Medical conditions as a contributing factor in crash causation

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Abstract:

Despite recognition that medical conditions contribute to the risk of crash involvement, little is understood about the mechanisms by which these conditions lead to drivers, riders and pedestrians being involved in motor vehicle collisions. This study involved in-depth at-scene investigation of 298 road crashes in the Adelaide metropolitan area in which at least one person was transported to hospital or fatally injured as a result of injuries sustained in the crash. Medical records for those attending hospital or undergoing post-mortem examination were checked for medical documentation providing evidence that a medical condition was a contributing factor in the crash. This information was then matched with the information gathered at-scene and during personal interviews to determine the extent to which the medical condition contributed to the crash, taking into account other factors. We found that almost half the drivers, riders and pedestrians (referred to as active participants) involved in the crashes had at least one pre-existing medical condition, and half of these individuals had two or more such conditions. Importantly, we found that a medical condition was the main causal factor in 13% of the casualty crashes investigated and accounted for 23% of all hospital admission and fatal crash outcomes. The findings highlight the role of medical conditions as a contributing factor in crash causation based on real crash data.

Key Words:

Medical conditions, crash causation, in-depth crash investigation, fitness to drive

Introduction

Impairment as a result of medical conditions and the role that impairment takes in crash causation have long been recognised as important road safety issues in Australia and other industrialised nations. Specific medical conditions identified as potentially placing drivers at risk include epilepsy [1], cardiovascular conditions [2], dementia [3], cerebrovascular accidents [4], diabetes [1], and eye conditions such as cataract [5] and glaucoma [6]. In addition to medical conditions themselves, medications taken to treat them can also place a driver at risk of a crash [7-8]. Furthermore, some drivers have multiple medical conditions and it may be that the combination of conditions compromises driving ability even when the individual manifestations of each of the separate conditions are minor [9]. It is also not only drivers who may be placed at the risk of a crash by the effects of a medical condition. A recent study by Gorrie et al [10] demonstrated links between older pedestrian fatalities and dementia.

Although studies using licensing records or self-reports of volunteer samples have identified medical conditions associated with an increased risk of crashing, very few have actually involved consideration and examination of the crashes themselves. The presence of a medical condition for a driver or pedestrian does not suffice to claim that a crash was related to the condition in question. Often, many factors contribute to the occurrence of a crash and isolating the effect of a medical condition can be difficult [11-13].

The primary aim of this study was to determine the proportion of casualty crashes that can be associated with the effects of a medical condition or an acute medical event (e.g. a seizure). The study involved the investigation of 298 casualty crashes occurring within metropolitan Adelaide, using a combination of data from a number of sources. These sources included evidence gathered from immediate examination of the crash scene, information obtained from follow-up structured interviews with crash participants, and information contained within hospital medical records. This detailed examination of the circumstances of

each crash allowed us to identify the crashes that were directly related to medical conditions, as opposed to those for which a crash participant's pre-existing medical condition was unrelated.

Methods

The study involved in-depth at-scene investigation of road crashes within the Adelaide metropolitan area to which an ambulance was called. Researchers within the Centre were notified of road crashes by way of a direct paging system by the South Australian Ambulance Service. Members of the research team immediately attended the crash site, where they photographed and examined the crash involved vehicle(s), while they were still in position, and all aspects of the road environment potentially related to the crash. The time gap between notification and attendance at the crash scene varied depending on the location of the collision and ranged between five minutes and two hours, with an average time gap of twenty-one minutes. In most instances, the police personnel attending the crash were still on scene and were able to provide some information regarding those involved in the collision, their injury status and the hospital that injured parties were conveyed to. Generally, members of the research team were available on-call to attend crashes between the hours of 0800 and 1800 on week days. The collisions investigated were, therefore, not a representative sample of all metropolitan crashes, with more than 90% occurring between the hours of 0800 and 2200, the majority occurring from Monday to Friday. Selection of crashes to be investigated was based on availability of an on-call team to attend the crash at the time of notification. All crashes that were attended by the research team in which at least one person was transported to hospital, or was fatally injured, as a result of the crash were included in the study. A total of 298 road crashes were investigated in-depth within the study period between April 2002 and October 2005. They included 218 multiple or single vehicle crashes and 80 crashes involving a vehicle and one or more pedestrians.

At-scene investigation was supported by data collected from five sources:

1. medical records for those who were treated at, or admitted to, hospital as a result of injuries sustained in the collision.
2. Coroner's reports for those who were fatally injured
3. personal interviews with drivers, riders and pedestrians involved in the collisions, as well as passengers and witnesses
4. Vehicle Collision Records generated by the South Australian Police
5. Traffic Accident Recording System (TARS) records, providing information related to the crash histories of driver/riders and the sites where the crashes occurred

Approximately 98% of those individuals in the study who required hospital treatment attended a trauma centre where access to medical records was granted. The records examined included those documented at the collision scene by South Australian Ambulance Service personnel, Emergency Department records, specific diagnostic results, medical and allied health records generated throughout the in-patient period and, in some instances, records related to rehabilitative care.

The following details were sought from the records:

1. documentation related to existing medical conditions
2. medication use at the time of the crash
3. injuries incurred as a result of the crash
4. results of blood screening for alcohol and other drugs
5. medical documentation that gave support to or refuted medical conditions as a contributing factor in crash causation
6. results of diagnostic tests
7. length of hospitalisation as a result of injuries
8. long term health outcomes as a result of involvement in the crash

Coroner's reports provided specific information related to cause of death and included detailed reports on post-mortem examinations. In addition, these records provided information related to toxicology studies

and, in some instances, identified health status information prior to the person's involvement in the collision and death.

Vehicle Collision Records (VCR's) generated by the South Australian Police provided information related to the names of the persons involved in the collision, their contact details, licence status of drivers and riders, injury status and a brief synopsis of the crash.

Interviews were sought with drivers, riders, cyclists and pedestrians (the active participants of the collisions) and, in some cases, vehicle passengers and witnesses. Interviews were undertaken on a voluntary basis after informed consent had been obtained; interviews with active participants who were minors were undertaken following consultation with, and informed consent of, a parent or guardian. The interviews took in the vicinity of 30-45 minutes. They were generally conducted in person as soon as practical, most often within the first week following the crash. These interviews provided information related to driving experience, exposure and history; familiarity with the vehicle and vehicle condition; familiarity with the road environment where the collision occurred; health status of the active participant prior to their involvement in the collision, including their use of therapeutic medication, alcohol and illicit drugs; their recollection of events leading up to the collision and impressions of why a collision occurred; and their personal understanding of health outcomes as a result of involvement in the collision. It was the research team's intention to seek interviews with all active participants who were able to be identified and contacted. However, an interview was deemed inappropriate in some cases and so a decision was made not to seek one. The reasons behind these decisions were based on the following criteria: diminished cognitive ability, being detained under the Mental Health Act, or seriousness of injury that was likely to have resulted in crash amnesia. Interviews were sought with all remaining active participants who were able to be contacted, with approximately 60% voluntarily consenting to participate in the study.

Results

A total of 298 road crashes were investigated in-depth within the study period between April 2002 and October 2005. The collisions investigated included 218 multiple or single vehicle crashes and 80 crashes involving a vehicle and one or more pedestrians. There were 606 drivers, riders, cyclists and pedestrians, referred to as active participants, involved in these 298 crashes. These active participants consisted of 492 drivers (38 driving a truck or bus with the remainder driving a car or car derivative), 83 pedestrians, 20 motorcycle riders and 11 pedal cyclists. A further 175 passengers (passive participants) were involved in these collisions.

Injury Severity

The crashes investigated were categorised in relation to the most severely injured participant. There were 21 crashes that resulted in at least one fatally injured participant, 91 crashes that resulted in at least one participant requiring hospital admission, 186 crashes where a participant required hospital treatment and two cases in which a person required transport to hospital for medical attention but, because they attended a hospital where access to medical records was not obtained, no further information regarding level of care was known. A total of 408 people required hospital treatment, hospital admission or were fatally injured as a result of these collisions; 325 of whom were active participants (drivers, riders or pedestrians) and 83 of whom were passive participants (vehicle occupants).

Of the 408 people who required medical assessment, 24 were fatally injured (20 of whom were active participants), 111 required hospital admission (93 of whom were active participants) and 273 required hospital treatment (212 of whom were active participants). All motorcycle riders, pedal cyclist and pedestrians (i.e. the vulnerable road users) required medical intervention as a result of their involvement in the collision. Only 214 of the 492 drivers (43%) required such interventions. Medical records and Coroner's data were available for 325 of the 606 active participants within the study.

Pre-Existing Medical Conditions

The medical records were examined for documentation related to pre-existing medical conditions. This information was often found in the medical documentation related to the person's primary assessment in the Emergency Department but could also be found in the documentation occurring throughout the in-patient period. In some cases, the level of impairment experienced by the person as a result of their medical condition was recorded but as a general rule this information was limited. Of the 298 crashes investigated, there were 138 cases in which at least one active participant involved in the crash was identified as having a pre-existing medical condition. Half had two or more medical conditions while nine participants had four or more. Table 1 provides details of the types of medical conditions identified among the active participants, while Table 2 shows the ten most common individual medical conditions found.

Table 1: Pre-Existing medical conditions among active participants in the study.

Medical condition classification	Number of cases
Cardio-vascular disease	71
Mental health deficits	68
Musculo-skeletal disease/disorders	39
Respiratory disease	24
Endocrine disorders	23
Neurological disease/disorders	18
Cognitive deficits	9
Sensory deficits	9
Others	14
Total	276

Table 2: Ten most common pre-existing medical conditions found among active participants in the study.

Most common pre-existing medical conditions	Number of cases
Hypertension	36
Depression	24
Non-insulin dependent diabetes mellitus	21
Arthritis	18
Asthma	14
Anxiety disorders	11
Shoulder/neck or spinal injuries	10
Schizophrenia	7
Epilepsy or absence seizures	7
History of previous cerebro-vascular accident	7

In addition to these, alcohol dependence, a current history of illicit substance abuse and a past history of serious suicide attempts were dominant features. There were twelve cases in which medical assessment deemed that a participant met the criteria for alcohol dependence, ten cases in which the participant was known to currently use illicit substances and eight cases in which the participant had previously required hospitalisation as a result of one or more serious suicide attempts.

Although the presence of a medical condition is of interest, it does not necessarily mean that the condition played any role in the crash. To determine if these conditions contributed to crash causation, the medical records were examined for medical documentation that identified the condition as a contributing factor.

In 39 of the 298 crashes investigated, there was medical documentation providing evidence that a medical condition, or conditions, was the direct causal factor in the active participant's involvement in the collision. These 39 cases consisted of 25 car drivers (11.5% of crashes involving drivers/riders/cyclists), and 14 pedestrians (17.5% of all pedestrians). Those medical conditions identified with a high degree of confidence as directly contributing to the crash can be seen in Tables 3 (drivers) and 4 (pedestrians). Whilst acute alcohol intoxication was found to contribute to the crashes in this study, the research team decided to follow the lead of Sjogren et al [14], who made a distinction between alcohol or drug

intoxication and more 'intrinsic' medical factors. For this reason cases of alcohol or drug intoxication are not included in the study findings presented or in Tables 3 and 4.

Table 3: Medical conditions identified as contributing to the crash for drivers.

Identified medical condition/event	Number of cases
Cardiac-related event	7
Epileptic event	5
Schizophrenia-related episode	2
Hypoglycaemic event	2
Other psychosis-related episode	1
Dementia	1
Asthma-related event	1
Complications related to end stage Conn's disease	1
Loss of consciousness related to pregnancy	1
Chronic sleep deprivation with severe and chronic pain	1
Cumulative effects of multiple medical conditions	1
Loss of consciousness with cause yet to be determined	2
Total	25

In nineteen (76%) of the twenty-five cases involving a driver, there was a reported loss or reduction in level of consciousness that led to the collision. In the majority of cases, drivers lost consciousness as a result of an acute cardiac event, while experiencing an epileptic seizure, or as a result of hypoglycaemia.

Table 4: Medical conditions/events identified as contributing to the crash for pedestrians.

Medical condition/event	Number of cases
Deliberate suicide attempt	9
Psychosis related-episode	1
Dementia	1
Cognitive deficit (unrelated to dementia)	1
Eye sight deficit	1
Combination of cognitive and eye sight deficit	1
Total	14

Examples of cases where a medical condition was determined with a high degree of certainty to have contributed to the crash:

Case 1: A 39 year old woman was travelling on a straight road and approaching a signalised intersection when she began to feel unwell. The driver sought to pull her vehicle off the carriageway but was confined by peak hour traffic on all sides of her vehicle. The driver lost all memory of the lead up to the collision from that time. The driver continued forward within her lane for a further 500 metres and travelled through the intersection on a red signal before crossing a raised median and colliding head-on with a large truck. She was hospitalised for more than eight weeks as a result of her injuries. The driver was known to have had one epileptic type episode in the twelve months preceding this collision and had been commenced on a relatively low dose of anti-convulsant therapy. During her hospitalisation, she demonstrated episodes of absence seizure and it was determined by the treating medical team that these were the cause of her involvement in this collision. She was subsequently placed on a higher dose of anti-convulsant therapy and further investigation was pending.

Case 2: A 71 year old male driver was travelling on a straight uncongested road when he experienced a sudden loss of consciousness. The vehicle drifted toward the centre of the carriageway where it mounted

a raised median and collided with a pedestrian safety barrier. The vehicle came to rest straddling both sides of the road. No other vehicles were involved in the crash. The driver had numerous pre-existing medical conditions including emphysema, sleep apnoea, chronic renal failure and aortic stenosis. He reported having had a similar episode of loss of consciousness at home in the weeks preceding this collision. On both occasions he had no prior warning before the loss of consciousness occurred. Medical assessment concluded that the driver's collapse was related to cardiac arrhythmias. He had a pacemaker inserted in the week following the collision.

Case 3: A 65 year old male driver was travelling on a straight uncongested road when he moved toward the centreline of the carriageway and side swiped an oncoming car that was slowing behind other vehicles. The driver of the striking car was seen to be unresponsive at the wheel prior to the collision. The vehicle was deflected away from the impact, returning to the correct side of the road, and continued to travel at low speed away from the primary collision. The vehicle continued a further 1km along the road before mounting the kerb to the left and striking a pole. The driver was found to have a blood glucose level of 2.3 mmol/l at the scene. He had a four year history of insulin-dependent diabetes that had, up to this point, been well controlled. The driver had commenced his trip with the intention of travelling to his home four kilometres away. The driver was seen by his partner to arrive home but did not stop or respond to his partner as he travelled past his home residence. He continued to drive for a further two to three kilometres before the primary collision. The driver has no memory of driving or of the two collisions.

Injury severity in medical condition cases

Those crashes in which a medical condition was identified in the medical documentation as a contributing factor were examined to determine the injury severity for both the person with the identified condition and also for those others involved in the crash. Of the 39 active participants who had an identified medical factor that contributed to the crash, there were 16 who required hospital treatment, 19 who required admission to hospital and four who were fatally injured. Among the 16 requiring hospital treatment, there were two who, once treated for the acute injuries related to the crash, were detained under the Mental Health Act and taken to a mental health care facility. There were seven cases in which other people involved in the crashes were injured. In five of these cases, the other participants were more severely injured than the person identified with the medical condition. There were three cases in which the person with the medical condition was treated in hospital but their crashes resulted in hospital admission of at least one other person involved in the crash. There was one case in which the person with the medical condition required hospital admission but the crash resulted in the fatal injury of another participant, and there was one case in which the person with the medical condition was fatally injured but the collision also resulted in the fatal injury of one other person and hospital admission for another two persons involved in that collision.

Implications for driver licence status

There were 11 cases in which the driver's licence status of the medically impaired driver was reviewed following their involvement in the crash. In all of these cases, the licence reviews were instigated by a medical officer following medical assessment. There were five cases in which a medical officer advised the Motor Registration Department that a driver's licence should be suspended pending further investigation. There were three cases in which a medical officer recommended that the licence should be suspended with little to no likelihood of return due to declining health that was unlikely to improve, and one case each in which a medical officer recommended that a licence should be suspended for a period of twelve months, that a licence be suspended for two years, and that the driver undergo a formal driving assessment.

Age distributions

Figure 1 shows the age distribution of all drivers in the study, according to the involvement of a medical condition. Seven of the 25 drivers in which a medical condition was identified were 70 years or older. This constitutes 28% of all cases involving an active participant in this age group. There were also seven medical condition cases in which the active participant was aged between 40 and 49 but this number only accounted for 8% of this age group. There were six medical condition cases in which the active participant was between the ages of 20 and 29, accounting for 6% of this age group.

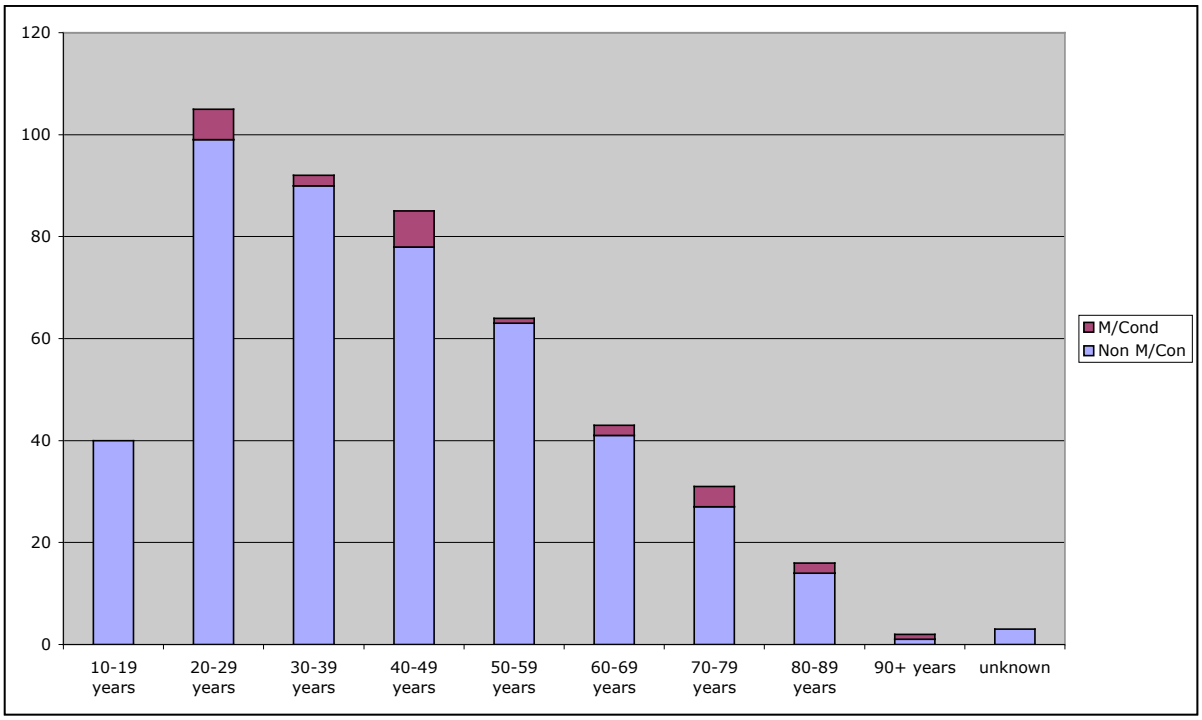

Figure 1: Age distribution of all drivers, riders and cyclists within the study and those for whom a medical condition was seen as a contributor to their involvement in the crash.

Figure 2 shows the age distribution of the crash-involved pedestrians according to medical condition involvement. As can be seen, those pedestrians for whom a medical condition was identified as a contributor to their involvement in the crash are distributed evenly among most age groups except for among the small number of child pedestrians who make up the 1-9 year age group. Three of the thirteen pedestrians over the age of 70 were identified as having a medical condition contributing to their involvement in the crash, comprising 23% of all pedestrians from this age group. However, almost 29% of pedestrians in the 40-49 year old age group were identified as having a medical condition as a contributor. The age group of 20-29 showed an even higher incidence of a medical condition as a contributor, with more than 37% of this group falling into that category.

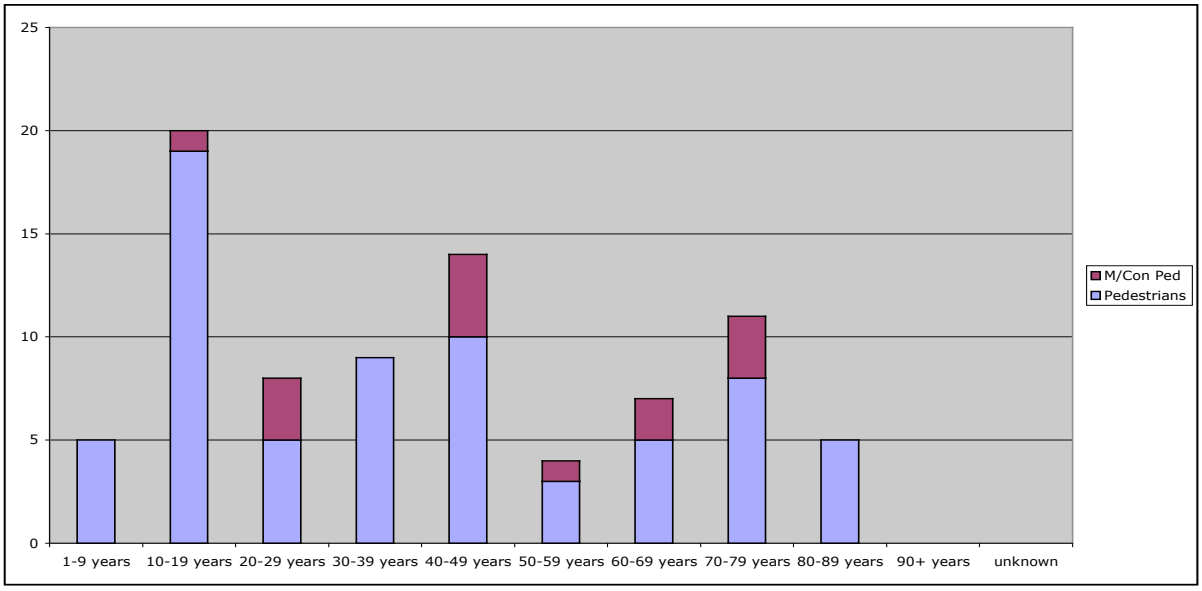

Figure 2: Age distribution of all pedestrians within the study and those for whom a medical condition was a contributor to their involvement in the crash.

TARS records

The Traffic Accident Recording System (TARS) was checked for the 25 drivers identified in the study as having a medical condition contributing to their involvement in a crash. There were two specific areas of interest in this examination: evidence of previous crash history, and whether the records documented a medical condition as a cause for the crash investigated in this study or for any previous crash. Their crash histories were then compared against all other drivers and riders within the study to determine if the two sets of crash histories were different. Twenty-one of the 25 drivers were found to have either not been involved in a previous crash or had a crash history of two or less over an extended period of time. In most cases, but not all, the driver was identified as not at fault in the majority of these previous crashes. Such crash histories were similar to those found among the other drivers and riders within the study who were not identified as having a medical condition as a crash contributor. The four remaining drivers had crash histories that demonstrated a higher than average crash rate. There was one driver who had a history of 14 crashes over a 24 year period, one with a history of 8 crashes over a 13 year period, one with a history of 11 crashes over a 20 year period and one who had four crashes during the four years preceding this crash. In each of the four cases above, the driver was found to be at fault for most of the crashes he or she had been involved in. The at-fault cause identified, however, was almost always 'inattention', with no driver identified as being involved in the collisions because of an identified medical factor.

When reviewing the TARS information related to the specific crashes investigated in this study, it was found that all but two of the drivers, riders and pedestrians identified as having a medical condition as a contributing factor in the crash were found to be at-fault for the crashes they were involved in. These two cases involved pedestrians. Of interest is that, in both of these cases, the pedestrian was crossing a road on, or adjacent to, a non-activated pedestrian crossing at the time of their involvement in the crash. In both cases, the pedestrians were known to have eyesight deficits that contributed to their crash involvement. In 11 of the 25 cases involving a driver or rider, the TARS records identified a medical event in the crash causation, with 'black-out', 'loss of consciousness' or 'sick at the wheel' being the three commonly used terms. Overall, in 21 of the 39 cases, there was no documentation in TARS that identified a medical condition as a contributor to the crash.

Possible inclusions

Although there were 39 cases in which documented medical assessment indicated, with a high degree of confidence, that a medical condition was a contributing factor in the crash, this does not provide a full account of the extent to which medical conditions were a causal factor in the crashes investigated. This is particularly relevant when considering that only 43% of drivers were injured and presented for medical scrutiny. There were at least seven further cases that were thought to have involved at least a high probability that a medical condition directly contributed to the crash, and a number of others in which the contribution of a medical condition could not confidently be ruled out. The designation of the seven cases as highly probable was based on a number of other data sources, including discussions with drivers at the scene, follow-up conversations with drivers and/or direct family members and interviews. Three of these cases were single vehicle crashes, three cases were drivers travelling into the path of other vehicles while undertaking a manoeuvre against traffic control and one was a pedestrian. In all of these cases, the person with the medical condition was considered at-fault for the crash by the attending police.

One example to illustrate this is a case where cognitive decline was suspected:

A driver, 79 years old, arrived at a T-junction where she was required to give way to traffic on the adjoining road. The driver failed to give way and her vehicle struck the side of a vehicle travelling on the main road. She continued to travel across the four lanes of the busy road through opposing traffic before driving into a private driveway not related to her proposed trip. The driver stated at-scene that she knew that something had gone wrong but did not know that she had been involved in a collision until told by eyewitnesses; she was uncertain how she came to be in the private driveway. She demonstrated overt confusion at the scene, prompting the attending police officer to order that she undertake a formal driving assessment. She was unable to demonstrate driving competency and failed this assessment. Furthermore, she lacked insight regarding the identified deficits. She was a widow who lived alone and a long distance from family supports. The driver in this case was shaken by her involvement in the collision but was uninjured and therefore did not undergo medical scrutiny. This is the only known case in the study where an attending police officer made a recommendation that a driver or rider should undergo a formal driving assessment as a result of their involvement in a collision.

Discussion

The findings from this study demonstrate that medical conditions and acute medical events contribute to the risk of crash involvement and suggest that the contribution is likely to be higher than those cited by previous studies, including Sjogren who proposed that an intrinsic medical condition is likely to contribute to crash causation in approximately six percent of crashes [14] and Gordon who suggests that, once alcohol is removed from the equation, medical conditions account for less than one percent of injury crashes [15]. One of the reasons why a higher than previously reported incidence was found may relate to the diversity in data sources accessed and the ability of this study to incorporate medical sources of information with information gathered at-scene for each individual crash investigated. The inclusion of in-depth interviews with participants provides a further dimension to the over-all understanding of the events leading to the collisions and the role of the medical condition in the crash. Further exploration of this under-researched area of road safety has considerable potential to confirm these findings and inform road safety policy makers and the medical profession when considering future countermeasures.

The examination of medical records for participants following involvement in the crashes was an invaluable tool, without which an understanding of the role of medical conditions in the crash causation could not occur. This examination provided medically documented evidence of both the prevalence of pre-existing medical conditions and medical opinion on the contribution of a medical condition or event that lead to the participants involvement in the crash. However, the level of documented information in medical records varied considerably. This was particularly so in relation to pre-existing medical conditions, for which the available information was found to be less than comprehensive. For example, the degree of impairment related to the identified medical condition(s) and the specific effects of these on the individual were commonly lacking and, in most cases, information was limited to a list of conditions only. This was more frequently the case when the active participant sustained only minor injury and where medical intervention was limited to primary assessment and treatment of the specific injury occurring in the crash. Compounding this further is that most of the crash-involved persons had no prior

contact with the hospital and so knowledge of pre-existing medical conditions was often reliant on self-report or reports from family members. It could be argued that some of the participants may have been reluctant to disclose information related to existing medical conditions or could have withheld information related to health deficits if they perceived a risk of licence loss as a consequence of that disclosure. Those who required hospital admission as a result of their injuries tended to be subjected to more in-depth exploration of medical status, and in some cases the records included information provided by the participant's general practitioner or specialists. Those showing very clear medical problems, such as seizure-like activity or impaired consciousness at-scene, were more likely to be medically assessed in more depth.

Though the hospital medical records provide an understanding of the role of medical conditions for those who underwent medical scrutiny, there was no opportunity to gather medical information for those involved in the crashes who did not present to hospital. More than 57% of drivers involved in the crashes within the study were either uninjured or sustained only minor injury and did not undergo medical assessment in the hospital setting. The prevalence of pre-existing medical conditions and the impact of medical conditions on crash causation among this group is unknown. It is therefore highly likely that this study presents an under-estimate of the role of medical conditions in crash causation. During the in-depth investigation there were at least seven crashes in which an active participant was considered to have had a medical condition that was highly likely to have contributed to the crash but no medical assessment of that condition was undertaken to support the assertion. In addition to these highly probable cases, there were a number of crashes in which the involvement of a medical condition as a contributor could not be confidently ruled out. These considerations were based primarily on discussions with participants at scene, follow-up interviews with participants who disclosed deficits related to an existing medical condition(s) and unsolicited discussions with family members who were concerned regarding their family member's fitness to drive. One particular area of concern expressed by some family members related to a driver, commonly a parent, who had previously been diagnosed with dementia but had continued to drive. An example of this was a case where the family member, an occupational therapist with some understanding of fitness to drive criteria, reported that their parent had been involved in an increasing number of minor, non-injury crashes before the collision investigated in this study. The elderly driver in this instance is believed to have not had their right to hold a driver's licence questioned by their treating medical officer and the family member had been unable to persuade their parent to relinquish their licence.

More than 75% of the drivers who were found to have a medical condition that contributed to the crash had a loss of, or a reduction in level of consciousness in the lead up to their involvement in the collision. This information may give the impression that it is only obvious and severe medical problems that contribute to crash causation. However, we would suggest that, in many of the other crashes investigated, it is possible that more subtle impairments may have contributed to the participants' involvement in the crash. For example, we know that many of the drivers involved in the crashes within the study had histories of arthritis, spinal injuries and other musculo-skeletal deficits, with some participants demonstrating significant mobility deficits at scene, yet these were rarely explored in the medical assessments undertaken on presentation to hospital. Other conditions, such as visual deficits, drug or alcohol dependence and sleep apnoea are also identified within the literature as related to an increased crash risk [5, 16-19] yet were equally difficult to extract from the available medically documented data. One of the reasons for this may be that these subtle impairments are less easy to quantify as a contributor to the crash, particularly when the information available to the medical team related to the events of the crash and time to assess these is limited. Future studies that include access to medical records held by general practitioners, as well as hospital generated records, have the potential to narrow the information gap presented in the current study. This access is likely to provide a more comprehensive understanding of the stage of the condition(s) as well as level of impairment associated with those conditions.

Though much of the focus on medical conditions in road crashes relates to drivers and riders, there is also a pedestrian population who are at risk of crash involvement as a result of impairment related to medical conditions. Some conditions in particular have been identified as placing pedestrians at an increased risk of crash involvement, including pedestrians with dementia and those experiencing mental health deficits, including suicidal ideation [10,20]. The relatively high incidence of crashes involving a pedestrian who deliberately attempted suicide in this study indicates that this phenomenon continues to be a significant feature in pedestrian crash involvement and highlights a need to look further at this mental health issue.

Pedestrian suicide attempts that result in the fatal outcome for the pedestrian are generally not included in road crash fatality statistics, particularly when the act can be confirmed as deliberate. It could be argued that excluding such crashes from road trauma statistics renders the occurrence of these crashes less visible and therefore less likely to be addressed.

Advancing age is often associated with a likelihood of having a medical condition that has an impact on crash risks [12, 21-23]. However, the results of this study demonstrate that a medical condition contributed to crash involvement across all age groups. While ten of the 39 crashes involving a medical condition as a contributor were seen among participants aged 70 years or more, there were 20 cases in which the active participant was between the ages of 20 and 49 years. The age distribution among pedestrians where a medical condition was identified as a contributor are more difficult to interpret due to the small overall number and the high incidence of self-harm/deliberate suicide attempts among the study participants who were generally from the younger age groups.

Study limitations

The crashes investigated in this study were not a representative sample of all metropolitan casualty crashes; more than 90% of those investigated occurred between 8am and 10pm, Monday to Friday. This had the potential to have resulted in a bias towards the elderly, who tend to travel mainly during daylight hours [24], and away from young and/or alcohol-impaired drivers. In response to these potential biases, CASR commenced a follow-up study in January 2008. This new study involves examination of the data collected for a representative sample of drivers, motorcycle riders and pedestrians who attend the major trauma service in South Australia over a two year period. This study will be extended to include those presenting as a result of their involvement in both metropolitan and rural crashes. Additionally, data collection will include examination of records related to driver licence history, status and any conditions imposed on the licence as a result of identified medical conditions.

Conclusion

At-scene crash investigation and follow-up interviews of active participants provide a unique opportunity to view the gathered medical information in a more holistic light, allowing a more comprehensive understanding of the variety of factors that contribute to a single crash. The information available in the medical documentation reflects the prevalence of medical conditions that were able to be established with a high degree of confidence to have contributed to the occurrence of crashes. This information may give the impression that it is only obvious and severe medical problems that contribute to crashes but we would suggest that, in many of the other crashes investigated, it is possible that a medical condition was a contributing factor. These cases are often less easy to determine due to the subtle impairment that is difficult to identify from hospital medical records alone. We therefore suggest that the information presented is likely to be an under-estimate of the impact of medical conditions in the causation of road crashes. This under-researched area of road safety warrants further exploration to provide evidence-based information to support both the medical profession and road safety authorities in making decisions related to fitness to drive.

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