

# Hospital Inpatient Admissions With Dehydration and/or Malnutrition in Medicare Beneficiaries Receiving Enteral Nutrition: A Cohort Study

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## Abstract

**Background:** Enteral nutrition (EN) supports many older and disabled Americans. This study describes the frequency and cost of acute care hospitalization with dehydration and/or malnutrition of Medicare beneficiaries receiving EN, focusing on those receiving home EN. **Methods:** Medicare 5% Standard Analytic Files were used to determine Medicare spending for EN supplies and the proportion and cost of beneficiaries receiving EN, specifically home EN, admitted to the hospital with dehydration and/or malnutrition. **Results:** In 2013, Medicare paid \$370,549,760 to provide EN supplies for 125,440 beneficiaries, 55% of whom were also eligible for Medicaid. Acute care hospitalization with dehydration and/or malnutrition occurred in 43,180 beneficiaries receiving EN. The most common principal diagnoses were septicemia (21%), aspiration pneumonitis (9%), and pneumonia (5%). In beneficiaries receiving EN at home, >one-third (37%) were admitted with dehydration and/or malnutrition during a mean observation interval of  $231 \pm 187$  days. Admitted patients were usually hospitalized more than once with dehydration and/or malnutrition ( $1.73 \pm 1.30$  admissions) costing  $\$23,579 \pm 24,966$  per admitted patient, totaling  $>\$129,685,622$  during a mean observation interval of  $276 \pm 187$  days. Mortality in the year following enterostomy tube placement was significantly higher for admitted compared with nonadmitted patients (40% vs 33%;  $P = .05$ ). **Conclusion:** Acute care hospitalizations with dehydration and/or malnutrition in Medicare beneficiaries receiving EN were common and expensive. Additional strategies to reduce these, with particular focus on vulnerable populations such as Medicaid-eligible patients, are needed. (*JPEN J Parenter Enteral Nutr.* 2018;42:730–738)

## Keywords

enteral nutrition; nutrition; home nutrition support; dehydration; malnutrition; Medicare; dual eligible

## Clinical Relevancy Statement

The high frequency and cost of acute care hospitalization of Medicare beneficiaries with dehydration and/or malnutrition provide evidence that new strategies to reduce their occurrence are needed. In addition, a large proportion of

these patients are Medicaid eligible, indicating particular focus on vulnerable populations is warranted. These findings are clinically relevant for clinicians who are responsible for prescribing and caring for patients who receive enteral nutrition.

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## Background

Enteral nutrition (EN) administered through a percutaneous enterostomy tube (ET) can support improved outcomes<sup>1</sup> in patients with a wide array of acute and chronic conditions. Currently, there are limited data available to evaluate the frequency and cost of EN use in Medicare beneficiaries (beneficiaries), especially in the homecare setting.<sup>2</sup>

Medicare is a U.S. federal government program that provides healthcare coverage for patients who are 65 years or older, are disabled, or have end-stage renal disease (ESRD). Most beneficiaries qualify based on age. Because EN is used most commonly in older patients, a large proportion of EN supplies in the United States are paid for by Medicare. There are 2 ways Medicare pays for EN supplies: (1) as Medicare Part A for EN supplies during the initial portion of admissions to an acute care hospital, a Medicare-qualified skilled nursing facility (SNF), or Medicare qualified long-term care hospital (LTCH) or (2) as Medicare Part B durable medical equipment (DME) for patients residing at home and after the Part A benefits have been exhausted during admissions to an acute care hospital, SNF, or LTCH.

While EN provides specific benefits, it can also be associated with complications that lead to morbidity, mortality, and consumption of healthcare resources.<sup>2-5</sup> Patients who receive EN are at increased risk for dehydration from inadequate fluid administration. Dehydration is associated with a variety of complications, including altered absorption of medications, delirium, weakness, fatigue, exacerbation of underlying medical conditions, hospitalization, functional decline, and increased risk of death.<sup>6,7</sup> While dehydration is considered a serious problem, it is often a preventable condition.<sup>8-11</sup>

Malnutrition is another complication associated with EN, occurring with inadequate caloric intake, increased nutrient requirements, or altered metabolism and absorption.<sup>12</sup> Malnutrition is associated with poorer patient outcomes,<sup>13</sup> longer hospital admissions,<sup>11,12</sup> and increased healthcare costs.<sup>12</sup>

This study sought to determine the frequency and cost of acute care hospital admissions with dehydration and/or malnutrition in beneficiaries receiving EN, with a focus on patients receiving EN at home (ie, covered by Medicare DME benefits). These data will help define the role and potential benefit of surveillance and intervention in this population.

## Materials and Methods

### Study Design

Medicare 5% Standard Analytic Files were used for this study. These files contain the Medicare health insurance claims for a random 5% sample of all beneficiaries using traditional Medicare (ie, not enrolled in a healthcare

maintenance organization). Three cohorts of beneficiaries were selected to answer 3 distinct questions about EN in the Medicare population. Cross-sectional analyses were used to determine (1) total Medicare spending for EN supplies under the DME benefit and (2) the number of beneficiaries receiving EN under the DME benefit admitted to the hospital with a diagnosis of dehydration and/or malnutrition. Longitudinal analysis was used to determine (3) the proportion and cost of beneficiaries receiving EN at home admitted to the hospital.

This study uses DME claims for EN supplies, which only capture EN supplies for beneficiaries residing at home and those who have exhausted their Medicare Part A coverage for a facility. Claims for Medicare beneficiaries receiving EN in an acute care hospital, SNF, or LTCH before their Part A benefits are exhausted are not captured using DME claims.

### Medicare Spending for EN Supplies

Beneficiary DME claims for EN supplies were identified if they had 1 or more Healthcare Common Procedure Coding System (HCPCS) codes for EN supplies (Supplementary Table S1 and Supplementary Figure S1A). Total Medicare spending for EN supplies was estimated as the sum of Medicare payments, including the beneficiary portion, for EN supplies on DME claims in 2013.

### Hospital Admission With Dehydration and/or Malnutrition of Medicare Beneficiaries Receiving EN

All 2013 beneficiary hospital inpatient admission claims with a diagnosis of dehydration and/or malnutrition present on admission (POA) were identified if they had 1 or more *International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)* diagnosis codes for dehydration and malnutrition designated as POA (Supplementary Table S2). The EN supply claims for these patients were obtained from the DME claims file. The interval, in days, from the claim date to the first inpatient admission with either dehydration and/or malnutrition POA was calculated. Those with a hospital inpatient admission within 45 days of an EN supply DME claim were subdivided into those admitted with dehydration, malnutrition, or dehydration and malnutrition (Supplementary Figure S1B).

### Hospital Admissions With Dehydration and/or Malnutrition for Medicare Beneficiaries Receiving EN at Home

Beneficiary procedure claims for ET (percutaneous gastrostomy or jejunostomy tube) placement in 2013 were identified if they had *Current Procedural Terminology (CPT)* procedure codes for 1 or more of those procedures

**Table 1.** Demographic Characteristics and Annual Cost of Enteral Feeding Supplies for Medicare Beneficiaries With Part B Durable Medical Equipment Enteral Nutrition Supply Claims in 2013.<sup>a</sup>

Characteristic	Value
Patient total	125,440 (100)
Age, mean (SD), y	70 (17)
Sex	
Male	62,240 (50)
Female	63,200 (50)
Race	
White	84,560 (67)
Nonwhite	40,880 (33)
Medicare eligibility: ESRD or disability	54,860 (44)
Medicaid eligible	68,820 (55)
Annual enteral feeding supply costs	
Cost/patient, mean (SD), \$	2954 (2745)
Total, \$	370,549,760

ESRD, end-stage renal disease.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample.

(Supplementary Table S3). All EN supply DME claims through December 31, 2014, were compiled for these beneficiaries. Beneficiaries were included in the analysis if they had at least 1 EN supply DME claim within 365 days of ET placement. They were then divided into 2 groups: those with and without acute care hospital inpatient admissions with dehydration and/or malnutrition POA between the first EN supply DME claim after ET placement and the last EN supply DME claim prior to December 31, 2014 (observation interval) (Supplementary Figure S2). If only 1 EN supply DME claim occurred between ET placement and December 31, 2014, no observation interval for an inpatient admission occurred, but they were counted as having an EN supply DME claim. To identify a cohort of patients receiving home EN, further analysis was limited to those who also had a home health visit (HHV) during the observation interval (ie, HHV was a marker for patients who received at least part of their EN at home). There may have been patients receiving EN at home who were excluded because they did not have an HHV, but all patients with an HHV did reside at home at the time of the visit.

### Statistical Analysis

Claims were linked to the corresponding record in the Medicare Demographic File using encrypted identifiers. Beneficiaries with duplicate or missing data were excluded. National patient number estimates presented in Tables 1–6 were extrapolated from the Medicare 5% sample (ie, 5% sample population  $\times$  20). All statistical comparisons were made using the number of patients from the 5% Medicare

sample. Continuous variables are summarized as the mean  $\pm$  standard deviation (SD), and comparisons were done using a 2-tailed Student *t* test. Categorical variables are presented as a percent, and comparisons were done using a  $\chi^2$  test. A 2-tailed threshold of significance of .05 was used for all comparisons.

## Results

### Medicare Spending for EN Supplies

A total of 125,440 beneficiaries received EN supplies in the home or in a long-term care setting covered by the DME benefit in 2013 (Table 1). Their mean age was  $70 \pm 17$  years, 50% were women, 33% were nonwhite, and 55% were also Medicaid eligible. A large proportion were eligible for Medicare because of disability or ESRD, rather than age (44%). The average annual cost of EN supplies for these patients was  $\$2954 \pm \$2745$  per patient. This corresponds to an estimated annual Medicare expenditure of  $\$370,549,760$  for DME benefit EN supplies.

### Hospital Admission With Dehydration and/or Malnutrition for Medicare Beneficiaries Receiving EN

To determine how many acute care hospital admissions with dehydration and/or malnutrition occurred in beneficiaries receiving EN in 2013, the number of beneficiary admissions within 45 days of a DME claim for EN supplies was calculated. Approximately 43,180 beneficiaries were admitted to an acute care hospital with dehydration and/or malnutrition POA within 45 days of an EN supply DME claim (Table 2). Their mean age was  $72 \pm 15$  years, 48% were women, 38% were nonwhite, and >half (55%) were also Medicaid eligible.

Most were admitted with dehydration and/or malnutrition as comorbidities, rather than the principal diagnosis. The most common principal diagnoses were septicemia (21%), aspiration pneumonitis (9%), pneumonia (5%), acute renal failure (4%), and urinary tract infection (4%) (Supplementary Figure S3).

Over two-thirds of the cohort (67%) were admitted with dehydration alone, 19% with malnutrition alone, and 14% with both (Table 2).

### Hospital Admissions With Dehydration and/or Malnutrition for Medicare Beneficiaries Receiving EN at Home

A primary goal of this study was to determine the frequency and cost of acute care hospitalizations with dehydration and/or malnutrition in beneficiaries receiving EN at home. To define a cohort of beneficiaries receiving EN at home, beneficiaries receiving EN following ET placement were first

**Table 2.** Demographic Characteristics of Medicare Beneficiaries With Acute Care Hospital Inpatient Admission With Dehydration and/or Malnutrition <45 Days After a Durable Medical Equipment Enteral Nutrition Supply Claim.<sup>a</sup>

Characteristic	Admission With Dehydration and/or Malnutrition	Admission With Dehydration	Admission With Malnutrition	Admission With Dehydration and Malnutrition
Patients, % of cohort	43,180 (100)	28,960 (67)	8360 (19)	5860 (14)
Age, mean (SD), y	72 (15)	73 (15)	70 (16)	72 (14)
Sex				
Male	22,420 (52)	14,560 (50)	4660 (56)	3200 (55)
Female	20,760 (48)	14,400 (50)	3700 (44)	2660 (45)
Race				
White	26,960 (62)	17,400 (60)	5860 (70)	3700 (63)
Nonwhite	16,220 (38)	11,560 (40)	2500 (30)	2160 (37)
Medicare eligibility: ESRD or disability	17,240 (40)	11,800 (41)	3280 (39)	2160 (37)
Medicaid eligible	23,720 (55)	16,700 (58)	4100 (49)	2920 (50)

ESRD, end-stage renal disease.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample.

**Table 3.** Demographic Characteristics of Medicare Beneficiaries With a Durable Medical Equipment Enteral Nutrition Supply Claims in the Year Following Enterostomy Tube Placement.<sup>a</sup>

Characteristic	All Patients	No Admission With Dehydration or Malnutrition	Admission With Dehydration and/or Malnutrition	Admission With Dehydration	Admission With Malnutrition	Admission With Dehydration and Malnutrition
Patients, % of cohort	33,400 (100)	24,380 (73)	9020 (27)	5140 (15)	1280 (4)	2600 (8)
Age, mean (SD), y	73 (13)	73 (13)	74 (13)	75 (12)	71 (13)	72 (13)
Sex						
Male	17,660 (53)	12,980 (53)	4680 (52)	2560 (50)	700 (55)	1420 (55)
Female	15,740 (47)	11,400 (47)	4340 (48)	2580 (50)	580 (45)	1180 (45)
Race						
White	23,140 (69)	17,000 (70)	6140 (68)	3280 (64)	1000 (78)	1860 (72)
Nonwhite	10,260 (31)	7380 (30)	2880 (32)	1860 (36)	280 (22)	740 (28)
Medicare eligibility: ESRD or disability	11,440 (34)	7980 (33)	3460 (38)	1800 (35)	620 (48)	1040 (40)
Medicaid eligible	14,360 (43)	10,300 (42)	4060 (45)	2400 (47)	560 (44)	1100 (42)

ESRD, end-stage renal disease.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample.

identified, and then an analysis of those who had an HHV in the interval between the first and last EN DME supply claim was conducted.

There were 122,320 ET placements in beneficiaries in 2013. Patients without a DME claim for EN supplies in the first year following tube placement were excluded, leaving 33,400 patients (Table 3). The mean age was 73 ± 13 years, 47% were women, 31% were nonwhite, and 43% were Medicaid eligible (Table 3). The mean cost of enteral feeding supplies per patient was \$11 per day (Table 4). More than one-quarter of these beneficiaries (27%) were admitted with dehydration and/or malnutrition during the mean observation interval of 202 ± 190 days. Most were admitted with dehydration (23%), either alone (15%) or in combination with malnutrition (8%). Most admissions (54%) occurred >90 days after the first EN DME supply claim. On average,

beneficiaries had <1 admission with dehydration and/or malnutrition (0.43 ± 0.92 admissions per patient), but if they were admitted, they had an average of >1 admission (1.61 ± 1.12 admissions per patients) (Table 4). Mortality in the year following ET placement did not differ significantly between those admitted and not admitted (39% vs 38%) (Table 4). The cost of these admissions with dehydration and/or malnutrition over the observation interval of 272 ± 184 days was \$23,263 ± \$24,569 per admitted patient, corresponding to a total cost of \$209,832,361 (Table 4). The cost of these admissions per patient with dehydration alone was \$20,107 ± \$22,648, malnutrition alone \$18,108 ± \$19,064, and dehydration with malnutrition \$32,040 ± \$28,278, for observation intervals of 268 ± 184 days, 223 ± 195 days, and 306 ± 174 days, respectively (Table 4). The corresponding total cost for admissions with dehydration

**Table 4.** Outcomes for Medicare Beneficiaries With Enteral Nutrition Supply Claims in the Year Following Percutaneous Endoscopic Gastrostomy/Jejunostomy, With or Without Inpatient Admission With Dehydration and/or Malnutrition.<sup>a</sup>

Characteristic	All Patients	No Admission With Dehydration or Malnutrition	Admission With Dehydration and/or Malnutrition	Admission With Dehydration	Admission With Malnutrition	Admission With Dehydration and Malnutrition
Patients, % of cohort	33,400 (100)	24,380 (73)	9020 (27)	5140 (15)	1280 (4)	2600 (8)
Days between first and last enteral feeding supply claims (ie, observation interval), mean (SD)	202 (190)	176 (185)	272 (184)	268 (184)	223 (195)	306 (174)
Admissions with dehydration and/or malnutrition						
Number of admissions/patient, mean (SD)	0.43 (0.92)		1.61 (1.12)	1.39 (0.81)	1.25 (0.69)	2.22 (1.52)
Total number of admissions	14,500 (100)	0	14,500 (100)	7140 (100)	1600 (100)	5760 (100)
≤30 days from first enteral feeding supply claim	3080 (21)	0	3080 (21)	1520 (21)	520 (33)	1040 (18)
31–90 days from first enteral feeding supply claim	3600 (25)	0	3600 (25)	2060 (29)	440 (28)	1100 (19)
>90 days from first enteral feeding supply claim	7820 (54)	0	7820 (54)	3560 (50)	640 (40)	3620 (63)
Enteral feeding supply costs						
Cost/patient, mean (SD), \$	2315 (2705)	2020 (2470)	3114 (3120)	3167 (3260)	2574 (2710)	3273 (3018)
Cost/patient/day of observation interval, \$	11	11	11	12	12	11
Total, \$	77,332,726	49,247,713	28,085,013	16,280,794	3,294,878	8,509,340
Costs for inpatient admissions with dehydration and/or malnutrition						
Cost/patient, mean (SD), \$	6282 (16,416)	0	23,263 (24,569)	20,107 (22,648)	18,108 (19,064)	32,040 (28,278)
Total, \$	209,832,361	0	209,832,361	103,350,752	23,178,023	83,303,586
Died within 1 year of PEG/PEJ placement	12,800 (38)	9280 (38)	3520 (39)	1920 (37)	640 (50)	960 (37)
Home health visits	15,000 (45)	9500 (39)	5500 (61)	2920 (57)	780 (61)	1800 (69)
Home health visit /patient/observation day	0.22	0.22	0.22	0.21	0.27	0.23

PEG, percutaneous endoscopic gastrostomy; PEJ, percutaneous endoscopic jejunostomy.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample.

alone was \$103,350,752, malnutrition alone \$23,178,023, and dehydration with malnutrition \$83,303,586 (Table 4).

In the cohort of 33,400 patients with a DME claim in the first year following ET placement, <half (45%) had an HHV during the mean observation interval of 202 ± 190 days (Table 4). Although the proportion of patients who received an HHV was greater for admitted patients (61% vs 39%), when normalized for the duration of the observation interval (272 vs 176 days), they were identical, 0.22% per observation interval day (Table 4). Beneficiaries with an HHV were younger (72 ± 13 years vs 74 ± 13 years; *P* = .03), more likely to be men (57% vs 50%; *P* = .01) and white (75% vs 65%; *P* < .001), and less likely to be Medicaid eligible (31% vs 53%; *P* < .001) compared with those without an HHV (Table 5).

More than one-third (37%) of beneficiaries with an HHV were admitted with dehydration and/or malnutrition during the mean observation period of 231 ± 187 days (Table 6). Beneficiaries with an HHV who were admitted were more likely to qualify for Medicare based on disability or ESRD rather than age (37% vs 29%; *P* < .001) and more likely to be eligible for Medicaid (34% vs 29%; *P* < .001) compared with those not admitted (Table 6).

Most were admitted with dehydration (31%), either alone (19%) or in combination with malnutrition (12%) (Table 6). Most admissions (55%) occurred >90 days from the first EN supply claim (Table 7). On average, beneficiaries with an HHV had <1 admission with dehydration and/or malnutrition (0.63 ± 1.15), but if admitted, they had an average of >1 admission (1.73 ± 1.30) (Table 7). Mortality in the year following ET placement was higher for those admitted with dehydration and/or malnutrition compared with those not admitted (40% vs 33%; *P* = .05). For patients with an HHV, the cost of these admissions with dehydration and/or malnutrition over the observation interval of 276 ± 187 days was \$23,579 ± \$24,966 per admitted patient, corresponding to a total cost of \$129,685,622 (Table 7). The cost of these admissions per patient with dehydration alone was \$18,733 ± \$21,724, malnutrition alone \$20,299 ± \$23,014, and dehydration with malnutrition \$32,863 ± \$28,169, for observation intervals of 270 ± 181 days, 213 ± 191 days, and 313 ± 189 days, respectively (Table 7). The corresponding total cost for admissions with dehydration alone was \$54,699,414, malnutrition alone \$15,833,215, and dehydration with malnutrition \$59,152,993 (Table 7).

**Table 5.** Comparison of Demographic Characteristics of Patients With Enteral Nutrition Supply Claims in the Year Following Percutaneous Endoscopic Gastrostomy/Jejunostomy Tube Placement, With or Without a Home Health Visit.<sup>a</sup>

Characteristic	Home Health Visit	No Home Health Visit	P Value
Patients, % of cohort	15,000 (898)	18,400 (1102)	
Age, mean (SD), y	72 (13)	74 (13)	.03
Sex			
Male	8500 (57)	9160 (50)	.01
Female	6500 (43)	9240 (50)	.01
Race			
White	11,220 (75)	11,920 (65)	<.001
Nonwhite	3780 (25)	6480 (35)	<.001
Medicare eligibility: ESRD or disability	4780 (32)	6660 (36)	.07
Medicaid eligible	4620 (31)	9740 (53)	<.001
Died within 1 year of PEG/PEJ placement	5340 (36)	7460 (41)	.04

ESRD, end-stage renal disease; PEG, percutaneous endoscopic gastrostomy; PEJ, percutaneous endoscopic jejunostomy.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample. Statistical comparisons based on patient numbers from a 5% Medicare sample.

**Table 6.** Demographic Characteristics of Medicare Beneficiaries With Enteral Nutrition Supply Claims in the Year Following Percutaneous Endoscopic Gastrostomy/Jejunostomy and a Home Health Visit, With or Without Inpatient Admission with Dehydration and/or Malnutrition.<sup>a</sup>

Characteristic	Total Cohort	No Admission for Dehydration or Malnutrition	Admission With Dehydration and/or Malnutrition	Admission With Dehydration	Admission With Malnutrition	Admission With Dehydration and Malnutrition
Patients, % of cohort	15,000 (100)	9500 (63)	5500 (37)	2920 (19)	780 (5)	1800 (12)
Age, mean (SD), y	72 (13)	72 (12)	72 (13)	74 (13)	71 (13)	70 (13)
Sex						
Male	8500 (57)	5340 (56)	3160 (57)	1700 (58)	420 (54)	1040 (58)
Female	6500 (43)	4160 (44)	2340 (43)	1220 (42)	360 (46)	760 (42)
Race						
White	11,220 (75)	7240 (76)	3980 (72)	1920 (66)	660 (85)	1400 (78)
Nonwhite	3780 (25)	2260 (24)	1520 (28)	1000 (34)	120 (15)	400 (22)
Medicare eligibility:	4780 (32)	2740 (29)	2040 (37)	960 (33)	300 (38)	780 (43)
ESRD or disability						
Medicaid eligible	4620 (31)	2760 (29)	1860 (34)	920 (32)	280 (36)	660 (37)

ESRD, end-stage renal disease.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample.

## Discussion

This study demonstrates Medicare paid \$370,549,760 to provide EN supplies for 125,440 beneficiaries in 2013. It is likely the total number of beneficiaries who used EN supplies in 2013 and the associated costs were substantially higher, because the EN costs included in facility payments under Part A benefits were not included.

This study identified 2 demographic characteristics of Medicare beneficiaries receiving EN that differ significantly from the Medicare population as a whole. First, 44% of beneficiaries receiving EN in this study qualified for Medicare based on disability or ESRD rather than age, compared with about 16% of all Medicare beneficiaries. Second, 55% of Medicare beneficiaries receiving EN were

also eligible for Medicaid, compared with about 18% of all Medicare beneficiaries. Patients eligible for both Medicare and Medicaid, referred to as dual-eligible beneficiaries, are of significant interest because of their increased medical complexity and cost. In 2015, dual-eligible patients comprised 20% of Medicare beneficiaries but consumed 34% of the Medicare budget.<sup>14</sup> Medicaid eligibility is determined by each state and includes maximum income criteria set at or near the federal poverty limit.<sup>14</sup> As a result, most dual-eligible beneficiaries are both older and poor. The increased frequency of disabled and poor patients makes beneficiaries receiving EN a particularly vulnerable population.

Patients receiving EN are at increased risk for dehydration, a serious yet preventable condition that occurs mostly in patients with underlying illnesses.<sup>8-10</sup> Our analysis

**Table 7.** Outcomes for Medicare Beneficiaries With Enteral Nutrition Supply Claims in the Year Following Percutaneous Endoscopic Gastrostomy/Jejunostomy and a Home Health Visit, With or Without Inpatient Admission With Dehydration and/or Malnutrition.<sup>a</sup>

Characteristic	Total Cohort	No Admission for Dehydration or Malnutrition	Admission With Dehydration and/or Malnutrition	Admission With Dehydration	Admission With Malnutrition	Admission With Dehydration and Malnutrition
Patients, % of cohort	15,000 (100)	9500 (63)	5500 (37)	2920 (19)	780 (5)	1800 (12)
Days between first and last enteral feeding supply claims (ie, observation interval), mean (SD)	231 (187)	205 (182)	276 (187)	270 (181)	213 (191)	313 (189)
Admissions with dehydration and/or malnutrition						
Number of admissions/patient, mean (SD)	0.63 (1.15)	0	1.73 (1.30)	1.42 (0.88)	1.36 (0.84)	2.40 (1.72)
Total number of admissions	9520 (100)	0	9520 (100)	4140 (100)	1060 (100)	4320 (100)
≤30 days from first enteral feeding supply claim	2020 (21)	0	2020 (21)	900 (22)	320 (30)	800 (19)
31–90 days from first enteral feeding supply claim	2260 (24)	0	2260 (24)	1140 (28)	280 (26)	840 (19)
>90 days from first enteral feeding supply claim	5240 (55)	0	5240 (55)	2100 (51)	460 (43)	2680 (62)
Enteral feeding supply costs						
Cost/patient, mean (SD), \$	2370 (2524)	2032 (2089)	2953 (3055)	2933 (3069)	2057 (2039)	3372 (3328)
Cost/patient/day of observation interval, \$	10	10	11	11	10	11
Total, \$	35,545,580	19,305,685	16,239,896	8,565,117	1,604,794	6,069,985
Costs for inpatient admissions with dehydration and/or malnutrition						
Cost/patient, mean (SD), \$	8646 (18,902)	0	23,579 (24,966)	18,733 (21,724)	20,299 (23,014)	32,863 (28,169)
Total, \$	129,685,620	0	129,685,622	54,699,414	15,833,215	59,152,993
Died within 1 year of PEG/PEJ placement	5340 (36)	3120 (33)	2220 (40)	1120 (38)	440 (56)	660 (37)

PEG, percutaneous endoscopic gastrostomy; PEJ, percutaneous endoscopic jejunostomy.

<sup>a</sup>Values are presented as number (%) unless otherwise indicated. Data are national Medicare estimates derived from a 5% Medicare sample.

found that in 2013, >43,000 beneficiaries receiving EN were admitted for acute care hospitalization with dehydration and/or malnutrition. Dehydration was substantially more common than malnutrition; >two-thirds of these patients were admitted with dehydration in the absence of malnutrition.

Patients receiving EN in this study were more likely to be admitted with dehydration and/or malnutrition as a

comorbidity rather than the principal diagnosis for admission, similar to Medicare beneficiaries as a whole.<sup>15</sup> Admission with dehydration is associated with significantly increased short term (30-day) and longer term (31–365 days) mortality in beneficiaries hospitalized with many common principal diagnoses, including respiratory illness, urinary tract infection, cancer, sepsis, diabetes, and cardiac disease.<sup>15</sup> In the current study, the most common principal

diagnoses were septicemia, aspiration pneumonitis, pneumonia, and acute renal failure. Whether concomitant dehydration exacerbates the principal diagnosis or is a marker for increased severity of the principal diagnosis cannot be determined from the administrative data used in this study. Nonetheless, its prognostic importance is clinically significant.

A primary goal of this study was to determine the frequency and cost of admission with dehydration and/or malnutrition in beneficiaries receiving EN at home. A cohort of beneficiaries receiving EN following ET placement was first identified, and then an analysis of those who had an HHV in the interval between the first and last EN DME supply claim was conducted. Patients who received EN following ET placement were chosen because ETs are usually placed in patients expected to require EN for longer than 4 weeks,<sup>16,17</sup> providing a longer window to follow patients for admission, compared with those who received home EN as part of a brief procedure-related interruption of normal feeding or end-of-life care.

During the mean observation interval of  $202 \pm 190$  days, slightly <half (45%) of the ET patients had an HHV. This study identified demographic differences between the beneficiaries who did and did not receive an HHV. Patients without an HHV were more likely to be older, women, nonwhite, and Medicaid eligible. It would be useful to understand the basis for fewer HHVs in populations that have traditionally been underserved.

Despite an HHV, admissions with dehydration and/or malnutrition were common in this study. More than one-third of patients with an HHV were admitted with dehydration and/or malnutrition during an observation interval of  $231 \pm 187$  days, and patients who were admitted once were usually admitted more than once, contributing to a total cost to Medicare of \$129,685,622 during a mean observation period of  $276 \pm 187$  days. Mortality in the year following ET placement was significantly higher for admitted compared with nonadmitted patients (40% vs 33%;  $P = .05$ ).

Patients with an HHV who were admitted were more likely to be eligible for Medicaid, compared with those who were not admitted. Previous work demonstrates that support from home EN dietitians can reduce unnecessary hospital admission of patients receiving home EN.<sup>18</sup> This suggests it is helpful for clinicians to be aware of the Medicaid-eligible status of their EN patients and that support from home EN dietitians may be particularly effective for reducing acute care hospital admissions in this population.

This study has several limitations. First, these data were collected from the Medicare claims databases. While these databases are designed to accurately capture the occurrence, duration, and cost of hospital admissions and durable medical equipment costs, they are not optimized to capture

comprehensive details of clinical care. Second, because inpatient physicians' fees and required outpatient care are not captured, it may underestimate total costs associated with dehydration and/or malnutrition admissions. Third, patients receiving EN in settings such as acute care hospitals, SNFs, and LTCHs are not captured before their Part A benefits are exhausted, causing our study to underestimate the total number of beneficiaries receiving EN and the associated cost. Fourth, because Part B benefits pay for EN supplies after Part A benefits have been exhausted for patients in acute care hospitals, SNFs, or LTCHs, we cannot be sure whether patients with a DME claim for EN supplies reside at home or in an institution. Finally, cost data are based on Medicare payment rates, including beneficiary responsibility, and may not represent the actual cost to provide these services. Despite these limitations, we feel the results from this large observational study provide valid and useful insights into admissions with dehydration and/or malnutrition in beneficiaries who received EN.

In summary, this analysis demonstrates Medicare pays >\$370 million each year to provide EN supplies for >125,000 beneficiaries, >half belong to the highly vulnerable population of dual-eligible patients, and >one-third of patients receiving EN at home are admitted for acute care hospitalization within an observation interval of <1 year, costing >\$129 million. Additional strategies to reduce dehydration in enterally fed patients, including evaluation of the adequacy of hydration administered through the ET, should be developed and evaluated. Extra attention should be focused on vulnerable populations such as dual-eligible patients.

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### Statement of Authorship

R. Drake, A. Ozols, W. J. Nadeau, and M. J. Braid-Forbes contributed to the conception and design of the research, as well as the interpretation of the data; M. J. Braid-Forbes contributed to the acquisition and analysis of the data; and R. Drake and M. J. Braid-Forbes drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

### Supplementary Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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