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The Clinical Course after Long-Term Acute Care Hospital Admission among Older Medicare Beneficiaries

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Short Running Title: Clinical Course after LTAC Admission

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ABSTRACT

OBJECTIVE: Long-term acute care hospitals (LTACs) provide extended, complex post-acute care to over 120,000 Medicare beneficiaries annually, with the goal of helping patients to regain independence and recover. Since little is known about patients' long-term outcomes, we sought to examine the clinical course after LTAC admission.

DESIGN: Nationally representative, 5-year cohort study using 5% Medicare data from 2009-2013.

SETTING & PARTICIPANTS: Hospitalized Medicare fee-for-service beneficiaries ≥ 65 years of age who were transferred to an LTAC.

MEASUREMENTS: Mortality, recovery (defined as achieving 60 consecutive days alive without inpatient care), time spent in an inpatient facility following LTAC admission, receipt of an artificial life-prolonging procedure (feeding tube, tracheostomy, hemodialysis), and palliative care physician consultation.

RESULTS: Of 14,072 hospitalized older adults transferred to an LTAC, median survival was 8.3 months, and 1- and 5-year survival were 45% and 18%, respectively. Following LTAC admission, 53% never achieved a 60-day recovery. The median time of their remaining life a patient spent as an inpatient after LTAC admission was 65.6% (IQR, 21.4%-100%). Over one-third (36.9%) died in an inpatient setting, never returning home after the LTAC admission. During the preceding hospitalization and index LTAC admission, 30.9% received an artificial life prolonging procedure, and 1% had a palliative care physician consultation.

CONCLUSION: Hospitalized older adults transferred to LTACs have poor survival, spend majority of their remaining life as an inpatient, and frequently undergo life-prolonging procedures. This prognostic understanding is essential to inform goals of care discussions and prioritize healthcare needs for hospitalized older adults admitted to LTACs. Given the exceedingly low rates of palliative care consultations, future research is needed to examine unmet palliative care needs in this population.

Keywords: Post-acute care; Medicare; older adults; prognosis; palliative care

INTRODUCTION

Each year, over 120,000 hospitalized older adults survive an acute or critical illness and are transferred to a long-term acute care hospital (LTAC) to recover.¹ LTACs are distinct from acute care hospitals and skilled nursing facilities (SNFs) in their focus on treating patients who require extended inpatient care, typically for three to five weeks following the initial hospitalization.² While most commonly understood as the post-acute care setting of choice for chronically critically ill patients needing prolonged mechanical ventilation,^{3,4} nearly three-quarters of LTAC patients are not mechanically ventilated,^{5,6} but rather, require other medically complex inpatient care (e.g., complex wound care). The intended goal of LTACs is to help patients recover and regain independence; however, very little is known about older adults' long-term clinical course after LTAC admission. Understanding the clinical course after LTAC admission can inform goals of care discussions, advance care planning, and prioritization of healthcare needs. Additionally, awareness of prognosis may lead some patients to shift from intensive life-sustaining and rehabilitative treatment to hospice care, with a focus on symptom management and improving the quality of their remaining life.

For older adults transferred to an LTAC, we know very little about survival, recovery, and how much time they will spend in an inpatient facility following LTAC admission rather than home. Our understanding of prognosis after LTAC admission is limited to the minority of patients who are chronically critically ill and mechanically ventilated.⁷⁻¹⁰ Among these patients, nearly half die within the first year following LTAC admission.^{8,10} However, even for this highly selected population study limitations of short follow-up period,⁷ inclusion of patients from only a few

centers,^{7,9} inclusion of patients in post-acute care settings other than LTACs,⁹ and a narrow focus on mortality^{7,8,10} do not permit robust characterization of the clinical course.

We designed this longitudinal, 5-year, nationally representative observational study of Medicare beneficiaries to examine the long-term clinical course of hospitalized older adults transferred to an LTAC, including survival, recovery, and patterns of healthcare utilization.

METHODS

Design, Data Sources, and Study Population

We conducted a retrospective cohort study using national 5% Medicare data, including the Medicare Denominator, Inpatient, Outpatient, Carrier, and Hospice files. We included Medicare fee-for-service beneficiaries age 65 years or older who were hospitalized and subsequently transferred to an LTAC on the same or next day after discharge (the index episode of care) in the period 2009-2012 using a temporally adjacent claims algorithm.^{11,12} Patients were followed for up to 5 years after LTAC admission, through 2013. We identified LTACs by the Centers for Medicare and Medicaid Services (CMS) provider number (last 4 digits between 2000-2299), which are based on Medicare certification. We confirmed LTACs by review of the facility name followed by an Internet search if the facility type was uncertain. We excluded older adults without Medicare Parts A or B, or those with Medicare Advantage at any time in the prior 12 months. We excluded patients with an LTAC admission within 12 months prior to the index episode of care. If patients had multiple eligible LTAC admissions during our study period, we selected the first one as the index episode of care. To benchmark our findings, we also included an equivalent number of randomly selected Medicare beneficiaries who were hospitalized but not

transferred to an LTAC, stratified by hospital length of stay (< 1 week, 1-2 weeks, or >2 weeks). These patients also met all inclusion and exclusion criteria aside from LTAC transfer.

Outcomes after LTAC Admission

Our primary outcomes included all-cause mortality, recovery, time spent in an inpatient facility after LTAC admission, receipt of an artificial life-prolonging procedure, and receipt of a palliative care physician consultation. Vital status and dates of death were ascertained from Medicare Denominator files. We defined recovery as achieving 60 consecutive days without care in an inpatient facility following LTAC admission, which could include a hospitalization, observation stay, or inpatient post-acute care stay (LTAC, SNF, or inpatient rehabilitation facility [IRF]). Sixty days without inpatient care is also the time period CMS uses to define the end of one benefit period (a spell of illness) and start of a new benefit period. Time spent in an inpatient facility was defined as the total number of days spent in one of the aforementioned inpatient facilities divided by the overall number of days before hospice enrollment or death, up to a maximum of one year following LTAC admission. Less time spent in an inpatient facility is a patient-centered outcome,^{9,13,14} is consistent with patients' expressed preferences of being at home at the end of the life,¹⁵ and is associated with better self-rated health and functioning.¹⁶

An artificial life-prolonging procedure was defined as receipt of a tracheostomy, permanent feeding tube (not including replacement),¹⁷ or hemodialysis, using ICD-9-CM procedure, CPT, and revenue center codes from Medicare Inpatient and Carrier files (see **Supplementary Table S1 for definitions**). Procedures were ascertained up to one year before, during the index episode of care, and up to three years after the index episode of care.

Since we hypothesized that older adults admitted to an LTAC would have a poor prognosis, we assessed the incidence of palliative care physician consultations using Medicare specialty code 17 associated with any inpatient evaluation and management CPT code during the index episode of care (initial hospitalization and subsequent LTAC admission). Given that geriatricians may also be well versed in providing palliative care, we also assessed the incidence of geriatric physician consultations using Medicare specialty code 38. Medicare specialty codes are self-designated by the physician and are used by CMS to identify distinct physician evaluation and management services for reimbursement if multiple physicians from the same group bill services for the same day.¹⁸

Subgroups

We assessed survival, recovery, and time spent as an inpatient for pre-specified subgroups, including age, gender, race/ethnicity, diagnosis, mechanical ventilation use (defined using ICD-9-CM diagnosis and procedure codes), and whether the patient's LTAC admission would have been subjected to the impending site-neutral payment policy. Beginning in 2020, the site-neutral payment policy stipulates that LTAC admissions for patients who 1) spend fewer than three days in an intensive care unit during the preceding hospitalization, 2) do not require prolonged mechanical ventilation ≥ 96 hours, or 3) have a primary psychiatric or rehabilitation LTAC diagnosis will receive reduced reimbursement, equivalent to the lower of the estimated cost of care or the comparable inpatient per diem rate. Consequently, these patients are anticipated to have lower LTAC access starting in 2020.¹⁹

Statistical Analysis

We examined mortality using time-to-event Kaplan Meier analyses and log-rank tests to compare unadjusted mortality rates among patients transferred to an LTAC against those who were hospitalized but ultimately not transferred. For non-demographic subgroups, we used Cox proportional hazards models adjusting for age, gender, and race/ethnicity. To examine whether patients recovered, we used Fine and Grey cumulative incidence function curves accounting for competing risks of hospice enrollment and death. Non-demographic subgroups for recovery were adjusted for age, gender, and race/ethnicity.

To examine patterns of healthcare use, we created a heat map to permit visualization of individual variation in utilization after LTAC admission.²⁰ In the heat map, each individual is represented by a single row with up to one year of follow-up after transfer, which we set as day 0. Each day is represented by a single box and is color-coded according to the status of the patient for that day (**Supplementary Figure S1**). To facilitate visualization of patients who die and those with a high burden of time spent as an inpatient, we sorted the data prior to plotting. We first plotted patients who died, sorting them in ascending order as follows: 1) total observation time until death; 2) number of days spent at home; 3) number of days spent in an inpatient facility; 4) number of days enrolled in hospice; 5) number of days spent in a SNF or IRF; and 6) number of days spent in an LTAC. We then plotted patients who were alive, sorting patients in ascending order by number of days spent at home. For ease of visualization, heat maps were constructed using a random sample of 1,000 patients transferred to an LTAC from our cohort, and who were not administratively censored for losing Medicare coverage.

We assessed receipt of an artificial life support procedure using Fine and Grey cumulative incidence function curves, accounting for competing risks of hospice enrollment and death. We used descriptive statistics to assess the incidence of hospice and palliative care physician consultations during the index hospitalization and subsequent LTAC admission for years 2010-2012 since the hospice/palliative care specialty code was introduced in 2009. Analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC). The heat map was created using R version 3.3.2. This study was approved by the University of Texas Southwestern Institutional Review Board.

RESULTS

We included 14,072 hospitalized older adults who were transferred to an LTAC (**Supplementary Table S2**). The median follow-up was 0.67 years (IQR, 0.12-2.07). Nearly 41% of patients were age ≥ 80 years, 53% were female, and 77% were white (**Table 1**). Forty percent were admitted to an LTAC for a respiratory diagnosis. The majority of patients (71%) were never mechanically ventilated and 61% would have been exempt from the site-neutral payment policy stipulating lower reimbursement.

Mortality

Following LTAC admission, median survival was 8.3 months. Fewer than half of patients (45%) were alive at one year, and only 18% at five years (**Figure 1**). Unadjusted survival rates were considerably lower among older patients transferred to an LTAC compared with older patients who were hospitalized but not transferred, even among those with prolonged hospitalizations greater than two weeks ($p < 0.001$).

Recovery

Fewer than half (47.1%) of older adults achieved recovery after LTAC admission, which in unadjusted comparisons, is lower than for those hospitalized and not transferred to an LTAC (Figure 2). The incidence for recovery plateaued at nine months after LTAC admission, signifying that few patients achieved recovery after this time point.

Healthcare Utilization

In the first year after LTAC admission, older adults spent, on average, two-thirds of their remaining life in an inpatient facility (median 65.6%, IQR, 21.4%-100%). Over one-third of patients (36.9%) spent the entirety of their remaining life as an inpatient, dying before ever returning home (Figure 3, Table 2). Overall, 16% of patients enrolled in hospice, with a median of ten total hospice days (IQR, 3-46).

Subgroup Analyses

There were notable differences in survival, recovery, and time spent as an inpatient by subgroup (Table 2). The youngest old patients (age 65-69 years) and those transferred for a musculoskeletal diagnosis had the most favorable prognosis (median survival of 17.3 and 25.9 months respectively), whereas the oldest-old (age ≥85 years) and those with a primary respiratory diagnosis had the worst prognosis (median survival of 4.0 and 5.3 months; median time of remaining life spent as an inpatient of 97.7% and 88.8% respectively). Patients who were mechanically ventilated did worse, but even patients not requiring mechanical ventilation had a poor prognosis (median survival 10.6 months; 9-month recovery rate of 49.6%; median time

spent as an inpatient of 55.6%). Patients who would be exempt from the impending site-neutral payment policy (and more likely to be representative of the LTAC population in 2020 and beyond) had a much poorer prognosis than those who would be subjected to the reduced reimbursement (median survival of 6.7 vs. 13.6 months; median time spent as an inpatient of 83.0% vs. 47.1%; **Table 2; Supplementary Figure S2**).

Artificial Life Prolonging Procedures

Almost one-third of patients (30.6%) received at least one life prolonging procedure during the index episode of care (20.6% of patients during the initial hospitalization and 10.0% of patients during the subsequent LTAC admission). Permanent feeding tubes were the most common (22.3%), followed by tracheostomy (18.5%) and hemodialysis (8.9%). Fewer patients received a life prolonging procedure either before or after the index episode of care (**Supplementary Figure S3**). Over a 4-year time period (1-year look-back plus 3-years of follow-up), 45.1% of patients received at least one life prolonging procedure.

Palliative Care Physician Consultations

During the index episode of care, 1.0% of patients were seen by a palliative care physician and 3.2% were seen by a geriatrician. The incidence of palliative care physician consultations increased from 0.6% in 2010 to 1.2% in 2011, but remained at 1.2% in 2012. The incidence of geriatrician consultations slightly increased from 3.0% in 2010, to 3.1% in 2011, to 3.5% in 2012.

DISCUSSION

In this nationally representative cohort study, we found that older adults admitted to an LTAC have a worse prognosis than many terminal illnesses, such as advanced cancer,^{21,22} end-stage heart failure,²³ and advanced dementia.²⁴ Fewer than one in five hospitalized older Medicare beneficiaries transferred to an LTAC were alive at five years. Patients spent on average of two-thirds of their remaining time alive after LTAC admission in a hospital or inpatient post-acute care setting. Only half experienced a minimal definition of recovery (i.e., 60 consecutive days alive without inpatient care) and one-third received at least one invasive artificial life-prolonging procedure. Over one-third of patients were confined to an inpatient setting and never returned home before dying. Yet, only 1% of patients were ever seen by a palliative care physician during their initial hospitalization or subsequent LTAC admission, and 16% enrolled into hospice for a median of 10 days, which is far lower than for the overall Medicare program, where 48% of all decedents in 2016 enrolled in hospice with a median length of stay of 24 days.²⁵

Our findings corroborate and extend prior research reporting high mortality among patients transferred to an LTAC with chronic critical illness requiring prolonged mechanical ventilation.^{8,10} The present study included all older Medicare beneficiaries transferred to an LTAC (and not just the chronically critically ill), extended follow-up to five years, and examined several patient-centered outcomes which may be as, if not more, important to this population than living as long as possible.²⁶ Notably, even those who were never mechanically ventilated also had limited survival, poor recovery, and high burden of inpatient care.

In light of the poor prognosis and low penetration of palliative care physician consultation and hospice use, older adults transferred to an LTAC may have a substantial burden of unmet

palliative care needs. However, patients in LTACs may represent a distinct population who either desired in advance or decided in the moment of an acute illness to pursue life-sustaining and intensive care. In our study, we do not know if goals of care discussions occurred, if patients were informed and knowledgeable of their prognosis, if patients expressed desire for life-sustaining treatment, if patients received generalist palliative care from their primary physician in the hospital or LTAC (typically a hospitalist or intensivist), or the extent of patients' physical and psychosocial symptom burden and quality of life. However, prior research has shown that chronically critically ill patients transferred to LTACs have a high burden of unmet palliative care needs, overly optimistic expectations of recovery, and a strong desire to be at home, even if that meant not living as long as possible.^{26,27} Furthermore, since specialty palliative care is considered the standard of care among patients with similarly poor prognoses due to cancer or other end-stage diseases, older adults needing LTAC care should also be recognized as potentially appropriate candidates for palliative care consultations which could improve quality of life, decrease symptom burden, improve advance care planning, and decrease subsequent burdensome healthcare utilization.²⁸ In many ways LTACs are a more ideal setting for palliative care interventions than acute care hospitals given their much longer length of stay, higher concentration of very ill patients, and less focus on diagnostic evaluation. To better understand the scope of the problem, future research is needed to define the burden of unmet palliative care needs in this population.

The need for palliative care within LTACs takes on increased relevance beginning in 2020,¹⁹ since patients exempt from the reduced financial reimbursement per the site-neutral payment policy, and thus more likely to be representative of the LTAC population moving forward, have

a median survival of only 6.7 months. Given that nearly 50% will die within six months, an LTAC admission alone is nearly sufficient to meet Medicare’s criteria for having a terminal illness.

Another implication of our study is that clinicians should prioritize healthcare needs among this population and consider forgoing interventions with lengthy time horizons for benefit.^{29,30} This is especially pertinent to older adults admitted to LTACs who have limited life expectancy. If the time required for a patient to accrue on treatment is longer than their anticipated survival, patients will not realize any meaningful benefits, but will certainly be exposed to upfront harms. To prevent unnecessary harm and avoid additional burdensome care, clinicians should strongly consider forgoing non-vaccination preventive care (e.g., cancer screening), treatments for asymptomatic conditions (e.g., latent tuberculosis or chronic hepatitis C), or modifying risk factors to prevent adverse outcomes in the distant future (e.g. bisphosphonate therapy for osteoporosis or intensive glycemic control for type 2 diabetes).

Our study had certain limitations. First, our findings may not be applicable to younger LTAC patients or those with Medicare Advantage, private insurance, or Medicaid. Though, Medicare fee-for-service represents about two-thirds of the LTAC population.¹ Second, we overestimated recovery rates, since even if patients survived and made it home for 60 consecutive days, they still may not have achieved meaningful recovery in their functional status, cognition, or quality of life.

297 The goals of LTAC care are to help patients recover and regain independence after an acute or
298 critical illness. However, in this national 5-year longitudinal outcomes study, we found that older
299 Medicare beneficiaries transferred to LTACs have poor survival, spend majority of their
300 remaining life as an inpatient, and frequently undergo artificial life-prolonging procedures. This
301 prognostic understanding is essential to inform goals of care discussions and prioritize healthcare
302 needs for hospitalized older adults admitted to LTACs. Given the exceedingly low rates of
303 palliative care consultations and low penetration of hospice, future research is needed to examine
304 unmet palliative care needs in this population.

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Figure Legends

Figure 1. Five-Year Survival Among Hospitalized Older Adults Transferred to an LTAC Compared to Those Hospitalized But Discharged Elsewhere

^a Start of follow-up was the date of LTAC admission for the LTAC cohort and the date of hospital discharge for the three cohorts of hospitalized older adults who were discharged elsewhere.

Figure 2. Five-Year Cumulative Incidence of Recovery Among Hospitalized Older Adults After LTAC Transfer

^a Start of follow-up was the date of LTAC discharge for the LTAC cohort and the date of hospital discharge for the three cohorts of hospitalized older adults who were discharged elsewhere.

Figure 3. Heat Map of Healthcare Utilization after LTAC Admission ^a

^a Each individual is represented by a single row with up to 1 year of follow-up after long-term acute care hospital admission (day 0). Each day is represented by a single box and is color-coded according to the status of the patient for that day (**Supplementary Figure S1**). The first black box represents the day the patient died and subsequent black boxes signify time after death. Heat maps were constructed using a random sample of 1,000 patients transferred to an LTAC, and who were not administratively censored for losing Medicare coverage.

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Table 1. Baseline Characteristics of Hospitalized Older Adults Transferred to an LTAC (n=14,072)

	N (%)
Age (years)	
65-69	2456 (17.5)
70-74	2918 (20.7)
75-79	2881 (20.5)
80-84	2794 (19.9)
≥85	3023 (21.5)
Female	7494 (53.3)
Race/ethnicity	
White	10827 (76.9)
Black	2253 (16.0)
Other	992 (7.1)
Diagnosis type	
Medical	7363 (52.3)
Surgical	6709 (47.7)
LTAC diagnosis, Major Diagnostic Category	
Respiratory	5561 (39.5)
Infectious	1722 (12.2)
Musculoskeletal	1037 (7.4)
Circulatory	929 (6.6)
Skin	876 (6.2)
Digestive	657 (4.7)
Kidney or urinary	586 (4.2)
Nervous system	489 (3.5)
Injury, poisoning, or drugs	373 (2.7)
Endocrine	364 (2.6)
Mechanical ventilation use	
None	10065 (71.5)
Transient (<96 hours)	1028 (7.3)
Prolonged (≥96 hours)	2979 (21.2)
Site-neutral payment policy ^a	
Subjected to	5460 (38.8)
Exempt	8612 (61.2)

Abbreviation: LTAC, long-term acute care hospital

^a The policy stipulates a reduced ‘site-neutral’ payment for LTAC admissions by patients who spend fewer than three days in the intensive care unit in the preceding hospitalization prior to LTAC transfer, do not require prolonged mechanical ventilation ≥ 96 hours in the LTAC, or have a psychiatric or rehabilitation LTAC diagnosis. Admissions not meeting these criteria are exempt and qualify for full LTAC reimbursement.

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Table 2. Subgroup Analyses for Primary Outcomes

	n	Survival			Recovery ^a		Time Spent as an Inpatient ^b		
		Median, mo	1-year %	5-year %	3-month %	9-month %	n	Median %	Entirety of life, n (%)
Overall	14072	8.3	45.1	18.3	24.6	47.1	6827	65.6	2522 (36.9)
Age (years)									
65-69	2456	17.3	55.2	29.4	31.4	56.0	1124	44.1	331 (29.4)
75-79	2881	8.8	45.4	18.4	24.4	47.7	1431	66.4	515 (36)
≥85	3023	4.0	33.3	9.0	18.3	36.6	1511	97.7	718 (47.5)
Gender									
Female	7494	10.3	47.9	19.4	24.7	49.1	3686	58.9	1276 (34.6)
Male	6578	6.6	41.9	17.0	24.6	44.7	3141	75.2	1246 (39.7)
Race/ethnicity									
White	10827	8.4	45.5	19.2	25.3	47.7	5241	64.2	1942 (37.1)
Black	2253	7.2	42.9	15.7	21.8	43.7	1081	73.4	404 (37.4)
Other	992	8.4	45.6	14.6	24.5	47.9	505	60.5	176 (34.9)
LTAC Diagnosis									
Respiratory	5561	5.3	38.6	12.2	21.1	39.3	2717	88.8	1190 (43.8)
Infectious	1722	8.6	45.5	17.5	22.8	45.8	809	69.5	293 (36.2)
Circulatory	929	10.0	47.3	19.1	25.8	50.1	461	49.6	155 (33.6)
Skin	876	10.0	47.4	18.1	24.1	47.9	447	62.5	155 (34.7)
Musculoskeletal	1037	25.9	60.7	33.1	32.6	60.8	498	38.8	120 (24.1)
Mechanical Ventilation									
None	10065	10.6	48.1	19.9	25.2	49.6	4978	55.6	1662 (33.4)
Transient	1028	5.9	40.2	13.4	19.9	40.8	468	98.5	225 (48.1)
Prolonged	2979	5.4	38.5	12.2	16.9	35.4	1381	95.5	635 (46.0)
Site-Neutral Payment									
Subjected to	5460	13.6	51.6	23.2	27.8	53.6	2656	47.1	759 (28.6)
Exempt	8612	6.7	41.6	14.4	20.0	41.0	4171	83.0	1763 (42.3)

Abbreviations: LTAC, long-term acute care hospital

^a Recovery was defined as achieving 60 consecutive days without a hospitalization or inpatient post-acute care stay (LTAC, skilled nursing facility, or inpatient rehabilitation facility).

^b Time spent in an inpatient facility was defined as the time spent in a hospital or inpatient post-acute care facility (LTAC, skilled nursing facility, or inpatient rehabilitation facility) divided by the overall time the patient before hospice enrollment or death during the first year following LTAC admission. This was estimated for patients who were not administratively censored for losing Medicare fee-for-service coverage.

Figure 1. Five-Year Survival Among Hospitalized Older Adults Transferred to an LTAC Compared to Those Hospitalized But Discharged Elsewhere^a Start of follow-up was the date of LTAC admission for the LTAC cohort and the date of hospital discharge for the three cohorts of hospitalized older adults who were discharged elsewhere.

48x34mm (300 x 300 DPI)

Figure 2. Five-Year Cumulative Incidence of Recovery Among Hospitalized Older Adults After LTAC Transfer^a
Start of follow-up was the date of LTAC discharge for the LTAC cohort and the date of hospital discharge for the three cohorts of hospitalized older adults who were discharged elsewhere.

48x34mm (300 x 300 DPI)

Figure 3. Heat Map of Healthcare Utilization after LTAC Admission a^a Each individual is represented by a single row with up to 1 year of follow-up after long-term acute care hospital admission (day 0). Each day is represented by a single box and is color-coded according to the status of the patient for that day (Supplementary Figure S1). The first black box represents the day the patient died and subsequent black boxes signify time after death. Heat maps were constructed using a random sample of 1,000 patients transferred to an LTAC, and who were not administratively censored for losing Medicare coverage.

244x162mm (96 x 96 DPI)

SUPPLEMENTARY APPENDIX**The Clinical Course after Long-Term Acute Care Hospital Admission among Older Medicare Beneficiaries**

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Supplementary Table S1. Definition of Artificial Life Support Procedures	
Procedure	Codes ^a
Tracheostomy	ICD-9 procedure code 31.1x or 31.2x; CPT code 31600, 31601, 31603, 31605, or V44.0
Feeding Tube	ICD-9 procedure code 43.11, 43.19, 44.32, 46.32; CPT code 43246, 43750, 43653, 43830, 43832, 44372, 44373, 74350
Hemodialysis	ICD-9 procedure code 39.95, CPT codes 90935 or 90937, revenue center codes 0800-0809
^a Data sources included Medicare Inpatient, Outpatient, and Carrier Files	

Supplementary Figure S1. Schematic Representation of the Health Care Utilization Heat Map

Abbreviations: LTAC, long-term acute care hospital; SNF, skilled nursing facility; ACH, acute care hospital

To illustrate how the heat map was constructed, we show 6 hypothetical patients who were transferred to an LTAC (day 0), and followed for up to 20 days. Each patient is represented by one row. Each day is color-coded per the legend. For example, patient 3 was transferred to an LTAC on day 0, was hospitalized from days 14-17, and then was transferred back to the LTAC on day 18. Patient 5 was transferred to an LTAC on day 0, then was enrolled into hospice on days 13-16, and died on day 17. Our actual heat map shown in Figure 3, was constructed using 1,000 patients and followed for 365 days after transfer.

Supplementary Table S2. Study Flow Table		
Exclusion Criteria	Excluded, n (%)	Included, n
Hospitalized adults ≥65 years transferred to LTAC	-	18,812
No continuous Parts A & B in prior 12 months	926 (4.9%)	17,886
Had Medicare Part C ≥1 month in prior 12 months	760 (4.2%)	17,126
Hospitalized in Alaska or Hawaii	15 (0.0%)	17,111
Missing Diagnosis Related Group	140 (0.8%)	16,971
LTAC stay in prior 12 months	2,465 (14.5%)	14,506
Not first eligible LTAC transfer from 2009-2012	434 (3.0%)	14,072

Supplementary Figure S2. Heat Map of Healthcare Utilization by Site-Neutral Payment Status

A. Exempt from Site-Neutral Payment (Sicker Population)

B. Subjected to Reduced Site-Neutral Payment (Less Sick Population)

Supplementary Figure S3. Cumulative Incidence of Receiving an Artificial Life Prolonging Procedure

Incidence of receiving an artificial life prolonging procedure were estimated using Fine and Grey cumulative incidence function curves, accounting for competing risks of death and hospice enrollment. The date of LTAC transfer was set as time 0, with a 12-month look-back period and 3-year follow up period. Almost half (45.0%) of older adults in the cohort received at least one artificial life prolonging procedure within this time period (9.7% before the index episode of care, 20.6% during the initial hospitalization, 10.0% during the subsequent LTAC admission, and 4.7% after the LTAC stay).