Driving Status and Risk of Entry Into Long-Term Care in Older Adults

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Objectives. Given the importance of driving in American society, older nondrivers may be unable to meet basic needs while living independently. We assessed whether not driving is an independent risk factor for entering long-term care (LTC) institutions.

Methods. Data were used from 1593 older adults who participated in the Salisbury Eye Evaluation cohort study and completed an additional telephone survey. Questions on driving status and LTC entry were obtained by self/proxy report. Cox time-dependent regression procedures were used to adjust for demographic and health factors.

Results. Former and never drivers had higher hazards of LTC entry after adjustment for demographic and health variables (hazard ratio [HR] = 4.85; 95% confidence interval [CI] = 3.26, 7.21; and HR = 3.53; 95% CI = 1.89, 6.58, respectively). Also, having no other drivers in the house was an independent risk factor for LTC entry (HR = 1.72; 95% CI = 1.15, 2.57).

Discussion. Older adults are expected to make good decisions about when to stop driving, but the hardships imposed on older adults by not driving are not widely recognized. Innovative strategies to improve transportation options for older adults should be considered. (*Am J Public Health.* 2006;96:1254–1259. doi:10.2105/AJPH.2005.069146)

Many older adults are faced with the difficult decision of when they should no longer drive a car after experiencing functional decline. A large percentage of adults continue to drive well past the age of 70 years. In 1 study, 82% of men and 55% of women aged 70 years and older who lived in the community still drove.[1] Given this great dependence on the car for mobility, it is important to understand what happens to older people who find it necessary to give up driving or who have relied all of their lives on someone else who is no longer able to drive.

Ideally, the public transportation system, including buses, railways, and shuttles, could provide an alternative to driving for older adults. However, an estimated 40% of older adults in rural areas have no access to public transportation services and another 25% have negligible access.[2] Two national studies estimate that older people use public transportation for only 2% to 3% of their trips.[3,4] Many elderly people instead rely on informal transportation support from friends and family[5] but at the same time may feel concerned about being a burden to others and thus, limit their activities.

Certain subgroups of older adults may be more susceptible to transportation problems after giving up driving. For example, one study of older people with dementia who had recently given up driving found that those who were unmarried or with no other licensed drivers in the household were more likely to report transportation problems.[5] Other populations who may be more susceptible to problems are those in rural areas, where there may be little or no public transportation.

Some older adults may have no other choice but to enter long-term care (LTC) institutions because of transportation problems, despite being otherwise able to function independently inside the home. Entry into LTC is extremely expensive, as the average annual cost for nursing home admission is now $69 000 and the average annual cost of assisted living entry is $30 000.[6]

Some studies have examined the consequences of driving cessation and have found them to include increased levels of depression[7,8] and decreased out-of-home activity levels.[9] Whether driving status increases a person's risk of LTC entry is unknown, although such factors as "needing aid to get around"[10] and "getting out" less than daily,[11] which may include not driving, have been associated with nursing home entry in previous studies.

The purpose of this study was to assess whether not driving was an independent risk factor for entering LTC in a small city on the eastern shore of Maryland. To accomplish this aim, we utilized data from the Salisbury Eye Evaluation (SEE) project, a prospective population-based cohort study collecting data over 8 years.[12]

METHODS

Study Population

The SEE project consisted of a random sample of 2520 older adults living in Salisbury, Maryland, in 1993.[12] The original purpose of the study was to evaluate how vision affected functional status in older adults.[13–15] The sample was selected from the Health Care Financing Administration Medicare database. Individuals were eligible for enrollment if their age was between 65 and 84 years, they resided near Salisbury, they were not in a nursing home, they had the ability to communicate, and they scored greater than 17 on the Mini-Mental State Examination. Of 3906 eligible persons, 2520 completed both the home questionnaire and the medical examination (65% response rate).

Baseline data (round 1) were collected between 1993 and 1995. Follow-up data were collected at 2 years (round 2), 6 years (round 3), and 8 years (round 4) after baseline.

Questionnaire and Clinic Examination

Interviewer-administered questionnaires collected data from participants at each of the 4 rounds. They asked questions on demographic information, medical history, and driving history. At each round, proxies were identified who could be contacted for information about the participant. Questions on driving history asked about having ever driven, miles driven in the past year, and having stopped driving. Participants were asked if a physician had ever told them that they had any of 15 possible medical conditions like diabetes, high blood pressure, cancer, arthritis, or fracture. They were also asked if they needed help with such care needs as eating, bathing, dressing, or getting around the home. Cognitive status was measured with the Mini-Mental State Examination, in which higher scores indicate better cognition.[16] Depressive symptoms were assessed with the General Health Questionnaire part D.[17]

An additional questionnaire was administered by telephone in the summer of 2003 to improve data on driving and entry into LTC. Participants or their proxies were asked the month and year that driving had stopped and how many other people who lived with the participant were able to drive a car at the times of each of the 4 rounds. Participants were also asked if they had entered LTC, if the duration had been more than 3 months, and the type of LTC facility. We were not able to obtain data on noninstitutional LTC services. Subject–proxy agreement was found to be very good for the questions on other drivers in the house at each of 4 rounds ($\kappa \geq 0.8$), date of driving cessation (Pearson $r=0.9$), and date of LTC entry (Pearson $r=0.9$) in a subsample of 39 individuals and their designated proxies.

Definitions

The date of driving cessation was obtained in the following way: the participant or proxy was asked in 2003 if he/she/participant had driven in the last 6 months (or the last 6 months before death). If not, the month and year of the last time the participant drove were used as the date of driving cessation. If participants had driven in the last 6 months (or 6 months before death), they were coded as drivers for the entire follow-up.

LTC was defined as entry for more than 3 months into a nursing home, assisted living facility, or retirement home that offered meals or transportation services. A nursing home was defined as an institution offering skilled nursing services, an assisted living facility as a building with connected units in which meals and unskilled nursing services were offered, and a retirement home as independent, unconnected units in which meals or transportation services were offered. If a person lived in a retirement home without meals or transportation services, the person was not considered to be in LTC for the purposes of this analysis. The 3-month time requirement was intended to filter out individuals who only entered an institution for recuperation from an acute event or someone who entered for hospice care. Thus, if someone entered LTC for 3 months or less, the person was not considered to have entered LTC for these analyses.

Depressive symptoms were defined as a report of 1 or more affirmative responses, using binary scoring, out of 7 questions on part D of the General Health Questionnaire.

Statistical Analysis

Those we were unable to contact for the summer 2003 survey were compared with those we were able to contact. Age-adjusted logistic regression was used to determine if any differences between the 2 groups that differed in contact status were due solely to age. Next, baseline characteristics were compared by driving status (never, former, and current drivers) and by LTC entry status (no entry, entry into nursing home, entry into assisted living or retirement home). Age-adjusted polychotomous logistic regression was used to determine if any differences between the 3 groups were solely because of age.

The crude risk of ever entering a LTC facility was calculated by comparing the cumulative incidence of LTC entry among those at baseline who reported never, former, or current driving. We used Kaplan–Meier estimates and a Cox regression model to compare the impact of driving status on time until long-term care entry. Time zero was entry into the SEE study. Those who had not entered LTC by June 2003 were censored at that time or (if deceased) at their date of death. On the basis of several prospective cohort studies, the risk of nursing home entry is thought to be a function of demographic factors (like age and race), social factors (like marital status, size of social network), and health variables (like needing help with activities of daily living [ADLs], cognitive impairment, stroke).[10,11,18–22] Therefore, to try to isolate the relation of driving variables and LTC entry, we adjusted with Cox regression for potential confounders including age, gender, race, marital status, needing help with ADLs, cognitive functioning, number of comorbid conditions, and depressive symptoms. Variables that changed with time (driving status, marital status, ADL help, cognitive status, depressive symptoms, number of comorbid conditions, other drivers in the house) were entered into the model as time dependent by splitting the observation time for each individual into periods when the exposure values were constant. There were 11 individuals who stopped driving the same month and year as they entered LTC. To be conservative, these individuals were considered current drivers for their entire follow-up (their exposure was not changed).

Having no other drivers in the house was assessed as an independent risk factor as well as an effect modifier through stratification and the inclusion of an interaction term. Other variables that were evaluated for effect modification included needing ADL help, gender, cognitive impairment, age category, and race.

Secondary analyses were conducted to determine if the relation between driving status and LTC entry differed by type of LTC (nursing home compared with non–nursing home). Sensitivity analyses were done to determine if excluding those participants who may have been cognitively impaired (more than 3 errors on the Short Portable Mental Status Questionnaire[23]) at the time of the summer 2003 survey affected the results.

RESULTS

Of the 2520 SEE study participants, 14 were already in a LTC facility at baseline, whereas 5 had no baseline information on driving status and thus were excluded from this analysis. Therefore, of the 2501 eligible for LTC entry with baseline driving status

information, in 2003 we were able to contact and obtain telephone interviews from 1593 (64%) SEE participants or their proxies—69% from the participants themselves and 31% from proxies. The main reason for proxy response was death (85%), but other reasons for proxy response included hearing difficulties (5%), cognitive impairment (4%), participant's inaccessibility (4%), and physical inability (2%). There were 908 individuals who could not be contacted because of refusal (27%) or inability to locate them and establish contact (73%). Those we were unable to contact were older and more likely to be African American, be cognitively impaired, be depressed, have diabetes, have had a stroke, have more co-morbidities, and have been a nondriver than those we were able to contact (data not shown).

Of the 1593 individuals from whom we obtained interviews about LTC entry, at baseline 1347 (85%) were current drivers, 160 (10%) were former drivers, and 86 (5%) never drove (Table 1). The proportion of never drivers and former drivers at baseline who entered LTC was 17% and 13%, respectively, and the proportion of current drivers who entered was 8% (Table 1). Former drivers and those who never drove tended to be older and were more likely to be female, African American, cognitively impaired, and depressed than current drivers. In addition, former drivers were more likely to have a greater average number of co-morbidities and to have been more likely to need help with ADLs than current drivers (Table 1). Of the 1347 current drivers at baseline, 299 (22%) stopped driving during the study. The percentage of participants with no other drivers in the house increased in each round from 33% in round 1 to 47% by round 4. The percentage also differed by gender, as 58% of women had no other drivers in the house by round 4 compared with 29% of men.

There were 149 (9%) individuals who entered LTC for more than 3 months after baseline. Of these, 71 (48%) entered a nursing home, 42 (28%) an assisted living facility, and 36 (24%) an independent living community with meals or transportation services. Characteristics of those who entered LTC tended to differ by whether they entered a nursing home or not. Those who entered a nursing home were older, more likely to be cognitively impaired, and more likely to need ADL help than those who did not enter LTC (Table 2). Those who entered a non–nursing home type of LTC were also older, more likely to be female and White, less likely to be cognitively impaired, and less likely to have had other drivers in the house than those who did not enter LTC (Table 2).

In Figure 1, the Kaplan–Meier time-to-event curves are plotted by driving status at baseline. The curves that represent the former and never drivers show a shorter time to LTC entry compared with the current drivers (logrank test, $P<.001$).

In a time-dependent Cox regression model that adjusted for demographic and health variables, both former and never drivers had an increased risk of LTC entry compared with current drivers (hazard ratio [HR]=4.85, 95% confidence interval [CI]=3.26, 7.21; and HR=3.53, 95% CI=1.89, 6.58, respectively) (Table 3, Model 1). Also, individuals with no other drivers in the house were also more likely to enter LTC than those with 1 or more other drivers in the house (HR=1.72, 95% CI=1.15, 2.57). Driving status did not modify the relation between no other drivers in the house and LTC entry. In fact, no statistically significant interaction terms were identified.

The association between nondrivers and LTC entry did not differ by type of LTC. Both former and never drivers had increased risks of LTC entry regardless of whether an individual entered a nursing home or a non–nursing home type of LTC (data not shown). Also, the association between having no other drivers in

TABLE 1—Characteristics of 1593 Salisbury Eye Evaluation Participants, by Baseline Driving Status: Salisbury, Md, 1993

	Current Drivers (n = 1347)	Former Drivers (n = 160)	Never Drivers (n = 86)
Mean age, y	73	75*	75*
Gender, %			
Male (n = 697)	47	34	3
Female (n = 896)	53	66*	97*
Race, %			
White (n = 1229)	82	54	50
African American (n = 364)	18	46*	50*
Baseline cognitive status, %			
≥ 24 points on MMSE (n = 1455)	94	74	77
< 24 points on MMSE (n = 138)	6	26*	23*
Baseline depressive symptoms, %			
0 on GHQ (n = 1454)	94	80	85
≥ 1 on GHQ (n = 128)	6	20*	15*
Co-morbidities at baseline, mean no.	2.3	2.9*	2.5
Need help with ADLs (baseline), %			
No (n = 1540)	98	87	99
Yes (n = 51)	2	13*	1
Other drivers in house (baseline), %			
≥ 1 other drivers (n = 1060)	67	64	57
0 other drivers (n = 532)	33	36	43
LTC entry after baseline, %			
No (n = 1444)	92	87	83
Yes (n = 149)	8	13	17

Note. MMSE = Mini-Mental State Examination; GHQ = General Health Questionnaire; ADLs = activities of daily living; LTC = long-term care.
*$P \leq .05$ from (age-adjusted) polychotomous logistic regression with current drivers as the reference group.

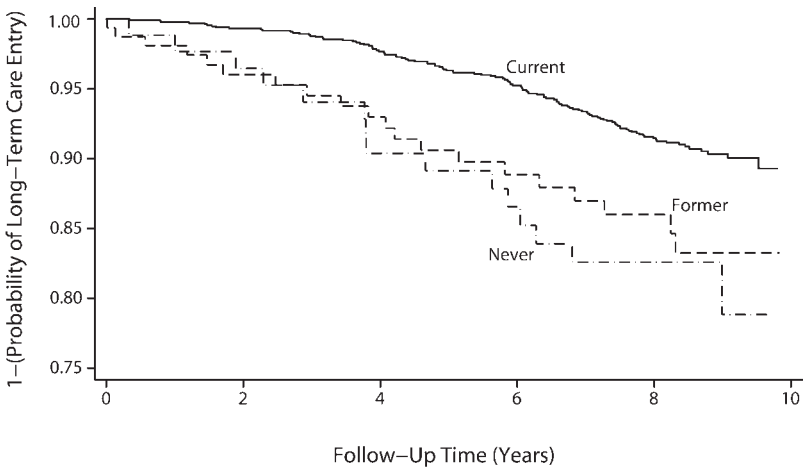

FIGURE 1—Kaplan–Meier graph of time until long-term care entry by driving status at baseline.

TABLE 2—Baseline Characteristics of 1593 Salisbury Eye Evaluation Participants, by Long-Term Entry Status: Salisbury, Md, 1993

	Nursing Home LTC Entry (n = 71)	Non–Nursing Home LTC Entry (n = 78)	No LTC Entry (n = 1444)
Mean age, y	76*	76*	73
Gender, %			
Male (n = 697)	46	31	44
Female (n = 896)	54	69*	56
Race, %			
White (n = 1229)	79	88	77
African American (n = 364)	21	12*	23
Cognitive status, %			
≥24 on MMSE (n = 1455)	77*	97*	92
<24 on MMSE (n = 138)	23	3	8
Depressive symptoms, %			
0 on GHQ (n = 1454)	91	94	92
≥1 on GHQ (n = 128)	9	6	8
Mean number of co-morbidities	2.6	2.5	2.3
Need help with ADLs, %			
No (n = 1540)	89	99	97
Yes (n = 51)	11*	1	3
Other drivers in house, %			
0 other drivers (n = 532)	44	50	32
≥1 other driver (n = 1060)	56	50*	68

Note. LTC = long-term care; MMSE = Mini-Mental State Examination; GHQ = General Health Questionnaire; ADLs = activities of daily living. Entry was for more than 3 months into a nursing home, assisted living facility, or independent living unit with meal or transportation services.
*$P \leq .05$ from (age-adjusted) polychotomous logistic regression with no LTC entry as the reference group

the house and LTC entry was qualitatively similar regardless of LTC type (data not shown).

Because 15% (n=232) of the participants were married or living together, the probability of entering LTC may not have been independent among participants. Therefore, a sensitivity analysis was done to exclude the second member of the household in a random fashion. The associations between the driving variables and LTC entry were essentially unchanged.

When those individuals who may have had cognitive impairment at the time of our follow-up telephone survey (missed more than 3 questions on the Short Portable Mental Status Questionnaire) were excluded from the analysis (n=64), the results were essentially unchanged. These results provided reassurances that the data we collected from this older population were not affected by cognitive impairment.

DISCUSSION

We have found that being a nondriver, because an individual either never drove or stopped driving, was an independent risk factor for subsequently entering LTC. In addition, having no other drivers in the house was also an independent risk factor for LTC entry. This association remained unchanged even after adjustment for marital status (not being married or being widowed are risk factors for nursing home admission, particularly in men[10,19,22]), which suggests that it was the absence of other drivers and not the absence of a spouse or partner that increased the LTC entry risk. These increased risks associated with driving status and having no other drivers in the house were similar for both nursing home and non–nursing home types of LTC entry.

We evaluated the concern that someone who stops driving may do so for poor health reasons and that the association between former drivers and LTC entry is due to the residual confounding of health factors rather than the inability to drive. If this were true, we would not expect to see an association between never drivers and LTC entry. However, never drivers were also more likely to enter LTC, and the never drivers were in better health at baseline than the former drivers. In addition, we adjusted for such variables as ADL help, number of co-morbidities, depressive symptoms, and cognitive impairment in a time-dependent manner, and the association between driving and LTC entry remained strong. However, driving cessation may in part be a marker for severity of these health conditions, because once driving status was

TABLE 3—Cox Time-Dependent Regression Results on Driving Status and the Adjusted Risk of Long-Term Care Entry

	Hazard Ratio (95% CI)	
	Model 1: With Driving Variables	Model 2: No Driving Variables
Driving status		
Current drivers	1.00 reference	. . .
Never drivers	3.53 (1.89, 6.58)	. . .
Former drivers	4.85 (3.26, 7.21)	. . .
Other drivers in house		
≥1 other drivers	1.00 reference	. . .
0 other drivers	1.72 (1.15, 2.57)	. . .
Age, 1-y difference	1.08 (1.05, 1.12)	1.11 (1.08, 1.15)
Gender		
Female	1.00 reference	1.00 reference
Male	1.44 (0.97, 2.13)	1.08 (0.74, 1.57)
Race		
African American	1.00 reference	1.00 reference
White	3.05 (1.91, 4.86)	2.27 (1.44, 3.58)
Marital status		
Married/living together	1.00 reference	1.00 reference
Not partnered	1.30 (0.83, 2.04)	1.72 (1.18, 2.52)
Need help with ADLs		
No	1.00 reference	1.00 reference
Yes	1.45 (0.85, 2.45)	2.14 (1.25, 3.67)
Number of co-morbidities		
<3	1.00 reference	1.00 reference
≥3	1.15 (0.81, 1.62)	1.38 (0.98, 1.95)
MMSE, 1 unit difference	0.95 (0.91, 0.99)	0.92 (0.88, 0.96)
Depressive symptoms		
No	1.00 reference	1.00 reference
Yes	1.28 (0.81, 2.00)	1.52 (0.97, 2.39)

Note. LTC = long-term care; CI = confidence interval; ADLs = activities of daily living; MMSE = Mini-Mental State Examination. If participant did not enter LTC by June 2003, he or she was censored at death date or at end of study (whichever came first). Variables that changed with time were driving status, other drivers in the house, marital status, ADL help, number of co-morbidities, MMSE score, and depressive symptoms.

entered into the model, the relation with ADL help was no longer significant, and the hazard ratios were attenuated for the other health variables as well. Alternately, it may be that driving cessation acts as an intervening variable in the pathway from these health variables to LTC entry.

We were unable to contact 36% of individuals to ask about LTC entry or availability of other drivers in the house in the summer 2003 survey. Therefore, it is important to determine if selection bias influenced our results. Those we were unable to contact tended to be older and sicker and less likely to have other adults in the house. These factors suggest that they were probably more likely to have entered LTC than those we were able to contact. We have some data to support this assumption. SEE data that are available on the 8-year risk of nursing home admission indicate that those we were unable to contact were more likely to enter a nursing home than those we were able to contact (10% vs 3%). In addition, those we were unable to contact were more likely to be nondrivers at baseline. Therefore, the inclusion of these individuals in the study likely would have resulted in a stronger association between nondrivers and LTC entry. Also, because those whom we were unable to contact were less likely to have other adults in the house, it is reasonable to assume that they were probably also less likely to have other drivers in the house. Therefore, it is likely that our association between no other drivers in the house and LTC entry would also be upheld.

The retrospective nature of the 2003 survey on LTC entry, driving cessation, and whether there were other drivers in the house may also be a limitation. Because of the older study population and the 10-year follow-up time, there is likely to be some measurement error. However, given the life impact of events such as LTC entry and driving cessation and the objective nature of our question on how many other drivers were in the house, we think there was minimal difficulty with recall. Indeed, research has indicated that the ability to remember autobiographical event dates does not decline with age.[24] Also, our interviewers used probes based on available information to help participants narrow down the time frame if a date was required. Another challenge was that we had to use proxies for 31% of the participants. However, we found good correlation and agreement for the questions that we asked on a subsample of participants, and proxies have been used successfully before in research studies of older adults.[25–27]

Data on noninstitutional LTC services that include home and community-based services were not available in the SEE data. Future work could examine whether driving status is also related to the use of these services, as well as whether the use of these services acts as a moderator on the relation between driving status and entry into institutional LTC.

Salisbury is a semirural town of about 40 000 people located on the eastern shore of Maryland. At the time of this study, there was no formal public transportation. The results of this study may only generalize to other areas similar to Salisbury. For example, not driving in an urban environment, where one could potentially walk to the corner store for groceries, may not be associated with an increased risk of LTC entry. Future research should attempt to confirm this finding and to examine whether the relation between driving and LTC entry holds in urban environments as well.

In summary, our data suggest that being a nondriver increases the risk of entering LTC, which can be a significant drain on financial resources. This information could be used to better prepare older adults, their families, and society for the difficult circumstances that can result from not being able to drive. We expect older adults to make good decisions about when they should stop driving, but we fail to fully recognize the hardships that not being able to drive places on an older adult. One way to aid older adults without transportation options is to develop better public transportation programs specifically targeting older adults. One successful model program in Maine is called the Independent Transportation Network, which offers prearranged, paid, shared rides 7 days a week, 24 hours a day.[28] Other strategies by families, organizations, and governments to improve the transportation options for older adults should be developed to ensure road safety and living independence for as long as safely desired. ■

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Contributors

E.E. Freeman and S.K. West contributed to the study's design, data collection, and analysis, and to the writing of the article. S.J. Gange and B. Muñoz contributed primarily to the design and analysis.

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Human Participant Protection

Approval for this study came from The Johns Hopkins University Joint Committee on Clinical Investigation, and informed consent was obtained for all participants.

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