Published in final edited form as:

Am J Phys Med Rehabil. 2016 November ; 95(11): 850–861. doi:10.1097/PHM.0000000000000629.

Program interruptions and short-stay transfers represent potential targets for inpatient rehabilitation care-improvement efforts

Addie Middleton, PhD, DPT, James E. Graham, PhD, DC, Shilpa Krishnan, PhD, PT, and Kenneth J. Ottenbacher, PhD, OTR

Division of Rehabilitation Sciences, University of Texas Medical Branch, Galveston, Texas

Abstract

Objective—To present comprehensive descriptive summaries of program interruptions and short-stay transfers among Medicare fee-for-service beneficiaries receiving inpatient rehabilitation following stroke, traumatic brain injury (TBI), and traumatic spinal cord injury (SCI).

Design—Retrospective cohort study of Medicare beneficiaries with any of the three conditions of interest who were admitted to inpatient rehabilitation directly from an acute hospital between July 1, 2012 and November 15, 2013.

Results—In the final sample (stroke: n=71 769; TBI: n=7109; SCI: n=659), program interruption rates were 0.9% (stroke), 0.8% (TBI), and 1.4% (SCI). Short-stay transfer rates were 22.3% (stroke), 21.8% (TBI), and 31.6% (SCI). 14.7% of short-stay transfers and 12.3% of interruptions resulting in a return to acute care were identified as potentially preventable among those with stroke, 10.2% of transfers and 11.7% of interruptions among those with TBI, and 3.8% of transfers and 11.1% of interruptions among those with SCI.

Conclusions—Broad healthcare policies aimed at improving quality and reducing costs are currently being implemented. Reducing program interruptions and short-stay transfers during inpatient rehabilitative care represents a potential target for care-improvement efforts. Future research focused on identifying modifiable risk factors for potentially undesirable outcomes will allow for targeted preventative interventions.

Keywords

Rehabilitation; Medicare; Health Care Reform; Quality Improvement

CORRESPONDENCE: Addie Middleton, University of Texas Medical Branch, 301 University Blvd., Galveston, TX. Phone: 409.747.1611, Fax: 409.747.1638, jamiddle@utmb.edu.

AUTHOR DISCLOSURES: The authors have no commercial interest relevant to the subject of the manuscript, nor any other conflicts of interest to report. The information included in the manuscript has not been submitted to any other source for publication or presentation.

Supplementary checklist
STROBE checklist

INTRODUCTION

Policy reforms aimed at improving quality and reducing costs of healthcare are currently being implemented.¹ Inpatient rehabilitation facilities are a focus of many initiatives, as these facilities provide intensive rehabilitative care in a medical setting and are often viewed as a costly postacute care alternative.² For this level of care to be “reasonable and necessary,” the Centers for Medicare and Medicaid Services (CMS) require that patients be sufficiently stable at the time of admission, need at least two modalities of therapy, be able to actively participate in and benefit from intensive therapy, and require supervision by a physician.³ Potential patients are screened prior to admission and evaluated post-admission by a physician to ensure eligibility.⁴ Despite these requisites, not all patients complete their rehabilitation programs as planned. Program interruptions and short-stay transfers are undesirable outcomes that may impact patient recovery and healthcare expenditures.⁵⁻⁷

CMS defines a program interruption as a transfer from an inpatient rehabilitation facility to another setting with a return to the facility within three days to continue rehabilitation.⁸ A program interruption often represents a complication that results in disrupted rehabilitative care. Between 2002 and 2008 the program interruption rate ranged from 0.9% to 1.6% for patients receiving rehabilitation following stroke⁹ and 1.0% to 1.8% for patients receiving rehabilitation following traumatic brain injury (TBI).¹⁰ Between 2002 and 2010 the program interruption rate for patients with traumatic spinal cord injury (SCI) ranged from 1.6% to 3.5% for those who used a wheelchair for locomotion and from 0.9% to 2.1% for those who were ambulatory.¹¹ Although program interruptions are an undesirable outcome, only incidence has been reported.⁹⁻¹²

Short-stay transfers are defined by CMS as a transfer from an inpatient rehabilitation facility to another institutional setting prior to the length of stay projected for the patient. This length of stay is based on the average length of stay given the patient's Case-Mix Group and comorbidities. Case-Mix Groups are assigned by CMS at inpatient rehabilitation admission and reflect the patients' diagnosis, age, and functional status.⁴ Short-stay transfers should not be confused with another similarly named CMS outcome- short stays. Short stays are stays that are three days or less.¹³ For clarification, short-stay transfers are the outcome referred to in this article. In other words, we were interested in inpatient rehabilitation stays longer than 3 days that ended in a transfer to another institutional setting prior to the average length of stay given the patient's Case-Mix Group and comorbidities. Short-stay transfers may represent truncated rehabilitative care.

Previous investigations have focused on transfers from inpatient rehabilitation facilities to acute care settings occurring at any point during the rehabilitation stay or within three days of admission, not on CMS-defined short-stay transfers.^{5,14-16} Short-stay transfers differ from the typically reported return to acute care outcome in two important ways. First, short-stay transfers have a time-dependent definition (i.e. prior to average length of stay given the patient's Case-Mix Group and comorbidities).¹³ Additionally, short-stay transfers encompass transfers to any institutional setting accepting payment from CMS, not just acute care.¹⁷ Although these patients met the criteria for inpatient rehabilitation admission, they were discharged to institutional care rather than returning to the community. The Medicare

Payment Advisory Commission (MedPAC) considers this a poor outcome for the patient and may reflect an inefficient use of resources.³ As with program interruptions, basic descriptive information on short-stay transfers is limited.

Improving postacute outcomes is a current focus of CMS quality improvement initiatives.⁴ In addition to the established metrics, program interruptions and short-stay transfers may be sensible provider performance measures. What is needed now is a better understanding of potential sociodemographic and clinical characteristics associated with program interruptions and short-stay transfers as well as percentages of these disruptive outcomes that may be potentially preventable. In turn, this may provide insight into whether these outcomes represent targets for care-improvement efforts.³ The objective of this study was to present comprehensive descriptive summaries of program interruptions and short-stay transfers among Medicare fee-for-service beneficiaries receiving inpatient rehabilitation following stroke, TBI, and traumatic SCI. These three diagnostic categories were selected because they represent 1) an increasing percentage of the inpatient rehabilitation case mix² and 2) patients at increased risk for negative outcomes during and/or following post-acute care.^{14-16,18} We hypothesized that both the rates of and the reasons for program interruptions and short-stay transfers would differ across the diagnostic categories. Such findings would have important implications for policy-makers and providers if either outcome were selected as a performance measure.

METHODS

Data Sources

Data were extracted from the following 2012 to 2013 100% Medicare files: Inpatient Rehabilitation Facility-Patient Assessment Instrument (IRF-PAI), Medicare Provider Analysis and Review (MedPAR), and Beneficiary Summary files. The IRF-PAI file was used for sample selection, and then patient data from the MedPAR and Beneficiary Summary files were linked and integrated with the IRF-PAI data. The study was approved by the University Institutional Review Board, and a Data Use Agreement was completed following CMS requirements.

Patient Population

IRF-PAI assessment records for all patients admitted between July 1, 2012 and November 15, 2013 were reviewed for inclusion. This time frame was selected to allow a 6-month look back before admission, while accounting for maximum inpatient rehabilitation (45 days) lengths of stays. The population of interest was patients admitted directly from acute care for initial rehabilitation for stroke, TBI, or traumatic SCI. Patients who had inpatient rehabilitation stays of less than three days were excluded, as stays less than three days are recognized by CMS as a separate outcome from short-stay transfers.¹⁹ Additionally, those who did not survive their stay, were discharged against medical advice, were not admitted to acute care and inpatient rehabilitation for the same diagnosis (i.e. stroke, TBI, SCI), or were not Medicare-fee-for-service over the relevant period (6 months prior to index hospitalization through inpatient rehabilitation) were excluded (**Figure 1**). To determine if patients were admitted to acute care and inpatient rehabilitation for the same diagnosis, the patient's

primary hospital diagnosis (ICD-9 code) was compared to their inpatient rehabilitation impairment group. The list of ICD-9 codes related to inpatient rehabilitation impairment groups available in The Inpatient Rehabilitation Facility- Patient Assessment Instrument (IRF-PAI) Training Manual was used to verify matching diagnoses.²⁰

Outcomes

We defined a program interruption as a three day or less claim from another inpatient provider occurring during an inpatient rehabilitation stay.⁸ A short-stay transfer was defined as discharge to an institutional setting prior to the average length of stay for the patient's Case-Mix Group and comorbidities.⁴ Patients are classified at admission to rehabilitation into a Case-Mix Group based on their primary impairment, functional status, and age. Patients within the same Case Mix Group are predicted to require similar resource utilization, for example length of stay. Accordingly, each Case Mix Group and comorbidity tier combination has an associated average length of stay, which is updated annually by CMS and used for payment purposes.⁴ Patients who did not experience a program interruption or short-stay transfer were considered to have an “uninterrupted stay” for comparative purposes.

Potentially preventable program interruptions and short-stay transfers to acute care settings were identified using the Prevention Quality Indicators developed by the Agency for Healthcare Research and Quality.²¹ This approach identifies hospital admissions for “ambulatory care sensitive conditions;” conditions that should not occur under appropriate outpatient care.²¹ Accordingly, these conditions should also not occur while receiving care in an inpatient facility. Examples of potentially preventable diagnoses include urinary tract infections, dehydration, bacterial pneumonia, and heart failure. A detailed description of the Prevention Quality Indicators is available through the Agency for Healthcare Research and Quality.²¹

Descriptors

Based on a review of the literature and clinical judgment, the following sociodemographic and clinical variables were selected for a descriptive analysis of program interruptions and short-stay transfers among patients receiving inpatient rehabilitation following stroke, TBI, and traumatic SCI. The sociodemographic characteristics extracted were patient age (continuous), gender (male/female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic/Latino, or Other), disability entitlement (yes/no, disability original reason for Medicare enrollment), and dual eligibility (yes/no, Medicare and Medicaid eligible). The clinical descriptors extracted were number of hospital admissions over the six months prior to the index hospital admission (count), index hospital length of stay (days), comorbidity tier (no tier, low, medium, high), and functional status (continuous, FIMs™ instrument).

Comorbidity Tier—At inpatient rehabilitation admission, patients are assigned to one of four comorbidity tiers developed by CMS as part of the inpatient rehabilitation prospective payment system.² Reimbursement under the prospective payment system is based on patient characteristics and subsequent expected resource utilization. The CMS comorbidity tiers reflect the severity of patients’ comorbid conditions and are weighted based on the relative

cost of treating patients within in that tier compared to the average patient. Comorbid conditions in the higher tier are projected to require greater resource utilization, which is reflected in Medicare reimbursement.¹⁹ The CMS comorbidity tiers may provide a proxy for a patient's overall health beyond the inpatient rehabilitation admitting diagnosis (e.g. stroke, TBI, traumatic SCI).

Functional Status—In the inpatient rehabilitation setting, functional status is evaluated at admission and discharge as part of the IRF-PAI using items from the FIM instrument.⁸ The FIM assesses patient independence during performance of 18 items rated on a seven-point scale (1=total assistance, 7=complete independence, score range 18-126 points). The instrument covers self-care, sphincter control, transfers, locomotion, communication, and social cognition and can be subdivided into separate Motor (13 items, score range 13-91 points) and Cognitive (5 items, score range 5-35 points) scales.

Data Analysis

Patients within each diagnostic category (stroke, TBI, traumatic SCI) were classified into one of three outcome groups: “Uninterrupted Stay”, “Program Interruption”, or “Short-stay Transfer.” Short-stay transfers were further dichotomized into transfers to an acute care setting (short-stay acute care hospital, long-term acute care hospital, or psychiatric hospital) and transfers to a non-acute care setting (skilled nursing facility or another inpatient rehabilitation facility). Descriptive statistics (means, standard deviations, counts, percentages) were calculated for the selected variables within each outcome group.

RESULTS

Study Samples

The final sample included 71 769 individuals with stroke, 7109 individuals with TBI, and 659 individuals with SCI. Sample characteristics by diagnostic category (stroke, TBI, SCI) and outcome (uninterrupted stay, program interruption, short-stay transfer) are presented in **Tables 1-3**.

Program Interruptions

The program interruption rates were 0.9% for individuals with stroke, 0.8% for individuals with TBI, and 1.4% for individuals with SCI (**Tables 1-3**). Descriptive statistics for individuals with SCI experiencing program interruptions are not presented in **Table 3** due to the low occurrence of this outcome. In accordance with CMS data use guidelines, cell sizes less than 11 are suppressed. An acute hospital was the setting for 99.8% of program interruptions among individuals with stroke and 100% of program interruptions among those with TBI and those with SCI. Reasons for hospital admission varied across the diagnostic groups (**Table 4**). Individuals with stroke or TBI were admitted most frequently for stroke or brain injury-related complications.

Within program interruptions, 12.3% were identified as potentially preventable among individuals with stroke, 11.7% among individuals with TBI, and 11.1% among individuals with SCI. Of the potentially preventable conditions resulting in program interruptions, the

most frequent were dehydration conditions (35.9%) and urinary tract infections (28.2%) among patients with stroke, and urinary tract infections (42.9%) and heart failure (28.6%) among individuals with TBI.

Short-Stay Transfers

The short-stay transfer rates were 22.3% among individuals with stroke, 21.8% among individuals with TBI, and 31.6% among individuals with SCI. The percentage of transfers to an acute setting versus a non-acute setting varied across the diagnostic categories: 46.7% of short-stay transfers were to an acute setting among individuals with TBI, 38.9% among individuals with traumatic SCI, and 32.5% among individuals with stroke.

Short-Stay Transfers to Acute Care Setting—Short-stay transfer to an acute care setting rates ranged from 7.2% (stroke) to 12.3% (SCI) (**Tables 1-3**). Reasons for transfer to acute care differed across the diagnostic categories (**Table 5**). The only common reason for acute care admission was infection.

Of the short-stay transfers to acute care, 14.7% were identified as potentially preventable among those with stroke, 10.2% among those with TBI, and 3.8% among those with SCI. Among patients with stroke, 30.6% of the potentially preventable short-stay transfers were for dehydration and 26.8% were for heart failure. Among patients with TBI, 26.4% of the potentially preventable short-stay transfers were for dehydration and 26.4% were for bacterial pneumonia. Finally, among patients with traumatic SCI, 66.7% of the potentially preventable transfers were for bacterial pneumonia and 33.3% for urinary tract infections.

Short-Stay Transfers to Non-Acute Care Setting—Short-stay transfer to a non-acute care setting rates were 15.1% among individuals with stroke, 11.6% among individuals with TBI, and 19.3% among individuals with SCI (**Tables 1-3**). A majority of these transfers were to skilled nursing facilities (99.9% among individuals with stroke and individuals with TBI, 100% among individuals with SCI).

DISCUSSION

Program interruptions and short-stay transfers are considered undesirable inpatient rehabilitation outcomes by the Medicare Payment Advisory Commission with the potential to impact patient recovery and healthcare expenditures.³ In our sample of Medicare fee-for-service beneficiaries, 0.9% of patients receiving rehabilitation following a stroke, 0.8% of patients receiving rehabilitation following TBI, and 1.4% of patients receiving rehabilitation following SCI experienced a program interruption; 22.3% of patients with stroke, 21.8% of patients with TBI, and 31.6% of patients with SCI had rehabilitation programs that ended in a short-stay transfer.

The program interruption rates observed in our sample demonstrate slight improvement over the most recently reported rates. In 2008, a 1.1% program interruption rate was reported for individuals with stroke⁹ and a 1.0% rate for individuals with TBI.¹⁰ Our observed 2012-2013 rates were 0.9% for individuals with stroke and 0.8% for individuals with TBI. For individuals with SCI, the previously reported rates from 2010 were 2.2% for individuals

who used a wheelchair for locomotion and 1.0%¹¹ for those who were ambulatory. Our sample combined individuals who used a wheelchair and individuals who were ambulatory, and the resultant program interruption rate observed in 2012-2013 was 1.4%. Although it appears that program interruption rates may be improving, comparisons with the previously reported rates should be interpreted with caution. The previously reported rates represent patients from all payers,⁹⁻¹¹ whereas our rates represent Medicare fee-for-service beneficiaries only. Patient characteristics, such as age, also differed between our sample and those included in previous reports, with our sample being older. On average, individuals in our sample with stroke were 5.9 years older, individuals with TBI were 24.9 years older, and individuals with SCI were 23.9 years older.⁹⁻¹¹

Our findings indicate that almost all program interruptions are temporary transfers to an acute care hospital (versus another setting submitting claims to CMS). Readmission to an acute care setting increases healthcare expenditures.²² Among diagnoses commonly receiving post-acute care, rehospitalization for potentially preventable conditions doubles the cost for an episode of care.²² The additional hospitalization exposure is also associated with increased risk for adverse outcomes, such as functional decline,²³ pressure ulcers,²⁴ thrombosis,²⁵ in-hospital falls,²⁶ hospital-acquired infections,²⁷ and one-year mortality.²⁸

To our knowledge, this study is the first to report descriptive statistics for short-stay transfers among individuals receiving inpatient rehabilitation following stroke, TBI, and traumatic SCI. Previous reports have focused on returns to acute care at any point during rehabilitation,^{5,14-16} not transfers to any institutional setting occurring prior to the average length of stay given the patient's case-mix group and comorbidity tier. The relatively high rates observed in our sample indicate that one-fifth to one-third of patients receiving inpatient rehabilitation following stroke, TBI, or traumatic SCI experience this outcome.

The overarching goal of CMS's quality initiative is to "build a healthcare delivery system that is better, smarter, and healthier."²⁹ The "Triple Aim" will be achieved by "improving the individual experience of care; improving the health of populations; and reducing the per capita costs of care for populations."¹ Reducing program interruptions and/or short-stay transfer rates could achieve all three aims. At the individual level, preventing program interruptions and short-stay transfers could improve the patient's experience of care. At the population level, reducing rates of program interruptions and short-stay transfers could improve the health of the inpatient rehabilitation population and reduce per capita healthcare costs. Reducing rates of program interruptions and short-stay transfers align with the overarching goal of CMS's quality initiative and warrant consideration as quality metrics. Publicly reporting these rates could improve patients' and caregivers' abilities to make informed decisions regarding inpatient rehabilitation.³⁰ Informed decision-making is a key element of patient-centered care.

Program interruptions and short-stay transfers may be more reflective of quality of care than post-discharge readmissions, as these outcomes occur while the patient is under the care of the facility. Moreover, there are two unique requirements for inpatient rehabilitation care that ideally should minimize the need for patients to be transferred prior to completing their rehabilitation program: 1) facilities are responsible for pre-screening and selecting patients

that are appropriate for intensive rehabilitation and 2) care must be provided in a medical setting under the supervision of a physician.² Examining the destinations of and reasons for program interruptions and short-stay transfers is an important first step in evaluating the appropriateness of interruptions and transfers as provider quality performance measures.

Not all short-stay transfers represent “undesirable” outcomes. For example, patients may be transferred in order to be closer to family. In our sample, almost all short-stay transfers to a non-acute setting were to skilled nursing facilities. Skilled nursing facilities provide a lower level of rehabilitative care, but are not the ideal or desired discharge setting for patients admitted to an inpatient rehabilitation facility. This is recognized at the policy-level, and rates of discharge to skilled nursing facilities is one of the metrics the Medicare Payment Advisory Commission tracks and reports to Congress as an indicator of quality of care in the inpatient rehabilitation setting.³ Such transfers may be unavoidable, if for example, the patient's family determines they are no longer able to provide the support required for the patient to safely discharge to the community. Transfer to a skilled nursing facility would also be an appropriate outcome for a patient residing in a nursing facility prior to their hospitalization. The inpatient rehabilitation stay may have been a planned step in their recovery allowing them to safely return to their prior living setting. However, patients transferred from inpatient rehabilitation to skilled nursing facilities may also represent inappropriately selected patients, as the transfer may suggest these patients were either unable to tolerate intensive therapy or not achieving the expected functional gains. The Medicare Payment Advisory Committee reported variation in the rates of discharge to skilled nursing facilities across inpatient rehabilitation facilities,³ indicating there may be room for improvement on this outcome.

Nearly all program interruptions and one-third of short-stay transfers were returns to acute care. The reasons for return to acute care should be considered to determine if any are potentially preventable. The Agency for Healthcare Research and Quality has established a list of potentially preventable diagnoses. These diagnoses were identified by the Agency as “ambulatory care sensitive conditions”; conditions that should not occur under appropriate outpatient care.²¹ If the conditions are manageable under outpatient care, they should not have occurred under inpatient care. In our sample, approximately 12% of program interruptions and 14% of short-stay transfers to acute care were for potentially preventable conditions. These rates are relatively low and suggest inpatient rehabilitation facilities are performing well in preventing complications. However, given that more than one in ten of the rehospitalized patients returned to acute care for a potentially avoidable condition, there is still room for improvement.

Prevention of even a small percent of these rehospitalizations has the potential to impact a large number of patients. Readmissions that are potentially preventable are clear targets for care-improvement efforts. By tracking reasons for potentially preventable readmissions to acute care, providers may be able to implement targeted programs within their facilities and reduce patients' risk of rehospitalization.

Although reducing rates of program interruptions and short-stay transfers to acute care may represent targets for care-improvement efforts, unintended consequences would need to be

monitored. Unintended consequences are a concern with the implementation of any quality metric. A concern with measures related to hospital readmissions, such as program interruptions and short-stay transfers to acute care, is decreased access to care for more medically complex patients.³¹ Monitoring for unintended consequences will be important if these outcomes are selected for quality reporting.

Reducing rates of program interruptions and short-stay transfers will not just improve patient experiences of care, they will also likely translate to lower Medicare spending per beneficiary.³² This outcome will become increasingly important as bundled payment models are implemented. CMS is currently testing four bundled payment models in the Bundled Payments for Care Improvement initiative.³³ Although the structures differ, all models place the accountable entity in charge of coordinating a patient's care across multiple providers and settings for “episodes of care” lasting 30, 60, or 90 days. Only one payment is made per episode, and providers must work together to deliver quality, cost-effective care within the constraints of the “bundled” payment.³⁴ Preliminary findings from the Bundled Payments for Care Improvement initiative appear positive and CMS recently implemented mandatory bundled payments for lower extremity joint replacements in certain geographic areas.^{35,36} As bundled payments become a reality, providers (hospitals) will be incentivized to partner with other providers who deliver efficient quality care, for example those with low program interruption and transfer rates. Our findings provide initial insight into the current rates of program interruptions and short-stay transfers among Medicare beneficiaries receiving inpatient rehabilitation following stroke, TBI, and traumatic SCI.

Limitations

A limitation when using administrative datasets is the lack of information regarding the consistency and accuracy of data entry.³⁷ However, these datasets allow for the inclusion of a nationally representative sample, which is important for descriptive analyses. Our descriptive analyses were limited to individuals receiving inpatient rehabilitation in the early stages following stroke, TBI, or traumatic SCI. The findings may not be generalizable to individuals in the chronic phases of these conditions or to patients receiving rehabilitative care for other diagnoses.

Another consideration is our use of the Agency for Healthcare Research and Quality's list of potentially preventable diagnoses. These diagnoses were developed for identifying potentially preventable acute care admissions among individuals under outpatient care, not among patients in an inpatient setting. Potentially preventable hospital readmission measures for patients under the care of inpatient rehabilitation facilities are currently under development and build on the Agency's list.³⁸ Future research will benefit from the availability of a list of potentially preventable diagnoses developed for this specific population.

There are limitations associated with our definition of a program interruption as “a three day or less claim from another inpatient provider occurring during an inpatient rehabilitation stay”. Program interruptions do not always generate claims, as a patient may have briefly discharged home or to another non-Medicare covered setting. Therefore, we may have underestimated rates of program interruptions.

The descriptive statistics reported represent the Medicare-fee-for service population. This population is older than the average TBI and traumatic SCI populations receiving inpatient rehabilitation, and results should be interpreted accordingly.^{10,11} Additionally, we are using Medicare defined outcomes (i.e. “program interruption” and “short-stay transfer”). These outcomes may not be viewed as adverse by all patients, providers, and payers. However, these outcomes were selected because they represent potential targets for improving the care of Medicare beneficiaries. A final consideration is that our analyses are descriptive only; conclusions cannot be drawn regarding patient- and facility-level predictors of program interruptions and short-stay transfers.

Conclusions

Our findings indicate that program interruptions and short-stay transfers represent targets for care-improvement efforts among Medicare fee-for-service beneficiaries receiving inpatient rehabilitation following stroke, TBI, and SCI. Future research focused on identifying modifiable risk factors for these outcomes will allow for targeted preventative interventions. Further research is also needed in other patient populations. Importantly, longitudinal analyses should be conducted to observe trends in program interruptions and short-stay transfers as policy and payment reforms are implemented.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

This work was partially funded by the National Institutes of Health (R24-HD065702, R01-HD069443, and 5K12HD055929-09 PI, K. Ottenbacher) and the National Institute on Disability, Independent Living, and Rehabilitation Research (H133G140127, PI, K. Ottenbacher).

References

1. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff (Millwood)*. 2008; 27(3):759–769. [PubMed: 18474969]
2. Medicare Payment Advisory Commission (MedPAC). Report to the Congress: Medicare Payment Policy. Medicare Payment Advisory Commission; Washington, DC: Mar. 2015
3. Medicare Payment Advisory Commission. Report to the Congress: Medicare Payment Policy. 2016
4. Department of Health and Human Services. Vol. 79. *Federal Register*; 2014.
5. Carney ML, Ullrich P, Esselman P. Early unplanned transfers from inpatient rehabilitation. *Am J Phys Med Rehabil*. 2006; 85(5):453–460. quiz 461–453. [PubMed: 16628154]
6. Downey LV, Zun LS, Burke T. Patient transfer from a rehabilitation hospital to an emergency department : a retrospective study of an American trauma center. *Ann Phys Rehabil Med*. 2014; 57(3):193–199. [PubMed: 24631398]
7. Meikle B, Devlin M, Garfinkel S. Interruptions to amputee rehabilitation. *Arch Phys Med Rehabil*. 2002; 83(9):1222–1228. [PubMed: 12235601]
8. UB Foundation Activities. The Inpatient Rehabilitation Facility- Patient Assessment Instrument (IRF-PAI) Training Manual. 2012. <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-payment/InpatientRehabFacPPS/IRFPAI.html>
9. Granger CV, Markello SJ, Graham JE, Deutsch A, Ottenbacher KJ. The uniform data system for medical rehabilitation: report of patients with stroke discharged from comprehensive medical programs in 2000-2007. *Am J Phys Med Rehabil*. 2009; 88(12):961–972. [PubMed: 19935180]

10. Granger CV, Markello SJ, Graham JE, Deutsch A, Reistetter TA, Ottenbacher KJ. The uniform data system for medical rehabilitation: report of patients with traumatic brain injury discharged from rehabilitation programs in 2000-2007. *Am J Phys Med Rehabil.* 2010; 89(4):265–278. [PubMed: 20299850]
11. Granger CV, Karmarkar AM, Graham JE, et al. The uniform data system for medical rehabilitation: report of patients with traumatic spinal cord injury discharged from rehabilitation programs in 2002-2010. *Am J Phys Med Rehabil.* 2012; 91(4):289–299. [PubMed: 22407160]
12. Deutsch A, Granger CV, Russell C, Heinemann AW, Ottenbacher KJ. Apparent changes in inpatient rehabilitation facility outcomes due to a change in the definition of program interruption. *Arch Phys Med Rehabil.* 2008; 89(12):2274–2277. [PubMed: 19061738]
13. Department of Health and Human Services. Centers for Medicare & Medicaid Services. Medicare Program; Inpatient Rehabilitation Facility Prospective Payment System for Federal Fiscal Year. Final Rule. 2016
14. Hammond FM, Horn SD, Smout RJ, et al. Acute rehospitalizations during inpatient rehabilitation for spinal cord injury. *Arch Phys Med Rehabil.* 2013; 94(4 Suppl):S98–105. [PubMed: 23527777]
15. Hammond FM, Horn SD, Smout RJ, et al. Readmission to an Acute Care Hospital During Inpatient Rehabilitation for Traumatic Brain Injury. *Arch Phys Med Rehabil.* 2015; 96(8 Suppl):S293–S303. e291. [PubMed: 26212405]
16. Stineman MG, Ross R, Maislin G, Fiedler RC, Granger CV. Risks of acute hospital transfer and mortality during stroke rehabilitation. *Arch Phys Med Rehabil.* 2003; 84(5):712–718. [PubMed: 12736887]
17. Department of Health and Human Services. Centers for Medicare & Medicaid Services. [6/20/2016] Transmittal A-01-110 Instructions for Implementing the Inpatient Rehabilitation Facility Prospective Payment System (IRF PPS). <https://www.cms.gov/Regulations-and-Guidance/Guidance/Transmittals/downloads/A01110.pdf>.
18. Ottenbacher KJ, Karmarkar A, Graham JE, et al. Thirty-day hospital readmission following discharge from postacute rehabilitation in fee-for-service Medicare patients. *JAMA.* 2014; 311(6): 604–614. [PubMed: 24519300]
19. Department of Health and Human Services. Centers for Medicare & Medicaid Services. Inpatient Rehabilitation Facility Prospective Payment System- Payment System Fact Sheet Series. 2014
20. UB Foundation Activities. The Inpatient Rehabilitation Facility- Patient Assessment Instrument (IRF-PAI) Training Manual. 2012. Available at: <http://www.cms.gov/Medicare/Medicare-Fee-for-Service-payment/InpatientRehabFacPPS/IRFPAI.html>
21. Agency for Healthcare Research and Quality. [6/16/2016] Prevention Quality Indicators Overview. Available at: http://www.qualityindicators.ahrq.gov/modules/pqi_resources.aspx.
22. Medicare Payment Advisory Commission (MedPAC). [10/05/2015] Medicare post-acute care reforms. Available at: [http://www.medpac.gov/documents/congressional-testimony/testimony-medicare-post-acute-care-reforms-\(energy-and-commerce\).pdf?sfvrsn=0](http://www.medpac.gov/documents/congressional-testimony/testimony-medicare-post-acute-care-reforms-(energy-and-commerce).pdf?sfvrsn=0).
23. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc.* 2003; 51(4):451–458. [PubMed: 12657063]
24. Gardiner JC, Reed PL, Bonner JD, Haggerty DK, Hale DG. Incidence of hospital-acquired pressure ulcers - a population-based cohort study. *Int Wound J.* 2014
25. Engbers MJ, Blom JW, Cushman M, Rosendaal FR, van Hylckama Vlieg A. The contribution of immobility risk factors to the incidence of venous thrombosis in an older population. *J Thromb Haemost.* 2014; 12(3):290–296. [PubMed: 24330554]
26. Dunne TJ, Gaboury I, Ashe MC. Falls in hospital increase length of stay regardless of degree of harm. *J Eval Clin Pract.* 2014; 20(4):396–400. [PubMed: 24814338]
27. Kaye KS, Marchaim D, Chen TY, et al. Effect of nosocomial bloodstream infections on mortality, length of stay, and hospital costs in older adults. *J Am Geriatr Soc.* 2014; 62(2):306–311. [PubMed: 24438554]
28. Lum HD, Studenski SA, Degenholtz HB, Hardy SE. Early hospital readmission is a predictor of one-year mortality in community-dwelling older Medicare beneficiaries. *J Gen Intern Med.* 2012; 27(11):1467–1474. [PubMed: 22692634]

29. Centers for Medicare & Medicaid Services. [12/8/15] CMS Quality Strategy. <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/QualityInitiativesGenInfo/CMS-Quality-Strategy.html>.
30. Werner R, Stuart E, Polsky D. Public reporting drove quality gains at nursing homes. *Health Aff (Millwood)*. 2010; 29(9):1706–1713. [PubMed: 20820030]
31. National Quality Forum. [12/10/2015] #2502 All-Cause Unplanned Readmission Measure for 30 Days Post Discharge from Inpatient Rehabilitation Facilities (IRFs). Last Updated: Nov 03, 2015. Available at: <http://www.qualityforum.org/ProjectMeasures.aspx?projectID=73619>.
32. Acumen, LLC. Draft Specifications for the Medicare Spending Per Beneficiary-Post-Acute Care (MSPB-PAC) Resource Use Measures, Provided for Public Comment. Jan. 2016 <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/Downloads/MSPB-PAC-Measure-Specifications-Draft.pdf>
33. Centers for Medicare & Medicaid Services. [10/24/15] Bundled Payments for Care Improvement Initiative (BPCI) Fact Sheet. 2014. Available from Centers for Medicare & Medicaid Services: <https://www.cms.gov/Newsroom/MediaReleaseDatabase/Fact-sheets/2015-Fact-sheets-items/2015-08-13-2.html>.
34. Press MJ, Rajkumar R, Conway PH. Medicare's New Bundled Payments: Design, Strategy, and Evolution. *JAMA*. 2016; 315(2):131–132. [PubMed: 26720889]
35. The Lewin Group. CMS Bundled Payments for Care Improvement (BPCI) Initiative Models 2-4: Year 1 Evaluation & Monitoring Annual Report. 2015. <https://innovation.cms.gov/Files/reports/BPCI-EvalRpt1.pdf>
36. Department of Health and Human Services. Centers for Medicare & Medicaid Services. Federal Register. Medicare Program; Comprehensive Care for Joint Replacement Payment Model for Acute Care Hospitals Furnishing Lower Extremity Joint Replacement Services; Final Rule. 2015
37. van Walraven C, Austin P. Administrative database research has unique characteristics that can risk biased results. *J Clin Epidemiol*. 2012; 65(2):126–131. [PubMed: 22075111]
38. RTI International and Abt Associates. [6/16/2016] DRAFT Measure Specifications: Potentially Preventable Hospital Readmission Measures for Post-Acute Care. Available at: <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/Downloads/Draft-Measure-Specifications-for-Potentially-Preventable-Hospital-Readmission-Measures-for-PAC-.pdf>.

Figure 1.

Flow chart presenting number and percent of eligible participants remaining as exclusion criteria applied.

Table 1

Sample characteristics of individuals with stroke

	n	Uninterrupted Stay ^a	Program Interruption	Short-stay Transfer	
				Acute	Non-Acute
n % ^b	71769	77.0%	0.9%	7.2%	15.1%
Age (years), mean ± SD		75.8 ± 10.35	77.0 ± 10.19	76.6 ± 10.3	79.0 ± 9.73
Sex					
Female	38980	76.2%	0.9%	6.7%	16.4%
Male	32789	78.0%	0.9%	7.8%	13.5%
Race/Ethnicity					
Non-Hispanic White	54866	76.5%	0.9%	7.0%	15.8%
Non-Hispanic Black	10363	79.2%	0.7%	7.8%	12.5%
Hispanic/Latino	4014	77.8%	0.7%	8.8%	12.8%
Other	2346	79.5%	0.7%	6.9%	13.0%
Unknown	180	76.7%	0.6%	9.4%	13.3%
Disability ^c					
Yes	14850	79.7%	0.8%	7.4%	12.2%
No	56919	76.3%	0.9%	7.2%	15.8%
Dual Eligibility ^d					
Yes	15417	74.5%	0.8%	7.5%	17.4%
No	56352	77.7%	0.9%	7.2%	14.4%
Prior hospital admissions ^e					
0	52993	78.0%	0.8%	6.3%	15.1%
1	13477	75.2%	1.0%	8.7%	15.3%
2	3544	72.5%	1.1%	12.2%	14.5%
3+	1755	71.7%	1.2%	14.2%	13.2%
Hospital LOS (days) ^f , mean ± SD		5.5 ± 4.61	6.7 ± 6.04	7.6 ± 5.94	6.35 ± 4.89
Comorbidity Tier					
No Tier	49313	78.4%	0.7%	6.2%	14.9%
Low	19347	74.6%	1.2%	9.1%	15.3%
Medium	1186	67.0%	1.4%	10.8%	21.3%
High	1923	72.5%	1.5%	14.2%	12.3%
Admission FIM, mean ± SD					
Motor Scale		36.3 ± 13.68	28.1 ± 13.12	25.9 ± 12.60	24.5 ± 11.32
Cognitive Scale		19.9 ± 6.94	16.8 ± 7.04	16.2 ± 7.22	15.8 ± 6.76

Abbreviations: SD, standard deviation; LOS, length of stay; ICU, intensive care unit; FIM, Functional Independence Measure

^a“Uninterrupted stay” refers to individuals who did not experience a program interruption or short-stay transfer^b All percentages presented are row percentages^c“Disability” original reason for receiving Medicare

d Eligible for Medicare and Medicaid

e # of acute care admissions during 6 months prior to index admission

f Length of stay for index hospital admission

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Sample characteristics of individuals with traumatic brain injury

	n	Uninterrupted Stay ^a	Program Interruption	Short-stay Transfer	
				Acute	Non-Acute
n % ^b	7109	77.5%	0.8%	10.2%	11.6%
Age in years, mean ± SD		78.8 ± 9.93	78.7 ± 9.56	79.6 ± 9.18	80.7 ± 9.25
Sex					
Female	3485	78.3%	0.8%	9.3%	11.5%
Male	3624	76.7%	0.9%	11.0%	11.7%
Race/Ethnicity					
Non-Hispanic White	6076	77.2%	0.9%	10.0%	12.0%
Non-Hispanic Black	342	75.1%	0.9%	14.3%	9.9%
Hispanic/Latino	370	79.7%	0.3%	9.7%	10.3%
Other	305	83.0%	0.0%	9.5%	7.5%
Unknown	16	68.8%	0.0%	12.5%	18.8%
Disability ^c					
Yes	1068	79.2%	0.9%	9.8%	10.1%
No	6041	77.2%	0.8%	10.2%	11.9%
Dual Eligibility ^d					
Yes	1032	76.4%	0.8%	8.9%	14.1%
No	6077	77.7%	0.9%	10.4%	11.2%
Prior hospital admissions ^e					
0	5128	77.9%	0.8%	9.8%	11.6%
1	1389	77.6%	0.9%	9.8%	11.7%
2	397	77.1%	0.8%	11.3%	11.1%
3+	195	67.2%	0.5%	19.5%	12.8%
Hospital LOS in days ^f , mean ± SD		6.9 ± 5.40	8.4 ± 6.43	7.7 ± 6.00	8.1 ± 6.47
Comorbidity Tier					
No Tier	3815	82.1%	0.5%	8.4%	9.0%
Low	1513	77.7%	1.1%	11.2%	10.0%
Medium	1532	66.8%	1.5%	12.4%	19.6%
High	249	71.5%	0.8%	16.9%	11.6%
Admission FIM score, mean ± SD					
Motor Scale		36.7 ± 13.01	30.5 ± 12.25	29.3 ± 12.9	26.9 ± 11.71
Cognitive Scale		18.9 ± 6.94	16.7 ± 7.08	16.3 ± 6.85	14.9 ± 6.51

Abbreviations: SD, standard deviation; LOS, length of stay; ICU, intensive care unit; FIM, Functional Independence Measure

^a“Uninterrupted stay” refers to individuals who did not experience a program interruption or short-stay transfer^b All percentages presented are row percentages^c“Disability” original reason for receiving Medicare

d Eligible for Medicare and Medicaid

e # of acute care admissions during 6 months prior to index admission

f Length of stay for index hospital admission

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3

Sample characteristics of individuals with traumatic spinal cord injury

	n	Uninterrupted Stay ^a	Short-stay Transfer	
			Acute	Non-Acute
n % ^b	659	67.7%	12.3%	19.3%
Age in years, mean ± SD		72.5 ± 10.52	70.1 ± 11.71	75.4 ± 10.98
Sex				
Female	257	68.9%	11.7%	18.7%
Male	402	66.9%	12.7%	19.7%
Race/Ethnicity				
Non-Hispanic White	514	68.3%	10.5%	20.6%
Non-Hispanic Black	77	63.6%	24.7%	10.4%
Hispanic/Latino	27	55.6%	14.8%	25.9%
Other	38	76.3%	10.5%	13.2%
Disability ^c				
Yes	169	66.3%	15.4%	17.8%
No	490	68.2%	11.2%	19.8%
Dual Eligibility ^d				
Yes	134	62.7%	14.9%	22.4%
No	525	69.0%	11.6%	18.5%
Prior hospital admissions ^e				
0	509	68.8%	11.8%	19.1%
1	111	67.6%	13.5%	18.9%
2	26	61.5%	15.4%	15.4%
3+	13	38.5%	15.4%	38.5%
Hospital LOS in days ^f , mean ± SD		8.8 ± 6.69	9.7 ± 6.09	10.3 ± 8.87
Comorbidity Tier				
No Tier	325	74.2%	8.9%	16.6%
Low	131	59.5%	20.6%	18.3%
Medium	161	65.8%	8.7%	24.2%
High	42	50.0%	26.2%	23.8%
Admission FIM score, mean ± SD				
Motor Scale		23.0 ± 12.42	18.5 ± 9.59	15.7 ± 8.37
Cognitive Scale		25.0 ± 6.52	23.1 ± 7.32	23.6 ± 6.97

Abbreviations: SD, standard deviation; LOS, length of stay; ICU, intensive care unit; FIM, Functional Independence Measure

Note: Program interruption descriptives are not presented due to insufficient cell size (n<11)

^a“Uninterrupted stay” refers to individuals who did not experience a program interruption or short -stay transfer^b All percentages presented are row percentages^c“Disability” original reason for receiving Medicare

d Eligible for Medicare and Medicaid

e # of acute care admissions during 6 months prior to index admission

f Length of stay for index hospital admission

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 4

Most frequent acute care admitting diagnoses for program interruptions

Overall
Cerebral artery occlusion, unspecified, with cerebral infarction (10.5%)
Atrial fibrillation (5.8%)
Occlusion and stenosis of carotid artery without cerebral infarction (3.6%)
Urinary tract infection site not specified (3.1%)*
Syncope and collapse (3.0%)
Stroke
Cerebral artery occlusion, unspecified, with cerebral infarction (11.4%)
Atrial fibrillation (5.7%)
Occlusion and stenosis of carotid artery without cerebral infarction (3.9%)
Unspecified transient cerebral ischemia (3.2%)
Syncope and collapse (3.2%)
Traumatic Brain Injury
Subdural hemorrhage (10.0%)
Subdural hemorrhage following injury without open intracranial wound with no loss of consciousness (8.3%)
Altered mental status (6.7%)
Urinary tract infection site not specified (5.0%)*
Other acquired deformity of head, other specified deformity (5.0%)
Other pulmonary embolism and infarction (5.0%)
Subdural hemorrhage following injury without open intracranial wound with state of consciousness unspecified (5.0%)

Note: Acute care diagnoses for program interruptions among patients with spinal cord injury are not presented due to insufficient cell size (n<11)

* Indicates preventable admitting diagnosis¹⁸

Table 5

Most frequent admitting diagnoses for short-stay transfers to acute care.*

Overall
Cerebral artery occlusion, unspecified, with cerebral infarction (8.3%)
Unspecified septicemia (6.8%)
Pneumonitis due to inhalation of food or vomitus (4.4%)
Atrial fibrillation (3.3%)
Intracerebral hemorrhage (3.2%)
Stroke
Cerebral artery occlusion, unspecified, with cerebral infarction (9.3%)
Unspecified septicemia (6.9%)
Pneumonitis due to inhalation of food or vomitus (4.6%)
Intracerebral hemorrhage (3.5%)
Atrial fibrillation (3.5%)
Traumatic Brain Injury
Subdural hemorrhage (10.6%)
Subdural hemorrhage following injury without open intracranial wound with state of consciousness unspecified (8.7%)
Subdural hemorrhage following injury without open intracranial wound with no loss of consciousness (7.9%)
Unspecified septicemia (5.1%)
Pneumonitis due to inhalation of food or vomitus (3.0%)
Traumatic Spinal Cord Injury
Unspecified septicemia (12.8%)
Other postoperative infection (9.0%)
Other pulmonary embolism and infarction (5.1%)
C1-C4 level with central cord syndrome (5.1%)
Other mechanical complication of other internal orthopedic device, implant, and graft (3.8%)

Note: None of the admitting diagnoses presented in the Table were identified as preventable.¹⁸