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Comparative Analysis of Enteral and Parenteral Nutrition Impact on Outcomes in Esophageal Cancer Patients: A Paradigm for Nutritional Optimization in Oncology

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Abstract

Background: Individuals diagnosed with esophageal cancer face a pronounced risk of malnutrition, primarily attributed to the early onset of gastrointestinal obstruction. This risk persists and may even intensify following therapeutic interventions and the subsequent reconstruction of gastrointestinal passages. The current study focuses on elucidating the differential impact of enteral vs. parenteral nutrition on outcomes in patients hospitalized with esophageal cancer.

Methods: The study analyzed adult discharges related to esophageal cancer from 2019 and 2020 using data from the National Inpatient Sample. Exclusion criteria included discharges involving minors and mixed nutritional regimens. Enteral nutrition and parenteral nutrition subgroups were identified using International Classification of Diseases, 10th revision codes. Outcome variables were determined through ICD-10 codes in the NIS dataset. Multivariable regression analyses were used to investigate associations between mode of nutrition and specified outcomes.

Results: In this study involving 28,015 hospitalizations for esophageal cancer, 756(2.7%) received enteral nutrition, and 1064(3.8%) received parenteral nutrition. After adjusting for confounding variables, parenteral nutrition emerged as an independent predictor of mortality (OR 1.75, P=0.023), while enteral nutrition showed no association with higher mortality (OR 0.56, P=0.162). Both nutrition modes were associated with increased length of stay, with patients on parenteral nutrition having significantly longer stays (+9.07 days, P<0.001 vs 3.07 days, P=0.001). While both nutrition modes were linked to high total hospitalization charges, patients with parenteral nutrition experienced a significantly more significant increase in total treatment cost compared to those on enteral nutrition (112,093 USD, P<0.001 vs 54,953 USD, P=0.01) patients on enteral nutrition had lower odds of pneumonia compared to the parenteral nutrition group. The parenteral nutrition group had higher odds of various complications, including esophageal perforation, constipation, diarrhea, acute kidney injury, ICU admission, and acute respiratory failure, than those on enteral nutrition. Both forms of nutrition were associated with increased odds of malnutrition, fluid and electrolyte disorders, and septic shock.

Conclusion: Parenteral nutrition has a higher risk of mortality compared to enteral nutrition. Both types are linked to longer hospital stays, increased treatment costs, and other adverse outcomes, with parenteral nutrition leading to more complications than enteral nutrition.

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Introduction

Esophageal cancer is one of the most malignant types of cancer, with an estimated 600,000 new cases and 540,000 deaths worldwide in 2020 [1]. Due to the fact that early esophageal carcinomas lack obvious symptoms, detection often occurs at a later stage, with nearly half of all patients developing distant metastasis within five years of diagnosis [2]. Esophageal cancer is the eighth most commonly diagnosed cancer and the sixth leading cause of cancer death on a global scale [3].

As the cancer advances, complications include bleeding, pain, and obstruction of the esophagus by the tumor. This can make it difficult for food and liquid to pass through the esophagus into the stomach for digestion. Patients with esophageal cancer often face an elevated risk of malnutrition stemming from complications such as nausea and vomiting, pain, dysphagia, and dyspepsia. Additionally, various treatment interventions like surgical resections further contribute to the susceptibility of these patients to malnutrition and hinder their postoperative recovery [4]. Hence, the significance of nutrition becomes paramount in this patient population. Consequently, ensuring adequate nutrition without jeopardizing hospital outcomes poses a crucial and challenging task for healthcare providers caring for hospitalized cancer patients.

Since enteral nutrition bypasses the esophagus and delivers nutrients directly into the stomach or small intestine, this form of artificial nutrition can promote unobstructed healing in the esophagus post-treatment. Enteral nutrition can maintain the function and integrity of the gut barrier and has been associated with increased protection against airway infections (as a result of increased immunoglobulin A production.) However, enteral nutrition is often disturbed by diagnostic interventions and patient care such as respiratory support, which may affect its capacity to maintain nutritional goals [5].

Parenteral nutrition is unphysiological in nature this form of nutrition bypasses the gastrointestinal tract and portal venous system altogether and can provide nutritional support in an "all-in-one" system with no further intervention needed. While this lack of disturbance, compared to enteral nutrition, has its benefits, it is important to note that parenteral nutrition can increase the risk of overfeeding and poses an increased susceptibility to catheter-related bloodstream infections [5].

Several comprehensive studies have explored the diverse modes of nutrition following surgical resection in esophageal cancer patients. However, there remains a scarcity of data regarding the specific nutritional methods utilized by these patients, their associated complications, and their potential impact on outcomes for hospitalized esophageal cancer patients, irrespective of treatment modality (including radiotherapy, chemotherapy, or surgical resection). Our study seeks to thoroughly explore the overall influence of various nutrition modes (enteral vs. parenteral) among hospitalized esophageal cancer patients.

Materials and methods

Data design and source: This research utilized the National Inpatient Sample for 2019-2020, a comprehensive database on inpatient care across the United States. It is the largest publicly available database, covering over 21 million hospital admissions with an annual sample size ranging from 7 to 8 million. Notably, it represents a strict 20% sample of all hospital admissions in the country, excluding entries related to rehabilitation and federal hospitals like Veterans Affairs hospitals. This dataset covers data from 46 states plus the District of Columbia and includes approximately 98% coverage of the U.S. population. Managed by the Agency for Healthcare Research and Quality through the Healthcare Costs and Utilization Project, this resource enables analysis of diverse healthcare phenomena due to its large sample size comprising around 8 million hospital stays annually, making it suitable for generating national estimates and examining rare diseases in depth.

Study population: The study analyzed the discharge data of adult patients aged 18 and above diagnosed with esophageal cancer in the NIS database using the ICD-10-Clinical Modification/Procedure Coding System (ICD-10-CM/PCS). The participants were then divided into enteral and parenteral nutrition groups.

Study variables and outcomes: The study aimed to compare the effects of enteral and parenteral nutrition on outcomes in hospitalized patients diagnosed with esophageal cancer. The primary endpoint was inpatient mortality rates among esophageal cancer patients receiving enteral versus parenteral nutrition. Secondary outcomes included length of hospital stay, overall treatment costs, occurrences of pneumonia, rates of surgical interventions, complications such as esophageal perforation, instances of malnutrition, constipation, hypoglycemia, fluid and electrolyte imbalances, septic shock, acute kidney injury, and acute respiratory failure.

Covariates: Patients' characteristics included age groups (<18-35, 36-45, 46-64, >65 years), gender, race/ethnicity, household income level, insurance status (Medicare, Medicaid, private and uninsured), as well as certain comorbidities such as diabetes, hypertension, hyperlipidemia, fluid, and electrolyte disorders. Hospital-related characteristics included hospital bed size (small, medium, large), location (rural-urban), teaching vs non-teaching status, and hospital region (Northeast, Midwest, South, West). The evaluation of comorbidity burden utilized the Elixhauser Comorbidity Index, a thoroughly validated metric relying on ICD-10-CM codes. Designed for application in extensive administrative datasets, this index serves the purpose of prognosticating both mortality and the utilization of hospital resources.

Statistical analysis: Categorical data was presented as percentages. Continuous variables were described as mean values and standard deviations. We used Pearson's chi-square test or Fisher's exact test to compare outcomes between different groups for categorical variables. The student's t-test was used for continuous variables. Both univariate and multivariate analyses were conducted to identify the associations between nutrition methods and in-hospital mortality, extended length of stay, total treatment cost, and adverse outcomes. All statistical analyses were performed using the software program Stata 17 (College Station, TX, USA). The findings and outcomes of the statistical analyses conducted using Stata 17 provided valuable insights into the research questions and hypotheses, contributing to the overall quality and rigor of the study.

Results

A total of 28015 hospitalizations with esophageal cancer were studied. Approximately 756(2.7%) received enteral nutrition,

while 1064(3.8%) received parenteral nutrition.

A comparison of baseline patient characteristics revealed an interesting disparity in insurance coverage between enteral and parenteral nutrition groups. It is notable that patients on enteral nutrition tended to have higher Medicare group representation compared to those on parenteral nutrition (69.4% vs 52.91%, P=0.03). Conversely, a larger proportion of patients receiving parenteral nutrition possessed private insurance (31.07% vs. 17.91%, P=0.03) and Medicaid coverage (13.59% vs. 8.21%, P=0.03), while uninsured patients were more prevalent in the enteral group (4.48% vs 2.4%, P=0.03).

A higher proportion of patients receiving parenteral nutrition experienced fluid and electrolyte disorders (53.77% vs 43.07%, P<0.001). A larger percentage of patients on parenteral nutrition were discharged to skilled nursing facilities (5.19% vs 0%, P<0.001), while a higher proportion of enteral nutrition patients were discharged to home with home health (66.92% vs 60.39%, P<0.001). Smaller hospitals had fewer patients receiving parenteral nutrition compared to large hospitals (11.32% vs 22.63%, P=0.001). Similarly, non-teaching hospitals had a higher percentage of patients on enteral nutrition compared to teaching hospitals (30.66% vs 15.09%, P<0.001) (Table 1).

Table 1: Comparison of baseline characteristics in esophageal cancer patients with enteral and parenteral nutrition.

	Esophageal cancer with enteral nutrition	Esophageal cancer with parenteral nutrition	P-Value
No. of patients	756	1064	
Patient characteristics			
Gender (%)			P=0.5933
Male	568 (75.18)	803 (75.47)	
Female	188 (24.82)	261 (24.53)	
Age			P=0.548
Mean age (SD)	68.78 (11.55)	66.55 (11.06)	
Age distribution (%)			P=0.3433
18-35	0 (0)	10 (0.94)	
36-45	17 (2.19)	35 (3.3)	
46-64	237 (31.39)	442 (41.51)	
>65	502 (66.42)	577 (54.25)	
Race (%)			P=0.6048
White	594 (78.63)	842 (79.1)	
Black	110 (14.5)	117 (10.95)	
Hispanic	29 (3.82)	74 (6.97)	
Other	23 (3.05)	32 (2.99)	
Median household income national quartile for patient zip code (%)			P=0.3529
$1-$49,999	258 (34.09)	305 (28.71)	
$50,000-$64,999	206 (27.27)	270 (25.36)	
$65,000-$85,999	172 (22.73)	219 (20.57)	
>$86,000	120 (15.91)	270 (25.36)	
Charlson comorbidity index (%)			P<0.001
2	171 (22.63)	226 (21.23)	
3 or more	585 (77.37)	838 (78.77)	
Insurance provider (%)			P=0.0353
Medicare	525 (69.4)	563 (52.91)	
Medicaid	62 (8.21)	145 (13.59)	
Private	135 (17.91)	331 (31.07)	
Uninsured	34 (4.48)	26 (2.4)	
Comorbidities (%)			
Hypertension	337 (44.53)	462 (43.4)	P=0.6561
Diabetes mellitus	105 (13.87)	201 (18.87)	P=0.1524
Fluid & ectrolyte disorders	326 (43.07)	572 (53.77)	P<0.001
Chronic kidney disease	61 (8.03)	105 (9.91)	P=0.7254
ESRD	11 (1.46)	10 (0.94)	P=0.4875
Hyperlipidemia	210 (27.74)	351 (33.02)	P=0.1540
Smoking	11 (1.46)	5 (0.47)	P=0.6342
Discharge disposition			P<0.001
Home	250 (33.04)	366 (34.42)	
Home with home health	506 (66.96)	643 (60.39)	
Skilled nursing facility	0 (0)	55 (5.19)	
Against medical advice	0 (0)	0 (0)	
Hospital characteristics (%)			
Bed size of hospital (STRATA)			P=0.0016
Small	171 (22.63)	120 (11.32)	
Medium	232 (30.66)	211 (19.81)	
Large	353 (46.72)	733 (68.87)	
Hospital location			P=0.2124
Rural	61 (8.03)	45 (4.25)	
Urban	695 (91.97)	1019 (95.75)	
Hospital teaching status			P<0.001
Non-teaching hospital	232 (30.66)	161 (15.09)	
Teaching hospital	524 (69.34)	903 (84.91)	
Region of hospital			P=0.7767
Northeast	171 (22.63)	226 (21.23)	
Midwest	149 (19.71)	241 (22.64)	
South	315 (41.61)	381 (35.85)	
West	121 (16.06)	216 (20.28)	

After adjusting for the confounding variables, parenteral nutrition was determined to be an independent predictor of mortality in cancer patients, whereas enteral nutrition was not associated with higher mortality (OR 1.75, 95% CI: 1.08-2.84, P=0.023 vs OR 0.56, 95% CI: 0.25-1.26, P=0.162). Both modes of nutrition were linked to increased length of stay, but patients receiving parenteral nutrition had significantly longer stays compared to those on enteral nutrition (+9.07 days, 95% CI: 6.40-11.74, P<0.001 vs (+3.07 days 95% CI: 1.23-4.92, P=0.001). Both modes of nutrition were associated with high total hospitalization charges, but patients with parenteral nutrition had a significantly more pronounced increase in the total cost of treatment compared to those on enteral nutrition (+112093 USD, 95% CI: 66905-157281, P<0.001 vs (+54953 USD, 95% CI: 12595-97310, P=0.01) (Table 2).

Table 2: Regression analysis for LOS and TOTCHG in esophageal cancer patients with enteral vs parenteral nutrition.

	Esophageal cancer with enteral nutrition			Esophageal cancer with parenteral nutrition		
Linear regression	**Coefficient**	**95% CI**	**P value**	**Coefficient**	**95% CI**	**P value**
Length of hospitalization (days)						
Univariate regression	4.46	(0.42-8.50)	P=0.03	9.61	(7.15-12.07)	P<0.001
Multivariate regression	3.07	(1.23-4.92)	P=0.001	9.07	(6.40-11.74)	P<0.001
Total hospital cost (USD)						
Univariate regression	78100	(-6731-162932)	P=0.071	122119	(78580-165657)	P<0.001
Multivariate regression	54953	(12595-97310)	P=0.01	112093	(66905-157281)	P<0.001
	Mortality in esophageal cancer patients with enteral vs parenteral nutrition					
	Esophageal cancer with enteral nutrition			**Esophageal cancer with parenteral nutrition**		
Logistic regression	**Odds Ratio**	**95 % CI**	**P value**	**Odds Ratio**	**95% CI**	**P value**
Mortality						
Unadjusted odds ratio	0.73	(0.34-1.59)	P=0.438	2	(1.28-3.07)	P=0.002
Adjusted odds ratio	0.56	(0.25-1.26)	P=0.162	1.75	(1.08-2.84)	P=0.023

LOS: Length of Stay, TOTCHG: Total Charges, USD: United States Dollar, CI: Confidence Interval.

Table 3: Comparison of secondary outcomes in esophageal cancer with enteral and parenteral nutrition.

	Esophageal cancer with enteral nutrition				Esophageal cancer with parenteral nutrition			
Secondary outcomes	**Unadjusted OR (95% CI)**	**P value**	**Adjusted OR (95% CI)**	**P value**	**Unadjusted OR (95% CI)**	**P value**	**Adjusted OR (95% CI)**	**P-value**
Pneumonia	0.12 (.02-.87)	P=0.036	0.11 (0.02-.76)	P=0.025	1.77 (1.08- 2.91)	P=0.023	1.43 (0.83- 2.49)	P=0.195
Esophageal perforation	1.45 (0.45-4.66)	P=0.529	1.93 (0.60- 6.23)	P=0.266	3.81 (1.93- 7.52)	P<0.001	3.51 (1.71-7.22)	P=0.001
Malnutrition	2.68 (1.89- 3.79)	P<0.001	2.25 (1.54- 3.26)	P<0.001	3.50 (2.57- 4.76)	P<0.001	3.24 (2.31- 4.54)	P<0.001
Constipation	1.18 (0.73- 1.92)	P=0.492	1.23 (0.73- 2.06)	P=0.425	1.57 (1.08- 2.27)	P=0.016	1.61 (1.1- 2.37)	P=0.016
Diarrhea	-0.01 (-0.03-0.01)	P=0.346	0.70 (0.17- 2.97)	P=0.637	.025 (-0.003-.05)	P=0.081	2.34 (1.14-4.79)	P=0.021
Hypoglycemia	1.55 (0.48-5.01)	P=0.457	1.36 (0.42- 4.44)	P=0.613	2.28 (0.97-5.31)	P=0.056	2.21 (0.94- 5.17)	P=0.066
Fluid and electrolyte disorders	1.49 (1.07-2.07)	P=0.017	1.52 (1.07-2.16)	P=0.019	2.22 (1.70- 2.90)	P<0.001	2.12 (1.57- 2.84)	P<0.001
Septic shock	3.60 (1.83- 7.03)	P<0.001	2.85 (1.31- 6.22)	P=0.008	3.94 (2.25- 6.90)	P<0.001	3.27 (1.80- 5.93)	P<0.001
Acute kidney injury	1.47 (0.97-2.22)	P=0.069	1.22 (0.77- 1.94)	P=0.401	2.18 (1.59- 2.99)	P<0.001	1.91 (1.33- 2.74)	P<0.001
Intensive Care Unit (ICU)	1.70 (1.02-2.70)	P=0.040	1.61 (0.95-2.71)	P= 0.074	3.21 (2.28-4.51)	P<0.001	2.44 (1.69-3.54)	P<0.001
Acute respiratory failure	1.33 (0.82- 2.16)	P=0.242	1.38 (0.83- 2.29)	P=0.213	2.26 (1.62- 3.15)	P<0.001	1.82 (1.25-2.63)	P=0.001
Esophageal resection/surgery	0.82 (0.57- 1.20)	P=0.328	1.09 (0.72-1.63)	P= 0.685	1.11 (0.84- 1.47)	P=0.442	1.05 (.77-1.44)	P=0.741

OR: Odds Ratio.

Patients on enteral nutrition were less likely to have pneumonia compared to the parenteral nutrition group (OR 0.11, 95% CI: 0.02-0.76, P=0.025). Patients receiving parenteral nutrition had higher odds of esophageal perforation (OR 3.51 95% CI: 1.71-7.22, P=0.001), constipation (OR 1.61, 95% CI: 1.1-2.37, P=0.016), diarrhea (OR 2.34, 95% CI: 1.14-4.79, P=0.021), acute kidney injury (OR 1.91, 95% CI: 1.33-2.74, P<0.001), ICU admission (OR 2.44,95% CI: 1.69-3.54 P<0.001), and acute respiratory failure (OR 1.82, 95% CI: 1.25-2.63, P=0.001) compared to those on enteral nutrition. However, both forms of nutrition were linked to higher odds of malnutrition (OR 2.25, 95% CI: 1.54-3.26, P<0.001 and OR 3.24, 95% CI: 2.31-4.54, P<0.001), fluid and electrolyte disorders (OR 1.52, 95% CI: 1.07-2.16, P=0.019 & OR 2.12, 95% CI: 1.57-2.84, P<0.001)) as well as septic shock (OR 2.85, 95% CI 1.31- 6.22, P=0.008 and OR 3.27, 95% CI 1.80-5.93, P<0.001) (Table 3).

Discussion

The current study addressed a clinical concern pertaining to individuals diagnosed with esophageal cancer, namely the heightened risk of malnutrition and its correlative association with divergent modes of nutritional intervention. The study adopted a rigorous analytical framework, analyzing adult discharges associated with esophageal cancer within the confines of 2019 to 2020, utilizing data obtained from the National Inpatient Sample.

Our retrospective study found parenteral nutrition was determined to be an independent predictor of mortality in cancer patients, whereas enteral nutrition was not associated with higher mortality. Both modes of nutrition were linked to increased length of stay, but patients receiving parenteral nutrition had significantly longer stays compared to those on enteral nutrition.

Both modes of nutrition were associated with high total hospitalization charges, but patients with parenteral nutrition had a significantly more pronounced increase in the total cost of treatment compared to those on enteral nutrition. Furthermore, patients on enteral nutrition were less likely to have pneumonia compared to the parenteral nutrition group. Patients receiving parenteral nutrition had higher odds of esophageal perforation, constipation, diarrhea, acute kidney injury, ICU admission, and acute respiratory failure compared to those on enteral nutrition. Both forms of nutrition were linked to higher odds of malnutrition, fluid and electrolyte disorders, as well as septic shock.

A literature review and meta-analysis of enteral versus parenteral nutrition in cancer patients showed that EN and PN are considered equally effective in maintaining or improving nutritional status in cancer patients [6]. The review strongly supports the recommendation that a baseline nutritional assessment should be carried out by a healthcare professional expert in AN for all cancer patients and the patient symptoms, performance status, estimated life expectancy, and mainly, will or preferences have to be evaluated and incorporated into the nutrition support plan before the definitive choice of the route for delivering nutrients is decided [7]. A decision-making process tailored to individual patient needs—regardless of whether receiving or not anticancer treatment for esophageal cancer—allows one to choose reasonably the optimal nutritional support strategy.

Another study evaluated clinical outcomes and hospitalization cost between Early Enteral Nutrition (EEN) and Parenteral Nutrition (PN) after resection of esophageal cancer. The clinical factors such as time to first fecal passage, postoperative albumin infusion, differences of serum albumin value, hospital stay, Systemic Inflammatory Response Syndrome (SIRS) duration, complications, initial hospitalization cost, and mortality were retrospectively compared. The findings of this study concurred with our conducted research, adding further support to the robustness of our conclusions. The study found pneumonia was significantly more frequent in the PN group compared with the EEN group [8]. The EEN group had a significantly shorter hospital stay, lower initial hospitalization cost, earlier first fecal passage, and shorter duration of SIRS than PN group [8]. The percentage of patients having any postoperative complication was much higher in the PN group than the EEN group.

Previously, metabolic complications have been mentioned throughout the literature in frail patients receiving parenteral nutrition [9]. Specifically, The European Society for Clinical Nutrition and Metabolism Guidelines for Parenteral Nutrition in Geriatric Patients state metabolic complications are more frequent in elderly patients. However, literature provides limited information about metabolic complications in older patients receiving parenteral nutrition. Patients at Cooper University Hospital were assessed for acid-base disturbances, hepatic complications, hypercapnia, hyperchloremia, hyperglycemia, hypernatremia, hypertriglyceridemia, hypochloremia, hypoglycemia, hypokalemia, hypophosphatemia, and refeeding syndrome. The study found that older hospitalized patients are more likely to develop a metabolic complication during their PN course than younger patients [9].

Regarding acute kidney injury and parenteral nutrition, previous research analyzing current long-term total parenteral nutrition (TPN) patients (13 men, 20 women) aged 21 to 79 years were prospectively studied to evaluate their change in glomerular filtration rate since beginning TPN. Creatinine Clearance (CrCl) from the subject's initial home TPN clinic visit and at present were estimated from standard formulas and compared. The study ultimately described a profound decrease in renal function associated with long-term TPN, most of which is largely unexplained [10]. Diarrhea and fatty liver disease have also been identified in previous case reports and literature reviews with total parenteral nutrition [11,12]. While mini reviews suggest multiple comorbidities and complications with enteral and parenteral nutrition in patients with esophageal cancer, there remains a dearth of current case reports and findings on many of the associations we discovered through our retrospective study.

Additional complications have been addressed in literature reviews on the topic of nutrition and esophageal resection or esophagectomy. In esophagectomy, timing and type of postoperative feeding remain a matter of debate. Total Parenteral Nutrition (TPN) was found to be associated with severe septic complications and Enteral Nutrition (EN) does not increase major complications. Therefore, this review found early EN after esophagectomy is favored over TPN [13]. However, with enteral feeding tubes minor complications occur frequently (13-38%) and in some cases this can hamper recovery [13]. Based on experience in other types of upper gastro-intestinal surgery, early start of oral feeding could improve time to functional recovery after surgery. The total length of stay was significantly shorter in four prospective studies (6-12 vs. 8-13 days) [13]. However, large randomized controlled trials are lacking and the potential benefit of early oral feeding after esophageal surgery remains unknown. EN is currently the optimal feeding route after esophagectomy. TPN should only be used in specific cases in which EN is contraindicated. Early initiation of oral intake was found to be promising and could improve postoperative recovery. TPN after esophagectomy was also associated with severe catheter-related complications, an increase in infectious complications and costs of this feeding route are relatively high in contrast to EN [13].

Literature reviews have discussed that due to the severity of complications associated with parenteral nutrition, many of which were identified in our retrospective study, TPN is not considered the preferred route of postoperative feeding. Early initiation of parenteral nutrition does not improve recovery and is associated with a higher incidence of septic complications [14]. Most trials comparing EN and TPN after esophageal surgery found a reduction in severe complications and length of hospitalization in favor of EN [15-17]. Therefore, the use of TPN after esophageal surgery should be administered only if EN is not recommended.

Economic ramifications of the nutritional paradigms were examined, revealing that patients reliant on parenteral nutrition incurred significantly elevated total hospitalization charges in comparison to their enteral nutrition counterparts. This finding accentuates the considerable fiscal encumbrance entailed in the adoption of parenteral nutrition.

Regardless of the reason for hospitalization, whether it was due to surgical resection, complex chemotherapy or radiotherapeutic interventions, complications of procedures, or acute illness, our research findings align with prior studies in indicating that paren-

teral nutrition is associated with more adverse events in hospitalized esophageal cancer patients. However, the generalization of our study provides deeper insight into the overall impact of parenteral nutrition in this patient population and emphasizes the importance of careful consideration and monitoring when implementing this form of nutritional support.

Our research aimed to ensure the accuracy and validity of the data in this database, it is essential to acknowledge its limitations. One limitation relates to the reliance on administrative data for the NIS, which can lead to incorrect coding for diagnoses and procedures. Another significant shortcoming concerns the exclusion criteria for patients not admitted or treated at non-HCUP hospitals or those receiving outpatient care not captured by NIS. Moreover, while the large sample size provided by NIS aids in creating strong statistical models, this extensive coverage may result in biased prevalence and incidence estimates due to a lack of representation of smaller populations or rare events. Finally, beyond issues with patient population selection biasing outcomes, measures such as readmission rates can also be affected since post-discharge follow-ups are not included in the data.

Conclusion

Our retrospective study highlights that both parenteral and enteral nutrition are linked to increased hospitalization costs, length of stays, and other in-hospital adverse outcomes. It is important to note that complications are more frequently observed in parenteral nutrition, associated with an increased mortality risk compared to enteral nutrition. Since esophageal cancer patients face the highest risk of malnutrition and adverse effects, this work is imperative in providing cancer patients with necessary information on the choices they have for artificial nutrition and expected outcomes, timeframes, and costs associated with either parenteral or enteral nutrition.

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