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Quality Improvement

An Early and Routinely Collected Applied Cognitive Assessment Is Associated with Post-Acute Care Facility Discharge from the Hospital

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Abstract

Objective

Although patient cognition can have an impact on health services needs once discharged from the hospital, it is typically not evaluated as part of routine care. We aimed to investigate how routinely collected Activity Measure for Post-Acute Care Applied Cognitive Inpatient Short Form (AM-PAC ACISF) scores, a measure of applied cognition, are associated with discharge disposition.

Methods

A retrospective analysis was conducted on 5,236 electronic medical records of adult patients admitted in Johns Hopkins Hospital (JHH) between July 1, 2020 to November 2, 2021. Data was evaluated on whether patients who have been admitted across hospital services required post-acute care based on their AM-PAC ACISF scores. A cut-off raw score of 21 or less was considered as having cognitive impairment.

Results

The applied cognitive t-scale scores assessed near time of admission were 9.3 points lower in patients discharged to PAC compared to discharge home. Adjusted regression models showed the odds of PAC needs for patients with AM-PAC ACISF t-scale scores in the lowest tertile were 3.4 times greater than patients in the highest tertile (95% CI 2.8,4.0; p <0.001). Patients with scores in the middle tertile have 1.9 times greater odds for PAC needs than those in the highest tertile (95% CI 1.6,2.2; p<0.001). Bivariate and multivariate logistic regression models showed AM-PAC ACISF, living alone, male gender, prior residence outside of home, admission due to general surgery, neurology, or orthopedics services versus medicine service all increased the odds of discharge to PAC (OR 1.2–4.4, p=<0.001).

Conclusions

This study provides empirical evidence that a routinely collected cognitive assessment could be a care coordination strategy to help identify patients who are more likely to require PAC after discharge.

Abbreviations

Post-Acute Care (PAC), Activity Measure for Post-Acute Care Applied Cognitive Inpatient Short Form (AM-PAC ACISF), Occupational Therapy (OT) and Speech-Language Pathology (SLP)

INTRODUCTION

Applied cognition is an important element of completing essential functions for maintaining independence at home and the community.[1,2] It is characterized by a hierarchical order of functional domains, which include sensory and perception, motor skills and construction, memory, attention, language, executive functioning, and processing speed.[3,4] These cognitive domains are compo-

nents of a broad and complex hierarchy of neural processing that are interdependent of each other.[4,5] Impairments in applied cognition have direct and serious consequences on health outcomes across the clinical spectrum, imposing limitations in the patient's ability with self-management of symptoms, medications, medical appointments, daily schedule, and overall safety awareness.[1,2,6,7] The fast-paced environment of acute care hospitals often leads to under-recognition of impairments in applied cognition. As many as 40% of patients aged 65 and older may present with cognitive impairments.[6] These deficits can be misdiagnosed, present prior to hospitalization, or develop within the context of hospital-acquired complications. Acute cognitive decline, such as delirium, is associated with adverse health outcomes such as increased morbidity and risk for future falls, readmissions, institutionalization, length of stay, and mortality.[8-10] Under-recognition of impairments in applied cognition is associated with significant functional and financial costs from compounding interventions necessary in managing the cognitive-behavioral and medical complications that delay recovery.[8-12] This highlights the need for routine monitoring of applied cognition and using appropriate assessment tools for early recognition and intervention of these impairments.

Despite its prevalence and clinical importance, the empirical contributions of applied cognition in discharge planning and predicting post-acute care (PAC) needs in inpatient acute care hospitals is sparse.[9,13,14] Existing evidence is focused on motor function or performance-based assessments,^17, 18,19,20,21,,26^ while little is known about the unique contributions of applied cognition and its association with discharge disposition in the larger hospitalized patient population.[6,9,14] Furthermore, no single standardized outcome measurement tool for applied cognitive assessment is currently being consistently utilized, with varying levels of clinical integration and utilization in the routine care of patients across different hospital services due to providers' reported lack of time and resources.[1,2,8,13] These important clinical barriers leave the needs of patients across hospital services either unmet or unrecognized, with missed opportunities to prevent or address applied cognitive dysfunction and mitigate its impact on patient safety and health outcomes in the long term.[1,3,7,15,16] These limitations have direct implications on patient care and healthcare delivery process, including prolonged morbidity and increased healthcare costs across the patient's continuum of care. Therefore, it is imperative that applied cognitive assessment is integrated as part of routine care across larger patient population in the comprehensive approach to discharge planning.

This study aimed to investigate how applied cognition scores, measured by the Activity Measure for Post-Acute Care Applied Cognitive Inpatient Short Form (AM-PAC ACISF), at the time of hospital admission were associated with discharge disposition in an acute inpatient hospital across various clinical services. The study's findings can aid the healthcare team in comprehending the critical function of applied cognition in discharge planning and care coordination. Early and regular cognitive assessments can enable care coordination and improve discharge planning for patients across different hospital services, potentially enhancing patient outcomes.

METHODS

A retrospective analysis was conducted on 5,236 electronic medical records of adult patients admitted in Johns Hopkins Hospital (JHH) between July 1, 2020 to November 2, 2021. Patients in psychiatric units and labor and delivery units were not included in the analysis. A waiver of consent was approved by the Institutional Review Board at Johns Hopkins University. Data were obtained from the electronic medical records and have been validated for accuracy. The first recorded applied cognition t-scale scores using the AM-PAC ACISF within 72 hours of hospital admission were considered as the primary exposure variable. Prior to the analysis, we considered other patient and health-related characteristics hypothesized to influence discharge disposition and available for analysis: age, race, sex, Body Mass Index (BMI), residence prior to admission, type of hospital service, health insurance/third-party payor, admission due to surgery, prior level of function, lives alone and comorbidity count. The outcome variable was discharge disposition, dichotomized between discharge to home or post-acute care (PAC) facility. Data was evaluated on whether patients who have been admitted across hospital services required PAC based on their AM-PAC ACISF scores, including other patient and health-related characteristics.

Measures

The AM-PAC ACISF is a reliable (91% test-retest reliability, 86% interrater reliability), sensitive (100%) and specific (98%) screening tool that captures cognitive impairments in hospitalized adult inpatients.[9,17-20] Similar to other acute care cognitive screening tool such as the Brief Cognitive Assessment Tool Short Form (BCAT-SF), both the BCAT-SF and the AM-PAC ACISF have 100% sensitivity with 74% and 98% specificity, respectively.[9] The domains in its item pool was created using item response theory with evidence of high structural and content validity.[11] Each item captures discrete cognitive elements in an adult's typical functional routine such as reading, day-to-day routine, and complex task management that are not well-assessed in other cognitive assessment tools.[11] It was originally designed as a self-reported outcome measure which can also be scored by proxy by nursing or rehabilitation staff such as Occupational Therapists (OT) or Speech Language Pathologists (SLP).[9,17]

Specifically, the tool has six scored items that include: following a speech or presentation, understanding ordinary conversation, taking medications, remembering where things were placed or put away, remembering a list of 4-5 errands, and taking care of complicated tasks. Each rater assessed the patient's level of difficulty in completing each of the six tasks, rated from 1- 4 points: 1 (unable - unable to do the task or requires any help or cueing from another person to complete the task, 2 (a lot of difficulty - can complete the task with a lot of extra time and effort but without the help of another person, 3 (a little - can perform the activity without help from another person but requires a little more time and effort, and 4 (no difficulty completing the task). Patients who required any cueing or assistance in the task completion earned 1 point ("unable"). Patients who did not demonstrate any difficulty in completing any of the six tasks earned the maximum raw score of 24 points. A cut-off raw score of 21 or less was considered as having cognitive impairment.[12,17]

The AM-PAC ACISF scoring process requires transformation of raw scores into standardized t-scale scores, which are then divided into different ranges to identify a patient's functional level at specific range of t-scale scores.[12] This process was used in the calculation of the applied cognitive scores, where raw scores were converted into t-scale scores and divided into tertiles to differentiate the patient's level of applied cognitive function at the time of assessment: highest tertile (47.8 - 62.2), middle tertile (30.5 - 44.3) and lowest tertile (7.7 - 28.8). We also performed our analysis considering a ten-point difference in AM-PAC ACISF scores, as has been done for the AM-PAC mobility and activity measures.[21-24]

Descriptive statistics were used to illustrate the sample's distribution. Correlation and logistic regression models were conducted to examine relationships between applied cognition discharge disposition to home or post-acute care (PAC). Bivariate and multivariate models included other patient or health-related characteristics (age, BMI, lives alone, sex, race, prior residence, payor, type of medical service, admitted for surgery, prior function and comorbidity count) that may be predictive of discharge disposition as adjustment variables. Receiver operating curve (ROC) and area under the curve (AUC) were examined to quantify the accuracy of the regression model in discriminating between discharge to home or PAC.

The completion of this study was made possible by a crucial leadership decision that involved integrating the AM-PAC ACISF cognitive assessment into the daily operations of Occupational Therapy (OT) and Speech-Language Pathology (SLP) practitioners at JHH. This assessment was administered during the initial patient examination and on every subsequent patient encounter for rehabilitation sessions. To ensure a standardized assessment process across all providers and patient population, cognitive assessment training was completed by all OT's and SLP's prior to its full clinical implementation. The training process included a presentation with screen shots of the AM-PAC ACISF scoring, the associated rationale behind the rating, including the appropriate documentation process in the patient's electronic medical record. The 20-minute training was recorded for consistent delivery since its initial integration at JHH in August 2020. On average, applied cognitive assessment using the AM-PAC ACISF takes only one minute of extra time beyond the usual time it takes to administer the routine patient care. In a prior study, examination of the AM-PAC ACISF's psychometric properties among rehabilitation staff showed good interrater reliability (ICC = 0.86) with 100% sensitivity and 98% specificity.[9] Therefore, the interdisciplinary team at JHH used the AM-PAC ACISF as a quick, valid, and reliable screening tool for assessment of cognitive impairment that is feasible for use in an acute care setting. Initial compliance audits showed 98.2% compliance of each OT and SLP in completing the applied cognitive assessment using the AM-PAC ACISF per session.

RESULTS

The sample's demographics and other health-related characteristics are presented in **Table 1**, including the AM-PAC ACISF t-scale scores distribution of patients discharged home or to PAC. The sample's median age was 64 years, 52% were females; the mean BMI was 27.4 (overweight), and 57% percent were admitted for surgery. The number of days between the date of admission and the completion of the first AM-PAC ACISF assessment was a median of three days (IQR = 2.0, 4.0, data not shown). Sixty-four percent of patients (N = 3,350) were discharged home and 36% (N = 1,886) were discharged to a PAC facility. The median score of the AM-PAC ACISF for patients discharged home was 39.8 points (30.5, 62.2), while those discharged to post-acute care (PAC) was 30.5 (19.3, 41.8).

Results from bivariate and multivariate logistic regression models using the tertile categories of the first AM-PAC ACISF scores as predictor variable and discharge to PAC as the outcome variable are presented in Table II. Unadjusted regression model results showed that the odds of PAC needs for patients with AM-PAC ACISF t-scale scores in the lowest tertile (7.7 - 28.8 points) were four times greater than in patients in the highest tertile (47.8 - 62.2 points) of the applied cognitive scores spectrum (95% CI 3.4, 4.6; $p < 0.001$). The odds of PAC needs for patients in the middle tertile (30.46 - 44.3 points) were more than two times greater than those at the highest tertile (OR = 2.1, 95% CI=1.8, 2.4; $p < 0.001$). Furthermore, adjusted regression models showed the odds of PAC for patients with AM-PAC ACISF t-scale scores in the lowest tertile were 3.4 times greater than patients in the highest tertile (95% CI 2.8, 4.0; $p <0.001$). Patients with scores in the middle tertile have

Table 1. Sample's Demographics and Other Health-Related Characteristics Including the AM-PAC Applied Cognitive Scores between Patients Discharged to Home Versus Post-Acute Care

Characteristic	Total (N = 5,236)	Discharged Home (N = 3,350)	Discharge to Post-Acute Care (N=1,886)
Age (in years), median*	64.0 (53.0,74.0)	62.0 (51.0,72.0)	67.0 (57.0,76.0)
Female (%)	2713 (51.8)	1793 (53.5)	920 (48.8)
Race			
Black	2109 (40.3)	1274 (38.0)	835 (44.3)
White	2686 (51.3)	1762 (52.6)	924 (49.0)
Other	415 (7.9)	299 (8.9)	116 (6.2)
Unknown/declined	26 (0.5)	15 (0.4)	11 (0.6)
BMI, median*	27.4 (23.1,32.6)	27.5 (23.3,32.6)	27.1 (22.8,32.8)
Payor			
Commercial	949 (18.1)	700 (20.9)	249 (13.2)
Medicaid	787 (15.0)	522 (15.6)	265 (14.1)
Medicare	2741 (52.4)	1575 (47.0)	1166 (61.8)
Other	758 (14.5)	552 (16.5)	206 (10.9)
Residence prior to hospitalization			
Home	5005 (95.6)	3268 (97.6)	1737 (92.1)
Facility	85 (1.6)	18 (0.5)	67 (3.6)
Other	146 (2.8)	64 (1.9)	82 (4.3)
Lives alone	1196 (23.2)	617 (18.6)	579 (31.3)
Medical service			
Medicine	2156 (41.2)	1352 (40.4)	804 (42.6)
Neurology	745 (14.2)	425 (12.7)	320 (17.0)
General surgery	229 (4.4)	128 (3.8)	101 (5.4)
Neurosurgery	1266 (24.2)	892 (26.6)	374 (19.8)
Other surgery	182 (3.5)	124 (3.7)	58 (3.1)
Orthopedics	658 (12.6)	429 (12.8)	229 (12.1)
Admitted for surgery	2986 (57.0)	1944 (58.0)	1042 (55.2)
Prior level of function			
Modified independent[a]	4508 (86.1)	2958 (88.3)	1550 (82.2)
Needed assistance[b]	728 (13.9)	392 (11.7)	336 (17.8)
Comorbidity count, median*	4.0 (2.0,6.0)	4.0 (2.0,6.0)	4.0 (3.0,6.0)
Length of hospital stay as # of days, median*	8.0 (4.0,14.0)	6.0 (4.0,11.0)	10.0 (7.0,18.0)
First AM-PAC cognition t-scale score, median*	38.1 (25.0,62.2)	39.8 (30.5,62.2)	30.5 (19.3,41.8)

*IQR = interquartile range

Missing values: BMI 23, payor 1, lives alone 71, comorbidity count 1

a = independent but used assistive devices or needed extra time

b = required minimal, moderate, maximal, or dependent assistance

1.9 times greater odds for PAC needs than those in the highest tertile (95% CI 1.6 , 2.2; p <0.001). Applied cognition is moderately correlated with functional scores on mobility and activity (r = 0.48 and 0.57 respectively, p < 0.001, data not shown). As a continuous variable, every ten-point decrease in AM-PAC ACISF scores were associated with 1.4 times higher odds for discharge to a PAC facility (OR = 1.4, 95% CI 1.3,1.4; p <0.001). Bivariate and multivariate logistic regression model results are presented in **Table 2**, showing applied cognition score, living alone, male gender, prior residence outside of home, admission due to general surgery, neurology, or orthopedics services versus medicine service all increased the odds of discharge to PAC (OR 1.2 – 4.4, p = <0.001).

DISCUSSION

Applied cognition is an important attribute of functional performance and a unique contributor to health outcomes.[1,2,16] Although cognitive assessment is generally recognized as part of patient evaluation for discharge planning, it is rarely performed in conjunction with routine care due to personnel and time constraints, as well as lack of a standard measure that can be utilized in broad patient populations.[3,4,11,16,25] In this retrospective study, we provide the first empiric evidence that the AM-PAC ACISF is independently and significantly associated with discharge disposition. We found that patients in the

Table 2. Multivariate and Bivariate Logistic Regression Models Using the Tertiles of the First AM-PAC ACISF Scores and Outcome as Discharge to PAC

	Bivariable Analysis		Multivariable Analysis	
Effect	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
AM-PAC ACISF t-scale scores		.		.
1st vs. 3rd tertile*	4.0 (3.4,4.6)	<0.001	3.4 (2.8,4.0)	<0.001
2nd vs. 3rd tertile*	2.1 (1.8,2.4)	<0.001	1.9 (1.6,2.2)	<0.001
Age	1.0 (1.0,1.0)	<0.001	1.0 (1.0,1.0)	<0.001
BMI	1.0 (1.0,1.0)	0.558	1.0 (1.0,1.0)	0.004
Lives alone (Yes vs. No)	2.0 (1.7,2.2)	<0.001	1.9 (1.6,2.2)	<0.001
Male vs. Female	1.2 (1.1,1.4)	<0.001	1.3 (1.1,1.4)	<0.001
Race		.		.
Black vs. White	1.2 (1.1,1.4)	<0.001	1.1 (1.0,1.3)	0.074
Other vs. White	0.7 (0.6,0.9)	0.010	0.9 (0.7,1.2)	0.429
Unknown/declined vs. White	1.4 (0.6,3.1)	0.401	1.3 (0.6,3.0)	0.474
Prior residence		.		.
Facility vs. home	7.0 (4.1,11.8)	<0.001	4.0 (2.3,6.9)	<0.001
Other vs. home	2.4 (1.7,3.4)	<0.001	2.2 (1.5,3.1)	<0.001
Payor		.		.
Medicaid vs. commercial	1.4 (1.2,1.8)	<0.001	1.1 (0.8,1.3)	0.605
Medicare vs. commercial	2.1 (1.8,2.4)	<0.001	1.3 (1.1,1.6)	0.005
Other payor vs. commercial	1.0 (0.8,1.3)	0.664	1.0 (0.8,1.3)	0.874
Type of hospital service		.		.
General surgery vs. medicine	1.3 (1.1,1.5)	0.006	2.1 (1.7,2.5)	<0.001
Neurology vs. medicine	1.3 (1.0,1.7)	0.044	2.3 (1.7,3.1)	<0.001
Neurosurgery vs. medicine	0.7 (0.6,0.8)	<0.001	1.4 (1.1,1.8)	0.001
Orthopedics vs. medicine	0.8 (0.6,1.1)	0.146	1.1 (0.8,1.6)	0.524
Other surgery vs. medicine	0.9 (0.7,1.1)	0.246	1.8 (1.4,2.3)	<0.001
Admitted for surgery (Yes vs. No)	0.9 (0.8,1.0)	0.051	1.3 (1.1,1.5)	0.003
Prior function, modified independent vs. needed assistance	0.6 (0.5,0.7)	<0.001	0.7 (0.6,0.8)	<0.001
Comorbidity count	1.1 (1.1,1.1)	<0.001	1.1 (1.0,1.1)	<0.001

*AMPAC-ACISF t-scale scores tertile categories: Highest tertile = 47.83 - 62.21 points, middle tertile = 30.46 – 44.3 points, lowest tertile = 7.69 - 28.82 points.

lowest tertile had nearly four times increased odds of being discharged to a PAC facility, even after we considered potential confounders associated with discharge disposition. These findings provide important evidence on the critical role that early and routine applied cognitive assessment can play in enhancing the process of delivering coordinated care in the hospital.

The fact that cognitive deficits can pose significant challenges for patients to safely manage daily life at home is well-established, making our results unsurprising. Cognitive function is important in personal and environmental safety awareness, self-care, bowel/bladder management, self-management of symptoms, medications and daily schedule, including social participation and community reintegration.[1,2,6,9,15,16] Our results suggest that even among a diverse patient population, lower cognition scores can help identify patient groups who are likely to require PAC services and help the clinical team begin early discharge planning strategies. These strategies may include timely initiation of preventive measures for cognitive decline or targeted interventions to address cognitive dysfunction, such as cognitive rehabilitation, physical activity, dietary and sleep interventions, and psychosocial interventions.[26,27]

Given the usefulness of AM-PAC ACISF as a standardized outcome measure, this tool appears to be meaningful and feasible in helping integrate applied cognitive assessment to facilitate the clinical team's discharge planning.[9,13,17,28] Other cognitive assessment tools exist, but have limitations for use in routine care. For example, the Montreal Cognitive Assessment (MoCA) is a validated and reliable cognitive screening instrument but the burden of time to complete the assessment is 20 minutes or longer.[9,13,17] The AM-PAC ACISF, on the other hand, requires only an additional minute beyond the regular time required for administering routine patient care.[9] Incorporating cognitive assessment into routine care is often challenging due to the lack of time and resources available to clinical teams. However, using the AM-PAC ACISF may help overcome these barriers and prove useful in improving patient outcomes in acute care settings. Careful attention to implementation can mitigate the

negative impact of undetected cognitive dysfunction, such as missed opportunities for targeted intervention strategies among at-risk patients or groups while in the hospital.

A multidisciplinary clinical team approach at JHH implemented early and routine applied cognitive assessment. Data collection in the EMR of patients across a wide variety of hospital services was conducted for this study. This approach has been feasible at our institution and could serve as model for other acute inpatient hospitals to incorporate similar collection of the AM-PAC ACISF into routine practice of rehabilitation therapists. To do this, electronic medical record systems and assessment protocols should be designed to facilitate early and routine clinical integration of applied cognition assessment while minimizing clinical and documentation burdens.[24] Doing so will help ensure that patient needs are addressed in a timely and comprehensive manner to provide high quality and coordinated care.[2,13-15]

Our study acknowledges certain limitations, including the fact that the first AM-PAC ACISF assessment occurred between two and four days after patient admission. As a result, the initial applied cognition scores may have already captured changes in cognitive status during that period. Moreover, we only had access to a single score at the outset of care by an OT or SLP, without follow-up assessments. While scores collected soon after admission remain useful, repeated assessments over time will yield a more robust data on applied cognitive changes during hospitalization and help identify the optimal timing for interventions. The patients in our study were from different medical services with a wide spectrum of comorbidities. Although applied cognition assessment was implemented in patients across a wide variety of hospital services, only those who received OT and SLP services were included, as OT and SLP complete the AMPAC ACISF every patient care session. At this time, no other discipline completes the AMPAC ACISF. As such, these data do not represent all hospitalized patients and reflect only patients who received OT and SLP services. It is important to replicate this study in other settings, with other disciplines such as nursing, to further explore the generalizability of the findings.

CONCLUSION

Our study underscores the significance of integrating applied cognitive assessment into the early phases of hospitalization and highlights its impact on discharge disposition. Although change in applied cognition scores from admission to discharge was not assessed, our findings remain meaningful and relevant in acute care hospital practice. The value of this study demonstrating that early applied cognition scores are associated with discharge location is to facilitate delivery of health services to prevent further cognitive decline, avoid delays in care coordination, as well as identify and obtain needed resources on the projected patient needs early in the discharge planning process. Clinical teams are often focused on the acute medical issues and may not recognize potential barriers to discharge until later in the hospitalization, which can cause delays in providing the services patients need. By acknowledging the pivotal role of applied cognition early in the healthcare delivery, clinical teams can take a more proactive approach to help optimize health outcomes and ensure patient safety during hospitalization and beyond.

Author Contributions

All authors have reviewed the final manuscript prior to submission. All the authors have contributed significantly to the manuscript, per the International Committee of Medical Journal Editors criteria of authorship.

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflicts of Interest/Disclosures

The authors confirm that there are no financial conflicts of interest to report.

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