Assessing and Managing Older Drivers' Crash Risk using Safe System Principles

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ABSTRACT

The last decade has seen a large amount of road safety effort put into investigating the so-called 'older driver problem'. As a consequence, our knowledge of older drivers and their functional performance, their driving and crash patterns and their crash risk, has increased substantially. However the research has given little direct attention to the special challenges that older drivers pose to a Safe System approach to road safety.

During this same decade, Australasian jurisdictions have increasingly accepted a Safe System approach to managing road safety. Main components of this strategy include:

- it is accepted that crashes will continue to occur, prevention efforts notwithstanding;
- the key task is to manage vehicles, the road infrastructure and speeds in order to minimise the probability of death and serious injury as a consequence of a road crash;
- individual road user responsibilities and behavioural countermeasures are not dismissed but are explicitly presented as supporting components of the Safe System.

This paper aims to evaluate the latest research findings:

- to assess the extent and nature of older drivers' crash risk in both absolute and relative terms;
- to identify the array of effective countermeasures compatible with Safe System principles.

Topics covered include: physical frailty, the low mileage bias, fitness to drive, self-regulation, safer roads, safer cars and safer road users.

1 INTRODUCTION

1.1 Background to the Safe System approach

Australia's road toll reached its peak during the 1970s, when the death rate exceeded 30 per 100,000 population (see Figure 1). A concerted program of road safety countermeasures which was then progressively developed, resulted in the rate dropping to below 10 per 100,000 population by the mid-1990s.

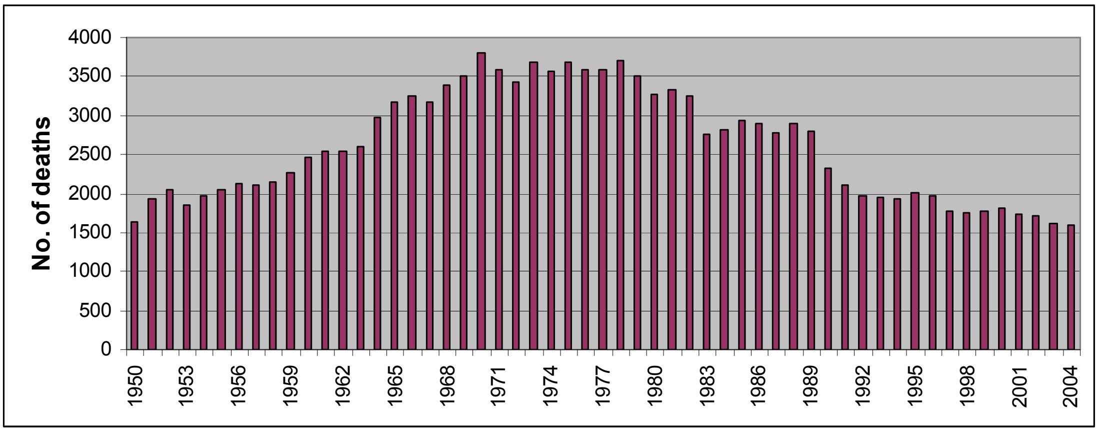

FIGURE 1: Road fatalities in Australia, 1950-2004

In 1975, Australia's road death rate was some 45% above the median value for all Organisation for Economic Co-operation and Development (OECD) countries, but from 1990 onwards it has been consistently below this marker (Australian Transport Safety Bureau, 2004). In 2003, Australia ranked amongst the better performing OECD countries with 8 road fatalities per 100,000 population. The best performing countries were Sweden, the United Kingdom, Norway and the Netherlands with 6 fatalities each per 100,000 population (OECD, 2005).

1.2 The Safe System approach

The plateau in the national road toll from the mid-1990s shown in Figure 1 suggests the need for a fresh approach to tackling road safety problems. In 2003 Austroads accepted that further road safety gains would best be achieved through adopting a Safe System approach, a strategy derived from Sweden's Vision Zero and the Netherlands' Sustainable Safety approaches. An overview of Austroads' Safe System approach is given in Figure 2 (Australian Transport Council, undated).

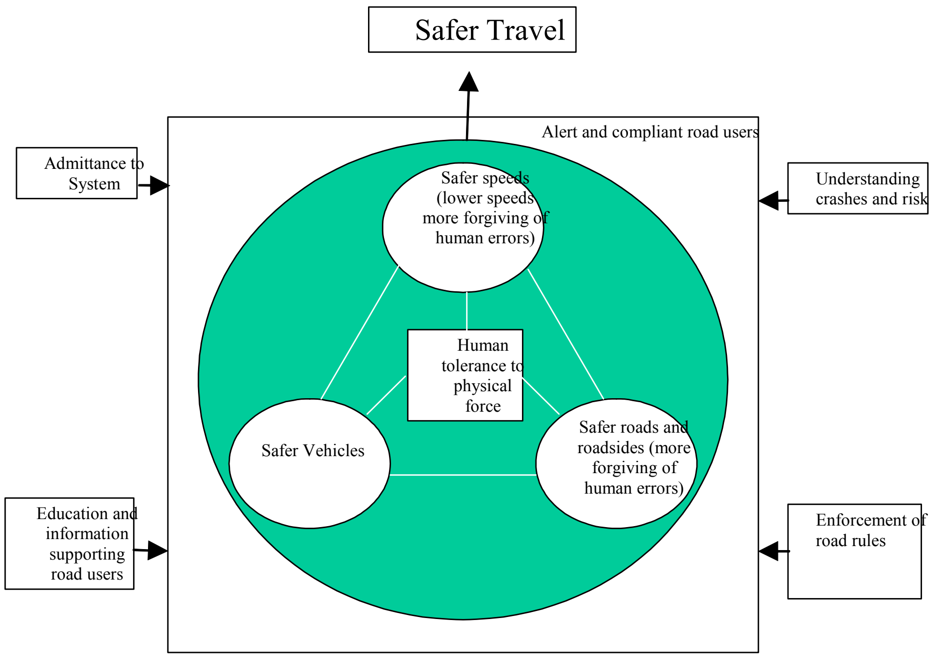

FIGURE 2: Australia's Safe System approach to road safety

The Safe System strategy accepts that while many crashes can be prevented, some will continue to occur despite efforts to the contrary. A key task of the Safe System therefore is to manage vehicles, the road infrastructure, speeds, and the interactions between these components to ensure that when crashes do occur, crash energies will remain at levels that minimize the probability of death and serious injury.

The Safe System approach does not dismiss individual road user responsibilities but explicitly points to them as supporting components of the system. Road user components include admittance to the system (especially graduated licensing schemes for young drivers), compliance with road rules, strengthened sanctions to control unlicensed driving, improved assessment of fitness to drive in the face of medical conditions and functional declines, and information and education to support safe use of the transport system.

The importance that the Safe System approach places on safer roads and safer vehicles in particular, is reflected in the current national road safety strategy. The strategy anticipates that the target of a 40 percent reduction in road deaths from 9.3 per 100,000 people (1999) to 5.6 (2010), will be achieved thus (Australian Transport Council, undated):

Proportion of the target reduction
safer roads 48%;
safer vehicles 25%;
safer road users 23%;
new technology 5%.

In round terms, it is expected that three of every four deaths prevented will be due to safer roads and vehicles.

2 THE 'OLDER DRIVER PROBLEM'

2.1 Size of the problem

Drivers aged 70 years and above accounted for between 70 and 100 deaths per year from 1996-1999, representing between five and six percent of all road fatalities (Langford, Andrea, Fildes, Williams & Hull, 2005). Projections of pending demographic changes and changes in older driver licensing rates and driving patterns suggest that, in the absence of new countermeasures, older driver fatalities will at least double over the next thirty or so years (Fildes, Fitzharris, Charlton & Pronk, 2001). A transport system which aspires to achieving Safe System objectives cannot ignore either the current or especially, the expected older driver fatality (and other casualty) levels.

2.2 Crash risk

Older drivers' crash risk is greatest when based on per distance travelled. Figure 3 shows the age of driver and fatal and serious injury crash involvement per distance travelled, Australia, 1996 (Fildes, Fitzharris, Charlton & Pronk, 2001).

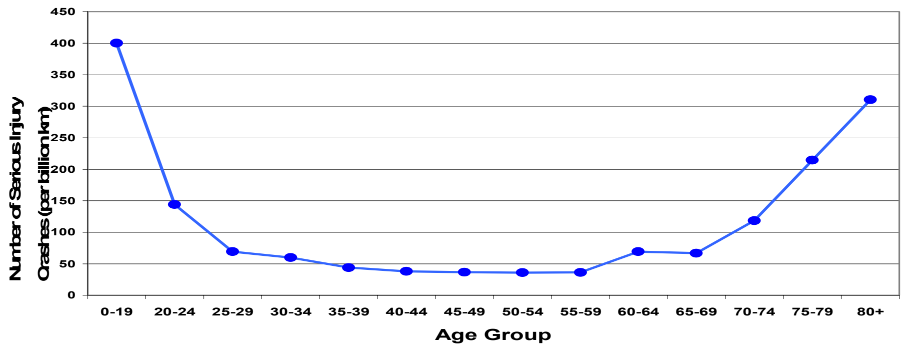

FIGURE 3: Age of driver and fatal and serious injury crashes per distance travelled, Australia, 1996.

Risk curves of the type in Figure 3, which show heightened crash risk particularly for drivers aged around 75 years and above, are characteristic of most Western societies (OECD, 2001).

3 EXPLAINING THE 'OLD DRIVER PROBLEM'

The over-representation of older drivers in serious injury and fatal crashes can be explained by a number of factors. These are discussed below.

3.1 Frailty

It has been long recognized that older adults' biomechanical tolerances to injury are lower than those of younger persons, primarily due to reductions in bone strength and fracture tolerance (OECD, 2001). The amount of energy required to produce an injury reduces as a person ages and thus increases the likelihood of serious injuries among older drivers involved in a crash. This results in a larger share of older drivers' crashes being included in casualty databases, thereby contributing to an apparent over-representation in crashes.

There have been various attempts to quantify the impact of frailty when explaining older drivers' crash risk, with some variation in the subsequent estimates, according to the methods and data used. As a recent example, it was estimated that, fragility accounted for around 60-90% of the excess death rates amongst older drivers – with excessive crash involvement due to 'other factors' being largely restricted to drivers aged 80 years or older (Li, Braver & Chen, 2003). For these oldest male and female drivers, 'other factors' accounted for 37% to 43% of their overall fatal crash involvement.

3.2 Location of driving

Drivers travelling longer distances will typically have lower crash rates per kilometre, compared to those driving shorter distances (Janke,1991) – and when different annual driving distances are controlled for, there is no age-related increase in crashes per distance driven (Hakamies-Blomqvist, Raitanen & O'Neill, 2002). Both Janke and Hakamies-Blomqvist et al. attributed the mileage/crash association at least in part to different driving locations. High mileage drivers are more likely to use freeways and multi-lane divided roadways with limited access: low mileage drivers are more likely to do more of their driving on local roads and streets, which have greater number of potential conflict points and hence higher crash rates per unit distance. Janke noted that there were 2.75 times more crashes per mile driven on non-freeways than freeways. Urban travel is even more likely to result in crashes for older drivers (Keall & Frith, 2004), given their well-documented difficulties in negotiating intersections (for a summary of evidence, see OECD, 2001).

3.3 Reduced fitness to drive

There is widespread agreement that even 'normal ageing' is associated with the onset of medical conditions, many of which have safety implications. Stutts and Wilkins (2003) summarized much of the research in this area thus:

> As a group, older drivers have poorer visual acuity, reduced nighttime vision, poorer depth perception, and greater sensitivity to glare; they have reduced muscle strength, decreased flexibility of the neck and trunk, and slower reaction times; they are also less able to divide their attention among tasks, filter out unimportant stimuli, and make quick judgements.

However the full impact of the association between ageing, medical conditions, functional decline and reduced driving skills upon crash involvement is mitigated by older drivers themselves. As summarized by the OECD (2001), older adults typically reduce their exposure by choosing to drive fewer annual kilometres, making shorter trips and making fewer trips by linking different trips together; they also limit their peak hour and night driving, restrict long distance travel, take more frequent breaks and drive only on familiar and well lit roads.

Although self-regulation does not entirely prevent older driver crashes, it is effective in keeping older driver crash rates at 'normal' levels. Smiley (2004) has claimed:

> Older drivers have a general awareness of their diminishing capabilities and make numerous appropriate … adaptations to compensate. … The success of older driver adaptation is shown by the fact that when their greater frailty is taken into account, absolute involvement rates, calculated per 1 million drivers, remain at the level of middle-aged drivers.

Self-regulation notwithstanding, there is evidence from crash data that at least some older drivers – whether because of 'normal ageing' or because of more severe medical conditions and functional impairments – are at heightened crash risk as a result of reduced fitness to drive. This evidence is best considered in two stages.

First, as shown in Figure 4, Langford, Methorst and Hakamies-Blomqvist (2006) used travel survey data from a sample of 47,502 Dutch drivers to confirm the earlier demonstrations of the mileage-crash association (Janke 1991, Hakamies-Blomqvist et al. 2002).

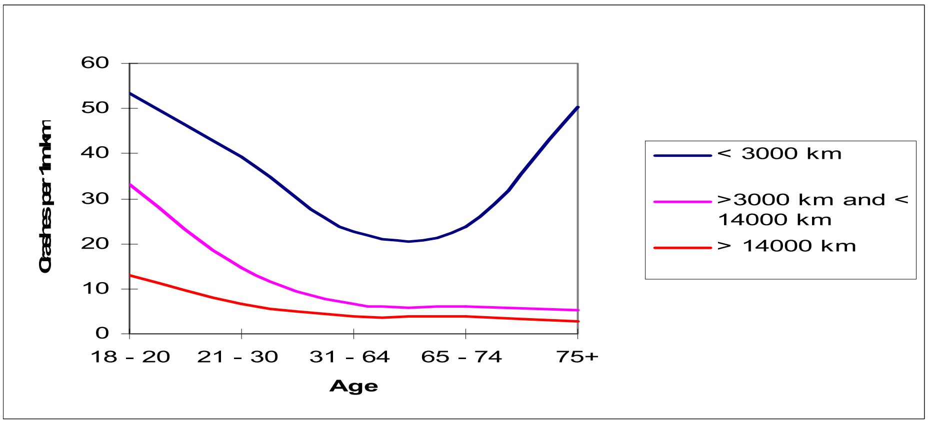

FIGURE 4: Annual crash involvement for different driver ages, controlling for annual mileages, (from Langford, Methorst & Hakamies-Blomqvist, 2006).

After being matched for yearly driving distance, most drivers aged 75 years and above were safer than drivers of other ages. The only age-related increase in crash involvement was for low mileage drivers (comprising just over 10 per cent of older drivers in the survey), where the sustained decline in crash involvement until around 75 years of age, was reversed for the oldest drivers. However, these increases were not statistically significant and were regarded as indicative only.

Secondly, Langford, Koppel, Charlton, Fildes and Newstead (2006) followed up the hypothesis that low-mileage older drivers' indicatively high crash risk may be at least partly due to reduced fitness to drive. Data from a sample of almost 1,000 New Zealand older drivers confirmed that drivers who travelled low mileage had more crashes per distance driven than drivers with higher mileage, and the differences were statistically significant in most instances. The data also showed that low mileage drivers were more likely to report a reduction in their driving performance and to report a range of health and medical conditions. Further, the low mileage drivers also performed less well on two of three off-road tests of fitness to drive and on an on-road driving test.

3.4 Conclusions about the 'older driver problem'

Older drivers as a group have a heightened casualty crash involvement per distance travelled. As a group they are more likely to have some level of functional impairment and, at least intuitively, a reduction in some driving skills. However this latter factor is considered to have only a modest role in all older driver crashes, due to older drivers' propensity to self-regulate, thereby reducing driving exposure (particularly to difficult or otherwise uncomfortable driving situations).

In explaining older drivers' heightened casualty crash involvement per distance travelled, the following have a particular role:

- for almost all, physical frailty;
- for many, a high level of urban driving;
- for some, reduced fitness to drive.

4 COUNTERING THE ‘OLDER DRIVER PROBLEM’ IN A SAFE SYSTEM CONTEXT

4.1 Safer roads

Older driver crashes are predominantly an urban problem.

In round terms, over two-thirds of all casualty crashes involving older drivers occur on urban roads, predominantly in low-speed zones, with one-half of all older driver crashes occurring at intersections (Langford et al., 2005). This pattern, and particularly the predominance of intersection crashes, has been widely confirmed, both in Australia and elsewhere in the world (OECD, 2001).

There have been many research studies which have examined older drivers’ difficulties with road design features (for a review, see OECD, 2001). In both the US (Federal Highway Administration, 1997) and Australia (Fildes, Corben, Morris, Oxley, Pronk, Brown & Fitzharris, 2000), engineering handbooks have been prepared which contain design recommendations for making the driving task easier and safer for older drivers, especially at intersections.

Oxley, Fildes, Corben and Langford (in press) have conducted in-depth analyses of older driver behaviour at 62 ‘blackspot’ (high-crash) locations around Australia and New Zealand, with intersections accounting for 97% of all locations. They concluded that while intersection design was rarely the primary cause of the crashes, improved design would have had substantial safety benefits and recommended greater use of roundabouts, fully controlled right-turn phases at intersections controlled by traffic lights and numerous other design features.

4.2 Safer vehicles

Older drivers’ frailty is a major determinant of crash outcomes.

Vehicle crashworthiness may be defined as an estimate of a driver’s risk of being killed or admitted to hospital once involved in a crash where at least one person is injured or one vehicle is towed away. Current vehicles, as a group, are twice as safe as vehicles manufactured some thirty years earlier (Newstead, Cameron, Watson, and Delaney, 2003). At the same time however, there is considerable variation in crashworthiness across modern vehicles: for example, the least safe model has more than five times the risk of death or serious injury in a tow-away crash, compared to the safest model.

Given older drivers’ additional need for protection in the event of a crash due to their frailty, the purchase of modern vehicles with maximum crashworthiness ratings is a paramount countermeasure. However it appears that this policy is currently not followed by many older drivers. In an analysis of fatal crashes in Australia (Langford et al., 2005), drivers aged 75 years and older were significantly more likely to be driving older vehicles, compared middle-aged drivers.

Older drivers have a distinct crash epidemiology

Langford and Mitchell (2003) examined fatal crash data for Australia to identify aspects of older driver crashes which can potentially be controlled by either active or passive in-vehicle ITS systems. The results are given in Table 6.

Table 6 Aspects of older driver crashes and ITS implications, Australia

Crash aspects	**% of drivers aged 75+ years**	**% of drivers aged 40-55 yrs**	**In-vehicle ITS Implications**
More likely to involve 'failure to see other road user' (responsible drivers in multi-vehicle crashes)	54.0	15.4	Front, rear and side collision warning devices relevant. Vision enhancement systems may have limited relevance.
More likely to occur at intersection and More likely to involve attempted right-hand turn (responsible drivers in multi-vehicle crashes)	64.0 36.0	21.2 7.7	Front, rear and side collision warning devices relevant. Note also an in-the-pipeline vehicle/infrastructure system, whereby a driver approaching an intersection is warned whether the next gap in the on-coming traffic is sufficient to allow crossing that stream into a side street (Oxley 1996).
More likely to occur during daylight hours (responsible drivers in multi-vehicle crashes)	92.0	73.1	Vision enhancement systems may have limited relevance while current driving patterns persist.
More likely to be killed once in a fatal crash (all drivers in crashes)	74.7	46.5	Stresses importance of using all appropriate in-vehicle crash-avoidance devices. Also stresses importance of smart restraint and occupant protection systems.
More likely to survive until admitted to hospital (all drivers in crashes)	39.8	5.9	Stresses the importance of emergency callout (mayday) systems to ensure earliest possible medical attention.
Less likely to occur in a modern vehicle - 5 or less years (all drivers in crashes)	11.5	38.9	Indicates that there will be difficulties in getting ITS options delivered promptly to older drivers.
Less likely to involve drink driving - bac >=0.05 (responsible drivers in multi-vehicle crashes)	2.0	13.5	Indicates that alcohol-interlocks will have little direct impact on older drivers' safety.
Less likely to (possibly/definitely) involve speed	6.0	26.9	Indicates that speed-alert and speed-control systems will have little direct impact (although they may protect older drivers from other drivers).

Notes: 1. '%' refers to the proportion of drivers – either 'all drivers in crashes' or 'responsible drivers in multi-vehicle crashes' - measuring positively for the specified aspect.

While it is currently impossible confidently to estimate the crash reduction benefits arising from the range of ITS applications (Regan, Oxley, Godley & Tingvall, 2000), ITS developments have considerable potential to improve older driver safety.

4.3 Safer speeds

Older drivers generally drive at or below posted speeds.

Given older drivers' characteristic slow travel speeds, speed policies within the Safe System approach are likely to have only a modest impact upon their own speed choices.

However reduced speeds are likely to lessen older driver crash involvement and reduce the severity of crash outcomes, if only because of the slower speeds of other drivers. In particular, effective steps in reducing all drivers' speeds when travelling through intersections (whether by means of lowered posted speeds or by traffic-calming measures) would have disproportionately high benefits for older drivers.

4.4 Safer road users

A minority of older drivers have reduced levels of reduced fitness to drive.

There are no rational grounds for implementing mandatory age-based testing of driving fitness for a group, the large majority of whose members are demonstrably as safe as or safer than drivers of other ages. Further, research suggests that age-based 'across the board' mandatory assessment has no demonstrable road safety benefits and may even result in an increased concentration of unsafe drivers on the roads (OECD, 2001).

At the same time, it appears that a minority of older drivers require assessment due to their reduced fitness to drive. Attempts to identify these drivers should focus upon those giving preliminary evidence of being at risk, without involving all older drivers in a formal assessment process. The proposed licensing model for managing older driver safety currently being developed and trialled in Australasia (Fildes, Pronk, Langford, Hull, Frith & Anderson, 2001) complies with this stance. The model's features include:

- the establishment of a network of community notification sources, whereby only drivers suspected to have a high crash risk are identified and referred to the licensing authority for formal assessment. It is proposed that notification sources include general practitioners, police, family and friends – as well as older drivers themselves;
- the use of multi-tiered assessment, involving general practitioners, occupational therapists and other health specialists at more elaborate levels of assessment;
- the use of assessment instruments of known validity for testing safe driving.

Older drivers with reduced levels of reduced fitness to drive, are not always aware either of their limitations or the crash implications.

Most Australian jurisdictions conduct education programs, directly targeting either older drivers through workshops and handbooks or their doctors through in-service seminars. These programs are similar to overseas endeavours delivered through a variety of formats (Eby, Molnar, Shope, Vivoda, Fordyce, 2003; Stutts and Wilkins, 2003; Roadwise Review^{TM}, 2004) which generally aim to assist older drivers to:

- assess their health, functional performance and driving skills;
- develop a better understanding of their crash risk;
- adjust their driving habits to reduce their crash risk – either through reduced exposure particularly to challenging situations or (in the extreme cases), through total cessation.

These educational efforts are fully consistent with the Safe System emphasis upon informed road users. However it needs to be recognized that not all older drivers might be responsive to these efforts and ultimately, other more direct measures may be necessary (for example, through referral to licensing authorities for assessment).

5 SUMMARY

Two principal objectives of Australia's Safe System approach to road safety are the prevention of crashes and where this fails, the management of crash energy to prevent the occurrence of deaths and serious injuries while using the transport system.

Older drivers pose a particular challenge in this context, given particularly their greater physical frailty, their preponderance of urban driving and for some at least, their reduced fitness to drive. An additional challenge lies in maintaining their safe mobility for as long as possible, in light of these factors.

This paper has analyzed the so-called 'older driver problem' and identified a number of key factors underpinning their crash levels, for which countermeasures can be identified and implemented within a Safe System framework. The recommended countermeasures consist of: (1) safer roads, through a series of design improvements particularly governing urban intersections; (2) safer vehicles, through both the promotion of crashworthiness as a critical consideration when purchasing a vehicle and the wide use of developed and developing ITS technologies; (3) safer speeds especially at intersections; and (4) safer road users, through both improved assessment procedures to identify the minority of older drivers with reduced fitness to drive and educational efforts to encourage safer driving habits particularly but not only through self-regulation.

The application of Safe System countermeasures will enable current and future older drivers to continue driving in relative safety, ensuring adequate access to the services and facilities as necessary to older people as to others.

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