Utilization of ICU nutrition consultation is associated with reduced mortality

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Abstract

Objective: The aim of this project was to investigate the prevalence of nutrition consultation (NC) in American ICUs and to examine its association with patient outcomes.

Design: Retrospective cohort study

Setting: The Healthcare Cost and Use Project state inpatient database for Wisconsin, New Jersey, and Rhode Island from 2010 - 2014

Patients: 67,130 patients, 18 years or older who required admission to US ICUs.

Measurements and Main Results: Institutional ICU NC rates varied significantly (mean:14%, range: 0.1%-73%). Significant variation among underlying disease processes was identified, with burn patients having the highest consult rate (p<0.001, mean: 6%, range: 2%-25%). Multilevel mixed effects logistic regression models were fit to the data to estimate the effect of NC on clinical outcomes. ICU patients who received NC had significantly lower in-hospital mortality (OR 0.59, 95%CI 0.48–0.74, p<0.001), as did the subset with malnutrition (OR 0.72, 95%CI 0.53–0.99, p=0.047), and the subset with concomitant physical therapy consultation (OR 0.53, 95%CI 0.38–0.74, p<0.001). NC was associated with significantly lower rates of intubation, pulmonary failure, pneumonia, and GI bleeding (p<0.05). Furthermore, patients who received NC were more likely to receive enteral or parenteral (ENPN) nutrition (OR 1.8, 95%CI 1.4-2.3, p < 0.001). Patients who received follow-up NC were even more likely to receive ENPN (OR 3.0, 95%CI 2.1–4.2, p<0.001).

Conclusions: Rates of NC were low in critically ill patients. This study suggests that increased utilization of NC in critically ill patients may be associated with improved clinical outcomes.

Clinical Relevancy Statement: This study identified that rates of nutrition consultation is low in critically ill patients. Routine nutrition consultation was associated with improved delivery of enteral or parenteral nutrition and improved survival.

Introduction

Meeting appropriate nutritional demands is a fundamental aspect of optimal patient care.[1] This is particularly relevant in the critically ill. Numerous studies over the past 30+ years have repeatedly demonstrated that patients who accumulate a negative protein-calorie energy balance while in the hospital have significantly increased rates of infectious complications and mortality.[2-7] While it is equally possible that a negative protein-calorie balance resulted secondary to increased illness burden, it is still imperative to prevent, or at least moderate, the development of malnutrition in the critically ill to avoid the ramifications that come with a malnourished state.

Despite awareness and attempts to identify patients at risk for malnutrition early in their hospital course, healthcare-associated malnutrition persists worldwide.[8] One fundamental intervention aimed at reducing iatrogenic malnutrition is the routine utilization of nutrition consultation (NC) for patients who require critical care resources during their hospitalization.[9] While many hospitals have registered dietitians (RD) rounding in the intensive care unit (ICU), this practice is not ubiquitous across all centers. Multiple studies have identified poor compliance with NC for malnourished and patients at risk for malnutrition. A 2001 study of Medicare patients at risk for pressure ulcers (of which 76%

were malnourished) showed that only 34% received a formal NC. Additionally, a 2011 study from Johns Hopkins University identified that only 20% of malnourished patients received NC prior to the implementation of a nutrition intervention. Even after the implementation of a nutrition intervention, only 44% of malnourished patients received NC.[10]

Benefits of routine NC in the critically ill include the assessment of nutritional risk for malnutrition or risk for nutritional related complications using validated nutrition screening tools and the calculation of appropriate nutrition needs using either indirect calorimetry or predictive equations by trained professionals familiar with the applicability and limitations of these tools.[11-13] Furthermore, patients who receive RD-driven nutritional care reach goal feedings quicker and have improved clinical outcomes.[14,15]

Despite the widespread recommendation for a multidisciplinary approach to critical care, the prevalence of routine NC for patients requiring ICU admission remains unknown. Therefore, the aim of this project is to characterize the variation in NC practices in New Jersey, Wisconsin, and Rhode Island hospitals for critically ill patients and to examine its association with clinical outcomes.

Materials and Methods

Data collection

We conducted a retrospective cohort study using hospital discharge records from the Healthcare Cost and Use Project (HCUP) state inpatient databases (SID) from the Agency for Healthcare Research and Quality. The SIDs include nearly 100% of discharges from over 1000 nonfederal hospitals in 46 states and includes data on all patients regardless of payer status.[16] The University of Michigan Medical School Institutional Review Board determined that this study of de-identified data was not regulated as human subjects research, HUM00127378. This study was approved by the University of Minnesota Institutional Review Board, STUDY00001489.

Participants

Patient-level data were obtained from the database from January 1, 2010 to December 31, 2014 for the states submitting CPT codes capturing nutrition provider billing (Wisconsin, Rhode Island, and New Jersey). NC from an RD or certified clinical nutritionist (CCN) was identified using the CPT codes 97802, 97804, G0270, G0271, and ICD-9 code V653. Follow-up NC was identified using the CPT code 97803. 41% of hospitals from these three states routinely submitted CPT/ICD-9 codes for RD or CCN billing. We included only the hospitals that submit NC CPT/ICD-9 codes and all patients who required an ICU admission during their hospitalization. Exclusion criteria included patients less than 18 years of age, patients who were discharged to hospice, patients with ICD codes reported in a non-standard format, and hospitals that submitted less than 5 patients annually. After these exclusion criteria, there was an overall low level of missing data elements (< 6%).[17,18]

Measures

Outcomes

The primary endpoint was all-cause in-hospital mortality. Secondary endpoints included receiving enteral or parenteral nutrition (HCUP CPT Clinical Classification 223[19]); 7-day hospital readmission; and the development of complications (as defined by Iezzoni et al.[20]). Physical therapy (PT) consultation was identified using the HCUP CPT Clinical Classification for physical therapy. Malnutrition was identified using the HCUP ICD-9 Clinical Classifications for malnutrition.

Adjustment variables

Adjustment variables included demographic data (age and gender); patient comorbidities (using the Charlson Comorbidity Index[21]); annual ICU volume; presence of organ failure on hospital admission (using ICD-9-CM codes for renal, cardiovascular, hepatic, hematologic, neurologic, and respiratory failure as defined by Angus et al.[22]); year of admission, and hospital level random effects. Race and ethnicity were omitted as these data were missing for many of the patients in the study. This is a common practice for studies using this database.[23] Age was categorized as 18-25, 26-45, 46-65, 66-75, and greater than 75 years. All models were adjusted for these variables.

Statistical Analysis

For descriptive purposes, data were expressed as the mean and standard deviation (SD) for continuous variables, and as percentages for categorical variables. Student's t-tests and Pearson's χ^2 tests were used in the preliminary analyses. Multilevel mixed effects logistic regression models were used to estimate the independent effect of NC on all-cause in-hospital mortality, hospital readmission, and the development of complications. Subgroup analysis included stratification by malnutrition or PT consultation. We set alpha at 0.05 and used two-tailed tests.

The time to ENPN was known for 441 patients. Patients were dichotomized into 2 groups, early (ENPN < 8 days) and late (ENPN ≥ 8 days). Patients who already had a diagnosis of protein-calorie malnutrition were excluded as current guidelines recommend early feeding in this group.[24] A mixed-effects logistic regression analysis was used to evaluate the interaction of early (vs. late) ENPN and receiving a NC (or not) on in-hospital mortality.

All statistical analyses were computed using Stata MP, version 15 (StataCorp, College Station, TX).

Results

Patient Characteristics

In total, 67,130 adult patients who required ICU admission were identified from 29 hospitals over a 5-year period (Figure 1). Patient characteristics for those who received (vs. did not receive) a NC are shown in Table 1. Significant variation existed across ICUs regarding the rate of NC, ranging from 0.1% to 73.3% with a mean of 14%. Significant variability was noted for NC based on discharge diagnosis-related group (DRG), ranging from 2% - 25%, with burn patients most likely to receive NC (Figure 2).

Nutrition consultation and mortality

Critically ill patients who received NC had significantly lower in-hospital mortality (OR 0.59, 95% CI 0.48 – 0.74, $p < 0.001$) on logistic regression analysis (Table 2).

Nutrition consultation and risk-adjusted secondary outcomes

Critically ill patients who received NC were less likely to develop pneumonia, pulmonary failure, gastrointestinal bleeding, or require mechanical ventilation (Table 2). Critically ill patients who received NC were more likely to develop acute renal failure (Table 2).

Subgroup analysis

26,142 patients received PT consultation. Critically ill patients who received combined NC and PT consultation had further improved in-hospital mortality (OR 0.53, 95% CI 0.38 -0.74, $p < 0.001$). 21,918 patients had a diagnosis of malnutrition. Patients who carried a diagnosis of malnutrition and received NC also had significantly lower in-hospital mortality compared with patients with malnutrition that did not receive NC (OR 0.72, 95% CI 0.53 – 0.99, $p = 0.047$).

Enteral / Parenteral Nutrition

Patients who received initial NC were more likely to receive enteral or parenteral nutrition (OR 1.8, 95% CI 1.4 – 2.3, $p < 0.001$). Patients who received a follow-up NC were even more likely to receive enteral or parenteral nutrition (OR 3.0, 95% CI 2.1 – 4.2, p <

0.001). Patients who received late ENPN guided by NC had significantly improved mortality (OR 0.18, p = 0.044) compared with patients who received early ENPN without a NC (Table 3).

Discussion

Malnutrition increases the risk of significant morbidity, mortality, surgical outcomes, and length of stay for patients and consequentially, substantially increases cost burden.[25] Despite the widespread recommendations for a multidisciplinary approach to critical care, the prevalence of routine NC for patients requiring ICU admission remains unknown. This study set out to characterize the variation in NC practices in New Jersey, Wisconsin, and Rhode Island for critically ill patients and examine its association with clinical outcomes.

While we were unable to evaluate causality, this retrospective cohort study identified a potential association between obtaining a nutrition consult and improved patient outcomes. NC in critically ill patients was associated with lower in-hospital mortality, pneumonia, pulmonary failure, gastrointestinal bleeding, or requirement for mechanical ventilation. Decreasing the risk of most complications should also result in decreased associated mortality. As enteral nutrition has been found to decrease pulmonary complications and infections (possibly partly due to enhancing the immune system through production of GALT and MALT, strengthening the health of the intestinal mucosal barrier, as well as decreasing GI bleeding episodes), these findings are not surprising.[26,27] Patients that received ENPN may have received more electrolytes including sodium salts which increased the rate of acute renal failure. Preclinical research and more recent randomized trials have identified that patients treated with sodium chloride or increased amounts of amino acids are at risk to develop acute kidney injury.[28-32]

Another possibility for the improved outcomes associated with NC is related to timing of initiation of nutrition. An emerging trend suggests that nutritional support may actually be harmful when delivered to patients who are still in the pro-inflammatory phase of critical illness; however, additional studies are need to further investigate this claim.[33,34] It is possible that institutions that routinely involve CCN/RDs in nutritional planning are more cognizant of this trend and thus are less likely to provide nutritional support until patients are beyond the pro-inflammatory phase of illness. In this study, we identified an association between improved outcomes in patients who received late (> 8 days) initiation of ENPN along with NC compared with patients who received early ENPN without NC. This benefit was not solely due to the late initiation of ENPN, as patients without NC did not benefit from late ENPN. It is possible that nutritional supplementation guided by NC is more likely to be in concordance with evidence-based nutritional care. Protein delivery, not simply calories, may be the most essential nutrient supplement for supporting the immune system, healing, and prevention of lean body mass loss.[35] Research has demonstrated that critically ill patients with multi-organ failure can lose up to 25% of their muscle mass by day 10 of their hospital admission, but adequate supplementation (>1.2 g/kg/d) may be able to improve outcomes.[36,37] The 2016 guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient published as a joint venture of the Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.), recommend providing and monitoring for adequate protein delivery as an expert consensus recommendation.[24]

Concomitant nutrition and PT consultation was also associated with improved in-hospital mortality. This finding is supported by previous research demonstrating that a holistic approach to treatment, including early mobility protocols, improves functional outcomes.[38,39] These findings suggest there are benefits to having highly trained specialist teams caring for patients with complex problems beyond ordering nutritional supplementation.

As most of the literature on nutrition supplementation and outcomes in hospitalized patients is concentrated on the specifics of the nutrition intervention (administration routes, timing, and duration) and not necessarily on the presence or absence of a formal nutrition evaluation or treatment regimen, clinicians may think it is adequate to implement these recommendations in their practice.[40,41] However, guidelines designed to help direct nutrition supplementation for the care of critically ill patients based on these recommendations usually infer there is a benefit to formalized clinical nutrition specialist consultation when caring for critically ill and malnourished patients.[42,43] There are many reviews also suggesting perioperative nutrition interventions can improve morbidity and mortality, but it is unclear if formal consultation with a nutrition specialist is required to realize a benefit.[44] The findings in our study suggest that critical care physicians are managing the ICU patient's nutritional status. If this practice continues, it carries implications that there continues to be need for increased nutrition education during critical care fellowship training.

Conclusive evidence that formal NC improves patient outcomes in hospitalized patients has not yet been demonstrated. One recent literature review by Malafarina et. al supports the concept that any nutritional intervention in an at-risk hospitalized patient can improve morbidity and mortality in specific populations.[45] This review evaluated the relationship of nutritional status and outcomes in elderly patients with hip fractures. The authors defined nutrition intervention as patients who received nutrition supplements (either orally, by tube, or intravenously) or advice on the characteristics of the diet (by an RD). Any nutrition intervention was found to be associated with decreased morbidity and mortality both in the short and long term, an increase in quality of life, and improvement in activities of daily living (ADLs). The potential for confounding, however, cannot be downplayed and the possibility of selection bias, whereas only the more healthy patients were likely to receive nutritional intervention exists. Additionally, confounding exists as related to the time of initiation of nutritional intervention. As previously mentioned, nutritional intervention within the first week of illness may be associated with worsened clinical outcomes and the majority of studies in this review failed to account for differences in the time of initiation of nutrition. Furthermore, it is unknown if a formal NC in this patient population has any incremental improvement over nutrition intervention by the treatment care team alone

Despite the association between NC and improved outcomes, our study has a number of limitations. It has traditionally been very difficult to study the impact of NC on outcomes due to many factors. Recognizing and diagnosing malnutrition and nutrition risk historically has been difficult and accurate documentation of malnutrition is still underutilized. The recent development of a consensus criteria is likely to reduce variability for diagnosing patients with malnutrition.[46] However, in the patients who did not receive a NC, we were unable to ascertain the accuracy of and the party responsible for the diagnosis of malnutrition. Additionally, nutrition interventions for malnourished patients are individualized and compliance with recommendations are not always followed or documented, even in the era of electronic medical records. Numerous disciplines and specialties are involved in recommending nutrition supplementation. Thus, practices regarding NC vary nationally which further complicates associating nutritional interventions with outcomes. Finally, it is possible that there were unmeasured confounders that influenced which patients were more likely to receive NC (beyond the variables that were adjusted for). For example, we were limited in the data fields available within the database and were unable to evaluate estimated patient caloric needs, calories and protein received, timing to NC or type of formula delivered to patients.

Additionally, ICU provider bias may exist, whereas providers that were unlikely to obtain NC may also have been more likely to not provide other best practices to their patients. The results of this study identify an association between NC and improved clinical outcomes in critically ill patients. Given the potential for confounding and retrospective nature of this study we are unable to evaluate the casual relationship between NC and clinical outcomes.

This study attempted to overcome some of these limitations with using the power of large databases, but this method comes with its own set of difficulties. The accuracy and completeness of the data entered is dependent on numerous human and electronic factors. Without robust calibration and scrutiny, errors in data entry and extraction can be compounded. As only data from Wisconsin, Rhode Island, and New Jersey were available, these findings may not fully generalize to other states with different patient populations or healthcare delivery systems.

Conclusions

Significant institutional variability exists in the utilization of NC for critically ill patients. NC was associated with improved survival. This may be due to patients who receive NC receiving increased ENPN and developing less complications.

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Figure Legends

Figure 1. Study diagram detailing selection of patients in Healthcare Cost and Utilization Project State Inpatient Database

Abbreviations: CPT, current procedural terminology; ICD, international classification of diseases; ICU, intensive care unit; NC, nutrition consultation; SID, state inpatient database

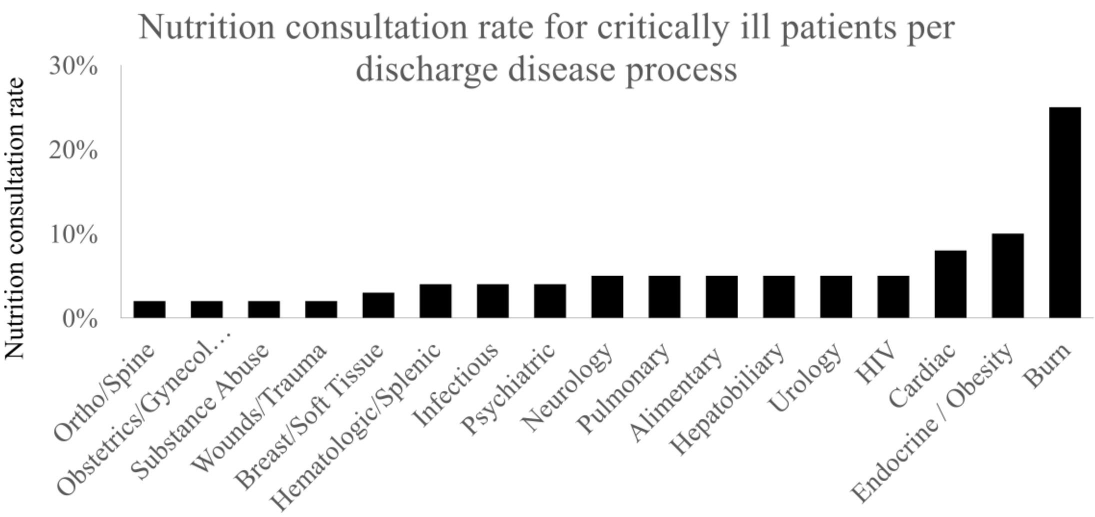

Figure 2. Nutrition consultation rate for critically ill patients per discharge disease process

Abbreviations: HIV, Human immunodeficiency virus

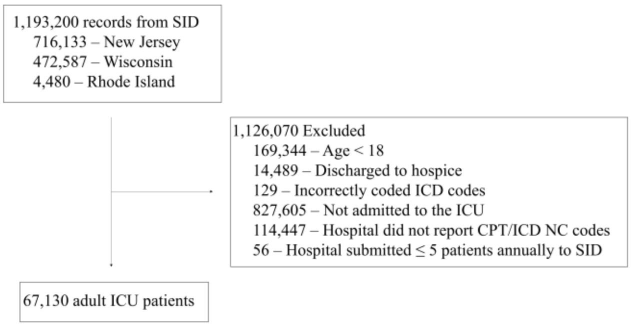

Table 1. Patient Characteristics

Characteristic	No Nutrition Consultation	Nutrition Consultation	p-value
N	63,264	3,866	
Age, n (%)			< 0.001
18– 25	1,857 (3)	65 (2)	
26 – 45	7,720 (12)	386 (10)	
46 – 65	22,143 (35)	1,361 (35)	
66 – 75	11,959 (19)	859 (22)	
> 75	19,585 (31)	1,195 (31)	
Male, %	49	53	< 0.001
Medical Admission, %	75	73	0.1
Charlson Comorbidity Index, Mean (SD)	2.2 (2.0)	2.4 (1.9)	< 0.001
Acute renal failure, %	19	18	0.3
Cardiovascular failure, %	12	7	< 0.001
Acute hepatic failure, %	1	1	0.4
Acute hematologic failure, %	7	5	0.001
Neurologic failure, %	6	3	< 0.001
Acute respiratory failure, %	16	12	< 0.001
ICU volume, Mean (SD)	1726 (1181)	1102 (1101)	< 0.001
Malnutrition, %	33	34	0.2

Abbreviations: ICU, intensive care unit; SD, standard deviation

Table 2: Association between nutrition consultation and clinical outcomes

Primary Outcome	Nutrition Consultation		
	OR	**95% CI**	**P value**
In-Hospital Mortality	0.59	0.48 – 0.74	< 0.001
Secondary Outcome			
Hospital Readmission	1.10	0.86 - 1.50	0.4
Gastrointestinal Bleeding	0.73	0.57 - 0.94	0.02
Intubation	0.74	0.64 -0.86	< 0.001
Pneumonia	0.78	0.64 - 0.93	0.007
Pulmonary Failure	0.82	0.74 - 0.90	< 0.001
Septicemia	0.91	0.80 - 1.04	0.2
Surgical Site Infection	1.04	0.73 -1.50	0.8
Acute Renal Failure	1.22	1.10 - 1.30	< 0.001

Abbreviations: CI, confidence interval; OR, odds ratio

Table 3: Association between nutrition consultation and early (< 8 days) verses late (≥ 8 days) ENPN on in-hospital mortality for patients without protein-calorie malnutrition

Cohort	**n**	**In-hospital mortality OR**	**P value**
Early ENPN + No NC	143	*reference*	N/A
Early ENPN + NC	31	0.38	0.2
Late ENPN + No NC	239	0.91	0.8
Late ENPN + NC	28	0.18	0.044

Abbreviations: ENPN, enteral or parenteral nutrition; NC, nutrition consultation; OR, odds ratio