

The Use of Parenteral Nutrition Support in an Acute Care Hospital and the Cost Implications of Short-term Parenteral Nutrition

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Abstract

Introduction: Parenteral nutrition (PN) is indicated for patients who are unable to progress to oral or enteral nutrition. There are no local studies done on estimating the cost of PN in acute settings. The aims of this study are to describe the demographics, costs of PN and manpower required; and to determine the avoidable PN costs for patients and hospital on short-term PN. **Materials and Methods:** Patient data between October 2011 and December 2013 were reviewed. Data collected include demographics, length of stay (LOS), and the indication/duration of PN. PN administration cost was based on the cost of the PN bags, blood tests and miscellaneous items, adjusted to subsidy levels. Manpower costs were based on the average hourly rate. **Results:** Costs for PN and manpower were approximately S\$1.2 million for 2791 PN days. Thirty-six cases (18.8%) of 140 PN days were short-term and considered to be avoidable where patients progressed to oral/enteral diet within 5 days. These short-term cases totalled S\$9,154.42, where S\$42,183.15 was payable by the patients. The daily costs for PN is also significantly higher for patients on short-term PN ($P < 0.001$). **Conclusion:** In our acute hospital, 90% of patients referred for PN were surgical patients. Majority of the cost comes from the direct daily cost of the bag and blood tests, while extensive manpower cost was borne by the hospital; 18.8% of our cohort had short-term avoidable PN. Daily PN may cost up to 60% more in patients receiving short-term PN. Clinicians should assess patient's suitability for oral/enteral feeding to limit the use of short-term PN.

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Key words: Hospitalised, Avoidable, Nutrition support team

Introduction

Parenteral nutrition (PN) is indicated for patients who are unable to progress to oral or enteral nutrition. The European Society for Clinical Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN) both recommend PN if a patient is unable to progress to oral or enteral nutrition within 7 days postoperatively.^{1,2} The ASPEN guidelines² further recommend that "PN provided for duration of <5 to 7 days would be expected to have no outcome effect and may result in increased risk to the patient".

In a paper by the Nutrition Support Team (NST) in Singapore General Hospital,³ it was found that 14.9% of

patients had PN durations less than 7 days. Approximately one-third of these patients were also found to have started on PN inappropriately, based on the ASPEN 2002 guidelines on the indication for nutrition support therapy.⁴ Inappropriate PN use is associated with medical complications and incurs additional costs for both patients and hospital.^{2,5,6} Delegge et al⁷ reported an additional US\$80,000 PN hospital cost within 6 months for inappropriate PN use, while another study reported annual costs of US\$81,000.⁸

The cost of PN varies across different parts of the world, due to the differences in healthcare subsidies and insurance coverage. PN can be in the form of premixed multichamber bags or pharmacy compounded all-in-one

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bags, with the former at a lower price. The average costs for 1 day of PN therapy (inclusive of additives and service fees) in the United States is US\$186.92 (S\$244.87) for premixed multichamber bags and US\$272.40 (S\$356.84) for compounded PN.⁹ In Europe, premixed bags without additives may cost between €39.69 and €72.87 (S\$63.90 to S\$117.32), while compounded bags cost between €46.04 and €82.02 (S\$74.12 to S\$132.05), depending on whether it is compounded within the hospitals or by subcontractors.¹⁰⁻¹² The cost range for compounded PN in neighbouring Malaysia is reported to be between MYR 235 to MYR 398^{13,14} (S\$89.30 to S\$151.24). However, majority of the authors only included manpower for preparing and administering the bags, and not the overall manpower required by NST that includes assessment, reviewing, nursing and phlebotomy.

PN cost varies locally; depending on the negotiated price individual hospitals have with the compounding laboratory. A few hospitals have in-house laboratories to compound PN bags. Some hospitals also provide extra subsidies for patients while others do not. Hence, costs of compounded PN can range from S\$150 to S\$230. The variety of premixed bags available in each hospital also varies greatly, and costs can range anywhere from S\$50 to S\$130, based on the negotiated price between the hospital and the pharmaceutical companies. In our hospital, costs of premixed bags range from S\$73 to S\$127, and compounded bags from S\$174 to S\$214, depending on the bag composition and volume.

Singapore has a complex system for medical bills, where the government/Ministry of Health (MOH) provides subsidies of up to 80% for the total bill in acute public hospital wards. This is the first-tier of healthcare protection where the government-run hospitals will apply means testing to determine the level of subsidy for the patients. However, PN does not come at a subsidised cost in majority of the hospitals, as it is not classified as a standard medication. As such, the second tier of protection, also known as Medisave, a compulsory individual medical savings account scheme, will pay for the cost of PN. The MOH reported an average Medisave balance of S\$16,900 in the year 2010.¹⁵ However, the current Medisave withdrawal limit is S\$450 per day, and patients have to pay the remaining daily hospital expenses that exceed this amount. Patients may be covered from the additional expenses through Medishield Life activation, which is the third tier protective insurance scheme, by the end of 2015.

There is currently no national policy or guidelines on the use of PN. Each hospital has its own set of PN policy and protocol; hence the types, frequencies and costs of blood tests and miscellaneous items (intravenous [IV] drip sets, IV pumps etc.) may differ as well. Manpower hours allocated to the administering of PN may also be

different, with some hospitals having a NST to look after the patients on PN. The NST's role in our hospital is to provide support and monitoring of patients on PN, and to assist in the transitioning of PN to enteral or oral nutrition.

Many studies pertaining to cost of PN generally were done on home PN, where patients require long-term nutritional support. There are no known local studies done on estimating the cost of PN support in acute settings, or for short durations of less than 5 days, regardless of intentional or unintentional short-term prescription. There are no known studies on manpower-related hours and costs involved in administering PN in the local healthcare settings.

The aims of this study are to: a) describe the demographics, costs of PN, associated blood tests, manpower as well as manpower hours required for patients on short-term PN less than 5 days; b) compare the average daily bill size of patients on short-term PN to patients who required PN on extended periods while warded; and c) determine the costs for patients and hospital on short-term PN that are avoidable.

Materials and Methods

Patients admitted to our hospital who received PN between October 2011 and December 2013 were eligible for analysis. The hospital started electronic ordering of PN since October 2011. Data collected include patient demographics, admission diagnoses, intensive care unit (ICU) admissions, hospital length of stay (LOS), indication and duration of PN, reasons for stopping PN, central line insertions, types of central lines and number of line changes.

Patients were considered to be in the short-term avoidable PN group if they were started on PN and terminated within 5 days. Patients were excluded from analysis for PN $\leq$ 5 days if they died within 5 days of commencing PN, multiple short periods ($\leq$ 5 days) of PN in the same admission because of medical complications, refused PN after referral was made to the NST or transferred to another hospital within 5 days.

Patients were considered to be in the unavoidable PN group if the number of PN days was $>$ 5 days and unable to progress to oral/enteral nutrition. Those started on PN for more than once in the same admission was considered as a single patient for cost and mortality analysis. Those who had PN support during the different admissions were considered as repeated patients for cost analysis.

Manpower hours and costs were calculated based on time spent by the NST (gastroenterology consultant, pharmacist and dietitian), additional nursing hours and phlebotomist hours. The NST does not charge patient per consult and hence manpower costs are fully borne by the hospital. Costs were obtained from the hospital's human resources department, based on the average hourly rate in the year 2014 that the hospital was paying for each professional service.

Table 1. Costs* and Frequencies of Blood Tests Required for PN Monitoring in Changi General Hospital

Blood Tests	Baseline	Week 1	Week 2	Subsequent Weeks	Cost† Per Test (S\$)
Urea	Compulsory	Daily	Alternate day	Alternate day	0.08 – 7.00
Creatinine					0.08 – 7.00
Sodium					0.08 – 7.00
Potassium					0.08 – 7.00
Magnesium					0.08 – 12.00
Chloride					0.08 – 8.00
Bicarbonate					0.08 – 7.00
Glucose					0.08 – 6.50
Calcium	Compulsory	Daily	Once	Once	0.08 – 7.00
Phosphate					0.08 – 8.00
LFTs	Compulsory	Once	Once	Once	0.48 – 54.00
Lipid profile					0.24 – 28.60
Pre-albumin					0.08 – 25.00
Prothrombin & partial thromboplastin time					0.16 – 29.10
Full blood count					0.08 – 14.52
Zinc					0.16 – 58.00
C-reactive protein	As required	As required	As required	As required	0.08 – 12.00
Finger prick hypocount					2.32 – 24.00

LFT: Liver function test

*Costs are dependent on the subsidy levels that patients received.

†Where the lower range of cost indicates cost for subsidised patients and the higher range for private full fee-paying patients.

PN cost was based on the cost of the bags to patients and adjusted according to the patient's paying class (subsidised or private rates). Majority of the patients are provided with compounded PN in our hospital. Patients may start on premixed PN in the intensive care units over the weekend if the NST is not available to review the patient, and subsequently switched to compounded PN.

Costs for blood biochemistry were also calculated based on level of subsidies the patient receives, which can be up to 90% of usual costs. Only blood tests specifically ordered for PN monitoring were included (Table 1). Additional tests not in the PN protocol are not included in the final bill size calculations. Daily blood glucose monitoring by finger prick test was also added to the costs of PN as they are charged to patients.

Peripherally inserted central catheter (PICC) line insertion was calculated and added to total costs if it was specifically inserted for nutrition support (Table 2). Additional line costs were included if the patient had received line changes during the PN period specifically for PN use. Central venous catheters were not factored into the cost as they were required for critically ill patients and not solely inserted for PN. However, changes from central to PICC lines were added into the final cost if it was solely for PN use. Manpower costs for PICC line insertion were factored into total line

Table 2. Costs* of PICC Line Insertion and Other Miscellaneous Items Required for the Provision of PN

Central Lines and Other Equipment Required	Cost (S\$)
PICC line inclusive of procedural costs	400.00 – 950.00
Intravenous administration set	0.58 – 6.25 daily
Basic dressing set	0.58 – 6.00 daily
Sterile gloves	Not applicable as it is included in standard daily treatment fee in the ward
Alcohol wipes	
Disinfecting agents e.g. chlorhexidine	
IV pump	Not applicable as pumps are provided for free by pharmaceutical companies as per agreement with the hospital
IV drip pole	Not applicable as it is not charged to patients

PICC: Peripherally inserted central catheter; IV: Intravenous

*Costs are dependent on the subsidy levels that patients received.

costs. Miscellaneous items required for administration of PN were also included in the final costing. These include the intravenous administration and dressing sets required.

Manpower hours were estimated by observation and recording of time taken for nursing staff to set up a new PN bag, the administrative work in preparing the tubes for blood collection, and handing over of information to staff for the next shift. Phlebotomy hours were estimated through observing and recording the time taken to obtain blood samples from patients. NST discussion and ward round timings for each patient was estimated at 10 minutes per patient. Time taken by the pharmacist in reviewing patients, ordering of bags and liaising with compounding pharmacy were also included. Dietitian review per patient was estimated for initial patient assessment, regular reviews and extra time required in weaning patient off PN.

Statistical Analysis

All data were entered into SPSS Version 19.0 (IBM, Chicago, IL). Tests were run at a two-tailed significance level of 0.05. Normally distributed data was presented as median or mean $\pm$ SD. Independent t-test was used to detect any differences between continuous variables.

Results

A total of 192 patients were placed on PN between October 2011 and December 2013. The demographics for the total patient population are as described in Table 3. The median LOS was 34 days with median PN administration of 9 days. Majority of the patients were surgical patients (90.1%) and 30-day mortality rate was at 21.4%. Twenty-eight patients

were excluded from the cost analyses and comparison analyses, of which 10 patients had multiple short periods (≤ 5 days) of PN in the same admission and 18 patients died within 5 days of commencing PN. The patients were started on PN for reasons as indicated in Table 4.

Thirty-six patients (18.8%) were placed on short-term PN. These patients were admitted for the following reasons: perforated gastric or intestinal ulcer requiring surgical intervention ($n = 10$); suspected ileus/postoperative ileus ($n = 7$); small bowel obstruction requiring resections ($n = 3$) or conservative management ($n = 3$); bleeding gastrointestinal

Table 4. Comparison between Patients on Short-term Avoidable and Unavoidable PN

	Short-term (n = 36)	Unavoidable (n = 128)
Reasons for PN		
Bowel ischaemia	0	3
Conservative management (NBM ≥ 7 days)	14	30
Ileus	7	24
Intestinal/gastric obstruction	6	15
Poor nutritional status (pre- and post-operation)	5	23
Short bowel syndrome	0	3
Postoperative complications (e.g. anastomotic leak)	2	23
Unable to progress to EN or oral diet	2	7
Patient type		
Surgical	30	119
Medical	6	9
Gender		
Male	22	77
Female	14	51
Age	61.3 $\pm$ 15.5	67.0 $\pm$ 15.4*
PN days		
Total	140	2268
Median	4	11
Reasons for termination of PN		
Progressed to oral diet	26	83
Progressed to enteral feeding	10	32
Line infection requiring removal of PICC line	-	5
Death/palliation	-	4
Others (refusing PN therapy, transfer to other facilities)	-	4

EN: Enteral nutrition; NBM: Nil by mouth; PICC: Peripherally inserted central catheter; PN: Parenteral nutrition

*Nil significant difference between the 2 groups.

†Excluding patients who died within 5 days after commencing PN.

Table 3. Demographics of Patients on PN Support in the Hospital

Baseline Demographics	
No. of patients	192
Patient paying class type (%)	
Private	33 (17.2)
Subsidised	159 (82.8)
Age (years)	65.6 $\pm$ 15.7
Median length of stay (days)	34 (min 6 – max 290)
Median length of PN days (days)	9 (min 2 – max 267)
Total PN days (days)	2791
Sex (%)	
Male	113 (58.9)
Female	79 (41.1)
Patient type (%)	
Surgical	173 (90.1)
Medical	19 (9.9)
Mortality (%)	
Died while on PN	18 (9.4)
30-day	41 (21.4)

PN: Parenteral nutrition

Table 5. Total Administrative and Manpower Costs Related to PN for All 192 Patients

PN Cost Components	Full Fee Paying Patients (Private Class) (S\$) n = 33	Subsidised Patients Before Subsidy (S\$) n = 159	Subsidised Patients After Subsidy (S\$) n = 159	Total Costs Before Subsidy (S\$) n = 192
Total costs for PN administration	182,108.87	840,587.64	407,452.49	1,022,696.51
Central line insertion	31,350.00	140,600.00	59,600.00	171,950.00
Parenteral nutrition	96,816.95	449,344.66	340,732.40	546,161.61
Blood tests	43,345.92	199,018.98	2,129.77	242,364.90
Miscellaneous items*	10,596.00	51,624.00	4,990.32	62,220.00
Manpower costs not charged to patients	42,446.17	193,148.00	NA	235,594.17
Pharmacist	30,168.67	136,777.33	-	166,946.00
Dietitian	4430.00	20,266.67	-	24,696.67
Physician	3820.00	17,575.00	-	21,395.00
Nursing	2722.50	12,661.00	-	15,383.50
Phlebotomy	1305.00	5868.00	-	7173.00

NA: Not applicable; PN: Parenteral nutrition

*Include daily dressing and IV drip set.

tract (n = 3); bowel ischaemia (n = 2); gastric outlet obstruction requiring stenting (n = 2); pancreatitis (n = 1); pancolitis (n = 1); esophageal varices (n = 1); advanced rectal cancer requiring resection (n = 1); ruptured liver cyst (n = 1); and colon cancer with suspected anastomotic leak postoperation (n = 1). All of these 36 patients progressed to oral/enteral nutrition within 5 days of commencing PN.

Total PN and manpower costs for all 192 patients add up to S\$1,258,290.68 for the 2791 PN days (S\$450.84 per PN day) (Table 5). Of the total costs, S\$589,561.36 (46.9% of total costs) was payable by the patients through their Medisave account/cash/insurance, with S\$433,135.15 subsidised by the hospital or MOH based on the prevailing subsidy rates. Total manpower costs not charged to patients

amounted to S\$235,594.17.

Thirty-six cases (18.8%) with a total of 140 PN days were considered to be short-term PN as they had less than 5 days of PN (range of 2 to 5 days) and were progressed to oral diet (n = 26) or enteral feeding (n = 10) within 5 days of commencing PN. These short-term PN cases totalled S\$59,154.42, of which S\$42,183.15 was payable by the patients after MOH and hospital subsidies were applied on the blood tests and PN formulations.

The mean daily PN cost for private class patients was higher for those on short-term avoidable PN compared to those of unavoidable PN, which may be up to 60% more (Table 6). The total costs were affected mainly by the cost of PICC line insertion, daily blood analyses for the

Table 6. Itemised Daily Parenteral Nutrition Costs for Private and Subsidised Class Patients

Itemised Daily Costs	Avoidable (PN Days ≤5) (S\$)	Unavoidable (PN Days >5) (S\$)	P Value
Private class patients	n = 10	n = 22	
Total PN costs without PICC line	367.96 ± 26.13	312.39 ± 24.39	<0.001
Total PN costs with PICC line	603.88 ± 183.54	376.73 ± 57.22	0.003
PN bag	195.13 ± 9.06	194.94 ± 12.50	NS
Blood analyses	136.83 ± 24.88	93.59 ± 17.65	<0.001
Miscellaneous items*	36.00 ± 0.00	23.86 ± 6.73	<0.001
Subsidised class patients	n = 26	n = 106	
Total PN costs without PICC line costs	138.27 ± 29.24	151.76 ± 9.10	0.028
Total PN costs with PICC line costs	206.47 ± 79.65	185.67 ± 29.28	NS
PN bag	133.42 ± 29.24	147.92 ± 9.26	0.019
Blood analyses	1.32 ± 0.41	1.20 ± 0.50	NS
Miscellaneous items	3.52 ± 0.23	2.66 ± 0.65	<0.001

NS: Not significant; PICC: Peripherally inserted central catheter; PN: Parenteral nutrition

*Include IV drip set and wound dressing set.

Table 7. Comparison of Average Daily Manpower Hours Required for Patients with Avoidable Versus Unavoidable PN

Manpower	Avoidable PN n = 36	Unavoidable PN n = 128	P Value
Pharmacist (hours)	1.28 ± 0.24	1.17 ± 0.49	<0.001
Dietitian (hours)	0.41 ± 0.02	0.25 ± 0.05	<0.001
Nutrition support physician (hours)	0.17 ± 0.00	0.13 ± 0.01	<0.001
Nursing (hours)	0.25 ± 0.00	0.25 ± 0.01	NS
Phlebotomy (hours)	0.25 ± 0.00	0.16 ± 0.03	<0.001
Total			
Daily manpower (hours)	2.35 ± 0.02	1.96 ± 0.11	<0.001
Daily manpower cost (S\$)	102.83 ± 1.09	87.61 ± 3.79	<0.001

NS: Not significant; PN: Parenteral nutrition

first 5 days of PN, and the miscellaneous items required for administration. For long-term PN patients, the cost of initial PICC line insertion was averaged out and less blood analyses were required, which significantly reduced daily average cost. This was not replicated in the subsidised patient group. This is likely due to the large subsidies provided for PICC line insertions and blood analyses, which may be as high as 80%. Total PN-related costs for a private class patient is approximately 2.5 times higher than a subsidised class patient.

In addition, 326.67 manpower hours were incurred for these 36 patients, which is an additional manpower cost of S\$14,400.33. The average daily manpower hours for pharmacist, dietitian, nutrition support physician and phlebotomy were significantly higher in these patients as well (Table 7), due to higher manpower needs during the initial assessment and monitoring phases for PN initiation. As a result, average daily manpower cost is also higher in these patients (Table 7). Nursing manpower hours was similar between the 2 groups, as the similar nursing procedures or needs are required for each PN day.

Discussion

This is the first local study that reported the total costs related to PN. Majority of the patients referred for PN in our institution are surgical patients, where patients with postoperative complications and ileus accounting for one-third of the referrals. The median length of PN days is 9 days, similar to other local studies.^{3,16} The total costs inclusive of manpower for 2791 PN days was approximately S\$1.2 million (S\$450.84 per PN day). The main cost components are from blood tests and PN formulations, which accounted for three-quarters of the total costs. While it is not a huge component of healthcare cost in Singapore, it should be treated with importance as the patients paid for nearly half of the PN-related bills, as PN does not

qualify for major subsidies. Majority of the PN patients were receiving subsidised medical care and the amount of subsidies provided amounted to approximately S\$433,000, with the patients paying the remnant S\$590,000 (46.9% of total costs). Manpower costs amounted to S\$235,000 for the 2791 PN days and this was not included in the bill.

In our PN population, majority of patients on PN can progress safely to oral or enteral nutrition. Of the 36 patients with short-term PN, all of them progressed safely to oral and enteral nutrition without any complications and may have avoided the need for PN. A total of 140 PN days (S\$ 525.39 per PN day) could have been saved if patients were transitioned to oral/enteral nutrition earlier. This would have also saved approximately S\$74,000 (PN-related and manpower costs), of which S\$43,000 (57.3%) were payable by the patients. While PN is indicated for patients who are unable to progress to enteral or oral diet within 5 to 7 days, it could have been avoided in these 36 patients if they were trialled on oral/enteral feeds before referring for PN support.

Similar conclusions encouraging the trial of oral or enteral feeding have been reported by other authors.^{3,6-8,16} A large number of studies have shown that enteral nutrition can be started for patients postgastrointestinal surgery without problems.¹⁷⁻²⁰ Surgical teams should assess patient suitability for insertion of a feeding jejunostomy during the time of operation. This will help reduce the need for postoperative PN support. In our patient group, majority of the patients did not require insertion of feeding tubes and could have progressed to oral trials easily.

In the Singapore healthcare model where maximum daily Medisave withdrawal is only S\$450, this has implications on the daily medical bills. For example, a subsidised patient would have spent half of the daily permissible Medisave withdrawal on paying the PN associated bills. Any excess payments would have to be paid in cash if the patient has

no other healthcare insurance. This will deplete Medisave funds, which may be required in future hospital admissions or other medical payments.

Additionally, the provision of PN requires intensive manpower to assess patient, monitor progress, preparation and administration of PN bags. Approximately 327 hours, translating to S\$14,400 was invested on patients with short-term PN that were avoidable. Better manpower could have been spent on other aspects of patient care, should the patient have been initiated with enteral nutrition or oral diet. Initiating enteral or oral nutrition will result in 10 to 15 fold decreases in hospitalisation costs based on a 1500 to 2000 kcal daily requirement.

Initiation of PN requires extensive blood tests that are costly for the institutions as majority of the blood tests, are provided at a subsidised rate. Central venous line insertion is also required for central PN initiation and PICC line is the main option for patients in our institution. For the short-term PN cases, the insertion of central venous lines increases the medical cost and risk of line infections for these patients. PN is associated with increased central line-associated bloodstream infections in a number of studies.²¹⁻²⁴

Initiating PN also requires additional blood taking, which may lead to spurious blood work.²⁵ Although such occurrences are rare and we were unable to identify if any of our patients had spurious blood work for this study, it may possibly lead to unnecessary medical intervention and costs. The initiation of PN in these patients may have inadvertently increased the LOS and the medical bill size because of the extended period of stay. The Enhanced Recovery After Surgery (ERAS[®]) guidelines for elective colorectal surgery recommend “preoperative fasting should be minimised and postoperatively patients should be encouraged to take normal food as soon as possible after surgery”.²⁶

One of the limitations in this study is that we estimated the time taken for individual patient review. However, it is likely that we may have underestimated the time taken as patients on PN tend to have more complicated medical conditions, hence requiring much more time during the ward rounds. The other limitation is that we were unable to determine the number of patients who required activating Medishield coverage or financial support assistance from the hospital’s social work department. This has implications on the final medical bill size that the patient needs to pay, as well as the amount of financial assistance the hospital needs to provide should the patient have insufficient medical funds coverage.

Conclusion

In this study, 90% of patients in our acute care hospital who were referred for PN had underlying surgical conditions. The total cost of providing PN, including manpower

cost, was \$450.87 per PN day of which 46.9% of total cost was payable by patients. Majority of the cost for PN administration came from the cost of PN bags and blood tests; 18.8% of our study cohort had short-term PN which could have been avoided. This translated to higher PN cost at \$525 per PN day, of which 57.3% was payable by patients. The cost for patients on short-term avoidable PN was up to 60% more compared to those who needed long-term PN. In addition, extensive manpower hours were required to manage this group of patients and manpower costs of S\$14,400.33 were fully borne by the hospital. Clinicians should assess patient’s suitability for oral/enteral feeding to limit the use of short-term PN. The MOH may also need to look into the possibility of providing subsidy for PN, or include PN to be centrally purchased through the healthcare cluster’s Group Procurement Office. This will standardise the price of PN and benefits from bulk purchase will be passed on to the patients.

REFERENCES

1. Braga M, Ljungqvist O, Soeters P, Fearon K, Weimann A, Bozzeti F. ESPEN Guidelines on parenteral nutrition: surgery. *Clin Nutr* 2009;28:378-86.
2. McClave SA, Martindale RG, Vanek VW, McCarthy M, Roberts P, Taylor B, 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;33:277-316.
3. Chuah SW, Ng DH, Liu P, Liu MH, Ng JL, Ling KL. The use of parenteral nutrition in an acute care hospital. *Ann Acad Med Singapore* 2013;42:395-400.
4. ASPEN Board of Directors and the Clinical Guidelines Task Force. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. *JPEN J Parenter Enteral Nutr* 2002;26:1s-138s.
5. Kennedy JF, Nightingale JM. Cost savings of an adult hospital nutrition support team. *Nutrition* 2005;21:1127-33.
6. Trujillo EB, Young LS, Chertow GM, Randall S, Clemons T, Jacobs DO, et al. Metabolic and monetary costs of avoidable parenteral nutrition use. *JPEN J Parenter Enteral Nutr* 1999;23:109-13.
7. DeLegge MH, Basel MD, Bannister C, Budak AR. Parenteral nutrition use for adult hospitalized patients: a study of usage in a tertiary medical center. *Nutr Clin Pract* 2007;22:246-9.
8. Maurer J, Weinbaum F, Turner J, Brady T, Pistone B, D’Addario V, et al. Reducing the inappropriate use of parenteral nutrition in an acute care teaching hospital. *JPEN J Parenter Enteral Nutr* 1996;20:272-4.

9. Turpin RS, Canada T, Liu FX, Mercaldi CJ, Pontes-Arruda A, Wischmeyer P. Nutrition therapy cost analysis in the us: pre-mixed multi-chamber bag vs compounded parenteral nutrition. *Appl Health Econ Health Policy* 2011;9:281-92.
10. Achach K, Peroux E, Hebuterne X. [Economic assessment of different administration modes for total parenteral nutrition]. *Gastroenterol Clin Biol* 2002;26:680-5.
11. Berlanda D, Sabin P, Gimeno-Ballester V, Romero-Jiménez R, Zapata-Rojas A, Marquez E, et al. Cost analysis of adult parenteral nutrition systems: three-compartment bag versus customized. *Nutr Hosp* 2013;28:2135-41.
12. Menne R, Adolph M, Brock E, Schneider H, Senkal M. Cost analysis of parenteral nutrition regimens in the intensive care unit: three-compartment bag system vs multibottle system. *JPEN J Parenter Enteral Nutr* 2008;32:606-12.
13. Batani RA, Kadir NA, Bahari MB. Evaluation of the parenteral nutrition services in Hospital Pulau Pinang. *Malaysian J Pharm Sci* 2006;4:25-32. Available at: http://web.usm.my/mjps/mjps04022006/mjps04022006_3.pdf. Accessed on 2 May 2014.
14. Batani RA, Abdullah D, Bahari MB. Evaluation of the total parenteral nutrition service at Universiti Sains Malaysia Hospital. *e-SPEN* 2007;2:e111-e5. Available at: [http://www.clinicalnutritionespen.com/article/S1751-4991\(07\)00034-0/fulltext](http://www.clinicalnutritionespen.com/article/S1751-4991(07)00034-0/fulltext). Accessed on 2 May 2014.
15. Ministry of Health. Costs and Financing 2013. Available at: http://www.moh.gov.sg/content/moh_web/home/costs_and_financing/financing.html. Accessed on 2 May 2014.
16. Chan SL, Luman W. Appropriateness of the use of parenteral nutrition in a local tertiary-care hospital. *Ann Acad Med Singapore* 2004;33:494-8.
17. Akashi Y, Hiki N, Nunobe S, Jiang XH, Yamaguchi T. Safe management of anastomotic leakage after gastric cancer surgery with enteral nutrition via a nasointestinal tube. *Langenbecks Arch Surg* 2012;397:737-44.
18. Harvey SE, Parrott F, Harrison DA, Bear DE, Segaran E, Beale R, et al. Trial of the route of early nutritional support in critically ill adults. *N Engl J Med* 2014;371:1673-84.
19. Gerritsen A, Besselink MG, Cieslak KP, Vriens MR, Steenhagen E, van Hillegersber R, et al. Efficacy and complications of nasojejunal, jejunostomy and parenteral feeding after pancreaticoduodenectomy. *J Gastrointest Surg* 2012;16:1144-51.
20. Kudsk KA, Croce MA, Fabian TC, Minard G, Tolley EA, Poret A, et al. Enteral versus parenteral feeding. Effects on septic morbidity after blunt and penetrating abdominal trauma. *Ann Surg* 1992;215:503-11.
21. Beghetto MG, Victorino J, Teixeira L, deAzevedo MJ. Parenteral nutrition as a risk factor for central venous catheter-related infection. *JPEN J Parenter Enteral Nutr* 2005;29:367-73.
22. Casaer MP, Mesotten D, Hermans G, Schetz M, Meyfroidt G, Van Cromphaut S, et al. Early versus late parenteral nutrition in critically ill adults. *N Engl J Me* 2011;365:506-17.
23. Ippolito P, Larson EL, Furuya EY, Liu JF, Seres DS. Utility of electronic medical records to assess the relationship between parenteral nutrition and central line-associated bloodstream infections in adult hospitalized patients. *JPEN J Parenter Enteral Nutr* 2015;39:929-34.
24. Yilmaz G, Koksall I, Aydin K, Caylan R, Sucu N, Aksoy F. Risk factors of catheter-related bloodstream infections in parenteral nutrition catheterization. *JPEN J Parenter Enteral Nutr* 2007;31:284-7.
25. Fairholm L, Saqui O, Baun M, Yeung M, Fernandes G, Allard JP. Monitoring parenteral nutrition in hospitalized patients: issues related to spurious bloodwork. *Nutr Clin Pract* 2011;26:700-7.
26. Gustafsson UO, Scott MJ, Schwenk W, Demartines N, Roulin D, Francis N, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Clin Nutr* 2012;31:783-800.