ABSTRACT

Alcohol-related collisions cause numerous deaths and injuries. The purpose of this paper is to review the technological changes that could be made and are being made that could reduce rates of impaired driving collisions. These can be classified into four categories: 1) interlock systems based on testing drivers’ blood alcohol concentration, 2) systems for monitoring driver behaviors such as head and eye or pupil movements, 3) systems that monitor vehicle dynamics and behavior, and 4) remote detection and stopping vehicles technologies. Each of these technologies has some efficiency and uses and varying levels of social and individual acceptance. Innovation may come from looking at novel ways of combining these technological designs to achieve targets to reduce the devastating effects of impaired driving for many communities.

INTRODUCTION

Alcohol involved collisions cause numerous deaths and injuries in all countries where alcohol consumption is common. In Canada, over 1,000 fatalities are the result of alcohol-related collisions each year (Traffic Injury Research Foundation (TIRF), 2005). In the United States, about 8,515 drivers are fatally injured and about 17,000 in total occur because of alcohol (Insurance Institute for Highway Safety (IIHS), 2006). Although rates of alcohol-related deaths were declining since 1982, that decline stopped in the late 1990s when a slight increase was seen in the rate of drivers and pedestrians killed in alcohol-related crashes (IIHS, 2006). The continuing trend of alcohol-related collision warrants exploration of innovative design technologies that may reduce the prevalence of drinking and driving and reduce the fatalities associated with impaired driving.

Motor vehicles have not been designed to prevent drinking driving. However, numerous laws have been introduced to prevent driving after drinking, e.g., breath-testing drivers, license suspensions for drinking driving, impounding a vehicle for driving under suspension. Also, remedial programs for convicted drinking drivers have been instituted in many jurisdictions. In recent years new technologies for cars (e.g., the alcohol ignition interlock) have been considered for use in prevention of impaired driving. However, these devices were not designed as original equipment for cars. Technologies that prevent all types of collisions have become more common in the past few years. Some motor vehicles have been equipped with electronic stability controls and collision warning systems. Although not designed for this purpose, some of these technologies could prevent alcohol-related collisions.

In-depth studies over many years (Storie, 1975; TIRF, 1975) have established alcohol as a factor in many crashes, especially the more serious crashes. Storie (1975) found that alcohol was involved in 9% of all collisions, 14% of single vehicle crashes and 30% of
nighttime crashes. In Canada, 38% of driver fatalities had blood alcohol concentrations (BACs) over 80 mg% (the legal limit), with 27% in multiple vehicle collisions and 53% in single vehicle crashes (TIRF, 1975). More recent statistics (IIHS, 2006) show that 31% of fatally injured drivers had a BAC over 80 mg%. Among those killed in single vehicle nighttime crashes in the U.S., 72% had a high BAC (IIHS, 2006). Studies in other countries have confirmed these findings (Nordzij, 1983; TIRF, 1975; Gjerde et al., 1993) and now single vehicle nighttime fatalities or crashes are viewed as an important indicator of the effect of laws to decrease drinking and driving (e.g., Preussser et al., 1988; Ross, 1982).

Single vehicle roadway departure crashes involve one vehicle running off the road, usually to the right and rolling over, hitting a tree, building or other object. Almost all (95%) of these types of crashes involve excessive speed, poor lane tracking, driver intoxication, excessive evasive measures or some type of driver error or impaired driver condition (Mironer and Hendricks, 1994). Single vehicle crashes are more likely to occur at night. Alcohol involved injured drivers are less likely to be wearing seat belts and are more likely to be traveling at high speeds (Stoduto et al., 1993). The majority of alcohol-related fatalities occur on rural or secondary roads, not well-traveled routes or divided highways (Blatt and Furman, 1998).

Many studies have examined the characteristics of drinking drivers in the general population, drinking drivers involved in collisions, and drivers caught and convicted of a drinking driving offense. While the overlap between these groups is not complete (e.g., Mann et al., 1983), the commonalities are sufficient so that shared characteristics can be described. Drinking drivers are typically male and young to middle-aged. Most are married and employed, and the largest proportion have a high school education (Macdonald and Mann, 1996; Sharpley et al., 2007). As a group, they consume more alcohol than the general population on average; most would be characterized as episodic heavy drinkers, but the prevalence of alcohol dependence appears low (Macdonald and Mann, 1996; Sharpley et al., 2007; Vingilis, 1983).

A typical alcohol-related collision involves a driver and a passenger drinking in a local pub in a small city or town (Blatt and Furman, 1998) who each consume 5 or 6 drinks and leave at midnight to drive home. They travel over unpaved roads because that is convenient or to avoid police. The driver is intoxicated and may be drowsy; he loses control of the car, often on a hill or bend, and runs off the road hitting a tree or building and perhaps rolling over. Neither driver nor passenger are be wearing seat belts and are typically taken to hospital with severe or fatal injuries (Stoduto et al., 1993). In order to reduce alcohol-related collisions substantially, methods will have to be found to reduce the number of single vehicle rural crashes. The challenge for public health and for the auto industry is to devise ways of preventing this scenario or at least reducing the resulting injuries. The purpose of this paper is to consider design innovations in motor vehicles with the potential to prevent or reduce drinking-driving collisions. We should note that while vehicle design innovation is an inherently attractive method to reduce deaths and injuries from impaired driving, it is important to recognize that no technological innovation will solve the drunk driving problem by itself. However, with innovation in vehicle design in combination with education, public awareness, legislation and enforcement it is possible that drunk driving injuries and fatalities may be greatly reduced from present levels.

SYSTEMS AND TECHNOLOGIES USED TO PREVENT DRINKING DRIVING COLLISIONS

Many existing automotive technologies may help reduce impaired driving and others could be developed easily with what is already known. Apart from some road infrastructure improvements such as implementing rumble strips everywhere or better road markers, current and future technologies to reduce injuries and fatalities due to alcohol impaired driving can be classified roughly into four categories: 1) interlock systems based on testing drivers’ blood alcohol concentration, 2) systems for monitoring driver behaviors such as head and eye or pupil movements, 3) technologies to monitor vehicle dynamics and behavior, and 4) remote detection and stopping vehicles technologies. Each of these technologies has some efficiency and uses and varying levels of social and individual acceptance.

IGNITION INTERLOCK SYSTEMS – The current technologies available are based on the measurement of alcohol from the exhaled breath of the driver, and those based on optical measurement from the skin.

Alcohol ignition interlocks based on breath analysis have been available for about 20 years and are used in many countries in North America and Europe (Bierness and Marques, 2004; Voas and DeYoung, 2002). An alcohol ignition interlock or alcolock is an integrated system for vehicles aimed at preventing drunk or alcohol impaired drivers from starting their engine by measuring the alcohol concentration in the breath of the individual and by locking the starter, if the alcohol concentration level is over a predefined limited value. They are often mandated for convicted impaired drivers before they can get their licenses back. They resemble a large car phone on a tube and they fit under the dashboard. The driver must blow into the device and the car will not start if the BAC is over 10 mg%, which is equivalent to about 1 or 2 drinks for most people. At random intervals, the device also requires the driver to provide a breath sample while they are driving. The device can only be operated by someone sitting in the driver’s seat and not by passengers.

One automotive manufacturer, Volvo, introduced in 2005 an alcolock system built into the seat belt (Alcolock News, 2005). When one enters a car with an integrated
alcohol interlock system the driver is prompted to execute the process of alcohol measurement by using the integrated handheld device immediately before turning the key. If the alcohol concentration is below the predefined limiting value the control unit will unlock the starter. If the alcohol concentration exceeds the limit, the starter will stay locked and the car cannot be started.

Blood ethanol (i.e., alcohol) concentration can be determined from its concentration in breath (Mizohata, 1983); a blood-breath alcohol partition ratio of 2000 is widely adopted (Sato and Kitagawa, 1993). The permissible legal limit of blood ethanol for driving in most countries is 50-80 mg\%, which corresponds to 130-208 ppm in human breath (Park et al., 1999). Generally, reliable sensors that can detect breath ethanol concentration ranging from 20-800 ppm are required for the rapid assessment of drunken driving. Many types of gas sensors have been investigated and developed (Garzella et al., 2002; Brousse and Schnleich, 1996). The detection of breath ethanol has generally been performed by gas sensors based on a chemically sensitive semiconductor. To evaluate breath analysis sensors, we need to consider metrics such as sensitivity, calibration behavior and selectivity. Considerable effort has gone into improving the ethanol selectivity and sensitivity of semi-conductor type gas sensors (Maekawa et al., 1992; Liewhiran et al., 2007). Semiconductor sensors are, however, still at present inadequate for sensing multi-analyte samples such as human expiratory gas, because the sensor response is based on only changes in electrical conductivity of the device following adsorption of gaseous substances (Mitsubayashi et al., 2004; Maekawa et al., 1992). This has translated thus far into extremely poor selectivity of such devices. However, improvement in semiconductor based-sensors for gaseous ethanol has been reported recently (Liewhiran et al., 2007) using flame made ZnO nanoparticles as sensing mechanism of semiconducting material printed on Al2O3 substrate interdigitated with Au electrodes. It has been reported that a thick (5 mm) ZnO film-based sensor showed high sensitivity and fast response times. The sensitivity increased and the response time decreased with increasing ethanol concentration. However, the current sensors provide a selectivity still far lower than the selectivity achievable using biological recognition systems, such as enzymes.

The i-Key™ is a commercial product proposed by Champion Technology (2004) that is based on breath analysis, where the sensing module is integrated into the car key. Implementing the alcohol test into the key avoids the need for modification of the vehicle and therefore makes the technology independent of the body of the vehicle. According to the company, the device integrates a breath analyzer to any car key and can function regardless of the type of vehicle. The key has a protruding interlock that blocks entry to the ignition and retracts once a breath sample under the legal limit has been analyzed. The driver needs to blow into a small mouthpiece on the side of the key to get the “green light” to start the car engine. If the alcohol level exceeds the legal limit, a red light will show and the interlock will disable the car key. Despite its simplicity, no information is available about the sensitivity of the device and the problem of driver identification remains unresolved. Indeed it is rather easy to let someone else blow into the key to cheat the interlock system.

First time offenders in Canadian provinces must use interlocks for one year, and longer if they are repeat offenders, in order to get their driver’s license back. Reconviction rates are very low for drivers using interlock devices because they do prevent drinking and driving while they are being used (Voas and De Young, 2002). However, they have no long-term beneficial effect. After they are disconnected, rates of drinking driving reconviction return to normal. Interlocks are an engineering success but are a very clear example of the failure of any technology that attempts to control human behavior. Studies indicate that very few drivers who should use them actually do (e.g., Voas et al., 1999). In Alberta, only 8.9% of convicted impaired drivers actually had them installed (Voas et al., 1999). They are expensive for drivers, currently about $1500 for one year. They require maintenance and calibration, plus the breath test results must be gathered at regular intervals. Interlocks are also problematic due to social desirability. Since the majority of these drivers do not want others to know about prior convictions for impaired driving, a requirement to use an interlock will be avoided at all costs, making the utility of this technology limited. These drivers would be highly motivated to keep their conviction a secret.

It may be possible to increase rates of interlock usage if the design of this technology can overcome the social desirability issue and the very obtrusive nature of the device that requires active, voluntary behaviors of the driver to use this device to control drinking driving. Future design developments may make them smaller and less obvious, and more automated so that system functions autonomously. Also, the cost may be reduced if more cars had them. Some people argue that if all cars have them, this would prevent drinking driving and reduce costs. However, most driving events do not involve drinking drivers, especially daytime driving. If all cars had them, non-drinkers and light drinkers as well as heavy drinkers would have to blow into them to start their car. Resistance by drivers to this measure would be great, and it is difficult to imagine that legislators, courts or automotive manufacturers would agree to alcohol interlocks being mandated for every car sold.

Another promising technology is passive breath analysis systems that do not require the driver to breath into a device but instead the alcohol level is measured in the driver compartment air. Non-invasive systems for monitoring ambient air in cars have been tested but no production cars have integrated ambient air testers at present. Passive air testing devices can identify about 75% of drivers with a BAC of 100 mg% and 70% of drivers at 80 mg% (Farmer et al., 1998). These handheld devices are used by some police departments to
determine if they should request a roadside breath test from a driver. They put the device 5 inches away from the driver’s face and the device takes a measure of the alcohol level in the vehicle compartment air. There are several problems inherent in these devices: 1) linking those levels to the driver’s BAC is difficult if passengers are also present, 2) car windows can be opened to let alcohol-laden air out prior to the measurement of the air and ruin the test, and 3) when we have designated driver programs, neither sober drivers nor drinking passengers could get home by car if one of them has been drinking. Although people could take a taxi, walk or use public transit, this is not practical in many rural areas and in inclement weather.

Another technology takes optical measurements of the skin to detect alcohol. The Alcoh-meter (Steinberg, 1998) is a dash-mounted sensor for receiving a person’s finger and absorbing incident light from a multiple wavelength light source, which causes a light absorption reading to be generated based on the person’s blood alcohol concentration in the finger tissue. This system uses a specific visible light wavelength to determine the BAC. Another method (Durfee, 1998) uses a fixed frequency photospectrometer that tests the BAC using two LEDs that emit light at a wavelength of 580 nm and monitors light absorbance. The fixed frequency photospectrometer specifically measures only ethyl alcohol in the blood. It consists of an enclosed test chamber in which a person inserts their finger, turns the device on with a switch, and obtains a reading that notifies them of their intoxication level. A level above the legal limit is signaled by a digital readout.

The main challenge of this technology is to reliably ensure that it is the driver who performs the test. Indeed, it is likely that the alcohol impaired driver will attempt to tamper, manipulate or bypass the system, for example, by using the finger/breath of another person, or by using the air from a balloon or an external tube in order to start the car. Improvements to existing alcohol interlock systems require a reliable driver identity check. Again this identity check must be performed in the daytime and nighttime, and at various temperatures (−40°C to +65°C). This challenge has not been resolved in a satisfactory manner. Various approaches have been considered, such as those based on machine vision optical techniques for face recognition and fingerprints, chemical techniques, for example, to monitor the hand sweat on the steering wheel, or even genetic tests. But all these techniques are as yet too expensive, too complex or not reliable enough to be considered for a large deployment in an automotive application. Apart from the technical issues above, this approach has serious legal implications and rather low level of individual and social acceptance. For all these reasons, it is unlikely that those systems will be broadly used without proper technical solutions and legal enforcement.

SYSTEMS FOR MONITORING DRIVER’S BEHAVIOR - Driver behavior has increasingly been the focus of research on vehicle safety, human-machine interface design and system integration. Several studies (e.g., Liu and Ho, 2007) have investigated the effects of different breath alcohol concentrations upon driver driving behavior and subsidiary task performance. Driver behavior monitoring systems (DBMS) can be coupled with other driver assistance systems such as lane departure warning and forward collision sensors to generate attention modulated warnings in cases of impaired driving or fatigue. DBMS is usually based on machine vision technologies using single or multiple CMOS/CCD cameras depending on the architecture (Hammoud et al., 2005). Some systems also use IR illumination and IR imaging to cope with variations of illumination and transitions between day and night. Several intelligent sensing modules perform various tasks such as face finding, localization and tracking, 3D head motion tracking, face modeling and pupil/eyelid motion tracking. The data collected is then processed by an intelligent processing unit to compute all face and eye tracking parameters in real-time and to ensure data quality and tracking performance.

This type of technology that monitors behavior could be an important innovation if combined with vehicle warning systems. Marketing such a technology to the general public could be appealing in terms of supporting the safety of vehicle occupants and members of communities. These systems are capable of detecting unsafe driving behaviors, and also intervening in restoring stability and safety to the vehicle in any situation when drivers lose control of the vehicle. The marketing approach could appeal specifically to older drivers or professional drivers who are at greater risk for experiencing fatigue, or suddenly becoming ill or incapacitated (e.g., stroke, heart attack, seizure). Fatigue is a major issue for driver safety among truckers or other professional drivers. Also, many people now commute great distances to and from work placing them at higher risk of fatigue-related crashes. This technology could be marketed to employers to keep their driver workforce safe in the event of a driving fatigue event, whereby the system controls the vehicle and safely slows it down while warning the driver they are driving erratically. As populations age, the issue of fatigue or illness while driving becomes a greater concern. This technology would likely be more appealing to the general public and have the added benefit of managing drinking drivers when sensing impaired, unsafe driving, and then controlling or stabilizing the vehicle to minimize risk of crash and injury.

SYSTEMS FOR MONITORING VEHICLE DYNAMICS AND VEHICLE BEHAVIOR - It has been reported that high alcohol doses in driver’s blood has a negative impact on the vehicle’s dynamics, including longitudinal speed and lateral acceleration of the vehicle (Liu and Ho, 2007). The variance in vehicles’ longitudinal speed and lateral acceleration increases greatly with BAC levels, which suggests that alcohol seriously affects driving skill and thus vehicle behavior. For these reasons, safety enhancement systems based on the
monitoring of vehicle dynamics and environmental conditions have been proposed to detect abnormal driving situations and vehicle dynamics instability including rollover detection and prediction. Systems such as Crash Avoidance System, Active Safety System, and Emergency Breaking System (Pan et al., 2001; Takahama et al., 2003; Acarman et al., 2001; Barfield and Dingus, 1998; Hartley, 1995; Noy, 1997) are designed to detect the vehicle’s unsafe behavior, for example, approaching an obstacle or a pedestrian too closely, lane departure, speeding, or following a vehicle too closely. These systems then provide a warning message to the driver and/or trigger some driving assistance system to enhance safety. Time to Lane Crossing (Goodrich and Roer, 2000) detects potential unnecessary lane departure and then takes actions to avoid the lane departure. In the Emergency Breaking System (Acarman et al., 2001), the necessary time to stop the vehicle is estimated and then it is determined whether to switch control from the driver to a computer control system to stop the vehicle as soon as possible. If vehicle behavior suggests the driver is impaired, the computer will give the driver a warning message or switch control of the vehicle to a drive assistance system or stop the vehicle depending on the degree of impairment. This technology may contain a warning system function to verbally warn the driver they are not driving safely and encourage them to stop the vehicle independently. This system warns unsuspecting passengers that they are not safe so they could intervene to stop the vehicle. This combination of sensing and warning drivers to stop the vehicle offers an important innovation to reduce impaired driving.

Numerous automated systems are now available to reduce the risk of collisions while requiring little of the driver. A recent review (Campbell et al., 2007) described forty Crash Warning Systems currently available or to be available soon. Systems have been developed and used by Mercedes Benz, Jaguar, Citroen, Toyota, Honda, Ford, and Volvo among automakers and by Delphi, Bosch, Visteon and Continental among parts suppliers. Most of these systems involve radar, Lidar, ultrasonic detectors, infrared or other means to find potential crash events and prevent them. Some systems merely warn drivers of impending crashes and others apply brakes or reduce throttle settings to prevent them. Both preventive procedures may be in the same system. Some systems are designed to prevent rear end collisions and collisions to the front of the vehicle. Others are concerned with preventing crashes involving lane changes or running off the road. Most systems are not in many vehicle models and when models that do have them tend to be expensive models, e.g., Jaguar, BMW, and Mercedes Benz. Very few systems, with the exception of those preventing lateral collisions, seem to have been evaluated for their effects on crash rates. None have been evaluated specifically for their effect on alcohol-related collisions; however, their effectiveness in preventing alcohol involved crashes could be similar to those with sober drivers.

Electronic Stability Controls (ESC) are a sub-set of crash warning systems devoted to preventing crashes due to lane changes, rollovers and running off the road. They were developed mainly to prevent rollovers in SUVs but they could be especially important in preventing single vehicle alcohol involved crashes. ESCs seem to be standard equipment on more cars than other crash avoidance systems. In 2004, all cars and light trucks made by Audi, BMW and Mercedes had ESCs, and select models of most auto manufacturers had them (Farmer, 2004). Most of these systems use cameras that monitor lane markings and detect lane departures at an early stage. They alert the driver and in some cases apply brakes or steer the car to maintain control (California Center for Innovative Transportation, 2007). Usually they are effective in all weather but some do not function if there is heavy rain at night.

Numerous evaluations have been made of the effectiveness of ESCs (for a review see Farmer, 2004). Studies in Japan and the US have shown a 35% reduction in single vehicle crashes for cars with ESCs. An in-depth study (Farmer, 2004) in 10 American states found a 56% reduction in single vehicle fatal crashes for ESCs but little effect on multiple vehicle fatal crashes. There were some states where ESCs did not reduce the level of crashes. A later study (Farmer, 2006) found that cars with ESCs had 41% lower rates of single vehicle crashes than those without ESCs. Again, some states did not show this result. However, the overall results clearly show that ESCs contribute to lower single vehicle crashes, especially fatal crashes.

The number of cars with ESCs has greatly increased from 2000 to the present. For example, the Insurance Institute for Highway Safety (2008) found that ESC was standard on 64% of new passenger cars and optional on another 19% in 2008. Farmer (2006) found 38 cars had ESCs as standard or optional equipment for 2000-2002. They were primarily expensive sports sedans, luxury cars, and SUVs. No basic model car seems to have ESC yet.

Despite the large reduction in single vehicle collisions due to ESC it is not clear whether it will soon affect alcohol-related collisions. However, there is much promise for the future. Not all new cars have ESC and no old ones do, so complete coverage will take a long time as old cars are retired. A further problem is that ESCs depend on lane marking and many of them use centre line or margin indicators. Rural paved roads often do not have such lane markers nor do unpaved dirt or gravel roads. Putting those features into all rural roads would be extremely expensive but it could be a long-term solution. Also, smaller secondary roads in cities do not have lane markings. Furthermore, ESCs based on line tracking are ineffective in northern countries where snow and ice are covering road markings for several months. Despite the large increase in ESCs on the road, there is no indication that alcohol-related collisions have declined in frequency since 2000. No studies are available that examine how ESCs affect alcohol-related
crashes or fatalities. Once again, this is a technology that may be developed in tandem with the driver behavior sensing technologies to combine the warning systems to drivers and passengers with engaging electronic stability controls.

REMOTE DETECTION AND STOPPING VEHICLE TECHNOLOGIES - To detect or stop remotely a vehicle having a suspect behavior can be an interesting complement to improve road safety and reduce impaired driving (Hammond and Rooke, 2003). In many drunk driving or other criminal situations, police are required to stop vehicles. Police now have improved high visibility clothing and access to some of the fastest vehicles, but in reality stopping vehicles is a very risky undertaking. Currently, police tactics involve following moving vehicles or chasing them and they may refuse to stop. This leaves officers with limited options: wait for the vehicle to crash or run out of gas, discontinue the pursuit, or take other action. In these situations, remote-stopping vehicles may be a viable option. Some technologies that could potentially be used to stop a vehicle remotely are wireless telecommunication, GPS and positioning devices, automatic license or plate recognition, as well as vehicle dynamic monitoring systems using video networks. In future, vehicles will likely be equipped with secure and highly reliable means of communication between the car and the road infrastructure as well as accurate, secure and reliable location information and location based services. All vehicles will need to be equipped with remote control of ignition and vehicle speed for this kind of application to be effective. Remote stopping vehicle solutions will also require effective partnerships and cooperation with service centers and enforcement agencies to integrate efforts and technology to do remote stopping in a controlled and safe manner.

Decreasing the speed of the vehicle, if done in an uncontrolled way, brings risks and liabilities often equal to the use of existing tactics. However, remotely degrading the engine speed when police are in a position to have effective control of the situation can minimize risk and liabilities to more acceptable levels. To achieve this, a secure and continuous communication link with the target vehicle is vital. The key elements to ensure safety is that the police are able to reduce the speed of the vehicle in a progressive and controlled way, without compromising the safety of the public, the police or the persons in the target vehicle.

The current practicality of these systems that can stop vehicles is unknown at present in the context of preventing impaired driving. Such systems are not in use in any jurisdiction and hence have not had real time and event testing. Legal and insurance issues have not been addressed adequately. Stopping cars remotely may result in collisions and injuries as well as prevent some and the liability for such collisions is not clear.

Each of the technologies described has the primary purpose of controlling vehicle operations in the event that a driver is impaired or not driving safely. In each case, these technologies are limited by the individual’s ability to “override” or diminish the intent of the system to control behavior. In order to overcome these limitations, future development of technologies may consider adding specialized warning systems to support drivers’ judgment and help them realize they are impaired and not safe to drive. A verbal message in the vehicle would serve as a warning to passengers who may not realize the driver is impaired and may encourage the passengers to intervene directly with the impaired driver. Warning systems build on the very successful safety strategy of seat belt warnings that have been effective. People typically use the seat belt as an alternative to listening to the constant and relentless beeping sound that indicates their belt is not engaged. New warning systems could be integrated into technologies that require a driving behavioral response such as slowing down the vehicle, pulling over to stop the vehicle, or even in high risk situations send an “onstar” type signal to 911 call centers that a vehicle is driving erratically.

Additional design features to consider may be building in information systems to alert others. For example, many parents are very anxious when their young teen driver begins to drive independently. An innovative online GPS tracking system that could tell parents where their children are driving and how safely (e.g., speed) they are driving may be a very popular and important technology to reduce impaired driving in young drivers. This type of technology would have to use GPS and information feedback online in “real time”, meaning as they are driving, so a parent could intervene by calling their cell, signaling them somehow to drive safely. This type of warning system might be extended to employers who need to track progress in deliveries, and driving safety during long distance driving.

Another option for warning systems for impaired drivers would alert people external to the vehicle. Such a warning system would alert pedestrians and other drivers on the road to the unsafe driving situation and offer them the opportunity to avoid the vehicle or even report the vehicle to police. A simple flashing signal sequence of the lighting of a vehicle could be a “universal” warning system for communities that a vehicle driver is impaired and to be extra vigilant when traveling nearby. Also, GPS systems could be developed to slow down or stop cars with impaired drivers, once ambient air testers were developed, while at the same time warn pedestrians, cyclists, or other vehicles immediately nearby to take additional protective measures to avoid possible collision.

SUMMARY AND CONCLUSIONS

Reducing impaired driving collisions could save many lives in most countries of the world. Many automotive technologies at their current state of development offer advantages and potential uses in reducing drinking driving and alcohol-related collisions. An ideal solution might be to have interlocks in all cars to prevent all
impaired driving but that is impractical at present. Collision avoidance and electronic stability control devices could reduce collision rates by about 30%, including those for impaired drivers. To date these technologies have been considered in relative isolation of other technologies or public policy type strategies. Innovation may come from looking at novel ways of combining these technological developments with warning systems or remote control type systems to achieve targets to reduce the devastating effects of drinking driving for many communities.

Many technologies, such as those for remote stopping procedures, ambient air testing devices, GPS warning systems and the like are promising but are not yet at a stage where they are practical for on road situations. As this review has demonstrated, there are many ways in which innovative vehicle design could prevent impaired driving and its consequences, and further development of these ideas could eventually be very successful in preventing alcohol-related collisions, injuries and fatalities.

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