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Parental nutrition in emergency surgery: a multicentre cross-sectional study

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On behalf of The Nutrition in Emergency Surgery (NEmS) collaborative (appendix one)

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Key words: Emergency general surgery; nutritional assessment; parenteral nutrition; delivery of nutrition; decision making.

Abstract

Background

Emergency general surgical patients are inherently at high risk of malnutrition. Early decision making with implementation is fundamental to patient recovery. For many patients, parenteral nutrition (PN) is the only feeding option available. This study assesses the timing and outcomes of this decision making process.

Methods

A sample of at least 10 consecutive adult patients admitted as a general surgical emergency to eight UK hospitals over one year whom had received PN. Patient demographics, basic descriptors and nutritional data were captured. Process measures regarding dates decisions were made or activities completed were extracted from records, as were outcome measures including PN complications. Six time frames examining the process of PN delivery were analysed. Associations between categorical and binary variables were investigated with chi-squared test with significance determined if $p < 0.05$.

Results

A total of 125 patients were included. Intestinal obstruction was the most common diagnosis with 59% of all patients deemed high risk on nutritional assessment at admission. Median time to decision for PN was five days following admission (n = 122, IQR 7). Patients received PN for a mean of 11 days. Eighty-five percent of patients developed a complication; a phosphate abnormality was the most commonly reported (54%). Only altered blood glucose levels appeared to correlate with a delay in starting PN ($p<0.01$).

Conclusion

This study shows there are delays in the decision to use PN in the acutely ill surgical patient. Once initiated, the pathway is relatively short. There are high rates of electrolyte abnormalities in this population.

Introduction

Emergency general surgery provides complex management for patients admitted with an acute surgical pathology ([1]). Poorer outcomes have been established in this high risk group in the UK ([2,3]) and globally ([4,5]). The emergency general surgery patient population is also commonly an at-risk patient group for being malnourished. There may be a variety of reasons including; poor oral intake prior to admission, greater fluid disturbances, being kept nil by mouth while awaiting or recovering from emergency surgery, and then proceeding to surgery which in itself has a metabolic stress response exacerbating the issue ([6]).

It is recommended all patients admitted to hospital within the UK are assessed with a nutritional screening tool for malnutrition, for example, the Malnutrition Universal Screening Tool (MUST) ([7,8]). Both admission and 'highest during admission' MUST scores predict the need for artificial nutritional support ([9]). Many patients with acute abdominal pathology will also have type I intestinal failure, leading to a high risk of malnutrition. This means that parenteral nutrition (PN) is the only option for a number of acute surgical patients who will have a prolonged period without adequate oral or enteral nutrition, due to intestinal obstruction, perforation or failure ([10,11]). In the UK, nutritional support for those malnourished or considered at risk of malnutrition is recommended ([7]). Guidelines from European and American Societies for Parenteral and Enteral Nutrition offer relatively less clarity and focus on the use of PN in the elective surgical patient ([12,13]). Malnutrition is recognised as having significant negative effects in the elective setting ([13–15]). Similar observations have been made in the emergency setting ([16]), but evidence on the efficacy of interventions for the acutely unwell surgical patient is lacking.

The process to commence PN may be challenging. Vascular access must be secured ([17–19]) and input of Nutritional Support Teams (NST) is recommended([7,10,20–22]). In addition, the patient must undergo metabolic optimisation to avoid or minimise the occurrence of electrolyte abnormalities which may lead to refeeding syndrome ([23–25]). Previous work has suggested that variations in availability and access to nutrition and related services might be related to the use of it in the emergency setting ([26]). It has also been suggested that recognition of the risk of malnutrition does not lead to the use of nutritional interventions ([27]).

This study aimed to review the pathway to receiving parenteral nutrition and associated outcomes in emergency general surgical patients in the UK. Specific objectives were 1) to examine the time frames to initiate PN and identify potential delays for commencing PN; 2) to consider whether

patients assessed as high risk using a validated risk assessment tool were also considered high risk of refeeding syndrome clinically; 3) to assess whether patients deemed high risk of refeeding syndrome were given appropriate supplementation (thiamine/ B12); and 4) review the outcomes of patients who received PN in terms of common electrolyte disturbances, and line related complications.

Methods

This study is reported with reference to the STROBE guidelines ([28]). It is a multi-centre, retrospective study of consecutive patients receiving PN between January and December 2018.

Centre selection

Candidate centres were identified through participation in previous emergency surgery audit work ([29]). A convenience sample of 8 sites from different geographical regions of the UK was purposively selected to ensure local or regional policies did not bias findings. All sites provided emergency surgical services and have the capacity to provide parenteral nutrition in the emergency setting.

Case identification

Adult patients aged 18 and over admitted as a general surgical emergency that had received PN during their admission were identified at each centre. Eligibility was confirmed by cross referencing admission records with records of the local nutrition specialist team. All general surgical emergencies, as were both non-operative and operative cases eligible for inclusion. Sites were asked to identify approximately 10 consecutive patients to allow comparison.

Data extraction

Records were reviewed by local collaborators to confirm eligibility. Data were collected from three time points during the patient's admission; on admission; decisions relating to parenteral nutrition; and outcomes following PN. Data was collated locally, and anonymised data was uploaded to a central REDCap server ([30]) which is housed at the University of Sheffield. The server is encrypted and accessible only by username and password through an SSL connection within a browser. A sample collection report form and definitions are shown in appendix two.

Admission data

Data relating to demographics (age, sex, height, weight), surgical diagnosis ('intestinal obstruction', 'intra-abdominal sepsis', 'intestinal perforation', 'intestinal ischaemia' and 'other intra-abdominal condition'), biochemical markers (white cell count $x10^9$/L (WCC) and albumin (g/L) on admission) and the date of the first nutritional assessment were collected. Body Mass Index (BMI) was calculated from weight (Kg)/height (m^2).

Process measures/definitions

Process measures namely constituted dates decisions were made or activities completed, as defined in appendix 2. These included a date for: admission; decision for PN; line requested; line inserted; PN started; and PN stopped. This allowed for the time frames between two decisions to be analysed. In addition, data regarding the type of line used for PN (dedicated cannula/ peripherally inserted central catheter (PICC)/central venous catheter (CVC)/other) and type of PN used (standard, bespoke or other), as well as whether patients were considered high risk of refeeding syndrome (yes/no) and subsequently prescribed supplementary thiamine/ B12 (yes/no).

Outcome definitions

Data relating to the following binary (yes/no) variables were collected: occurrence of hypophosphataemia (serum phosphate <0.8mmol/L); hypokalaemia (serum potassium <3.5mmol/L); deranged liver function tests (serum aspartate aminotransferase (AST)/ alanine aminotransferase (ALT) or alkaline phosphatase (ALP) or bilirubin 1.5x upper limit of normal); and line sepsis (culture confirmed or clinically suspected).

Nutritional screening tools

The nutritional assessment screening tools used were the Malnutrition Universal Screening Tool (MUST), which was used in seven of the eight centres, all in England, and the All Wales Adult Nutritional Risk Screening Tool 'Weight, Appetite, Ability to eat, Stress factor, Pressure ulcer/wound' (WAASP) used in Wales, had scores converted from raw scores to low-, medium- or high-risk to facilitate maximum data inclusion ([8,31]). An assessment by the EGS team of risk of refeeding syndrome (low, medium, high) in each patient was also included. This assessment was based on clinical grounds without use of an objective score.

Ethical approvals

Use of routinely collected data to improve clinical services does not require formal research ethics approval in the UK, and can be approved as a service evaluation at a local level. Local approvals were secured for each participating site prior to data collection.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics version 10. The number of days between two decisions (e.g. decision between admission and line request) were calculated using standard formula between two dates with Microsoft Excel 2010, then analysed as continuous data, and categorical data after grouping according into 0-5 days, 6-10 days, 11-15 days, and more than 16 days to account for the effect of outliers. The first group 0-5 days comprises the same day (day

0) and five days from this. These were pre-determined groups prior to analysing the data set. Groups of five days were chosen to align with NICE guidance advising nutritional support for those that are identified as malnourished or considered at risk of malnutrition is started within five days of admission, and there are typically five working days in a standard week. Six time frames examining the process of PN delivery to patients were considered to identify potential delays for commencing PN.

These included the: 1) number of days between the date of admission and the date the decision for PN was made; 2) number of days between date of line request and line insertion; 3) number of days between line insertion and starting PN; 4) number of days between date decision was made and starting PN; 5) number of days between admission and starting PN; 6) and, duration of PN. Independent samples median test was used to compare process measures between sites. Only patients with complete data for the variables of interest were analysed, and the number of patients included in each analysis are displayed. Estimated numbers of cases per site were calculated as (365/number of days to identify consecutive cases) x number of cases submitted, and rounded up to the nearest whole number. Associations between categorical and binary variables were investigated with chi-squared test with significance determined if $p < 0.05$. Patients identified as low risk of malnutrition were compared to those identified as high risk by linear regression analysis for number of days between PN start and PN stopped, and admission and starting PN (with number of days as a continuous variable).

Results

Summary

A total of 125 patients were included, slightly over half of which were male (54% male (n = 67), 46% female (n = 57); 1 missing data). Characteristics and admission data relating to demographics is shown in table one. There were no significant differences in sex regarding age, height, weight, body mass index, white cell count or albumin at admission (results not shown). Intestinal obstruction was the most common diagnosis (47%, n = 59), followed by intestinal perforation (22%, n = 27). The number of patients scored low, medium and high risk were 35% (n = 42), 5.6% (n = 7) and 59% (n = 71), respectively. Patients typically received PN for 11 days (mean 11.4 days, median 9 days, n = 123, SD = 13.2, IQR = 8), with half of the patients having 'off the shelf' PN (51%, n = 62).

Site characteristics

All sites contributed at least fifteen patients to the study over a period of 95-296 days (mean 151/median 124). The estimated number of emergency surgery cases receiving PN ranged from 18-58 per year (mean = 41.8/median = 47). This is summarised in table two.

Process of PN delivery

Table three and figure one summarise the various time frames in the process of PN delivery.

Number of days between the date of admission and the date the decision for PN was made: Although for almost two thirds of patients the decision was made for PN within the first five days of their admission (64%, n = 78), the median time to decision for PN was four days (n = 122, IQR = 7). *Number of days between date of line request and line insertion*: The majority of lines were inserted on the same day (76%, n = 80) or the next day (91%, n = 96). All lines were inserted by day 6. The median number of days from request to insertion was 0 (n = 105, IQR = 0). *Number of days between line insertion and starting PN:* Almost all patients had PN started within three days of their line insertion (92%, n = 101, median = 0, IQR = 1). *Number of days between date decision was made and starting PN*: Almost all patients (97%, n = 118) started PN with five days of deciding it was appropriate, with over half (51%, n = 62) of all patients starting PN on the same day, and the majority (81%, n = 98) within 1 day of the decision being made. All patients started PN within one week of the decision for PN. *Number of days between admission and starting PN*: Over half of patients started PN within five days of admission (59%, n = 74). Median days from admission to starting PN was 5 days (n = 125, IQR = 5). *Duration of PN:* Patients received PN for a mean period of 11 days (SD = 13.2). There was no significant difference in the number of days on PN for

patients identified as low risk when compared to patients identified as medium (β = -0.9 (95%CI = -11.6, 9.7), p = 0.854) and high risk (β = 0.3 (95%CI = -4.7, 5.3), p = 0.913). Similarly, there was no significant difference in the number of days between admission and starting PN for patients identified as low risk when compared to patients identified as medium (β = -0.74 (95%CI = -5.9, 4.5), p = 0.780) and high risk (β = 1.1 (95%CI = -1.4, 3.5), p = 0385). One site showed significantly shorter time from admission to line request, but no variation in other parameters.

Of those patients identified as high risk using a validated malnutrition score, fewer than six out of ten were considered high risk of refeeding syndrome clinically (59%, n = 42/71). Conversely, of those patients identified as low risk using a validated malnutrition score, almost half of patients were considered high risk of feeding syndrome (48%, n = 20/42).

In patients identified as high risk of refeeding syndrome clinically, almost 80% of patients subsequently received supplementary vitamin supplementation (79%, n = 51/65). Conversely, of those patients considered low risk of refeeding syndrome clinically, one third of patients received supplementary vitamin supplementation (36%, n = 21/59). Overall, just over half the patients received supplementary vitamin supplementation regardless of their risk (58%, n = 72/124).

Complications of PN

PN related complications affected 83% of patients, and 46% of patient experienced two or more complications. Hypophosphataemia was the most common abnormality recorded at 52%. When considering the duration variables as categorical data, there was no difference identified in relation to the number of days between PN started and PN stopped and hypophosphataemia, hypokaelaemia altered LFTs, blood sugar or 'any complication' (table four). However there was a significant difference between an increased number of days prior to use of PN and hypokalaemia (p = 0.049).

PICC lines were the most common route of vascular access (52%, n = 64). CVCs were used in 44% (n = 54) and cannulas were only used in 3.0% of patients (n = 4). Overall, line sepsis was present in 7.1% (n = 9) patients. There were no significant differences between line type and risk of line sepsis (n = 123, df = 3, X^2 = 4.59, p = 0.204). In addition, when considering the duration variables as categorical data, there were no significant differences when assessing for line sepsis in relation to the number of days between admission and PN started, or in relation to the number of days between PN started and PN stopped (table four).

Discussion

This study has evaluated the process of initiating and implementing nutritional support in emergency surgical patients in a range of hospital sites (table two). It shows that the main 'delay' is the time from admission to deciding when to start PN, whereas delays in obtaining adequate venous access or starting PN are minimal.

The decision to use PN was made within five days for almost two thirds of patients, with a median time for the decision of four days from admission. NICE guidance recommends nutritional support for those that are identified as malnourished or considered at risk of malnutrition is started within five days of admission ([7]). Obtaining adequate venous access and starting PN was much more efficient, with the majority of patients (81%) having obtained suitable venous access and having started PN within one day of the decision for PN. Overall, it took five days to start PN from admission (median = 5 days, n = 125, SD = 6.46). Despite this, some patients still experience a delay in the implementation of nutritional support. Although current practice is within guidelines, this time frame does not include the time the patient may actually have not been tolerating oral diet prior to presenting to the emergency surgery team. We know this patient set are high risk patients([27]). In addition to this, almost a third of patients had PN only for 0-5 days, and two-thirds only for 0-10 days. This is a relatively high proportion of patients stopping in a short period of time, and although not assessed here, the appropriateness and effectiveness of this is unknown. The criteria for evaluating which patients warrant PN was not investigated but would be an interesting avenue.

Emergency general surgery patients can be complex, and it takes time for the diagnosis and most appropriate treatment plan to unveil itself. Intestinal obstruction was the most common diagnosis in approximately a third of patients, whom may have been given a 'trial' period conservative management with the hope their obstruction settles, and only if it did not was the decision made for PN ([32]). If this was the case, it is not known whether PN was initiated pre- or post-operatively, or exactly the nature of the intestinal obstruction. Data assessing timing of surgery was not availabe, though this would be an area to consider in any future studies assessing the impact on nutritional support in EGS patients.

Approximately 40% of patients identified as high risk using a validated malnutrition score were not considered clinically high risk for refeeding syndrome. Although the majority (~80%) of patients at high risk of refeeding syndrome clinically did receive supplementary vitamins to minimise their

risk, there is room for improvement. Nutritional risk assessments are commonly completed at admission and may not be repeated frequently throughout the patient's duration of stay; they remain a static measure despite the patient's circumstances changing. This study found the time between admission and starting PN, as well as duration of PN was not associated with severity of risk as identified using a nutritional risk assessment. This suggests that the nutritional assessment at admission is not a good predictor of the need for or duration of support. Further, supplementation with thiamine, vitamin B and a balanced multivitamin before and during the first ten days of feeding is recommended if there is a high risk of refeeding syndrome ([7,25,33]). It is unclear why a substantial number of patients considered clinically high risk of refeeding syndrome were not prescribed supplementary vitamins. This may be difficult to untangle. It may be due to poor documentation of refeeding risk or decisions ([20]) and/ or clinicians' perceptions of risk itself ([34–37]).

Finally, although no concise definition exists for refeeding syndrome, it typically features electrolyte imbalance including hypophosphataemia. ([38]). This was seen in this study, along with widespread electrolyte abnormality. Almost every patient encountered a complication (electrolyte imbalance or line sepsis) at some point during their PN treatment, with hypophosphataemia being the most common. The rate of hypophosphataemia was slightly more common than reported in some studies [[39]], and much higher than the 6% reported in others ([40]). This may have been due to a difference in diagnostic criteria, and selection of patients from general surgical wards. In contrast, patients in an intensive care setting would have daily blood tests and closer monitoring, potentially allowing identification of early changes, and early mitigation of such disturbances ([20]). Further, this study did not account for other risk factors such as alcohol abuse, diabetic ketoacidosis, or sepsis, which are known to result in low phosphate and other electrolyte abnormalities ([41,42]). No difference was found between electrolyte abnormality and delay to starting PN or duration of PN, except hypokalaemia and delay to starting PN. These might also be associated with the underlying surgical pathology. Although not assessed in this study, other studies have also shown there to be no difference in nutritional status and electrolyte abnormalities, or diagnosis and electrolyte abnormalities ([43]). The associated morbidity and mortality, and length of stay due to electrolyte abnormalities, were not assessed but may be worthwhile investigating.

The main limitation of this study was the proportion of patients with incomplete data. Only 87 of 125 patients had complete data for all variables, however data analysis was only performed on variables with complete data sets. Date of line insertion was the most common variable with missing data points. Further, we did not collect data regarding: how the nutritional screening tool was completed and who performed it; whether the score was calculated correctly; whether patients

were reassessed at any point during their admission; whether the score was a contributory factor to the decision for PN; whether the hospital has a NST in situ; and the impact of surgery on the process of PN delivery. Although two nutritional screening tools were used in this study, scores were converted into low-, medium- and high-risk categories for maximum patient inclusion in this study.

However, this study benefits from a broad selection of hospitals within the UK with wide eligibility criteria. It focuses on simple outcome measures with clear definitions, and uniquely, at the processes of an emergency surgical admission throughout the patient's journey from admission to a decision for PN and initiation of PN. This provides a useful dataset to begin further investigation into the clinical problem within this cohort.

Clearly further study is required to investigate the reasons for delays such as those seen here, as well as the high rate of complications regarding PN. The impact of nutritional support teams or nutritional support training amongst surgical teams was beyond the scope of this study, but may warrant further research. Other avenues of research might include tools to provide better prognostication on the need for nutritional support in the acutely ill surgical patient. This data reflects a subset of the surgical population, but might indicate the need for more thorough nutritional screening of patients. This may include early assessment of electrolytes as derangement was prevalent here. Clinicians may also wish to consider local policies to speed up decision making on need for parenteral nutrition.

Conclusion

The process of initiating and implementing nutritional support in emergency surgical patients requires improvement. Sequelae of use of PN are common in this setting.

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Transparency Declaration

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead

author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

References

1. The Royal College of Surgeons of England (2011) Emergency Surgery, standards for unscheduled surgical care, guidance for providers, commissioners and service planners. https://www.rcseng.ac.uk/library-and-publications/rcs-publications/docs/emergency-surgery-standards-for-unscheduled-care/ (accessed July 14).
2. Symons NRA, Moorthy K, Almoudaris AM, et al. Mortality in high-risk emergency general surgical admissions. Br J Surg. 2013;100:1318–25.
3. Pearse RM, Harrison DA, James P et al. Identification and characterisation of the high-risk surgical population in the United Kingdom. Crit Care. 2006;10:10–5.
4. Pearse RM, Moreno RP, Bauer P et al. Mortality after surgery in Europe: A 7 day cohort study. Lancet. 2012;380:1059–65.
5. Havens JM, Peetz AB, Do WS et al. The excess morbidity and mortality of emergency general surgery. J Trauma Acute Care Surg. 2015;78:306–11.
6. Mignini E V, Scarpellini E, Rinninella E et al. Impact of patients nutritional status on major surgery outcome. Eur Rev Med Pharmacol Sci. 2018;22:3524–33.
7. National Institute for Health and Care Excellence. NICE Clinical Guidline 32. Nutrition support for adults: oral nutrition support, enteral tube feeding and parenteral nutrition. 2017.
8. Malnutrition Advisory Group. The “MUST” Report. Nutritional screening of adults: a multidisciplinary responsibility. 2003.
9. Vaughan-Shaw P, Jones S, Saunders JA et al. OC-074 Nutritional assessment and outcome in patients undergoing emergency abdominal surgery. Gut. 2012;61:A32.2-A32.
10. Nightingale J. Nutrition support teams: how they work, are set up and maintained. Frontline Gastroenterol. 2010;1:171–7.
11. Vaizey CJ, Maeda Y, Barbosa E et al. ESCP consensus on the surgical management of intestinal failure in adults. Color Dis. 2016;18:535–48.
12. McClave SA, Taylor BE, Martindale RG 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.). J Parenter Enter Nutr. 2016;40:159–211.
13. Braga M, Ljungqvist O, Soeters P et al. ESPEN Guidelines on Parenteral Nutrition: Surgery. Clin Nutr. 2009;28:378–86.
14. Weimann A, Braga M, Carli F et al. ESPEN guideline: Clinical nutrition in surgery. Clin Nutr. 2017;36:623–50.
15. Weimann A, Braga M, Harsanyi L et al. ESPEN Guidelines on Enteral Nutrition: Surgery

including Organ Transplantation. Clin Nutr. 2006;25:224–44.
16. Havens JM, Columbus AB, Seshadri AJ et al. Malnutrition at Intensive Care Unit Admission Predicts Mortality in Emergency General Surgery Patients. J Parenter Enter Nutr. 2018;42:156–63.
17. Cowl CT, Weinstock J V., Al-Jurf A et al. Complications and cost associated with parenteral nutrition delivered to hospitalized patients through either subclavian or peripherally-inserted central catheters. Clin Nutr. 2000;19:237–43.
18. Pittiruti M, Hamilton H, Biffi R et al. ESPEN Guidelines on Parenteral Nutrition: Central Venous Catheters (access, care, diagnosis and therapy of complications). Clin Nutr. 2009;28:365–77.
19. Horattas MC, Trupiano J, Hopkins S et al. Changing concepts in long-term central venous access: Catheter selection and cost savings. Am J Infect Control. 2001;29:32–40.
20. Stewart J, Mason D, Smith N et al. A mixed bag. An enquiry into the care of hospital patients receiving parenteral nutrition. Natl Confid Enq into Patient Outcome Death. 2010;
21. Shang E, Hasenberg T, Schlegel B et al. An European survey of structure and organisation of nutrition support teams in Germany, Austria and Switzerland. Clin Nutr. 2005;24:1005–13.
22. Delegge MH, True Kelley A. State of nutrition support teams. Nutr Clin Pract. 2013;28:691–7.
23. Reber E, Gomes F, Vasiloglou MF et al. Nutritional Risk Screening and Assessment. J Clin Med. 2019;8:1065.
24. Knochel JP. Complications of total parenteral nutrition. Kidney Int. 1985;27:489–96.
25. Worthington PH, Gilbert KA. Parenteral nutrition: Risks, complications, and management. J Infus Nurs. 2012;35:52–64.
26. Lee MJ, Sayers AE, Wilson TR et al. Current management of small bowel obstruction in the UK: results from the National Audit of Small Bowel Obstruction clinical practice survey. Color Dis. 2018;20:623–30.
27. Lee MJ, Sayers AE, Drake TM et al. Malnutrition, nutritional interventions and clinical outcomes of patients with acute small bowel obstruction: Results from a national, multicentre, prospective audit. BMJ Open. 2019;9:1–14.
28. von Elm E, Altman DG, Egger M et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. Int J Surg. 2014;12:1495–9.
29. Lee MJ, Sayers AE, Drake TM et al. National prospective cohort study of the burden of acute small bowel obstruction. BJS open. 2019;3:354–66.
30. Harris PA, Taylor R, Thielke R et al. NIH Public Access Author Manuscript J Biomed

Inform. Author manuscript; available in PMC 2010 April 1. Published in final edited form as: J Biomed Inform. 2009 April ; 42: 377–381. Research Electronic Data Capture (REDCap. J Biomed Inf. 2009;42:377–81.

31. Jukes A, Wales A, Screening N (2018) Nutrition Screening - working towards an All Wales approach. https://www.bapen.org.uk/pdfs/conference-presentations/2018/tues/symposium-3/Amelia-Jukes.pdf (accessed July 14).

32. Catena F, Di Saverio S, Kelly MD et al. Bologna Guidelines for Diagnosis and Management of Adhesive Small Bowel Obstruction (ASBO) 2010 Evidence-Based Guidelines of the World Society of Emergency Surgery. World J Emerg Surg. 2011;6:5.

33. BAPEN. Refeeding syndrome: Identification of those at risk - Decision Tree. 2012; 3–6.

34. Dilaver NM, Gwilym BL, Preece R et al. Systematic review and narrative synthesis of surgeons' perception of postoperative outcomes and risk. BJS open. 2020;4:16–26.

35. Fisher R. Towards appropriate nutritional prescribing : challenges and solutions. 2019;1:556–64.

36. Barnett N, Kelly O. Deprescribing: Is the law on your side? Eur J Hosp Pharm . 2017;24:21–5.

37. Arrieta A, García-Prado A, González P et al. Risk attitudes in medical decisions for others: An experimental approach. Heal Econ (United Kingdom). 2017;26:97–113.

38. Walmsley RS. Refeeding syndrome: Screening, incidence, and treatment during parenteral nutrition. J Gastroenterol Hepatol. 2013;28:113–7.

39. Marik P, Bedigian M. Refeeding Hypophosphatemia in Critically Ill Patients in an Intensive Care Unit A Prospective Study. Arch Surg. 1996;131:1043–7.

40. Rio A, Whelan K, Goff L et al. Occurrence of refeeding syndrome in adults started on artificial nutrition support: Prospective cohort study. BMJ Open. 2013;3:1–9.

41. Camp M, Allon M. Severe hypophosphatemia in hospitalized patients. Miner Electrolyte Metab. 1990;16:365–8.

42. Braun K, Utech A, Velez ME et al. Parenteral Nutrition Electrolyte Abnormalities and Associated Factors Before and After Nutrition Support Team Initiation. J Parenter Enter Nutr. 2018;42:387–92.

43. Burch NE, Stewart J, Smith N. Are nutrition support teams useful? Results from the NCEPOD study into parenteral nutrition. Gut. 2011;60:A2–A2.

Variable	Median (range, SD)	Total (n)	Missing cases (n)
Age (years)	67.0 (18-90, 15.9)	125	0
Height (m)	1.7 (1.40-1.94, 0.1)	119	6
Weight (Kg)	70.0 (44.0-140.0, 20.2)	121	4
Body Mass Index (Kg/m^2)	24.5 (16.4-61.2, 6.9)	119	6
WCC at admission ($10^9/L$)	11.6 (1.4-33.6, 6.0)	124	1
Albumin at admission (g/L)	34.0 (11.0-76.0, 9.1)	124	1
Diagnosis	**Frequency % (n)**	**Total (n)**	**Missing cases (n)**
Intestinal obstruction	47.2 (59)	125	0
Intra-abdominal sepsis	12.8 (16)		
Intestinal perforation	21.6 (27)		
Intestinal ischaemia	7.2 (9)		
Other intra-abdominal condition	11.2 (14)		

462 Table one: Admission data. n, number of patients; SD, standard deviation.

463

Site	Number of patients	Percentage total	Days between admission of first and last case	Estimated no of cases per year
1	15	11.9	157	35
2	15	11.9	113	49
3	15	11.9	296	18
4	19	15.1	103	53
5	15	11.9	119	46
6	17	13.5	129	48
7	15	11.9	196	28
8	15	11.9	95	58
	126	**100**	**Mean 151**	**Mean 41.8**

Table two: Number of patients contributed per site with number of days between first and last admission at each site. 126 patients were included; a mean of 151 days between admission of first and last case.

Outcome	0-5 days	6-10 days	11-15 days	≥16 days	Mean (days)	Median (days)	Range (days)	SD	IQR (days)
Admission-decision for PN % (n)	63.9 (78)	20.5 (25)	10.7 (13)	4.9 (6)	5.7	4	0-35	6.1	7
Line request-Line insertion % (n)	99 (104)	1.0 (1)	0 (0)	0 (0)	0.4	0	0-6	0.9	0
Line insertion-starting PN % (n)	93.6 (103)	3.6 (4)	0.9 (1)	1.8 (2)	1.3	0	0-32	3.5	1
Decision for PN-PN started % (n)	97.5 (118)	2.5 (3)	0 (0)	0 (0)	0.9	0	0-7	1.3	1
Admission-PN started % (n)	59.2 (74)	24.0 (30)	10.4 (13)	6.4 (8)	6.6	5	0-36	6.5	5
PN started-PN stopped % (n)	30.9 (38)	36.6 (45)	17.1 (21)	15.4 (19)	11.4	9	1-92	13.2	8

Table three: Process measure data of six time frames. Data indicates the percentage (n) of patients within each time frame. The number of days between two decisions were grouped into 0-5 days, 6-10 days, 11-15 days, and more than 16 days. n, number of patients; SD, standard deviation; IQR, interquartile range.

Outcome	0-5 days (n=74)	6-10 days (n=30)	11-15 days (n=13)	16+ days (n=8)	Overall (n=126)	p value
Hypophophataemia	42 (57%)	13 (43%)	9 (69%)	2 (25%)	66 (52%)	0.223
Hypokalaemia	19 (26%)	10 (33%)	7 (54%)	0 (0%)	36 (29%)	0.049
Altered Liver function tests	26 (35%)	12 (40%)	6 (46%)	2 (25%)	46 (37%)	0.742
Altered blood sugar	27 (37%)	12 (40%)	9 (69%)	5 (63%)	53 (42%)	0.064
Line sepsis	6 (8%)	0 (0%)	1 (8%)	2 (25%)	9 (7%)	0.108
Any complication	60 (81%)	25 (83%)	13 (100%)	7 (88%)	105 (83%)	0.413

Table four: Outcome data for electrolyte abnormality and line sepsis in relation to number of days between admission and PN started. Time frames were grouped into 0-5 days, 6-10 days, 11-15 days, and more than 16 days 'Any complication' is a composite variable for any complication in phosphate/ potassium/ liver function test/ blood sugar abnormality/ line sepsis. Percentages have been rounded to nearest integer. P-value calculated using chi squared test (only summary data shown).

Figure one: Process measure data displayed as histograms for six time frames. A = Days between admission date and decision for PN. B = Days between line request and insertion date. C = Days between line insertion and PN start date. D = Days between decision for PN and starting PN. E = Days between admission date and PN start date. F = Duration of PN. PN, parenteral nutrition.