Older drivers and motor vehicle crashes

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Older drivers are a source of great public concern, particularly after well-publicized incidents in which an older driver has caused a grievous event. As their numbers grow, understanding the risks that older drivers pose to themselves and other road users is important for appropriate clinical and policy decisions.

Ageing is associated with a multitude of chronic medical conditions that may affect driving performance, including musculoskeletal ailments and visual impairment (Janke, 2001; Vernon et al, 2001; Wang et al, 2003). In addition, the prevalence of cognitive impairment increases markedly with age, affecting an estimated one-third of 85-year-olds living in the community (Skoog et al, 1993).

Among the medical conditions that have been shown to be associated with driving problems are physical impairments, such as arthritis, and diabetes, cardiovascular disease and neurological disorders (Vernon et al, 2001; Stefano and Macdonald, 2003). Yet another factor is the use of medications that may have adverse effects on driving; long-acting benzodiazepines have been shown to increase crash risk among older patients, for whom a disproportionate share of benzodiazepines are prescribed (Hemmelgarn et al, 1997).

The occurrence of physical and cognitive impairments varies greatly among older people; furthermore, the degree to which these impairments affect individual functioning also is highly variable (Wang et al, 2003). Thus, neither age alone nor the presence of medical conditions can predict whether a particular older driver is at high risk for unsafe driving acts.

Being able to travel from one place to another is essential for having a normal life. Riding in passenger vehicles has become a primary, and sometimes the only, means of transport in many communities. Revoking drivers' licenses can have drastic consequences for physical and mental health, and can condemn people to extreme social isolation and difficulty in procuring basic goods and services (Organisation for Economic Co-operation and Development, 2001; Harrison and Ragland, 2003). Accordingly, great care must be exercised both when determining public policy regarding ageing drivers and in making clinical recommendations for individual drivers.

Travel patterns change with age. On average, US drivers aged 65 years or older travel half the annual distances covered by drivers aged 35–54 years (Pickrell and Schimek, 1998). In addition, many older drivers avoid driving at night, during peak commuting times, during inclement weather and on motorways (divided highways) (Ball et al, 1998; National Highway Traffic Safety Administration, 1999). The self-restrictions imposed by older drivers are another important consideration for policy-makers and clinicians.

This article reviews the question of whether older drivers actually have an elevated risk of crash involvement, describes the increased vulnerability to injury with increasing age, and estimates the relative contributions of fragility *vs* excessive crash involvement to the elevated fatality risk among older drivers. The effects of older drivers on their own safety and that of other road users also are presented, together with some projections of the impact of the growing population of older drivers. Findings are presented for the full range of driver ages to enable comparison with other age groups and provide a public health context for the challenge posed by older drivers. The article concludes with a discussion of potential countermeasures to address traffic safety problems associated with ageing.

RISK OF CRASH INVOLVEMENT

Whether older drivers have elevated rates of crash involvement depends on the outcome of the crash – fatal or non-fatal – and on whether the measure is involvements per licensed driver or per unit of vehicle travel. Per licensed driver, older drivers in the United States have low rates of police-reported crashes, which are primarily

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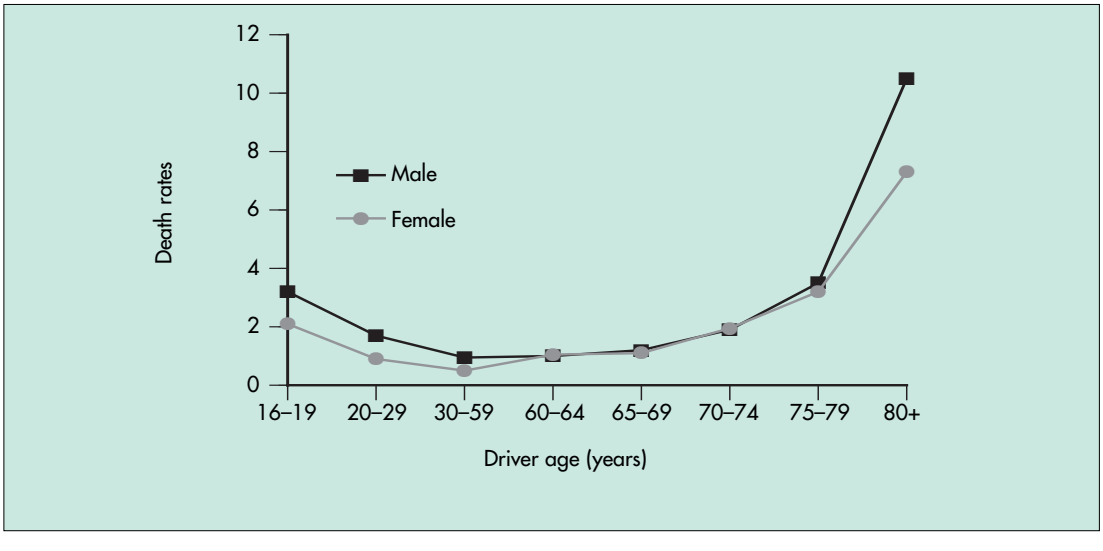
non-fatal; their crash rates contrast strikingly to the very high rates of teenage drivers and those aged 20–29 years (Lyman et al, 2002; *Figure 1*). For fatal US crashes, there is an upturn in risk per licensed driver starting at the age of 70–74 years that continues to increase with increasing age, yet young drivers have a much higher risk of involvement in fatal crashes (*Figure 1*). A similar pattern of overrepresentation of older people among motor vehicle deaths and underrepresentation in overall crashes is present in countries other than the United States (Mitchell, 2003). Arguably, crash rates per driver may be the best measure of the public health impact of granting licenses to drivers in different age groups (Evans, 2000).

Yet crash rates per licensed driver do not provide a complete picture of older driver crash risk because older drivers drive less per year. Examining rates per unit of vehicle travel tells us what happens when older drivers do decide to operate vehicles. A dramatic U-shaped curve is present when calculating rates of police-reported crashes (most of which do not result in injury) per unit of travel by driver age, with very high risk among young drivers, stabilization of risk from the ages of 30–69 years, and then risk starting to increase again over the age of 70 years (Li et al, 2003). An even more marked increase occurs when driver deaths are computed per unit of vehicle travel, with a very high mortality risk among drivers in their 80s that surpasses the high risk among the youngest drivers (*Figure 2*) (Li et al, 2003).

Among older drivers, gender patterns for fatal crash involvements differ from those of non-fatal crash events. For police-reported crashes, female drivers have about 10% higher crash rates per

Figure 1. Involvement rates in police-reported and fatal crashes by age, USA 1995. Per licensed driver. From Lyman et al (2002).

Figure 2. Driver deaths by age and gender, USA, 1993–97. Per 161 million vehicle-kilometres. From Li et al (2003).



unit of travel until the age of 80 years, when gender differences are no longer apparent (Li et al, 2003). Conversely, male drivers have substantially higher deaths per unit of travel than women when men are younger than 30 years or aged 80 years and older (Li et al, 2003).

INCREASED FRAGILITY

Another concern relating to ageing drivers and passengers is their heightened vulnerability to injury. Numerous studies have reported that older drivers are more likely to die or be hospitalized following motor vehicle crashes than their younger counterparts involved in crashes of similar severity (Evans and Gerrish, 2001; Mitchell, 2003; Griffin, 2004). Older vehicle occupants are at particularly high risk of sustaining serious chest injuries or having poor outcomes from chest injuries, such as rib fractures, that would have minor consequences for younger occupants (Zhou et al, 1996; Augenstein, 2001; Morris et al, 2003). Older people also are more prone to receiving injuries related to seat belt use (Zhou et al, 1996; Augenstein, 2001; Morris et al, 2003).

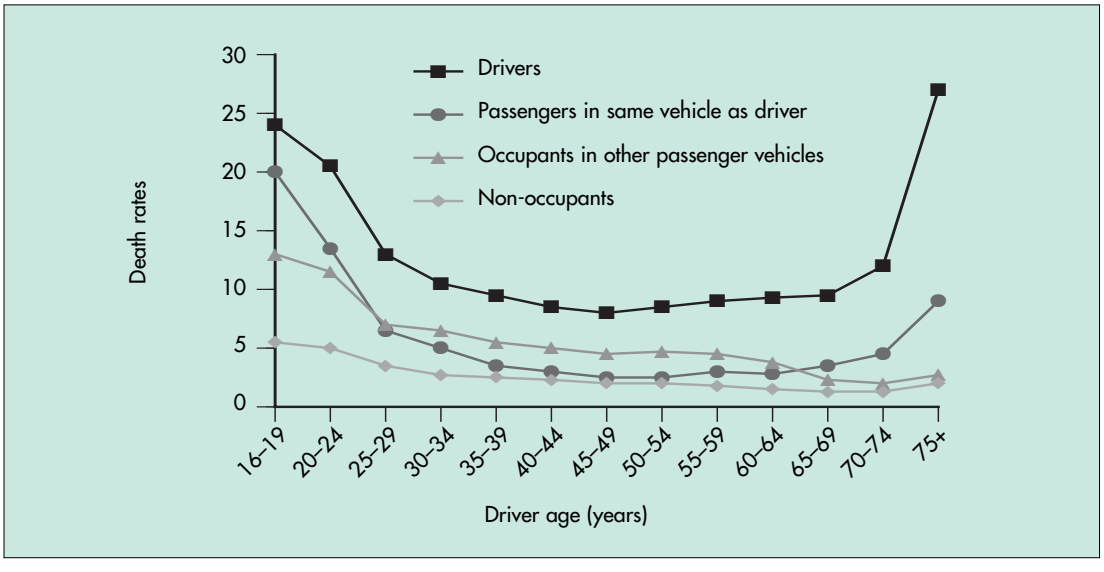
Several studies have tried to assess the relative importance of fragility *vs* increased crash involvement in explaining elevated fatality risks among older drivers. Li et al (2003) examined older drivers' excess mortality per unit of vehicle travel and concluded that fragility increased with increasing driver age and explained most of the excess risk, even among the oldest drivers. Nonetheless, elevated crash involvements per unit of travel partially explains a sizeable proportion of the increased fatality risk per unit of travel starting at the age of 75 years.

Using a different outcome measure, risk of fatal crash involvement per licensed driver, Dellinger et al (2002) estimated a greater role for crash overinvolvement. Their study also estimated the role of decreased vehicle travel in explaining fatality risk per driver. The disparate findings between the two studies are probably the result of the different outcome measures as well as somewhat different methods of assessing fragility. To approximate fragility, Li et al (2003) used driver deaths per police-reported crash and Dellinger et al (2002) used involvements in fatal crashes per police-reported crash.

RISKS POSED TO SELVES AND OTHER ROAD USERS

The source of greatest public concern is the potential hazards posed to other road users by older drivers. Evans (2000) reported that older drivers had lower rates of involvement in pedestrian deaths per licensed driver, but had elevated pedestrian death involvement rates per unit of travel. Compared with drivers aged 30–59 years and using deaths per driver as the risk measure, Braver and Trempel (2004) estimated that drivers aged 75 years or older had a 3-fold increased risk of collision involvements resulting in deaths to themselves, a 2.5-fold increased risk of involvements resulting in deaths among their passengers, a significantly decreased risk of two-vehicle involvements in which occupants died in other passenger vehicles, and a significantly decreased risk of one-vehicle involvements resulting in deaths of non-occupants, such as pedestrians (*Figure 3*). Thus, older drivers and their passengers, most of whom were elderly, suffered the worst consequences of their crashes.

Figure 3. Deaths per 100 000 drivers. By driver age and person type, USA, 1993–97. From Braver and Trempel (2004).



Using a risk measure with vehicle travel as the denominator, Dellinger et al (2004) observed a nearly 3-fold increase in fatality risk among other road users involved in collisions with drivers aged 75 years or older compared with drivers aged 35–59 years; passengers of older drivers were not examined separately. Dellinger et al pointed out that older drivers were involved in fewer collisions resulting in deaths to other road users than younger drivers.

There were a few differences in the patterns of risk for fatal and non-fatal injuries among other road users. In contrast to the absence of increased fatality risk to occupants of other vehicles colliding with older drivers, drivers aged 75 years or older had a non-significant 10% increased risk per driver of involvement in police-reported collisions resulting in non-fatal injuries to occupants of other vehicles relative to 30-59-year-old drivers (Braver and Trempel, 2004). Another difference is that non-fatal injury rates per older driver were not elevated for their passengers. Per unit of vehicle travel, Dellinger et al (2004) observed that older drivers had marked elevations in crash involvements resulting in other road users needing emergency department treatment compared with drivers aged 35–59 years.

To investigate the likelihood of drivers in different age groups being considered at fault for motor vehicle injuries received by occupants of other passenger vehicles, insurance claims for bodily injury liability were examined. Compared with those aged 30–59 years, older drivers started to have an increased risk of bodily injury liability claims per insured vehicle-year at the age of 75 years (Braver and Trempel, 2004). Drivers aged 85 years or older had a 1.8-fold increased risk of such claims.

Both Braver and Trempel (2004) and Dellinger et al (2004) observed that the youngest drivers posed the greatest risk of fatal and non-fatal injuries to passengers, occupants in other vehicles, and non-occupants. Increased risks to other road users also were associated with drivers aged 20–29 years, albeit not as high as those observed for teenage drivers.

FUTURE IMPACT OF OLDER DRIVERS

The future impact of the growing numbers of older drivers on the road is another matter of concern for policymakers. Demographic estimates consistently indicate that a larger proportion of the population in Western countries will be 65 years or older in the future (U.S. Census Bureau, 2004; Department for Transport, 2000). Based on recent trends, the percentage of the older population that will be licensed to drive will also be higher than in the past, particularly the percentage of older women (Spain, 1997; Department of Transport, 2000).

Estimating the future crash involvements and fatalities involving older drivers is inherently uncertain because of the multitude of factors that affect these variables. Potential influential factors include safer vehicles, improved roadway design, lower travel speeds as a result of traffic congestion, higher seat belt use rates, reductions in alcohol-impaired driving and improvements in health status (Hu et al, 2000; Lyman et al, 2002). During a period of steadily increasing vehicle travel, the total number of motor vehicle-related deaths in the United States has stayed fairly constant, whereas historical trends would have forecast major increases in total fatalities (Lyman et al, 2002).

Amid these uncertainties, researchers have projected that American drivers aged 65 years or older would change from constituting 14% of fatal crash involvements in 1999 to 25% in 2030, with a 2.5-fold increase in the total number of older driver fatal involvements (Lyman et al, 2002). Hu et al (2000) estimated that total older driver fatal involvements in the United States would triple between 1995 and 2025, but cautioned that this might be a worst-case scenario. In contrast, from 1998 through 2022, the Department of Transport (2000) in the UK forecast annual declines in numbers of crashes resulting in deaths or serious injuries for older drivers, with the exception of 80–84-year-old females, who are projected to have about a 1% annual increase in such crashes. The disparate estimates from these three studies may be attributable to different statistical methods and, perhaps, different crash trends in the United States and UK.

COUNTERMEASURES

A great deal of research has been and is being conducted to determine accurate and feasible ways to screen older drivers to determine which of them are hazardous vehicle operators. Some simple screening methods have been recommended for use in the office setting; however, screening by itself is insufficient to identify high-risk drivers (Staplin et al, 2003; Wang et al, 2003). Screening, careful assessment of medical conditions and, as warranted, testing by occupational therapists certified to evaluate driving skills has been advocated as the most reasonable approach for assessment of older drivers' functional capacity (Wang et al, 2003), but such an approach has not yet been rigorously tested to

ascertain if it is successful in reducing crashes among high-risk drivers.

Another approach aimed at high-risk drivers is to require older drivers to renew their licenses in person at shorter intervals than the 4–5-year renewal cycle common in the United States, which presumably would encourage some problem drivers to find other means of transport. One study reported that in-person renewals led to lower driver death rates among persons aged 85 years or older, but did not observe statistically significant benefits from more frequent renewals, mandatory vision tests or mandatory road tests for older persons seeking to renew licenses (Grabowski et al, 2004). These findings suggest that the visual acuity tests administered by licensing agencies may not adequately reflect the visual challenges posed by driving; however, other studies have reported decreased fatality risk from mandatory visual tests (Levy et al, 1995; Shipp, 1998). The lack of an association between fatality risk and more frequent renewals is puzzling because presumably in-person license renewals and more frequent renewals would share the same causal pathway in reducing deaths among older drivers.

Older people will be travelling in vehicles whether or not they are drivers. Furthermore, the trends indicate that the numbers of licensed older drivers and their annual amount of travel will continue to grow. Accordingly, greater emphasis must be placed on countermeasures to address the increased frailty of older vehicle occupants. Such measures would benefit drivers of all ages.

Improving seat belts so as to better distribute restraining forces is one research area that should be vigorously pursued, given the greater susceptibility of older occupants to belt-related chest injuries (Zhou et al, 1996; Augenstein, 2001; Morris et al, 2003). Researchers have suggested making belts wider, inflatable and adding another point of attachment (Kent, 2001; Vala, 2001, Wang, 2001). Side air bags that protect both the head and torso also may benefit older vehicle occupants (Braver and Kyrychenko, 2004). Designing vehicles so as to lengthen crush zones while decreasing front end stiffness is another possibility; however, consumer acceptance would be paramount in whether such a design modification would be successful (Li et al, 2003).

CONCLUSIONS

Older drivers have elevated rates of involvement in fatal crashes per driver and per mile. For overall police-reported crashes, most of which result solely in property damage, older drivers have higher involvement rates per unit of travel, but have lower involvement rates per driver owing to their decreased quantity of travel. In terms of the impact on themselves and other road users, older drivers and their elderly passengers appear to suffer the worst consequences of crashes with regard to fatalities per driver. Occupants of other vehicles and pedestrians are involved in fatal collisions with older drivers at higher rates per unit of vehicle travel, but not per driver. There is some evidence that the oldest drivers may be overinvolved in collisions resulting in non-fatal injuries to occupants of other vehicles per driver and per unit of vehicle travel.

However, the age group that poses the highest risk to other road users consists of teenage drivers and drivers in their 20s; these two groups of young drivers also present a very high risk to themselves. Young drivers are a much greater motor vehicle safety problem than older drivers.

The elevated fatality rates per unit of travel largely are attributable to the greater susceptibility to injury of older vehicle occupants rather than crash overinvolvement. The increased frailty with age must be addressed, given the increasing numbers of older vehicle occupants on the roads. Potential countermeasures include improvements in the design of seat belts, instal-

KEY POINTS

- Drivers in their teens and 20s pose the greatest risk to their passengers and other road users.
- Overall crash involvements per driver decrease with age, but fatal involvements increase among drivers starting at the age of 70 years.
- Per mile driven, overall and fatal involvement rates begin to increase at the age of 70 years.
- Except for deaths among their passengers, older drivers are not overinvolved in crashes in which other road users are killed per driver, but are overinvolved per unit of vehicle travel.
- Drivers aged over 75 years may have a modestly increased risk per driver of involvement in collisions in which occupants of other vehicles receive non-fatal injuries.
- Older drivers experience the most serious consequences of their collisions, comprising two-thirds of the deaths in crashes involving drivers 75 years and older.
- Frailty is a major contributor to the elevated risk of older driver deaths per unit of travel. Countermeasures should be developed to address frailty, including improvements to seat belt design.
- Although screening tests are far from perfect, it is reasonable for clinicians to start to perform simple periodic tests in the office setting among older drivers and refer them for more in-depth evaluations as needed.

lation of side air bags that protect the head and torso, and modifications in vehicle design.

A consistent finding among different studies is for crash risk to start increasing by the age of 75 years. Periodic screening for at-risk older drivers may be appropriate for clinicians to undertake when people enter their 70s and some straightforward tests have been developed for the office setting. Clinicians must weigh the considerable benefits of mobility against the risks of individual drivers. When screening tests or medical judgment indicate a potential for impaired driving performance, referral of older patients for further evaluation by government medical advisory boards or occupational therapists with special expertise in driver assessment may be advisable. **HM**

Figure 3 *is reproduced by kind permission of* Injury Prevention.
Conflict of interest: none.

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