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

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Editor's Note: *This article is based on a full paper scheduled to be published as part of the 2011 Living to 100 and Beyond monograph by the Society of Actuaries later in 2011.*

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 age 65 and over 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.[1,2,3,4,5,6,7,8] 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.

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:

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- 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 sub-set of Long-Term Care Insurance (LTCI) applicants, we will also analyze whether there is a relationship between having limitations in activities of daily living (ADLs) and subsequent mortality rates.

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[9] and there are about 8 million policies in force. Over the past two decades, LifePlans has 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. 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.[10] 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 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, this test, which is called the Enhanced Mental Skills Test (EMST), has been in use since 2004. It identifies those having Mild Cognitive Impairment (MCI).[11]

Our research relies on in-person and telephonic underwriting assessment data which were collected 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 linked to the latest Social Security Administration's Death Master File, which enabled us to determine who, during this roughly 14-year time period, died and their date of death. Given that the vast majority of the sample is comprised of individuals age 65 and over, a significant number of deaths have occurred over the period (See Table 1 on page 6). Total deaths in the sample were 162,518, almost all from older DWR data. The data set has over 5.8 million exposure years of experience for the DWR sample and roughly 376,000 exposure years of experience for the EMST sample.

ANALYTIC METHODS

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. 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 broadly applicable and is the most widely used method of survival analysis.

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. 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.[12] These represent the denominators in subsequent analyses of relative mortality ratios.

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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 age 65	27%	48%
Age 65-74	29%	36%
Age 75-79	28%	11%
Age 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%

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RESULTS

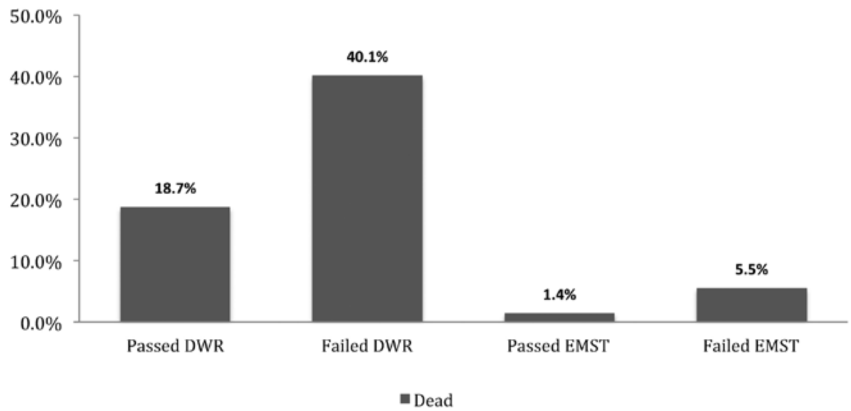
We present findings for applicants who completed the DWR as well as for those who completed the EMST. Someone is classified as cognitively impaired by the DWR if they are shown to be unable to recall at least five words on a 10-word recall list, which they have practiced in sentences two times prior 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 or failing each test.

As shown and without accounting for differences in age and gender, the proportion of individuals who were classified as cognitively impaired using both DWR and EMST have higher relative mortality compared to those who are 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. The implication is that the correlation between classification result and subsequent mortality is statistically significant at the 99 percent confident level, which means that there is a less than 1 percent chance that the observed results are due to chance.

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 percent and 22 percent of them had been classified as cognitively impaired. In contrast, among those who were still alive, between 7 percent and 9 percent had been classified as cognitively impaired, depending on the particular screen use. These differences are statistically significant as indicated previously for Figure 1. This highlights the positive relationship between mortality status and cognitive classification.

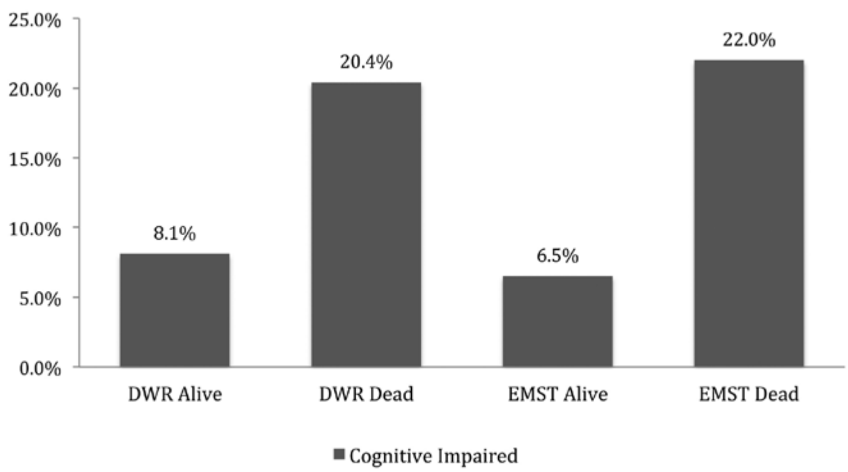
While the univariate analysis does suggest a strong correlation between cognitive impairment classification and subsequent mortality, we have not yet taken into account any age or gender differences. It may be the case that those who are cognitively impaired are also older and thus it would be difficult 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.

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



Note: Differences are significant at the .001 level.

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



Note: Differences are significant at the .001 level.

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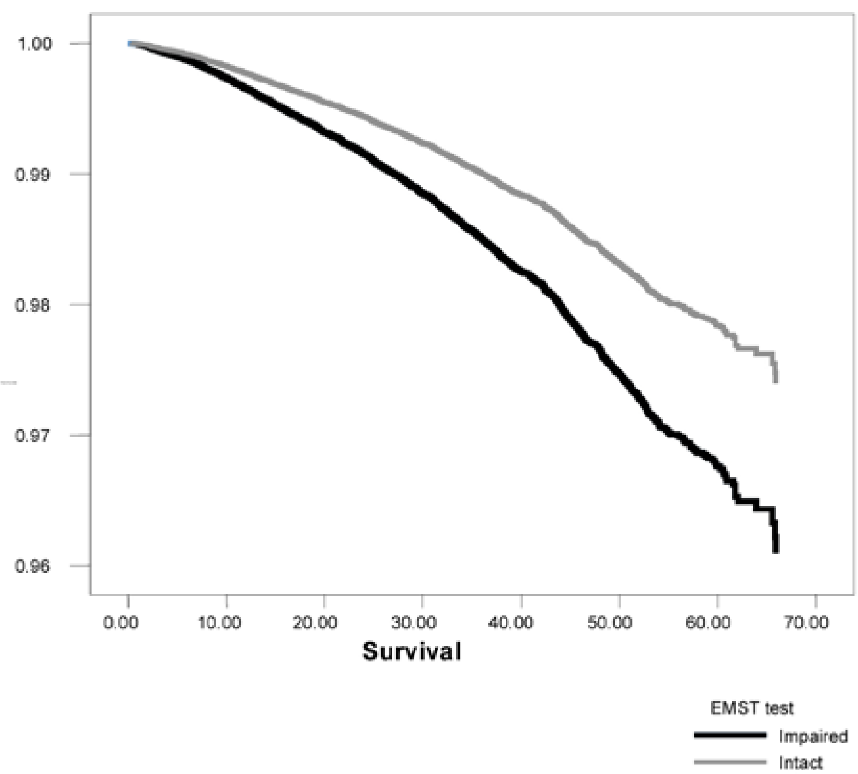
Table 2: Cox Proportional Hazards Results for DWR and EMST Cognitive Screen

	DWR Results			EMST Results		
	B	Sig.	Exp(B)	B	Sig.	Exp(B)
Cognitively Intact as measured by Screen	-.534	.000	.586	-.411	.000	.663
Age	.109	.000	1.115	.102	.000	1.108
Female	-.385	.000	.680	-.447	.000	.640
Have an ADL limitation	.518	.000	1.679	N.A.	N.A.	N.A.

Figure 3: Survival Function Patterns for EMST Classification Results



The dependent variable in this analysis 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 results in Table 2 show that age, gender, and whether one is assessed to be cognitively intact or impaired are all related to the probability of dying. Other variables held constant, individuals who pass the EMST, that is, 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 about 36 percent smaller than that of males.

When age, gender and ADL status are held constant, 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. Figure 3 shows the survival function for those who are classified as cognitively impaired or cognitively intact by the EMST. As shown, those who are classified as cognitively impaired have a lower survival curve, hence greater mortality hazard. Because the EMST is a far more sensitive tool in uncovering mild cognitive impairment among applicants than is DWR, 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.

RELATIVE MORTALITY RATIO RESULTS

In Table 3 on page 9 we present the relative mortality ratio analysis for each of the two cognitive tests. Again, relative mortality ratios for sub-groups 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 Commissioners Standard Ordinary (CSO) Composite table. This allows the ratios to be standardized so that comparisons across groups can be made.

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.

Table 3: 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%

CONCLUSIONS

Cognitive changes are a component of the aging process and understanding how they influence both morbidity and mortality are important, especially toward the end of life. Cognitive changes 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. 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 for long-term care as well as life insurance policies.

Marc A. Cohen, Ph.D., was a presenter at the 2011 Living to 100 fourth triennial symposium that drew attendees from 17 countries, nearly 50 participating organizations/sponsors and speakers from all over the world. About 35 papers were presented at the symposium and will be included in an online monograph expected to be completed later in 2011. More information on this research effort can be found at http://livingto100.soa.org/default.aspx.

Co-authors on the original paper are Xiaomei Shi and Jessica S. Miller. ■

ENDNOTES

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10 Mortality Risk Assessment in the Elderly: The Utility of Delayed Word Recall, *Journal of Insurance Medicine*, 2006; 38:111-115.

11 Methods to Improve the Detection of Mild Cognitive Impairment. William R. Shankle, A. Kimball Romney, Junko Hara, Dennis Fortier, Malcom B. Dick, James M. Chen, Timothy Chan, Xijiang Sun, PNAS, March 29, 2005. Volume 102, Number 13, p. 4949-4214. 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.

12 This method was described in Hauser, P. The Minnesota Cognitive Acuity Screen–Valuable Predictor of Mortality. On the Risk. Volume 26, Number 1, 2010.