Peer-reviewed papers

Can radar detectors and safety warning system (SWS) signals improve road safety?

by CM Rudin-Brown and M Cornelissen, Human Factors Team, Monash University Accident Research Centre (MUARC), Monash Injury Research Institute (MIRI)

Abstract

The relationship between speed, crash risk and crash severity is well documented. In-vehicle radar detectors are small, specialised radio receivers tuned to the frequency range used by police radar guns. These devices make it possible for drivers to detect police radar efforts and to alter their travel speed. Safety Warning Systems (SWS) emit pre-programmed radar signals that can be received by radar detectors up to one kilometre away, and can provide warnings to an equipped vehicle regarding potential road safety hazards. SWS have been promoted by some as inexpensive and practical warning devices that can be used within existing infrastructure; however, it is unclear whether any potential benefits would outweigh speeding-related costs. An independent review of the survey, observational and crash data literature pertaining to SWS and radar detectors was conducted. Collectively, the literature indicates that, because radar detectors are used predominantly by an already high-risk group of drivers, their application as receivers of SWS signals is unlikely to result in overall benefits to road safety.

Keywords

Crash risk, Drone radar, Road safety, Speed choice

Introduction

The relationship between speed and crash risk is well documented [1-6]. Each year in Australia over 1,400 people die as a result of road crashes. Speeding is a contributing factor in about 34 % of Australian road deaths and 13% of serious injuries [7]. The yearly economic cost to society of speeding-related crashes is high. In Australia in 2006, the Bureau of Transport Economics estimated that road trauma costs the Australian community almost $18 billion annually [8]. In the United States in 2007, the annual cost was estimated to be $40.4 billion [9]. Driving at high speeds reduces the available time margin for a driver to recognise and respond to hazards in the road environment and makes lateral control of the vehicle more difficult [1, 4]. In turn, crash severity is also highly affected by impact speed [10].

In-vehicle radar detectors - small, specialised radio receivers tuned to the frequency range used by police radar guns - make it possible for drivers to detect police radar efforts and to alter their travel speed to avoid penalties for speeding infractions [11]. Radar detectors are illegal in many jurisdictions around the world, including most European countries, Canadian provinces and territories, and American states. In Australia, the use of in-vehicle radar detectors is prohibited in all states except Western Australia. In keeping with Australian Road Rule 225 *Using radar detectors and similar devices*, the Government of Western Australia is drafting proposed amendments that will ban the fitment and use of radar detectors by drivers. There is opposition, however, from certain driver lobby groups that argue against the proposed ban and contend that radar detectors offer safety benefits by allowing drivers to be more aware of their speed and to slow down. More specifically, the primary benefit advanced by these lobby groups is the ability of some radar detector devices to detect warning signals emitted by Safety Warning Systems (SWS) and drone radar. SWS are pre-programmed devices that emit radar signals that can be received by radar detectors up to one km away. 'Smart' detectors can, in turn, provide an audible and/or visual warning to a driver regarding a potential road safety hazard [12]. Drone radar simulates the presence of law enforcement by transmitting signals using the same radar frequency, therefore activating radar detectors in passing vehicles. According to the Australia Drivers' Rights Association (ADRA), as of 1 June 2010, there were approximately 170 SWS transmitter locations in Western Australia.

The aims of the present review were to investigate the road safety impacts of radar detector use by drivers, and of SWS signals transmitted from roadworks sites, emergency vehicles and black spot locations being received by users of radar detectors.

Method

The relevant road safety literature pertaining to SWS and radar detectors was sourced through an extensive search of national and international road safety research, transport and road links websites and research databases using appropriate key words.

Literature review

Research has indicated that the presence of in-vehicle radar detectors contributes to drivers' non-compliance with highway speed limits. For example, in a random sampled telephone survey in the United States, 58% of radar detector users said they drove faster than they would without a radar detector and 75% of the users said that the apparatus saved them from at least one speeding ticket [11].

Besides those that only detect police radar emissions, there are also so-called 'smart' radar detectors that can also detect SWS messages. When activated, SWS emit pre-programmed messages that can warn a driver through the use of either an audible tone or a visual (on-screen) message. There are currently 64 standard messages that can warn drivers, amongst other things, of accidents, lane closings, severe weather conditions, road construction, and the presence of emergency vehicles. It has been asserted that other radar detectors, which are not SWS-compatible, can nevertheless detect SWS signals; however, they generally produce only a simple audible tone and do not display standard SWS messages [13].

One of the benefits of SWS is that they can be used immediately within existing infrastructure; this makes them inexpensive and practical to implement. Furthermore, it is possible to use SWS technology in a safety warning-only receiver system capacity that displays highway safety and information messages only, while not being able to detect and alert a motorist to the presence of police radar [14].

The question remains as to whether the proposed benefits of SWS signals on road safety are, in fact, accurate. Are radar detectors really a means of improving safety on our roads? To answer this question, available survey, observational (on-road), and crash (insurance) data studies were reviewed.

Surveys of radar detector owner/users

Three surveys of radar detector users were found to be prominent in the international discussion concerning banning of these detectors [15,16, 17]. Probably the most referred-to study in the debate is a study by Yankelovich, Clancy, and Schulman [15]. Unfortunately, the original, complete report is not publicly available; therefore, only highlights and abstracts as described by other sources are presented. The ostensible purpose of the study was to determine whether there was a significant difference in the accident rate per miles driven of users vs. non-users of radar detectors in the United States. Researchers selected two samples of participants for a telephone survey: one consisted of 1000 randomly drawn drivers, and the second consisted of 1000 recent purchasers of radar detectors (although only 805 reported having and using a radar detector at the time of the survey). Radar detector users were found to report driving, on average, twice the mileage of non-users. The authors of the study conclude that radar detector users are at least as safe as non-users because they drive more miles between collisions (233,933 miles for users vs. 174,554 miles for non-users). A limitation of the survey, however, is that the two samples were not balanced across any other, possibly contributory, factors. This makes it difficult to conclude whether the difference in mileage driven is due to radar detector use or because of other reasons.

Users of radar detectors believe that they are safer drivers when using their radar detectors than when not using them [16]. A multi-method survey of radar detector users undertaken by the Australian Drivers' Rights Association (ADRA) revealed that 75% of drivers interviewed believed that they were safer drivers with their detector. Unfortunately, the original ADRA survey data is not publicly available; therefore, it was not possible to systematically review the survey methodology used. Three hundred radar detector owners in Australia were randomly selected for the survey that was conducted by telephone, fax and email. For an unknown reason, only the first 200 responses were analysed. Non-users of radar detectors were not included. Users reported driving between 12,500 and 25,000 miles (20,000 – 40,000 kms) annually. 93% of respondents were male and 37 %were aged between 26 and 35 years old. When asked about their driving behaviours when using radar detectors, 41% of the sample reported not slowing their average speed after fitting a radar detector. Those who reported that they drove faster than the posted speed limit reported that they only did so in rural areas and that they stayed with the flow of traffic. Almost 70% of respondents said they were more aware of enforcement while using a radar detector, and 86% reported being more aware of their speed, speed limits (71%) and driving conditions (82%). Two-thirds of the respondents reported that the use of radar detectors helped them combat fatigue. Interestingly, 4% of respondents reported having been involved in an accident, and 45% reported that they had received one or more speeding tickets since they purchased their radar detector.

Radar users and non-users appear to differ on a number of driving-related and demographic characteristics. A telephone-based survey of over one thousand radar detector users and non-users, conducted for the Drivers' Technology Association in the UK, was designed to gain insight into drivers' behaviour and attitudes towards in-vehicle radar detectors [17]. Results showed that users and non-users differ in characteristics including annual mileage driven, employment status, and type of vehicle model owned. In general, users of radar detectors were found to drive almost twice the annual mileage of non-users. Further, compared to non-users, a larger proportion of users were employed full-time, had higher incomes, and were more likely to driver a high performance vehicle (e.g. Audi, Volkswagen, BMW, Mercedes or Jaguar), which, in turn, were also more likely to be equipped with other in-vehicle technological features [17]. Users of radar detectors also reported travelling 50% further between collisions than did non-users. Interestingly, 75% of users reported that they had become more aware of the speed limit since purchasing a radar detector and that purchasing a radar detector had had a positive effect on their driving behaviour.

Because of limitations in methodology, it is difficult to draw conclusions from these studies regarding whether radar detector users are safer drivers than non-users. Radar detector users reported that they are more aware of speed limits and their speed than non-users. The data suggest, however, that non-users are naturally more aware of their own speed than users, as users only appear to gain this awareness after the purchase of their radar detector. Whether the awareness of speed results in corollary changes in driving behaviour is questionable; only 41% of users reported having slowed their average speed since beginning to use a radar detector and, despite having one, many (45%) report continuing to receive speeding tickets. The lack of objective performance data associated with the above surveys prevents reliable conclusions from being drawn regarding the safety of users vs. non-users. Observational (on-road) studies should provide more objective evidence of any differences between user vs. non-user groups.

Observational studies

Potentially, experimental and/or observational studies can provide objective evidence regarding the effect of radar detectors, and whether there are safety benefits associated with the use of these devices. Observational studies typically use a variety of methods to measure the speed of vehicles and whether they are equipped with radar detectors. For example, to measure the speed of passing traffic, typically non-detectable speed measuring devices (e.g. in-pavement loop detectors or retuned radars) are used to determine the normal mean traffic speeds. Following this first measure, regular police radar emissions, which can be received by radar detectors, are then activated. The resulting speed change (if effected) is then measured using the non-detectable speed measuring devices. Vehicles that change their speed by a certain threshold after the regular radar has been used are then presumed to be equipped with a radar detector. Studies may also use the observation of brake light activation following the discharge of regular radar to determine whether vehicles are fitted with a radar detector. Finally, radar-detector-detectors (devices that can detect the presence of a radar detector within vehicles) have been used by some researchers to provide a more reliable measure of radar detector usage [18].

Effects of SWS signals on vehicle speeds

Vehicles equipped with radar detectors slow down when in proximity to SWS signals. For example, an observational study conducted in work zones in the US measured speed in passing vehicles under three conditions: no transmitter activity, a drone radar signal, or SWS messages. Speeds were subsequently measured at three stations: road tube station, data collection vehicle station, and radar station. A radar-detector-detector was used to determine whether passing vehicles were equipped with radar detectors. Results showed no significant changes in speed, probably due to the low level of use of radar detectors in the traffic stream. When data of individual vehicles were analysed, however, the majority of the vehicles with radar detectors were found to slow down, and to do so more when exposed to a SWS message than to a drone radar signal or no signal at all [10].

Studies in the US in which multiple devices, including a SWS, were evaluated revealed mixed results. Reports from Iowa [19] showed no significant change in measured vehicle speed. Speed was measured in a work zone involving a left lane closure with a crossover leading into two-way traffic. Data was collected two days prior to, and two days following, the installation of the SWS. None of the speed measures showed a significant difference. According to Robinson et al. [20], the lack of an effect might have been due to the small number of vehicles equipped with radar detectors in the traffic stream. In Kansas, however, researchers [21] also installed a SWS on a crossover point in a work zone. There they measured speed prior to reaching the crossover and half way through the crossover bend. The data of the prior measurements were not usable, but measurements taken in the curve were, and they showed a significant decrease in speed after installing the SWS.

Although there are indications that SWS might be more beneficial than the use of radar drones in reducing speeds of radar detector-equipped vehicles, this cannot be concluded based on the above studies. This is especially true since users of older detectors will receive the same signal in their vehicle regardless of whether the transmitter is an SWS or drone radar. The use of drone radars will be discussed next.

Effects of drone or police radar on vehicle speeds

Results from observational studies examining the ability of drone radar to reduce vehicle speed are generally inconclusive. Streff, Kostyniuk and Christoff [22] evaluated the effectiveness of drone radars in reducing speed (with and without police patrol car presence) on a US freeway (speed limit of 65 mph or 105 km/h) and in a construction zone (speed limit of 55 mph or 90 km/h). Measurement conditions varied. The radar drones were either on or off; police patrols were present or not; and speed was measured at three locations (upstream, at, and downstream of the drone radar). Different speed measures were used. Presence of radar detectors was measured using radar-detector-detectors. Results from the freeway and the work zones appeared to be consistent. Approximately five % of the traffic stream was equipped with a radar detector. The results show that the actual differences in mean speed were small (between 1 and 1.5 mph), but statistically significant. However, differences between measurements in the opposite directions showed that other factors influenced the speed of passing traffic. Surprisingly, the additional presence of police patrols did not cause practical reductions in the speed of the vehicles, which is contrary to findings of other studies (see next paragraph). Further, the speed reducing effect of drone radar was consistently found for commercial vehicles, which are generally more likely than other vehicle types to be equipped with radar detectors.

Roadwork zones

Observational studies find that vehicles equipped with radar detectors were generally speeding more before the radar detectors were activated [23]. Further, research by Ullman [24] has found that any safety benefits probably would not be observed by using SWS alone, but rather in combination with warning signs, for example.

Turochy [25] reports a study that found a speed control effect of drone radar in freeway working zones. On-site data were collected in several work zones. Speed measurements were conducted upstream as well as near the unmanned radars. The results showed significant reductions in mean speed and the percentage of traffic that was exceeding the speed limit. Interestingly, unmanned radar was most effective when police presence was expected by drivers. This has been confirmed by Benekohal [26] who, despite not obtaining consistent results, showed that speed reductions were not as effective when drivers knew the radar was a drone than when they did not.

A recent (2007) study of drone radars in South Carolina (US) work zones by Eckenrode and colleagues [23] used a radar-detector-detector to identify those vehicles equipped with active radar detectors. Results revealed a 10 km/h decrease in speed in those vehicles that were equipped with radar detectorsalthough the sample size for these types of vehicles was insufficient to run a statistical test. While statistically significant, speed reductions were more conservative, however, in terms of reducing mean speeds of all traffic (reduction of ≅3km/h), and in the percentage of vehicles that were exceeding the speed limit (reduction of 2 – 8km/h).Further, observed speed reductions were of only brief duration. Of particular interest was the observation that, when the drone radar was turned off, major differences between the vehicle groups were observed. Radar detector-equipped vehicles travelled much faster than non-detector-equipped vehicles, which is the opposite of what happened when the drone radar was turned on. The researchers conclude that, due to the ease of installation and low costs involved, radar detector use might be effective to reduce speeds in certain radar-equipped vehicles.

Several studies have found interaction effects concerning vehicles equipped with radar detectors vs. those that are not. Ullman [24] found different effects for those vehicles observed to be exceeding the speed limit, and for trucks. Speed measurements were collected upstream from, and in, a work zone, and speed changes within the work zone as well as vehicle conflicts were recorded. Results showed that, across seven of eight sites tested, radar signals were associated with minimal (0.3 to 2.5 km/h) speed reduction effects on average speeds within the work zone, and this effect was only statistically significant at two of the eight sites. The greatest effect, however, was demonstrated by those who were approaching the work zone with a speed greater than 105 km/h (the speed limit), and by trucks. Ullman notes that this coincides with the observation that those target vehicles (speeding and commercial vehicles) are generally more likely to be equipped with a radar detector than other vehicles. Interestingly, these researchers also looked at vehicle conflicts during their study and found that crashes due to severe braking may increase in the presence of radar signals.

As part of a larger research project, Carlson, Fontaine and Hawkins [27] tested the effect of drone radar on speed reduction in a work zone and found an interaction with the use of other devices. Speed reductions as a result of the drone radar were marginal (≅ 3.2 km/h) and were not statistically significant. Radar drones were also tested alongside other devices, like warning signs. Together with advisory signs of the temporary speed limit, speed of cars was reduced significantly (≅4.8 km/h) and it reduced the number of vehicles exceeding the maximum speed limit. These researchers note that, in previous research, it has been noted that commuters and truck drivers who drive the road regularly become suspicious if no obvious enforcement is in place.

The effectiveness of drone radars appears to depend on several factors. On the basis of their literature review, Eckenrode and colleagues [23] concluded that effectiveness depends on three factors: the number of radar detectors in the traffic stream, the frequency used (as some bands have more false alarms than others), and whether drivers are actually deceived that there is police presence. It was also suggested that, with advancements in the sophistication of radar detector technology, drone radars were becoming less effective at reducing speeds. The review also concluded that only a limited number of studies have been conducted in the United States since 1995, the year in which radar detectors became illegal, and thus the number of radar detectors in the traffic stream is reduced [23].

Blackspots/high accident zones

A study by Pigman et al. [28], undertaken in a high accident zone in the US state of Kentucky, involved the assessment of unmanned radars as well as the diversion of trucks onto a bypass route. Speed-related data were collected over time and a survey on radar detector use was undertaken. Differences in mean speed following installation of the unmanned radars were small; however, the individual speed of vehicles with radar detectors decreased significantly, while those of vehicles that were not equipped with radar detectors was not affected.

Long-term effects

Although research has found that speed is reduced when police radars are activated, direct empirical evidence regarding the duration of speed reduction is lacking [11]. Two separate studies were conducted to determine the duration of speed reductions caused by radar detector exposure. In the first study, speed of ambient traffic was measured using an inductance loop. Speed measurements were made in five different conditions: a) no police radar present, b) police radar at inductance loop, c) police radar one mile before the loop, d) police radar 2 miles before the loop, and e) police radar 5 miles before the loop. Results showed that when speed was measured directly after exposure to the police radar, the vehicles exceeding the speed limit by 10 mph decreased from 42% to 28%. Measurements taken one mile after police radar activation showed that 38% of vehicles were travelling more than 10 mph above the speed limit again. By two or five miles after exposure to the police radar, 40 % of vehicles were exceeding the speed limit by more than 10 mph [11].

In a second study (reported in [11]), only speeding vehicles were included in the analysis. Speed of a vehicle was measured at five different locations. First, a non-detectable speed measurement device was used. If this device indicated that a vehicle was speeding, a detectable radar was then directed towards the vehicle, and speed was re-measured (1, 3 and 4 miles after activation of the detectable radar) and potential lane changes and brake light activation were observed. Results revealed that, of those vehicles speeding (more than 10 mph above the speed limit, which was 65 mph on this particular stretch of road), 39% reduced their speed by at least five mph after activation of the detectable radar. In total, 44% of the vehicles reduced their speeds by at least five mph or activated their brake lights (without receiving obvious traffic obstructions), which suggests that 44% of the speeding vehicles passing the study zone were using active radar detectors [11]. Speed measurements also revealed that speed prior to detectable radar activation was, on average, higher for those assumed to be using radar detectors than for those assumed not to be using radar detectors. After activation of the detectable radar, the vehicles assumed to use radar detectors slowed down by more than 10 mph, while other vehicles only slowed down by 1 mph, on average. The speed of the vehicles with assumed radar detectors was equivalent to the other speeding vehicles again four miles after radar activation; however, it did not return to the speed level recorded before activation within those four miles. The authors of the study therefore conclude that radar detectors do not induce long-term compliance with speed limits, and view the results as supporting their contention that the motivation for buying a radar detector is to avoid speeding-related infractions.

To conclude, results from observational studies reveal that radar detector users generally seem to drive faster than non-users. Upon detecting radar signals, however, users decrease their speed more than non-users. Whether this has an effect on the flow of the general traffic stream remains to be determined. Furthermore, the speed reduction related to radar detectors is greatest directly after exposure to a detectable radar. By approximately three to five kilometres after the exposure, effects are largely nonexistent. This effect may be similar in nature to the 'halo' effects (lasting effects over time or distance from a speed enforcement treatment) observed upstream and downstream of other speed enforcement approaches, including speed cameras and police presence [29-31].

Analysis of crash data of radar users vs. non-users

There is no conclusive research evidence regarding whether higher speeds are an expected outcome resulting from the protection offered by radar detectors, or whether those who own (and use) such devices would be faster drivers than others regardless of radar detector use. While radar detector manufacturers and lobby groups claim that those who use detectors are actually better drivers and have fewer accidents per kilometre driven than those drivers who do not use radar detectors, such claims are difficult to evaluate without more solid data concerning the safety impact of radar detectors [32].

In an effort to provide an objective answer to the question of whether radar detector users are less safe than non-users, researchers in Canada used records of an insurer -Insurance Cooperation of British Columbia (ICBC) - to sample participants [33]. Radar detector users were identified by categorising claims and policies in which radar detectors were listed. The researchers acknowledged that the group of users that took out the extra insurance probably was not representative of the general population, and this was confirmed as this group were more likely to be younger, male, owners of expensive cars, and they were more likely to drive either to/from work or as part of their work than the general population. As a consequence, the researchers controlled the sample for exposure. However, because of the non-representativeness of the sample, conclusions based on the results can only be extended to the subgroup of male drivers between ages of 21 and 42 who drive for business purposes or to/from work, typically in medium- or higher-priced vehicles. For that group, and controlled for exposure, radar detector ownership was associated with significantly higher rates of collision claims per year in general as well as for those where the driver was at-fault or for those occurring on weekends with only a single vehicle involved. The radar detector users in this subgroup were also convicted of speeding more often than were non-users.

Based on these results, and the attempt to control for as many factors as possible, it was concluded that radar detector users in the subgroup under study were less safe than non-users. However, a cause-and-effect relationship between owning a radar detector and driving less safely could not be concluded. Rather, ownership of a radar detector was put forth as being indicative of a predisposition toward more risky driving behaviour in the first place [33].

Discussion

The main question guiding this review was: 'Will radar detectors and, specifically, those that can receive SWS messages, increase safety on our roads?' This is a very broad and complex question; however, it can be answered on the basis of the literature reviewed above.

It seems that, based on the literature reviewed,the use of radar detectors is more prevalentin large commercial trucks than in cars. Furthermore, radar detector use seems to be largely restricted to a particular subgroup of the population: young men, with good jobs and high performing cars, who drive long distances [24]. Claims regarding the effects of radar detector use can therefore only be made regarding this subgroup of drivers. This subgroup generally seems to speed more often than the general population, which may be either because they feel protected by the radar detector, or because they are more predisposed to speeding in the first place—the available data does not allow for determination of cause and effect.

When radar emissions are received by vehicles equipped with radar detectors, drivers of those vehicles appear to reduce their speed more than non-users (as non-users do not detect the signal of the radar detector), and will then show slower speeds than non-users [24]. After a few miles, though, the effect seems to diminish and the users are either back to their previous speed or to the speed of the traffic flow locally [23]. These transient effects of speed enforcement treatments are often referred to as 'halo effects' and have been observed as a consequence of other speed reduction techniques including speed cameras and visible police presence [29-31].

Based on the literature, the transmission of radar or SWS messages seems be associated with reduced average speeds for the high-risk driver subgroup described above. These speed reductions appear to last only for a short distance within a local area. The effect is only temporary; the literature suggests that it would not result in reduced average speeds of the entire traffic stream, and vehicle collisions due to the braking of those drivers responding to the radar signal have been reported [24].

Whether the use of radar detectors makes drivers safer is difficult to determine. The research is inconsistent. Surveys find that people report that they are safer drivers when using a radar detector and that radar users report driving more kilometres in between collisions than non-users. However, samples are non-representative and, therefore, user and non-user groups are not comparable. Furthermore, the surveys are based on self-reported data, which is recognised as being limited methodologically [34]. Interestingly, a crash data evaluation study that controlled for exposure within its sample found that radar detector users were actually found to be less safe than non-users [33]. One further issue regarding the research literature in the area of SWS and radar detectors is that it is relatively old—most likely because the use of radar detectors has been prohibited in much of the western world since the mid-1990s.

Whether the results should encourage or discourage the use of radar detectors should be subject to more in-depth research. For example, controlled or driving simulator experiments could be used to investigate the effect of radar detector use on a wider group of the general population and under different circumstances. This would overcome some of the limitations within the current literature described above, for example, the non-representativeness of samples. Also, the question remains as to whether the benefits of speed reduction locally due to the use of radar detectors outweigh the costs of speed increases in areas that are not under radar transmission by those same drivers. That is a question that is impossible to answer based on the reviewed research.

Finally, the effects of prolonged exposure to radar warning transmissions by radar detector users are not known. Research suggests that, if vehicles are exposed to drone radars without obvious enforcement for long periods, they will be less likely to decrease their speed; however, there is, at present, no objective research available to confirm this contention.

Conclusions

The literature review identified a number of survey, observational and crash data studies that have been undertaken in the area of radar detectors, owner characteristics, and driver speed choice. Limitations associated with some of these research methodologies, in particular with surveys and observational studies, limit the extent to which the findings can be used to inform definitive conclusions. Despite these limitations, the available literature revealed several reliable findings. These include:

- In-vehicle radar detectors are associated with non-compliance of highway speed limits.
- Drivers of vehicles equipped with radar detectors tend to be predominantly young, employed males, who own expensive, high-performance vehicles.
- Compared to others, drivers of vehicles equipped with radar detectors tend to drive greater distances and be involved in more collisions (make more insurance claims).
- Collectively, results from observational studies indicate that the presence of SWS or drone radar signals results in small (3 to 10 km/h) but significant reductions in the speed of radar detector-equipped vehicles in their vicinity.
- The speed reduction effects of radar detectors are limited to vehicles that are equipped with an active device.
- The speed reduction effects of radar detectors are limited to a small area (approximately 3 km) around the location of a SWS/drone radar.
- Some research has found an increase in crashes in areas surrounding drone radar emissions. This may be due to increases in speed variability between those vehicles equipped with radar detectors vs. those that are not.
- There are currently a limited number (approximately 170) of SWS transmitters in use in WA.

To conclude, because radar detectors are used predominantly by an already high-risk group of drivers (young, affluent males who own high performance vehicles and drive long distances), the application of radar detectors as receivers of SWS and drone radar signals is unlikely to result in overall benefits to road safety. Such a system would only be of benefit to *temporarily* and *locally* reduce the speed of those target vehicles equipped with radar detectors, which are already likely to be exceeding the speed limit (possibly due to the pre-existing presence of an active radar detector). A focus by jurisdictions on more recently developed, in-vehicle advanced driver assistance systems (ADAS), such as Intelligent Speed Adaptation (ISA), would be more likely to result in significant gains in overall road safety.

References

1. Davis, G.A., Davuluri, S., & Pei, J. P. (2006). Speed as a Risk Factor in Serious Run-off-Road Crashes: Bayesian Case-Control Analysis with Case Speed Uncertainty.Journal of Transportation and Statistics. 9(1): p. 17-28.
2. Kloeden, C., & McLean, J. (1998). How traveling speed relates to the risk of crash involvement.ITE Journal. 68(9): p. 16-17.
3. Kloeden, C.N., & McLean, A. J. Rural speed and crash risk in Road Safety Research, Policing and Education conference. 2001. Melbourne.
4. Liu, G.X., &Popoff, A. (1997). Provincial-wide travel speed and traffic safety study in Saskatchewan.Transportation Research Record. 1595(8-13).
5. TRB (1998). Managing speed: review of current practice for setting and enforcing speed limits. SR254:Transportation Research Board
6. Vorko-Jovic, A., Kern, J., &Biloglav, Z. (2006). Risk Factors in Urban Road Traffic Accidents.Journal of Safety Research. 37(1): p. 93-98.
7. Dept. of Infrastructure Transport Regional Development and Local Government (2011). Road deaths Australia: May 2011 summary. Canberra.
8. Bureau of Infrastructure Transport and Regional Economics (BITRE) (2009). Cost of road crashes in Australia in 2006. Research Report 118:November: Canberra.
9. NHTSA (2007). Traffic safety facts: 2007 data. Speeding. Report number DOT HS 810 998: Washington, DC.
10. OECD (2006). Speed Management Summary Document. European Conference of Ministers of Transport/OECD Joint Transport Research Centre
11. Teed, N., A.K. Lund, and R. Knoblauch (1993). The duration of speed reductions attributable to radar detectors.Accident Analysis and Prevention. 25(2): p. 131-137.
12. Australian Drivers Rights Association.(2011). ADRA. [cited 5 July 2011]; Available from: www.adrawa.com.au/sws.htm.
13. Scaduto, T. (1996). Driving intelligence: now radar detectors can alert you to road hazards, approaching emergency vehicles and a lot more than just speed traps.Popular Mechanics. October: p. 66-68.
14. Greneker, E.F. The safety warning system: An in-vehicle signing system using an existing infrastructure of 10 to20 million vehicular receivers. in Proceedings of 7th Annual Meeting and Exposition of Merging the Transportation and Communications Revolutions. 1997. Washington, DC.
15. Yankelovich.(1987). Yankelovich Clancy Schulman Radar Detector Survey Highlights. [cited 6 July 2011]; Available from: www.carr.org.au/d-yankelovich.pdf.
16. Safety Warning System (2001). Speed, radar detectors and safety: New Australian survey validates concept behind SWS [Electronic version]. SWS Monitor. p. 1-2.
17. Leaman, J. and J. Down (2001). Radar Detector Survey.MORI.
18. Freedman, M., A.F. Williams, N. Teed, and A.K. Lund (1990). Radar detector use and speeds in Maryland and Virginia. Insurance Institute for Highway Safety: Arlington.
19. Kamyab, A., T.H. Maze, S. Gent, and C. Poole. Evaluation of speed reduction techniques at work zones.in Proceedings of the Mid-Continent Transportation Symposium. 2000. Ames, Iowa.
20. Robinson, M., P. McGowen, A. Habets, and C. Strong (2002). Safety applications of ITS in rural areas. DTFH61-98-C-00073,Science Applications International Corporation: McLean, Va.
21. Meyer, E. Midwest smart work zone deployment initiative: Kansas' results. in Proceedings of the Mid-Continent Transportation Symposium. 2000. Ames, Iowa.
22. Streff, F.J., L.P. Kostyniuk, and C. Christoff (1995). Effects of drone radar and police enforcement on travel speeds: Test on a 65 mph freeway and 55 mph construction zone. Report number UMTRI-95-22:The University of Michigan Transportation Research Institute: Ann Arbor.
23. Eckenrode, R.T., W.A. Sarasua, J.H. Mattox, J.H. Ogle, and M. Chowdhury. Revisiting the use of drone radar to reduce speed in work zones: South Carolina's experience.in Proceedings of the Transportation Research Board Annual Meeting. 2007. Washington, DC.
24. Ullman, G.L. (1991). Effect of radar transmissions on traffic operations at highway work zones.Transportation Research Record. 1304.
25. Turochy, R.E., A study of the effectiveness of unmanned radar as a speed control technique in freeway work zones, in Civil Engineering. 1997, Virginia Polytechnic Institute and State University: Blacksburg.
26. Benekohal, R.F. (1993). Temporal speed reduction effects of drone radar in work zones.Transportation Research Record. 1409: p. 32 - 41.
27. Carlson, P.J., M.D. Fontaine, and H.G.H. Jr. (2000). Evaluation of traffic control devices for rural high-speed maintenance work zones. FHWA/TX-00/1879-1,Texas Transportation Institute: College Station.
28. Pigman, J.G., K.R. Agent, J.A. Deacon, and R.J. Kryscio (1989). Evaluation of unmanned radar installations.Transportation Research Record. 1244: p. 7 - 16.
29. Hajbabaie, A., M.-H. Wang, J. Medina, M. Chitturi, and R. Benekohal. Sustained and Halo Effects of Various Speed Reduction Treatments in Highway Work Zones. In Proceedings of the 90th Annual Meeting of the Transportation Research Board. 2011. Washington, DC: TRB.
30. Anderson, R. Introducing speed cameras in the ACT: How to win friends and influence people. In Proceedings of the Road Safety Research, Policing, and Education Conference. 2000. Brisbane, Qld: Queensland University of Technology.
31. Sisiopiku, V.P. and H. Patel (1999). Study of the impact of police enforcement on motorists' speed.Transportation Research Record. 1693: p. 31-36.
32. Cooper, P.J. (1992). Speed safety and radar detectors.ITE journal. 62(10): p. 17-20.
33. Cooper, P.J., Y. Zuo, and M. Pinili (1992). Are radar detector users less safe than nonusers? Accident Analysis and Prevention. 24(4): p. 329 - 338.
34. Rudin-Brown, C.M., R.W. Jenkins, T. Whitehead, and P.C. Burns (2009). Could ESC (Electronic Stability Control) change the way we drive? Traffic Injury Prevention. 10(4): p. 340-347.