007	29.29±4.081	p = 0.601

Value are *means ± standard error of the means*

Table 3. Number and Cause of Deaths and Significance of Difference between Groups

Time of death	TPN Continous	Enteral	TPN std	Significance (ANOVA)
Early deaths (<7 days)	0	0	0	
Late deaths (>7 days)	1 brain death	1 brain death 1 IVH sepsis	0	p = 0.667
Total case	1	2	0	

P>0.05: No significant difference between groups based on factor of deaths

Table 4. Mean Outcome Neurological Based on GCS 14th Day between Groups. There was a significant difference among groups on GCS 14th day with p<0.05

Factor	TPN Continous	Enteral	TPN std	Significance (ANOVA)
Cases	7	7	7	
14th day GCS	10.86±0.508	9±0.316	8.86±0.459	0.010

Table 5. Mean Standard Error Outcome Neurologic Based on Albumin on 14th Among Groups. There was a significant difference among groups based on albumin at 14th day, p=0.02

Factor	TPN Continous	Enteral	TPN std	Significance (ANOVA)
Cases	7	7	7	
14th day albumin	3.867±0.3777	3.360±0.2702	3.429±0.2215	0.020

Table 6. Mean with Standard Error Neurological Outcome Based on 14th Day Total Protein. There was no significant difference between groups based on protein total 14th day, p=0.066

Factor	TPN Continous	Enteral	TPN std	Significance (ANOVA)
Cases	7	7	7	
14th day total protein	6.967±0.5046	6.340±0.3507	6.3±0.5944	0.066

Table 7. Mode of Patients with Incidence of Pneumonia

Factor	TPN Continous	Enteral	TPN std
Cases	6 (100%)	5 (100%)	7 (100%)
Pneumonia	1 (16%)	5 (100%)	6 (85%)
Not Pneumonia	5 (83%)	0 (0%)	1 (15%)

Table 8. Mean Standard Error of Neurological Outcome Based on 14th Day Lymphocyte Count. There were significant difference among groups based on lymphocyte count 14th day, p= 0.007

Factor	TPN Continous	Enteral	TPN std	Significance (ANOVA)
Cases	7	7	7	
14th day lymphocyte count	3233.33±454.171	1708.40±994.212	1610.86±103.668	0.007

Table 7 gives us the number of pneumonia and non-pneumonia cases of patients based upon nutritional groups. Inside the TPN continuous group there is only one pneumonia case from 6 cases of severe head injury. Enteral group demonstrates that there have been 5 pneumonia cases out of 5 patients. The standard TPN group presents us with 6 pneumonia cases out of 7 patients. The contents of Table 8 are levels of 14th day's lymphocyte count. In it, the p value is 0.007, which means that there is a significant difference of lymphocyte count compared among nutritional groups. The TPN continuous group has the highest lymphocyte count of 3233.33±454.171.

Figure 1 illustrates GCS day 1, 7, and 14 which are compared between nutritional groups. On the 14th day's GCS we can see that TPN continuous group has the highest mean GCS of 10.86, meanwhile TPN standard had 8.86 and enteral group has 9. Next is Figure 2 where we compare albumin levels of the

1st, 7th, and 14th day based upon nutritional groups. At the 14th day TPN continuous group has the highest significant increasing albumin levels by 3.867, while TPN standard increases by 3.429 and enteral 3.360.

Within Figure 3 we compare total protein levels of day 1, 7, and 14 between nutritional groups and show that there has been a significant increase of protein total on the 14th day. TP continuous group has the highest increase by 6.967, whereas TP standard 6.3 and enteral 6.340. Figure 4 demonstrates comparisons of nutritional urine based on nutritional groups. There is no significant difference between groups with p=0.067. TPN continuous has the lowest nitrogen urine of -4.41, whilst TP standard 3.23 and enteral 5.25.

Figure 5 shows comparisons between nutritional groups with and without pneumonia. TPN continuous group has 1 pneumonia out of 6, meanwhile enteral group has 5 out of 5 and standard TPN group has 6 out of 7 severe head injury patients.

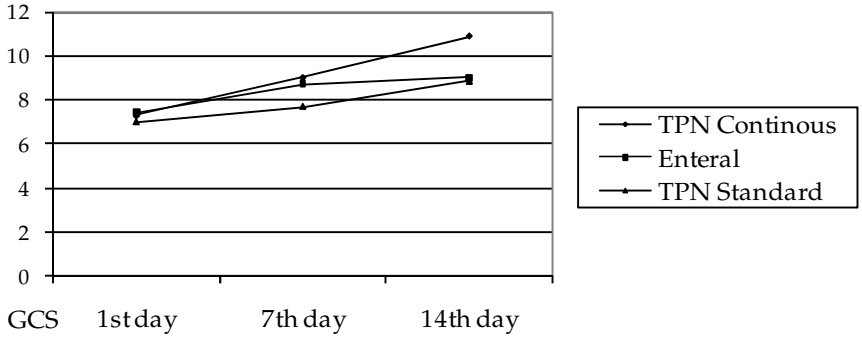

Figure 1. Comparison of GCS 1st, 7th and 14th Day among Groups

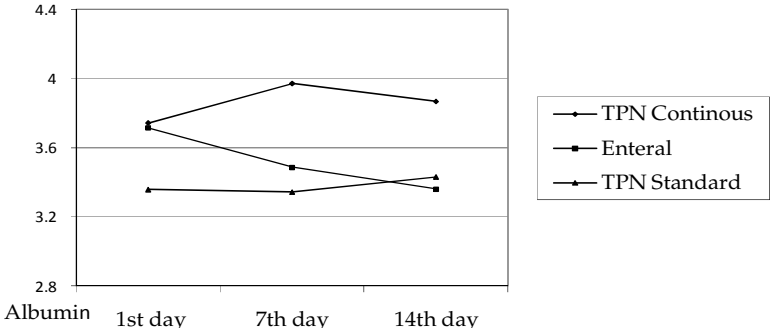

Figure 2. Comparison of Albumin 1st, 7th and 14th Day among Groups. TPN continous had significant increase albumin 3.867; TPN std 3.429 and enteral 3.360

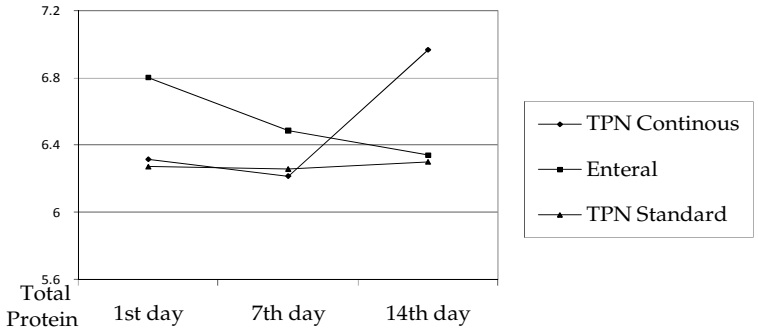

Figure 3. Comparison Mean Total Protein 1st, 7th and 14th Day among Groups. TPNC group had significantly increased total protein on 14th day 6.967, enteral 6.,340 and TPNS 6.3

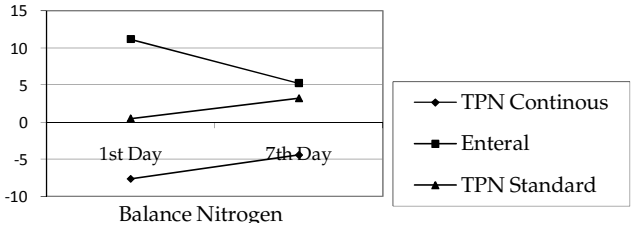

Figure 4. Comparison between Nutritional and Nitrogen Urine, Value Means Standard Error of Mean. There were no significant difference among groups based on nitrogen balanced on 7th day, p= 0.067

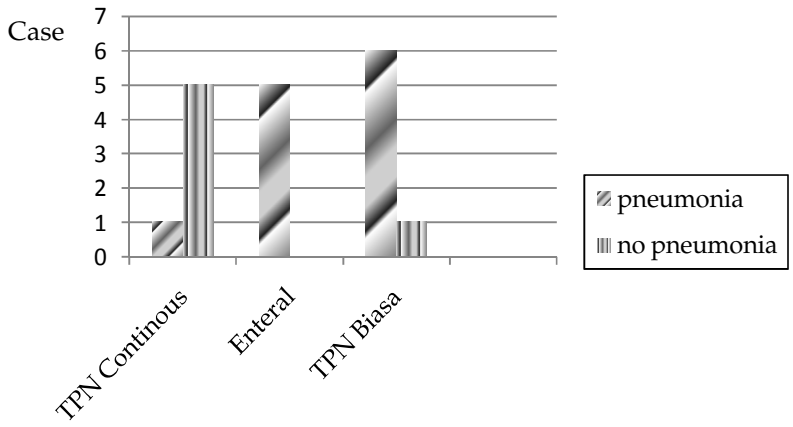

Figure 5. Comparisons between Groups with Pneumonia or Not. There were significant difference between groups with incidence of pneumonia sig 0.006 (P<0.05)

Discussion

Demographic features such as height, body weight, and sex had no significant difference between nutritional groups. Since there was no textbook or article that suggested otherwise, this result was expected.

Most of the patients had late death and many factors can contribute to their deaths, so no significant difference between nutritional groups based on factors of death was predicted.

TPN nutritional group had the highest neurological outcome in the form of 14th day's GCS and albumin levels. We believe it is because Aminovel contains L form amino acids, sugar, vitamin, and electrolytes needed by the body. We also believe that giving it 24 hours continuously helps the body during early trauma phase which needed a higher number of protein, so this result was expected. Also, there was less pneumonia and higher lymphocyte count in the TPN continuous group. We consider that continuous nutrition might have given the body raised immunocompetence.

Based upon protein levels and nutritional urine, there is no significant difference between nutritional groups. We deem this result as unforeseen because all three groups were given protein from three different routes. There should be a difference in pharmacokinetic, so we need more research to clarify this.

Based upon all those deduction, this study shows that the TPNC group, which received calories and protein less than the EN group, had a significantly higher GCS score by day 14. Although it is widely accepted that provision of nutritional support lessens morbidity and mortality and improves outcome of trauma patients, there are no well-

controlled studies that prospectively randomize patients between fed and unfed group. This study provided two important conclusions: 1) TPNC patients who received significant calories and protein had significantly better outcome than, TPNS and EN patients; and 2) improved outcome was attributable to less susceptibility to infection. Some of the results of the current study are different from the first study; however, the enterally fed patients in this study received significantly more cumulative calories and protein than in the first trial. In contrast, the current investigation evaluates the efficacy of TPNC compared with TPN Standard and EN using improved current standards of enteral support. These variations in methodology may partially explain the differences in results between the three investigations. Our initial study showed that the TPN patients who were fed more calories and protein had better outcomes and fewer complications than the EN group. This trend continued in this study although the differences were less pronounced, most likely due to the switching of patients not tolerating enteral feeding to the parenteral route to provide better nutritional support. The lack of adequate nutrient administration during the first week post injury in the EN group may account for the greater incidence of sepsis in the EN group than in the TPN group. The 2 patients who did not tolerate tube feedings by day 7 post injury and who were switched to TPN had a statistically higher incidence of sepsis, perhaps due to immunocompetence caused by inadequate nutritional support. We observed that positive nitrogen balance is not always associated with increases in serum albumin, and suggested that changes in body water compartments cause serum albumin depression in critically ill patients.

Conclusion

In conclusion, more calories and protein can usually be administered continously via the TPN route to patients with acute brain injury. This is better than managing EN feedings by nasogastric routes. Nutritional assessment using traditional parameters is not useful in studying efficacy of nutritional support during the first 2 weeks after head injury. Neurological recovery from head injury occurs more rapidly in patients with better and earlier nutritional support.

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