

Long Term Acute Care Hospitals Reduce Length of Stay and Days in an Intensive Care Unit for Critically Ill and Medical Complex Patients

Final Report

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Executive Summary

Background: Research has documented negative impacts on patients from hospital capacity strains. The COVID-19 pandemic highlighted the challenges faced by hospitals in meeting the needs of critically ill patients in their communities. Researchers and policy makers have identified long-term acute care hospitals (LTACHs) as a potentially important resource to increase hospital capacity.

Purpose: To evaluate differences in hospital length of stay and days in an intensive care unit (ICU) during a short-term acute care hospital (STACH) stay between patients discharged to an LTACH and those discharged to a non-LTACH setting.

Methods: Using 2016-2019 Medicare fee-for-service inpatient claims data, we conducted regression analyses to examine the effects of LTACH use on STACH length of stay and ICU days. Our model controlled for patient demographic, socioeconomic, and clinical characteristics, as well as STACH characteristics. To limit sample to the types of patients most commonly treated in LTACHs, we only analyzed patients who spent 3 or more days in an ICU and had a condition frequently treated in LTACHs.

Results: LTACH patients, on average, were more medically complex than non-LTACH patients, frailer, and had higher rates of prolonged mechanical ventilation (PMV). Overall, patients discharged to non-LTACH settings after an acute care hospitalization spent 7.0 more days in the STACH and had 2.2 more ICU days compared to similar patients who were discharged to an LTACH. We found larger impacts of LTACH care on STACH length of stay and ICU days for PMV patients than for other patients, although effects were statistically significant and policy relevant for both sets of patients.

Conclusions and Implications: LTACHs significantly decreased the time medically complex patients spent in a STACH and in an ICU. The LTACH sector has been in decline, with the number of LTACHs falling from approximately 440 in 2012 to 341 in 2021. Industry representatives suggest a potential wave of additional LTACH closures could occur with the end of the COVID-19 public health emergency, which would further reduce access to LTACH care. As policymakers consider improvements to the U.S. healthcare system to ensure the ability of it to address current hospital capacity constraints and future public health emergencies, approaches to ensure access to LTACH care may be needed.

1. Introduction

The COVID-19 pandemic created challenges for hospitals in meeting the needs of critically ill patients in their communities. Shortages of intensive care unit (ICU) capacity resulted in negative outcomes for both COVID-19 and non-COVID-19 patients.^{1,2} Findings of negative impacts of hospital capacity strains on patients are not limited to the COVID-19 pandemic period. Pre-pandemic studies have documented an association between hospital-level capacity strains and care delivery changes, and in some cases, poorer outcomes among critically ill patients.³ For example, overall hospital-wide mortality,^{4,5} mortality among those admitted during times of high patient surges,⁶ mortality among critically ill patients with a delayed admission to an ICU,⁷ and mortality among ICU patients increase during times of hospital capacity strains. In addition, ICU capacity strains during the COVID-19 pandemic were more likely in hospitals that treated a higher share of Black beneficiaries, raising questions about the effects of hospital capacity strains on health equity.⁸

While policy makers consider ways to make the U.S. healthcare system more resilient in the wake of the COVID-19 pandemic, the role of

long-term acute care hospitals (LTACHs) in supplementing hospital capacity may be considered as part of the broader planning efforts. To be recognized by the Medicare program, LTACHs must meet Medicare's Conditions of Participation for acute care hospitals and have an average length of stay (ALOS) of more than 25 days for certain Medicare beneficiaries. Although LTACHs are acute care hospitals, they are often considered part of the post-acute care (PAC) continuum, because roughly 90 percent of Medicare admissions to an LTACH come directly from a short-term acute care hospital (STACH). Nonetheless, their ability to provide extended hospital-level care for critically ill and medically complex patients distinguishes LTACHs from other PAC providers, such as skilled nursing facilities (See Appendix Figure A1 for a comparison of Medicare requirements governing LTACHs and traditional PAC providers).

Because of the specialized nature of these hospitals, only a small segment of patients discharged from a STACH receives care at an LTACH (e.g., 1.0% of hospitalized beneficiaries in Traditional Medicare were discharged to an LTACH in 2021).⁹ However, LTACH patients

¹ Dahn CM, Maheshwari S, Stansky D, Smith S, Lee DC. Unexpected ICU Transfer and Mortality in COVID-19 Related to Hospital Volume. *West J Emerg Med.* 2022 Nov 1;23(6):907-912. doi: 10.5811/westjem.2022.8.57035. PMID: 36409956; PMCID: PMC9683769.

² Gupta S, Hayek SS, Wang W, Chan L, Mathews KS, Melamed ML, et al. Factors Associated With Death in Critically Ill Patients With Coronavirus Disease 2019 in the US. *JAMA Intern Med.* 2020 Nov 1;180(11):1436-1447. doi: 10.1001/jamainternmed.2020.3596. Erratum in: *JAMA Intern Med.* 2020 Nov 1;180(11):1555. Erratum in: *JAMA Intern Med.* 2021 Aug 1;181(8):1144. PMID: 32667668; PMCID: PMC7364338.

³ Eriksson CO, Stoner RC, Eden KB, Newgard CD, Guise JM. The association between hospital capacity strain and inpatient outcomes in highly developed countries: A systematic review. *J Gen Intern Med.* 2017 Jun;32(6):686-696.

⁴ Gabler NB, Ratcliffe SJ, Wagner J, Asch DA, Rubenfeld GD, Angus DC, Halpern SD. Mortality among patients admitted to strained intensive care units. *Am J Resp Crit Care.* 2013;188(7):800-806.

⁵ Clark K, Normile L. Nursing informatics and data collection from the electronic medical record: Study of characteristics, factors and occupancy

impacting outcomes of critical care admissions from the emergency department. *Health Inform J.* 2012;18(4):309-319.

⁶ Jenkins PC, Richardson CR, Norton EC, Cooke CR, Banerjee M, Nathens AB, Hemmila MR. Trauma surge index: Advancing the measurement of trauma surges and their influence on mortality. *J Am Coll Surgeons.* 2015;221(3):729-738e1.

⁷ Chalfin DB, Trzeciak S, Likourezos A, Baumann BM, Dellinger RP. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. *Crit Care Med.* June 2007;35(6):1477-1483.

⁸ Levinson Z, Cantor J, Williams MV, Whaley C. The association of strained ICU capacity with hospital patient racial and ethnic composition and federal relief during the COVID-19 pandemic. *Health Serv Res.* 2022 Dec;57 Suppl 2(Suppl 2):279-290. doi: 10.1111/1475-6773.14028. Epub 2022 Jul 25. PMID: 35808952; PMCID: PMC9349922.

⁹ Koenig, L and Piper, J. Medicare Advantage Use of Long-Term Care Hospitals Increased During the COVID-19 Public Health Emergency, but Utilization Remained Less than Half of Traditional Medicare. January 2023. Accessed on August 21, 2023 at <https://cdn.ymaws.com/nalth.site->

consume a disproportionate share of healthcare resources, because of their higher clinical severity and complexity as compared to patients discharged to skilled nursing facilities (SNFs), inpatient rehabilitation facilities (IRFs), and home health agencies (HHAs). For example, in 2019, patients admitted to an LTACH had a short-term acute care hospital ALOS of 14.4 as compared to 6.8 days for patients discharged to a SNF, while approximately 90 percent of LTACH patients spent time in an ICU prior to admission (with an ICU ALOS of 10.4 days for ICU users) – more than double the rate for SNF admissions (with an ICU ALOS of 2.3 days for ICU users).¹⁰

Early in the COVID-19 pandemic, researchers and policy makers had identified LTACHs as a potentially important resource to increase hospital capacity by caring for both COVID-19 patients and other critically ill and medically complex patients.^{11,12} Evidence suggests that LTACHs were able to serve such a role, with COVID-19 patients being 2 to 3 times more likely to be admitted to an LTACH than a non-COVID-19 patient between March 2020 and January 2021.¹³

With the end of COVID-19 Public Health Emergency (PHE) in May 2023, there are renewed questions related to the role of LTACHs in caring for critically ill patients and their long-term viability given Medicare reimbursement changes (See Text Box 1). In this study, we quantify the impact of receiving care in an LTACH on Medicare beneficiaries' length of stay and ICU days in a STACH immediately preceding

PAC admission or discharge home. The purpose of the study is to better understand the role of LTACHs in supplementing hospital capacity in communities who may face constraints with respect to medical, surgical, and ICU beds.

Text Box 1: LTACH Payment Reforms

In fiscal year (FY) 2016, Medicare began paying LTACHs based on a new dual payment system established by the Pathway for SGR Reform Act of 2013. For patients that meet certain payment criteria ("standard rate cases"), payment rates are largely unchanged. For all other cases, Medicare pays a "site-neutral" rate set at the lower of the LTACH cost of care or an amount comparable to what a STACH would be paid for the same case. The purpose of the dual payment system was to encourage LTACHs to increase their focus on critically ill and medically complex patients. Congress established two ways in which a patient could meet criteria: (1) if he or she spent 3 or more days in the ICU during an immediately preceding STACH stay; or (2) if the patient received prolonged mechanical ventilation at the LTACH and had a STACH stay immediately preceding LTACH admission.

Congress initially established a two-year transition to the dual payment policy, which was subsequently extended until FY 2020. During the transition period, LTACHs received a 50/50 blend of the site-neutral rate and the standard rate for cases not meeting payment criteria. The site-neutral policy was waived during the COVID-19 PHE but is now fully reinstated for LTACH Medicare admissions on or after May 12, 2023.

2. Methods

In examining the effects of LTACH care on STACH resource use, we focused on the types of patients that are targeted under Medicare's LTACH payment system. Since introduction of

[ym.com/resource/resmgr/members/congressionalcontacts/itach_roundtable/Itach-ma-final.pdf](https://www.gao.gov/resources/resmgr/members/congressionalcontacts/itach_roundtable/Itach-ma-final.pdf)

¹⁰ Koenig L, et al. "What Role Did Post-Acute Care Providers Play in Addressing the COVID-19 Public Health Emergency?" (2021). Table A2. Accessed on August 21, 2023 at

<https://georgetown.app.box.com/s/2lf8ta0a2atxmfqo6e7iar3rh0tngx>

¹¹ Makam AN, and Grabowski DC. How can we ramp up hospital capacity to handle the surge of COVID-19 patients? Long-term acute care hospitals can play a critical role. *Health Affairs Forefront* (2020).

¹² Grigonis AM, Mathews KS, Benka-Coker WO, Dawson AM, Hammerman SI. Long-Term Acute Care Hospitals Extend ICU Capacity for COVID-19 Response and Recovery. *Chest*. 2021 May;159(5):1894-1901. doi: 10.1016/j.chest.2020.12.001. Epub 2020 Dec 10. PMID: 33309523; PMCID: PMC7832791.

¹³ Koenig L, and Unuigbo A. The Role of Post-Acute Care Providers in Addressing the COVID-19 Public Health Emergency: An Update. Accessed on August 21, 2023 at <https://georgetown.app.box.com/s/unaqm6pf93g5xjvp9cm98mgsl5z18737>

the payment system in 2016, LTACHs have been more selective with their admissions: the percentage of Medicare fee-for-service (FFS) LTACH discharges that were “standard rate” cases increased from 58 to 75 percent between 2016 and 2019.¹⁴ While the site-neutral policy was waived during the COVID-19 PHE, LTACHs are subject to the lower reimbursement under full site-neutral payments with admissions starting after May 11, 2023. As a result, LTACHs are expected to continue to shift their patient populations toward the more complex, standard rate cases.

Data Source. Our primary data sources were the 2016 - 2019 Medicare Inpatient Standard Analytic Files, which contain 100% Medicare claims for services provided at STACHs and LTACHs, and associated Medicare Beneficiary Summary Files.

Study Population. The study population consisted of Medicare Part A beneficiaries enrolled in FFS who were discharged from a STACH between October 1, 2015, and December 31, 2018, spent 3 or more days in an ICU, and were assigned to a Medicare Severity Diagnosis Related Groups (MS-DRGs) commonly treated in LTACHs (See Appendix Table A2). LTACH patients were identified as those who were admitted to an LTACH on the same day or the next day following the discharge from the STACH. All remaining STACH discharges (i.e., those discharged to IRFs, SNFs, HHAs, and home without home health care) were included in the non-LTACH group. We examined the study population as a whole and conducted analyses separately for patients on prolonged mechanical ventilation (PMV) and all other patients. In

Appendix Table A1, we provide an attrition chart showing how the final analytical sample was derived.

Outcome Measures. We examine two outcomes based on STACH stay prior to PAC admission: (1) length of stay (including the days spent in the ICU); and (2) number of ICU days.

Statistical Analysis. We compared outcomes between patients treated in an LTACH versus patients not treated in an LTACH using regression analyses, controlling for patient demographic and socioeconomic characteristics, clinical characteristics based on the STACH stay and STACH characteristics. See the Methods section in the Appendix for a more detailed description of our model specifications.

3. Results

Descriptive Statistics. There was a total of 3.6 million patient discharges from STACHs in our sample, of which 196,104 (or 5.4%) were transferred to an LTACH. Although only 7.6 percent of the sample was on PMV, patients on PMV were significantly more likely to be transferred to an LTACH than other patients (27.9% vs. 3.6%). As a result, the LTACH patient population is skewed heavily toward the PMV population, with slightly more than 39 percent of LTACH transfers on PMV versus 5.8 percent for patients not transferred to an LTACH.

Across all patients in the study sample, those transferred to an LTACH were different from those not transferred to LTACHs across all demographic and clinical dimension examined (Table 1; all differences are statistically significant at $p < .01$ level). LTACH patients were

¹⁴ MedPAC March 2021 Report to the Congress: Medicare Payment Policy. <https://www.medpac.gov/document/march-2021-report-to-the-congress-medicare-payment-policy/>

younger on average (69.9 vs. 73.3), more likely to be dually enrolled in Medicare and Medicaid (23.2% vs. 17.4%), and more likely to be non-white (28.9% vs. 21.7%). In addition, LTACH patients were, on average, sicker than non-LTACH patients, with greater frailty¹⁵ (frailty risk score of 11.2 vs. 9.0), higher rates of sepsis (55.1% vs. 33.2%) and multiple organ system failures (67.1% vs. 53.4%), and higher number of comorbidities and complications (CCs) and major CCs. Finally, LTACH patients tended to have longer unadjusted STACH stays (16.0 vs. 9.1 days) with more days in an ICU (13.4 vs. 7.1) during the hospitalization immediately preceding PAC admission or discharge home.

When comparing the LTACH and non-LTACH patient groups, we find that demographic and clinical differences between the groups are almost entirely driven by differences in the non-PMV cohort (Table 1). In fact, we observe few meaningful differences between LTACH and other patients in the PMV group. In some cases, LTACH patients on PMV were of lower clinical severity and complexity than other patients on PMV. For example, in the PMV population, LTACH patients were less likely to have sepsis (60.3% vs. 63.3%) and multiple organ failure (75.6% vs. 77.6%). Among non-PMV patients, we found the LTACH population was more medically complex, on average, across all indicators.

We note that our sample is limited to all patients with at least three days in an ICU and limited to common MS-DRGs transferred to LTACHs. Thus, the overall population is more medically complex than the broader Medicare beneficiaries cared for in STACHs.

Regression Analysis. We estimate that LTACH patients spent 7.03 fewer days in the STACH compared to similar patients who were discharged elsewhere (95% Confidence Interval (C.I.) (-7.15, -6.91)) and have 2.24 fewer ICU days at the STACH (95% C.I. (-2.35, -2.14)) (Figure 1).

We next examined results separately for PMV and other patients. We estimate that PMV patients who transferred to an LTACH spent 15.46 fewer days in the STACH compared to PMV patients who were not transferred to an LTACH (95% C.I. (-16.01, -14.91)) and 6.12 fewer ICU days (95% C.I. (-6.56, -5.67)). By comparison, we found that non-PMV patients who transferred to an LTACH spent, on average, 4.92 fewer days in the STACH compared to non-PMV patients who were not transferred to an LTACH (95% C.I. (-5.03, -4.80)) and spent 0.28 fewer days in an ICU (95% C.I. (-0.42, -0.15)).

National Impacts. Based on our model, we estimate that, for the 196,194 LTACH discharges in our database, transferring patients from a STACH to an LTACH reduced aggregate STACH days by 3.7 million and ICU days by 693.1 thousand. For the 72,499 PMV patients only, transfer to an LTACH resulted in 1.9 million hospital days saved and 643.7 thousand ICU days saved.

¹⁵ Gilbert, T., Neuburger, J., Kraindler, J., Keeble, E., Smith, P., Ariti, C., ... & Bardsley, M. (2018). Development and validation of a Hospital Frailty Risk Score focusing on older people in acute care settings using electronic

hospital records: an observational study. *The Lancet*, 391(10132), 1775-1782.

4. Discussion

In this study, we examined the impact of receiving care in an LTACH on length of stay and ICU days in the short-term acute hospital immediately preceding PAC admission or discharge home. We found that LTACHs significantly decreased the time patients spent in a STACH prior to discharge as well as days spent in an ICU, with larger effects for patients on prolonged mechanical ventilation.

The LTACH sector has been in decline since 2012, with the number of LTACHs falling from approximately 440 to 341 in 2021, although most of the decline has occurred since 2015.¹⁶ Between 2015 and 2021, Medicare FFS spending on LTACH fell from \$5.0 to \$3.3 billion, while combined Medicare FFS spending for SNFs, IRFs, and HHA fell from \$55.4 to \$53.5 billion.¹⁷

Two primary factors for the reduction in Medicare beneficiary access to LTACHs and reduced FFS spending have been the growth in Medicare Advantage (MA) and implementation of the new Medicare payment system for LTACHs in 2016. The rate of transfer from a STACH to an LTACH in MA is roughly 40 percent the rate in Medicare FFS.⁹ As a result, the growth in MA has reduced the demand for LTACH care.

Although MA growth has contributed to the reduction in LTACH spending, the new payment system appears to be the key driver.¹⁸ Congress intended for the LTACH payment system to increase the acuity of Medicare patients cared for at LTACHs and reduce Medicare spending, by

reducing payments for and volume of site-neutral cases. The policy has achieved its intended effects: increasing the share of Medicare FFS volume at LTACHs that met criteria. The changes to date reflect partial implementation of the site-neutral payment policy, as full implementation was supposed to occur starting in fiscal year 2020 but was delayed by the COVID-19 PHE.

With the end of the COVID-19 PHE, LTACHs are now subject to full implementation of the site-neutral policy. As a result, payment for site-neutral cases will be reduced significantly, causing LTACHs to avoid admitting these patients or, if admitted, facing significant losses. The full implementation of the site-neutral policy is occurring in an environment of labor shortages and high labor and other costs for providers, including hospitals. Preliminary data on LTACH margins indicate that rising costs have materially reduced margins for LTACHs, a sector whose Medicare margins were already below other PAC providers.

Industry representatives and data from the National Association of Long Term Hospitals suggest a potential wave of additional LTACH closures could occur with the end of the PHE. These closures will further reduce the ability of LTACHs to care for all patients, Medicare and non-Medicare beneficiaries, and site-neutral and standard rate case. As a result, STACHs would have fewer options to address capacity strains overall and, particularly, during times of demand surges.

¹⁶ Koenig, L., Sheriff, J., Hamlett, L. Patients Face Reduced Access to Long-Term Care Hospitals Due to Closures and Bed Reductions. December 2022. Accessed on August 25, 2023 at https://cdn.ymaws.com/nalth.site-ym.com/resource/resmgr/members/congressionalcontacts/ltch_roundtable/ltch_roundtable,_ltch_closur.pdf

¹⁷ MedPAC. Data Book: Health Care Spending and the Medicare Program. July 2023. Chapter 8. Accessed on August 25, 2023 at

https://www.medpac.gov/wp-content/uploads/2023/07/July2023_MedPAC_DataBook_SEC.pdf

¹⁸ Consider, for example, that the number of beneficiaries enrolled in Traditional Medicare (or FFS) fell by 5% between 2015 and 2021, while LTACH FFS spending fell by 34%.

As policymakers consider improvements to the U.S. healthcare system to ensure the ability of it to address current hospital capacity constraints and future public health emergencies, approaches to ensure access to LTACH care should be considered as part of planning efforts.

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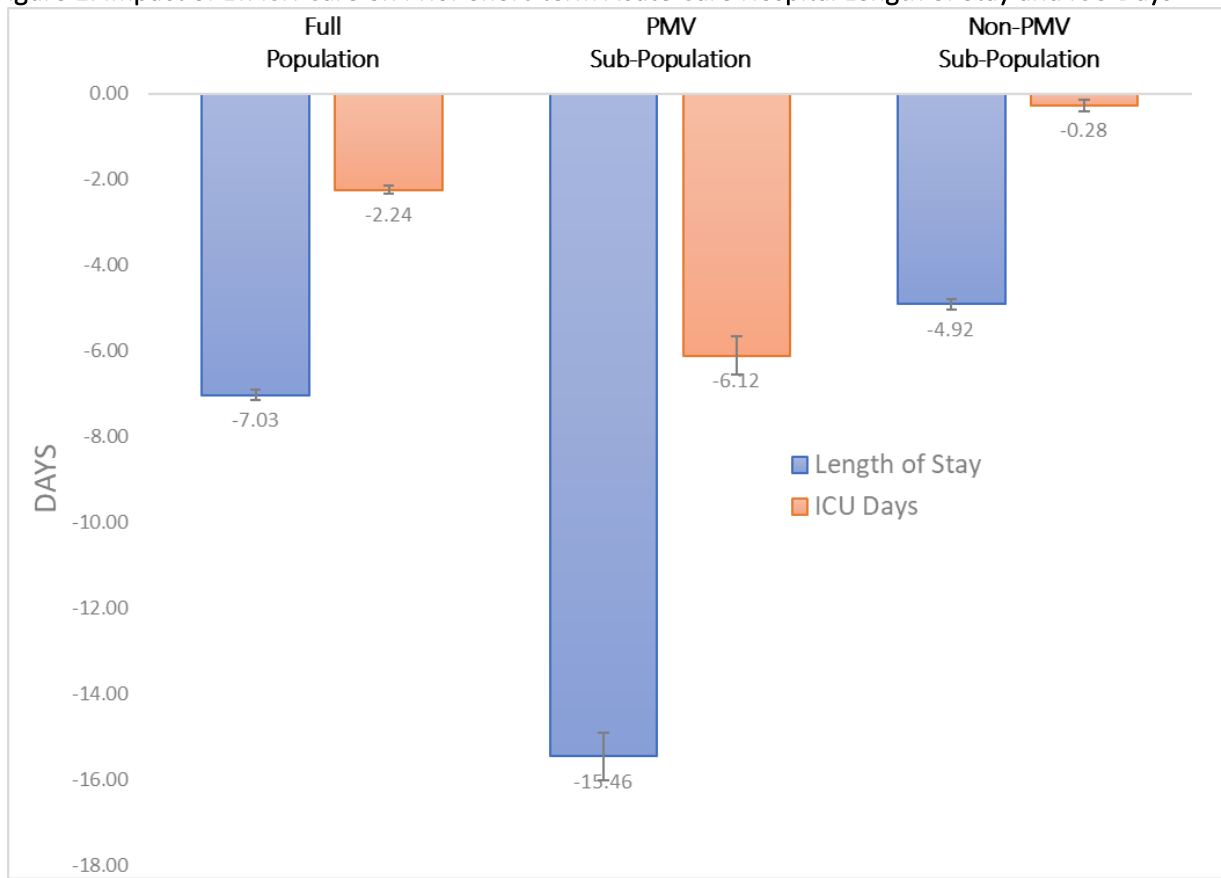
Table 1. Descriptive Statistics for Analytic Cohorts

Characteristic	All			Prolonged Mechanical Ventilation (PMV)			Other		
	LTACH	Other	Difference	LTACH	Other	Difference	LTACH	Other	Difference
Age	69.9	73.3	-3.4	68.1	68.8	-0.7	71.0	73.6	-2.5
Female (%)	52.5	49.0	3.5	53.4	53.2	0.1	51.9	48.7	3.2
Black (%)	19.4	14.1	5.3	21.7	18.5	3.1	18.0	13.9	4.1
White (%)	72.1	78.3	-6.2	69.9	72.5	-2.6	73.5	78.7	-5.2
Other (%)	8.5	7.5	0.9	8.4	8.9	-0.5	8.5	7.4	1.1
Dual Eligible (%)	23.2	17.4	5.9	24.3	27.3	-3.0	22.5	16.7	5.8
STACH Days*	16.0	9.1	6.9	21.4	21.0	0.4	12.6	8.4	4.2
ICU Days**	13.4	7.1	6.3	19.3	16.4	2.9	9.5	6.5	3.1
Frailty Risk Score	11.2	9.0	2.2	11.9	11.7	0.1	10.8	8.9	1.9
Cognitive Condition (%)	21.7	20.8	0.8	21.5	23.4	-1.8	21.7	20.7	1.1
Number of CCs	5.5	3.5	1.9	6.5	6.0	0.4	4.8	3.4	1.5
Number of Major CCs	3.6	2.0	1.6	4.7	4.5	0.2	2.9	1.9	1.1
PMV (%)	39.1	5.8	33.3	100.0	100.0	0.0	0.0	0.0	0.0
Sepsis (%)	55.1	33.2	21.9	60.3	63.3	-3.1	51.8	31.4	20.5
Multiple Organ Failure (%)	67.1	53.4	13.7	75.6	77.6	-2.0	61.6	51.9	9.7
Organ Failure (%)	94.4	87.5	6.9	99.6	99.4	0.1	91.1	86.8	4.3
Stroke (%)	8.7	5.2	3.5	14.0	10.6	3.4	5.3	4.9	0.4
Traumatic Brain Injury (%)	1.7	0.5	1.2	3.4	1.6	1.9	0.6	0.4	0.2
Severe Wound (%)	3.9	1.3	2.6	3.6	2.6	1.1	4.1	1.2	2.9
Tracheostomy (%)	25.4	0.9	24.6	58.9	11.3	47.6	3.9	0.2	3.7
Dialysis (%)	16.6	12.5	4.0	16.3	15.9	0.4	16.7	12.3	4.4

Notes: *STACH Days = short-term acute care hospital days in the hospital stay immediately prior to LTACH or other setting admission. **ICU Days = intensive care unit days at STACH immediately prior to LTACH or other setting admission.

Source: Authors' analysis of 2015-2019 Medicare Inpatient, Skilled Nursing Facility, and Home Health Agency Standard Analytic Files and Denominator Files.

Figure 1. Impact of LTACH Care on Prior Short-term Acute Care Hospital Length of Stay and ICU Days



Notes: Length of Stay = Inpatient days in short-term acute care hospital (STACH) days immediately prior to LTACH or other setting admission. ICU Days = intensive care unit days at STACH immediately prior to LTACH or other setting admission. PMV = Prolonged Mechanical Ventilation (96+hours on ventilator) at STACH.

Source: Authors' analysis of 2015-2019 Medicare Inpatient, Skilled Nursing Facility, and Home Health Agency Standard Analytic Files and Denominator Files.

Appendix

Figure A1. Post Acute Care Setting Descriptions



Table A1. Attrition Chart

Inclusion Criteria	Number of Observations After Implementation	% of Cases Excluded (Relative to Prior Step)
Discharged from STACH within October 1, 2015 and December 31, 2018	31,975,272	
Not discharged to another STACH ^a	31,157,450	2.6%
3 or more days in the ICU/CCU ^b	7,091,629	77.2%
Not Discharged against medical advice ^a	7,061,314	0.4%
STACH participates in the inpatient prospective payment system ^c	7,035,471	0.4%
Not missing a discharge date ^d	7,031,735	0.0%
Claim has positive charges and a positive number of Medicare paid days ^d	6,895,148	1.9%
Primary payer is Medicare ^c	6,885,138	0.2%
STACH stay is less than one year ^d	6,885,082	0.0%
STACH stay does not overlap with another STACH stay ^d	6,880,217	0.1%
Patient has continuous Part A enrollment without HMO during STACH stay and 180 days following ^c	6,616,154	3.8%
Patient did not die before the MS-DRG geometric mean time to transfer to an LTACH ^b	6,272,250	5.2%
Claim has a MS-DRG that is commonly sent to LTACHs ^{b*}	3,609,176	42.5%

Notes: a. These criteria were applied to be able to link the episode of care and outcomes to the index hospitalization.

b. These criteria were applied to improve comparability between the Treatment and Comparison groups.

c. These criteria were applied to ensure that Medicare administrative data includes their medical utilization.

d. These criteria were applied to ensure data completeness and correctness.

* In order for a STACH MS-DRG to be deemed as commonly sent to LTACHs, it must map to a common MS-LTC-DRG and there must have been at least 200 STACH discharges with that MS-DRG transferred to an LTACH within our database.

Source: Authors' analysis of 2015-2019 Medicare Inpatient, Skilled Nursing Facility, and Home Health Agency Standard Analytic Files and Denominator Files.

Additional Methods

Population of Interest: We limited our analytic sample to hospitalizations that are similar to those most commonly discharged to LTACHs. First, the sample only included hospital stays with an ICU length of stay of 3 or more days. Second, we only included cases that were alive in the STACH beyond a minimum number of days (established as the mean STACH length of stay by MS-DRG among cases discharged to an LTACH). Finally, we limited the sample to patients in specific MS-DRGs that map to the most common MS-LTC-DRGs (189, 207, 208, 871, 949, 166, 682, 4, 981, 539, 177, 592, 190, 862, 314, 919, 559, 291, 56, and 371) and that had at least 200 LTACH transfers in our database (See Table A2). These restrictions results in an analytic sample with 73 unique MS-DRGs and captures 86.2% of STACH stays with 3 or more ICU days and that transferred to an LTACH. Appendix Table A2 provides the MS-DRG composition of our final database.

Model Specification: We control for demographic and socioeconomic characteristics (age, gender, race, and dual eligibility status), clinical characteristics based on the index STACH stay (MS-DRG, number of comorbidities and complications, frailty risk score, and several condition flags) and index STACH characteristics (number of beds, teaching status, and ownership type).

We use a generalized linear model with log link function and negative binomial distribution to model the outcomes. We estimate robust standard errors clustered at the index STACH level in all regressions. Patients transferred to

LTACHs may be more severe than other patients in ways that are not observable from administrative data. These unmeasured differences, if not controlled in the statistical analysis, can lead to selection bias, and threaten the internal validity of study findings. To adjust for unobservable differences in the two patient populations, we use an instrumental variable (IV) approach. This technique has been applied by Einav et al. (2018), Koenig et al. (2015), and Kahn et al. (2013) in their previous work on this topic. The IV was the distance between index STACH and nearest LTACH, with an F-statistic of 168.5, which is significant according to thresholds provided in Stock and Yogo (2005).¹⁹ Since the outcome models are non-linear, we use the two-stage residual inclusion technique (2SRI) to implement the instrumental variable approach.

Table A2: Short-term Acute Care Hospital MS-DRGs Included in Analysis

MS-DRG	Description	Cases Transferred to an LTACH		Cases NOT Transferred to an LTACH	
		Number of MS-DRG Discharges	Percent of MS-DRG Discharges	Number of MS-DRG Discharges	Percent of MS-DRG Discharges
001	HEART TRANSPLANT OR IMPLANT OF HEART ASSIST SYSTEM W MCC	315	5.5%	5,371	94.5%
003	ECMO OR TRACH W MV >96 HRS OR PDX EXC FACE, MOUTH & NECK W MAJ O.R.	24,415	60.9%	15,708	39.2%
004	TRACH W MV >96 HRS OR PDX EXC FACE, MOUTH & NECK W/O MAJ O.R.	24,951	67.7%	11,886	32.3%
011	TRACHEOSTOMY FOR FACE, MOUTH & NECK DIAGNOSES W MCC	613	16.6%	3,083	83.4%
023	CRANIOTOMY W MAJOR DEVICE IMPLANT OR ACUTE CNS PDX W MCC OR CHEMOTHERAPY IMPLANT OR EPILEPSY W NEUROSTIMULATOR	835	5.7%	13,876	94.3%
025	CRANIOTOMY & ENDOVASCULAR INTRACRANIAL PROCEDURES W MCC	932	2.8%	32,744	97.2%
064	INTRACRANIAL HEMORRHAGE OR CEREBRAL INFARCTION W MCC	2,267	2.6%	83,612	97.4%
070	NONSPECIFIC CEREBROVASCULAR DISORDERS W MCC	404	2.7%	14,323	97.3%
091	OTHER DISORDERS OF NERVOUS SYSTEM W MCC	310	2.7%	11,016	97.3%
100	SEIZURES W MCC	647	2.4%	26,779	97.6%
163	MAJOR CHEST PROCEDURES W MCC	1,402	6.0%	21,840	94.0%
166	OTHER RESP SYSTEM O.R. PROCEDURES W MCC	2,341	6.8%	32,077	93.2%
175	PULMONARY EMBOLISM W MCC	476	1.7%	28,124	98.3%
177	RESPIRATORY INFECTIONS & INFLAMMATIONS W MCC	3,173	4.5%	66,965	95.5%
178	RESPIRATORY INFECTIONS & INFLAMMATIONS W CC	312	1.7%	17,979	98.3%
189	PULMONARY EDEMA & RESPIRATORY FAILURE	5,129	3.8%	129,323	96.2%
190	CHRONIC OBSTRUCTIVE PULMONARY DISEASE W MCC	2,329	2.1%	111,234	98.0%
193	SIMPLE PNEUMONIA & PLEURISY W MCC	2,919	2.6%	107,817	97.4%
196	INTERSTITIAL LUNG DISEASE W MCC	495	6.5%	7,093	93.5%
205	OTHER RESPIRATORY SYSTEM DIAGNOSES W MCC	284	4.4%	6,162	95.6%
207	RESPIRATORY SYSTEM DIAGNOSIS W VENTILATOR SUPPORT >96 HOURS	6,032	14.6%	35,423	85.5%
208	RESPIRATORY SYSTEM DIAGNOSIS W VENTILATOR SUPPORT <=96 HOURS	5,257	5.8%	85,617	94.2%
216	CARDIAC VALVE & OTH MAJ CARDIOTHORACIC PROC W CARD CATH W MCC	701	4.0%	16,974	96.0%
219	CARDIAC VALVE & OTH MAJ CARDIOTHORACIC PROC W/O CARD CATH W MCC	1,073	2.8%	37,687	97.2%
233	CORONARY BYPASS W CARDIAC CATH W MCC	835	2.6%	30,909	97.4%
235	CORONARY BYPASS W/O CARDIAC CATH W MCC	550	2.1%	25,455	97.9%

¹⁹ Stock, James H. and Yogo, Motohiro, (2005), Testing for Weak Instruments in Linear IV Regression. In Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg, ed. D. W. K. Andrews and J. H. Stock, p.80-108. Cambridge: Cambridge University Press.

MS-DRG	Description	Cases Transferred to an LTACH		Cases NOT Transferred to an LTACH	
		Number of MS-DRG Discharges	Percent of MS-DRG Discharges	Number of MS-DRG Discharges	Percent of MS-DRG Discharges
239	AMPUTATION FOR CIRC SYS DISORDERS EXC UPPER LIMB & TOE W MCC	920	9.0%	9,257	90.96%
242	PERMANENT CARDIAC PACEMAKER IMPLANT W MCC	527	1.6%	31,571	98.4%
246	PERCUTANEOUS CARDIOVASCULAR PROCEDURES W DRUG-ELUTING STENT W MCC OR 4+ ARTERIES OR STENTS	728	1.2%	61,272	98.8%
252	OTHER VASCULAR PROCEDURES W MCC	1,714	4.5%	36,583	95.5%
260	CARDIAC PACEMAKER REVISION EXCEPT DEVICE REPLACEMENT W MCC	298	8.5%	3,230	91.6%
264	OTHER CIRCULATORY SYSTEM O.R. PROCEDURES	680	5.5%	11,641	94.5%
268	AORTIC AND HEART ASSIST PROCEDURES EXCEPT PULSATION BALLOON W MCC	332	5.0%	6,323	95.0%
270	OTHER MAJOR CARDIOVASCULAR PROCEDURES W MCC	1,153	4.3%	25,810	95.7%
280	ACUTE MYOCARDIAL INFARCTION, DISCHARGED ALIVE W MCC	1,891	1.8%	101,165	98.2%
286	CIRCULATORY DISORDERS EXCEPT AMI, W CARD CATH W MCC	707	1.4%	50,125	98.6%
291	HEART FAILURE & SHOCK W MCC	7,092	2.0%	347,692	98.0%
292	HEART FAILURE & SHOCK W CC	496	0.5%	102,161	99.5%
308	CARDIAC ARRHYTHMIA & CONDUCTION DISORDERS W MCC	801	1.0%	82,542	99.0%
314	OTHER CIRCULATORY SYSTEM DIAGNOSES W MCC	1,817	4.7%	37,053	95.3%
326	STOMACH, ESOPHAGEAL & DUODENAL PROC W MCC	1,627	8.5%	17,453	91.5%
329	MAJOR SMALL & LARGE BOWEL PROCEDURES W MCC	4,313	9.1%	43,046	90.9%
330	MAJOR SMALL & LARGE BOWEL PROCEDURES W CC	424	1.5%	27,827	98.5%
335	PERITONEAL ADHESIOLYSIS W MCC	494	6.7%	6,910	93.3%
356	OTHER DIGESTIVE SYSTEM O.R. PROCEDURES W MCC	506	5.0%	9,725	95.1%
371	MAJOR GASTROINTESTINAL DISORDERS & PERITONEAL INFECTIONS W MCC	409	3.4%	11,528	96.6%
377	G.I. HEMORRHAGE W MCC	1,225	1.8%	66,683	98.2%
388	G.I. OBSTRUCTION W MCC	328	3.1%	10,268	96.9%
391	ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS W MCC	342	1.7%	19,789	98.3%
393	OTHER DIGESTIVE SYSTEM DIAGNOSES W MCC	696	4.3%	15,583	95.7%
463	WND DEBRID & SKN GRFT EXC HAND, FOR MUSCULO-CONN TISS DIS W MCC	918	16.8%	4,550	83.2%
469	MAJOR HIP AND KNEE JOINT REPLACEMENT OR REATTACHMENT OF LOWER EXTREMITY W MCC OR TOTAL ANKLE REPLACEMENT	528	3.0%	16,975	97.0%
480	HIP & FEMUR PROCEDURES EXCEPT MAJOR JOINT W MCC	812	3.4%	22,847	96.6%
570	SKIN DEBRIDEMENT W MCC	459	17.2%	2,218	82.9%
579	OTHER SKIN, SUBCUT TISS & BREAST PROC W MCC	439	13.1%	2,917	86.9%
602	CELLULITIS W MCC	529	3.6%	14,153	96.4%
637	DIABETES W MCC	555	2.1%	25,764	97.9%
640	MISC DISORDERS OF NUTRITION, METABOLISM, FLUIDS/ELECTROLYTES W MCC	659	1.5%	43,427	98.5%
673	OTHER KIDNEY & URINARY TRACT PROCEDURES W MCC	678	6.1%	10,420	93.9%
682	RENAL FAILURE W MCC	2,332	2.5%	91,173	97.5%
689	KIDNEY & URINARY TRACT INFECTIONS W MCC	637	1.5%	41,778	98.5%
698	OTHER KIDNEY & URINARY TRACT DIAGNOSES W MCC	1,639	3.6%	43,985	96.4%
853	INFECTIOUS & PARASITIC DISEASES W O.R. PROCEDURE W MCC	18,808	13.3%	122,506	86.7%
856	POSTOPERATIVE OR POST-TRAUMATIC INFECTIONS W O.R. PROC W MCC	1,410	15.7%	7,594	84.3%
862	POSTOPERATIVE & POST-TRAUMATIC INFECTIONS W MCC	542	6.9%	7,273	93.1%

MS-DRG	Description	Cases Transferred to an LTACH		Cases NOT Transferred to an LTACH	
		Number of MS-DRG Discharges	Percent of MS-DRG Discharges	Number of MS-DRG Discharges	Percent of MS-DRG Discharges
870	SEPTICEMIA OR SEVERE SEPSIS W MV >96 HOURS	10,231	15.2%	56,992	84.8%
871	SEPTICEMIA OR SEVERE SEPSIS W/O MV >96 HOURS W MCC	29,883	4.8%	599,538	95.3%
872	SEPTICEMIA OR SEVERE SEPSIS W/O MV >96 HOURS W/O MCC	1,260	1.5%	84,796	98.5%
907	OTHER O.R. PROCEDURES FOR INJURIES W MCC	788	7.6%	9,632	92.4%
917	POISONING & TOXIC EFFECTS OF DRUGS W MCC	489	1.7%	28,131	98.3%
919	COMPLICATIONS OF TREATMENT W MCC	366	3.9%	9,002	96.1%
981	EXTENSIVE O.R. PROCEDURE UNRELATED TO PRINCIPAL DIAGNOSIS W MCC	2,943	6.7%	41,310	93.4%
987	NON-EXTENSIVE O.R. PROC UNRELATED TO PRINCIPAL DIAGNOSIS W MCC	682	5.5%	11,777	94.5%
ALL		196,104	5.4%	3,413,072	94.6%

Source: Authors' analysis of 2015-2019 Medicare Inpatient, Skilled Nursing Facility, and Home Health Agency Standard Analytic Files and Denominator Files.