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Analysis of Injuries to Young and Old Victorian Public Transport Users: 2006 to 2010

by

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Analysis of Injuries to Young and Old Victorian Public Transport Users: 2006 to 2010

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This report was funded by a research grant from the Medical Research Council's Lifelong Health and Well-being (LLHW) for a project on improving the safety for older public transport users.

Abstract:

A study was undertaken to identify injurious events to users of public transport systems in Australia to assist in the UK project on Improving the Safety for Older Public Transport Users. Two analyses were undertaken comprising an analysis of surveillance data (the Victorian Emergency Minimum Dataset), collected at a number of participating trauma hospitals in the state of Victoria, and an analysis of National Coronial Information System (NCIS) data in Australia. For the VEMD database, details of injuries were recorded on attendance and the patients' account of the circumstances of the accident and causation factors were noted. Data from the NCIS involved a collection of coronial data on deaths reported to the Australian coroner from 2000 onwards and contains details on the police report of death, autopsy reports, toxicology reports and coronial findings.

The VEMD results showed that injury was more common among bus passengers than those on either trams or trains, especially when taking account of their relatively lower usage. The most common injuries from these incidents were to the head and face regions and upper and lower limbs. Chest injuries were especially problematic for older travellers: they sustained more multiple injuries especially those likely to be life-threatening than their younger counterparts. Getting on or off the vehicle accounted for almost two-thirds of all injury-causing events and the most common mechanisms involved a slip, trip or fall while getting on and off the vehicle or while onboard or running to catch public transport. Being hit, struck or crushed by another person or an object was also reported. Injuries to older public transport users appeared to be positively correlated with increasing age. The majority of those injured only required out-patient treatment at the participating hospital but this too was somewhat dependent on the participant's age. The NCIS results further showed that for fatal outcomes to public transport users, self-harm was a predominant cause and older people seemed less involved than younger ones, albeit young-older groups. Males predominated over females and most mechanisms involved external impacts. Trains were heavily over-involved as a vehicle type and there were high proportions of multiple injuries, especially those judged to be intentional. A range of possible interventions to prevent these events and mitigate injury severity was identified and a number of limitations in this study were noted. Several areas requiring further research were identified for future studies, in particular, the need for more definitive in-depth studies of public transport injurious incidents was especially noteworthy.

Key Words:

Disclaimer

This report is disseminated in the interest of information exchange. The views expressed here are those of the authors, and not necessarily those of Monash or Loughborough Universities.

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The Project Partners in the Improving Safety for Older Public Transport Users Project

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1 INTRODUCTION

The Victorian Emergency Minimum Dataset (VEMD) is a valuable source of information for injury prevention, containing de-identified demographic, administrative and clinical data. These data are collected from presentations at 38 public hospitals across Victoria that receive the non-admitted emergency services grant (VicHealth, 2012).

Submission to the VEMD in Victoria commenced in October 1995 as an initiative of the Department of Human Services in collaboration with the Victorian Emergency Department's Association, the Australasian College for Emergency Medicine Victoria Faculty, the Emergency Nurse's Association, and Monash University Accident Research Centre (MUARC).

The VEMD is compiled in financial years (July to June). A list of all data fields stored in the VEMD for any given year is available from Victorian Hospital Data Reports.

In order to maintain and protect patient privacy, only the minimum data required for effective monitoring and analysis purposes are collected.

Collection processes are based on standard definitions and collection protocols to ensure comparability over time and across geographical and agency boundaries. Definitions of patient categories and other terms used in the VEMD are set out in the most recent VEMD Manual. Where possible, these conform to the definitions in the National Health Data Dictionary, published by the Australian Institute of Health and Welfare (AIHW), and the DHS Common Client Dataset.

Uses of the Data Collection

The VEMD provides information for:

- Epidemiological purposes;
- Health service planning and coordination;
- Policy assessment and formulation;
- Clinical research;
- Quality improvement;
- Patient management; and
- ED operation and management

In addition, these data enable Victoria to fulfil its reporting obligations under the National Health Information Agreement and the Australian Health Care Agreement.

Management of VEMD

The VEMD is managed by the Funding, Health & Information Policy Branch in the Metropolitan Health and Aged Care Services Division (Metropolitan Health and Aged Care Services Division) of the Victorian Department of Human Services.

The Department creates an annual consolidated file of the VEMD by combining data from all contributing hospitals and this is closed on (or around) 21 September each year, three months after the end of the financial year. Hospitals should have transmitted and finalised all data for that financial year's separations by this date.

Once the consolidated file has been closed, the file is not amended or updated, thus maintaining the integrity of reports and datasets released for analysis. The Department maintains separate notes on any significant data anomalies identified in the consolidated file. Data are not considered to be final until the file is consolidated.

1.1.1 VEMD Update Cycle

Towards the end of each calendar year, the Health Data Standards and Systems Unit calls for submissions for revisions to the VEMD with effect from the following 1 July. Revisions may be necessary, for example, to provide data for a change in funding mechanism or to monitor a new policy. Revisions may also be necessary to follow changes to the National Health Data Dictionary. Opportunities are also taken wherever possible to simplify and streamline the dataset. At all times, HDSS attempts to keep changes to a minimum.

The proposals are outlined in the "*Proposals for Revisions to the Victorian Emergency Minimum Dataset document*", which is circulated to hospitals, software suppliers and other users. All parties are invited to submit comments and questions on the proposals. A Specification for Revisions document is then prepared, providing full details of the changes. This is usually distributed early in the new calendar year.

Hospitals may then request that their software suppliers revise software in accordance with the Specification for Revision document ready to use from 1 July.

Hospital must transmit data to the VEMD according to the Victoria-public hospitals and mental health services, Policy and Funding Guidelines, General Conditions of Funding for the current year.

1.1.2 VEMD Manual

The VEMD Manual is produced and distributed at the beginning of the financial year.

The purpose of the VEMD manual is to provide clinical, nursing and clerical staff with the level of detail necessary to accurately record patient demographics, diagnoses, procedures, injury surveillance and other data.

Software suppliers should bear in mind that hospital systems do not need to exactly replicate the data items and edits outlined in the manual. However, the interface must be capable of formatting the data appropriately for transmission and processing to DHS.

1.1.3 VEMD Technical Reference Group

The VEMD Technical Reference Group was formed in November 2007 and comprises nominated representatives of Emergency Department (ES) clinicians, hospital management, ED clerical (data submission) staff, Health Information Managers and other relevant industry bodies, together with representatives of the Department of Human Services.

Study Objectives

This report has been prepared as part of the research project on Improving Safety for Older Public Transport Users program for the Medical Research Council (MRC) in the UK. This feasibility study managed by the Transport Safety Research Centre at Loughborough University set out with three main objectives:

- To undertake an initial analysis of the nature and circumstances of injuries that afflict senior citizens according to public transport mode (focusing specifically on injury biomechanics);
- To analyse the data to examine specific features of the public transport system which may influence injury outcomes to the elderly – including design features and service operator guidelines;
- To develop a method for the investigation of 'Fatal' accidents involving older public transport users;

This report attempts to address the first objective outlining the nature and circumstances of injuries to older public transport users. While it is based on surveillance data collected in Victoria, Australia, it is argued that many of the findings are still of some relevance to public transport users in the UK. Besides, it provides an international comparison as a benchmark for comparing with similar findings in the UK.

2 METHOD

Relevant cases were extracted from the Victorian Emergency Minimum Dataset (VEMD) by the Victorian Injury Surveillance Unit at Monash University. Cases were selected if the text 'description of injury event' variable contained the terms 'tram', 'train' or 'bus' or spelling variations. The description of injury event variable can be up to 250 characters and is often filled in by triage staff in busy emergency departments so data quality is variable. Consequently the numbers reported here and very likely to underestimate the true burden of injury.

2.1 Public Transport Services

Public Transport Victoria is a statutory authority of the Victorian Government that administers the states trains, trams and bus services. According to Charting Transport (2010), public transport trips per kilometre was around 11% of all journeys in Melbourne in 2009 (private motor vehicle trips accounted for 89%). The same year, The Age newspaper (Clay Lucas, 2009-03-16) noted that there had been no growth in private car travel over the preceding 5 years. Conversely, public transport use (Trains, Trams and Buses) in Melbourne rose from 36 million boardings to just below 50 million between 2000 and 2009 (Ashley Gardiner, 2009).

Serving the residents of the Melbourne Metropolitan area is challenging, given its relative small population and hence public transport systems tend to include radial train services from the central rail station with connection trams and buses in the outer regions. The city is blessed with a matrix of tram and bus services to cater for its growing business and commercial activities. Most of these services are operated by private organisations, under contract to Public Transport Victoria.

D-Class Low-Floor Tram
(Source: Wikipedia, 2012)

Metro Suburban Train
(Source: Wikipedia, 2012)

Ventura Bus in Melbourne suburbs
(Source: Wikipedia, 2012)

2.1.1 Melbourne Trams

Trams in and around Melbourne are operated by Yarra Trams. According to their statistics, Melbourne trams travel more than 24 million kilometres each year over 29 separate tram routes that involve more than 1760 tram stops (Yarra Trams, 2012). Thus, as noted by Wikipedia (2012), the Tram network in Melbourne is the largest Tram network in the World. There is a range of different designs of Trams in Melbourne, some dating back many years. Yarra Trams (2012) reported that in recent years, 100 low floor trams were introduced by the Victorian Government as part of the Victorian Transport Plan in 2008 and a further 50 are expected to be rolled out later this year.

There are a variety of different designs of Tram stops in and around Melbourne (see Figures 1 to 4). The older original designs (Fig 1) required passengers disembarking and alighting from the tram to cross the road with stopped traffic. The safety zone stop in Fig 2 separated the tram passengers from the passing vehicles but still required a step up from the road surface. Fig 3 and 4 are more recent designs, involving separation with a raised platform so that passenger alighting or exiting the tram could do so with less stepping (especially with low floor trams). There are currently further designs being trialled that involve greater speed restrictions on motorists, but installations of these are still quite rare.

Fig 1: Original on-road design Stop
(Source: Currie et al 2011)

Fig 2: Traditional safety zone stop
(Source: Macdonald & Coxon 2011)

Fig 3: On-road raised platform stop
(Source: Macdonald & Coxon 2011)

Fig 4: Collins Street Melbourne, "Superstop"
(Source: Macdonald & Coxon 2011)

While most trams operate on roads and streets with other motorised vehicles, they have recently also taken over some suburban rail networks and operate as light-rail. These "trams" are for all intention operating as a suburban train, although they can start and end as a road Tram and then move to a totally separated rail network with separated platforms as if they were a train.

2.1.2 Melbourne Suburban Trains

Fig 5: Flinders Street Railway Station
(Source: Wikipedia, 2012)

Metro Trains, a privately operated company, took over from Connex Melbourne in 2009, as the manager of operations of Melbourne Trains. The rail network consists of 16 separated train lines, essentially above-ground but can also travel through a metro-like underground link through the city centre. The train system main hub is the Flinders Street rail station and most lines radiate out to the suburbs from this central station. Platforms at all city and suburban stations are flush with the floor of the train, hence passengers can step directly onto the train at the same level on entering and exiting. Figures 6 and 7 show the step alignment for passengers entering and exiting a train at a Metro station and the inside of a Metro train's seating and standing facilities.

Fig 6: Stepping alignment at metro train station
(Source: Wikipedia, 2012)

Fig 7: Interior of a D-Class Metro train
(Source: Wikipedia, 2012)

2.1.3 Buses in Melbourne

Public Transport Victoria also manages the bus network in Melbourne which is operated by numerous bus companies (Melbourne Bus Link, National Bus Company, Invicta Bus Lines, Ventura Bus lines, etc.). Buses run regularly on city and suburban routes as well as nightrider services on Friday and Saturday, a Smart Bus orbital network for cross city travel as well as a tourist bus service each day around the city itself. Bus stops are marked curb-side locations and bus shelters are available at many bus stops in city and suburban locations.

Fig 8: Ventura Low Line Metro Bus
(Source: Wikipedia, 2012)

2.1.4 Regional Rail

Intrastate and interstate rail services are operated by V/Line Victoria for Public Transport Victoria. There are seven passenger rail lines in regional Victoria, connecting to various towns and cities across the state. Wikipedia (2012) reported that four of these lines have been upgraded to fast rail and operate VLocity diesel trains as shown in Figures 9 and 10.

Fig 9: V/Line operated VLocity diesel train
(Source: Wikipedia, 2012)

Fig 10: Interior of VLocity train
(Source: Wikipedia, 2012)

3 VEMD DATA ANALYSIS

The analysis was conducted using the SPSS statistical package. At this time, no statistics were conducted on these data but plans are to conduct a parametric analysis in future. In undertaking the data analysis, some

data variables were available on the database itself and could be directly interrogated. Other variables, however, could only be selected by searching the *'description of injury event*' statements (which were not always available for every case). These included variables such as type of transport (bus, train, tram), whether they were on the public transport, hit by the transport, running for transport, etc. Thus, the number of cases unfortunately does vary across the analysis presented below.

3.1 Results

The injury sample was based on 3,152 public transport related unintentional injury cases listed on the Victorian Emergency Minimum Dataset (VEMD). This number includes persons who sustained an injury while on a train, tram or bus in the state of Victoria as well as person hit by public transport, injured while running to catch public transport or injured on train/tram tracks. It included all persons (by age and sex) who attended a contributing Victorian hospital between 2006 and 2010.

3.2 Demographics

Table 3.1 shows the demographics of the sample of those who sustained an injury and presented to a Victorian hospital during the study period.

Table 3.1: Demographics of the 5-years of hospital presentations in Victoria

Factor	Number (n=3,152)	Percentage	Expected* (pop. Adjusted)
Year of Attendance			
2006	575	18%	-
2007	632	20%	-
2008	636	20%	-
2009	683	22%	-
2010	626	20%	-
Age Group			
<30 years	1,098	35%	1,260
30 to 59 years	1,003	32%	1,323
60 years and above	1,050	33%	567
Sex			
Male	1,386	44%	1,544
Female	1,766	56%	1,608
Transport Use			
Train	884	28%	-
Tram	1,097	35%	-
Bus	1,171	37%	-

NB: Expected numbers based on 2005 Population figures for Victoria.

Of interest, there were relatively consistent numbers of hospital attendances each year in the state of Victoria from public-transport related injuries, roughly spread across the three age groups. While the three age groups were roughly equal in terms of attendances, older people were, however, over-represented by 85 percent compared to their younger counterparts when adjusted for their percentage of the population. Interestingly, females were around 5 percent over-represented in transport-related injuries compared with males when adjusted for their population percentage.

3.3 Injury Causing Events

The injured public transport user was interviewed about the injuries they sustained and the cause of their injuries on presentation at a participating hospital. They also provided a short statement about the events leading up to their injuries and outcomes. These statements are the basis for prescribing their injury-causing event. An exemplar list of the individual statements provided can be found in Appendix 1.

Table 3.2: Public Transport Use by Injury-causing event (n=3,152)

Injury Causing Event	**Train**	**Tram**	**Bus**	**Total** (event)
Getting on/off and on the unit	303 (15%)	752 (37%)	975 (48%)	**2030** (64%)
Pedestrian hit by Public transport	40 (18%)	119 (55%)	58 (27%)	**217** (7%)
Running to catch public transport or at the stop	465 (64%)	126 (17%)	134 (18%)	**725** (23%)
Pedestrian hit on the tracks	76 (43%)	99 (57%)	-	**175** (6%)
Other unspecified	-	2 (33%)	4 (67%)	**6** (-)
Total (proportion of transport)	**884** (28%)	**1098** (35%)	**1170** (37%)	**3152** (100%)

These results show that injuries among bus and tram passengers were more frequent than train injuries. Getting on or off the bus accounted for almost half of these public transport passenger injuries, compared to only 15% for train passengers. Being hit by a tram, especially while on the tram tracks, and getting on and off the vehicle accounted for the majority of all tram injuries. Running to get a train was also noteworthy.

Table 3.3: Injury causing-event by age-group (n=3,152)

Injury Causing Event	**<30yrs**	**30-59yrs**	**60plus yrs**	**Total** (event)
Getting on/off and on the unit	672 (61%)	590 (59%)	768 (73%)	**2030** (64%)
Pedestrian hit by Public transport	104 (9%)	81 (8%)	32 (3%)	**217** (7%)
Running to catch public transport or at the stop	255 (23%)	263 (26%)	206 (20%)	**725** (23%)
Pedestrian hit on the tracks	67 (6%)	67 (7%)	41 (4%)	**175** (6%)
Other unspecified	-	2 (33%)	3 (67%)	**5** (-)
Total (proportion of age-group)	**1099** (35%)	**1003** (32%)	**1050** (33%)	**3152** (100%)

Getting on or off, as well as accidents while on public transport units, accounted for almost two-thirds of all injury-causing events on the three forms of public transport. Those aged 60 or more were particularly over-represented for these types of injury-causing events, especially if these findings are adjusted for their small numbers in the population. Running to catch a public transport unit was involved in almost one-quarter of injury-causing events during the analysis period.

Analysing the older age groups in Table 3.4 below, those aged 80 or more were almost twice as likely to sustain an injury while using public transport in Victoria (and around three times when corrected for their lower exposure), and therefore more dangerous for them, reflecting their increased mobility and frailty. The older public transport users (those aged 80 or more) were seemingly at slightly higher risk of injury in getting on and off or while travelling on the bus, tram or train. However, consistent with younger users, even those aged 80 or more were equally likely to sustain an injury while running to catch public transport or at the stop.

Table 3.4: Injury causing-event by older age-group breakdown (n=1,050)

Injury Causing Event	**60-64yrs**	**65-69yrs**	**70-74yrs**	**75-79yrs**	**80plus yrs**	**Total** (event)
Getting on/off and on unit	129 (71%)	116 (74%)	128 (72%)	137 (72%)	258 (75%)	**768** (73%)
Pedestrian hit by Public transport	8 (5%)	4 (3%)	5 (3%)	7 (4%)	8 (2%)	**32** (3%)
Running to catch public transport or at the stop	37 (20%)	30 (19%)	39 (22%)	36 (20%)	64 (18%)	**206** (20%)
Pedestrian hit on the tracks	7 (4%)	6 (4%)	5 (3%)	8 (4%)	15 (5%)	**41** (4%)
Other unspecified	0	1	0	1	1	**3** (-)
Total (proportion of age-group)	**182** (17%)	**157** (15%)	**177** (17%)	**189** (18%)	**346** (33%)	**1050**

Attendance data at the participating hospitals could only be interpreted for the sub-set of data derived from the description of injury event statements, discussed earlier. These results are shown in Tables 3.5 and 3.6.

Table 3.5: Attendance status by age group for those injured in a public transport accident (n=2,028)*

Attendance status	Age Group			
	<30yrs	30-59yrs	60+yrs	Overall
Admissions	12%	10%	28%	17%
Out-patient treatment	88%	90%	72%	83%
Unspecified	0%	0%	0%	0%
Total	**671** (33%)	**590** (29%)	**768** (38%)	**2028**

***the 2028 is a subset of public transport users on trains, trams and buses from the overall number of PTU cases reported in VEMD*

The majority of those attending a participating hospital were treated as out-patients and sent home after treatment. Of particular note, older people overall were two to three times more likely to be admitted to hospital from sustaining an injury in a public transport accident, considering their lower exposure. Furthermore, as shown in Table 3.6, the likelihood of admittance increased with increasing age beyond 60 years (those 80 or above were more than three times more likely than 60 year olds).

Table 3.6: Attendance status by age group for those injured in a public transport accident (n=767)*

Attendance Status	**60-64yrs**	**65-69yrs**	**70-74yrs**	**75-79yrs**	**80plus yrs**	**Overall**
Admissions	12%	23%	31%	26%	37%	**28%**
Out-patient treatment	88%	77%	69%	74%	63%	**72%**
Unspecified	0%	0%	0%	0%	0%	**0%**
Total	**129** (17%)	**116** (15%)	**127** (17%)	**137** (18%)	**258** (34%)	**767**

*the 767 is a subset of public transport users aged 60 years or older

3.4 Injuries Sustained

The injuries sustained by those presenting were categorised by age and sex, body region injured and nature of the main injury. The findings by body region injured for all age groups as well as those aged 60 plus are shown in Tables 3.7 and 3.8 below.

Table 3.7: Injuries sustained by age group (n=3,152)

Body Region Injured	**<30yrs**	**30-59yrs**	**60plus yrs**	**Total** (event)
Head, excludes face	92 (14%)	54 (9%)	93 (12%)	**239** (12%)
Face, excludes eye	36 (5%)	27 (5%)	50 (7%)	**113** (6%)
Neck	22 (3%)	27 (5%)	16 (2%)	**65** (3%)
Thorax	11 (2%)	31 (5%)	65 (8%)	**107** (5%)
Abdomen	1 (0%)	9 (2%)	3 (0%)	**13** (1%)
Lower back	14 (2%)	30 (5%)	18 (2%)	**62** (3%)
Pelvis	4 (1%)	2 (0%)	11 (1%)	**17** (1%)
Shoulder	29 (4%)	40 (7%)	49 (6%)	**118** (6%)
Upper arm	7 (1%)	10 (2%)	21 (3%)	**38** (2%)
Elbow	37 (6%)	18 (3%)	18 (2%)	**73** (4%)
Forearm	30 (4%)	10 (2%)	18 (2%)	**58** (3%)
Wrist	31 (5%)	21 (4%)	37 (5%)	**89** (4%)
Hand, includes fingers	42 (6%)	31 (5%)	28 (4%)	**101** (5%)
Hip	6 (1%)	13 (2%)	57 (7%)	**76** (4%)
Thigh	7 (1%)	9 (2%)	7 (1%)	**23** (1%)
Knee	57 (8%)	54 (9%)	80 (10%)	**191** (9%)
Lower leg	29 (4%)	28 (5%)	90 (12%)	**147** (7%)
Ankle	91 (14%)	77 (13%)	27 (4%)	**195** (10%)
Foot, includes toes	35 (5%)	37 (6%)	18 (2%)	**90** (4%)
Unspecified body region	6 (1%)	8 (1%)	7 (1%)	**21** (1%)
Multiple injuries	44 (7%)	41 (7%)	43 (6%)	**128** (6%)
Body region code not req'd	33 (5%)	11 (2%)	8 (1%)	**52** (3%)
FB in Eye	6 (1%)	3 (1%)	3 (0%)	**12** (1%)
Total (proportion of age-group)	**1098** (35%)	**1004** (32%)	**1050** (33%)	**3152** (100%)

The most frequent injuries to all those who presented were to the head and face region (18%), followed by the ankle (10%), knee (9%), lower leg (7%) and the shoulder (6%). For those aged 60 or over, the injury patterns were quite similar, apart from the extra 8% injuries to the thorax (chest). It should be stressed that injuries to the head and chest are commonly considered to be serious life-threatening injuries, especially for seniors.

Older transport users sustained a sizeable 38% of all body region injuries, which again illustrates their over-representation when taking into account their smaller population numbers (exposure). Given their increased frailty, these injuries are likely to lead to severe consequences in terms of threat to life and increased disabilities.

Table 3.8: Body region injured by those aged 60plus for the 3 public transport modes (n=767)

Body Region Injured	Public Transport Group			
	Train	Tram	Bus	Total
Head, excludes face	7 (11%)	43 (13%)	43 (11%)	**93** (12%)
Face, excludes eye	7 (11%)	19 (6%)	24 (6%)	**50** (7%)
Neck	1(2%)	6 (2%)	7 (2%)	**16** (2%)
Thorax	1 (2%)	38 (12%)	26 (7%)	**65** (8%)
Abdomen	0 (0%)	3 (1%)	0 (0%)	**3** (0%)
Lower back	2 (3%)	10 (3%)	6 (2%)	**18** (2%)
Pelvis	0 (0%)	7 (2%)	4 (1%)	**11** (1%)
Shoulder	2 (3%)	21 (7%)	26 (7%)	**49** (6%)
Upper arm	3 (5%)	9 (3%)	9 (2%)	**21** (3%)
Elbow	2 (3%)	12 (4%)	4 (1%)	**18** (2%)
Forearm	0 (0%)	11 (3%)	7 (2%)	**18** (2%)
Wrist	3 (5%)	15 (5%)	19 (5%)	**37** (5%)
Hand, includes fingers	7 (11%)	5 (2%)	16 (4%)	**28** (4%)
Hip	5 (5%)	26 (8%)	28 (7%)	**57** (7%)
Thigh	0 (0%)	4 (1%)	3 (1%)	**7** (1%)
Knee	7 (11%)	28 (9%)	45 (12%)	**80** (10%)
Lower leg	7 (11%)	19 (6%)	64 (17%)	**90** (12%)
Ankle	2 (3%)	8 (2%)	17 (4%)	**27** (4%)
Foot, includes toes	3 (5%)	8 (2%)	7 (2%)	**18** (2%)
Unspecified body region	1 (2%)	2 (1%)	4 (1%)	**7** (1%)
Multiple injuries	4 (6%)	22 (7%)	17 (4%)	**43** (6%)
Body region code not required	0 (0%)	5 (1%)	5 (1%)	**8** (1%)
FB in Eye	2 (3%)	1 (0%)	0 (0%)	**3** (0%)
FB in Soft tissues	0 (0%)	1 (0%)	0 (0%)	**1** (0%)
Total	**64** (8%)	**320** (42%)	**383** (50%)	**767** (100%)

*the 767 is a subset of public transport users aged 60 years or older

As seen earlier, more than 90 percent of injuries were the result of accidents on Trams and Buses (trains had only 8 percent of the injuries sustained from these accidents). This was in spite of the fact that there was 28 percent of injury causing events on trains.

Head and chest (thorax) injuries were slightly more predominant to older users on trams accidents and face injuries on trains. Lower leg and knee injuries occurred to around one in ten aged 60 years and older, injured on public transport, and more frequently on buses. While of less frequency, shoulder injuries to the elderly were more common on trams and buses.

3.5 Nature of Injury Sustained

The nature of the injury sustained by the person injured was identified from those listed against each claim on the database and has been summarised by all ages and the older age groups in Tables 3.9 and 3.10 below.

Table 3.9: Nature of the main injury by age group injured in a public transport accident (n=2,028)*

Nature of Injury	AGE Group			
	<30yrs	30-59yrs	60+yrs	Total
Sprain or strain	198 (30%)	202 (34%)	143 (19%)	**543** (27%)
Fracture, excludes tooth	86 (13%)	94 (16%)	189 (25%)	**369** (18%)
Superficial, excludes eye	102 (15%)	81 (14%)	122 (16%)	**305** (15%)
Open wound, excludes eye	81 (12%)	62 (11%)	151 (20%)	**294** (14%)
Injury to muscle or tendon	45 (7%)	58 (10%)	54 (7%)	**157** (8%)
Dislocation	32 (5%)	14 (2%)	11 (1%)	**57** (3%)
Intracranial injury	18 (3%)	6 (1%)	8 (1%)	**32** (2%)
Crushing injury	9 (1%)	10 (2%)	8 (1%)	**27** (1%)
Injury to internal organ	2 (0%)	5 (1%)	8 (1%)	**15** (1%)
Eye injury	8 (1%)	4 (1%)	2 (0%)	**14** (1%)
Foreign body	7 (1%)	3 (1%)	4 (1%)	**14** (1%)
Other specified injury	43 (6%)	25 (4%)	33 (4%)	**101** (5%)
Injury of unspecified nature	16 (2%)	11 (2%)	14 (2%)	**41** (2%)
Multiple injuries	24 (4%)	15 (3%)	21 (3%)	**60** (3%)
Total	**670** (33%)	**590** (29%)	**768** (38%)	**2028** (100%)

***the 2028 is a subset of public transport users on trains, trams and buses from the overall number of PTU cases reported in VEMD*

The most common type of injury was a sprain or strain, followed by a fracture, superficial or open wound (predominantly of a minor nature), or injury to muscle or tendon. Adults aged over thirty had fewer intracranial injuries, possibly reflecting their events to be less severe than their younger (riskier) counterparts. Older public transport users had proportionally more fractures and open wounds than younger users, probably a reflection of their increased frailty.

Table 3.10: Nature of the main injury by those aged 60plus group (n=767)*

Nature of Injury	Public Transport Group			
	Train	Tram	Bus	Total
Sprain or strain	12 (19%)	66 (21%)	65 (17%)	**143** (19%)
Fracture, excludes tooth	14 (22%)	83 (26%)	92 (24%)	**189** (25%)
Superficial, excludes eye	8 (13%)	51 (16%)	63 (16%)	**122** (16%)
Open wound, excludes eye	15 (23%)	51 (16%)	85 (22%)	**151** (20%)
Injury to muscle or tendon	2 (3%)	22 (7%)	30 (8%)	**54** (7%)
Dislocation	2 (3%)	6 (2%)	3 (1%)	**11** (1%)
Other specified injury	6 (9%)	25 (8%)	32 (8%)	**63** (8%)
Injury of unspecified nature	2 (3%)	6 (2%)	6 (2%)	**14** (2%)
Multiple injuries	3 (5%)	11 (3%)	7 (2%)	**21** (3%)
Total	**64** (8%)	**321** (42%)	**382** (50%)	**767** (100%)

*the 767 is a subset of public transport users aged 60 years or older

Fractures were the predominate injury type among those aged 60plus, occurring in roughly one-quarter and appeared to be even spread across each of the public transport modes. These injuries can be very disabling to older people and have serious consequences to their mobility. Fractures and sprains and strains were slightly more likely in tram injuries while open wounds were more common in train and bus events among the elderly.

3.6 Mechanism of Injury

The final analysis undertaken on these data was to examine the source of their injury to highlight the mechanisms involved. This would be useful to identify the mechanisms of injury and what can be done to minimise or prevent this trauma. Typically, these mechanisms are identified from a detailed in-depth examination of the injurious event, involving an experienced team of crash investigators. As discussed in Chapter 1, the VEMD surveillance data are not collected from a detailed in-depth procedure, but rather from a limited subjective account of the event by the individual upon presentation at a study hospital. Consequently, the mechanisms of injury able to be identified were restricted to six categories, nominated from those most commonly reported by the participants and are shown in Tables 3.11 and 3.12 for all events involving older age groups and the mode of public transport involved.

Table 3.11: Mechanism of Injury for older age groups in a public transport accident (n=767)*

Mechanism	60-64yrs	65-69yrs	70-74yrs	75-79yrs	80+ yrs	Overall
MVA Collision/crash	8 (6)	13 (11)	1 (1)	3 (2)	7 (3)	**32** (4)
Slip/trip/fall (getting on/off or onboard)	81 (63)	77 (66)	88 (69)	93 (68)	184 (71)	**523** (68)
Hit/struck/crush (by person or object)	16 (12)	18 (16)	21 (16)	21 (15)	38 (15)	**114** (15)
Cut or pierced	2 (2)	1 (1)	1 (1)	5 (4)	14 (5)	**23** (3)
Over extension or strenuous movement	10 (8)	5 (4)	12 (9)	7 (5)	8 (3)	**42** (5)
Other	12 (9)	2 (2)	5 (4)	8 (6)	7 (3)	**34** (4)
Total	**129** (17%)	**116** (15%)	**127** (17%)	**137** (18%)	**258** (34%)	**767**

*the 767 is a subset of public transport users aged 60 years or older

Table 3.12: Mechanism of Injury for older age groups by type of public transport (n=767)*

Mechanism	Train	Tram	Bus	Total (event)
MVA Collision/crash	3 (5%)	12 (4%)	17 (4%)	**32** (4%)
Slip/trip/fall (getting on/off or onboard	35 (55%)	244 (76%)	244 (64%)	**523** (68%)
Hit/struck/crush (by person or object)	13 (20%)	34 (11%)	67 (17%)	**114** (15%)
Cut or pierced	5 (8%)	2 (1%)	16 (4%)	**23** (3%)
Over extension or strenuous movement	4 (6%)	18 (6%)	20 (5%)	**42** (5%)
Other	4 (6%)	11 (3%)	19 (5%)	**34** (4%)
Total (proportion of transport)	**64** (8%)	**321** (42%)	**382** (50%)	**767** (100%)

*the 767 is a subset of public transport users aged 60 years or older

The action of a slip, trip, or a fall, while either getting on or off or while on-board, accounted for two-thirds of the mechanisms of injury for older people on public transport units. This mechanism was more frequent for older people on Trams than on Buses or Trains, possibly the result of the higher steps or the higher likelihood of not being seated and their inherent instability. Hit, struck or crushed by a person or an object accounted for a further 15% of the mechanisms of injury for elderly people on the three forms of public transport examined.

3.7 Discussion

This study set out to outline the nature and circumstances of injuries to older public transport users in Australia. It was undertaken as part of the feasibility study aimed at improving safety for older public transport users by the Transport Safety Research Centre at Loughborough University for the UK Medical Research Council (MRC). The lack of studies around the world that have addressed this topic comprehensively is acknowledged and thus hopefully, the evidence provided here will be of value to those responsible for safety in public transport generally.

Outline of the Analysis

The State of Victoria, Australia, is richly endowed by having a very comprehensive surveillance database of those injured who report to one of the major trauma hospitals in the State (the Victorian Emergency Minimum Dataset). The majority of these only require out-patient treatment, although more than one-quarter are admitted. These data comprise details on the individuals involved, the type of trauma experienced, their account of the circumstances of their injurious event, and details on the body region injured for all injuries sustained. These data are routinely used to provide information on the extent and circumstances of survivable injuries from all forms of trauma and hence, very suitable for use in this study.

The analysis undertaken focused on public transport injury events that occurred in the State of Victoria between 2006 and 2010. These years were selected as they represented the most recent forms of injurious events and hence relevant to today's forms of public transport systems. Given the predominance of the three most common forms of public transport in Victoria, the analysis was restricted to injuries that occurred on trains, trams and public buses. While the primary focus of the analysis was on older persons, injuries to all adults were included for comparison and to try and tease out the ageing effects from overall injury trends.

Mode of Public Transport Usage

The results show that injurious events among bus passengers were more frequent than either tram or train events (37% c.f. 35% and 28%). Lagura *et al* (2011) reported that daily trips by bus in the Melbourne metropolitan area in 2005 were significantly less than those by Tram and train (19% c.f. 38% and 43%). While the usage rate for buses in Victoria is likely to be much higher in rural areas, given their predominance as the primary mode of travel in these outer regions, nevertheless, these findings do suggest that bus travel is associated with a higher risk of injury than the other two modes. While injury causing events are discussed in the following section, it is not clear why buses are more hazardous for all travellers and particularly seniors.

Little evidence was found to confirm these findings. RED[3] (2007) reported the average numbers of injuries and deaths for travel modes across all Australia. While death and serious injury rates were significantly lower for all forms of public transport (less than one percent compared with motor cars), buses were twice that of trains and much more than trams for both outcomes. Fact Sheet, Trams in Edinburgh, (2007) claimed evidence shows that trams have few accidents when compared to other transport modes (although this evidence was not disclosed). AASHTO (2006) argued for public transport in the USA needs to improve these services for the elderly and special needs populations by better coordination and improvement of services (presumably including their safety).

Injury Causing Events

The injured public transport users were interviewed about the injuries they sustained and the cause of their injuries on presentation at a participating hospital. They also provided a short word-limited statement about the events leading up to their injuries. These individual statements were collated into five injury-causing events which showed that "*getting on or off the vehicle*", as well as accidents while on public transport units, accounted for almost two-thirds of all injury-causing events across the three forms of public transport. The analysis of what caused the injury and the mechanism of injury was dependent on the limited statement of the events leading up to sustaining the injury. In addition, not every participant was able to report these events,

either through lack of memory or inability. Nevertheless, for those who could, "*getting on or off the vehicle*", as well as accidents while on public transport units, accounted for almost two-thirds of all injury-causing events across the three forms of public transport, and surprisingly, more frequent among bus passengers than those of either trams or trains. Bjornstig *et al* (2005) also reported similar proportions in his study of injured bus occupants. Those aged 60 or more were particularly over-represented for these types of injury-causing events, both in terms of numbers and exposure. As noted in the results, running to catch a public transport unit was involved in 23% overall and buses, again, were over-represented here.

Injuries Sustained and Nature of the Injury

The analysis revealed a significant number of injuries to these public transport users. As noted earlier, the most common injuries from public transport accidents were to the head and face region. Less common, but still noteworthy, were injuries to the lower limbs and the shoulder. For those aged 60 or more, the injury patterns were quite similar apart from an increase in chest injuries. However, older transport users sustained more injuries in all body regions and were more likely to have sustained multiple injuries generally compared with comparative younger injured adults. This was also reported by Bylund *et al* (2007) in their study of Special Transport Services in Sweden where they noted that many of these injuries when the vehicle was at a standstill. Bjornstig et al (2005) also reported that two-thirds of the injuries to bus occupants occurred while the bus was stationary, and predominantly among older occupants.

The predominance of injuries to the head from public bus incidents in the USA was also noted by Olivares and Yadav (2009) involving mainly senior occupants. They further observed that many of these head injuries occurred from body-to-body contacts between unrestrained passengers as well as impacts with seatbacks and other internal structures and argued for greater improvement in structural design and seat belts to restrain occupants in a collision. Bjornstig *et al* (2005) also reported that the frequent injured regions among injured occupants from bus and coach passengers were to the head/neck and extremities (as found in this study). Clearly, head and chest injuries need to be avoided as they are the more serious injuries.

Injury Mechanisms

It should be stressed that the analysis of what was the mechanism of injury to each of the participants was dependent on their brief statement of the events leading up to their injury. In addition, not every participant was able to verbalise these events, either through lack of memory or inability. Nevertheless, these statements throw some limited light on what the most common mechanism of injury category was. As noted earlier, the most practical and reliable method of assessing mechanism of injury usually involves a detailed in-depth examination of the injurious event by an experienced team of crash investigators.

From these statements, the overwhelming "mechanism" was from a slip, a trip or a fall while either getting on or off the vehicle or while on board, accounting for two-thirds of all the mechanisms of injury among older people. Being hit, or struck or crushed by person or an object was also noteworthy. It was not possible to breakdown the injury mechanisms on these public transport units any further using these data.

In analysing the Swedish Traffic Accident Data Acquisition system, Berntman *et al* (2010) noted that while the injury risk for bus passengers is low compared to car users, passengers do still run the risk of sustaining injuries, especially for seniors. They noted that older people were over-represented in bus-related injuries from falls on pedestrian paths, inside the bus, while entering or exiting the bus, or from collisions. These findings concur with what has been found here. They further noted that passengers hit various interior parts of the buses, such as stanchions, sharp edges, glass barriers or seats inside the bus. No similar analyses were found for injuries on trains and trams though which clearly show the need for a more detail in-depth study.

Yarra Trams (2012) noted that passengers on trams (and possibly buses and trains too) need to follow five "*Golden Rules*" for their own personal safety. These include (i) hailing a tram driver as the unit approaches to alert the tram and passenger cars of intent to board, (ii) holding on while onboard to maintain stability and avoid surprise acceleration and deceleration forces, (iii) maintain a sturdy stance to position yourself to absorb

forward and backward movements of the vehicle (not that easy for older people with balance, joint and gait difficulties), (iv) seek a seat wherever possible, even on short trips (this would seem especially important for older people), and (v) plan your parting or departure from the vehicle and be careful when alighting, ensuring the vehicle has fully stopped and watch for passing cars.

While these all seem sensible strategies for all public transport users, it is clear from the evidence presented here that not all passengers obey these rules no doubt for a variety of reasons. Moreover, as some of the mechanisms observed here suggest, there is also scope for more closely examining the engineering aspects of these public vehicles to minimise or prevent injuries when passengers, knowingly or not, find themselves in a vulnerable position. This could include eliminating sharp edges and unnecessary stanchions, and an increase in padding hard surfaces. A lesson from road safety is that engineering the situation to protect the passenger is much more likely to be an effective safety strategy than expecting the passenger to modify their behaviour.

Strengths and Limitations of the Study

The public transportation network provides access to jobs and mobility for the young, elderly and disabled, and helps reduce congestion, conserve fuel, enhances the efficiency of highway transportation, reduces air pollution, and supports security and emergency preparedness activities. An efficient and safe public transportation system is essential to moving people in both urban and rural areas and to the health of the national economy. Of these priorities, safety must be a fundamental criterion to help maintain public health.

This analysis provides evidence of passenger injuries on three major Victorian public transport services, their causes, relative frequency, and age-related effects. Given the paucity of studies in this area, it is a valuable contribution to public health in the region and adaptable to other countries that provide similar services.

Given that, however, there are a number of limitations in this research that need to be highlighted from this research.

- The analysis was based on surveillance data at a number of participating trauma hospitals in Victoria. It focused on survival injury incidents on the three main forms of predominantly urban public transport.
- Those attending GPs and those not seeking medical attention will not be included so these findings are likely to be under reported.
- These data are essentially subjective reports and their widespread representativeness is unknown.
- None of the cases reported to the VEMD involved a fatal outcome at the time of reporting. It is recognised that fatal incidents are likely to show different injury characteristics and causes than those reported here.
- These data were limited in terms of detailed objective analysis and missing a number of important characteristics such as crash and injury severity and source of injury.
- Detailed exposure data that precisely matched the injury events was unavailable to permit accurate relative risk estimates to be made.

While it is based on surveillance data collected in Victoria, Australia, it is argued that many of the findings are still of some relevance to public transport users in other western countries. Besides, it provides an international comparison as a benchmark for comparing with similar findings in the UK.

4. THE NATIONAL CORONIAL INFORMATION SYSTEM (NCIS)

As noted above, to date, the findings reported here focussed on surveillance data which is a valuable contribution, given that it is hospital driven and especially as it includes attendances, not just those that are admitted. As surveillance data tends to include more minor injuries, it would be useful for understanding the full extent of public transport related trauma to include data from the more seriously injured cases.

The National Coronial Information System (NCIS) is a collection of coronial data on deaths reported to the Australian coroner from 2000 onwards and the New Zealand coroner from 2007 onwards. It was first developed in 1993 under the auspice of the Australian Coroners' Society following a Royal Commission into Aboriginal Deaths in Custody and other various investigations and aims to inform on unintentional deaths from trauma and to assist in injury prevention activities (NCIS, 2013). The NCIS involves a consortium of funding provided by the Justice Departments in each State and Territory of Australia and the New Zealand Government, with in-kind support from Monash University, the Victorian Institute of Forensic Medicine, the National Injury Surveillance Unit, the Australian Institute of Health and Welfare and the Australasian Coroners' Society. The NCIS is managed by the Victorian Department of Justice on behalf of its Board of Management and based at the Coronial Services Centre in Southbank, Victoria, Australia.

The NCIS database contains details on the police report of death, autopsy reports, toxicology reports and coronial findings. In all, details on over 25 coronial fields are recorded for each event primarily to explain the circumstances and cause of death. However, it is made available to enable coroners, their staff, public sector agencies, researchers and other approved agencies to access coronial data to assist in the prevention of death from trauma events. Further details on the NCIS system can be obtained on their website at http://www.ncis.org.au/.

4.1 The analysis of Public Transport User Deaths

To assist in further understanding the causes of injury and death to Public Transport Users in Australia, a second analysis was undertaken by NCIS staff (Saar, 2013) under direction of the author for all fatalities involving public transport that were reported to an Australian coroner between 2006 and 2010. This involved all "closed" cases, that is, those which were complete and no longer open. The NCIS undertakes a quality review of the coding for each case that has been closed to ensure consistency and accuracy of these data[1].

A Public transport vehicle was defined as a land vehicle involving a rail, bus or coach configuration. Duplicate cases were removed as were those not involving a Public Transport vehicle or where the death was considered to be from natural causes.

Particular interest in this analysis was in the proportions of deaths by:

- Country and state (Australia and Victoria);
- Age group (<30yrs, 30-60yrs, and >60yrs;
- Male and female;
- Type of Public Transport vehicle (train, tram or bus);
- Manner of death; and
- Intent (unintentional or self-harm).

While the main focus was on the overall percentages of cases across this 5-year period, it was further broken down by individual year during this period for an appreciation of any major changes in occurrence that might have occurred during the 5-year period.

[1] *There can be delays between the closure of a case and its availability from the Quality Assurance Review.*

4.2 Results

There were 470 deaths of adults and children identified during the period 2006 to 2010 in Australia involving a public transport vehicle, of which 196 occurred in the State of Victoria (Saar, 2013). Table 4.1 shows these figures broken down by recorded year.

Table 4.1: Deaths involving public transport by Year of Notification (National and Victorian data)

	Frequency					
	2006	2007	2008	2009	2010	Total
Australia	**107**	**93**	**94**	**87**	**89**	**470**
Percent	*22.7%*	*19.8%*	*20%*	*18.5%*	*19.0%*	*100%*
Victoria	**46**	**37**	**49**	**38**	**26**	**196**
Percent	*23.5%*	*18.9%*	*25%*	*19.3%*	*13.3%*	*100%*

While the overall show a disturbing number of deaths on average for both the State of Victoria and Australia generally (39 c.f. 94) for public transport users, there appeared to be a positive trend of a reduction in the number of public transport deaths from 2006 to 2010.

4.2.1 Australian Fatalities

Table 4.2: Deaths involving public transport by year of Notification and age range of the deceased

Age	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
<30yrs	27	34	33	30	38	**162**	*34.5%*
30-60yrs	61	44	43	38	44	**230**	*49.0%*
>60yrs	19	15	18	19	7	**78**	*16.5%*
Total	**107**	**93**	**94**	**87**	**89**	**470**	*100%*

The figures in Table 4.2 show the number of deaths in the NCIS database for each year and the overall average for all Australia. The averages show that only 16.5% of the public transport deaths were to people aged greater than 60 years which is around the current proportion of the population.

Table 4.3: Deaths involving public transport by year of Notification and older age of the deceased

Age	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
61-69yrs	4	8	12	10	3	**37**	*47.5%*
70-79yrs	6	3	2	5	2	**18**	*23%*
80+yrs	9	4	4	4	2	**23**	*29.5%*
Total	**19**	**15**	**18**	**19**	**7**[2]	**78**	*100%*

This shows that almost half the deaths occurred to young-old transport users (61-69yrs) but a disproportionate number to the very old, likely because of their increased frailty and reliance on using public transport.

[2] *Figures for 2010 have many more cases not finally settled yet from the Quality Assurance Review process.*

Table 4.4: Deaths involving public transport by year of Notification and sex of the deceased

Sex	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Male	78	71	72	64	68	**353**	*75.1%*
Female	29	22	22	23	21	**117**	*24.9%*
Total	**107**	**93**	**94**	**87**	**89**	**470**	*100%*

These data clearly show an over-involvement of males among those who died in a public transport accident in Australia (males and females are roughly of equal numbers in the population). What is not known though is their distribution among public transport users, although anecdotally, it would appear that females are more likely to travel by public transport. This warrants further research.

Table 4.5: Deaths involving public transport by year of Notification and type of transport

Public Transport	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Train	90	81	82	77	83	**413**	*87.9%*
Bus	17	10	10	10	6	**53**	*11.3%*
Tram	0	2	2	0	0	**4**	*0.8%*
Total	**107**	**93**	**94**	**87**	**89**	**470**	*100%*

Table 4.5 shows the breakdown of Australian deaths by type of public transport. The absolute major of these deaths involved trains with practically no deaths from external causes on trams. Buses, too, were only moderately involved. These results are in contrast with earlier figures for surveillance injuries, although it should be remembered that not all States and Territories have trams and it is not clear from these findings whether the public transport user was killed on-board or hit by the train as a pedestrian. This is further clarified below.

Table 4.6: Deaths involving public transport by year of Notification and type of crash

Type of crash	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Pedestrian/cyclist hit by public transport	92	83	83	77	81	**416**	*88.5%*
Driver/passenger death on-board	8	2	4	6	1	**21**	*4.5%*
Other cause	7	8	7	4	7	**33**	*7.0%*
Total	**107**	**93**	**94**	**87**	**89**	**470**	*100%*

Clearly, the vast majority of public transport deaths are more external than internal, which would be normally be classified as pedestrian crashes. However, the NCIS data also includes a judgement of intent, usually made by the coroner or the police. These findings are shown further in Table 4.7 below.

Table 4.7: Deaths involving public transport by year of Notification and intent of deceased

Intent	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Unintentional	35	28	26	24	23	**136**	*28.9%*
Intentional (self-harm)	68	60	64	59	58	**309**	*65.7%*
Unknown intent	4	5	4	4	8	**25**	*5.4%*
Total	**107**	**93**	**94**	**87**	**89**	**470**	*100%*

This is a rather surprising result with two-thirds of all public transport deaths judged to be intentional to cause self-harm by the user. Given the high proportion of train deaths shown in Table 4.5 and external causes in 4.6, it suggests that many of the train deaths may have been intentional on the part of the train user. This needs to be broken down by age group to see if it relates to young or old age groups but is somewhat disturbing. It should be stressed that the judgement of intent is often subjective, based on other associated factors.

4.2.2 Victorian Fatalities

The next section of results focuses on solely Victorian crashes only and is more comparable with the surveillance finding shown in Chapter 3.

Table 4.8: Victorian deaths involving public transport by year of Notification and type of transport

Public Transport	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Train	38	35	46	32	26	**177**	*90.3%*
Bus	8	1	3	6	0	**18**	*9.2%*
Tram	0	1	0	0	0	**1**	*0.5%*
Total	**46**	**37**	**49**	**38**	**26**	**196**	*100%*

Interestingly, while Trams are more common in the State of Victoria, the percentage of deaths in this State have little variation with those shown in Table 4.5 for all of Australia. Again, more than 90 percent of all public transport user deaths in Victoria were from external causes with very few from Trams.

Table 4.9: Victorian deaths involving public transport by year of Notification and age range

Age	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
<30yrs	7	15	17	16	12	**67**	*34.2%*
30-60yrs	31	16	21	14	11	**93**	*47.4%*
>60yrs	8	6	11	8	3	**36**	*18.4%*
Total	**46**	**37**	**49**	**38**	**26**	**196**	*100%*

The figures shown in Table 4.9 reveal little difference to the National figures in Table 4.2 where the averages show only 18.4% of the public transport deaths to people aged greater than 60 years. Given the lower numbers, it was not possible to break these down further by older age-group categories.

Table 4.10: Victorian deaths involving public transport by year of Notification and intent of deceased

Intent	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Unintentional	12	9	13	14	5	**53**	*27%*
Intentional (self-harm)	31	25	32	22	17	**127**	*64.8%*
Unknown intent	3	3	4	2	4	**16**	*8.2%*
Total	**46**	**37**	**49**	**38**	**26**	**196**	*100%*

Again, the majority of Victorian public transport deaths were judged to be intentional and of similar proportions to all Australian deaths shown in Figure 4.3.

Table 4.11: Victorian deaths involving public transport by year of Notification and intent of deceased

Injuries Sustained	Unintentional Death		Intentional Death	
	Total	Percent	**Total**	*Percent*
Multiple Injuries	31	58.5%	**93**	*73.3%*
Head Injuries	9	17%	**13**	*10.2%*
Other injuries	13	24.4%	**21**	*16.5%*
Total	**46**	**37**	**196**	*100%*

These results are interesting in that there were many more multiple injuries in intentional than unintentional deaths. It's not clear why this would be so but perhaps suggests that the intentional deaths were of greater severity than those that were accidental. This needs further analysis to confirm if this is true or not.

Table 4.12: Victorian deaths involving public transport by year of Notification and type of crash

Type of crash	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Pedestrian/cyclist hit by public transport	38	34	44	32	26	**174**	*88.8%*
Driver/passenger death on-board	6	1	1	4	0	**12**	*6.1%*
Other cause	2	2	4	2	0	**10**	*5.1%*
Total	**46**	**37**	**49**	**38**	**26**	**196**	*100%*

These figures are once more very similar to those in Table 4.6 for Australians, confirming that most public transport deaths are from external causes (pedestrian collisions) and seemingly intentional. This is clearly an issue of some concern in terms of station and infrastructure design.

Table 4.13: Victorian deaths involving public transport by year of Notification and the time between the incident and subsequent death

Time to Death	Frequency						
	2006	2007	2008	2009	2010	**Total**	*Percent*
Immediate	35	33	43	36	26	**173**	*88.2%*
< 1 hr	2	1	0	0	0	**7**	*3.6%*
<24 hrs	2	1	3	0	0	**6**	*3.1%*
>24 hrs	3	2	3	2	0	**10**	*5.1%*
Total	**46**	**37**	**49**	**38**	**26**	**196**	*100%*

The results in Table 4.14 show that more than 88% of the deaths were immediate which is in keeping with the proportion of intentional deaths and those involving a train. Clearly, if someone is intent on ending their life, they do it using Public Transport in a way that ensures an immediate outcome. Given the similarity shown earlier between other Victorian and National figures, it would be expected here, too, that similar findings would be likely across the whole of Australia.

4.3 Discussion

The analysis conducted in this Chapter involved records of fatal public transport users across Australia and in the State of Victoria from the period 2006 to 2010 to match those presented in Chapter 3 for less-severe cases. It was included to illustrate the events surrounding more-severe outcomes from public transport accidents and to address and supplement the limitations noted earlier with surveillance data findings.

As noted above, the National Coronial Information System (NCIS) is a collection of coronial data on deaths reported to the Australian coroner from 2000 onwards and contains details on the police report of death, autopsy reports, toxicology reports and coronial findings. It is made available to enable coroners, their staff, public sector agencies, researchers, and other approved agencies to access coronial data to assist in the prevention of death from trauma events.

4.3.1 Overall Findings

While the analysis separated Australian from Victorian fatalities, these will be discussed together, given the overall similarities in their proportions shown in these results.

Of special note was the apparent overall reduction in the number of deaths from 2006 to 2010, although this seemed to be more a trend among younger public transport users and less so for seniors. This is unlikely to be purely a consequence of the ageing population, given it was only over a 5-year period but nevertheless, should be monitored further as the population ages.

It was shown that the number of deaths among older public transport users was slightly less than their population rates (16.5% c.f. 19.3%) from the Australian statistics (ABS, 2012), suggesting they were slightly under-involved as a group. This is contrary to what the ageing statistics would have predicted and certainly different to the findings for those with less-severe injuries in the previous Chapter. The reasons for this may be the result of the intent of the public transport user where around two-thirds of these cases were judged to be intentional deaths. More will be said of this finding later.

There were differences among various sub-sets in these data. Males, for instance, had a much higher involvement rate than females (75% c.f. 30%) where population differences reported by ABS (2012) were very small overall (49.8% C.F. 50.2%). This could suggest that men have a higher risk of a fatality from public transport use. However, it could also reflect exposure and intent differences between men and women. It was

not possible to test for these influences in the early analysis. From casual observation, it would seem that females and males are roughly equal public transport users in Australia, but this needs to be more firmly established. Clearly, further detailed research in this area is warranted to fully understand this result and to confirm if it is exposure, risk or intent related.

While older people aged 60 to 69 years represented roughly half the number of public transport users killed, a disproportionate high proportion occurred to those aged 80 years or more when considering their population rates (29.5% c.f. 19.6%). It was speculated that this could be because of their increased frailty and reliance on using public transport, an issue that also requires further research.

4.3.2 Cause of death

Train-related deaths were the overwhelming source of public transport deaths in Victoria and Australia generally (90.3% and 87.9% respectively). Furthermore, two-thirds of all public transport deaths reported in Victoria were judged to be intentional to cause self-harm by the user. This suggests that many of the train deaths may have been intentional on the part of the train user to cause self-harm. This needs to be broken down further by age group to see if it relates to young or old age groups but is very disturbing. It should be stressed that the judgement of intent is often subjective, based on other associated event factors.

Not surprisingly, the vast majority of public transport deaths were judged to be “external” (hit by public transport) than “internal” (died on-board). These are normally classified as pedestrian crashes. In addition, multiple injuries were more frequent in intentional than unintentional events, possibly from higher severity impacts, and 88.2% of these deaths occurred immediately, rather than sometime after the event. These findings further confirm the high proportion of intentional cause to do self-harm to many users of public transport deaths in Australia.

In some European countries with highly developed rail networks, railway-related suicide is a common method for people taking their own lives. Rail-related locations include rail stations, tunnels, and on the lines themselves, particularly in wooded areas. Mueller (2009) noted that these types of suicides often lead to traumatizing the driver of the train and may lead to post-traumatic stress disorder.

Some countries have reported rail-related suicide rates. In the Netherlands, for instance, it is claimed that 10% of all suicides are rail-related. Baumert, et al (2006) reported that 7% of all suicides in Germany occur from train collisions and is the largest cause of suicides in this country. Suicide by train is seen as something of a major social problem in Japan too, especially in the larger cities such as Tokyo or Nagoya (Kunitachi City Journal; 2000). According to Bierman (2010) there are 300 to 500 train suicides every year in the US too, where public transport is generally less-frequent.

What was not clear from the analysis reported here, though, was where these “intentional” deaths occurred? For instance, if trains were the major mechanism of injury, it would be useful to know if they occurred at the station or further along the tracks to help identify what could be done to prevent these fatalities. It has been claimed that death rates in stations are less than on tracks as vehicles tends to be travelling at slower speeds. This needs to be established in these data to help guide intervention efforts.

Coats and Walter (1999) noted that different methods have been used in order to decrease the number of suicide attempts in the London underground. He reported that deep drainage pits halve the likelihood of fatality. In addition, separating the passengers from the track by means of a partition with sliding doors has being introduced in some stations, but is expensive. This treatment is also appearing in other countries too, such as France.

There are a range of interventions that have been used in an attempt to reduce the number of rail-related suicides. These include CCTV cameras for surveillance of stretches where suicides frequently occur with direct

links to the police or security companies. This facilitates fast access to the scene before and after these events and also provides a record of occurrences for site corrections.

As noted earlier by Kunitachi City Journal (2000), suicides with high speed trains are less common as they are generally zones that are difficult to gain access to. Public access to other tracks can be also made more difficult by erecting fences and trimming trees and bushes to increase driver visibility.

4.3.3 Mode of Travel

While the vast majority of deaths in the NCIS database were train related, it was of some comfort to know that the number of public transport user fatalities on either buses or trams was quite low (9.2% and 0.5% respectively). Public buses have significantly fewer accidents than private transport. Nevertheless, when they do crash, the outcomes can be quite severe.

TRB (2001) identified a number of characteristics related to improved safety for public buses. These included safe driver selection practices, driver training of new operators, safe driver incentive practices, safety practices by users, while boarding, riding, or exiting a bus, safe management practices including safety audits, ride checks, computerized accident or incident databases, safety committees and implementation practices, technology to improve bus safety, and safe Operating environment practices such as making safety an integral part of new bus route planning, designing safer bus stop zones and special bus lanes that remove buses from a high-speed or congested travel lane.

Interestingly, while Trams are a common form of public transport in several Australian states, their death rates among public transport users were almost non-existent. This seems to reflect the fact that they generally do not travel very fast and are able to stop more rapidly than trains. As shown in Chapter 3, there are a number of injuries to tram passengers, but their severity tends to be far less than in other transport modes. Many of the improvements nominated for buses would also be relevant to trams.

4.3.4 Study Limitations

There were limitations with the analysis of NCIS data and these data in this study that need to be recognised.

First, owing to time and cost restraints, it was not possible to undertake a more comprehensive analysis of these data. What has been reported here is really only an initial cut of the database which is richer in detail than was undertaken. While the initial analysis was planned to examine the extent of public transport user fatalities, it does suggest the need for a more detailed examination at a future date.

Second, given the small number of cases involved, it was agreed that a full statistical analysis to indicate significant findings was not appropriate. Clearly, some of the results would appear to be significant differences, while others may not. As the number of fatalities in Australia from public transport is relatively small, it is not easy to conduct a more robust and meaningful analysis of these data.

Another issue is with these data themselves. In compiling the NCIS database, it aims to present high quality data that is timely, comprehensive, reliable and complete. It recognizes, though, that it is limited by the quality of the source data entered into the system. It is acknowledged that quality and consistency of these documents may vary between and within each jurisdiction. It is also noted that the primary intention of these documents is for death investigation purposes in order to find the circumstances and cause of death. As a result there may be limitations when these documents are applied for public health use.

There are also differences between jurisdictions as to legislation governing the reporting of a death to a coroner, which can impact on the type, quality and quantity of the information collected and reported by each jurisdiction. This will also impact on the information available in the NCIS.

5. GENERAL DISCUSSION & CONCLUSIONS

This study offers an important contribution to public transport safety by identifying injury events to users, their outcomes and limited causation factors. The results from these survivable reported injurious incidents on trams, trains and buses highlight a number of important event and injury factors. Older people are clearly more likely to be injured with multiple and life-threatening injuries than their younger counterparts.

A number of injury circumstances for passengers getting on or off and while onboard these high-usage vehicles were identified and some preliminary detail is provided on injury causation and mechanisms of injury is presented.

Some possible intervention solutions were listed, although definitive details or priorities. A number of limitations in this study and areas requiring further research were identified for future studies and the need for more definitive in-depth studies of public transport injurious incidents was especially noteworthy.

5.1 Intervention Opportunities

The available data for this analysis was not sufficiently detailed to permit a definitive list of interventions to be identified and prioritised. However, from the numbers of events reported and the injuries sustained, a few possible key solutions seemed relevant. These are listed below in no particular order of importance.

1. At-grade entry and exit for all three modes of travel would conceivably help to address problems for users getting on and off these vehicles. External islands or platforms level with the vehicle floor itself on entry or exit would help to address this (a program is currently underway for train and tram entry and exit in and around Melbourne at high volume tram stops);
2. Alternatively, or in addition, low floor buses and trams that require less step-height from the curb would help especially older users when entering or exiting;
3. Removing or padding structural hazards inside these vehicles may help to address injuries that occur to free-standing occupants on loosing balance during sudden braking or acceleration;
4. Vehicle design that maximises seating capacity would go some of the way to minimise the risk of slipping or stumbling onboard; and
5. Education to alert public transport users of the dangers they face when using these services would be worthwhile, although it is recognised that engineering away the problems and difficulties they face is more likely to be effective than relying entirely on behavioural change.

Efforts to reduce the incidence of death for users of public transport would also seem possible and important.

6. Given the high incidence of train fatalities and intention to cause self-harm, we need to give some priority towards these events, possibly including:
    - deep drainage pits in subways;
    - CCTV cameras for surveillance of stations and “black-spots”;
    - Platform separation partitions with sliding doors for arriving and departing trains; and
    - for “black-spot track treatments, CCTV cameras, restricted public access fencing; and trimming trees and bushes to increase driver visibility.
7. Bus treatments would also seem to be useful to prevent fatalities and injuries, and could included where appropriate:
    - safe driver selection practices;
    - driver training of new operators;
    - safe driver incentive practices;
    - safety practices by users while boarding, riding, or exiting a bus;

- safe management practices (safety audits, ride checks, and computerized incident databases);
- technology to improve bus safety; and
- safe environment infrastructure such as making safety an integral part of new bus route planning, designing safer bus stop zones, and special bus lanes that remove buses from a high-speed or congested travel lane.

5.2 Recommendations for Further Research

Berntman and her colleagues (2010) noted that while the injury risk for bus (and tram and train) passengers is low compared to car users, public transport users also run the risk of sustaining serious injuries as vulnerable road users, and in particular, older people. This needs urgent attention to ensure these injuries are not overlooked. A number of areas for which further research is warranted from this research were identified:

- The lack of suitable representative in-depth data was evident in many of the studies reported here. As Olivares and Yadav (2009) noted, there is little enthusiasm for agencies to collect these crash data using in-depth investigative procedures and no standard for collecting these data for public transport incidents. This point was also made by WHO (2004), especially in developing countries, where public transport incidents are more frequent.
- With the lack of suitable crash data, it is almost impossible to identify intervention priorities for public transport vehicles and occupants. This requires urgent attention to improve public health in this region.
- Further research into the sources and effects of driver distraction in the public transport sector is also required (Salmon *et al*, 2009). Focus needs to be on understanding what the major distracters are for bus (and other public vehicle) drivers and occupants and develop suitable methods for assessing these.
  - *Priority research needs to be given to more in-depth data on injury mechanism, severity and patient relevant outcomes such as discharged to nursing home care or own home.*
- The lack of detailed and appropriate exposure data restricts the ability to assess relative risk among the various types of public transport and hence achieving optimum safety solutions.

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Attachment 1 – Exemplar Injury descriptor Statements

Case Summary - 60 plus years: Slip/Trip/Fall

- R) shoulder pain post mechanical fall in train 30/60 ago head-strike ? loc phx: t2dm htn
- fall from train pain L) leg
- fall off train
- falls- whilst stepping off train confused to place 1cm lac to nose unable to remember fall
- Footscray train station getting off train and fell
- lwr back pain post mech fall on train - ambulant post
- pt on train which took off pt tried to get off when fell off train onto face causing fracture to humerus and facial lacerations
- slipped getting off train and fell onto platform
- fall this afternoon while on train head strike to metal pole nil loc pt fell back o/a mas gcs 1
- departing from train slipped in gap 10 cm skin tear R/ shin L/ hand 4cm pain++
- mech fall bet train & platform large ++ h'toma R thigh lac to L foot will need suture as per lmo
- fall from moving train
- pt slipped between carriage of train landing on train tracks below nil loc nil neck pain pt c/o
- fall getting off a train approx 1 meter hit head on ground nil loc co pain to r hand headache p
- painful and swollen l) lower leg fell over trying to get on train bony tenderness
- doors closed on train pt tried to force open fell forward onto platform twisted back felt twinge
- fell in train on way to work
- head injury without loss of consciousness- pt fell getting off train approx 0630 hrs haematoma
- injury - arm (upper arm and elbow) tripped and fell getting off train now has left elbow pain and swelling
- injury - head (face - general) fall from train large egg to l) eyebrow pt confused about events o
- fall on train 2/7 ago – head-strike with ?loc now not 'feeling right' - can't specify, denies headache
- bilat hand grazes trying to get onto train that moved off while still trying to get on fell onto concrete siding
- c/o left rib and left arm pain post fall while getting on the train on Wednesday phx cags 2000 ht
- on the train at Caulfield at 1420hrs lost her footing landed on right arm c/o pain to upper right a
- fall while attempting to get to train door onto platform
- fell on to her luggage today as getting off the train
- fell over whilst travelling on the train
- fell whilst getting into train
- inj middle ring and little fingers fallen when get out of train
- injury - knees post fall whilst trying to catch a train
- no end location on the train, going out caused by tripped with equipment
- R) leg injured while stepping onto train caught between train and platform dizzy post bp 80/r dialysis
- tripped over whilst getting onto train at Yarraville station 4cm lac to forehead nil loc has been drinking since 0730 at the pub ph- etoh abuse
- fell on the train 2/7 ago hit L) wrist against wall ongoing pain nil swelling or deformity neurovasc inatct phx- ht high cholmeds- avapro lipitor cartia seretideallergy - elastoplast