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Accident Research Centre

ACCIDENT DATA ANALYSIS TO DEVELOP TARGET GROUPS FOR COUNTERMEASURES

**VOLUME 1 :
METHODS AND CONCLUSIONS**

by

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December 1992

Report No. 46

**MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE
REPORT DOCUMENTATION PAGE**

| Report No. | Report Date | ISBN | Pages |
|-------------------|--------------------|---------------|--------------|
| 46 | December 1992 | 0 7326 0046 4 | 52 |

Title and sub-title:

Accident Data Analysis to Develop Target Groups for Countermeasures
Volume 1: Methods and Conclusions

| Author(s) | Type of Report & Period Covered |
|------------------|--|
| Cameron, M.H. | General, 1990-92 |

Sponsoring Organisation - This project was funded through the Centre's baseline research program for which grants have been received from:

- . Australian Road Research Board
- . Department of Justice
- . Roads Corporation (VIC ROADS)
- . Royal Automobile Club of Victoria Ltd.
- . Transport Accident Commission

Abstract:

The general objective of the project was to disaggregate the road accident problem using mass accident data to find groups of road users, vehicles and road segments which would be suitable targets for countermeasures. Large data files of Police accident reports and Transport Accident Commission claims from accidents in Victoria during the 1980's were obtained and merged. Four methods of analysis to meet the objective were developed and applied to the data to address one or more key problem areas. Target groups for countermeasures were identified and, where possible, accident and injury mechanisms were suggested, and countermeasures to address these mechanisms were proposed.

Volume 1 covers the specific objectives, concepts, data, methods, conclusions and recommendations of the project, as well as the Executive Summaries of the analysis reports. The full analysis reports are given in Volume 2. The conclusions recommend that new surveys of the on-road exposure of drivers, passengers, motorcyclists and pedestrians be conducted in Victoria. It is also recommended that clustering methods be applied to other key road trauma problem areas as a matter of priority, as these methods are able to identify new target groups which are currently hidden.

Key Words:
(IRRD except when marked*)
road trauma, accident data*,
data processing, injury, statistics,
data bank, countermeasures,
exposure, safety, collision.

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VOLUME 1: METHODS AND CONCLUSIONS

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ACCIDENT DATA ANALYSIS TO DEVELOP TARGET GROUPS FOR COUNTERMEASURES

EXECUTIVE SUMMARY

Introduction

An important issue which emerged during the development of the 1991 Road Safety Strategy for Victoria was the need for new and better definitions of target groups for countermeasures. Research to define new target groups has not kept up with the rapid implementation of countermeasures. This report describes a major project which aimed to further develop methods of identifying target groups, and to demonstrate those methods by application to a number of key road safety problems.

The general objective was to disaggregate the road accident problem using mass accident data to find groups of road users, vehicles and road segments which would be suitable targets for countermeasures.

However this project was confined to identifying target groups and potential countermeasures. It has not considered fully the range of problems in the implementation of such countermeasures nor the expected benefits and costs. This would be a necessary next step.

Successful development of a countermeasure requires a clear understanding of where it can potentially break the chain of events leading to traumatic injury on the road. A countermeasure is a measure which attempts to break the road trauma chain before one of the undesirable steps can occur (eg. accident involvement, injury or death). A target group for a countermeasure is a group of entities (humans, vehicles or roads) for which the chain can be broken effectively and, desirably, cost-effectively.

Methods and Data

Mass accident data needs to be analysed to find target groups for countermeasures in a way which maximizes the chances that the countermeasure will be cost-effective. The study has developed general principles for analysis which meet this aim. These have led to four specific methods of mass data analysis, depending on the nature of the road trauma problem being addressed in the search for countermeasure target groups, namely:

- . High Risk Groups (groups with high rates of accident involvement per opportunity to be involved)
- . High Severity Groups (groups with high rates of severe injury per accident involvement)
- . Accident Involvement Clusters (groups involved in accidents who are homogeneous on a number of factors relevant to countermeasure design and as large as possible)
- . Severe Injury Clusters (groups associated with severe injury who are homogeneous

on a number of factors relevant to injury countermeasure design and as large as possible).

Large data files of Police accident reports and Transport Accident Commission claims from accidents in Victoria during the 1980's were obtained and merged. The four methods have each been applied to the data to address one or more key problem areas. Target groups for countermeasures were identified and, where possible, accident and injury mechanisms were suggested, and countermeasures to address these mechanisms were proposed.

As each was completed, the analysis reports were sent to MUARC's baseline sponsors for comments and immediate use, if appropriate. The final versions of these reports are included in Volume 2 of the project report (available on request). Volume 1 covers the methods and conclusions of the project, as well as including Executive Summaries of the analysis reports. The major findings of the analysis reports are summarised below.

Articulated Trucks

Articulated trucks have a high risk of casualty accident involvement compared with other types of trucks. An earlier study showed that in Australia, articulated trucks were involved in 7.4 fatal accidents per 100 million kilometres travelled, compared with an involvement rate of 1.7 for rigid trucks.

Semi-trailers and their drivers were substantially over-involved in a large number of specific crash circumstances compared with rigid trucks. Many of these over-involvements were potentially explainable by the truck size and load mass differences, and by the different usage patterns of semi-trailers (relatively greater use on rural highways, in the highest speed zones, and at night). However the following factors associated with substantial over-involvements of semi-trailers are apparently not fully explainable by the above differences between the two vehicle types:

- . crashes in the low speed zones in rural towns
- . at traffic lights and roundabouts in the low speed zones
- . running off straight roads in the low speed zones
- . side swipe and overtaking crashes
- . driver's seat belt not fitted or not worn if available
- . impacts to the front and left side of the semi-trailer in the low speed zones
- . impacts to the front corners of the semi-trailer in the high speed zones
- . death or serious injury to the semi-trailer driver from crashes in the high speed zones.

These factors represent target groups for potential countermeasures to address the high over-involvement rate of articulated trucks in casualty crashes. These countermeasures could address the crash involvement of articulated trucks, and/or also the risk of severe injury to the truck driver and other road users involved, as there appear to be high risk factors operating in both stages which influence whether a casualty crash occurs.

Cars Struck by Heavy Vehicles

Occupants of passenger cars struck by heavy vehicles frequently sustain much higher severity injuries compared with car occupants struck by other types of vehicle. Injured car occupants are four to seven times more likely to be killed when the striking vehicle is a

heavy vehicle, compared with being struck by another car.

Higher injury severities were observed in the higher speed zones and when the heavy vehicle was a semi-trailer. A large number of other environmental, crash, occupant, vehicle and impact factors were also found to be related to higher levels of injury severity of the car occupants. These factors define target groups for countermeasures which should be designed to reduce injury severity, with priority given to severity reduction in the specific circumstances and characteristics of the target group. The target groups also define car/truck crash types and circumstances which should be priority areas for countermeasures aimed at preventing collisions involving trucks.

An exponentially increasing relationship between injury severity and the truck to car mass ratio was found. The analysis also found that nearly 40% of car occupants killed or seriously injured in car/truck collisions resulted from front to front impacts. Some 60% of these collisions involved impacts with the front corners of the truck, with more than half of these corner impacts being to the right front corner.

A priority area for a countermeasure to reduce car occupant injury severity is improved frontal structures of trucks, especially the front corners outside the frame side members and especially the right front corner. There are developments in Europe to improve the front corners of trucks by structures which absorb energy and also reduce over-ride of the struck car in off-set front to front impacts. A study of these developments has recently been completed by MUARC.

Motorcyclists

A number of target groups for the motorcycle accident problem were identified by finding sub-groups which were over-involved in the following crash situations which previous research had shown to be of high risk: novice motorcyclists, motorcyclists on curves, and intoxicated motorcyclists. Further target groups were added by identifying sub-groups which were associated with higher injury severity than the overall average for all injured motorcyclists.

The target groups were reviewed collectively and mechanisms for the crashes or injuries occurring were suggested. This in turn led to a number of potential countermeasures for motorcyclist trauma, which included the following:

1. Random breath testing supported by publicity emphasising the focus on motorcyclists, during the "alcohol times" (and slightly earlier) on weekends in Spring and Summer, targeting riders of the larger and older motorcycles, and including licence checks. The problem is greatest for motorcyclists operating in residential areas of Melbourne and in rural areas outside towns.
2. A curve treatment program aimed at motorcycle accident blackspots on curves, involving warning signs, improved skid resistance and super-elevation, increased roadside recovery areas and the removal or shielding of fixed objects. As part of the cost-benefit assessment of this proposal, an investigation is needed of the extent to which such curves are also accident blackspots for other vehicles.

3. Visible mobile police patrols and stationary enforcement of speeding and BAC levels, located in the residential streets of the outer suburbs of Melbourne.
4.
 - (a) Inclusion or increased emphasis in the motorcycle pre-licence testing manual of the dangers due to the low conspicuity of motorcycles, and the need to compensate for braking difficulties while gaining experience
 - (b) Adding a higher speed curve negotiation test to the skills test for a Probationary motorcycle licence
5. A requirement that motorcycles be operated with front headlamps alight at all times.

Intoxicated Pedestrians

Previous research has shown that there is a 15 times higher risk of serious injury for pedestrians who are intoxicated (ie. those with a BAC above 0.15) compared with those who are sober.

Sub-groups of intoxicated pedestrians who were substantially over-involved in accidents compared with sober pedestrians were identified as suitable targets for countermeasures. The mechanisms explaining the over-involvement of each target group were suggested. The target groups could be addressed through VIC ROAD's existing Pedestrian Safety Program. The focus of each of the three program strategies aimed at intoxicated pedestrians should include:

Strategy 1: To prevent pedestrians reaching high blood alcohol levels

- drinkers who start early in the night, consume a relatively large amount of alcohol, and finish their drinking relatively early (before Midnight)
- drinkers who start drinking at lunchtime or during the afternoon
- drinkers on weekends
- drinkers on Fridays in the Melbourne suburbs
- adults aged between 30 and 60 drinking during the day
- adults aged between 30 and 50 drinking at night in the inner Melbourne suburbs

Strategy 2: To prevent intoxicated pedestrian exposure

- male drinkers in hotels and other licensed premises
- public education messages in these venues emphasising the high risk of death if an intoxicated pedestrian is struck by a vehicle, especially at the higher speeds travelled in the outer suburbs

Strategy 3: To reduce intoxicated pedestrian risk

- T-intersections in the inner Melbourne suburbs (treatment to be applicable during all times of day, especially daytime)
- roads in 75 km/h speed zones (treatments such as pedestrian crossings, supported by pedestrian fencing to encourage their use, and median refuges and improved lighting, to assist the pedestrian to cross a wide road and improve their conspicuity to drivers).

Elderly Pedestrians

Elderly pedestrians aged 60 and above have a high rate of casualty accident involvement which reaches three times the rate of younger adults for pedestrians aged in the mid-70's. Injury severity also increases with age, with pedestrians aged 65 and above having substantially higher rates of death or hospitalisation when injured in accidents.

Very few factors were found to be related to the over-involvement of the elderly pedestrians. However, a large number of factors were found to be related to the injury severity of pedestrians aged 65 and above who were killed or injured during the same period. These factors define sub-groups of the elderly pedestrian accident problem which should be target groups for countermeasures.

The target groups related to substantially higher injury severities were examined and mechanisms to explain their accident involvement or high severity were suggested. The target groups should be addressed through countermeasures in four general categories, with the focus in each category being as follows:

Category 1: Education of elderly pedestrians

- their poor conspicuity during darkness and dawn/dusk lighting conditions
- pedestrians aged 75 and above should be particularly careful in avoiding accident involvement because of their high injury susceptibility
- difficulties for drivers to brake rapidly on wet roads, and their poor visibility during raining conditions
- additional care needed when crossing divided arterial roads in Melbourne at major intersections
- the higher risk of death when intoxicated if an elderly pedestrian is struck by a vehicle
- additional care needed when crossing to or from a tram

Category 2: Education of drivers

- awareness of the poor conspicuity of elderly pedestrians during darkness and dawn/dusk lighting conditions
- difficulties in braking rapidly on wet roads
- poor visibility during raining conditions
- awareness of the unexpected presence of elderly pedestrians on roads in the residential areas of Melbourne, and areas outside Melbourne
- lack of awareness of elderly pedestrians to the presence of approaching vehicles, especially when intoxicated
- need to look out for elderly pedestrians at intersections in the residential areas of Melbourne, especially at STOP signs

Category 3: Enforcement of driving offences

- random breath testing to deter drink driving in the "alcohol times of the week", especially on arterial roads
- speed enforcement on divided arterial roads (especially in 75 km/h speed zones) in Melbourne
- speed enforcement on arterial roads in the vicinity of tram stops

Category 4: Road engineering

- improved street lighting in the vicinity of places frequented by elderly pedestrians at night
- pedestrian crossings on divided arterial roads at locations frequented by elderly pedestrians
- pedestrian refuges at intersections in residential areas with STOP signs
- speed warning signs on arterial roads in the vicinity of tram stops.

Speeding Drivers

Drivers involved in serious casualty accidents were categorised into three populations of crashes considered likely to be speed related :

- . Drivers running off the road on curves (Population 1)
- . Drivers hitting another vehicle in the rear (Population 2)
- . Drivers involved in pedestrian accidents resulting in death or serious injury (Population 3).

Eight large clusters of drivers were found within Population 1 and six large clusters for each of both Populations 2 and Population 3. For each population, the corresponding clusters together represented at least 70% of the total drivers involved in a speed related accident type.

The drivers in Population 1 were involved in most of their accidents on rural roads (52%) compared with the drivers in Populations 2 and 3 (12% and 6%, respectively). These two populations of drivers were more frequently involved in accidents in the inner and middle areas of the Melbourne Statistical Division (MSD). Population 1 drivers were also more likely to be aged 18-25 (52%), have a BAC above zero (43%), to crash at night (55%) or on wet roads (32%), and to drive older cars (48% more than ten years old) than the other populations.

The largest cluster in Population 1, representing 21% of the total drivers running off the road on curves, was :

- . mostly drivers with zero BAC
- . mostly during day time
- . mostly on weekdays
- . mostly on dry roads
- . more often female drivers than the population average
- . more often in middle MSD locations than average
- . more often drivers of small cars than average.

The largest cluster in Population 2, representing 31% of drivers hitting another vehicle in the rear, was :

- . only drivers with zero BAC
- . mostly during day time
- . mostly on weekdays
- . mostly on dry roads

- . more often driving a car less than 6 years older than the population average
- . more often in middle MSD locations than average.

The largest cluster in Population 3, representing 29% of drivers hitting pedestrians resulting in death or serious injury, was :

- . only on dry roads
- . mostly in inner MSD locations
- . otherwise similar to the population in total.

Speed enforcement supported by mass media publicity, if focussed on the identified clusters and aimed at deterring excessive speeding behaviour, would be expected to be effective.

Unrestrained Occupants

Occupants of cars and station wagons involved in crashes and considered by the recording Police officer to be unrestrained were clustered into homogeneous groups to form the basis of countermeasures. The occupants were clustered on the basis of their age, sex, and seating position, and the time of day, day of week, speed zone and location of the crash. The seven largest clusters covered 69% of the unrestrained occupants.

The total group of unrestrained occupants were 58% male and spanned all age groups with 39% aged 17 to 25. Drivers represented 41%, left front passengers 26% and rear passengers 32% of the total. 61% crashed in speed zones up to 75 km/h, and 63% of their crashes occurred in the Melbourne Statistical Division (MSD) while 28% occurred on the open road in rural areas. Weekdays accounted for 62% of the unrestrained occupants, while 59% were involved in crashes during daytime.

The two largest clusters, which together covered 24% of the unrestrained occupants, were both mostly drivers crashing in speed zones up to 75 km/h, but they differed in other characteristics. The largest cluster mostly crashed at night and more often at weekends than the total group of unrestrained occupants. The second largest cluster were mostly male occupants and mostly crashed during the day. In other respects, these two clusters resembled the total group of unrestrained occupants.

The other five identified clusters each covered 8-10% of the unrestrained occupants. Each differed from the total group in relatively unique ways, but the clusters were homogeneous in themselves.

Each of these clusters provide suitable targets for integrated enforcement and publicity aimed at encouraging restraint use. Countermeasures which aim at reducing the impact severity or preventing the crash involvements of each of the cluster groups should also be considered.

ACKNOWLEDGEMENTS

The preliminary analyses for this project were carried out by Alan Drummond, Senior Research Fellow at MUARC, during 1987-90. The author is indebted to Alan for initiating the project, developing some of the ideas at a conceptual level, and for sharing them with him.

Mrs Uma Rao, formerly Manager Accident Studies at VIC ROADS, and Mr David Attwood, Principal Statistician at the Transport Accident Commission (TAC), provided the data files of Police Accident Reports and TAC injury compensation claims on which the analyses for this project were based. Ms Cheryl Hamill, formerly of VIC ROADS, and Mr Foong Chee Wai, formerly of MUARC, developed and implemented the procedures for merging the Police Accident Reports and TAC claims.

Terry Mach and Dina Neiger, research assistants at MUARC, provided excellent support in carrying out the large number of analyses for the main part of the project. They also prepared the graphical presentations in the analysis reports and contributed to the drafting of the two reports based on cluster analysis. However any errors in the interpretation of their analyses are solely the responsibility of the author.

Dr Peter Vulcan, Director of MUARC, provided very valuable comments on the analysis reports as they evolved in content, style and format. Mr Ray Taylor, Director Accident Prevention of the TAC, also provided extensive comments on the analysis reports sent to the Centre's sponsors and was instrumental in improving their final presentation.

ACCIDENT DATA ANALYSIS TO DEVELOP TARGET GROUPS FOR COUNTERMEASURES

1. INTRODUCTION

An important issue which emerged during the development of the 1991 Road Safety Strategy for Victoria was the need for new and better definitions of target groups for countermeasures. Countermeasures may be categorized in various ways (eg. the "Road User/Vehicle/Road System" and the "Engineering/Enforcement/Education/Encouragement" categorisations), but all are characterized by being focussed on a target group representing a component of the total problem, rather than attempting to address the problem as a whole.

Research to define new target groups has not kept up with the rapid implementation of countermeasures. In particular, the research has tended to focus only on finding target groups with high rates of accident involvement or severe injury outcome. It has not always been recognised that:

- . finding a target group with a high rate is not a sufficient condition for a successful countermeasure; the countermeasure must also be economically, socially and politically feasible
- . target groups for countermeasures may also lie among those groups which do not have unusually high rates; however in this situation the countermeasure has reduced chance of being effective and probably must have broad coverage to be economically justifiable.

The Road Safety Strategy Facts Document (VIC ROADS 1990), produced to support development of the 1991 Road Safety Strategy, was an attempt to present readily available information on target groups, but a need to extend this data further was identified. This was because the Facts Document reflected past research and the already known high risk groups, which in turn had already been the target groups of existing countermeasures in most cases.

This report describes a major project which aimed to further develop methods of identifying target groups for countermeasures, and to demonstrate those methods by application to a number of key road safety problems. Specific proposals for countermeasures which may be applied to the identified target groups were also developed where possible.

2. GENERAL OBJECTIVE

The general objective was to disaggregate the road accident problem using mass accident data to find groups of road users, vehicles and road segments which would be suitable targets for countermeasures.

Before developing methods to achieve this objective, there was a need to review the general nature of the process leading to road trauma and the development of successful countermeasures to this process.

2.1 The Road Trauma Chain

Successful development of a countermeasure requires a clear understanding of where it can potentially break the chain of events leading to traumatic injury on the road. A conceptual model of the road trauma chain is shown in Figures 1 and 2. The individual entities which participate in the chain can be humans, vehicles or road segments, each of which may be classified into a group of like elements to form a countermeasure target, if appropriate.

Associated with various steps or links in the chain are probabilities or risks of one or more steps. In Figure 1, four different risks of crash involvement are shown, depending on the starting point from where the risk is measured. The existence or participation of an entity at a starting point is known as "exposure to risk". The risk can be estimated by dividing the number of crash involvements by the number of "exposures"; this is called the crash involvement rate and is a random variable with the true risk as its mean. Thus the public health risk (D) of road crash involvement is estimated by the total number of persons involved in crashes per annum divided by the population. At the other extreme, for example, the pedestrian risk (A) of accident involvement per exposure may be estimated by the number of pedestrian involvements divided by the number of road crossings made.

In Figure 2, the risks associated with the steps after the crash has occurred are shown. For the injury risks the starting point is crash involvement and this event represents "crash exposure" to injury risk. Injury risk is estimated by the injury rate, which is the number of persons killed or injured divided by the number involved in crashes. Another starting point in Figure 2 is injury and here the risk is associated with severe injury or death, reflecting the injury severity of the injury or injuries. The exposure to this risk is called "injury exposure", ie. the exposure to severe injury, if a person is injured. Thus the injury severity (A) is estimated by the injury severity rate, defined as the number of persons severely injured or killed divided by the number of persons injured in crashes. In some mass crash data systems, the event of being injured is the entry criterion for a person to be recorded (this is essentially the case for Police reported accidents in Victoria); thus only injury severity can be estimated and not injury risk.

2.2 Countermeasures and Target Groups

A countermeasure is a measure which attempts to break the road trauma chain before one of the undesirable steps can occur (eg. crash involvement, injury or death). A target group for a countermeasure is a group of entities (humans, vehicles or roads) for which the chain can be broken effectively and, desirably, cost-effectively.

In discussing broad types of countermeasures, a distinction is drawn between the two major mechanisms which separately contribute to the road crash problem:

- . crash involvement - Figure 1
- . crash severity (death or injury) - Figure 2.

Thus a countermeasure may address only one of these mechanisms (occasionally both) and

FIGURE 1

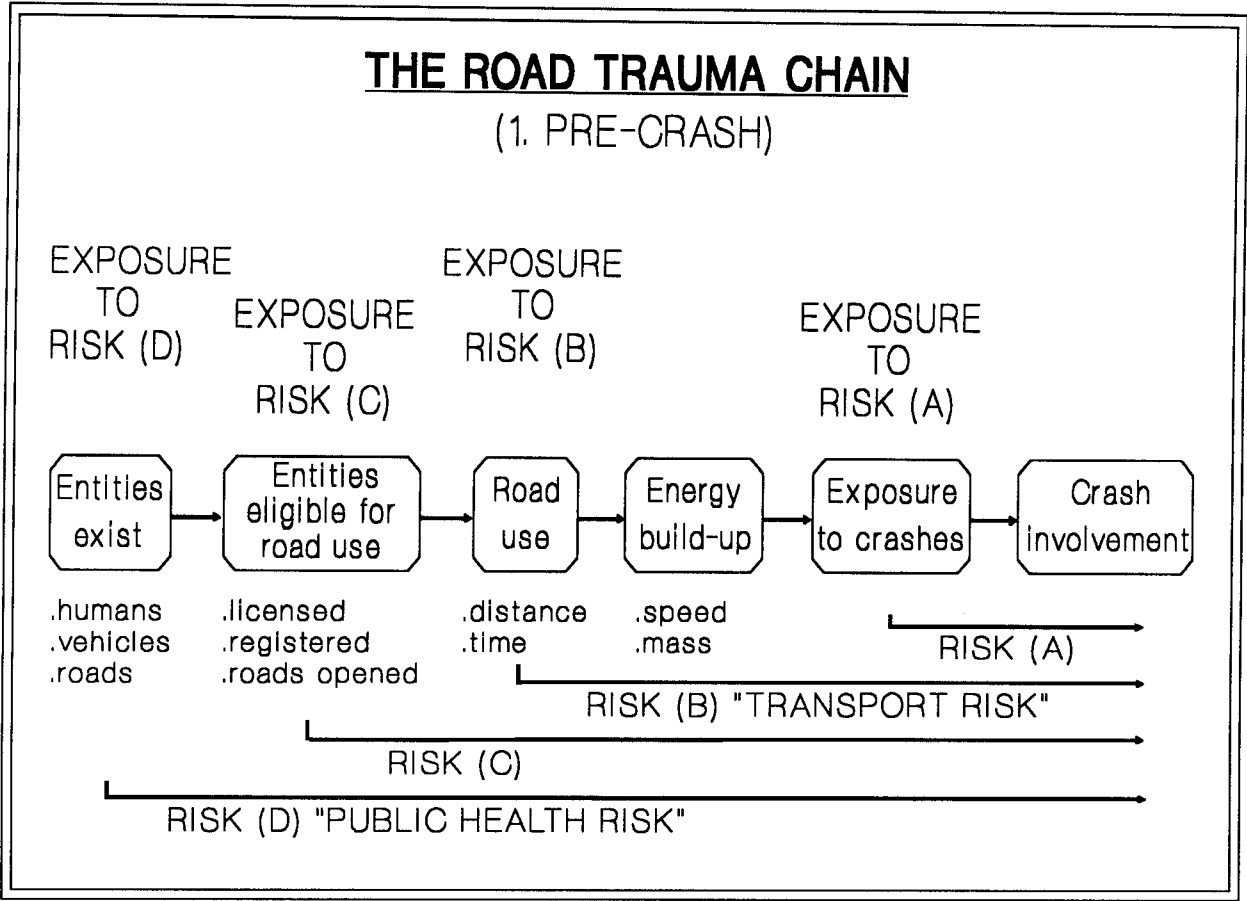
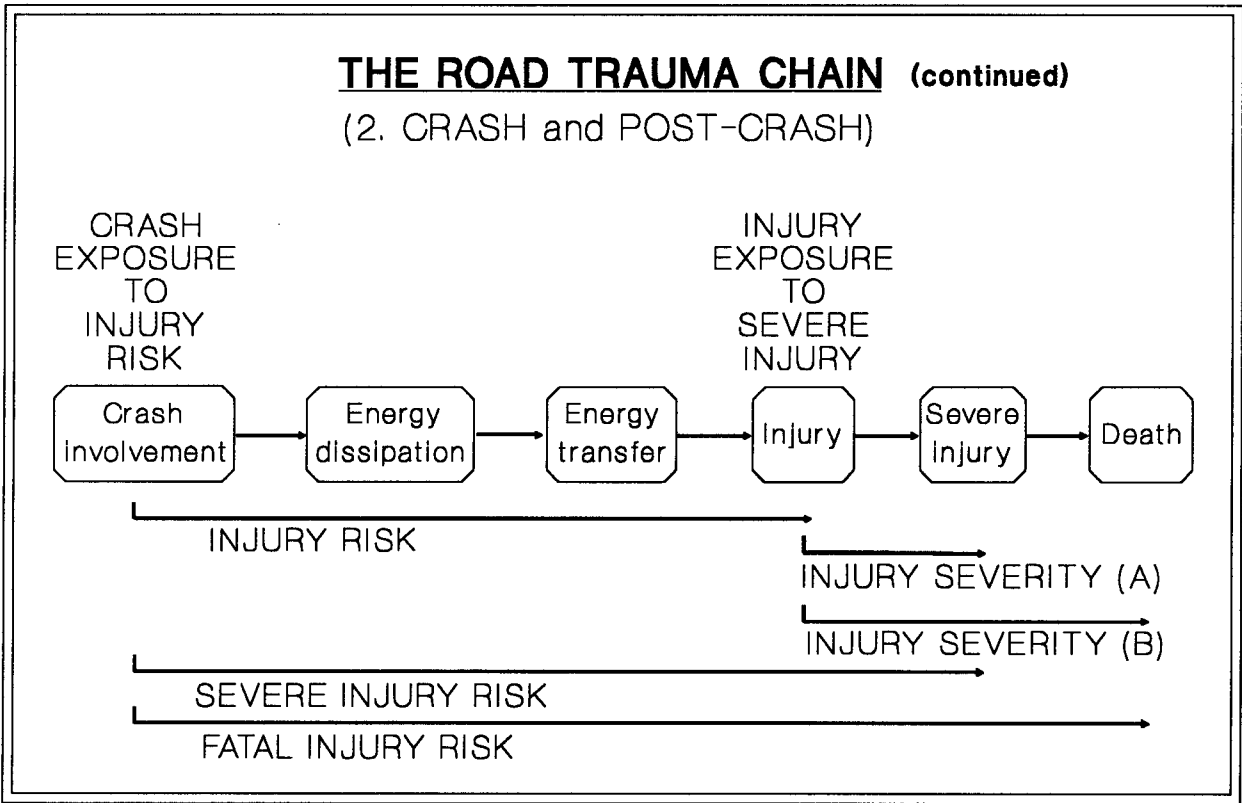


FIGURE 2



the target group must be chosen accordingly. A target group in the crash involvement area may not be a suitable target group for crash severity reduction.

Most road crash countermeasures are expensive in terms of implementation/operating costs, social and political costs, and the opportunity costs of other public investment foregone. Thus it is essential that countermeasure target groups be sought and found in a way that maximizes the chances that an implemented countermeasure returns benefits (crash loss reduction) which exceed its costs.

One approach to developing a countermeasure is to find a target group with an unusually high risk of a particular step in the road trauma chain. The countermeasure ideally should aim at that step; however one aimed at an earlier step may be still acceptable if the high risk of the later step exists. Another approach to countermeasure development is to seek a countermeasure with a low implementation cost, or a large target group which can have a single countermeasure applied to it and thus keep the unit cost of the measure low. In either case the effectiveness of the measure would not need to be high and the risk associated with the step at which it is aimed may be only low.

Mass crash data needs to be analysed to find target groups for countermeasures in a way which maximizes the chances that the countermeasure (as yet unspecified) will be cost-effective. In general terms the chances are maximized if:

- (a) the target group has a higher than average risk of crash involvement, or of severe injury when involved, since then the probability of being able to design an effective countermeasure would be high
 - because at the very least the countermeasure could aim to reduce the risk of the target group to the average level
 - alternatively, the high risk may be justification for a countermeasure which aims to restrict the exposure of the target group

or

- (b) the target group is sufficiently large and homogeneous that a single countermeasure could be applied to the whole group, thus distributing all or some of the costs more widely and requiring a lower level of effectiveness per target group member for the countermeasure to be cost-beneficial
 - however the target group may not have an unusually high risk and the countermeasure would need to reduce the risk to a below average level to be effective
 - in addition, a countermeasure which restricts exposure may be difficult to justify

or

- (c) both (a) and (b) apply (however most of the large target groups that satisfy both conditions have probably already been found, eg. intoxicated drivers, unrestrained passengers).

Approaches (a) and (b) lead to the following specific objectives for the project.

3. SPECIFIC OBJECTIVES

To find groups of road users, vehicles and road segments in the mass accident data with the following properties:

3.1 High Risk Groups

Groups with high rates of accident involvement per opportunity to be involved. This could be measured by:

- involvement rates per "exposure" (kilometres or time travelled, intersection conflicts, roads crossed),
- involvement rates per "population" (drivers licensed, vehicles registered, human population),
- over-involvement (compared with other groups) in an accident type with a known high risk per exposure (eg. alcohol-related accidents), since this would imply either:
 - . that the target group has a relatively high level of exposure to circumstances which lead to the accident type (eg. drunk driving), or
 - . that the target group has a higher level of accident risk when exposed to the specific circumstances, compared with other groups
- high representation among the group involved in an accident type with a known high risk per exposure, since this would suggest that the target group has essentially the same high risk.

The first two measures require compatible data from "exposure" and "population" data sources, whereas the latter measures are based on mass accident data alone.

The high risk accident types in which over-involvement or high representation of the target groups should be sought are listed below (high risk type listed first followed by the complement type for making the comparison to establish over-representation):

- intoxicated v. sober drivers
- speeding drivers v. not speeding drivers, defined by involvement in the following accident types:
 - . curved road v. straight road run-off-road accidents
 - . hitting v. being hit in rear end accidents
 - . fatal v. injury pedestrian accidents

- probationary v. fully licensed drivers
- intoxicated v. sober adult pedestrians
- young v. adult pedestrians
- elderly v. adult pedestrians
- curved v. straight road motorcycle accidents
- learner/probationary v. fully licensed motorcyclists
- intoxicated v. sober motorcyclists
- night v. day bicyclists
- arterial v. non-arterial road bicyclists
- articulated v. rigid trucks
- intersections v. mid-blocks in urban areas
- curved v. straight segments of rural highways

3.2 High Severity Groups

Groups with high rates of severe injury per accident involvement. Suitable measures would be:

- severe injury (death or hospitalisation) rates per accident involvement,
- fatality rates per involvement (these may be subject to considerable chance fluctuation with small groups),
- injury rates per involvement for specific severe (life-threatening) injuries.

Sub-groups which are over-involved or highly represented in severe injury outcome should be sought initially among those groups with known high injury severity rates per involvement, such as:

- unrestrained vehicle occupants
- occupants of cars struck in the side
- elderly pedestrians
- motorcyclists
- bicyclists without helmets
- bicyclists in 100 kmh zones
- small car occupants
- cars struck by trucks
- fixed roadside objects

3.3 Accident Involvement Clusters

Groups involved in accidents who are homogeneous on a number of factors relevant to countermeasure design (eg. time, location, road user type and age) and as large as possible. Priority should be given to seeking these sub-groups within large accident-involved groups known to have high risk per exposure, followed by a focus on other large accident-involved groups. The priority would be to find sub-groups within:

- intoxicated drivers

- excessively speeding drivers (defined by involvement in speed-related accident types)
- inexperienced drivers
- intoxicated pedestrians
- young pedestrians
- elderly pedestrians
- motorcyclists on curves
- inexperienced motorcyclists
- intoxicated motorcyclists
- bicyclists at night
- bicyclists on arterial roads
- articulated trucks
- urban intersections
- rural curved segments

3.4 Severe Injury Clusters

Groups associated with severe injury who are homogeneous on a number of factors relevant to injury countermeasure design (eg. restraint or helmet use, seating position, person age, vehicle type, location) and as large as possible. Priority should be given to seeking sub-groups within those large severely-injured groups who have high injury severity rates per involvement, such as:

- unrestrained vehicle occupants
- occupants of cars struck in the side
- elderly pedestrians
- motorcyclists
- bicyclists without helmets
- bicyclists in 100 kmh zones
- small car occupants
- cars struck by trucks
- fixed roadside objects

Within these priority groups there is also advantage in seeking sub-groups which are homogeneous on factors relevant to accident involvement countermeasure design, since it may transpire that an injury countermeasure is not feasible and an involvement countermeasure must be sought instead.

4. DATA SOURCES

4.1 Police Accident Reports

Police reports on casualty accidents in Victoria were used for finding high risk groups and accident involvement clusters, however Police reports on property damage accidents were not suitable for this purpose because of uncertainties about reasons for reporting. This means, however, that the findings relate to **casualty** accident risk and involvement, rather than to accidents in general.

Casualty accident reports include a coarse scale of injury severity (killed/serious injury/minor injury) which could be used for defining severe injury groups. Finer

and probably more accurate measures of injury severity were available from Transport Accident Commission (TAC) claims (see section 4.2).

Three special files of data on persons involved in Police reported casualty accidents were created for this study. The files covered persons killed or injured, plus drivers involved casualty accidents, for each of the following years:

- . 1982-86 (109,795 persons)
- . 1983-88 (230,918 persons)
- . 1984-89 (297,393 persons)

The latter file covers casualties and casualty accidents defined by the new injury scale adopted by the Police in 1989, and applied retrospectively to the 1984-88 data.

The files were also made available to and used by the Road Safety Division of VIC ROADS, as well as by other projects at MUARC. Further details of these and other files used in the project are available from the author.

4.2 TAC Claims

TAC claims data files include a number of factors related to injury countermeasures and hence could be used for finding high severity groups and severe injury clusters.

A file of data on claims made during the period July 1978 to June 1988 by occupants of post-1975 cars and station wagons (72,789 persons) was provided by the TAC. The focus was on occupants of post-1981 vehicles (17,969 persons) because the same data was analysed in a study of passenger car safety for the Federal Office of Road Safety (Fildes et al 1991).

4.3 Merged Police Accident Reports and TAC Claims

A file of TAC claims by occupants of post-1981 cars and station wagons merged with Police accident report data on persons involved in the same accident was created for crashes in the period 1983 to June 1988 (12,468 persons). This file enhances TAC claims with important factors related to injury countermeasures such as restraint use, speed zone and type of other vehicle or fixed object struck.

The file was further merged with Police report data on other persons in the same vehicle and in other vehicles in the same accident, to allow vehicle-based and accident-based analysis of factors related to injury risk and injury severity. These files covered 18466 vehicles and an estimated 9300 accidents, respectively.

5. PRELIMINARY ANALYSIS

5.1 Background data for the 1988 Road Safety Strategy

Analysis of data on persons involved in casualty accidents during 1982-86 was carried out to provide data to support countermeasure proposals which arose from a "brain-storming" session within the Road Traffic Authority during 1988. This analysis was driven by the proposals current at the time, and not by a search for new target groups. Some of the results related to over-involvement in accident types with known high risk per exposure.

5.2 Further analysis of 1982-86 data

Analysis of factors associated with over-involvement in the drunk (BAC > 0.05) road user group has been carried out for drivers, vehicle occupants, pedestrians, motorcyclists and bicyclists involved in casualty accidents during 1982-86. The findings have been summarized for drivers (Appendix A1 in Volume 2). These findings indicated the viability of the method of seeking over-involvement in an accident type with known high risk per exposure as a way of identifying high risk groups.

The same analysis compared road users involved in serious casualty accidents (ie. involving death or hospitalisation) with those involved in all casualty accidents. These comparisons indicated factors associated with higher injury severity. The comparisons have been performed for each road user group as a whole, and the factors summarized for drivers (Appendix A2 in Volume 2).

5.3 Analysis of 1983-88 data

Persons involved in casualty accidents during 1983-88 were analysed by road user type, severity of injury, location of accident and time of week related to alcohol involvement. These analyses provided useful reference data as a basis for later analysis of the same data. However, they were not specifically aimed at identifying target groups for countermeasures.

5.4 Specific analysis of 1987-88 data

Two specific analyses have been performed to examine factors associated with over-involvement in the speeding driver and drunk driver groups during 1987-88. The analyses compared:

- . speeding drivers v. not speeding drivers, defined by involvement in the following accident types:
 - curved road v. straight road run-off-road accidents
 - hitting v. being hit in rear end accidents
 - fatal v. injury pedestrian accidents (Appendix A3 in Volume 2)
- . sober v. drunk v. very drunk serious driver casualties (Appendix A4 in Volume 2).

6. OTHER RELATED ANALYSIS

The draft (May 1990) Road Safety Strategy Facts Document produced by VIC ROADS to support the development of the 1991 Road Safety Strategy contains data on a range of high risk and high severity groups, defined by a single factor in most cases (eg. drink drivers, unrestrained occupants). While this document was produced with similar objectives to the present study, it was constrained by readily available data and existing analysis. The document was a useful basis for a new impetus to the present study, by indicating at a gross level the high risk groups and high severity groups which should be priority areas for further disaggregation.

The document also included information on "high risk factors" and "high severity factors" which appeared to represent explanations for groups appearing as high risk or high severity, respectively. In general these factors were based on detailed prior surveys of characteristics of each such group, defined in earlier studies (eg. speeding drivers), and not on mass accident data.

The final Road Safety Strategy Facts Document (VIC ROADS 1990) was similar to the draft except for the omission of some information on high severity groups.

7. METHODS USED IN MAIN ANALYSIS

The methods used in the main analyses conducted in this project followed the four specific objectives described in section 3 and are outlined below. Each method was applied to one or more of the key problem areas listed under the corresponding specific objective.

7.1 High Risk Groups

As expected, it was not possible to disaggregate accident involvement rates per "exposure" or per "population" to a greater degree than has been previously done because of difficulties in obtaining disaggregated denominator data.

Hence the method was confined to seeking accident groups (described by one factor at a time initially) which are over-involved or highly represented in accident types with a known high risk, using two-way contingency table analysis. Where more than one factor was identified, and where resources permitted, multi-way contingency table analysis was used to test their independence.

7.2 High Severity Groups

Using a method similar to 7.1, groups involved in casualty accidents which are over-involved or highly represented in severe injury outcome were sought, initially based on one factor at a time. Where resources permitted, multi-way contingency table analysis was used to test the independence of multiple factors identified in this way.

7.3 Accident Involvement Clusters

This method uses cluster analysis to find homogeneous groups of casualty accident involvees, treating road users, vehicles and road segments in turn as the entities to be clustered. These clusters were sought initially within one of the high risk groups

listed in 3.3 above, namely speeding drivers.

7.4 Severe Injury Clusters

In this method, road users, vehicles and road segments associated with severe injury outcome are classified into homogeneous groups using cluster analysis. Priority was given to seeking clusters within one of the high severity groups listed in 3.4 above, namely unrestrained vehicle occupants.

8. PRELIMINARY RESULTS

During the course of the project a number of short reports on specific analyses of high risk and/or high severity groups have been prepared. These represent interim reports from the project. In general, the specific topic of each report reflects an issue of concern at the time and the report may have been prepared in response to a special request for information. These reports have been included in the Appendix of Volume 2.

9. MAIN RESULTS

In mid-1990 the project was reviewed and given the new direction described in this report. As each analysis using the methods described in section 7 was completed for specific problem areas, a report was produced and sent to MUARC's baseline sponsors for comments (these are summarised in section 10) and immediate use, if appropriate. The comments received on each analysis report influenced their final presentation and the methods and presentation used in subsequent reports.

The analysis reports are included in Volume 2 of this project report and their Executive Summaries are included in the Appendix of Volume 1 (this document). The analysis reports cover the following problem areas (the heading indicates the analysis method used to determine target groups for countermeasures to the specific problem).

9.1 High Risk Groups

9.1.1 Articulated Trucks

9.1.2 Novice Motorcyclists

9.1.3 Motorcyclists on Curves

9.1.4 Intoxicated Motorcyclists

9.1.5 Intoxicated Pedestrians

9.1.6 Elderly Pedestrians (combined with 9.2.3)

9.2 High Severity Groups

9.2.1 Cars Struck by Heavy Vehicles

9.2.2 Motorcyclists

9.2.3 Elderly Pedestrians (combined with 9.1.6)

9.3 Accident Involvement Clusters

9.3.1 Speeding Drivers

9.4 Severe Injury Clusters

9.4.1 Unrestrained Occupants

9.5 Executive Summaries

The Appendix includes an Executive Summary for the above analysis reports individually, with the exception of those reports related to motorcyclists. In these four cases, their results were assimilated in one summary report which selected a sub-set of target groups (based on substantial over-involvement or greater severity), suggested accident and injury mechanisms for related groups, and proposed a list of countermeasures to address these mechanisms. The procedures developed to evolve these countermeasure proposals were also used in subsequent individual analysis reports.

10. COMMENTS ON ANALYSIS REPORTS

Comments on each analysis report were received from one or more of MUARC's baseline sponsors. The suggestions relating to editorial matters and presentation issues have been incorporated in the final versions in Volume 2 when appropriate and wherever possible. The following comments were generally more fundamental in nature and raised issues regarding the feasibility of identifying viable target groups and the likelihood of being able to develop cost-effective countermeasures. The comments and the response are listed under the analysis area in which they arose.

10.1 Articulated Trucks

The major issue of concern about this analysis which measured over-involvements of semi-trailers by comparing them with rigid trucks was that the two types of truck have quite different road usage patterns and different sizes and load masses. Splitting the crashes analysed into two groups of speed zones at the accident location did not appear to be an adequate way of controlling the usage pattern differences. This issue was acknowledged and the executive summary of the analysis report focussed on the factors associated with over-involvements which were apparently not fully explainable by the differences in use, size or load mass.

No other type of road vehicle suitable for making comparisons with semi-trailers is apparent. In this situation there is a strong case for collecting exposure data

(measured, say, in kilometres travelled) for articulated trucks, in such a way that it can be directly compared with data on their accident involvements and allow accident involvement rates to be calculated for various sub-groups. This would allow sub-groups with high risks of accident involvement to be identified in a more direct way than that used in the analysis described in the report.

10.2 Cars Struck by Heavy Vehicles

Most commentators were comfortable with the measure of injury severity used in the analysis (ie. percentage of injured car occupants who were killed or seriously injured), and recognised that it did not cover the risk of injury *per se*. The risk of severe injury to injured occupants appears to be a measure which discriminates target groups warranting priority attention. However a need was seen for supplementary information on the size of each target group identified as having high injury severity. This was provided by giving the number of injured occupants (in the target group) used as the basis of the injury severity measure, previously found to be higher than the average injury severity for car occupants in total. The amount by which the target group injury severity exceeds the average, and the size of the group, are fundamental items of data for the calculation of the likely cost-effectiveness of a proposed countermeasure to the severe injury problem of the group.

It was commented that the monotonically increasing relationship found between injury severity and the truck to car mass ratio, particularly in urban (low speed zone) crashes, is consistent with findings in the USA.

10.3 Motorcyclists

Comments were provided on the four analysis reports related to motorcyclists collectively (ie. 9.1.2 to 9.1.4 and 9.2.2 in section 9 above). The analyses sought sub-groups of the motorcyclist trauma problem with high risk of crash involvement or high injury severity.

The major comment made on these analysis reports was that the methods tend to find a large number of small groups, and that there is a danger that resources for countermeasures may be attracted to small issues (this comment reflected a preference for a relatively small number of countermeasures aimed at large target groups). It was also noted that the size of the target group appeared to be inversely related to its extent of over-involvement or the relative amount by which its injury severity exceeds the average.

In response to the above comment, methods were developed to select and amalgamate target groups so that they could be addressed cost-effectively by relatively few countermeasures. In doing this, the four problem areas covered by the analysis reports were considered collectively. The process is described in the report "Development of Countermeasures to Motorcyclist Trauma" which forms the executive summary of all four analysis reports (see Appendix). In essence, a sub-set of target groups were initially selected on the basis of being substantially over-involved or substantially more severe, and more than a minimum size, then mechanisms for the crashes or injuries occurring in related target groups were

suggested, and finally a relatively small number of specific countermeasures to address those mechanisms were proposed.

A further comment related to the appropriateness of the comparison groups of motorcyclists used for assessing the over-involvement of sub-groups of the three motorcyclist problem areas previously identified as high risk (ie. novice motorcyclists, motorcyclists on curves, and intoxicated motorcyclists). While the comparison groups used were questioned, the concerns were not as strong as that felt about the use of rigid trucks as a comparison group for semi-trailers. However, once again there is a case for collecting relevant exposure data for motorcyclists (ideally this should include breath alcohol readings, for specific comparison with blood alcohol test results from killed and hospitalised motorcyclists). This would allow accident involvement rates to be calculated for various sub-groups to identify those with high risk in a more direct way.

10.4 Pedestrians

Comments were also provided collectively on the two analysis reports related to pedestrians (ie. 9.1.5 and 9.1.6/9.2.3 in section 9 above). These analyses sought sub-groups with high risks of accident involvement among intoxicated and elderly pedestrians, plus sub-groups with high injury severity among the elderly.

Regarding the over-involvements of elderly pedestrians, there was concern that relatively few factors emerged and that these were readily explainable by demographic and road use characteristics of the elderly population. It was suggested that other factors, not measured in mass accident data, may offer causal explanations. In contrast, a large number of factors available in the data appeared to be related to the injury severity of the elderly. However there appears to be a limit to which countermeasures can be designed to reduce injury severity (eg. by reducing speeds of the impacting vehicles), and there is a problem with focussing an accident involvement countermeasure on a target group which has high injury severity but usually not a high accident risk compared with elderly pedestrians overall. This is because the countermeasure must aim at reducing an accident risk which is already at an average level (or perhaps already low) and hence may not be feasible and may lack credibility.

Regarding intoxicated pedestrians, the comments noted that a number of over-involvements associated with time of day and day of week could be readily explained by known alcohol consumption patterns. Subsequent analysis in the report addressed this issue by splitting the pedestrian accidents into those occurring at night (after 6 pm to 6 am) and during the day. This controlled differences in alcohol consumption patterns in a general sense, and revealed that there were important differences between intoxicated and sober pedestrians by hour of the day (especially at night) which went beyond the general pattern.

The comments noted the high level of over-involvement of intoxicated pedestrians at T-intersections in the inner Melbourne suburbs. These locations represented a substantial proportion of their accidents, but the factors behind the increased risk at such intersections are not apparent. A special investigation of this issue was suggested.

Another comment noted that the proposed environmental treatments aimed at reducing the risk of accident involvement of pedestrians when they were already intoxicated (rather than aiming to prevent their intoxication), could also have substantial benefits for non-intoxicated pedestrians and hence are more likely to be cost-beneficial. This illustrates that some countermeasures aimed at specific target groups can have more general benefits and hence should be given higher priority.

10.5 Speeding Drivers

The method sought sub-groups of "speeding" drivers who were as similar as possible, rather than seeking sub-groups who were over-involved in speed-related accidents (this latter approach had been covered in the preliminary analysis; see Appendix A3 in Volume 2). It was commented that the methods have highlighted characteristics of target groups for the speeding driver problem which were previously hidden, and hence will be valuable for assisting educational and enforcement countermeasure development.

It was also noted that the analysis had not been able to consider the blood alcohol level of drivers in one of the major groups of drivers considered likely to have been speeding, ie. those involved in pedestrian accidents resulting in death or serious injury. This was because, in this type of accident, most drivers were not injured and hence a blood alcohol test was seldom taken at hospital. However, the blood alcohol level of drivers in these accidents is likely to be a key causal factor as well as their speed behaviour. This factor should be examined in a special investigation by considering data on the drivers' intoxication level from various sources such as preliminary and evidentiary breath tests, and the police officer's judgement of driver impairment, if available.

10.6 Unrestrained Occupants

The method focussed on unrestrained occupants because of their high injury severity in general, and sought sub-groups who were as similar as possible but not necessarily having particularly severe injuries. It was considered that, as for speeding drivers, the method highlighted characteristics of target groups of unrestrained occupants which had been hidden previously.

While the seven target groups identified were useful for countermeasure development, it was suggested that some of these could be combined leaving four target groups. This is not inconsistent with the general clustering approach used in the analysis; the question is how similar the group members need to be to be useful as a countermeasure target, versus maximizing the size of the group to be addressed by the countermeasure. Resolving this question is one for the countermeasure developer; the analysis report provides sufficient information to allow a variety of answers to be followed.

Another comment was that an important variable in defining the sub-groups may have been the blood alcohol level of the unrestrained occupant, since intoxicated occupants were considered less likely to wear available restraints in some cases and situations. Unfortunately the data file used for this analysis (the merged file of

Police accident reports and TAC claims) did not contain blood or breath test results. A new analysis making use of the blood alcohol results available in the Police accident report files held by VIC ROADS could address this issue.

11. DISCUSSION

The four methods of accident data analysis displayed a range of capabilities in meeting the general objective of finding target groups for countermeasures.

The most common method used when accident data is analysed alone is illustrated by the High Risk Groups approach used in the six corresponding analysis reports. While the intention was to find sub-groups with particularly high rates of accident involvement, the absence of exposure data for use as a denominator in such rates meant that the method was constrained to seeking factors which were "over-involved" relative to a comparison group which it was assumed had similar exposure patterns as the focus group. The assumption of similar exposure patterns was not a good one for rigid trucks (as a comparison group for semi-trailers) and was not ideal for the comparison groups used for the motorcyclist and pedestrian analyses.

It is clear that the availability of exposure data is critical for definite conclusions unless the comparison group is a very good one, ie. it closely resembles the focus group on a range of road use characteristics. The exposure data needs to be "matched" with the accident data in terms of the nature and specific values of each factor to be studied, eg. blood alcohol levels for the accident-involved and the exposed need to be collected in compatible ways. Driver exposure surveys using observational and interview techniques (necessary to measure some key factors) have not been conducted in Victoria since 1989 and the most recent motorcyclist and pedestrian surveys were even earlier. The exception is bicyclist exposure, which has been measured in Melbourne as recently as May/June 1992 (Finch et al 1992). With the large social changes in recent years due to the economic recession in Victoria, there is a need for more recent surveys of exposure of drivers (and their passengers), motorcyclists and pedestrians.

The High Severity Groups method, when applied to Police casualty accident reports in Victoria, was constrained to measuring the injury severity of injured road users rather than their risk of (severe) injury when involved in an accident. This was because the Police reports do not cover all uninjured persons involved in accidents defined by some criterion other than injury, eg. resulting in a vehicle being towed away, as in New South Wales' Police reports. Nevertheless the injury severity measure used was able to define target groups of the severely injured who appeared to have high risks of severe injury when involved in an accident, and thus were suitable for the application of countermeasures aimed at those risks.

When initially applied to the mass accident data, both the High Risk Groups method (using comparative over-involvements) and the High Severity Groups method tended to find a large number of relatively small target groups for countermeasures. The project subsequently developed procedures for selecting and amalgamating target groups, so that countermeasures could be defined with a broader coverage. While the number of target groups was reduced, the proposed countermeasures were still very specific in their focus, which was usually defined by a number of factors.

This could be a reflection of the nature of countermeasures needed to address the current road trauma problem in Victoria. While there has been considerable success in reducing road trauma during recent decades with a number of "silver bullets" (eg. seat belt wearing legislation, random breath testing, and the speed camera program) which have effectively addressed large parts of the problem, there may now be a need for a larger number of measures aimed at specific targets. These "bronze pellets" should be no less effective in reducing road trauma in their target group, but they need to be focussed on a specific and well-defined problem to achieve the high levels of effectiveness of the "silver bullets", and there needs to be many more of them. While highly desirable if they can be found, "silver bullets" have become much harder to design or are very expensive operationally, socially or politically.

The other two methods of analysis applied to the mass accident data (ie. Accident Involvement Clusters and Severe Injury Clusters) were designed to find target groups which are as large as possible, but also similar across a number of factors relevant to the countermeasure type which might be applied. While in theory these methods could be applied to any part of the road trauma problem, in this project the methods were applied, respectively, to an area considered to have high accident risk (ie. speeding drivers) and an area with known high injury severity (ie. unrestrained occupants). This ensured that the target groups defined by the analysis methods would also represent opportunities for improvement by traditional countermeasures aimed at reducing risk or injury severity. The comments received emphasised that the analysis methods were successful in identifying new target groups which were previously hidden. There would probably be value in applying the same methods appropriately to other problem areas listed in sections 3.3 and 3.4.

12. CONCLUSIONS AND RECOMMENDATIONS

The project has developed four methods of mass accident data analysis to find target groups for countermeasures, and has demonstrated those methods by application to a number of key road safety problems. It is possible to suggest accident or injury mechanisms for selected target groups, and to propose countermeasures to address those mechanisms which are likely to be cost-effective. Thus a systematic set of procedures now exists which could be further applied to other road trauma problem areas, using an appropriate analysis method reflecting the nature of the problem. This would assist in producing the large number of countermeasures each aimed at specific targets which will be required to ensure progress in road safety in Victoria in the future.

A weakness with the method for finding target groups with high accident involvement rates is its reliance on finding a comparison group with similar exposure patterns. This problem could be overcome if appropriate exposure data was available to act as the denominator in directly calculated involvement rates. It is **recommended** that new surveys of the on-road exposure of drivers, passengers, motorcyclists and pedestrians be conducted in Victoria to complement recent surveys of bicyclist exposure.

Clustering methods were used to find target groups which are as large as possible but also similar across a range of factors relevant to countermeasures which could be applied. The methods identified new target groups which were previously hidden. It is **recommended** that the methods be applied to other key road trauma problem areas as a matter of priority.

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APPENDIX

EXECUTIVE SUMMARIES OF ANALYSIS REPORTS

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MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

ACCIDENT DATA ANALYSIS PROJECT

HIGH RISK GROUP : ARTICULATED TRUCKS

EXECUTIVE SUMMARY

Articulated trucks have a high risk of casualty accident involvement compared with other types of trucks. In 1983 in Australia, articulated trucks were involved in 7.4 fatal accidents per 100 million kilometres travelled, compared with an involvement rate of 1.7 for rigid trucks. A higher level of involvement rate holds across all categories of accident severity, but the difference is relatively greater for the more severe accidents.

The over-involvement of articulated trucks was examined by comparing 2962 semi-trailers involved in casualty accidents in Victoria during 1984-89 with 5542 rigid trucks involved during the same period. It was recognised that semi-trailers operate over longer distances than rigid trucks and hence that they will be used and be involved in crashes on rural roads with the higher speed limits to a greater extent. For this reason the comparison of semi-trailer and rigid truck accidents was made within each of two groups of speed zones at the accident location (up to 75 km/h; 80 km/h and above).

Semi-trailers and their drivers were substantially over-involved in a large number of specific crash circumstances compared with rigid trucks. Many of these over-involvements were potentially explainable by the truck size and load mass differences, and by the different usage patterns of semi-trailers (relatively greater use on rural highways, in the highest speed zones, and at night). However the following factors associated with substantial over-involvements of semi-trailers are apparently not fully explainable by the above differences between the two vehicle types:

- . crashes in the low speed zones in rural towns
- . at traffic lights and roundabouts in the low speed zones
- . running off straight roads in the low speed zones
- . side swipe and overtaking crashes
- . driver's seat belt not fitted or not worn if available
- . impacts to the front and left side of the semi-trailer in the low speed zones
- . impacts to the front corners of the semi-trailer in the high speed zones
- . death or serious injury to the semi-trailer driver from crashes in the high speed zones.

These factors represent target groups for potential countermeasures to address the high over-involvement rate of articulated trucks in casualty crashes. These countermeasures could address the crash involvement of articulated trucks, and/or also the risk of severe injury to the truck driver and other road users involved, as there appear to be high risk factors operating in both stages which influence whether a casualty crash occurs.

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

ACCIDENT DATA ANALYSIS PROJECT

HIGH SEVERITY GROUP : CARS STRUCK BY HEAVY VEHICLES

EXECUTIVE SUMMARY

Occupants of passenger cars struck by heavy vehicles frequently sustain much higher severity injuries compared with car occupants struck by other types of vehicle. Injured car occupants are four to seven times more likely to be killed when the striking vehicle is a heavy vehicle, compared with being struck by another car. They are also substantially more likely to be taken to hospital when struck by a heavy vehicle than otherwise.

The objective of the analysis was to establish sub-groups of occupants of cars struck by heavy vehicles who had particularly high injury severities, as a basis of target groups for countermeasures. Injury severity was measured by the percentage of injured car occupants who were killed or seriously injured. Factors affecting the injury severity of 5496 car occupants involved in a collision with a heavy vehicle in Victoria during 1984-89 were examined. Preliminary analysis showed that the speed zone and the type of heavy vehicle were major factors affecting injury severity. Higher injury severities were observed in the higher speed zones and when the heavy vehicle was a semi-trailer. Subsequent analysis examined collisions involving semi-trailers and rigid trucks separately, within each of two groups of speed zones at the accident location (up to 75 km/h; 80 km/h and above).

A large number of environmental, crash, occupant, vehicle and impact factors were found to be related to higher levels of injury severity of the car occupants. These were:

(a) Environmental factors

- . rural roads outside towns
- . curved road alignments
- . at Stop signs
- . at Give Way signs (in most situations)
- . at cross intersections (in most situations)
- . away from intersections, for rigid truck collisions in the low speed zones
- . in the outer areas of Melbourne, for rigid truck collisions in the low speed zones

(b) Crash factors

- . car and truck approaching at right angles at intersections
- . head on crashes
- . car colliding with truck rear
- . right turn against crashes involving semi-trailers
- . car/truck collisions also involving a fixed object collision, when the truck was a rigid truck in the low speed zones or a semi-trailer in the high speed zones

(c) Car Occupant factors

- . unrestrained occupants
- . aged over 55 years
- . aged 18-25 years, for collisions in the high speed zones
- . male
- . positive BAC reading, for collisions in the low speed zones
- . driver seating position, for collisions with semi-trailers in the high speed zones

(d) Vehicle factors

- . small car (500 to 750 Kg)
- . intermediate size car (1250 to 1500 Kg) in the high speed zones
- . registered truck weight over 30 tonnes
- . truck to car mass ratio exceeding 20 (an exponentially increasing relationship between injury severity and mass ratio was also found)
- . truck model years 1960-69, in the high speed zones

(e) Collision points

- . impacts to the car:
 - right side
 - left side, for collisions in the low speed zones
 - front
 - resulting in extensive damage to the car
- . impacts to the truck:
 - front, especially the right front corner
 - left side
 - rear, for collisions in the low speed zones
- . impact configurations
 - front of truck colliding with car and producing extensive damage
 - front to front impacts between car and truck

These factors define target groups for countermeasures which should be designed to reduce injury severity, with priority given to severity reduction in the specific circumstances and characteristics of the target group. The target groups also define car/truck crash types and circumstances which should be priority areas for countermeasures aimed at preventing collisions involving trucks.

The analysis also found that nearly 40% of car occupants killed or seriously injured in car/truck collisions resulted from front to front impacts. Some 60% of these collisions involved impacts with the front corners of the truck, with more than half of these corner impacts being to the right front corner.

A priority area for a countermeasure to reduce car occupant injury severity is improved frontal structures of trucks, especially the front corners outside the frame side members and especially the right front corner. There are developments in Europe to improve the front corners of trucks by structures which absorb energy and also reduce over-ride of the struck car in off-set front to front impacts.

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

DEVELOPMENT OF COUNTERMEASURES TO MOTORCYCLIST TRAUMA

EXECUTIVE SUMMARY

In the Accident Data Analysis Project, a number of target groups for the motorcycle accident problem were identified by finding sub-groups which were over-involved in three crash situations which previous research had shown to be of high risk. Further target groups were added by identifying sub-groups which were associated with higher injury severity than the overall average for all injured motorcyclists.

A sub-set of target groups was selected on the basis of being substantially over-involved or substantially more severe. The selection criteria were designed to ensure that there is the potential for at least a 20% reduction (in most cases, 33% reduction) in the number of accident involvements, or the number of deaths or seriously injured, in the target group depending on its nature.

The selected target groups were reviewed collectively and mechanisms for the crashes or injuries occurring were suggested. This in turn led to the following suggested countermeasures for motorcyclist trauma:

1. Random breath testing during the "alcohol times" (and slightly earlier) on weekends in Spring and Summer, targetting riders of the larger and older motorcycles, and including licence checks. Priority should be given to deterring motorcyclists operating in residential areas of Melbourne and in rural areas outside towns, and there should be supporting publicity emphasising the focus on motorcyclists.
2. A curve treatment program aimed at motorcycle accident blackspots on curves, involving warning signs, improved skid resistance and super-elevation, increased roadside recovery areas and the removal or shielding of fixed objects. As part of the cost-benefit assessment of this proposal, an investigation is needed of the extent to which such curves are also accident blackspots for other vehicles.
3. Visible mobile police patrols and stationary enforcement of speeding and BAC levels, located in the residential streets of the outer suburbs of Melbourne.
4.
 - (a) Inclusion or increased emphasis in the motorcycle pre-licence testing manual of the dangers due to the low conspicuity of motorcycles, and the need to compensate for braking difficulties while gaining experience
 - (b) Adding a higher speed curve negotiation test to the skills test for a Probationary motorcycle licence
 - (c) Lower speed limit for novice motorcyclists on rural highways.
5. A requirement that motorcycles be operated with front headlamps alight at all times.

These suggestions arise from analysis of over-involvements without full consideration of the practicability of the suggested countermeasures.

INTRODUCTION

As part of the Accident Data Analysis Project, there have been four separate studies of the motorcycle accident problem. Three of these examined components of the problem where prior research had demonstrated a high risk of accident involvement, and attempted to find sub-groups which were particularly over-involved to act as countermeasure target groups. The three high risk components considered were:

- . motorcyclists crashing on curves
- . novice motorcyclists (learners and probationary licence holders)
- . intoxicated motorcyclists (BAC above 0.05).

In each case sub-groups were found by comparing the high risk component with its "low risk" complement (ie. motorcyclists crashing on straight roads, fully licensed motorcyclists, and sober motorcyclists, respectively) to establish factors which were over-represented to a statistically significant degree. It was not possible for most factors to say whether the sub-group defined had a high risk of accident involvement in the circumstances specified by the factor, or a high level of exposure to the circumstances leading to the accidents. However, each factor defines a target group for a countermeasure which should aim to reduce accident involvement by either reducing risk or reducing exposure, depending on what is likely to be effective, practical and acceptable.

The fourth study examined the injury severity of motorcyclists as a whole, because past research had identified motorcyclists as a road user group having one of the highest rates of severe injury. Sub-groups of injured motorcyclists who had high rates of severe injury (killed or seriously injured, with special focus on fatal injury) were sought to establish factors which were associated with higher injury severities than the overall average to a statistically significant degree. These factors define target groups for countermeasures which should aim to reduce the severe injuries sustained by motorcyclists involved in crashes. If such countermeasures are not practical or acceptable, then countermeasures should be aimed at reducing the accident involvements of the target group.

This report describes a process to develop countermeasures for the more significant target groups identified in the four studies. As well as giving attention to the size of the problem represented by the target group, it is proposed that "significant" target groups should be selected on the basis of:

- . the extent of over-involvement, in the case of target groups within each of the high risk components
- . the extent to which the injury severity is greater than the overall average, in the case of the high severity target groups.

SELECTED HIGH RISK TARGET GROUPS

In the first three reports there are a number of factors that were over-involved in the high risk component (eg. motorcyclists on curves) to only a small degree, even though this difference was statistically significant. In addition there were factors that, while substantially over-involved, were applicable to the high risk component in a small proportion of cases (the very small proportions were ignored in the three studies). Further, there were factors whose over-

involvement in the high risk component could be explained by a known difference in the exposure patterns of the two groups (eg. novice motorcyclists were more often constrained to engine capacities up to 250cc than fully licensed motorcyclists, due to a legislative requirement).

It is proposed that the significant target groups in the high risk components should be selected by the following criteria:

- . over-involvement by at least 1.5 times (ie. the proportion of the high risk component to which the factor is applicable should be at least 50% greater than the proportion of the "low risk" component),
- . the factor defining the target group is applicable to at least 5% of the high risk component,
- . the over-involvement of the factor in the high risk component is not substantially explainable by known differences in exposure of the groups being compared, and
- . the factor is a specific category of a more general factor which otherwise satisfies the above criteria, and the over-involvement lies substantially in the specific factor.

The first criterion ensures that the target group is substantially over-involved and hence that there is substantial room for change. It may be ambitious to expect a countermeasure to reduce the accident involvements of the target group by more than the group is over-involved, ie. to an accident involvement rate per motorcyclist lower than the rate of motorcyclists in the "low risk" component. An over-involvement criterion of at least 1.5 implies that a 33.3% or greater reduction in accident involvements is potentially available, without being overly ambitious, if this criterion is chosen. Whether the countermeasure would achieve this effect by risk reduction or exposure reduction (or a combination of both) is not relevant at this stage, only that the potential exists.

Table 1 shows the number of motorcyclists involved in crashes which were identified as target groups in the first three studies and which also satisfy the above criteria. These numbers are shown in **bold** font in the table; also shown in *italics* font are the numbers in selected target groups when the over-involvement criterion is relaxed to 1.25. For these target groups a reduction of accident involvements of at least 20% (up to 33.3%) is potentially available, without being overly ambitious.

SELECTED HIGH SEVERITY TARGET GROUPS

In the fourth report there were a number of target groups for which the injury severity measure (% killed or % seriously injured) was only slightly greater than the corresponding measure for all motorcyclists, even though this difference was statistically significant. However, groups of motorcyclists defined by factors which were applicable to only a small proportion of the total motorcyclists involved were not considered for identification as high severity target groups; this was because the calculated severity measure was based on few cases of injured motorcyclists and could not be considered reliable.

It is proposed that the significant target groups among those previously identified as having high severity should be selected by the following criteria:

- fatal injury severity at least 1.5 times the overall value (ie. the proportion of injured motorcyclists in the target group who were killed should be at least 50% greater than the proportion for injured motorcyclists overall), or
- serious injury severity at least 1.5 times the overall value (ie. the proportion of injured motorcyclists in the target group who were seriously injured should be at least 50% greater than the proportion for injured motorcyclists overall).

The overall injury severity measure used for reference should be that for all motorcyclists having essentially the same "crash exposure" to injury risk as the target group. In the fourth study it was found that motorcyclists crashing in the higher speed zones had higher levels of injury severity than those crashing in the lower speed zones; this was probably because they were exposed to higher impact speeds and hence had different "crash exposure" to injury. Hence in this case it would in general be necessary to compare the target group injury severity with the overall injury severity of motorcyclists crashing in the same speed zone categories; the exception would be if the target group had the same relatively high injury severity in each speed zone range.

One or both of the above criteria being true ensures that the target group has injury severity which is substantially higher than the norm and hence that there is substantial room for improvement. If the risk of fatal or serious injury to injured motorcyclists is at least 1.5 times the usual level, this implies that a 33.3% or greater reduction in the number of killed or seriously injured motorcyclists is potentially available without being overly ambitious. However, this potential is related to countermeasures which aim to achieve this effect by a reduction in injury severity (or reduction in severe injury risk); it is not relevant to the potential of countermeasures aimed at reducing the accident involvements of the same target group. The target group may not have an unusually high risk of motorcyclist accidents, or exposure to such crashes, so it may be difficult to design a countermeasure to reduce their accident involvements (this is not to say that such a countermeasure should not be given high priority if an injury severity countermeasure cannot be found).

Table 1 also shows the numbers of killed and seriously injured motorcyclists in the target groups identified in the fourth study, and where the target group satisfied one or both of the above criteria. These numbers are shown in **bold** font in the table: also shown in *italics* font are the corresponding numbers of severely injured in selected target groups when the criterion for the severity measure was 1.25 times the overall measure. For these target groups a reduction in deaths and/or serious injuries of at least 20% is potentially available, without being overly ambitious.

SIZE OF SELECTED TARGET GROUPS

Table 1 gives the number of involved motorcyclists (94% of whom were injured sufficiently to justify a Police report), or the numbers of killed and seriously injured motorcyclists, depending on the nature of the target group.

In conjunction with average motorcyclist injury costs by injury level, these numbers can be used to estimate the total cost of the accidents or serious injuries sustained by the target group per annum. This information should be used with estimates of the cost and expected effectiveness (percentage reduction in the target group) of a proposed countermeasure to judge whether it could be cost-beneficial and hence worth considering further. Appropriately chosen

countermeasures could reasonably expect to reduce the accident or injury costs associated with each target group by up to 20% (in most cases, up to 33.3%).

ACCIDENT AND INJURY MECHANISMS OF THE TARGET GROUPS

The first step in developing specific countermeasures for a selected target group is to obtain information on the mechanisms by which the accident involvement or injury occurrence was caused. In the case of accident involvement, it may be necessary to understand whether the target group has a high exposure or a high risk of accidents when exposed.

At times this information may not be readily available from past research or interstate or overseas experience. If the estimated cost of the target group accidents and/or injuries is large enough, there may be a case for diverting some of the countermeasure investment to research and development in order to gain a better understanding of the mechanisms to assist in the design of an effective countermeasure.

However the need for countermeasures to road trauma is acute in most areas, with motorcyclist crashes and injuries being one of them. While further research is clearly warranted, there is a case for attempting to develop countermeasures on the basis of the four studies of motorcycle accidents currently available.

SUGGESTED MECHANISMS AND COUNTERMEASURES

There is prior knowledge that many of the factors in Table 1 are related, eg. curved alignments occur predominantly on rural open roads; higher BAC's are observed at night during dark conditions. Hence some of the factors describe substantial parts of the same problem from a different perspective. Table 2 shows the percentage of motorcyclists in each target group; this measures the proportion of the problem associated with each factor and also indicates the potential for any countermeasure to have a major impact.

In general, the motorcyclists crashing on curves had many factors in common with intoxicated motorcyclists, even though the former had most of their crashes in the higher speed zones whereas the latter crashed mainly in the lower speed zones. In addition, the motorcyclist groups with high injury severity had many factors common to both of these high risk groups. Only the novice motorcyclists had relatively unique factors on which they were substantially over-represented.

It is possible by close examination of Tables 1 and 2 to suggest mechanisms and countermeasures for the crashes or injuries of a number of target groups simultaneously. These are:

1. Intoxicated motorcyclists are a well defined group for targetting and deserving of priority because of their high injury severity. Motorcyclists with BAC over 0.05 represent 43% of the killed and 17% of the seriously injured. Their accident mechanisms typically involve running off the road (44%), overturning or falling off (32% of crashes), and hitting objects (14%); typical alcohol-related crashes. However, the most important underlying mechanism is their prior alcohol consumption. Some 27% of their crashes occur on curves, so they are a significantly over-represented part of the curve problem as well.

Intoxicated motorcyclists are substantially over-involved during the alcohol times of the week (84%), on weekends (46%) and during October to February (52%). They are very over-represented among those motorcyclists riding bikes with engine capacity over 500cc (43%) or manufactured before 1980 (32%). A disproportionately high number of intoxicated motorcyclists are unlicensed (28%).

A suitable countermeasure would be the use of random breath testing during the alcohol times (and slightly earlier to provide a deterrent effect) on weekends in the Spring and Summer months, particularly targetting riders of the larger and older motorcycles, and including licence checks with follow-ups as well. Priority should be given to deterring motorcyclists operating in residential areas of Melbourne and in rural areas outside towns. The supporting publicity should emphasise the focus on motorcyclists and the particular target groups and areas.

2. Motorcyclists crashing on curves are substantially over-involved on rural roads outside towns (50%) and also in the low speed zones of the outer, semi-rural areas of Melbourne (12%). Their accidents frequently involve running off the road (64%), resulting in overturning or falling off (40%) or hitting objects (27%) especially trees, embankments, fences and walls (total 13%). Some 26% of these motorcyclists are intoxicated (and are over-represented in many of the same situations as intoxicated motorcyclists generally), but for the remainder who are sober the crash mechanism appears to be difficulty in negotiating curves and avoidance of roadside objects when they leave the road.

A suitable countermeasure would be a curve treatment program aimed at motorcycle accident blackspots on curves, involving warning signs and improved skid resistance and super-elevation. The treatment could also involve increased roadside recovery area and the removal or shielding of fixed objects. As part of the cost-benefit assessment of this proposal, an investigation is needed of the extent to which such curves are also accident blackspots for other vehicles.

3. Motorcyclists riding in the suburbs of Melbourne are a special target group. The residential areas off the arterial roads are substantially over-involved for those crashing on curves (14%) and for the intoxicated motorcyclists (20%). Severe injuries result from crashes in the outer suburbs, accounting for 24% of the deaths and also 24% of the seriously injured. The crash mechanisms appear to be a combination of alcohol consumption and speeding.

A suitable countermeasure would be a combination of visible mobile police patrols and stationary enforcement of speeding and BAC levels, located in the residential streets of the outer suburbs of Melbourne. Specific locations should be selected on the basis of motorcycle accident blackspots on curves, with priority given to the alcohol times of the week but not exclusively to those times.

4. Novice motorcyclists are not often substantially over-represented in situations and crash types which are different from experienced motorcyclists. They are very over-involved in crashes in rural towns (21%) and at Give Way signs (10%), and they have a disproportionately high number of crashes into the rear of other vehicles in the lower speed zones (6%) and hitting objects in the higher speed zones (4%). The crash mechanisms appear to be failure to be seen by other vehicles required to give way, and difficulties with braking while remaining stable. The over-involvement in rural towns probably relates to a high level of exposure by novice motorcyclists in those areas.

Suitable countermeasures would be:

- . inclusion or increased emphasis in the motorcycle pre-licence testing manual of the dangers due to the low conspicuity of motorcycles, and the need to compensate for braking difficulties and associated instability while gaining experience on motorcycles
 - . adding a higher speed curve negotiation test to the skills test for a Probationary motorcycle licence
 - . lower speed limit for learner and Probationary licensed motorcyclists on rural highways.
5. Motorcyclists as a whole have substantially higher injury severities when they are involved in right turn against crashes, and in crashes at Give Way and Stop signs in the higher speed zones. Right turn against crashes resulted in 14% of the killed and 16% of the seriously injured motorcyclists. The Give Way signs represent 5% of the deaths and Stop signs represent 1%; each type of intersection represents 1% of the seriously injured. The crash mechanism is likely to a failure to be seen by other vehicles required to give way (after first stopping in the case of a Stop sign).

A suitable countermeasure would be a requirement that motorcycles be operated with front headlamps alight at all times.

SUMMARY

Target groups for the motorcycle accident problem were identified by finding sub-groups which were over-involved in three crash situations which previous research had shown to be of high risk. Further target groups were added by identifying sub-groups which were associated with higher injury severity than the overall average for all injured motorcyclists.

A sub-set of target groups was selected on the basis of being substantially over-involved or substantially more severe. The selection criteria were designed to ensure that there is the potential for at least a 20% reduction (in most cases, 33% reduction) in the number of accident involvements, or the number of deaths or seriously injured, in the target group depending on its nature.

The selected target groups were reviewed collectively and mechanisms for the crashes or injuries occurring were suggested. This in turn led to the following suggested countermeasures for motorcyclist trauma:

1. Random breath testing during the alcohol times (and slightly earlier to provide a deterrent effect) on weekends in the Spring and Summer months, particularly targetting riders of the larger and older motorcycles, and including licence checks with follow-ups as well. Priority should be given to deterring motorcyclists operating in residential areas of Melbourne and in rural areas outside towns. The supporting publicity should emphasise the focus on motorcyclists and the particular target groups and areas.
2. A curve treatment program aimed at motorcycle accident blackspots on curves, involving warning signs and improved skid resistance and super-elevation. The treatment could also involve increased roadside recovery area and the removal or shielding of fixed objects.

3. A combination of visible mobile police patrols and stationary enforcement of speeding and BAC levels, located in the residential streets of the outer suburbs of Melbourne. Specific locations should be selected on the basis of motorcycle accident blackspots on curves, with priority given to the alcohol times of the week but not exclusively to those times.
4.
 - (a) inclusion or increased emphasis in the motorcycle pre-licence testing manual of the dangers due to the low conspicuity of motorcycles, and the need to compensate for braking difficulties and associated instability while gaining experience on motorcycles
 - (b) adding a higher speed curve negotiation test to the skills test for a Probationary motorcycle licence
 - (c) lower speed limit for learner and Probationary licensed motorcyclists on rural highways.
5. A requirement that motorcycles be operated with front headlamps alight at all times.

However, it should be noted that these suggestions have at this stage been based predominantly on the analysis of over-involvements of the target groups in high risk and/or high injury severity situations, without full consideration of practicability of the suggested countermeasure.

Each suggestion needs to be reviewed to assess its cost-effectiveness and the need for further research and development. In the case of the second suggestion, an investigation is needed of the extent to which motorcycle accident blackspot curves are also blackspots for other vehicles, as part of the cost-benefit assessment of this proposal.

Table 1: NUMBER OF MOTORCYCLISTS IN SELECTED HIGH RISK AND HIGH SEVERITY TARGET GROUPS (6 years: 1984-89)

| | A | B | C | D | E | F | G | H | I |
|----|--------------------------------|------------|----------------|----------------|---------------|---------------|-----------|---------------|---------|
| 1 | Target Group | Speed | Motorcyclists | Learner permit | Motorcyclists | Motorcyclists | | TOTAL | |
| 2 | | Zones | crashing on | & Probationary | involved with | | Seriously | MOTORCYCLISTS | |
| 3 | | applicable | curves | Motorcyclists | BAC > 0.05 | Killed | Injured | INVOLVED | |
| 4 | | | | involved | | | | No. | % |
| 5 | TOTALS INVOLVED | | 2158 | 5092 | 1722 | 380 | 5664 | 13445 | 100.00% |
| 6 | Percent of total involvements | | 16.05% | 37.87% | 12.81% | 2.83% | 42.13% | 100.00% | |
| 7 | | | | | | | | | |
| 8 | Speed Zones up to 75 km/h | | 953 | 4138 | 1262 | 236 | 4261 | 10579 | 78.68% |
| 9 | Speed Zones 80 km/h & above | | 1205 | 954 | 460 | 144 | 1403 | 2866 | 21.32% |
| 10 | | | | | | | | | |
| 11 | ENVIRONMENTAL FACTORS | | | | | | | | |
| 12 | Residential areas Melb. | low | 296 | | all zones 344 | | | 2060 | 15.32% |
| 13 | Outer Melbourne suburbs | low | | | | 90 | 1339 | 3195 | 23.76% |
| 14 | Outer areas of MSD | low | 259 | | | 42 | 406 | 1321 | 9.83% |
| 15 | Rural towns | all | high zones 141 | 1054 | | | | 2289 | 17.02% |
| 16 | Rural areas outside towns | all | 167 + (911) | | 443 | | | 2814 | 20.93% |
| 17 | 100 km/h speed zones | | | | 427 | | | 2704 | 20.11% |
| 18 | Curved alignment | all | 2158 | | 465 | | | 2158 | 16.05% |
| 19 | | low | | | | 47 | 406 | 941 | 7.00% |
| 20 | Give Way signs | all | | 524 | | | | 1138 | 8.46% |
| 21 | | high | | | | 18 | 63 | 139 | 1.03% |
| 22 | Stop signs | high | | | | 4 | 31 | 58 | 0.43% |
| 23 | | | | | | | | | |
| 24 | SITUATIONAL FACTORS | | | | | | | | |
| 25 | 10am to 4pm | high | 573 | | | | | 1147 | 8.53% |
| 26 | 6pm to 6am | all | low zones 459 | | 1199 | 169 | 1723 | 3813 | 28.36% |
| 27 | Alcohol times of week | all | low zones 521 | | 1445 | 222 | 2531 | 5689 | 42.31% |
| 28 | Weekends | all | | | 799 | | | 3910 | 29.08% |
| 29 | Sundays | all | 556 | | | 65 | 864 | 1868 | 13.89% |
| 30 | Saturdays | all | 442 | | | 72 | 914 | 2042 | 15.19% |
| 31 | Dark conditions | all | | | 968 | 140 | 1282 | 2937 | 21.84% |
| 32 | Dark, no street lights present | low | 59 | | | | | 155 | 1.15% |
| 33 | October to February | all | | | 887 | | | 5735 | 42.66% |

Table 1: NUMBER OF MOTORCYCLISTS IN SELECTED HIGH RISK AND HIGH SEVERITY TARGET GROUPS (6 years: 1984-89)

| | A | B | C | D | E | F | G | H | I |
|----|-----------------------------|------------|---------------|----------------|---------------|---------------|-----------|---------------|--------|
| 1 | Target Group | Speed | Motorcyclists | Learner permit | Motorcyclists | Motorcyclists | | TOTAL | |
| 2 | | Zones | crashing on | & Probationary | involved with | | Seriously | MOTORCYCLISTS | |
| 3 | | applicable | curves | Motorcyclists | BAC > 0.05 | Killed | Injured | INVOLVED | |
| 4 | | | | involved | | | | No. | % |
| 34 | | | | | | | | | |
| 35 | RIDER FACTORS | | | | | | | | |
| 36 | Unlicensed | all | 319 | | 489 | 80 | 697 | 1300 | 9.67% |
| 37 | Positive BAC | all | | | | 202 | 1179 | 2179 | 16.21% |
| 38 | BAC over 0.05 | all | 568 | | 1722 | 165 | 965 | 1722 | 12.81% |
| 39 | BAC over 0.15 | all | | | | 99 | 388 | 714 | 5.31% |
| 40 | Age under 18 years | all | 73 | | | 12 | 155 | 259 | 1.93% |
| 41 | Age over 55 years | all | | | | 8 | 65 | 143 | 1.06% |
| 42 | Female | all | | 311 | | | | 588 | 4.37% |
| 43 | Non-Victorian licence | all | | | 406 | | | 1788 | 13.30% |
| 44 | Helmet not worn | all | | | | 20 | 119 | 322 | 2.39% |
| 45 | | | | | | | | | |
| 46 | MOTORCYCLE FACTORS | | | | | | | | |
| 47 | Manufactured before 1980 | all | | | 548 | | | 2649 | 19.70% |
| 48 | Engine capacity > 500cc | high | | | all zones 739 | 65 | 478 | 1050 | 7.81% |
| 49 | Engine capacity 251-500cc | all | | | all zones 449 | | | 2624 | 19.52% |
| 50 | Extensively damaged | all | | | 133 | 61 | 317 | 557 | 4.14% |
| 51 | Front impacts | high | | | | 125 | 915 | 1224 | 9.10% |
| 52 | | | | | | | | | |
| 53 | CRASH FACTORS | | | | | | | | |
| 54 | Head on collisions | all | 369 | | | 56 | 335 | 587 | 4.37% |
| 55 | Collisions with heavy vehs. | all | | | | 38 | 207 | 397 | 2.95% |
| 56 | Right turn against crashes | all | | | | 52 | 925 | 1757 | 13.07% |
| 57 | Cross traffic collisions | high | | | | 19 | 80 | 158 | 1.18% |
| 58 | Into parked vehicle | low | | | | 16 | 108 | 207 | 1.54% |
| 59 | Into other vehicle rear | low | | 290 | 153 | | | 654 | 4.86% |
| 60 | Involving overtaking | high | | | | 15 | 57 | 132 | 0.98% |
| 61 | Crashes without collision | all | 872 | | 551 | | | 2800 | 20.83% |
| 62 | Running off road | all | 1382 | | 766 | | | 3412 | 25.38% |

Table 1: NUMBER OF MOTORCYCLISTS IN SELECTED HIGH RISK AND HIGH SEVERITY TARGET GROUPS (6 years: 1984-89)

| | A | B | C | D | E | F | G | H | I |
|----|-----------------------|------------|---------------|----------------|---------------|---------------|---------|---------------|-------|
| 1 | Target Group | Speed | Motorcyclists | Learner permit | Motorcyclists | Motorcyclists | | TOTAL | |
| 2 | | Zones | crashing on | & Probationary | involved with | Seriously | | MOTORCYCLISTS | |
| 3 | | applicable | curves | Motorcyclists | BAC > 0.05 | Killed | Injured | INVOLVED | |
| 4 | | | | involved | | | | No | % |
| 63 | CRASH FACTORS (cont.) | | | | | | | | |
| 64 | Hitting objects | all | 581 | high zones 183 | 242 | 88 | 488 | 1194 | 8.88% |
| 65 | . trees | all | 148 | low zones 22 | | 15 | 88 | | |
| 66 | . poles | low | | 20 | 31 | 4 | 23 | | |
| 67 | . fences or walls | all | 62 | 33 | 61 | 6 | 47 | | |
| 68 | . embankments | all | 81 | 30 | | low 2 | low 7 | | |
| 69 | . traffic signs | high | | 6 | 12 | 4 | 33 | | |
| 70 | . guard rails | high | all zones 40 | 6 | 9 | 1 | 9 | | |
| 71 | . guide posts | high | 43 | 19 | 28 | 3 | 20 | | |
| 72 | . traffic islands | low | | | | 2 | 8 | | |
| 73 | . other fixed objects | low | | | 43 | 3 | 23 | | |

Table 2: PERCENTAGE OF MOTORCYCLISTS IN SELECTED HIGH RISK AND HIGH SEVERITY TARGET GROUPS (6 years: 1984-89)

| | A | B | C | D | E | F | G | H |
|----|--------------------------------|------------|---------------|----------------|---------------|---------------|---------|---------------|
| 1 | | Speed | Motorcyclists | Learner permit | Motorcyclists | Motorcyclists | | TOTAL |
| 2 | | Zones | crashing on | & Probationary | involved with | Seriously | | MOTORCYCLISTS |
| 3 | Target Group | applicable | curves | Motorcyclists | BAC > 0.05 | Killed | Injured | INVOLVED |
| 4 | | | | involved | | | | |
| 5 | TOTALS INVOLVED | | 2158 | 5092 | 1722 | 380 | 5664 | 13445 |
| 6 | Percent of totals involved | | 100% | 100% | 100% | 100% | 100% | 100% |
| 7 | | | | | | | | |
| 8 | Speed Zones up to 75 km/h | | 44% | 81% | 73% | 62% | 75% | 79% |
| 9 | Speed Zones 80 km/h & above | | 56% | 19% | 27% | 38% | 25% | 21% |
| 10 | | | | | | | | |
| 11 | ENVIRONMENTAL FACTORS | | | | | | | |
| 12 | Residential areas Melb. | low | 14% | | 20% | | | 15% |
| 13 | Outer Melbourne suburbs | low | | | | 24% | 24% | 24% |
| 14 | Outer areas of MSD | low | 12% | | | 11% | 7% | 10% |
| 15 | Rural towns | all | 7% | 21% | | | | 17% |
| 16 | Rural areas outside towns | all | 50% | | 26% | | | 21% |
| 17 | 100 km/h speed zones | | | | 25% | | | 20% |
| 18 | Curved alignment | all | 100% | | 27% | | | 16% |
| 19 | | low | | | | 12% | 7% | 7% |
| 20 | Give Way signs | all | | 10% | | | | 8% |
| 21 | | high | | | | 5% | 1% | 1% |
| 22 | Stop signs | high | | | | 1% | 1% | 0% |
| 23 | | | | | | | | |
| 24 | SITUATIONAL FACTORS | | | | | | | |
| 25 | 10am to 4pm | high | 27% | | | | | 9% |
| 26 | 6pm to 6am | all | 21% | | 70% | 44% | 30% | 28% |
| 27 | Alcohol times of week | all | 24% | | 84% | 58% | 45% | 42% |
| 28 | Weekends | all | | | 46% | | | 29% |
| 29 | Sundays | all | 26% | | | 17% | 15% | 14% |
| 30 | Saturdays | all | 20% | | | 19% | 16% | 15% |
| 31 | Dark conditions | all | | | 56% | 37% | 23% | 22% |
| 32 | Dark, no street lights present | low | 3% | | | | | 1% |
| 33 | October to February | all | | | 52% | | | 43% |

Table 2: PERCENTAGE OF MOTORCYCLISTS IN SELECTED HIGH RISK AND HIGH SEVERITY TARGET GROUPS (6 years: 1984-89)

| | A | B | C | D | E | F | G | H |
|----|-----------------------------|------------------------|----------------------------------|--|--|----------------------|-------------------|------------------------------|
| 1 | Target Group | Speed Zones applicable | Motorcyclists crashing on curves | Learner permit & Probationary Motorcyclists involved | Motorcyclists involved with BAC > 0.05 | Motorcyclists Killed | Seriously Injured | TOTAL MOTORCYCLISTS INVOLVED |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | RIDER FACTORS | | | | | | | |
| 36 | Unlicensed | all | 15% | | 28% | 21% | 12% | 10% |
| 37 | Positive BAC | all | | | | 53% | 21% | 16% |
| 38 | BAC over 0.05 | all | 26% | | 100% | 43% | 17% | 13% |
| 39 | BAC over 0.15 | all | | | | 26% | 7% | 5% |
| 40 | Age under 18 years | all | 3% | | | 3% | 3% | 2% |
| 41 | Age over 55 years | all | | | | 2% | 1% | 1% |
| 42 | Female | all | | 6% | | | | 4% |
| 43 | Non-Victorian licence | all | | | 24% | | | 13% |
| 44 | Helmet not worn | all | | | | 5% | 2% | 2% |
| 45 | | | | | | | | |
| 46 | MOTORCYCLE FACTORS | | | | | | | |
| 47 | Manufactured before 1980 | all | | | 32% | | | 20% |
| 48 | Engine capacity > 500cc | high | | | 43% | 17% | 8% | 8% |
| 49 | Engine capacity 251-500cc | all | | | 26% | | | 20% |
| 50 | Extensively damaged | all | | | 8% | 16% | 6% | 4% |
| 51 | Front impacts | high | | | | 33% | 16% | 9% |
| 52 | | | | | | | | |
| 53 | CRASH FACTORS | | | | | | | |
| 54 | Head on collisions | all | 17% | | | 15% | 6% | 4% |
| 55 | Collisions with heavy vehs. | all | | | | 10% | 4% | 3% |
| 56 | Right turn against crashes | all | | | | 14% | 16% | 13% |
| 57 | Cross traffic collisions | high | | | | 5% | 1% | 1% |
| 58 | Into parked vehicle | low | | | | 4% | 2% | 2% |
| 59 | Into other vehicle rear | low | | 6% | 9% | | | 5% |
| 60 | Involving overtaking | high | | | | 4% | 1% | 1% |
| 61 | Crashes without collision | all | 40% | | 32% | | | 21% |
| 62 | Running off road | all | 64% | | 44% | | | 25% |

Table 2: PERCENTAGE OF MOTORCYCLISTS IN SELECTED HIGH RISK AND HIGH SEVERITY TARGET GROUPS (6 years: 1984-89)

| | A | B | C | D | E | F | G | H |
|----|-----------------------|------------|---------------|----------------|---------------|---------------|-----------|---------------|
| 1 | | Speed | Motorcyclists | Learner permit | Motorcyclists | Motorcyclists | | TOTAL |
| 2 | | Zones | crashing on | & Probationary | involved with | | Seriously | MOTORCYCLISTS |
| 3 | Target Group | applicable | curves | Motorcyclists | BAC > 0.05 | Killed | Injured | INVOLVED |
| 4 | | | | involved | | | | |
| 63 | CRASH FACTORS (cont.) | | | | | | | |
| 64 | Hitting objects | all | 27% | 4% | 14% | 23% | 9% | 9% |
| 65 | . trees | all | 6.86% | 0.43% | | 3.95% | 1.55% | |
| 66 | . poles | low | | 0.39% | 1.80% | 1.05% | 0.41% | |
| 67 | . fences or walls | all | 2.87% | 0.65% | 3.54% | 1.58% | 0.83% | |
| 68 | . embankments | all | 3.75% | 0.59% | | 0.53% | 0.12% | |
| 69 | . traffic signs | high | | 0.12% | 0.70% | 1.05% | 0.58% | |
| 70 | . guard rails | high | 1.85% | 0.12% | 0.52% | 0.26% | 0.16% | |
| 71 | . guide posts | high | 1.99% | 0.37% | 1.63% | 0.79% | 0.35% | |
| 72 | . traffic islands | low | | | | 0.53% | 0.14% | |
| 73 | . other fixed objects | low | | | 2.50% | 0.79% | 0.41% | |

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

ACCIDENT DATA ANALYSIS PROJECT

HIGH RISK GROUP : INTOXICATED PEDESTRIANS

EXECUTIVE SUMMARY

Previous
pedestrian
those who
involved
data on 29
during 19
environme

15 times
higher risk

There is a 15 times higher risk of serious injury for those with a BAC above 0.15) compared with those of intoxicated pedestrians who were over-18 sober pedestrians were found by analysing their own BAC readings which occurred in Victoria. These were defined by factors related to the road environment, the pedestrian, and the accident type and outcome.

Substantially over-involved sub-groups are suitable targets for countermeasures. The mechanisms explaining the over-involvement of each target group were suggested as part of the study. It is proposed that the target groups should be addressed through VIC ROAD's existing Pedestrian Safety Program. The focus of each of the three program strategies aimed at intoxicated pedestrians should include:

Strategy 1: To prevent pedestrians reaching high blood alcohol levels

- drinkers who start early in the night, consume a relatively large amount of alcohol, and finish their drinking relatively early (before Midnight)
- drinkers who start drinking at lunchtime or during the afternoon
- drinkers on weekends
- drinkers on Fridays in the Melbourne suburbs
- adults aged between 30 and 60 drinking during the day
- adults aged between 30 and 50 drinking at night in the inner Melbourne suburbs

Strategy 2: To prevent intoxicated pedestrian exposure

- male drinkers in hotels and other licensed premises
- public education messages in these venues emphasising the high risk of death if an intoxicated pedestrian is struck by a vehicle, especially at the higher speeds travelled in the outer suburbs

Strategy 3: To reduce intoxicated pedestrian risk

- T-intersections in the inner Melbourne suburbs (treatment to be applicable during all times of day, especially daytime)
- roads in 75 km/h speed zones (treatments such as pedestrian crossings, supported by pedestrian fencing to encourage their use, and median refuges and improved lighting, to assist the pedestrian to cross a wide road and improve their conspicuity to drivers).

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

ACCIDENT DATA ANALYSIS PROJECT

HIGH RISK AND HIGH SEVERITY GROUP : ELDERLY PEDESTRIANS

EXECUTIVE SUMMARY

Elderly pedestrians aged 60 and above have a high rate of casualty accident involvement which reaches three times the rate of younger adults for pedestrians aged in the mid-70's. Injury severity also increases with age, with pedestrians aged 65 and above having substantially higher rates of death or hospitalisation when injured in accidents.

The over-involvement of elderly pedestrians was examined by comparing 1024 pedestrian victims aged 60 and above with 653 aged 40-59 from accidents in Victoria during 1984-89; only pedestrians known to be sober were compared. Very few factors were found to be related to the over-involvement of the elderly pedestrians. However, a large number of factors were found to be related to the injury severity of 2097 pedestrians aged 65 and above who were killed or injured during the same period. These factors define sub-groups of the elderly pedestrian accident problem which should be target groups for countermeasures.

The target groups related to substantially higher injury severities were examined and mechanisms to explain their accident involvement or high severity were suggested. It is proposed that the target groups should be addressed through countermeasures in four general categories, with the focus in each category being as follows:

Category 1: Education of elderly pedestrians

- their poor conspicuity during darkness and dawn/dusk lighting conditions
- pedestrians aged 75 and above should be particularly careful in avoiding accident involvement because of their high injury susceptibility
- difficulties for drivers to brake rapidly on wet roads, and their poor visibility during raining conditions
- additional care needed when crossing divided arterial roads in Melbourne at major intersections
- the higher risk of death when intoxicated if an elderly pedestrian is struck by a vehicle
- additional care needed when crossing to or from a tram

Category 2: Education of drivers

- awareness of the poor conspicuity of elderly pedestrians during darkness and dawn/dusk lighting conditions
- difficulties in braking rapidly on wet roads
- poor visibility during raining conditions

- awareness of the unexpected presence of elderly pedestrians on roads in the residential areas of Melbourne, and areas outside Melbourne
- lack of awareness of elderly pedestrians to the presence of approaching vehicles, especially when intoxicated
- need to look out for elderly pedestrians at intersections in the residential areas of Melbourne, especially at STOP signs

Category 3: Enforcement of driving offences

- random breath testing to deter drink driving in the "alcohol times of the week", especially on arterial roads
- speed enforcement on divided arterial roads (especially in 75 km/h speed zones) in Melbourne
- speed enforcement on arterial roads in the vicinity of tram stops

Category 4: Road engineering

- improved street lighting in the vicinity of places frequented by elderly pedestrians at night
- pedestrian crossings on divided arterial roads at locations frequented by elderly pedestrians
- pedestrian refuges at intersections in residential areas with STOP signs
- speed warning signs on arterial roads in the vicinity of tram stops.

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ACCIDENT DATA ANALYSIS PROJECT

ACCIDENT INVOLVEMENT CLUSTERS: SPEEDING DRIVERS

EXECUTIVE SUMMARY

Drivers involved in serious casualty accidents were categorised into three populations of crashes considered likely to be speed related :

- . Drivers running off the road on curves (Population 1)
- . Drivers hitting another vehicle in the rear (Population 2)
- . Drivers involved in pedestrian accidents resulting in death or serious injury (Population 3).

Eight large clusters of drivers were found for Population 1 and six large clusters for each of both Populations 2 and Population 3. For each population, the corresponding clusters together represented at least 70% of the total drivers involved in a speed related accident type.

The drivers in Population 1 were involved in most of their accidents on rural roads (52%) compared with the drivers in Populations 2 and 3 (12% and 6%, respectively). These two populations of drivers were more frequently involved in accidents in the inner and middle areas of the Melbourne Statistical Division (MSD). Population 1 drivers were also more likely to be aged 18-25 (52%), have a BAC above zero (43%), to crash at night (55%) or on wet roads (32%), and to drive older cars (48% more than ten years old) than the other populations.

The largest cluster in Population 1, representing 21% of the total drivers running off the road on curves, was :

- . mostly drivers with zero BAC
- . mostly during day time
- . mostly on weekdays
- . mostly on dry roads
- . more often female drivers than the population average
- . more often in middle MSD locations than average
- . more often drivers of small cars than average.

The largest cluster in Population 2, representing 31% of drivers hitting another vehicle in the rear, was :

- . only drivers with zero BAC
- . mostly during day time
- . mostly on weekdays
- . mostly on dry roads
- . more often driving a car less than 6 years old than the population average
- . more often in middle MSD locations than average.

The largest cluster in Population 3, representing 29% of drivers hitting pedestrians resulting in death or serious injury, was :

- . only on dry roads
- . mostly in inner MSD locations
- . otherwise similar to the population in total.

Speed enforcement supported by mass media publicity should be focussed on the identified clusters and aimed at deterring excessive speeding behaviour.

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE

ACCIDENT DATA ANALYSIS PROJECT

SEVERE INJURY CLUSTERS : UNRESTRAINED OCCUPANTS

EXECUTIVE SUMMARY

Occupants of cars and station wagons involved in crashes and considered by the recording Police officer to be unrestrained were clustered into homogeneous groups to form the basis of countermeasures. The occupants were clustered on the basis of their age, sex, and seating position, and the time of day, day of week, speed zone and location of the crash. The seven largest clusters covered 69% of the 348 unrestrained occupants considered.

The total group of unrestrained occupants were 58% male and spanned all age groups with 39% aged 17 to 25. Drivers represented 41%, left front passengers 26% and rear passengers 32% of the total. 61% crashed in speed zones up to 75 km/h, and 63% of their crashes occurred in the Melbourne Statistical Division (MSD) while 28% occurred on the open road in rural areas. Weekdays accounted for 62% of the unrestrained occupants, while 59% were involved in crashes during daytime.

The two largest clusters, which together covered 24% of the unrestrained occupants, were both mostly drivers crashing in speed zones up to 75 km/h, but they differed in other characteristics. The largest cluster mostly crashed at night and more often at weekends than the total group of unrestrained occupants. The second largest cluster were mostly male occupants and mostly crashed during the day. In other respects, these two clusters resembled the total group of unrestrained occupants.

The other five identified clusters each covered 8-10% of the unrestrained occupants. Each differed from the total group in relatively unique ways, but the clusters were homogeneous in themselves.

Integrated enforcement and publicity aimed at encouraging restraint use should be targeted at each of the clusters. Countermeasures which aim at reducing the impact severity or preventing the crash involvements of each of the cluster groups should also be considered.