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Cost-effective road safety measures for reducing serious casualty crashes in South Australia

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**Biography**
Craig Kloeden is a Research Fellow at the Centre for Automotive Safety Research at the University of Adelaide. He has worked in the road safety research area for the last 17 years and has conducted numerous studies, particularly in the areas of speed, alcohol, and roadside hazards.

**Abstract**

A large number of road safety countermeasures were evaluated as to their likely effectiveness in reducing the total number of serious casualty crashes in South Australia and the cost to government authorities of their implementation. The five most promising countermeasures identified were speed limit reductions in three speed zones, raising the age of licensure and sealing the shoulders on the outside of curves.

## INTRODUCTION

Road crashes are a major cause of serious injuries and deaths in South Australia (1,538 hospital admissions and 154 deaths in 2002 according to police records). The purpose of this study was to identify road safety measures that can be implemented by South Australian government agencies at a reasonable cost that have real potential to significantly reduce the number of serious casualty crashes (those crashes leading to a fatality or hospital admission) in South Australia.

Estimates were made of the effectiveness of many commonly suggested measures and the number of serious casualty crashes potentially affected by each measure was extracted from crash records. These numbers were then combined to produce an estimated reduction in all South Australian serious casualty crashes for each measure both in the first year of implementation and in the long term. The cost to government agencies of implementing each measure was also estimated.

This paper presents the five countermeasures identified as having the potential to produce the greatest reductions in the number of serious casualty crashes in South Australia at a reasonable cost to South Australian government agencies.

## SPEED LIMIT REDUCTIONS

The lowering of speed limits is potentially the most effective road safety measure available. The apparent exponential increase in the risk of a casualty crash with increasing travel speed (Kloeden, Ponte and McLean 2001; Kloeden, McLean and Glonek, 2002) means that even small reductions in speeds can be expected to have a major impact on the frequency of serious casualty crashes.

South Australia also has relatively high speed limits by international standards and the public perception of speed as an undesirable risk factor is growing. These factors mean that it may be politically feasible to lower South Australian speed limits and achieve significant road safety gains. Indeed, the default urban speed limit in South Australia was lowered from 60 km/h to 50 km/h on 1 March 2003 and associated large reductions in serious casualty crashes were observed (Kloeden, Woolley and McLean, 2004).

Table 1 gives the breakdown of serious casualty crashes in South Australia by speed limit zone. The 60 km/h roads are subdivided into those where the speed limit was dropped to 50 km/h on 1 March 2003 and those where the speed limit remained at 60 km/h.

Table 1
Percentage of serious casualty crashes
by speed limit zone, South Australia 1998-2002

| Speed limit at location of crash | % of serious crashes |
|---|---|
| 60 (default 50) | 20.6 |
| 60 (remaining 60) | 32.3 |
| 70 | 2.1 |
| 80 | 7.5 |
| 90 | 0.8 |
| 100 | 14.6 |
| 110 | 19.3 |
| Other/unknown | 2.8 |
| Total | 100.0 |

The question now becomes, how would lowering the speed limit by 10 km/h in each of these areas affect the number of serious casualty crashes in those areas? Two studies of the relationship between the risk of casualty crash involvement and travelling speed in South Australia provide a method for computing this (Kloeden, McLean, Moore, Ponte, 1997; Kloeden, Ponte, McLean, 2001; Kloeden, McLean, Glonek, 2002), given an estimate of the effect of a new speed limit on vehicle travelling speeds and assuming that the effect of speed on the risk of a serious casualty crash is roughly equal to that for the casualty crashes used in these studies (hospital treatment or greater with a slight bias towards more serious crashes).

Recent experience in South Australia in 60 km/h zones (Kloeden, Woolley and McLean, 2004) indicates that lowering a speed limit by 10 km/h leads to an initial reduction in the mean speed of vehicles of at least 2 km/h. The variance of the speed distribution also tends to decrease with more vehicles travelling closer to the new mean speed. For speed limits that have been in place for a long time, the mean vehicle speed tends to reflect the speed limit so it would seem reasonable that in the long term vehicle mean speed will tend towards a given speed limit. For a 10 km/h reduction in the speed limit, it therefore seems reasonable, as a first approximation, to assume that all vehicles will initially slow down by 2 km/h. This assumption is probably conservative because, as indicated above, fast vehicles appear to slow down more than the average, with a consequent greater reduction in their relative risk of casualty crash involvement. In the longer term we could expect a full 10 km/h speed reduction for all vehicles.

Table 2 shows the estimated reductions in serious crashes by speed limit zone from a 10 km/h reduction in speed limits resulting in a 2 km/h uniform speed reduction by all vehicles. Overall, we would expect to see a 13.5 per cent initial reduction in serious casualty crashes. Note that only 2.7 per cent of this reduction derives from the already introduced default 50 km/h limit and that the largest benefit is derived from extending that 50 km/h speed limit to the remaining 60 km/h arterial roads.

Table 2
Estimated reductions in serious casualty crashes
in South Australia assuming a 2 km/h uniform speed reduction

| Speed limit zone | % of serious crashes affected | Estimated % reduction in these serious crashes* | % Reduction in all serious crashes |
|---|---|---|---|
| 60 km/h (default 50) | 20.6 | 13 | 2.7 |
| 60 km/h (remaining 60) | 32.3 | 13 | 4.2 |
| 70 km/h | 2.1 | 13 | 0.3 |
| 80 km/h | 7.5 | 15 | 1.1 |
| 90 km/h | 0.8 | 15 | 0.1 |
| 100 km/h | 14.6 | 15 | 2.2 |
| 110 km/h | 19.3 | 15 | 2.9 |
| Total | 97.2 | | 13.5 |

* From Kloeden et. al. 2001, 2002

Analysis of the default 50 km/h urban speed limit in South Australia conducted by CASR indicates that for the roads where the speed limit was reduced from 60 km/h to 50 km/h, average vehicle speeds fell by 2.3 km/h and serious casualty crashes fell by 14.6 per cent. This is remarkably close to the predictions made here giving some confidence in the method.

The current free speed distribution of vehicles in Adelaide 60 km/h zones is roughly centred around 60 km/h. Thus, it would be expected that in the long term the distribution of driver travelling speeds would in fact decrease by the full 10 km/h reduction in the speed limit.

Table 3 shows the estimated reductions in serious crashes by speed limit zone from a 10 km/h uniform speed reduction by all vehicles.

Table 3
Estimated reductions in serious casualty crashes in
South Australia assuming a 10 km/h uniform speed reduction

| Speed limit zone | % of serious crashes affected | Estimated % reduction in these serious crashes* | % Reduction in all serious crashes |
|---|---|---|---|
| 60 km/h (default 50) | 20.6 | 38 | 7.8 |
| 60 km/h (remaining 60) | 32.3 | 38 | 12.3 |
| 70 km/h | 2.1 | 38 | 0.8 |
| 80 km/h | 7.5 | 46 | 3.5 |
| 90 km/h | 0.8 | 46 | 0.4 |
| 100 km/h | 14.6 | 46 | 6.7 |
| 110 km/h | 19.3 | 46 | 8.9 |
| Total | 97.2 | | 40.3 |

* From Kloeden et. al. 2001, 2002

Given that the speed limit has already been reduced on local and some collector roads (“default 50” in Table 3), the roads that appear to provide the greatest potential safety benefits from a 10 km/h lower speed limit are the remaining 60 km/h roads, 110 km/h roads and 100 km/h roads in that order.

The primary cost to Transport SA of changing the speed limit on these roads would be that of replacing the speed limit signs which is estimated to be $200,000, $120,000 and $130,000 for the 60, 110 and 100 zones respectively. This is a very small cost given the large and ongoing potential reductions in serious crashes.

Another potential cost to Transport SA or some other body is a media campaign to introduce the public to the speed limit changes and to encourage compliance although this has partly been dealt with already with the default 50 km/h speed limit introduction. The associated enforcement of the new speed limits would be expected to be self funding.

The increased travelling time associated with lower limits would have some social and economic ramifications although the increase in travel time would not be as great as the raw difference in speed limits suggests since traffic does not always have the opportunity to travel at the speed limit. This would also be offset to some extent by the potential environmental benefits of vehicles travelling at more efficient speeds.

Perhaps the biggest cost to be paid is a political one. A government introducing radical speed limit reductions will not be popular with a segment of the population. However, this is a one-off cost and even if only part of the benefits predicted here are obtained, serious road crashes will soon reach all time lows which has political benefits in itself.

**DELAYING YOUNG DRIVER LICENSURE AGE**

Currently, in South Australia, a driver can obtain a learner's permit at 16, a provisional licence at 16 and a half, and a full licence at 19 years of age. Most other states in Australia have a minimum provisional licence age of 17. Victoria has a minimum provisional licence age of 18.

Among South Australian serious casualty crashes between 1998 to 2002, 8.1 per cent involved at least one 16-17 year old motor vehicle driver and 6.0 per cent involved a 16-17 year old motor vehicle driver judged by the police to be responsible for the crash.

Raising the minimum provisional licence age in South Australia to 18 years would have the effect of gradually decreasing the number of 16-17 year old provisional drivers on the road until after 18 months there would be very few (all illegal) 16-17 year old drivers on the road, apart from those on a learners permit.

A first approximation of the expected serious casualty crash reductions is between 6.0 and 8.1 per cent. The lower percentage assumes only crashes currently caused by 16-17 year old drivers are eliminated and the higher percentage assumes all crashes involving 16-17 year old drivers are eliminated. However, there are a number of factors that would limit these reductions:

- more 16-17 year olds would be expected to drive illegally
- the crash rates of older aged drivers would be expected to go up due to greater exposure from driving 16-17 year olds around on trips they would otherwise not have taken
- to the extent which safer driving is related to raw driving experience rather than physical age, crash rates among at least the 18 year olds would be expected to rise due to this group having less driving experience

None of these factors appears likely to have a large effect. Therefore, raising the licensure age from 16.5 to 18 could be expected to lead to a reduction of about 6 per cent in the number of serious casualty crashes in the long term. In the first year this would be about 2 per cent as the change was phased in.

As these changes would be purely legislative there would be no direct cost to Transport SA apart from a small and temporary loss in revenue from licence fees.

There may be political costs to a government introducing higher age of licensure as it will not be popular especially among young people. However, this would be offset to some extent by support from many parents concerned about the safety of their children driving on the road at a young age.

## SEALING ROADSIDE SHOULDERS

The unsealed shoulders of sealed roads are a major hazard for drivers in rural areas. A typical crash sequence involves: the left wheels of a vehicle running from the left edge of a sealed section of road onto a gravel or dirt shoulder; a sharp correction to the right by the driver to bring the vehicle back on to the roadway; the vehicle yawing violently to the right as the front left wheel makes contact with the sealed roadway, leading to the vehicle ultimately leaving the roadway or colliding with another vehicle.

The sealing of road shoulders combined with edge lining and preferably incorporating audible markers has been shown to be very effective in preventing this type of crash (Newstead and Corben, 2001).

In South Australia, between 1998 and 2002, 24 per cent of serious casualty crashes were on sealed roads with a speed limit of 100 km/h or 110 km/h. Analysis of CASR in-depth crash investigations of rural crashes in South Australia for this study indicated that about 32 per cent of such crashes involve a vehicle losing control on an unsealed shoulder in situations where the crash probably would have been prevented had there been a sealed shoulder present.

Some proportion of these crashes would still occur even with a sealed shoulder. We do not know what that proportion is and so we make an educated guess that it is about 20 per cent. Assuming then that sealing the shoulders of all such roads would be 80 per cent effective, the effect on overall serious casualty crash numbers of sealing all such shoulders would be a 6 per cent reduction (24% x 32% x 80%).

Currently, there are about 11,500 km of sealed rural roads and national highways in South Australia controlled by Transport SA. Of these, only about 650 km (5.7%) have a seal width (width of seal beyond the marked edge of the lane) of 0.5 m or greater. The cost of sealing the remaining 10,850 km would be around $760 million (at an average rate of $70,000 per km to seal both sides of the road).

Thus, spending $760 million could be expected to reduce serious casualty crashes by 6 per cent which equates to 85 fewer serious casualty crashes per year. Assuming a 10 year life of the road seal, the cost is $76 million per year or about $900,000 per serious casualty crash eliminated.

These figures are averages for the whole network and considerably greater cost effectiveness could be achieved by only sealing the shoulders of high volume or high crash rate sections of road.

Analysis of CASR in-depth crash investigations for this study indicate that about 64 per cent of shoulder involved crashes occur on the outside of a curve in the roadway. Assuming that sealing the shoulders on the outside of curves on all rural 100/110 km/h roads would be 80 per cent effective there would be a 4 per cent reduction State-wide in serious casualty crashes (24% x 32% x 64% x 80%).

Assuming that curves account for about 5 per cent of the total road length State-wide (an educated guess since firm data is not available) and given that only one side of a curve needs to have the shoulder sealed, the cost of sealing all such shoulders would be around $19 million.

Thus, using the above assumptions, spending $19 million could be expected to reduce serious casualty crashes by 4 per cent which equates to 54 fewer serious casualty crashes per year. Assuming a 10 year life of the road seal, the cost is $1.9 million per year or about $35,000 per serious casualty crash eliminated.

The above estimates of the safety benefits of shoulder sealing do not allow for the time taken to carry out the initial sealing. Consequently the costs and benefits should both be discounted until such time as sealing is completed at all relevant locations. Since it would take considerable time to seal approximately 500 km of shoulder the reduction in serious casualty crashes in the first year is estimated to be 1 per cent.

## SUMMARY

Out of a large number of road safety measures considered for reducing serious casualty crash numbers in South Australia, five were found that appear to be highly effective, affordable and politically feasible. They are summarised in Table 4.

Table 4
Top five most effective and affordable
road safety measures for South Australia

| Measure | Estimated per cent reduction in serious casualty crashes | | Direct cost |
|---|---|---|---|
| | First year | Long term | |
| 50 km/h limit on remaining 60 km/h roads | 4.2 | 12.3 | $200,000 |
| 110 km/h roads to 100 km/h | 2.9 | 8.9 | $120,000 |
| 100 km/h roads to 90 km/h | 2.2 | 6.7 | $130,000 |
| Raise age of licensure to 18 years | 2.0 | 6.0 | - |
| Seal shoulders on the outside of curves | 1.0 | 4.0 | $19,000,000 |

The full range of measures considered will appear in an upcoming CASR report.

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