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Applied nutritional investigation

Effects of arginine-based immunonutrition on inpatient total costs and hospitalization outcomes for patients undergoing colorectal surgery

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ABSTRACT

Objective: The aim of this study was to assess the effects of an arginine-based immunonutrition intervention for patients undergoing elective colorectal surgery on postsurgical utilization and cost outcomes.

Methods: This analysis was based on data from two Washington State databases: Surgical Care and Outcomes Assessment Program (SCOAP) linked to the Comprehensive Hospital Abstract Reporting System (CHARS). The sample (N=722) comprises adult patients who underwent elective colorectal surgery with anastomosis in a Washington State hospital that participated in the Strong for Surgery (S4S) initiative between January 1, 2012, and December 31, 2013. A generalized linear model was used to predict the outcomes, adjusting for demographic characteristics and patient health conditions within a multivariate regression framework.

Results: Findings from this study demonstrated significantly fewer readmissions and hospital days for the intervention group during the 180 d after index hospitalization. Clinical benefits included decreased risk for infections and venous thromboembolism. There was a similar pattern toward lower total costs in the immunonutrition patient group; however, these were not statistically different compared with the control group at any time point. Savings in the immunonutrition group were substantial—mean total costs per patient were less by ~$2500 at index hospitalization, $3500 less through 30 d of follow-up, and $5300 less over 180 d compared with the control group.

Conclusion: These findings suggest that arginine-based immunonutrition should be thoroughly evaluated for incorporation into clinical practice for patients undergoing elective surgery. Moreover, there is a need to assess the effects of the intervention in other hospitals both within and outside Washington.

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Introduction

Immunonutrition interventions have shown a significant clinical benefit for the surgical patient, as well as subsequently reducing costs [1,2]. Historically, however, nutrition assessment and intervention have not been an integral part of the care of the surgical patient. This could be due to several factors:

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1. A lack of awareness among clinicians;
2. A need for a change in practice workflow to accommodate the use of specialized nutrition formulas;
3. A lack of public knowledge and expectations about testing and intervention for nutritional status before surgery; and
4. A failure to use public health approaches to promote its use.

Consequently, in 2012, Nestle Healthcare Foundation contracted with the University of Washington's Comparative Effectiveness Research Translation Network (CERTAIN) team to develop strategies for educating and integrating nutritional interventions into surgical practices. This work resulted in the Strong for Surgery (S4S) Nutrition Checklist and partnering process improvement materials.

Postsurgical infections are a common source of comorbidity with urinary tract infections, surgical site infections, bloodstream infections, and pneumonia contributing to more than three-fourths of health care–associated infections in acute care hospitals [3–5]. Arginine-based immunonutrition (IMPACT, Nestle Health Science, Vevey, Switzerland)—a specialized nutrition formula—comprising arginine, ω-3 fatty acids and nucleotides has been shown to significantly reduce the likelihood of infectious complications and hospital length of stay (LOS) when provided pre-, peri-, and post-operatively for patients undergoing elective surgery compared with standard nutrition [6]. Additionally, the use of the specialized arginine-based immunonutrition formula was associated with a greater reduction in the likelihood of infections and hospital LOS compared with other arginine-supplemented formulas [7].

The primary objective of this analysis was to assess the effects of the specialized arginine-based immunonutrition intervention for patients undergoing elective colorectal surgery on postsurgical outcomes: total hospital costs and health care utilization.

Material and methods

Data sources

This analysis was based on data from the Surgical Care and Outcomes Assessment Program (SCOAP) linked to the Comprehensive Hospital Abstract Reporting System (CHARS). SCOAP is an initiative conducted by physicians in Washington to improve the quality of surgical care to reduce variations in different outcomes and delivery of care in hospitals in the state by promoting the appropriate use of specific interventions; at present, >50 hospitals are participating [8,9]. The CHARS is a Washington hospital discharge database and includes information on all inpatient hospitalizations from 1987 to the present. Beginning in 2011, information regarding patient use of nutritional interventions became available in SCOAP, and from 2012, information about a specific immunonutrition intervention (IMPACT, arginine-based immunonutrition) became available. The immunonutrition intervention was offered to all patients in hospitals that participated in the S4S initiative in Washington SCOAP hospitals before an elective colorectal surgical procedure.

Analytical sample and study groups

The overall analytical sample (N = 716) comprises adult patients (≥18 y of age) who have a SCOAP and CHARS record, and who underwent elective colorectal surgery with anastomosis in a Washington hospital that participated in the S4S initiative between January 1, 2012 and December 31, 2013. The comparison groups are defined and identified as follows:

- The immunonutrition intervention group (N = 151) comprised patients who received the arginine-based nutrition supplement for 5 d leading up to the day of their elective colorectal surgery with anastomosis in a S4S Washington hospital. Patients undergoing an elective procedure with anastomosis were identified as potential candidates for the intervention because prior research has found greatest benefit for this group of patients in terms of reduced infections and complications associated with the intervention.
- The control group (N = 565) comprised patients undergoing the same procedure—elective colorectal surgery with anastomosis in a S4S Washington hospital—who did not receive the arginine-based immunonutrition supplement or any other type of nutrition. The control group was chosen such that the patients were eligible but ultimately did not receive the intervention.

Outcomes

The primary focus of the present study was on total costs for the index hospital procedure and that of those relating to other hospital readmissions for varying periods of follow-up: 30, 90, and 180 d. Index hospitalization is defined as the first occurrence of hospitalization in a Washington SCOAP hospital for a colorectal surgical procedure. Additionally, secondary outcomes include hospital LOS for the index visit, number of readmissions, and total number of days hospitalized accumulated over 30, 90, and 180 d.

Methodology

The SCOAP data were extracted from hospital medical records, retrospectively by trained abstractors. The initial study sample included patients ≥18 y of age who underwent elective colorectal surgery with anastomosis in a Washington hospital that participated in the S4S initiative between 2012 and 2013 (N = 753). Subsequently, we excluded patients who received some nutrition intervention but not immunonutrition (N = 31) as our objective was to compare the effects of immunonutrition versus no nutrition interventions. Of the remaining 722 patients, we excluded those with missing information on body mass index (BMI; N = 5) and those with sleep apnea (N = 1), leaving an analytical sample of 716 patients.

Once extracting the data, we first examined the demographic characteristics (e.g., age, sex), patient health conditions (e.g., asthma, hypertension, diabetes), and complications (e.g., wound and other infections, venous thromboembolism) for both groups (Table 1). We also generated descriptive statistics of the unadjusted total costs and inpatient hospitalization outcomes to get a sense of the raw differences in outcomes between the two groups at index hospitalization and at subsequent readmissions using a 30-, 90-, and 180-d follow-up window post discharge from index visit (Tables 2–4). The outcomes were compared between the immunonutrition and no-nutrition group using mean and median. Due to the nonnormal cost and health care utilization data, we used the Wilcoxon signed rank tests for this comparison, which have been shown to be more efficient compared with the *t* tests when handling non-normal data [10].

We used a generalized linear model (GLM) [11] to predict total hospital costs, total hospital days, and total number of readmissions, adjusting for demographic characteristics and patient health conditions within a multivariate regression framework.

To assess the comparability of the two groups in terms of total costs and total hospital days at index visit and also for any readmissions using a 30-, 90-, and 180-d follow-up period, we adjusted for sample differences using multivariate analysis.

The comparisons of primary interest are the effects of the immunonutrition intervention, controlling for baseline demographic characteristics and patient health conditions (Table 5, and Appendix Tables 1–3). In a supplementary multivariate analysis (results not shown), we included measures of specific complications (e.g., wound and other infections, venous thromboembolism) in the models. The difference in the mean outcomes using the models with and without complication indicators provided an indication and estimate of the effects of complications in contributing to any differences in total costs and total inpatient days.

To aid in the interpretation of the point estimates in the different model specifications predicting total costs, we used the method of recycled predictions [12] to obtain the marginal effects (i.e., the dollar value of the difference in total costs between the two groups). The same method has been used for interpreting the number of hospital days and readmissions. Moreover, nonparametric bootstrapping was used to obtain SEs for the difference in total costs for the two groups. We used 1000 resamples from the empirical probability distribution of the original data set to obtain the SEs.

The cost measures are based on reported hospital charges. The CHARS hospital discharge database contains information on total charges for each inpatient hospitalization. For this analysis, total charges are converted to total cost using the Medicare-based cost-to-charge ratio at the hospital level, which is publicly available and, subsequently, the total costs are adjusted to 2015 US dollars using the medical care component of the Consumer Price Index.

To account for the non-normal nature of the cost data with a right-skewed cost distribution (count nature of the hospitalization outcomes), we used a GLM with a log link function and γ-family (log-link function and Poisson family). We estimate all the models at the patient level but clustered the SEs at the hospital level to account for hospital-level characteristics that were common across patients within the same hospital.

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