



Diagnosed dementia and the risk of motor vehicle crash among older drivers

Laura A. Fraade-Blanar^{a,e,*}, Ryan N. Hansen^{a,b,c,e}, Kwun Chuen G. Chan^{a,d}, Jeanne M. Sears^{a,e,f},
Hilaire J. Thompson^{e,g}, Paul K. Crane^{a,h}, Beth E. Ebel^{a,e,i,j}

^a Department of Health Services, University of Washington, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

^b Department of Pharmacy, University of Washington, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

^c Group Health Research Institute, 1730 Minor Ave, Seattle, WA, 98101, USA

^d Departments of Biostatistics, University of Washington, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

^e Harborview Injury Prevention Research Center, 401 Broadway, Seattle, WA, 98122, USA

^f Institute for Work & Health, Institute for Work & Health, Ontario, Canada

^g Department of Biobehavioral Nursing and Health Informatics, University of Washington, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

^h Department of Medicine, University of Washington, University of Washington, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

ⁱ Department of Pediatrics, University of Washington and Seattle Children's Hospital, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

^j Department of Epidemiology, University of Washington, 1410 NE Campus Parkway, Seattle, WA, 98195-5852, USA

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ABSTRACT

Older adults are an active and growing segment of drivers in the United States. We compared the risk of motor vehicle crash among older licensed drivers diagnosed with dementia to crash risk among older licensed drivers without diagnosis of dementia. This retrospective cohort study used data from Group Health (GH), a Washington State health maintenance organization. Research participants were members of GH, aged 65–79 during the study who lived in Washington State from 1999–2009. Participant health records were linked with police-reported crash and licensure records. We estimated the risk of crash for older drivers diagnosed with dementia compared to older drivers without diagnosis of dementia using a Cox proportional hazards model with robust standard errors, accounting for recurrent events (crashes). Multivariable models were adjusted for age, sex, history of alcohol abuse or depression, comorbidities, and medications. There were 29,730 eligible individuals with an active driving license. Approximately 6% were diagnosed with dementia before or during the study. The police-reported crash rate was 14.7 per 1000 driver-years. The adjusted hazard ratio of crash among older drivers with diagnosed dementia was 0.56 (95% CI 0.33, 0.95) compared to those without diagnosed dementia. On-road and simulator-based research showed older adults with dementia demonstrated impaired driving skill and capabilities. The observed lower crash risk in our study may result from protective steps to limit driving among older adults diagnosed with dementia. Future research should examine driving risk reduction strategies at the time of dementia diagnosis and their impact on reducing crash risk.

1. Introduction

In 2015, 18% of all licensed drivers in the United States (US) were aged 65 and above (NHTSA, 2015). There are health benefits of driving for older adults; and when driving is restricted, older adults are at greater risk of depression, social isolation, and entry into a long-term care facility (Martin et al., 2011; Breen et al., 2007; Freeman et al., 2006). The annual passenger vehicle fatal crash involvement rate per vehicle miles traveled among drivers aged 65 and above is high, second only to drivers aged 16–29.5. Sustaining a motor vehicle crash may be devastating or fatal for frail older adults and places other road users at risk (Alvarez and Fierro, 2008; Li et al., 2003).

One contributor to high crash rates per mile travelled may be cognitive decline or dementia (Martin et al., 2011; Breen et al., 2007; Horswill et al., 2008; Withaar et al., 2000; Anstey et al., 2005). Dementia is an umbrella term for a group of diseases and conditions wherein nerve cells in the brain die or no longer function normally (Alzheimer's Association, 2012). Cognitive function is a continuum with varying severity of symptoms and underlying pathologies. Individuals' cognitive states range from normal aging to prodromal dementia to diagnosed mild dementia to severe dementia (Alzheimer's Association, 2012; Snellgrove, 2005; Dickerson et al., 2007). One of nine adults over aged 65 has Alzheimer's disease, the most common type of dementia, with prevalence increasing with age. The number of

* Corresponding author at: Harborview Injury Prevention & Research Center, 325 Ninth Ave, Box 359960, Seattle, WA, 98104-2499, USA.

E-mail address: lblanar@uw.edu (L.A. Fraade-Blanar).

¹ Present address: RAND Corporation, 1776 Main St, Santa Monica, CA, 90401, USA.

individuals with dementia is projected to rise as the US population ages (Alzheimer's Association, 2013).

Simulator, lab, and road-based research has found that people with dementia have impaired driving skills, including impairments of hazard perception, processing of visual cues, attention, and decision-making (Martin et al., 2011; Breen et al., 2007; Horswill et al., 2008; Withaar et al., 2000; Anstey et al., 2005; Ott et al., 2008). Older drivers with cognitive decline may become lost, may struggle to negotiate intersections, and may stray from designated lanes and customary routes (Withaar et al., 2000; Dawson et al., 2009; Wagner et al., 2011; Carr and Ott, 2010; Rizzo et al., 2001; Owsley et al., 1991; Carr et al., 2000; Barco et al., 2015).

Cognitive impairment has been previously found to be associated with higher crash risk, although the strength and significance of the association differed between studies (Martin et al., 2011; Breen et al., 2007; Withaar et al., 2000; Anstey et al., 2005; Carr and Ott, 2010; Rizzo et al., 2001; Carr et al., 2000; Ball et al., 2006; Carr, 1997; Lincoln et al., 2006; Jones Ross et al., 2015; Duchek et al., 2003; Joseph et al., 2014; Marino et al., 2012). Prior research on dementia and crash risk has been limited by the method of crash ascertainment, brief follow-up time, use of driving simulators (Rizzo et al., 2001; Marino et al., 2012; Fitten et al., 1995), small sample sizes (Martin et al., 2011; Breen et al., 2007; Withaar et al., 2000; Anstey et al., 2005; Ott et al., 2008; Dawson et al., 2009; Wagner et al., 2011; Carr et al., 2000; Duchek et al., 2003; Molnar et al., 2006) and/or measures of cognition with limited clinical relevance (Ott et al., 2008; Duchek et al., 2003; Joseph et al., 2014). Driving tests (Anstey et al., 2005; Snellgrove, 2005; Dawson et al., 2009; Lincoln et al., 2006; Duchek et al., 2003; Marino et al., 2012; Fitten et al., 1995; Charlton et al., 2010; Martin et al., 2013), subject perceived driving ability (Breen et al., 2007; Charlton et al., 2010; Rapoport et al., 2016), recalled crash (Breen et al., 2007; Anstey et al., 2005; Joseph et al., 2014; Charlton et al., 2010; Martin et al., 2013), and simulated driving studies (Rizzo et al., 2001; Marino et al., 2012; Charlton et al., 2010; Martin et al., 2013; Anderson et al., 2004) may be situationally specific, may be non-replicable, and/or may not translate to real world crash risk (Charlton et al., 2010). The few naturalistic longitudinal studies reported an equivalent or lower crash risk associated with cognitive impairment defined using a variety of measures compared to the risk associated with no impairment (Ott et al., 2008; Carr et al., 2000; Joseph et al., 2014; Dow et al., 2013; Meuleners et al., 2016). However, these studies suffered from small sample sizes and/or short follow-up time. Investigators and policy-makers have stressed the need for longitudinal cohort studies with large sample sizes and reliable dementia and crash information (Wagner et al., 2011; Molnar et al., 2006).

State Departments of Motor Vehicles, the National Highway Traffic Safety Administration (NHTSA), medical and neurological associations, and technical and non-technical articles generally support limiting and eventual cessation of driving for individuals with dementia (Carr and Ott, 2010; AGS/NHTSA, 2016; Dickerson, 2014; Tung et al., 2013; Hartford, 2010; AAN, 2017). Older adults can limit driving, e.g. by taking shorter trips or driving only during the day. Studies on self-reported driving habits show that older drivers with dementia implement the above guidance around limiting or cessation of driving (Carr et al., 2000; Duchek et al., 2003; Seiler et al., 2012; Edwards et al., 2008; Lyman et al., 2001; Ka and McCartt, 2008; Stutts, 1998). Two small studies found that, compared with individuals with a Clinical Dementia Rating (CDR) of 0 (normal cognition), self-reported mileage was 15%–42% lower among those with a CDR of 0.5 (cognitively impaired but not demented), and 46% to 64% lower among those with a CDR of 1 (mild dementia) (Ott et al., 2008; Carr et al., 2000). A study of 18 people with dementia and age-matched cognitively normal elderly controls found 45% lower self-reported weekly mileage among people with dementia (Festa et al., 2013). However, self-reported mileage among older adults is often inaccurate (O'Connor et al., 2013), and these inaccuracies may be particularly pronounced in those with

dementia

This study aimed to compare the risk of motor vehicle crash among older drivers with diagnosed dementia to the risk of crash among older drivers without dementia using data on cognition and crash routinely generated and collected from administrative sources.

2. Materials and Methods

This was a retrospective cohort study examining crash risk for licensed individuals 65–79 years of age with a diagnosis of dementia, compared to crash risk for those without a diagnosis of dementia.

2.1. Participants

Study participants were Washington state residents, 65–79 years of age between January 1, 2003 and December 31, 2009, and enrolled at Group Health (GH), a large Washington State consumer-governed health maintenance organization (Ehlenbach and Hough, 2010; Hansen et al., 2015) (now part of Kaiser Permanente), for at least one year between January 1, 2003 and December 31, 2009. GH covers approximately 600,000 enrollees in Washington State and Idaho, who broadly resemble Washington State residents with respect to age, sex, and race (Hansen et al., 2015). Washington State uses a combination of letters from drivers' names and numbers derived from their birth years to generate driver license numbers. We used Group Health member names and birth years to derive driver license numbers, as we have done previously (Hansen et al., 2015; Gallian, 1991; Hansen et al., 2017). We merged GH electronic health records with licensure data from the State Department of Licensing and police-reported crash data from the State Department of Transportation. Participants were restricted to those with an active Washington State driving license, including those with commercial or motorcycle license.

2.2. Data

2.2.1. Diagnosis of dementia

Dementia status was classified using diagnosis codes and prescription records from the electronic health record. The date of diagnosis was assigned as the earlier of (1) the earliest dementia-related International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code recorded in a medical claim or (2) the earliest prescription for an anti-dementia medication [donepezil (Aricept®) or memantine (Namenda®)]. GH has a prescription drug formulary that does not permit use of these medications to treat mild cognitive impairment. ICD-9-CM diagnosis codes indicating Alzheimer's disease and similar dementias were 294.1, 294.10, 294.11, 294.8, 331, 331.0, 331.1, 331.11, 331.19, 331.2, 331.7, 331.82, 331.89, 331.9, and 294 (Appendix A). Senile dementia and vascular dementia (ICD-9-CM codes 290.0–290.9) were not included in the case definition as codes for these diagnoses were not made available to the study team for analyses. Individuals could be diagnosed with dementia during or before the study.

Exposure and outcome ascertainment began in January 2003, with medical record and prescription data from 1999–2002 serving as a pre-study period during which diagnosis information was gathered. We divided individuals into three groups: (1) patients with no diagnosis of dementia within four years prior to the study and during the study period (1999–2009); (2) patients diagnosed with dementia within the 4-year period prior to the study (1999–2002), (3) patients diagnosed with dementia during the study period (2003–2009).

2.2.2. Crashes

The outcome was any motor vehicle crash (including passenger vehicles, motorcycles, and commercial vehicles) on a non-private road within Washington State reported by or to police or Washington State Patrol (Hansen et al., 2015). Within Washington State, if a law

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