The Effect of Cognitive Impairment on Deconditioned/Debilitated Post-Acute Veterans

Anna Nagler

University of Michigan, Ann Arbor

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science with Honors in Biopsychology, Cognition, and Neuroscience from the University of Michigan 2017

Advisors:

Linas Bieliauskas, Ph.D., ABPP

Julija Stelmokas, Psy.D.

Abstract

Deconditioning/debility refers to functional decline associated with hospitalization. Despite the prevalence of hospital-associated deconditioning, little research has fully characterized this population, including the degree of cognitive impairment and negative long-term outcomes. This study aimed to evaluate the degree of cognitive impairment in older, deconditioned patients admitted to a post acute-care (PAC) unit following hospitalization (general medicine and/or acute care) at the Ann Arbor Veteran's Affairs hospital (AAVA). We further aimed to determine whether the added burden of cognitive impairment increased the risk for negative patient outcomes, such as length of PAC stay (LOS) and 90-day readmission rates. In this retrospective study, we reviewed medical records of older (55 years and older) adults (N=170) who completed cognitive testing (Addenbrooke Cognitive Examination-Revised, ACE-R) upon admission to the PAC unit. Additional demographic, medical, functional, and admission-related variables were coded. After accounting for demographics and medical complexity, ACE-R total score explained a mild (Cohen's D = .22) but statistically significant amount of variance (4.0%) in LOS [F (1,161) = 7.935, $p < .05$]. Surprisingly, 90-day readmission rates were not correlated with any demographic, medical, or cognitive scores, suggesting that admission-related variables are not robust predictors of post-discharge status. These results highlight the unique contribution of cognitive impairment in LOS of deconditioned patients, as well as consideration in PAC treatment planning relative to other demographic and medical factors.

Keywords: deconditioning, debilitation, Veterans, ACE-R, cognitive impairment, older adults

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Terms and Definitions

Many hospitalized older adults with physical, mental, and/or functional impairments are described as "deconditioned" or "debilitated". These patients encompass one of the most commonly admitted clinical groups to post-acute rehabilitation settings (Ottenbacher et al, 2014). In addition, this clinical group also has the highest rate of hospital re-admission. For instance, in a retrospective study of patients who were admitted to a rehabilitative inpatient setting following acute hospitalization, 10% of all cases were classified as debilitated and about one third of these patients were readmitted into acute care settings within 90 days of discharge (Galloway et al., 2016). Among these readmissions, three prevalent comorbidities contributing to the reason for readmission included heart failure, renal failure, and chronic pulmonary disease (Galloway et al., 2016). A review of patients identified as having hospital associated deconditioning studied the effectiveness of physical therapy programs for these patients. This review indicated that patients considered to be deconditioned largely received physical therapy, and their programs were often focused on improving strength and endurance but varied based on each patient's unique needs. In contrast, patients who had clearer diagnoses such as "hip fractures" received more standardized physical therapy programs tailored to their conditions and thus demonstrated better functional recovery (Falvey, Mangione, & Stevens-Lapsley, 2016). Although debilitated patients are commonly found in hospital settings and are likely quite medically complex, the medical, functional, and cognitive characteristics of this group have not been well characterized to date.

Currently, there is no standard diagnostic definition of "deconditioning" and multiple terms are used to define the functional and physical decline that can occur during hospitalization. "Debility," however, is a diagnostic term that includes deconditioning as part of the core symptoms. Although these two terms are often used interchangeably, debility is often referred to as a diagnosis while deconditioning is used as a general descriptor indicating physical decline. Deconditioning has been referenced in some cases to refer to physical changes resulting from inactivity (e.g., impaired mobility, immobility) and disuse (Cheruiyot, Laoingco, & Kamau, 2013). Deconditioning can also be separated into two causal groups, with one reflecting "acute inactivity secondary to bed rest" and the other "chronic inactivity from sedentary lifestyles", which is often more difficult to reverse (Delisa, 2005). Although there is no standardized definition, one commonly used definition for deconditioning within research literature is a "functional decline that occurs during acute hospitalization due to illness or injury, or both, and unrelated to a specific neurological or orthopedic insult, or both" (Kortebein, 2009). This definition moves beyond the basic description of deconditioning by including the specific effects of hospitalization while excluding the effects of other comorbid conditions that can lead to functional decline.

The terms "debility" and "deconditioning" must also be distinguished from "frailty," another common geriatric syndrome that includes similar signs of physical decline, such as weight loss, weakness, and slowed physical activity (McEvoy, 2016). Frailty can increase risk of developing other negative health outcomes while aging, such as institutionalization and cognitive impairment, and is also a predictor of mortality (Kane, Talley, Shamiliyan, & Pacala, 2011). The prevalence of frailty is not well understood and varying definitions can result in varying prevalence rates, from 3-30% depending on definition used (Kane et al., 2011). However, the current study will focus on debility/deconditioning, given that these terms are often associated with acute effects due to hospitalization while frailty is often used to describe general functional decline that occurs in the community setting.

Throughout transitions of care (e.g., transitioning from intensive care to general medicine to post-acute rehabilitation units) older patients face a variety of challenges, including post-intensive care syndrome (PICS). PICS reflects a state in which a patient develops severe physical deconditioning, cognitive, and emotional problems, such as delirium, anxiety, depression, acute stress disorder, and posttraumatic stress disorder, usually while undergoing treatment in an intensive care unit (ICU). These problems remain even after acute care hospitalization has concluded (Merbitz, Westie, Danmeyer, Butt, & Schneider, 2016). There are several known ways in which intensive care providers can reduce the risk of PICS, such as using minimal amounts of sedatives and making sure patients are mobile as soon as physically possible during their hospitalizations, yet many patients still arrive in post intensive care settings with severely reduced physical capabilities, cognitive impairments, and psychological distress. The ICU specifically can be a stressful hospital environment, as it is a place in which patients are fighting for their lives. Consequently, it may increase emotional distress, which can contribute to emotional difficulties such as posttraumatic stress disorder (PTSD), anxiety, and/or depression that can linger post ICU when the patients are moved to post acute care (PAC) settings (Merbitz et al., 2016). Therefore, physical problems due to hospitalization can have a severe impact on emotional and cognitive well-being as well.

Risk Factors and Outcomes

Deconditioning predominantly occurs in older adults during acute hospitalization, and is often associated with a significant decrease in functional abilities. Age is one of the greatest factors in determining risk of deconditioning because physiologic and functional capacity both decline with age. Some risk factors for functional decline in general include a history of functional impairment, cognitive impairment, and the use of walking aids (Kortebein, 2009).

Therefore, the factors that may characterize deconditioning may also serve as risk factors for further decline in the same domains. However, the number of individuals diagnosed with deconditioning in addition to other reasons for admission remains unclear. Generally, older patients are more medically complex than younger patients and may require a higher level and frequency of medical contact, including hospitalization. Unfortunately, the effects of hospitalization itself may further increase risk factors for further hospital decline and older adults may be at particular risk for decline, possibly due to a reduced cognitive or physical reserve compared to younger patients.

Hospitalization in the older adult can be a life changing experience, and without proper intervention and mobilization, many older adults can become deconditioned during their hospital stays. Deconditioned patients often have prolonged hospital stays, which can further increase their immobility as well as other physical issues, such as muscle atrophy, bone loss, and increased facture risk (Cheruiyot et al., 2013). In one multi-center study, one in six previously independent adults experienced significant functional decline during hospital stay, which coincided with greater dependency on others for activities of daily living (ADLs) following discharge (Mahoney, Sager, & Jalaluddin, 1998). Importantly, many functional declines were found to be associated with other negative health outcomes, such as nursing home placement post hospitalization. Although both physical and functional status were measured in this study, the effects on cognition were not investigated. In fact, patients with severe cognitive impairment were excluded from the study. Therefore, further research is needed to better understand how cognitive impairment impacts deconditioned patients in terms of their rehabilitation progress and long-term outcomes.

Given the complexity of medical issues in the older adult and the risk of further decline following hospitalization, a significant number of older patients may need to be readmitted to the hospital. One retrospective review compared medical charts of older, skilled nursing facility (SNF) rehabilitation patients that were re-hospitalized within four to 30 days post discharge to patients who were discharged from the same facility and were not re-hospitalized (Dombrowski, Yoos, Neufeld, & Tarshish, 2012). This study indicated that 62% of hospital readmissions were due to complications or recurrence of the original medical condition that led the patient to be hospitalized, and the majority of those readmitted demonstrated poor functioning with completing ADLs. The readmitted group in this review was also found to have more comorbid conditions (such as anemia and malignant solid tumors), lower hemoglobin and albumin levels, and required more assistance with eating and walking. This study did not consider any potential effects that cognition could have had on these outcomes (Dombrowski et al., 2012). This study did not mention deconditioning specifically, although it is likely that these patients did experience deconditioning due to the functional decline observed through their difficulty with ADLs. Furthermore, the patients readmitted are likely to be at risk for the negative effects of hospital associated deconditioning, though the study did not explicitly discuss this.

Changes in physical and functional health are often examined in older deconditioned adults, as declines in these areas during hospitalization may delay hospital discharge and require transfer to a post-acute rehabilitation unit. Nevertheless, many patients continue to experience functional impairment following post-acute admission; almost 22% may be described as severely dependent following admission (Sanchez-Rodriguez, Miralles, Muniesa, Mojal, Abadia-Escartin, & Vasquez-Ibar, 2015) and may require a higher level of care. Although assessment of physical and functional status is important when tracking rehabilitation potential, less is known about the effects of cognitive impairment in this population and its effects on long-term outcomes. The lack of research in this area is surprising considering that reduced cognitive abilities in the context of hospitalization can negatively impact a patient's LOS, treatment engagement, and discharge planning (McPhail, Varghese, & Kuys, 2014).

Cognitive Impairment

Deconditioning increases the risk of additional medical complications, reduces quality of life, and increases mortality (Gillis, MacDonald, & MacIsaac, 2008). Although a number of studies have evaluated the physical and functional declines characterizing deconditioned/debilitated patients, less is known about cognitive status. Given the decline in functional abilities, many deconditioned/debilitated patients are frequently referred to post-acute services following acute hospitalization. However, little is known about the degree and impact of cognitive impairment in these populations. The presence of cognitive impairment is common in older hospitalized patients in general (McPhail et al., 2014), but it is unclear if there is further increased risk of cognitive impairment in older patients with debility/deconditioning.

Currently, there is very little research evaluating the link between cognitive impairment and deconditioning/debilitation in older patients. One study examining the link between frailty and cognition in non-institutionalized elderly adults ages 65 and older labeled 7% of these individuals as frail. In this study frailty was defined as exhibiting at least three of the following: weight loss, weakness, exhaustion, slowness and low physical activity level. A person with only one or two of these symptoms was considered "prefrail". The cognitive examinations utilized were the Mini-Mental State Examination (MMSE) and The Isaacs Set Test to assess verbal fluency and speed of production. Results from this study indicated that frail individuals scored lower on cognitive examinations than pre-frail or non-frail individuals (Avila-Funes et al., 2009).

The results of this study highlight one of the first links between physical and cognitive decline. However, these cognitive screens are limited to studying global cognitive abilities, and further research is needed to determine if specific cognitive domains are preferentially impacted in deconditioned patients.

Boyle, Buchman, Wilson, Leurgans, and Bennett (2010) looked at how frailty may relate to cognitive impairment in a longitudinal study in which physical frailty and its relationship to cognitive impairment in older patients was examined. This study utilized grip strength, timed walking, body composition and fatigue as measures to assess frailty. This study also assessed cognitive function annually over a twelve-year period using a battery of 21 tests including MMSE and other tests measuring episodic memory, semantic memory, working memory, perceptual speed, and visuospatial ability. The results of this study indicated that physical frailty is associated with an increased risk of mild global cognitive impairment, indicated by a decrease in performance in all five cognitive measures mentioned above (Boyle et al., 2010). Frail and deconditioned patients are very similar in terms of physical status, and since frailty is correlated with cognitive impairment, it is likely that deconditioned patients would demonstrate a similar impairment of cognitive skills.

Another study examining cognitive decline inspected the correlation between length of hospital stay and cognitive deterioration (Binder & Robins, 1990). This study, examining patients over 65 years of age, involved utilizing interviews, examining health questionnaires to determine previous hospitalizations and conditions, and using the MMSE to evaluate cognitive impairment. Binder and Robins (1990) found that subjects who performed poorly on the MMSE, meaning they made 7 or more errors out of 30 responses, were more likely to be hospitalized within the next year. Subjects that made 7 to 12 errors were labeled “mildly impaired” whereas those with 13 or more errors were labeled “severely impaired”. Additionally, poor performance increased with age above 75 and decreased with greater years of education. Overall, MMSE score was highly correlated with subsequent hospitalizations, with a decline in score clearly associated with an increased risk of hospitalization within one year. This study concluded that initial poor MMSE performance or a decrease in performance on the MMSE over time both indicated increased risk of hospitalization and longer hospital stays. One limitation of this study, however, is that the MMSE score alone is not sufficient enough to predict imminent hospitalization and therefore other measures should be utilized in future studies as well (Binder & Robbins, 1990).

There have not been many studies to date investigating the relationship between cognitive and physical decline in deconditioned/debilitated patients in post-acute care settings (McPhail et al., 2014). One study performed in a sub-acute setting found that debilitated patients who experienced improvement in their physical status also exhibited a concomitant improvement in their cognitive status (McPhail et al., 2014). This highlights the potential relationship between cognition and physical function. These patients did not have acute physical injury or neurologic impairment, but were all classified as having physical debility during acute hospitalization and consequent admission to a subacute rehabilitation hospital. The sample had an average age of 76.5 years (*SD* = 12.2), and their primary reasons for hospital admission included falls, cardiac, pulmonary or vascular problems, general medicine admissions, surgical admissions, and musculoskeletal admissions. Acute cognitive effects due to illness and hospital stay are likely not necessarily permanent effects, but can affect LOS. However, this study only examined a brief measure of general cognitive functioning (cognitive subscale of the Functional Independence

Measure). Therefore, further research is necessary to determine if global or more specific cognitive domains are impacted by deconditioned/debilitated status.

Study Goals and Hypotheses

A majority of post-acute care (PAC) patients, particularly those admitted from general medicine or acute care services, are likely to be deconditioned or debilitated and experience significant functional limitations. However, little research has evaluated whether as a group, deconditioned/debilitated PAC residents have a high degree of cognitive impairment and whether these effects increase risk for negative outcomes. Therefore, the first major aim of this study was to evaluate the degree of cognitive impairment in a group of older, deconditioned patients admitted directly from the hospital to the PAC unit. Although these patients are considered deconditioned given their hospitalization prior to PAC transfer, some may be specifically identified or diagnosed with debility or deconditioning prior to admission. Therefore, we further aimed to evaluate whether individuals who are identified as deconditioned/debilitated upon PAC admission exhibit greater global cognitive impairment compared to those without this admitting diagnosis.

A second aim of this study was to determine whether the added burden of cognitive impairment in deconditioned/debilitated patients increases the risk for negative patient outcomes. Specifically we hypothesized that poor performance on cognitive testing in deconditioned patients predicts PAC length of stay and 90-day re-admission to the AAVA hospital following PAC discharge.

Method

Participants

We analyzed data collected from residents of a Community Living Center (CLC) PAC unit at the Veteran Affairs Ann Arbor Healthcare System (VAAAHS). The VAAAHS Institutional Review Board approved this retrospective study. The data utilized was gathered as part of the standard clinical care, including the routine cognitive screenings.

Inclusion and Exclusion criteria include:

Inclusion criteria included participants admitted to the CLC from the Ann Arbor Veteran Affairs (AAVA) hospital (e.g. intensive care or general medicine service) prior to the CLC admission who were 55 years or older and actively participating in physical therapy (PT) services while a resident of the CLC. A total of 36 patients were excluded due to admittance from an outside hospital or directly from home, in which case their prior medical records were not accessible for retrospective data review. A total of two patients were excluded due to a complete lack of physical therapy data available and 22 were excluded due to other missing information or unavailable cognitive test scores. Given that the current study focused on previously hospitalized, deconditioned patients, those who were primarily admitted for a simple orthopedic issue or prosthetic training were excluded (N = 20). Finally, based on observations from testing and/or medical record review, those with significant motor or sensory issues that interfered with testing were also excluded (N = 11). Patients who passed away during their CLC or hospital stay were also excluded. Following these inclusion/exclusion criteria, a total sample of 170 patients was included in this study.

Measures

*Demographics***.** Participants were predominantly male (97.1%) and Caucasian (88.8%) and had an average age of 68.4 years (*SD* = 9.2, Range = 55-91). In addition to age, gender, and race, several other demographics and clinical admission data were reviewed and included in the study in order to characterize the deconditioned sample. At the time of CLC PAC admission, most were married (39.4%) or divorced (35.8%), and completed high school (average years of education completed = 12.5; *SD* = 2.3). See Table 1 for additional demographic information of the sample.

Medical and Functional Complexity. The patients' medical status was characterized by primary reason for admission (wound care, orthopedic injuries, treatments (chemotherapy/radiation/antibiotics), cardiovascular/pulmonary problems, stroke/neurological problems, or other reasons (e.g., other types of treatment), number of total medications, body mass index (BMI), nutritional status (albumin level from nutritional assessment closest to day of cognitive screening), length of hospital stay prior to CLC admission, and whether or not the patient was admitted to the ICU prior to CLC admission. The presence of a diagnosis or descriptor of debility/deconditioning upon admission to the CLC PAC was also collected. Whether or not the patient screened positive for depression, as well as select questions from a depression screener (DSM-IV checklist; APA, 2000) were also included. These additional questions included whether the patient experienced cognitive complaints, motor slowing, or reduced energy/fatigue. See Table 1 for additional information regarding the medical complexity of the sample upon admission to the CLC PAC.

Cognitive functioning. Addenbrooke's Cognitive Examination Revised (ACE-R) was used to assess patients' cognition (Mioshi, Dawson, Mitchell, Arnold, & Hodges, 2006). This exam is scored out of 100 points and assesses the following five domains: attention and orientation (18 points), memory (26 points), verbal fluency (14 points), language (26 points), and visual spatial abilities (26 points). Scoring below 88 could suggest severe cognitive impairment (Mioshi et al., 2006). The average ACE-R total score of our sample was found to be 77.2 (*SD* =

12.4). In addition to objective cognitive test performance, subjective cognitive complaints were included as changes in concentration from the DSM-IV screener (yes/no), as noted above. See Table 2 for more information regarding cognitive functioning in this sample.

Outcomes. There were two primary outcomes to the study. The first outcome was length of stay in the CLC. An additional variable that was considered in the context of the patient's LOS in the CLC is if the patient was admitted to an acute or general medicine unit (i.e., the patient went "absent sick") during his CLC stay. Thus if a patient was absent sick, the total CLC LOS excludes the time transferred off unit. The second outcome was if a patient was re-admitted to the AAVA hospital within 90 days following discharge from the CLC.

Procedure

Trained and supervised undergraduate research assistants conducted the brief cognitive screen that included a brief interview, the self-report measure of depression symptoms (DSM-IV-TR) and the cognitive assessment (i.e., ACE-R). The average time from admission to initial testing was 8.2 days (*SD* = 9.8). This data, along with the demographic and medical/functional complexity variables (mentioned above) were all gathered at the time of admission to the CLC-PAC as part of the medical record review process. Outcome data (CLC LOS and re-hospitalization) was also reviewed retrospectively. Data included in the present study was collected between 2011 and 2013.

Medical record review. Demographic variables, readmission within 90 days, depression status, and deconditioned status were coded categorically. Where available, physical therapy data was also included to characterize Veteran's baseline functional abilities in terms of transfers and mobility. CLC length of stay was coded as a continuous variable.

Statistical Analyses

Statistical analysis was performed using IBM SPSS version 22 (IBM corp., 2013). Descriptive analyses included calculating means, standard deviations and frequencies (where appropriate) for each variable. Initial correlations were completed using Pearson (*r*), Mann-Whitney *U* and Chi-Square tests based on whether comparisons were continuous and/or dichotomous. Based on initial visualization and plotting of residuals, CLC LOS was significantly positively skewed. Therefore, we applied a logarithmic transformation to the CLC LOS data only and the results conformed to a normal distribution. In order to evaluate whether or not added cognitive burden increased risk for 90-day readmission to the AAVA hospital, we utilized a logistic regression while controlling for select demographic and medical variables.

Results

Due to the incomplete physical therapy data available to us, we were unable to include functional data in our statistical analyses. However, partial physical therapy data is included in Table 1 to further characterize the sample. Ability to perform transfers and mobility at baseline and at the time of the patient's admission to the CLC were rated as complete dependence (0), need for assistance or an assistive device (1), and complete independence (2). Combining scores from transfers and mobility yielded a total PT score ranging from 0 to 4.

Aim 1: Evaluate the degree of cognitive impairment in CLC residents.

Our sample's average ACE-R total score of 77.2 fell below the standard cut-off for cognitive impairment (<=88) according to Mioshi et al (2006). To better characterize the extent of cognitive impairment in our sample, we compared the total and individual sub-scale scores on the ACE-R in our CLC sample to other published clinical samples. These comparative samples included a healthy control group and those with mild cognitive impairment (MCI; Mioshi et al., 2006), a healthy control group and a mild to moderate Alzheimer's disease group (Rotomskis, Margeviciute, Germanavicius, Kaubrys, Budrys, & Bagdonas, 2015), a chronic brain injury group (Gaber, 2008), and older adults classified as “safe” and “unsafe” drivers (Ferreira, Simões, & Marôco, 2012). Based on visual inspection of score variability, our sample’s average ACE-R total score of 77.2 (SD = 12.4) was most similar to the chronic brain injury group (77.9, SD = 8.4), as well as the safe drivers group (78.3, SD = 11). Additional control groups all exhibited higher total scores on average compared to our sample, while the mild-moderate AD group (54.7, SD = 12.2) and unsafe drivers group (66.5, SD = 14.1) had lower average total scores. Although the average total ACE-R score of our sample performs most similarly to a traumatic brain injury sample (Gaber, 2007), there was some variability amongst the sub-scores when compared to the TBI group. These comparisons are found in Table 3, and further visualized in Figures 1 and 2.

We further sought to evaluate which demographic and medical factors may contribute to cognitive performance on the ACE-R upon admission to the CLC-PAC. ACE-R total score was negatively correlated with age ($r = -.37$, $p < .05$) and positively correlated with years of education ($r = .31$, $p < .05$), such that a younger patient or a patient with more years of education would likely score higher on the ACE-R. With regards to medical status, albumin level ($r = .26$, $p < .05$) was positively correlated with ACE-R total score, such that a worse nutritional status was significantly correlated with a lower score on the ACE-R. No other demographic or medical variables were correlated to cognitive performance.

Aim 2: Evaluate whether cognitive impairment differs between CLC PAC residents with and without a diagnosis of deconditioning/debility

First, we evaluated the prevalence of a diagnosis of debility or deconditioning in our sample. Although our entire sample was considered deconditioned based on previous stays in a general or acute medicine floor prior to transfer to the CLC, only 40.4% of patients were actually labeled as deconditioned/debilitated in the AAVA medical record upon admission. No correlation was found between a diagnosis of deconditioning/debility and ACE-R score (U = 3119, p = .246).

Aim 3: Determine whether cognitive impairment in deconditioned/debilitated patients increases the risk for negative outcomes.

A Mann-Whitney U test revealed a significant difference in the CLC LOS of patients who were transferred off-unit during CLC admission (i.e., being absent sick) (Md = 125.7, n = 37) and patients who were not transferred off-unit (Md = 73.6, n = 132), U = 935, $p < .05$, such that being absent sick correlated with an increase in LOS in the CLC. Additional demographic variables were not significantly correlated with LOS in the CLC.

As for medical complexity, CLC LOS was significantly positively correlated with total number of medications, such that a larger number of medications upon admission correlated with an increase in LOS (r = .31, $p < .05$). CLC LOS was also significantly negatively correlated with albumin level (r = -.19, $p < .05$), but not correlated with BMI (r =-.06, p = .41), meaning that a poorer nutritional status upon admission correlated with an increase in CLC LOS. Having a diagnosis of deconditioning or debility upon admission to the CLC was not significantly correlated with LOS (U = 3119, p = .25). As for depression screenings, neither the DSM-IV checklist “slowed down” item nor the “difficulty with concentration” item significantly correlated with CLC LOS. However, the DSM-IV fatigue/loss of energy item was significantly correlated with CLC LOS. A Mann-Whitney U test revealed a significant difference in the CLC LOS of patients who screened positively on the DSM-IV fatigue/loss of energy measure (Md = 34, n = 72) and patients who screened negatively on the DSM-IV fatigue/loss of energy measure

(*Md* = 28, *n* = 96), *U* = 2806, $p < .05$. CLC LOS was also negatively correlated with total ACE-R score ($r = -.21$, $p < .05$), such that a lower total ACE-R score correlated with an increase in CLC LOS.

A multiple, step-wise regression analysis was completed to evaluate whether the addition of cognitive burden above and beyond relevant demographic and medical factors predicted CLC LOS. In addition to age and education, variables that were significantly correlated with CLC LOS utilizing univariate analyses were included in the final model (i.e. DSM-IV fatigue/loss of energy measure, number of medications, and albumin levels). Preliminary analyses met initial model assumptions, including normality, linearity, and multi-colinearity. Demographic background (years of education and age) was entered at Step 1, and explained 1% of the variance in CLC LOS, but this was non-significant overall, F (2, 165) = .852, $p = .429$. Step 2 further included medical complexity variables (DSM-IV fatigue/loss of energy, number of medications, and albumin) in addition to age and education, and explained an additional 13.3% of the variance, F (3, 162) = 8.37, $p < .001$. After controlling for demographics and medical complexity, the addition of cognitive performance (ACE-R total score) in step 3 explained an additional 4.0% of variance, F (1,161) = 7.935, $p < .05$. The effect size for ACE-R total score was mild (Cohen's D = .22). In this final model, ACE-R total score was statistically significant, such that a lower score predicted an increase in CLC LOS (beta= -.230, $p < .05$). Interestingly, number of medications continued to contribute to the overall model fit, such that a greater number of medications contributed to a longer length of stay (*beta* = .313, $p < .01$) even after controlling for demographic, medical and cognitive variables.

Univariate analyses were also conducted between demographic, medical and cognitive test performance with readmission to the AAVA hospital within 90 days of CLC discharge using

Chi-square and Mann-Whitney *U* tests as appropriate. There were no significant correlations across any of the variables and outcome from these analyses. Therefore, we did not complete a logistic regression as none of the variables were significantly correlated based on univariate analysis. Please see Table 1 for results from initial univariate analyses of demographic and medical data with CLC LOS and 90-day readmission rate.

Discussion

The overall aim of the present study was to determine the degree of cognitive impairment in a group of older, deconditioned patients, and whether the added burden of cognitive impairment increased the risk for negative outcomes. Specifically, we hypothesized that the presence of cognitive impairment would uniquely contribute to a higher likelihood for the negative outcomes, such as CLC LOS and 90-day readmission rates.

Consistent with our hypothesis, on average the majority of our sample's ACE-R total scores fell below the standard cut-off for cognitive impairment (<=88; Mioshi et al., 2006). Our sample's ACE-R total and sub-scale performance was generally higher than demented patients and most similar to a traumatic brain injury (TBI) sample. This finding is not surprising given that our sample was composed of generally medically compromised older patients without a high degree of dementia to begin with, but likely a high degree of vascular compromise secondary to acute and chronic health conditions. The high total number of medications in this sample likely further contributed to cognitive performance. The similarity in performance on the ACE-R between our sample and the chronic TBI sample (Gaber, 2007) may also reflect frontal-subcortical dysfunction. For instance, previous studies have implicated short-term memory and verbal fluency as most sensitive to brain injury (Gaber, 2007; Reddy, Rajeswaran, Devi, & Kandavel, 2017), but these impairments, as well as executive dysfunction more broadly, may also be found in individuals with significant number of vascular risk factors (Hess & Smart, 2017; Kalaria, 2016). In our older, deconditioned sample, it is likely that the combination of vascular compromise, along with medical complexity and poor nutritional status upon admission, contribute to cognitive impairment.

In terms of cognitive performance, only select demographic and medical variables were correlated with global cognitive functioning (i.e., ACE-R total score). Consistent with our hypothesis, and similar to the Mioshi et al. (2006) original normative sample, age and education were correlated with performance on the ACE-R and specific age-adjusted cut-offs are provided. However, results from our current study suggest that cut-offs that include a more expanded age range (original study has a range of 50-75) and education may be more sensitive to cognitive impairment overall. Of the medical factors, only albumin was significantly correlated with total ACE-R score. The average albumin level of our entire sample was 2.9, which is considered low (normal ranges from 3.2-5.0). Albumin may also serve as a surrogate marker of mortality in medical complex patients. For instance, a 13-year longitudinal study found that low levels of albumin were correlated with the highest cardiovascular mortality in males and associated with all-cause mortality in both genders (Okamura et al., 2004). Llewellyn, Langa, and Lang (2010) also studied the link between low albumin levels and cognitive impairment, and found that a cognitively impaired sample group had an average albumin level of 3.9, compared to the cognitively normal group’s 4.1 average. Our group’s average of 2.9 is lower than this, further suggesting that our group is not only nutritionally compromised but may also experience cognitive impairment secondary to the systematic effects of under- or mal-nutrition.

Although our sample was considered deconditioned in general, only a small proportion (40.4%) were diagnosed or labeled as such upon admission. Unlike our original hypothesis, there was also no significant correlation between cognitive impairment and being labeled as deconditioned/debilitated upon admission to the CLC. As previously mentioned there is no standardized definition of deconditioning, so it is not clear what causes one patient to be labeled deconditioned while another patient is not. Although results from our study suggest that the presence of cognitive impairment does not differentiate whether someone is diagnosed/labeled as deconditioned upon admission, there is still the possibility that key differences exist in terms of functional status. However, our study had incomplete data with respect with physical therapy evaluations so we were unable to fully characterize the specific functional differences that may account for this discrepancy. However, we were able to rule-out that global cognitive impairment on its own differentiates those with and without this diagnosis. Thus, future research is needed to better evaluate the functional phenotype of deconditioning and its clinical utility, including the context under which it may be utilized by some clinicians and not by others.

As for the negative patient outcomes, LOS in the CLC was correlated with a number of medical complexity variables but not demographic background. In particular, number of medications, albumin level, the DSM-IV fatigue/loss of energy measure, and total ACE-R score were correlated with CLC LOS. This suggests that patients with more medications, or those with lower albumin levels, or those experiencing fatigue/loss of energy, or those with a lower total ACE-score upon admission may have an increase in hospital stay. It is somewhat surprising that, unlike our original hypothesis, other demographic factors were not correlated with CLC LOS. For instance, Garcia et al. (2012) assessed LOS in elderly hip fracture patients and found that the male gender was significantly correlated with LOS; although this is inconsistent with our data, it is possible that other psychosocial factors may account for the inconsistency in gender exerting an effect on LOS. Additional factors that may account for study differences is sample; our study included patients with a large number of medical and rehabilitation needs, which may have prohibited us from finding a unique contribution of gender on CLC LOS. It seems that the demographics significantly correlated to hospital LOS varies from study to study. Kato, Galynker, Miner, and Rosenblum (1995) looked at LOS and cognitive impairment in psychiatric patients and found that cognitive status upon admission predicted LOS greater than any of the demographic factors measured. However, Kato et al. (1995) also concluded that demographics combined with clinical variables are better predictors of LOS than demographics alone, and demographics alone are not great predictors of LOS overall. This is consistent with our data in that the majority of the demographics alone are not significantly correlated. Although demographic factors may not necessarily directly contribute to outcomes, such as LOS, it is possible that they may exert a moderating effect, which would need to be evaluated in future studies.

Consistent with our hypothesis, after controlling for the effects of demographic background and medical history, our results indicate that the presence of cognitive impairment significantly predicted LOS in the CLC. This finding is in keeping with other research highlighting the strong relationship between global cognition and LOS (Binder & Robbins, 1990). The influence of cognitive impairment within a rehabilitation sample is an important clinical variable that may compound the effects of other health conditions (acute and chronic), and our results suggest that this is particularly true in post-acute settings. However, it is also important to consider how cognitive impairment can impact rehabilitation gains, such as being able to learn and recall rehabilitation exercises. Thus, reduced rehabilitation efficiency may contribute to an increase in CLC LOS within our sample, and our results highlight the unique contribution of cognitive impairment in this regard. Given the medical complexity and total number of medications, the presence of cognitive impairment may provide further challenges for patients as they are discharged home and attempt to manage their health conditions.

Based on previous studies linking deconditioning and/or cognitive decline to a higher hospital readmission rate (Galloway et al., 2016, Ottenbacher et al., 2014), we expected 90-day readmission rate to significantly correlate with at least some of the initial variables as well. This hypothesis was also derived from the assumption that the addition of cognitive burden to other medical complexity variables may make it more difficult for patients to manage their health conditions after discharge, and thus, increase their risk for readmission. However, in contrast with our original hypothesis, our results did not indicate that demographic or medical issues, including cognitive impairment were significant predictors of readmission. One explanation could be that cognitive impairment may contribute to re-admission, but perhaps within a shorter window of time when patients are more vulnerable. For instance, Anderson and Birge (2016) found that cognitive impairment was a risk factor for a 30-day hospital readmission in patients managing their own medications, and for patients in this group taking more than seven medications, there was an even greater risk of readmission. Therefore, it could be that our chosen cut-off of 90 days was too broad and that a larger percentage of individuals with cognitive impairment were most at risk for re-admission within 30 and 90 days. It is also possible that patients who are re-admitted within 90 days are readmitted to the hospital for other conditions, potentially irrelevant to their previous stays, which may or may not relate to their cognitive status (e.g., need for prosthesis or gait training).

Limitations, Further Research, and Implications

One of the largest limitations of the study was the lack of functional data. Although we attempted to include physical therapy performance at baseline and at admission, the amount of missing data precluded inclusion in analyses. Both the combination of motor impairment (Tan, Heng, Chua, & Chan, 2009) and cognitive impairment impact activities of daily life (ADLs) (Zwecker, Levenkrohn, Fleisig, Zeilig, Ohry, & Adunsky, 2002), which can affect treatment and discharge planning. For instance, in stroke survivors, functional decline such as incontinence, poor arm function, or loss of sitting/balance, combined with cognitive function, are very strong predictors of poor functional outcomes and ADL performance (Zwecker et al., 2002). Therefore, impairment in either cognitive or motor domains could contribute to length of hospitalization. Therefore, the inclusion of standardized functional measures would greatly help in understanding the effect of cognitive impairment in our PAC sample.

Another limitation includes the use of retrospective data and reliance on medical record review for diagnoses, such as deconditioning or debility. We were unable to account for logistical and psychosocial variables that may increase length of stay (e.g. waiting on equipment). Therefore a prospective study would be beneficial in providing more comprehensive outcome measurement tools, as well as tracking of relevant variables. The question can also be raised as to whether the ACE-R is the best measure of cognition in this sample, given that it was originally normed for individuals with dementia. Therefore, future studies may wish to include measures that may be more sensitive to cognitive impairment. We also limited our analyses to total ACE-R score to evaluate global cognition, and further research is needed to determine if specific domains or sub-scales are driving the relationship between cognitive performance and LOS.

One limitation of our 90-day readmission measure is that we could only included data for patients who were re-admitted back to the AAVA hospital. It is possible that some patients were readmitted to different hospitals within 90-days, which could explain the null finding in this regard. This limitation also reflects our use of a local sample, and a more nationwide database would prove helpful in tracking readmission rates.

Conclusion

There is limited research that evaluates the relationship between physical deconditioning and cognitive impairment in older adults, despite the high degree of each in older age groups (McPhail et al., 2014). Although our results did not indicate a statistically significant link between demographic, medical, or cognitive data and 90-day re-admission rates, several of our variables were correlated with CLC LOS. Consistent with our hypothesis, cognitive impairment in deconditioned/debilitated patients explained a mild, but statistically significant amount of variance in CLC LOS even after controlling for key demographic and medical complexity variables. These results emphasize the influence of cognitive impairment in LOS of deconditioned patients, as well as the consideration in treatment planning relative to other demographic and medical factors in post acute care units.

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Acknowledgments

Anna Nagler, Department of Psychology, University of Michigan, Ann Arbor

I would like to thank Dr. Linas Bieliauskas and Dr. Julija Stelmokas for their valuable time and assistance throughout this project. This work would not have been possible without all of their knowledge and support. I would also like to thank Julia Granski for all of her time and assistance transcribing the data utilized in this project. I would like to thank the University of Michigan's Consulting for Statistics, Computing and Analytics Research (CSCAR) for their guidance and support in this project's data analysis and interpretation. Lastly, I would like to thank the patients and staff at the Veteran Affairs Ann Arbor Healthcare System for providing me with the invaluable clinical experiences that allowed this research to be possible. Correspondence regarding this paper should be addressed to Anna Nagler, 1024 Church Street, Ann Arbor, MI 48104. E-mail: Anagler@umich.edu

Table 1: Variables/Correlations with LOS and 90-day readmission in the CLC Sample

Variable	Mean (SD) OR Frequency (percent)	Min	Max	Statistic	
				LOS	Positive 90 day readmission
Demographics:					
Age	68.4 (9.2)	55	92	$r = -.03$ $p = .35$	$U = 2226.5$ $p = .89$
Gender	165 (97.1%) male			$U = 338$ $p = .49$	$\chi 2 = 1.4$ $p = .24$
Race	88.8% Caucasian 11.2% Non-Caucasian			$U = 1390$ $p = .83$	$\chi 2 = 2.7$ $p = .1$
Years of Education	12.5 (2.3)	8	20	$r = .09$ $p = .13$	$U = 2189.5$ $p = .78$
Marital Status	61 (39.4%) married 103 (60.6%) other			$U = 3375$ $p = .81$	$\chi 2 = 2.5$ $p = .11$
Medical:					
Number of Medications	13.6 (4.7)	1	31	$r = .31$ $p < .05$	$U = 2035$ $p = .37$
BMI	27.1 (7.1)	11.7	56.9	$r = -.06$ $p = .41$	$U = 2220$ $p = .87$
Albumin Level	2.9 (.61)	1.4	4.3	$r = -.19$ $p < .05$	$U = 1841.5$ $p = .18$
Positive Deconditioned/ Debilitated Status	69 (40.4%)			$U = 3119$ $p = .25$	$\chi 2 = 1.1$ $p = .30$
Length of Hospital Stay prior to CLC (days)	12.5 (12.62)	1	122	$r = .15$ $p = .05$	$U = 2077$ $p = .47$
Prior ICU admission (Yes)	18 (10.5%)			$U = 1249$ $p = .55$	$\chi 2 = .89$ $p = .35$
Primary Reason for CLC admission:					
Wound Care	27 (15.8%)				
Orthopedic Injury	17 (9.9%)				
Treatment (chemo/radiation/antibiotics)	47 (27.5%)				
Cardiovascular/Pulmonary or Stroke/Neurological Problems	17 (9.9%)				
Other reasons (treatment)	61 (35.7%)				
DSM-IV depression screening					
Positive depression (overall)	27 (15.8%)			$U = 1718$ $p = .42$	$\chi 2 = .51$ $p = .77$
Slowed-down	130 (22.40%)			$U = 2395$	$\chi 2 = .55$

				p = .78	*p* = .76
Lack of concentration	28 (16.50%)			*U* = 1771 *p* = .42	χ2 = .56 *p* = .76
Fatigue/Loss of Energy	72 (42.40%)			*U* = 2806 *p* < .05	χ2 = 1.0 *p* = .6
Physical Therapy Scale of 1-4 (1 =lowest, 4 = highest)					
Baseline PT	47 (27.5%) = 1 32 (18.7%) = 2 14 (8.2%) = 3 60 (35.1%) = 4				
Current PT	24 (14%) = 1 101 (59%) = 2 15 (8.8%) = 3 19 (11.1%) = 4				
Cognitive Measure					
ACE-R total Score	77.2 (12.4)	37	96	*r* = -.214 *p < .05*	*U* = 2174 *p = .733*

Table 2: CLC ACE total score and sub-scores

	Mean	**Standard Deviation**	**Minimum**	**Maximum**
Total Score	77.2	12.4	37	96
Attention	16.4	2.1	9	18
Memory	18.3	4.7	5	26
Fluency	7.4	3.1	0	14
Language	22.4	3.1	8	26
Visuospatial	12.7	3.0	3	16

Table 3: ACE-R total and sub-domain comparisons across comparison studies

Group	Total ACE	Attention	Memory	Fluency	Language	Visuospatial
CLC ACE-R	77.2 (12.4)	16.4 (2.1)	18.3 (4.7)	7.4 (3.1)	22.4 (3.1)	12.7 (3.0)
Mioshi 2006 control	93.7 (4.3)	17.7 (0.5)	23.4 (2.7)	11.9 (1.7)	25.1 (1.5)	15.7 (0.7)
Mioshi 2006 MCI	84.2 (7.3)	17.2 (1)	17.8 (4.7)	10.1 (2.4)	23.9 (1.6)	14.9 (2)
Rotomskis 2015 control	85.1 (7.2)	17.7 (0.7)	18.5 (3.4)	10.6 (2.2)	23.6 (2.2)	14.8 (1.7)
Rotomskis 2015 mild-moderate AD	54.7 (12.2)	11.8 (2.9)	8.3 (3.5)	6.1 (2.7)	17.2 (4.0)	11.4 (2.7)
Gaber 2007 brain injury	77.9 (8.4)	16.4 (2)	16.5 (4.2)	7.9 (4.2)	22.1 (2.6)	14.8 (1.4)
Ferreira 2012 control (safe drivers)	78.3 (11)	17 (1.7)	17 (5.8)	8.3 (2.9)	22.4 (3.0)	13.6 (2.3)
Ferreira 2012 (unsafe drivers)	66.5 (14.1)	15.9 (2.2)	14.2 (4.7)	5.8 (3.1)	19.3 (5.1)	11.3 (2.9)

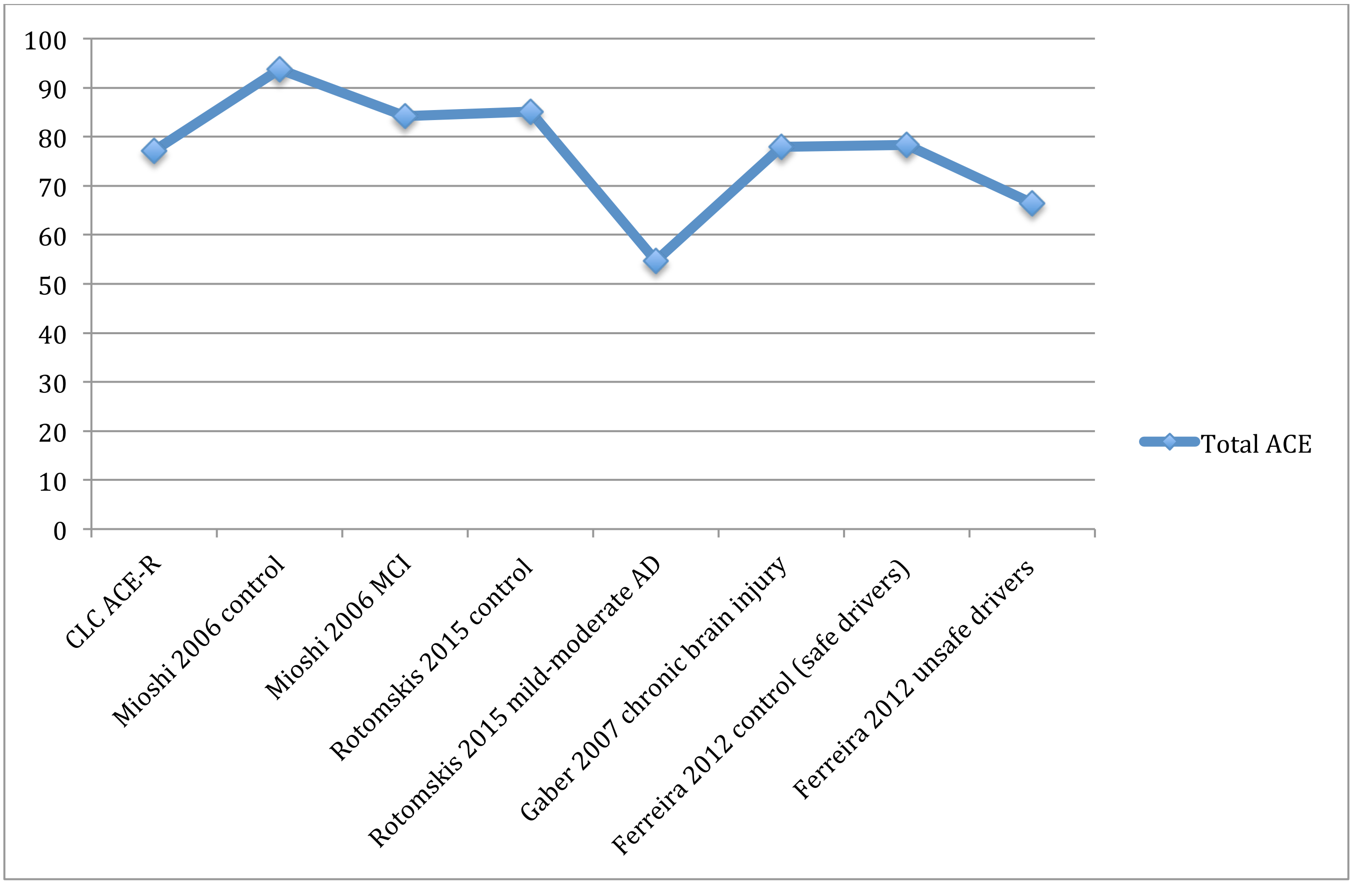

Figure 1. Addenbrooke cognitive examination revised total score across comparison studies

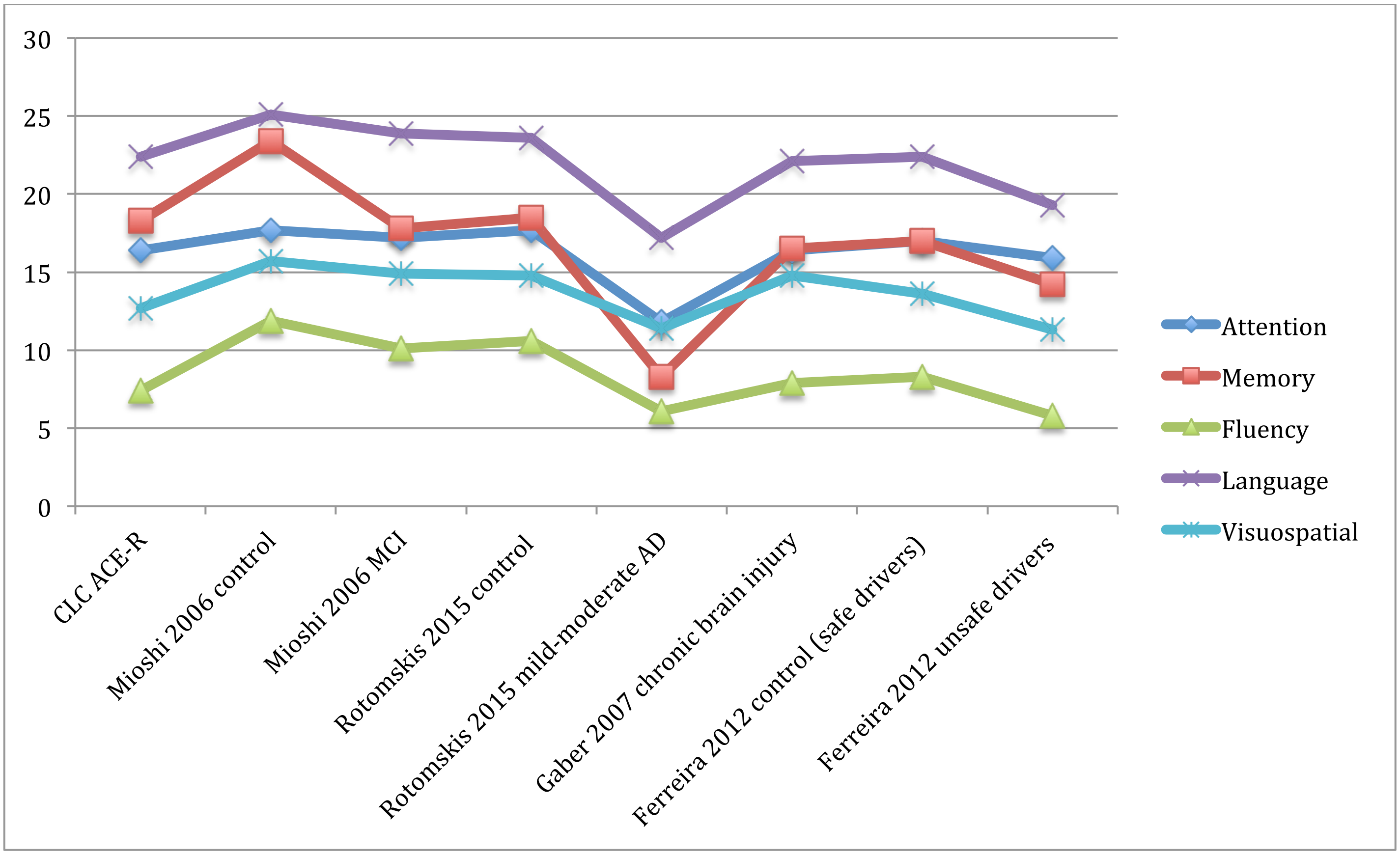

Figure 2. Addenbrooke cognitive examination revised cross study comparisons by subdomain