The Relationship Between Cognitive Impairment and Mortality Rates Among Long-Term Care Insurance Applicants

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Abstract

In this paper, we examine the relationship between the earliest stages of dementia—mild cognitive impairment—and mortality. Using data from 896,756 applicants of long-term care insurance who applied for policies between 1996 and 2008, and linking this to the Social Security Master Death File, we focus on the classification results of two cognitive screens used at various times in the underwriting process. These screens were deployed either telephonically or through in-person evaluations. The first, the Delayed Word Recall (DWR), was employed throughout the 1990s, and the second, the Enhanced Mental Skills Test (EMST), entered widespread use from 2004 through the present. This latter test is the most sensitive in the market at detecting individuals with mild cognitive impairment.

Using the Cox Proportional Hazards Model as well as relative mortality ratio analysis, we show that the proportion of individuals classified as cognitively impaired have significantly higher relative mortality compared to those classified as cognitively intact. This is true for both cognitive screens. In fact, holding age and gender constant, an applicant classified as cognitively impaired has a death hazard between 1.52 and 1.69 times greater than someone who is cognitively intact. With respect to relative mortality ratios, across all age and gender groups, higher relative mortality ratios are found among individuals classified as cognitively impaired, and individuals identified by the EMST as cognitively impaired have higher relative mortality ratios than those identified by the DWR. The results presented here have implications for forecasting health services use among the older adult populations, budgeting and funding of programs designed to serve their needs, underwriting methods for older age life insurance policies and policy pricing.

Introduction

Population aging presents important challenges for long-term care service providers, payers and policymakers, who together must find new ways to meet the growing service needs of older people. As age-specific mortality continues to decline for the 65-and-older population, people are living long enough to face an increasing risk of becoming functionally and/or cognitively impaired. There is already well established evidence that individuals with functional impairments and dementia face a higher risk of mortality than those who are not impaired.[i,ii,iii,iv,v,vi,vii,viii] What is less well known, however, is the association between the very earliest stages of cognitive decline— having mild cognitive impairment—and subsequent mortality experience. While there is a body of research that suggests a clear relationship between full-blown Alzheimer’s disease and excess mortality, there has been much less research completed on the relationship between cognitive impairment and excess mortality.[ix,x,xi] In part this is because only recently have there been effective screens for more accurate identification of the condition. Also, not all individuals who are classified as having cognitive impairment become demented. In fact, this stage of cognitive function can last for up to seven years before turning to dementia. Thus, as population aging trends continue, an important question is the extent to which classification of an individual as having cognitive impairment is related to mortality experience.

Purpose

The purpose of this research is to analyze the relationship between being classified as cognitively impaired by two alternative cognitive screens and mortality rates among long-term care (LTC) insurance applicants. More specifically, we answer the following research questions:

- What is the relationship between being classified as cognitively impaired and subsequent mortality experience?
- Holding age and gender constant, what is the magnitude of the effect of cognitive impairment on mortality rates?
- What is the difference in relative mortality ratios for individuals classified as cognitively impaired versus those classified as cognitively intact?

Where data permits among a subset of LTC insurance applicants, we will also analyze whether there is a relationship between having limitations in activities of daily living (ADLs) and subsequent mortality rates.

For a number of reasons, it is important to examine this relationship. First, cognitive impairment has been found to be a consistent predictor of increased health care service use and costs and understanding its relationship with mortality assists in forecasting the duration of service utilization. Second, cognitive impairment is most common among the elderly, and this has significant implications for public as well as private programs that pay for health care services for this group and other affected populations such as family caregivers. Finally, life insurance companies have been increasing their sales to older adults and information that enables them to better understand and evaluate mortality risk is critical to assuring properly priced and risk-managed policies.

Material and Methods

Data

To answer these questions, we focus on a sample of individuals applying for long-term care insurance policies. Approximately 250,000 individual LTC insurance policies are currently issued in the United States on an annual basis[xii] and there are roughly 8 million policies in force. More than 90 percent of individual policies are issued by the top 10 LTC insurance companies in the United States, and all of these perform some form of underwriting on applicants. Historically, LifePlans Inc. has been involved in the underwriting screening process for most if not all of these companies. More specifically, over the past 20 years, the company has conducted both in-person and telephonic evaluations of insurability for these companies and administered cognitive screens.

During this time, LifePlans deployed one of two cognitive screens as predictive measures for cognitive decline. One, the Delayed Word Recall (DWR), was developed by Dr. David Knopman at the University of Minnesota. The LTC insurance industry has used the DWR—and a variant of this test, the Minnesota Cognitive Acuity Screen (MCAS)—for almost 20 years to screen older age insurance applicants for the earliest stages of cognitive decline.[xiii,xiv] For the most part, this instrument has been valuable in identifying individuals with mild to moderate dementia, and less sensitive in capturing those with mild cognitive impairment (MCI). A previous study based on a much smaller sample of applicants with fewer exposure years established the relationship between DWR scores and mortality;[xv] the current study builds on this prior study by focusing on a much larger sample followed for up to 14 years of experience.

In recent years, a test based on the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) battery—the "gold-standard" for Alzheimer's and related dementia screening—has been used by the LTC insurance industry. Developed by Alzheimer's researcher Dr. William Shankle at the University of California-Irvine, the Enhanced Mental Skills Test (EMST) has been in use since 2004. It is considered to be a more accurate test for identifying individuals at the earliest stages of cognitive decline, that is, those having MCI.[xvi]

The EMST employs a method of word-recall trials based on three repeated trials followed by one recall trial. In scoring, it uses an algorithm that accounts for which words in the list are recalled, the order of recall, how performance changes over trials, the number of words recalled and other factors related to understanding underlying cognition. The EMST classifies individuals on a pass/fail basis; those who fail the test are classified as cognitively impaired and those who pass are classified as cognitively intact. From 1996 through 2003, LifePlans employed the DWR to collect information on cognitive function. After the EMST was introduced in 2004, the use of either test was dependent upon the needs of the insurance company seeking personal health information.

Our research relies on in-person and telephonic underwriting assessment data collected by LifePlans between Jan. 1, 1996, and Dec. 31, 2008. This data, comprising 896,756 lives, includes social security numbers as well as cognitive and some limited functional information. This dataset was then linked to the latest Social Security Administration's Death Master File, which enables us to determine who during this roughly 14-year period died and when. Given that the vast majority of the sample is comprised of individuals 65 and older, a significant number of deaths have occurred over the period (see Table 1). Total deaths in the sample were 162,518, almost all from older DWR data.

TABLE 1
Characteristics of the Dataset

	DWR Data	EMST Data
Number of Lives	764,037	132,719
Year Assessed		
1996	1%	
1997	2%	
1998	8%	
1999	12%	
2000	15%	
2001	17%	
2002	19%	
2003	12%	
2004	6%	2%
2005	5%	18%
2006	2%	12%
2007	1%	33%
2008		35%
Average age at Assessment	71	64
Under 65	27%	48%
65-74	29%	36%
75-79	28%	11%
80+	16%	5%
Gender		
Male	43%	45%
Female	57%	55%
Tests Scores		
0 recalled	2%	N.A.
1-2 recalled	2%	N.A.
3-4 recalled	7%	N.A.
5-6 recalled	28%	N.A.
7+ recalled	61%	N.A.
Pass	89%	93%
Fail	11%	7%
ADL Limitations		
0 Limitations	97%	N.A.
1 Limitation	3%	
Deaths		
Total Number	160,255	2,263
Total Rate	21%	1.7%

Table 2 summarizes the test samples in terms of exposure years as well as the number of deaths by age, gender, duration and cognitive impairment classification results. March 31, 2010, is the termination date for the analysis. For those who died before March 31, 2010, we calculate the survival time between the administration of the screen and their death date; for applicants still alive as of March 31, 2010, their data is "right censored," which means survival times are known up to a certain point. As shown, we have more than 5.8 million exposure years of experience for the DWR sample and roughly 376,000 exposure years of experience for the EMST sample.

TABLE 2
Characteristics of the Test Samples by Exposure Year and Deaths

	DWR		**EMST**	
	Exposure Years	**# Deaths**	**Exposure Years**	**# Deaths**
Total	5,834,654	160,255	375,739	2,263
Gender				
Male	2,430,565 (42%)	80,347 (50%)	168,750 (45%)	1,281 (57%)
Female	3,404,088 (58%	79,908 (50%)	206,989 (55%)	982 (43%)
Age at Test				
< 65	1,651,891 (28%)	6,553 (4%)	185,140 (49%	324 (14%)
65-69	496,402 (9%)	6,147 (4%)	79,003 (21%)	404 (18%)
70+	3,686,361 (63%)	147,555 (92%)	111,95 (30%)	1,535 (68%)
Duration				
1	5,834,654 (11%)	3,259 (2%)	375,739 (23%)	200 (9%)
2	5,833,736 (11%)	10,478 (7%)	375,683 (23%)	719 (32%)
3	5,822,935 (11%)	13,491 (8%)	357,627 (22%)	607 (27%)
4	5,794,066 (10%)	15,461 (10%)	263,055 (16%)	406 (18%)
5	5,723,617 (10%)	17,541 (11%)	143,309 (9%)	287 (13%)
6	5,563,827 (10%)	18,929 (12%)	91,163 (6%)	44 (2%)
7	5,287,204 (10%)	19,662 (12%)	5,222 (<1%)	
8	4,875,233 (9%)	19,092 (12%)		
9	4,062,882 (7%)	15,678 (10%)		
10	2,989,536 (5%)	12,331 (8%		
11	1,950,623 (4%)	8,357 (5%)		
12	1,044,938 (2%)	4,443 (3%)		
13	407,867 (1%)	1,210 (1%)		
14	84,589 (<1%)	297 (<1%)		
15	18,263 (<1%)	26 (<1%)		
Impairment Status Classification				
Impaired	587,132 (10%)	32,678 (20%)	25,647 (7%)	498 (22%)
Not Impaired	5,247,522 (90%)	127,577 (80%)	350,092 (93%)	1,765 (78%)

Data Cleaning

The basic assumption underlying subsequent analyses is that assessment data can be linked accurately to social security data. While the primary linkage variable is the social security number, secondary linkages include date of birth and name. To ensure an individual is accurately classified as dead, we use all three linkage variables. Thus, for an individual to be classified as dead, there had to be a complete match on the social security, date of birth and name. If there was a match only on two of these variables, the individual was not classified as dead and, instead, classified as an individual with "Incomplete Linkage Status." Moreover, if the date of death was determined to be incorrect—for example, the individual was assessed at a date subsequent to the reported date of death—the case cannot be linked. The distribution of cases classified with incomplete linkage status is given below.

TABLE 3
Distribution of Complete and Incomplete Links of Assessment Data to Master Death File

	DWR Data			EMST Data		
Assessment Year	**Incomplete Linkage Cases as a % of All Cases**	**# of Complete Linked Deaths**	**# of Incomplete Linked Deaths**	**Incomplete Linkage Cases as a % of All Cases**	**# of Complete Linked Deaths**	**# of Incomplete Linked Deaths**
1996	0.6%	3,303	34			
1997	0.4%	6,352	49			
1998	0.4%	26,694	240			
1999	0.3%	32,741	256			
2000	0.2%	28,493	251			
2001	0.2%	23,788	226			
2002	0.2%	20,984	236			
2003	0.4%	10,692	329			
2004	0.4%	4,016	189	0.0%	73	1
2005	0.5%	1,966	169	0.3%	863	74
2006	0.4%	943	67	0.4%	307	65
2007	0.3%	283	19	0.2%	626	107
2008				0.3%	394	129
Total		160,255	2,065		2,263	376

The vast majority of such discrepancies occurred in more recent data files, which would potentially affect the analysis for the EMST. This is likely due to two factors: (1) the social security data collected on the assessment form may be less accurate than in years past as more companies are using additional identifiers and not relaying exclusively on social security numbers, and (2) the Social Security Administration has a process to verify the accuracy of data and this process can occur over a period of a number of years. Thus, a higher percentage of deaths recorded in more recent years may still require final verification to ensure that all data recorded is correct (e.g. date of birth and name). We know this because in certain cases, the date that the assessment was performed came after the recorded death date. Thus, we are certain the match is not accurate. To ensure our results were not influenced by data integrity issues, we conducted sensitivity analyses based on different approaches to dealing with the cases that had incomplete linkage issues. In broad terms, we did the following:

1. For DWR data, we:
    a. Excluded from the analysis the cases that had incomplete linkage data; and
    b. Conducted an analysis of the DWR data up through 2002 and excluded all data in subsequent years to determine whether results varied. This minimized the number of cases with uncertain status.

2. For EMST data, we:
    a. Excluded cases with incomplete linkages from the data analysis;
    b. Recoded all cases with incomplete linkage status as “Alive” to determine whether and how this influenced the statistical significance of variables; and
    c. Recoded all cases with incomplete linkage status as “Dead” to determine whether and how this influenced the statistical significance of variables.

The primary analysis excludes cases with incomplete data linkages, and we discuss whether and if the results change when we conduct the sensitivity analyses.

Analytic Methods

A. Uncovering the Independent Impact of Cognitive Classification on Mortality

We employed a number of analytic techniques including descriptive statistics and Survival Analysis, to examine and model the time it takes for death to occur and the relationship with cognitive classification results. The analysis focuses on the distribution of survival times by specific characteristics. A nearly universal feature of survival data is censoring, and the most common form is right-censoring. Because our data is right censored and we are interested in estimating the effects of covariates such as age, gender and cognitive classification on the survival time, we use the Cox Proportional Hazards Model, which is a broadly applicable and the most widely used method of survival analysis. The proportional hazards model assumes that the time to death and the covariates are related through the following equation:

$$h_i(t) = h_0(t)\,e^{(\beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_k x_{ik})}$$

Where $h_i(t)$ is the hazard for the i^{th} case at time t, $h_0(t)$ is the baseline hazard at time t, k is the number of covariates, β_j is the value of the j^{th} regression coefficient, and x_{ij} is the value of the i^{th} case of the j^{th} covariate.

This model makes no assumption on the baseline hazard, which can take any form. The shape of the hazard function over time is defined by the baseline hazard for all cases. The covariates simply help to determine the overall magnitude of the function. This model has two assumptions. One is the proportional hazards assumption, the hazard ratio for any two observations at any time period is the ratio of their covariate effects. Consider two observations i and j that differ in their covariates, with the corresponding linear predictors $\eta_i = \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_k x_{ik}$ and $\eta_j = \beta_1 x_{j1} + \beta_2 x_{j2} + \cdots + \beta_k x_{jk}$. The hazard ratio for those two observations is: $\frac{h_i(t)}{h_j(t)} = \frac{h_0(t)e^{\eta_i}}{h_0(t)e^{\eta_j}} = \frac{e^{\eta_i}}{e^{\eta_j}}$, which is independent of time t. The other assumption is that there is a log-linear relationship between covariates and the underlying hazard function.

According to the information we captured in the data, we can define the model as follows:

$$h_i(t) = h_0(t)\exp(\beta_1 DWR_{i1} + \beta_2 Sex_{i2} + \beta_3 Age_{i3} + \beta_4 Age_{i4})$$

Where t is the survival time measured in months and DWR indicates whether the individual has passed the test by using different cut-off points. The value of $\exp(\beta_1)$ for DWR means that the death hazard for an individual who has passed the test is $\exp(\beta_1)$ times that for the person who failed the test, with all other things being equal.

We analyzed the data in Stata, which provides several ways to check the model and use the estimated coefficients to fit the baseline hazard function. Of course, the hazard function relates to mortality. As mentioned, in addition to applying the Cox Proportional Hazard Models, we also completed descriptive analyses. Chi-square tests were used to examine the correlation between mortality rate and classification by the DWR or EMST cognitive screens.

B. Assessing Classification Impacts in Terms of Relative Mortality Ratios

To assess the impact of cognitive classification on mortality across various age and gender groups, we calculated actual-to-expected mortality ratios for each group and these ratios were then standardized to enable cross-group comparisons. We used the 2001 Commissioners Standard Ordinary (CSO) composite table as a way to standardize mortality ratios. The age, gender and duration-specific 2001 CSO mortality rates were applied to the exposure counts to obtain an expected number of deaths in each of the samples. This "expected" number for each sample was then compared to the actual number of deaths to generate a sample-specific actual-to-expected ratio. Relative mortality ratios were derived by dividing the actual-to-expected ratios for specific age and gender categories by the underlying aggregate actual-to-expected sample ratio. We found, for example, that for the DWR sample, the actual-to-expected mortality ratio was 100 percent, whereas for the EMST sample, the ratio was 69 percent.[1] These represent the denominators in subsequent analyses of relative mortality ratios.

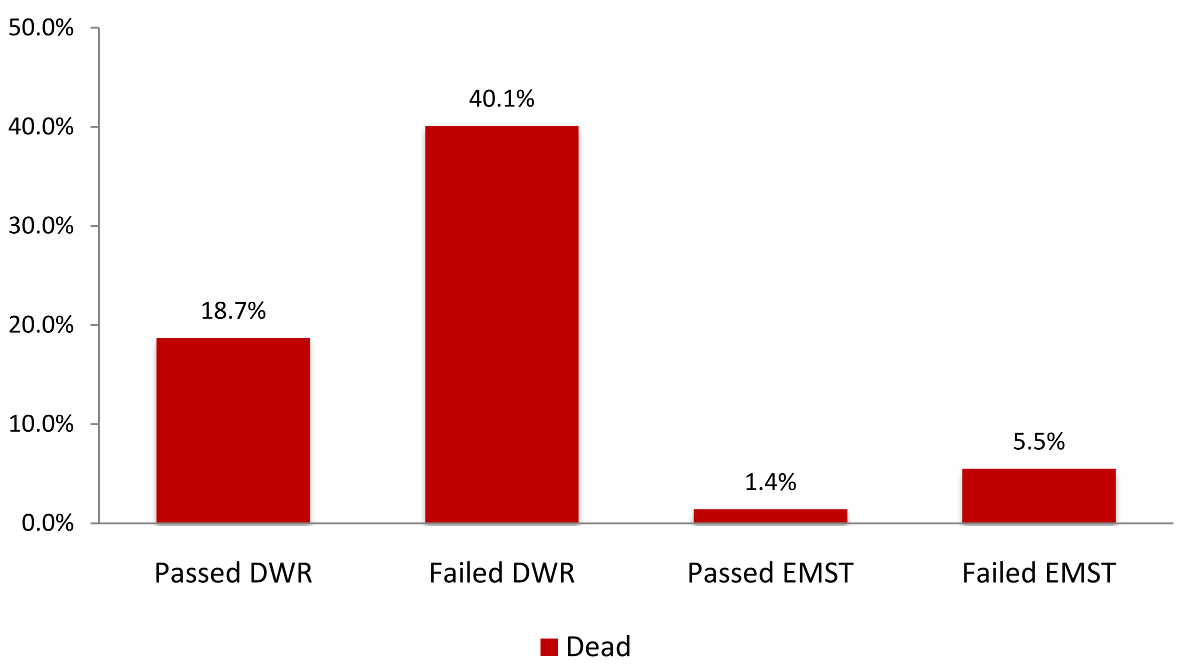
[1] This method was described in Hauser, P., "The Minnesota Cognitive Acuity Screen—Valuable Predictor of Mortality." *On the Risk* 26, no. 1 (2010).

Results and Discussion

Classification Results

We present findings for applicants who completed the DWR as well as for those who completed the EMST. Someone is classified as cognitively impaired by the DWR if they are shown to be unable to recall at least five words on a 10-word recall list, which they have practiced in sentences two times prior to the recall exercise. The EMST has an underlying algorithm based on Correspondence Analysis that classifies people as “passing” or “failing” the test. Figure 1 shows the mortality status of individuals passing and failing each test.

Figure 1
Classification Results for Deaths During the Study Period by Test Type

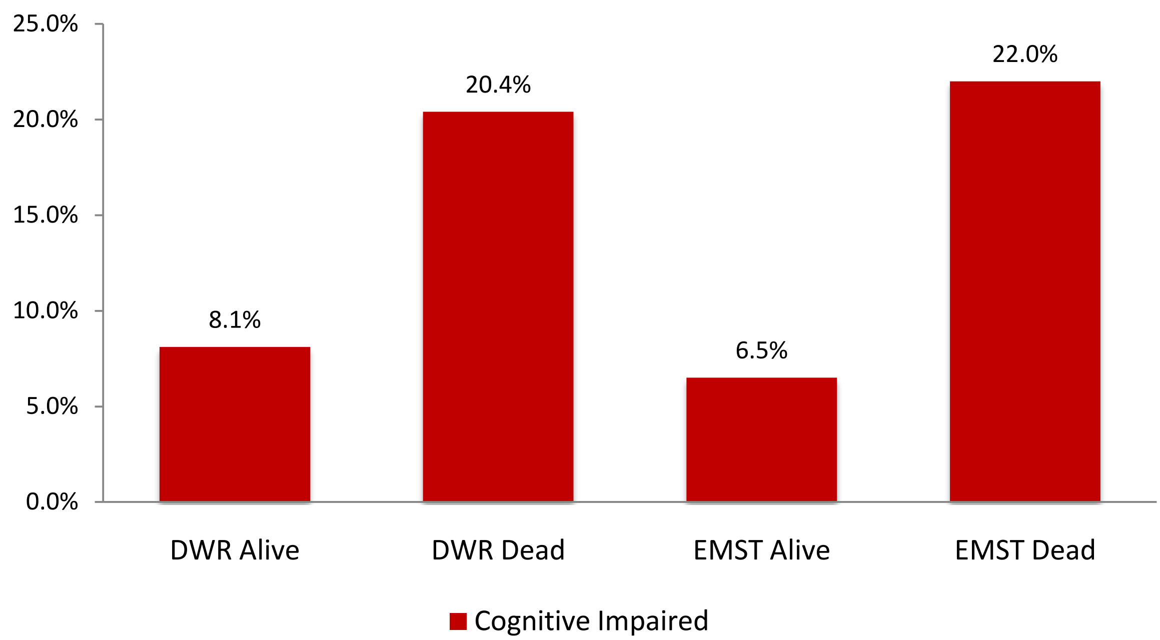


Note: Cases with incomplete data linkages are excluded from analysis. Differences are significant at the .001 level.

As shown, across both screens, the proportion of individuals classified as cognitively impaired have higher relative mortality compared to those classified as cognitively intact. The figures are relatively small for the EMST because we only have roughly six years of experience and the average age is so much lower. Even so, results based on both screens suggests there is more than twice the chance an individual classified as cognitively impaired will die before the end of the study period than will individuals classified as cognitively intact. These differences are statistically significant at the .001 level across a variety of measures of correlation including the Pearson Chi-Square, Fisher's Exact Test and the Linear-by-Linear Association test.

Another way to view the data is to focus on cognitive classification results among those who remain alive and those who have died. Figure 2 shows that among individuals who died during the study period, between 20 and 22 percent had been classified as cognitively impaired. In contrast, among those who were still alive, between 7 and 9 percent had been classified as cognitively impaired, depending on the particular screen use. These differences are statistically significant. This again highlights the positive relationship between mortality status and cognitive classification.

Figure 2
Mortality Status Among Those Classified as Cognitively Impaired by Test Type



Note: Cases with incomplete data linkages are excluded from analysis. Differences are significant at the .001 level.

Sensitivity Analysis: Univariate Analysis

The analyses presented in figures 1 and 2 exclude cases with incomplete data linkages, that is, cases where either the name or birth date of the individual do not match between the assessment and the Master Death File. For the DWR data, when we constrained the analysis to cases assessed up until 2002, the results did not change; that is to say, there was a statistically significant difference in mortality rates between individuals classified as cognitively impaired and those classified as cognitively intact, although the figure changes somewhat—37 percent of people classified as cognitively impaired die compared to 31 percent when the entire sample is used. The basic finding of the relationship between classification status and subsequent mortality does not change.

For the EMST, when individuals with incomplete linkages are included in the analysis and are classified as “alive,” results are similar to when these individuals are excluded from the analysis: Individuals classified as impaired have a statistically significant higher rate of mortality than those classified as cognitively intact. Even when all of these incomplete-linkage cases are coded as “dead,” the relationship still holds. Thus, the exclusion of those cases with incomplete linkages does not affect the basic finding that individuals who fail either tests are more likely to die than individuals who pass them.

While the univariate analysis does suggest a strong correlation between cognitive impairment classification and subsequent mortality, we have not yet taken into account any age or gender differences. It may be the case that those who are cognitively impaired are also older and thus it would be difficult to untangle the impact of age on mortality from the impact of cognitive status. To address this issue, we employ the Cox Proportional Hazards Model, which enables us to evaluate the independent effect of specific variables on the probability of surviving and also develop Survival and Death Hazard functions. The results of the analysis are presented next.

The dependent variable is the survival time through the end of the observation period, which is March 31, 2010, for individuals who were still alive and the death date for those who died during the period. The DWR analysis is based on 761,972 individuals of whom 21 percent (160,255) died during the study period.

TABLE 4
Cox Proportional Hazards Results for DWR Cognitive Screen

	Coefficient	Standard Error	Degrees of Freedom	Significance	Odds Ratio
Cognitively Intact as measured by the DWR	-.534	.006	1	.000	.586
Age	.109	.000	1	.000	1.115
Female	-.385	.005	1	.000	.680
Have an ADL limitation	.518	.010	1	.000	1.679

Note: The Cox Regression excludes those with incomplete data linkages.

What these results show is that age, gender and whether one is assessed to be cognitively intact or impaired are all related to the probability of dying. When age, gender and ADL status are held constant, individuals who pass the DWR, that is, recall at least five words, are less likely to die than are those who recall fewer words. In fact, someone who "passes" the DWR has only .59 times the death hazard as someone who fails the test. That is, they are far less likely to die than individuals who have failed the test. Put another way, holding age and gender constant, an applicant classified as cognitively impaired has a death hazard 1.69 times greater than someone who is cognitively intact. Similarly, the death hazard is increased by roughly 12 percent for each additional year of age and the death hazard is 32 percent lower for females than for males. Also having at least one ADL limitation increases the death hazard by 68 percent compared to someone without ADL limitations.

The graphs that follow show the survival function and the hazard function for those classified as cognitively impaired or cognitively intact by the DWR. As shown, those who are cognitively impaired (as measured by their DWR score) have a lower survival curve, hence greater mortality hazard.

Figure 3
Survival Function for DWR Classification

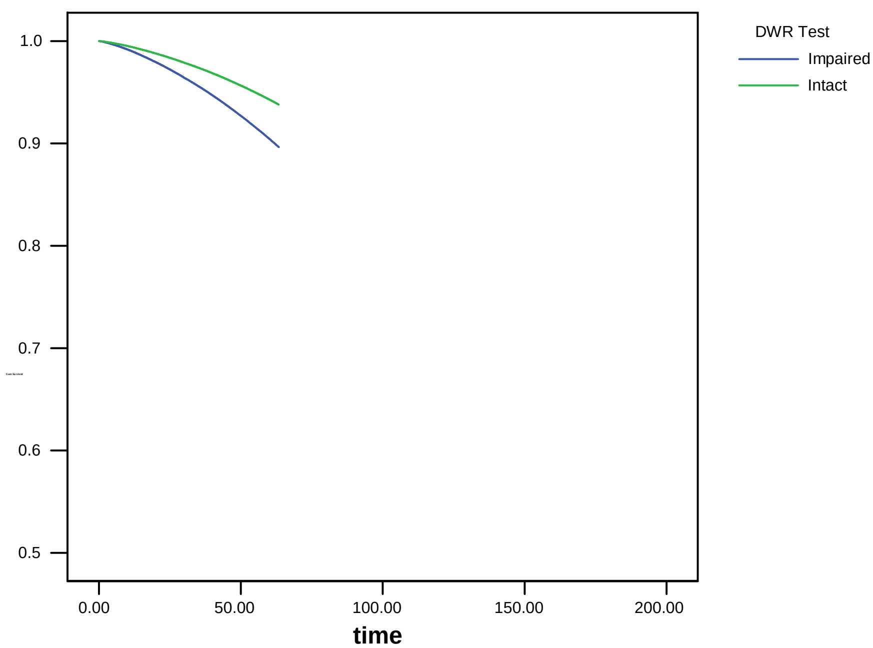
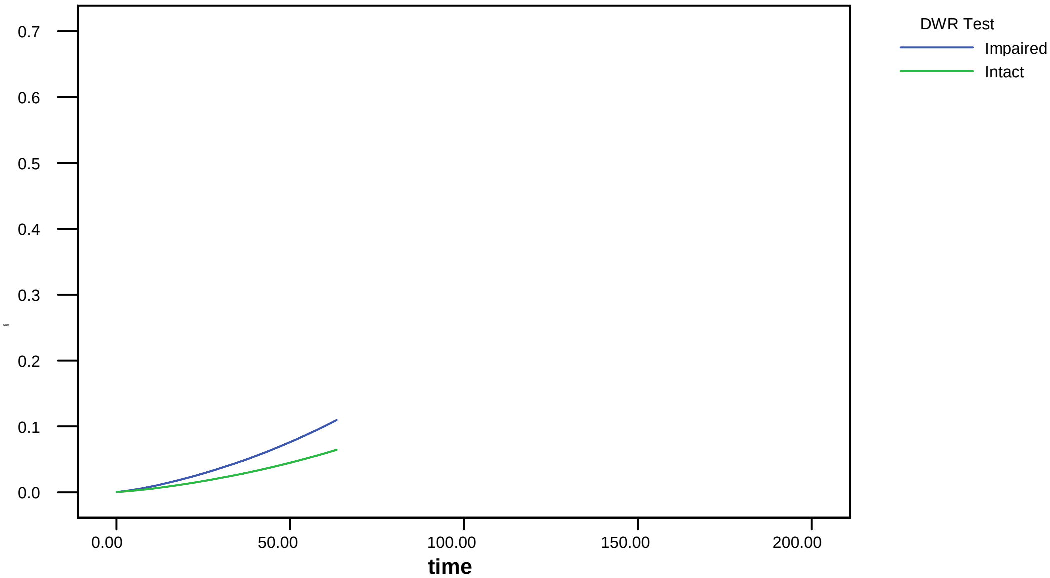


Figure 4
Hazard Function for DWR Classification



As mentioned, use of the EMST as a screening tool was first employed in the long-term care insurance market in 2004. Thus, at most there is up to six years of exposure data on which to analyze survival times. The analysis of EMST results is based on 132,719 individuals of whom roughly 2 percent (2,263) has died during the study period.

TABLE 5
Cox Proportional Hazards Results for EMST Cognitive Screen

	Coefficient	Standard Error	Degrees of Freedom	Significance	Odds Ratio
Cognitively Intact as measured by the EMST	-.411	.054	1	.000	.663
Age	.102	.002	1	.000	1.108
Female	-.447	.043	1	.000	.640

The results of the analysis of the EMST are similar to that found with the DWR, even though there are far fewer observations and less total exposure. Moreover, the EMST is a far more sensitive tool in uncovering mild cognitive impairment among applicants; this means that the analysis based on the EMST can more firmly establish the relationship between being classified as having mild cognitive impairment and being at significantly greater mortality risk.

Again, these results show that age, gender and whether one is assessed to be cognitively intact by the EMST are all related to the probability of dying. Other variables held constant, individuals who pass the EMST or are classified as "normal" are less likely to die than are those who fail the test. In fact, someone who "passes" the EMST has only .66 times the death hazard as someone who fails the test. Holding age and gender constant, an applicant classified as cognitively impaired has a death hazard that is 1.52 times greater than someone who is cognitively intact. Similarly, the death hazard is increased by roughly 11 percent for each additional year of age and the death hazard for females is 36 percent that of males. The graphs that follow show the survival function and the hazard function for those classified as cognitively impaired by the EMST.

Figure 5
Survival Function for EMST Classification

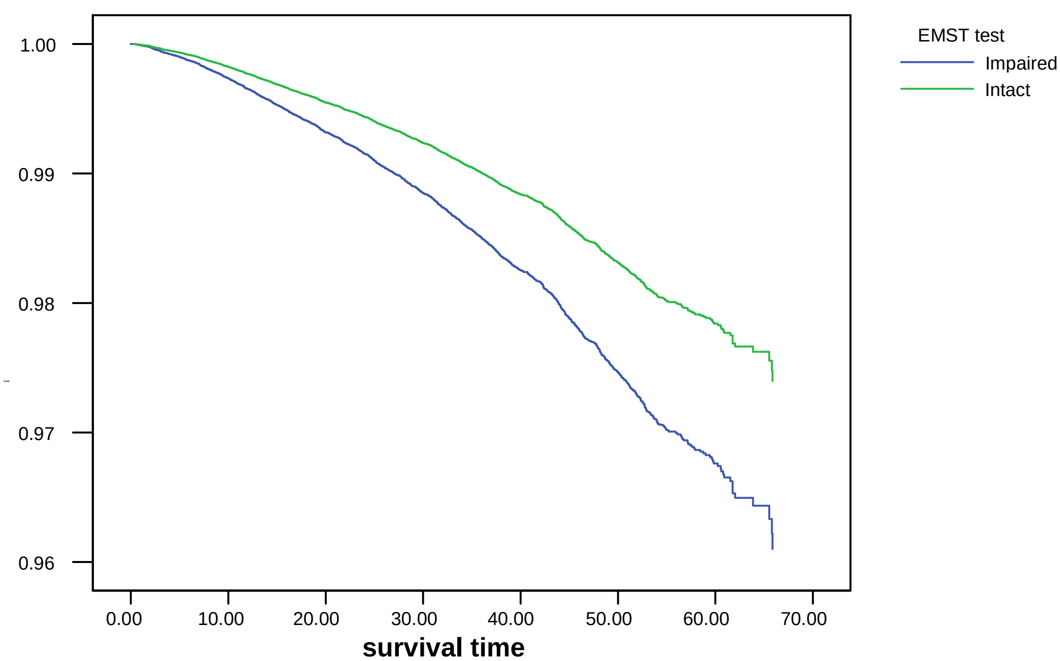
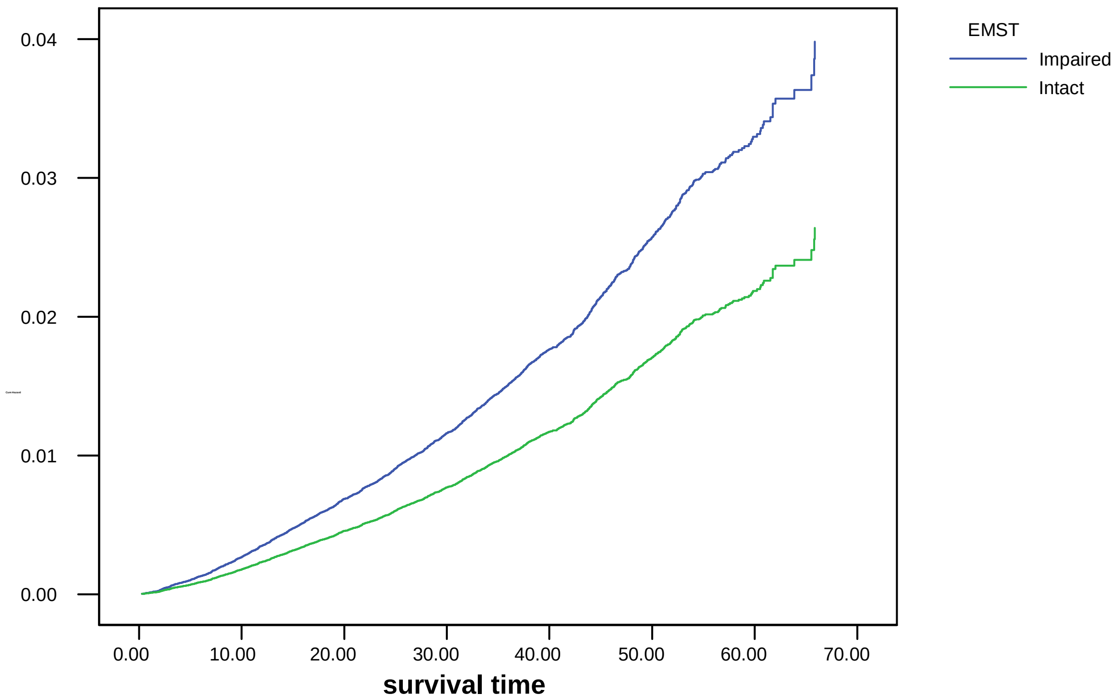


Figure 6
Hazard Function for EMST Classification



Sensitivity Analysis: Multivariate Analysis

We also fit a Cox Proportional Hazards Model to the DWR data based on assessments completed through 2002 (to maximize completed linked data). As shown, there is very little difference in the results.

TABLE 6
Cox Proportional Hazards Results for Alternative DWR Samples

	Complete Dataset			Data Through 2002		
	Coefficient	Standard Error	Odds Ratio	Coefficient	Standard Error	Odds Ratio
Cognitively Intact as Measured by the DWR	-.534	.006	.586	-.529	.007	.589
Age	.109	.000	1.115	.108	.000	1.114
Female	-.385	.005	.680	-.378	.005	.685
Have an ADL Limitation	.518	.010	1.679	.506	.011	1.659

In Table 7 below, we present results for the EMST under each of three modeled scenarios, including:

Scenario 1: Excluding cases with incomplete linkages;

Scenario 2: Recoding all of the cases with incomplete linkage status as "Alive"; and

Scenario 3: Recoding all of the cases with incomplete linkage status as "Dead" and computing their survival time as 50 percent of the difference between the assessment date and March 31, 2010, the censoring date.

TABLE 7
Cox Proportional Hazards Model for Sensitivity Modeling of EMST Sample

	Scenario 1		Scenario 2		Scenario 3	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Cognitively Intact as measured by the EMST	-.411	.663	-.411	.663	-.432	.649
Age	.102	1.108	.102	1.10 8	.080	1.083
Female	-.447	.640	-.447	.640	-.387	.679

*** All variables across all scenarios are statistically significant. Note: The results of Scenario 1 are the same as the results of Scenario 2 because the number of incomplete linkage is small and only accounts for less than 0.3 percent of the total alive; thus, there were no noticeable changes in the outputs.

As shown, across all scenarios, although the relative impact of variables changes, individuals classified as cognitively intact are less likely to die over the study period than are individuals classified by the EMST as cognitively impaired.

Relative Mortality Ratio Results

In Table 8 below, we present the relative mortality ratio analysis for each of the two cognitive tests. Again, relative mortality ratios for subgroups were derived by dividing the actual-to-expected ratios for specific age and gender categories by the underlying aggregate actual-to-expected sample ratio based on the 2001 CSO Composite table. This allows the ratios to be standardized so that comparisons across groups can be made.

TABLE 8
Relative Mortality Ratios by Age, Gender, Test Sample and Classification Result

Classification	Grand Total EMST	Male Total EMST	Female Total EMST	Female < 65 EMST	Female 65-69 EMST	Female 70+ EMST	Male < 65 EMST	Male 65-69 EMST	Male 70+ EMST
Cognitively Impaired	202%	161%	236%	209%	312%	232%	121%	187%	199%
Cognitively Intact	98%	101%	97%	87%	97%	112%	95%	100%	108%
	Grand Total DWR	**Male Total DWR**	**Female Total DWR**	**Female < 65 DWR**	**Female 65-69 DWR**	**Female 70+ DWR**	**Male < 65 DWR**	**Male 65-69 DWR**	**Male 70+ DWR**
Cognitively Impaired	178%	163%	190%	107%	150%	231%	108%	136%	191%
Cognitively Intact	91%	93%	89%	59%	93%	102%	70%	93%	103%

There are a number of important findings. First, the results show that across all age and gender groups, higher relative mortality ratios are found among individuals classified as cognitively impaired compared to those classified as cognitively intact. This is true for both of the cognitive tests analyzed. However, on an age and gender-adjusted basis, individuals identified by the EMST as cognitively impaired have higher relative mortality ratios than those identified by the DWR. This likely reflects the fact that the EMST is far more sensitive in identifying individuals with mild cognitive impairment so that a more accurate classification occurs. Second, for the most part, differences in relative mortality ratios are greater for females than for males. Third, although not uniform across all age categories, the results suggest that as the average age of the applicant increases, the differential in relative mortality ratios increases. The implication is that at older ages, identifying an individual with cognitive impairment has a more immediate impact on mortality than at younger ages.

Study Limitations

We collected this data through the underwriting process working with applicants for several LTC insurance policies. Each LTC insurance company has variable data it collects and this was difficult to standardize. Along with age, sex and functional status, many additional risk factors are known to affect mortality. These include marital status, education level, social class, self-reported health and accommodation type. The current study was unable to take these additional variables into account in the multivariate analysis due to the nature of data collection. We acknowledge these findings would be stronger with more variables included in the analysis. Also, because of the nature of risk-assessment as required for insurance underwriting, those who had more severe levels of cognitive impairment were excluded from the study. While this is necessary for the LTC insurance industry, the generalizeability of our findings to the general aging public is impeded by the preselection process that excludes a more representative aging population.

Finally, our study is not able to make a decisive conclusion about the degree of cognitive impairment present in our population. The majority of our population was assessed using the DWR. The scoring for the DWR has a cut-off that identifies an individual as cognitively intact if five or more words are recalled. If one recalls anywhere from zero to four words, he or she is classified as cognitively impaired. However, there is no method of differentiating the level of cognitive impairment present if one recalls only zero or one words versus four words. This limits the DWR’s ability to identify mild cognitive impairment from a more moderate form of dementia. Even with far more limited data points, results from the EMST, which focuses on detecting MCI, were fairly definitive in highlighting the relationship between MCI and mortality.

Conclusions

Cognitive changes are a component of the aging process and health care expenditures continue to increase for the elderly, especially toward the end of life. Recognition of these increased costs can have an effect on cost planning for individuals and their families, for public plans that fund care and for cost planning in the insurance industry. We considered the relationship between the presence of cognitive impairment and mortality rates, while taking gender, age and, for a subset, ADL status, into consideration. This analysis demonstrates a clear relationship between the classification status of an individual as being cognitively impaired or cognitively intact and mortality rates. Across both cognitive screens, individuals classified as cognitively impaired have lower survival times (or higher hazard rates) than do individuals who are cognitively intact. This is true even after controlling for age and gender and, in the case of the DWR, ADL status as well. The analysis of relative mortality ratios supports these findings. Moreover, tests like the EMST that can detect with a high degree of accuracy the very earliest stages of cognitive decline, are particularly useful in predicting mortality. The analysis suggests that if one is interested in estimating mortality among older individuals, either for the purposes of public policy planning or for risk management in the private insurance market, cognitive screening is a powerful way to do this.

Endnotes

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[xiv] Closely related to the DWR is the Minnesota Cognitive Acuity Screen (MCAS), a proprietary tool used exclusively in the long-term care insurance context; the foundation for the MCAS is the DWR, which comprises one of the test components. A recently published analysis showed that individuals classified as cognitively impaired by the MCAS had higher mortality rates than those classified as normal (P. Hauser, “The Minnesota Cognitive Acuity Screen: Valuable Predictor of Mortality,” *On the Risk* 26, no. 1 [2010]). The validation study for the test demonstrates its ability to identify those with mild to moderate dementia, rather than mild cognitive impairment (D.S. Knopman, D. Knudson, M.E. Yoes, and D.J. Weiss, “Development and Standardization of a new Telephonic Cognitive Screening Test: The Minnesota Cognitive Acuity Screen (MCAS),” *Neuropsychiatry, Neurophysical, and Behavioral Neurology* 13 (2000): 286-94.

[xv] L. Vecchione and E. Golus, “Mortality Risk Assessment in the Elderly: The Utility of Delayed Word Recall,” *Journal of Insurance Medicine* 38 (2006): 111-15.

[xvi] William R. Shankle, A. Kimball Romney, Junko Hara, Dennis Fortier, Malcom B. Dick, James M. Chen, Timothy Chan, and Xijiang Sun, “Methods to Improve the Detection of Mild Cognitive Impairment,” *Proceedings of the National Academy of Sciences* 102, no. 13 (March 29, 2005): 4919-24. Note that the test is called the EMST in the insurance market, but, in non-insurance settings, it is referred to as the MCI screen.