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Parenteral nutrition: How do patients initiated in the intensive care unit differ from those on the ward?

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SUMMARY

Background: Parenteral nutrition (PN) is important to maintain adequate nutrition in patients who have a non-functioning gastrointestinal tract. Our aim was to characterise patients receiving PN initiated in the intensive care unit (ICU) or the general wards.

Methods: Data from patients who received PN in two Australian hospital sites within a single health service between June and December 2016 (inclusive) was retrospectively collected. Demographics, cause for admission, indication and duration, and complications of PN were recorded. The latter included time to PN commencement, refeeding hypophosphataemia, biochemical liver dysfunction, hypoglycaemia and line sepsis.

Results: Sixty-one patients received PN during this period. There was no delay between referral and commencing PN in ICU whilst seven (21.2%) ward patients were delayed by an average of 2.0 days ($p = 0.01$). Ward patients averaged 8.1 days of negligible oral intake compared with 4.3 days in ICU ($p = 0.002$). Complications were recorded in 19 (67.9%) ICU PN patients and 13 (39.4%) ward PN patients ($p = 0.04$). Refeeding hypophosphataemia was detected in three (9.1%) ward patients and six (21.4%) in ICU. There were eight (24.2%) cases of liver biochemical abnormality post commencing PN on the ward compared with 14 (50%) in ICU. There was no difference in hospital length of stay or survival between the groups.

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Conclusions: Patients receiving nutritional support initiated in the ICU were commenced on PN sooner than patients on the ward but experienced more complications. Ward patients experienced negligible oral intake for almost twice as long as ICU patients.

Introduction

Parenteral nutrition (PN) is a therapeutic intervention to support nutrition in patients who are unable to be enterally fed. PN is indicated in patients with prolonged gastrointestinal tract dysfunction or afflicted with a disorder in which enteral nutrition is contraindicated such as bowel obstruction, severe malabsorption, or high enteric fistulae [1]. Patients with low body mass index, substantial weight loss or evidence of inflammatory activity are more likely to benefit from PN [2]. Where possible enteral feeding is the favoured delivery of nutrition due to lower rates of adverse events compared to PN such as refeeding syndrome, liver dysfunction, and central line associated blood stream infections (CLABSI).

Initiation of PN involves referral to a multi-disciplinary nutrition team for assessment of nutritional status to determine appropriate feeding route, formulations, monitoring and follow-up. The Eastern Health (Melbourne, Australia, catchment population of 750,000) nutrition team consists of dietitian, pharmacist, liaison nurse, and intensive care specialist. Our aim was to characterise and compare patients receiving PN initiated in the intensive care unit (ICU) with those initiated in a general ward.

Materials and methods

The nutrition team provides a PN service in two hospitals within Eastern Health. Both provide seven-day access to clinical nutrition and pharmacy services. Deidentified data from all patients who received PN between 1st June and 31st December 2016 (inclusive) was retrospectively collected from medical records. Patients were divided into two cohorts according to ward of initiation: ICU or general medical and surgical wards (ward). Ethical and governance approval including waiver of consent was obtained from the Eastern Health Human Research Ethics Committee and carried out in accordance with the principles of the Helsinki Declaration.

Demographics, reason for hospital admission, period of negligible oral intake, indication and duration of PN were recorded. 'Negligible oral intake' was determined by nutritional assessment carried out by the dietitian and defined as less than 50% of daily caloric requirement [2]. Complications included refeeding hypophosphataemia (as a surrogate for refeeding syndrome [3]), abnormalities of liver biochemistry, hypoglycaemia, CLABSI, and a composite of all complications. Refeeding hypophosphataemia was defined as a fall of serum phosphate levels by more than 0.16 mmol/L to below 0.65 mmol/L within 72 h of starting nutritional support [4]. Liver dysfunction was defined as a new elevation of alanine aminotransferase (ALT), aspartate aminotransferase (AST) or alkaline phosphate (ALP) greater than three times the upper limit of baseline. Hypoglycaemia was defined as blood sugar level <4.0 mmol/L. Descriptive statistics are presented as a number (%), prevalence (95% CI), median (IQR) or mean (SD). Categorical data were compared using Fisher's exact test, and parametric data by independent t-test with a p value < 0.05 considered significant.

Results

During the seven-month period there were 65,499 ward and 1501 ICU admissions. Sixty-one patients received PN during this period: thirty-three (54.1%) were commenced on the ward and twenty-

eight (45.9%) in ICU. Patient demographics are summarised in Table 1. Indications for PN are outlined in Table 2.

The prevalence of PN on the ward was 2.3 (95% CI: 2.1–2.6) PN days per 1000 bed-days compared to 17.4 (95% CI: 15.3–19.8) in ICU ($p < 0.001$). The median duration of PN of 7.0 days (5.0–10.0) did not differ between ward and ICU patients (Table 1). The mean energy requirement on commencement of PN was 7.7 MJ/day (6.0–9.4) with no significant difference between ward and ICU recipients ($p = 0.34$). Only one (1.6%) patient received enteral feeding prior to commencement of PN.

There was no delay between referral to commencement of PN in ICU patients whilst seven (21.2%) ward patients experienced a median delay of 2.0 days (IQR = 1.0–4.0; $p = 0.01$) to commencement. Twelve (36.4%) ward patients had negligible oral intake for ten or more days before referral for PN compared with two (7.1%) in ICU ($p = 0.01$). Patients on the ward had a median of 8.0 (4.0–10.0) days of negligible oral intake compared with 3.0 (1.0–6.0) days in ICU ($p = 0.002$).

Reported complications associated with PN are shown in Table 1. Thirty-two (52.5%) experienced one or more complications; nineteen (67.9%) in ICU and thirteen (39.4%) in ward patients ($p = 0.04$). Refeeding hypophosphataemia was detected in nine (14.7%) patients; three (9.1%) ward and six (21.4%) ICU patients ($p = 0.18$). Duration of negligible oral intake was not associated with risk of refeeding hypophosphataemia ($p = 0.18$). Nor was there any significant difference in the median body mass index between patients with refeeding hypophosphataemia (median 23.6 kg/m^2; IQR = 15.4–26.0) and those without (median 24.0 kg/m^2; IQR = 21.0–28.4; $p = 0.33$).

There were twenty-two (36.1%) cases of liver biochemistry abnormality. The number in ICU ($n = 14$, 50.0%) in ICU was not significantly higher than in the ward patients ($n = 8$, 24.2%; $p = 0.06$). The median body mass index in patients with liver biochemistry abnormalities was 23.3 kg/m^2 (19.2–27.0) compared with 26.0 kg/m^2 (20.7–30.1) in those without ($p = 0.19$). Three (4.9%) patients experienced hypoglycaemic events.

There were no reported case of CLABSI and the one (3.0%) death on the ward and two (7.1%) in ICU were not associated with nutritional support.

Discussion

This is the first Australian study to compare PN commenced in the ward and ICU. PN was an infrequent therapy (0.1% of admissions and 3-days per 10,000 bed-days) and was frequently associated with biochemical complications (52.5%). The most common complication was liver dysfunction (36.1%).

In our service model 54% of PN therapy was initiated on the ward, and although these patient were more likely to experience a delay in commencement they experienced fewer complications than those

Table 1
Demographics and complications of parenteral nutrition recipients.

	Ward (n = 33)	ICU (n = 28)	p value
Hospital admissions[a], n (%)	65,499	1501 (2.2%)	–
Hospital bed days[a], n (%)	167,093	14,620 (8.0%)	–
Study population, n (%)	33 (54.1%)	28 (45.9%)	<0.001
Male Gender, n (%)	18 (54.5%)	16 (57.1%)	1.00
Median Age [IQR], years	63.0 [53–72]	68.5 [55–77]	0.322
Median BMI [IQR], kg/m^2	22.5 [19.8–28.4]	25.0 [22.1–27.9]	0.529
Surgical admission, n (%)	24 (72.7%)	26 (92.9%)	0.051
Medical admission, n (%)	9 (27.3%)	2 (7.1%)	0.051
Median hospital length of stay [IQR], days	18.0 [11.0–27.0]	22.0 [16.0–27.0]	0.611
Median days negligible intake prior to PN [IQR], days	8.0 [4.0–10.0]	3.0 [1.0–6.0]	0.002
Median days on PN [IQR], days	6.0 [4.0–9.0]	7.5 [5.8–10.0]	0.429
Mean energy requirement starting PN, MJ/day (SD)	7.9 (6.4–9.4)	7.4 (5.6–9.3)	0.335
Adverse biochemistry, composite outcome n (%)	13 (39.4%)	19 (67.9%)	0.040
Refeeding hypophosphataemia, n (%)	3 (9.1%)	6 (21.4%)	0.279
Abnormal liver function tests, n (%)	8 (24.2%)	14 (50.0%)	0.063
Hypoglycaemic episode, n (%)	2 (6.1%)	1 (3.6%)	1.00

[a] Exclude day case procedures/admissions.

Table 2
Indication for parenteral nutrition.

	Ward (n = 33)	ICU (n = 28)	p-value
Bowel obstruction	10 (30.3%)	7 (25.0%)	0.777
Paralytic ileus	6 (18.2%)	3 (10.7%)	0.488
Bowel perforation	5 (15.2%)	3 (10.7%)	0.716
Ischaemic bowel disease	1 (3.0%)	5 (17.9%)	0.085
Prolonged bowel rest[a]	3 (9.1%)	3 (10.7%)	1.00
Gastric outlet obstruction	3 (9.1%)	1 (3.6%)	0.618
Mucositis secondary to autologous stem cell transplant (ASCT)	2 (6.1%)	1 (3.6%)	1.00
Neutropenic enterocolitis post ASCT	2 (6.1%)	0 (0%)	0.495
Anastomotic leak	1 (3.0%)	1 (3.6%)	1.00
Oesophageal perforation	0 (0%)	2 (7.1%)	0.201
Upper gastrointestinal tract resection	0 (0%)	2 (7.1%)	0.201

[a] Enteral feeding contraindicated or not tolerated due to underlying disease (advanced inflammatory bowel disease, short bowel syndrome and refractory emesis secondary to sepsis).

receiving earlier PN therapy in ICU. This may reflect other clinical factors such as comorbidity and illness severity.

Patients on the ward commenced PN after a median of eight days of negligible oral intake compared with three days in ICU. Delay in commencement of PN in ward patients was due to several factors, including delay to referral, and delay to placement of central venous access.

The evidence for early commencement of PN (within 48 h) remains controversial. ESPEN guidelines [5] suggest that clinically assisted nutrition should be considered for patients staying in ICU for more than 48 h and PN considered when enteral nutrition is not tolerated. Recent large randomised trials, however, have found that delayed initiation of PN until 8 days after admission to ICU was associated with faster recovery and fewer complications [6].

The rate of biochemical complications was significantly higher in the ICU cohort but the study size was insufficient to provide further insight. This may be accounted for by severity of illness and higher risk of malnutrition [7] in the ICU cohort. These represent potential latent (confounding) factors [8,9]. The frequency of monitoring is higher in ICU and thus the rate of biochemical events may also reflect this systematic bias. The absence of CLABSI in this study is consistent with low published rates of less than 1% in ward patients and less than 2% in ICU patients receiving PN [10,11].

ESPEN guidelines categorise risk of refeeding syndrome on the basis of multiple factors including body mass index (less than 18 kg/m^2), extensive weight loss and negligible oral intake for greater than 10 days prior to commencing PN [12]. Refeeding syndrome is far less common than its hallmark feature, acute hypophosphataemia [13]. Refeeding hypophosphataemia occurred in 14.8% of our population but none developed refeeding syndrome. Nor did we find an association with duration of fasting or body mass due to the small study size. Caloric restriction in conjunction with electrolyte replacement is a suitable therapeutic option for refeeding syndrome in critically ill adults [14,15]. Although outcomes relating to the management of refeeding syndrome were not measured in this study, these findings represent an area for further exploration in the ward management of refeeding syndrome. Guidelines facilitating timely referral and engagement with the nutritional service may assist nutritional support and minimise preventable or prolonged nutritional deficits.

Conclusion

PN is an infrequent complex therapeutic intervention associated with significant complications. Patients receiving PN initiated in the ICU were commenced sooner than PN initiated on the ward, and patients on the ward experienced negligible oral intake for effectively twice as long. There were no observed differences in patient outcomes due to the small study size. Further investigation of earlier intervention and service delivery in ward patients may be warranted.

Statement of authorship

All persons who meet authorship criteria are listed as authors, and all authors participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript.

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