

## **NZIPS Serious Injury Case Definition Review:**

The New Zealand Injury Prevention Strategy Serious Injury Outcome Indicators: Does the case definition of serious non-fatal injury miss a material number of serious injury cases?

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## Abstract

### Background:

In New Zealand, there had been some debate about whether the operational definition of serious injury, described in the specifications of the New Zealand Injury Prevention Strategy (NZIPS) serious injury outcome indicators, fails to capture a significant number of cases of serious non-fatal injury. For example, under the current NZIPS case definition, a principal diagnosis (PDX) of laceration of the wrist, with an external cause of injury of “self-harm” is counted as a case of self-harm injury. On the other hand, a PDX of a mental health condition with an additional diagnosis of laceration of the wrist, with an external cause of injury of “self-harm”, is not.

This project investigated the current and alternative definitions of serious non-fatal injury, and aimed to obtain agreement amongst key stakeholders in confirming the existing definition, or identifying a new definition that can be applied consistently across all relevant indicators.

### Research question:

Does the case definition of serious non-fatal injury, used in the specifications of the NZIPS serious injury outcome indicators, miss a material number of serious non-fatal injury cases of interest?

### Methods:

A combination of empirical methods and consultation with stakeholders was used.

The frequency and nature of additional cases of serious injury captured by using alternative methods of case selection were investigated using data from 2001-2008. In respect of the current definition, cases of injury are identified from first admissions which have a principal diagnosis (PDX) of injury. The first external cause of injury code, on the hospital record, is used to define the Priority Area. Two alternative case definitions were considered in this work: A) a case definition that relaxed the requirement for the PDX on the National Minimum Data Set (NMDS) of hospital discharges to be an injury code, provided there is at least one injury diagnosis recorded on the record; B) one which used all of the external cause of injury codes (E-codes) recorded on the NMDS hospital discharge record to define the Priority Area(s), rather than just the first occurrence of the E-code.

Alternative definition A: It could be argued that there is no reason to restrict the PDX to be an injury diagnosis, provided that there is at least one injury diagnosis recorded for the person, and provided the recorded injuries satisfy the severity threshold. The proposed alternative case definition A was, therefore: at least one injury diagnosis present in the range S00-T78; a first external cause code in the range V01-Y36; and  $ICISS \leq 0.941$ . (ICISS is the International Classification of Diseases-based Injury Severity Score.)

Alternative definition B: The current NZIPS serious injury case definition requires cases to be classified to the NZIPS Priority Area on the basis of the first E-code on the NMDS record for the injured person. For example, as currently defined, a PDX of laceration of the wrist, with a first listed E-code of “self-harm” would be counted as a case of self-harm injury. If the record also contained a second E-code of “sexual assault by bodily force”, the second E-code would not contribute to the frequencies or rates of injury for any Priority Area. This raised the question: If any E-code on the record was used to allocate a case to one or more Priority Areas (eg. self-harm and assault in the above example), what effect would this change have on the frequency and nature of cases captured? This too was investigated.

The proposed alternative case definition B was, therefore: any external cause code in the range V01-Y36; principal diagnosis in the range S00-T78; and ICISS $\leq$ 0.941.

Results were presented to a stakeholder group at two meetings, where agreement on the most appropriate case definition was sought.

### **Results:**

Using the current NZIPS case definition, there were 69,993 cases of serious non-fatal injury identified during the period 2001 to 2008.

Alternative definition A: Relaxing the requirement within the case definition for the PDx to be an injury resulted in 74,697 cases in the period 2001 to 2008, ie. 7% (n=4,704) more serious non-fatal injury cases. This was mainly due to the increased number of Falls cases ascertained (56% of 4,704, n=2,646), as well as additional Self-harm cases (6%, n=277). The Priority Area with the largest percentage increase in cases was Self-harm which showed a 17% increase (1,594 to 1,871).

There was general support from the members of the International Collaborative Effort on Injury Statistics, who responded to this proposal for a shift to the alternative case definition A. That is, relaxing the requirement for the PDx to be an injury, provided at least one additional diagnosis is an injury, and ICISS $\leq$ 0.941.

Alternative definition B: Relaxing the requirement, within the case definition, for the Priority Area to be defined using solely the first E-code, only resulted in an additional 480 Falls cases (1% increase), an additional 129 Assaults (2% increase), an additional 111 MVTCS (1% increase) and an additional 70 Self-harm cases (4% increase). Use of multiple E-codes for a given person-injury event is discouraged by the Ministry of Health. Some District Health Boards comply with this, others do not – thus, there is inconsistency across the country.

Further investigations: In order to gain greater insight into the results, the Stakeholder Group recommended that we investigate the time between the injury event and admission to hospital. They hypothesised that for some of the people with a non-injury PDx, and with injury only recorded as an additional diagnosis, their injury may relate to an old event. Also, they speculated that, for some people, more than one injury event could be represented on their record.

For the additional cases found, when alternative definitions A and B combined were applied, 52% were admitted on the day of the injury, 7% were admitted 1 or 2 days after the injury, 10% 3-14 days after the injury, and 21% had an injury date after the admission date. Nine percent were admitted over 2 weeks after the recorded date of injury.

Under alternative definitions A and B together, 6% (4,610/75,240) had more than one injury date listed on the record.

### **Discussion:**

Both the Stakeholder Group, and the international injury statistics community consulted, agreed to the relaxation of the need for the principal diagnosis to be an injury code, provided at least one additional diagnosis is an injury and ICISS $\leq$ 0.941. This relaxation alone would result in a 7% increase in the number of serious non-fatal injury cases ascertained overall, with a 17% increase in the number of Self-harm serious injury cases, and an 8% increase in the number of Falls cases.

The results show that, in some instances, there were multiple injury events captured on the inpatient record. In some instances, these additional events occurred in hospital. For example, an older person had a MVTC and sustained serious head injuries. Whilst treated

in hospital, they fell whilst moving around the ward and sustained a hip fracture. This phenomenon will account for some of the cases having an injury date after the date of admission.

The MoH discourages the use of multiple E-codes for a given person-event. The inconsistent use of multiple E-codes across the country suggests that the current policy of using only the first E-code after the diagnosis codes, to classify Priority Area, is sensible.

The E-code is coded immediately after the diagnosis codes to which it relates. It may be possible to use the sequence of diagnosis and E-codes on a record to identify multiple events. For example, the sequence of diagnosis and E-codes on the record DDDEE represents one person-event with multiple E-codes (where 'D' represents a diagnosis code and 'E' an E-code). For instance:

- D1=Focal cerebral haematoma.
- D2=Loss of consciousness of unspecified duration.
- D3=Open wound of the scalp.
- E1=Assault by blunt object.
- E2=Fall on the same level.

In this instance the assault and the fall are assumed to relate to the same person-event. Whereas, the sequence DDEDE potentially represents two person-events (DDE & DE), each with one E-code. For example:

- D1=Laceration of liver.
- D2=Laceration of kidney.
- E1=Car occupant injured in collision with another vehicle.
- D3=Contusion of eyelid and periocular area.
- E2=Assault by bodily force, partner.

Stakeholders agreed that records containing more than one injury event for the same person (multiple person-events) should be counted in this way, if it is feasible to do so.

On examination of a sample of records, it was clear that the validity of using sequences of diagnosis and E-codes to identify person-events should be investigated in further research, as well as the feasibility of applying this definition operationally - since, in approximately a third of the sample of records that we examined, there were uncertainties regarding the number and / or nature of the person-events shown on the discharge record.

### **Conclusion:**

The current NZIPS case definition misses a material number of serious non-fatal injury cases of interest to the stakeholder community. Therefore, there is a need to use an alternative case definition. There is evidence to support the adoption of alternative definition A<sup>1</sup>, but not alternative definition B<sup>2</sup>.

The attendees at the second stakeholder meeting agreed a case definition that counted one or more person-events from the same record. Before this proposal is adopted, further work is required to investigate the validity and feasibility of counting person-events in the manner proposed above.

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<sup>1</sup> Alternative definition A: at least one injury diagnosis present in the range S00-T78; a first external cause code in the range V01-Y36; and ICISS $\leq$ 0.941.

<sup>2</sup> Alternative definition B: The current NZIPS serious injury case definition requires cases to be classified to the NZIPS Priority Area on the basis of the first E-code on the NMDS record for the injured person. The question was: can any E-code on the record be used to allocate a case to one or more Priority Areas? The proposed alternative case definition B was: any external cause code in the range V01-Y36; principal diagnosis in the range S00-T78; and ICISS $\leq$ 0.941.

## Recommendations

- 1 Changed case definition: It is recommended that the change to alternative definition A be adopted by NZIPS, and the NZIPS indicator specifications be changed as soon as possible.
- 2 Person-events: The proposal relating to the possibility of counting more than one person-event from the same record should be investigated for its validity, as well as the feasibility of its implementation.
- 3 Adoption: If found to be valid and feasible, it should be adopted by NZIPS.
- 4 Counting person-events in more than one NZIPS Priority Area: Under the current NZIPS case definition of serious non-fatal injury, only one Priority Area is assigned in all cases except for work-related events. For example, a fall at work is currently counted both in Priority Areas 'Falls' and 'Work-related injury'. It is recommended that this should be highlighted in future Chartbooks, including the size of the "double counting" across Priority Areas.
- 5 Implementation: If any change to the NZIPS case definition is made, there should be parallel implementation – eg. for 5 years, NZIPS Chartbook chart trends should be shown with both the original case definition and the new case definition (or the new case definition in the body of the report with the original case definition as a hyper-linked appendix).

## Keywords

Injury; Non-fatal; Definition; Review; Indicators; NZIPS

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## Abbreviations

ACC	Accident Compensation Corporation
ADx	Additional Diagnosis
AIS	Abbreviated Injury Scale
DoL	Department of Labour
E-code	External cause of injury code as defined by the WHO's ICD.
FNOF	Fractured Neck of Femur
ICD	WHO's International Classification of Diseases and Related Health Problems
ICD-9	ICD Ninth Revision
ICD-9-CM	ICD Ninth Revision, Clinical Modification
ICD-10	ICD Tenth Revision
ICD-10-AM	ICD Tenth Revision, Australian Modification
ICE	International Collaborative Effort on Injury Statistics
ICISS	ICD-based Injury Severity Score
IIM	Injury Information Manager, Statistics New Zealand
IPRU	Injury Prevention Research Unit, University of Otago
ISS	Injury Severity Score
MoH	Ministry of Health
MoJ	Ministry of Justice
MoT	Ministry of Transport
MSD	Ministry of Social Development
MVTC	Motor vehicle traffic crashes
NMDS	NZ's National Minimum Data Set of hospital discharges
NTDB	US National Trauma Data Bank
NZ	New Zealand
NZIPS	NZ Injury Prevention Strategy
PDx	Principal Diagnosis
StatsNZ	Statistics New Zealand
STIPDA	US State and Territorial Injury Prevention Directors' Association
TARN	UK Trauma Audit & Research Network
UK	United Kingdom
US	United States
USA	United States of America
WHO	World Health Organization



# 1 Introduction

## 1.1 Background

The research question addressed by this work was: Does the case definition of serious non-fatal injury, used for the NZIPS serious injury outcome indicators, miss a material number of serious injury cases of interest?

For the NZIPS serious non-fatal injury outcome indicators, cases are identified from New Zealand's National Minimum Data Set (NMDS) of hospital discharges. After 1999, the natures and causes of injury captured on the NMDS have been coded to the World Health Organization's International Classification of Diseases 10<sup>th</sup> Revision (ICD-10) codes. The operational definition of injury for these indicators, stated in terms of ICD-10 code ranges, include the requirement that cases have:

- a principal diagnosis (PDx) of injury, coded to the range S00-T78; and
- a first external cause of injury (E-code<sup>3</sup>), coded to the range V01-Y36.

The code ranges specified exclude ICD-10 diagnosis codes for "medical" injury (eg. "Air embolism following infusion, transfusion and therapeutic injection") as well as sequelae (or late effects) of injury.

Collaborative work between the Injury Prevention Research Unit (IPRU) and the Ministry of Health (MoH), conducted in 2007 and 2008, highlighted the possibility that this operational definition may be too restrictive, at least in the context of the self-harm indicators, and that a material number of additional cases may be identified that do not have a PDx of injury. When the criterion that the PDx was an injury was relaxed, provided there was at least one injury diagnosis listed on the record, then a material increase in the number of serious self-harm injury cases was observed. For example, under the NZIPS serious non-fatal injury case definition, a PDx of laceration of the wrist, with an E-code of self-harm is counted as a case of self-harm injury. On the other hand, a PDx of a mental health condition with an additional diagnosis (ADx) of laceration of the wrist and with an E-code of self-harm is not.

In this project, we investigated the extent of the problem for the Self-Harm Priority Area, and the extent to which this potential problem extends beyond the Self-harm Priority Area.

### The New Zealand Injury Prevention Strategy Indicators

In 2003, the New Zealand Government signed off the New Zealand Injury Prevention Strategy (NZIPS) which established six Priority Areas (Assault, Workplace injuries, Self-harm, Falls, Motor vehicle traffic crashes (MVTC), and Drowning and near drowning). The NZIPS indicators are a key element in reporting progress, to Ministers and to the general public, in the prevention of serious injury in New Zealand, for "all serious injury" and for the six Priority Areas. (New Zealand Injury Prevention Strategy Secretariat, 2007) The indicators are fundamental to national priority setting, policy making and prevention of these serious injuries in New Zealand. It is important, therefore, that the best and most acceptable (to all key stakeholders) case definition of serious non-fatal injury, that captures all important threat to life injuries, is identified and used in the specifications of the NZIPS serious non-fatal injury indicators.

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<sup>3</sup> Under ICD-9, external cause of injury codes were referred to as "E-codes" since: a) 'E' designated 'external cause'; and b) external cause codes under ICD-9 had a prefix of 'E'. Even though the latter condition no longer holds, we have retained this same convention of referring to external cause of injury codes as "E-codes".

The NZIPS non-fatal injury indicators are restricted to serious injuries (defined as those with a high threat to life), since these injuries invariably get admitted to hospital (the same cannot be said for minor or moderately severe injuries). Indicators based on these serious injuries have no identified threats to their validity, when assessed against internationally published criteria. (Cryer, Langley & Stephenson, 2004) (Cryer, et al., 2005) (Cryer & Langley, 2006)

## 1.2 Previous injury case definitions

### Choice of diagnosis field

Similar to the NZIPS indicators, use of just PDx in the case definition of an injury (ie. not using ADx) has been commonplace. (Smith, Langlois & Buchner, 1991) (Cook & Sheikh, 2000) (Durbin et al. 2000) (Harrison & Steencamp, 2002) (Helps, Cripps & Harrison, 2002) The use of the PDx (without using ADx) to identify cases of hospitalised injury is also recommended, for surveillance purposes, by the US State and Territorial Injury Prevention Directors' Association (STIPDA). (Injury Surveillance Workgroup, 2003)

Lawrence and colleagues (2007) (Lawrence, Miller, Weiss & Spicer, 2007) have stated that this STIPDA definition undercounts injuries. In their work, they identified cases of injury using a multistage process. At the first stage, they kept any record that had an injury code in the first 3 diagnosis fields. At subsequent steps, a record could be dropped if it did not have an E-code, if found to be a readmission, or if found to be non-acute (admission for rehabilitation, chronic conditions, or late effects – although this does appear to contradict statements in other parts of their paper: see below). They also looked for combinations of diagnosis codes and E-codes that correspond to non-injury (no detail given). The key message, in the context of the current report, is that, when identifying cases of injury, they did not restrict consideration to just the first listed diagnosis – described as PDx in New Zealand – but considered the first 3 diagnosis fields. Other authors have similarly used additional diagnoses, as well as PDx, to identify cases of injury. (Jacobsen, et al., 1999) (Thurman & Guerrero, 1999)

### Choice of ICD code range

STIPDA recommended identifying cases of injury hospitalization if the PDx is coded to an injury, including certain late effects of injury. (Injury Surveillance Workgroup, 2003) They recommended that injuries be identified by the following ICD-9-CM nature of injury codes: diagnoses in the ICD-9-CM range 800-994, 995.5 (child maltreatment) or 995.80-.85 (adult maltreatment). This is not the whole of the injury chapter. It excludes

- certain adverse effects (eg. anaphylactic shock, allergies, adverse effects of drugs, biological agents, anaesthesia);
- complications of surgical and medical care.

There were also two exclusions of diagnoses from the range 800-994, namely:

- late effects of complications of medical care (909.3)
- late effect of drug, medicinal or biological substance (909.5)

They included other late effects (or sequelae), however. These include late effects of radiation, reduced temperature, heat, light, air pressure (eg. barotrauma), lightning, near drowning, hunger, thirst, excessive exertion, motion sickness, asphyxiation, electrocution, weightlessness, and the toxic effect of nonmedical products.

Lawrence and colleagues (2007) (Lawrence, Miller, Weiss & Spicer, 2007) stated a theoretical definition of injury as follows:

*“any ill effect that results from trauma or poisoning unrelated to medical care”*

Their operational definition was based on the same injury codes as the STIPDA recommended definition. Lawrence and colleagues also included ICD-9-CM codes from outside of the ICD “Injury and poisoning” chapter, however, namely:

- Solar retinopathy (363.24)
- Photokeratitis (370.24)
- Corneal disorder due to contact lens (371.82)
- Acoustic trauma (explosive) to ear (388.11)
- Maternal injury affecting foetus and newborn (760.5)

Berry and Harrison (2007) defined “community injury” using ICD-10-AM as S00-T75, T79. (Berry & Harrison, 2007) This includes trauma, burns, poisoning (S00-T75) and ‘certain early complications of trauma’ (T79). Harrison has stated that this is similar to the STIPDA ICD-9-CM specification, if one excludes not only medical injury but also sequelae, which they argue should be excluded since their stated aim was to estimate incidence of new cases in a period.

The US National Trauma Data Bank (NTDB) has an operational definition of injury as follows. There should be at least one of the following injury diagnostic codes defined using ICD-9-CM: 800–959.9, excluding the following isolated injuries:

- 905–909.9 (late effects of injury)
- 910–924.9 (superficial injuries, including blisters, contusions, abrasions, and insect bites)
- 930–939.9 (foreign bodies) (National Trauma Data Bank, 2009)

The cases captured by the NTDB are subject to other criteria outlined immediately below.

### **Case selection in trauma systems**

For the NTDB, as well as the operational definition of injury above, a record is captured for the NTDB if it is a:

- hospital admission as defined by the particular trauma registry inclusion criteria; or
- patient transfer via emergency medical system transport (including air ambulance) from one hospital to another hospital; or
- death resulting from the traumatic injury (independent of hospital admission or hospital transfer status). (National Trauma Data Bank, 2009)

Similarly, for the Trauma Audit & Research Network (TARN), in the UK, the inclusion criteria include patients of any age who sustain an injury resulting in:

- *“immediate admission to hospital for 3 days or longer,*
- *death,*
- *intensive or high dependency care,*
- *transfer between hospitals”.* (Bouamra, et al., 2006)

Excluded are patients over 65 with

- *“isolated fracture of the femoral neck or pubic ramus*
- *single uncomplicated limb injuries”.* (Bouamra, et al., 2006)

The Victorian State Trauma System has identified more extensive criteria for identifying major trauma. These are described as follows on their database:

*“The criteria were developed by the Victorian State Trauma Registry as broad-based inclusion criteria to ensure that data collection captures all major trauma patients in Victoria.*

*Inclusion criteria*

- 1 *Death after injury*
- 2 *Admission to an intensive care unit or high dependency area for more than 24 hours and mechanically ventilated after admission.*
- 3 *Significant injury to two or more Injury Severity Score (ISS) body regions or an ISS greater than 15.*
- 4 *Urgent surgery for intracranial, intrathoracic, or intra-abdominal injury, or for fixation of pelvic or spinal fractures.*
- 5 *Electrical injuries, drowning and asphyxia if admitted to an intensive care unit and receiving mechanical ventilation for longer than 24 hours.*
- 6 *All patients with injury as principal diagnosis whose length of stay is three days or more – unless they meet the exclusion criteria.*
- 7 *All patients with injury as principle diagnosis transferred or received from another hospital for further emergency care or admitted to a high dependency area - unless they meet the exclusion criteria.*

*The VSTR records details of trauma patients whose principle diagnosis is injury, irrespective of age, and who meet any of the above inclusion criteria.*

*Exclusion criteria*

- 1 *Isolated fractured neck of femur.*
- 2 *Isolated upper limb joint dislocation, shoulder girdle dislocation (unless associated with vascular compromise) and toe/foot/knee joint dislocation – unless meets inclusion criteria 1, 2 or 4.*
- 3 *Isolated closed limb fractures only (for example, fractured femur or Colles fracture) - unless meets inclusion criteria 1, 2 or 4.*
- 4 *Isolated injuries distal to the wrist and ankle only (for example, finger amputations) - unless meets inclusion criteria 1, 2 or 4.*
- 5 *Soft tissue injuries only (for example, tendon and nerve injury and uncomplicated skin injuries) unless meets inclusion criteria 1, 2 or 4.*
- 6 *Burns to less than 10 per cent of the body - unless meets inclusion criteria 1, 2 or 4.*
- 7 *Isolated eyeball injury.”*

<http://www.health.vic.gov.au/trauma/definition.htm>.

For our purposes, the trauma system / registry / database definitions are potentially problematic. For example, several elements are health services dependent (eg. length of stay of 3 days or longer, admission to an intensive care unit, inter-hospital transfer). It is our goal to minimize the impact of health service effects on our indicators, since these effects have been found to change over time. Consequently, inclusion of these elements would run counter to this goal. Furthermore, our non-fatal indicators do not, by definition, include deaths. Additionally, unlike some of these trauma databases, we include fractured neck of femur (and related fractures) to older people, since these are serious injuries with serious outcomes. (Bandolier, 1998) Finally, our severity threshold is based on the ICD-based Injury Severity Score (ICISS) rather than AIS (Stephenson, Henley, Harrison & Langley, 2004) (Committee on Injury Scaling - Association for the Advancement of Automotive Medicine, 1990) or ISS. (Baker, 1974)

The focus of this report is on the simple question of how to use the diagnosis and external cause of injury data, captured by the NMDS, to identify cases of injury that satisfy the NZIPS serious injury threshold. These other elements will not be considered further.

### **1.3 Aims**

The aims of this work were:

- To evaluate alternative case definitions of injury for the NZIPS serious non-fatal injury outcome indicators.
- To seek agreement from stakeholders on a common case definition of injury for the NZIPS serious non-fatal injury indicators applicable across all of the NZIPS Priority Areas.

### **1.4 Objectives**

The objectives of this work were:

1. To estimate the number of additional cases of serious non-fatal injury, for all injury and for each NZIPS Priority Area (separately), when (A) case selection is not constrained to the main cause of hospitalisation (principal diagnosis) being an injury diagnosis, or (B) relaxing the condition that classification of Priority Area is determined by the first E-code.
2. To describe the diagnoses and other features for any additional cases identified using alternative case definitions of injury.
3. To seek agreement between all stakeholders on a common case definition to be used across all NZIPS Priority Areas.

## 2 Methods

### 2.1 Overview

We found the number of cases, additional to the original case definition of serious non-fatal injury, using alternative definitions A, B and A+B. We then sought agreement amongst key stakeholders regarding a new definition of serious non-fatal injury that could be applied consistently across all Priority Areas. Alternative definitions investigated were: (A) relaxing the requirement for PDx on the NMDS to be an injury code, provided there is at least one injury diagnosis recorded on the record; and (B) to use all of the E-codes to define Priority Areas of Assault, Self-harm, Falls, and MVTCs. (Note that the remaining two Priority Areas are Drowning and Workplace injury. For the former, it is operationally defined by the *diagnosis* code for drowning, and for the latter it is operationally defined using ACC data.)

### 2.2 Detailed methods

#### Theoretical definition of injury

For this work, the theoretical definition of injury was that given in the WHO Injury Surveillance Guidelines. (Holder, et al., 2001) That is:

*“An injury is the physical damage that results when a human body is suddenly or briefly subjected to intolerable levels of energy. It can be a bodily lesion resulting from acute exposure to energy in amounts that exceed the threshold of physiological tolerance, or it can be an impairment of function resulting from a lack of one or more vital elements (ie. air, water, warmth), as in drowning, strangulation or freezing. The time between exposure to the energy and the appearance of the injury is short”. (p5)*

#### Original case definition of serious injury for the NZIPS indicators

##### Injury definition

For the reasons explained in a previous publication (Langley, Stephenson, Cryer & Borman, 2002), cases of injury are currently identified as those that had a PDx of injury, and are first admissions to hospital (hospital inpatients). (Re-admissions to hospital are excluded since we are interested in counting person-events only once, ie. incident cases. The method used for identifying readmissions has been described previously (Langley, Stephenson, Cryer & Borman, 2002)) We chose cases with a PDx of injury, since the PDx recorded on the hospital discharge record is the primary reason for hospital treatment. Any hospital admission is included if it satisfies the operational definition of a serious injury (see below). (Cryer, Langley & Stephenson, 2004)

The operational definition for the New Zealand indicators is based on the International Classification of Diseases 10<sup>th</sup> Revision (ICD-10) coding and classification system. (National Centre for Classification in Health, 2000) ICD-10 codes have been used in New Zealand (NZ) by the MoH and by hospital coders, since 2000, to code mortality and hospitalisation data. The following ICD-10 code ranges are currently used for the operational definition of an injury for the NZIPS non-fatal injury indicators: PDx within the range S00-T78 and first E-code within the range V01-Y36.

##### Serious non-fatal injury definition

The NZIPS non-fatal injury indicators are based on cases that were hospitalised with an ICD-based Injury Severity Score (Stephenson, Henley, Harrison & Langley, 2004) of less than or equal to 0.941 (ICISS<sub>≤</sub>0.941). This is equivalent to selecting those patients who, at

admission, have injuries that on average give the patient a survival probability of 94.1% or less. For NZ data, this has represented around 15% of all injury discharges. The justification for this threshold is included in the indicators development report to the NZIPS Secretariat. (Cryer, Langley & Stephenson, 2004) This severity threshold includes the majority of the following injuries: fracture of the neck of femur, intracranial (brain) injury (excluding concussion only injury), and injuries of the nerves and spinal cord at neck level. The full list of injuries that are included by this definition can be found in an appendix to the indicators development report. (Cryer, Langley & Stephenson, 2004)

### **Alternative case definitions to be investigated**

Two alternative case definitions were considered in this work: A) a case definition that relaxed the requirement for the PDx on the NMDS to be an injury code, provided there is at least one injury diagnosis recorded on the record; and B) one which used all of the E-codes recorded on the NMDS hospital discharge record to define the Priority Area, rather than just the first occurrence of the E-code.

#### **Alternative Definition A**

The current case definition for the NZIPS indicators requires the PDx to be an injury diagnosis in the ICD-10 range S00-T78, and the first E-code to be in the ICD-10 range V01-Y36. However, it has been argued that there is no reason to restrict the PDx to be an injury diagnosis, provided that there is at least one injury diagnosis recorded for the person, and provided the recorded injuries satisfy the severity threshold.

The proposed alternative case definition A was, therefore: at least one injury diagnosis present in the range S00-T78; a first E-code in the range V01-Y36; and  $ICISS \leq 0.941$ .

#### **Alternative Definition B**

There are some NMDS records that have more than one E-code recorded. (Anticipating the results of this work, there were 291 records with E-codes relating to 2 Priority Areas, and a further record with E-codes relating to 3 Priority Areas during 2001 to 2008. Using any E-code (not just the first) to classify priority area would result in a 1% increase in counts amongst the relevant Priority Areas.) The current NZIPS serious injury case definition requires cases to be classified to the NZIPS Priority Area on the basis of the first E-code on the NMDS record for the injured person. For example: as currently defined, a PDx of laceration of the wrist, with an first listed E-code of "self-harm" would be counted as a case of Self-harm injury. If the record also contained a second external cause code of "sexual assault by bodily force", the second external cause code would not contribute to the frequencies or rates of injury for any Priority Area.

This raised the question: If any E-code on the record was used to allocate a case to one or more Priority Areas, what effect would this change have on the frequency and nature of cases captured?

The proposed alternative case definition B was, therefore: any E-code in the range V01-Y36; PDx in the range S00-T78; and  $ICISS \leq 0.941$ .

**Operational definitions of the NZIPS Priority Areas**

Priority Areas were identified using ICD-10 codes as follows:

- Assault cases were identified as discharges with an E-code in the range X85-Y09,
- Self-harm cases were identified as discharges with an E-code in the range X60-X84,
- Falls cases were identified as discharges with an E-code in the range W00-W19,
- MVTC cases were identified as discharges with an E-code belonging to the list below:

V304-V309	V564-V569	V850-V853
V314-V319	V574-V579	V860-V863
V324-V329	V584-V589	V203-V209
V334-V339	V594-V599	V213-V219
V344-V349	V604-V609	V223-V229
V354-V359	V614-V619	V233-V239
V364-V369	V624-V629	V243-V249
V374-V379	V634-V639	V253-V259
V384-V389	V644-V649	V263-V269
V394-V399	V654-V659	V273-V279
V404-V409	V664-V669	V283-V289
V414-V419	V674-V679	V294-V299
V424-V429	V684-V689	V123-V129
V434-V439	V694-V699	V133-V139
V444-V449	V704-V709	V143-V149
V454-V459	V714-V719	V194-V196
V464-V469	V724-V729	V021-V029
V474-V479	V734-V739	V031-V039
V484-V489	V744-V749	V041-V049
V494-V499	V754-V759	V803-V805
V504-V509	V764-V769	V870-V878
V514-V519	V774-V779	V092
V524-V529	V784-V789	V811
V534-V539	V794-V799	V821
V544-V549	V830-V833	V892
V554-V559	V840-V843	

Drowning cases were identified as a PDx of T75.1 and first E-code within the range V01-Y36 excluding: X60-X84 (i.e., self-harm), X85-Y09 (i.e., assault), or Y35-Y36 (i.e., legal intervention and war).



Work-related injury cases were identified if they had a work-related ACC compensation claim (i.e., an ACC claim from Self-employed, Employers', or Residual accounts, with the "at work" flag set) that could be linked to the NMDS. This is in line with the chartbook operational definition of work-related injury. (Gulliver, Cryer & Davie, 2010)

### **Understanding the capture and prioritisation of external cause of injury codes**

As a preliminary step for the evaluation of alternative definition B, we needed to understand the process used in NZ to record and code multiple E-codes, and the appropriateness of choosing the first E-code rather than any E-code. This was investigated through discussions with MoH's Information Directorate and hospital coders (who populate the fields on the NMDS record).

### **Criteria used to assess alternatives**

The choice of case definition was based on face validity and acceptability. That is, we assessed (and presented to stakeholders) the nature of the cases that were captured using each of the definitions ("face validity"). We also asked the stakeholders to assess the acceptability of the proposed alternative definitions, using key examples of the additional cases selected using the two alternative case definitions ("acceptability").

### **Statistical analysis**

#### **Data sources**

The project used the NMDS of hospital discharges for the period 2001 to 2008 inclusive. The year 2000 was the first full year in which ICD-10 was used to code hospital diagnosis and external cause of injury. Allowing one year for the implementation of this ICD revision to "bed in" (given it represented a major change from ICD-9), we used 2001 as the first year in the time period considered. 2008 was the latest year for which the NMDS of hospitalisations was available when the analysis took place.

The IPRU purchases these data from the Ministry of Health annually, and has ethical approval to conduct research using these data for the purpose of monitoring injury at a national level.

ACC data for an equivalent period were also used for the identification of work-related injury cases. Following permission from ACC, the data supplied for the 2009 Chartbooks were used. (Gulliver, Cryer & Davie, 2010)

#### **Analysis**

The empirical component of this project involved estimating the frequency of injury using each case definition. Each case definition was applied to the NMDS for the years 2001 to 2008 for 'all injury', as well as for each of the NZIPS Priority Areas. Additional cases were identified by comparing cases selected using the alternative case definitions with those selected using the current NZIPS case definition.

For the additional cases identified using alternative definition A, the PDx (injury or non-injury) were tabulated (a) for all injury, and (b) for each Priority Area.

For alternative B, there was the possibility that an injury event could be classified to more than one Priority Area (eg. MVTC and Self-harm) through consideration of all E-codes on the record. This only applies to Assault, Self-harm, Falls, and MVTC, since Drowning is defined using a diagnosis code, and Work-related injury is defined from ACC data. Consequently, for these 4 Priority Areas, we tabulated cases that had E-codes belonging to

more than one Priority Area, eg. cross-tabulation showing the Priority Area as classified by the first E-code against Priority Area as classified by second E-code.

### Consultation with stakeholders

We needed to have “buy-in” from the NZIPS Priority Area lead organisations in order to maximize the likelihood that they would support the adoption of any alternative definition. A stakeholder group was formed comprising representatives from IPRU, NZIPS Secretariat, Statistics New Zealand (StatsNZ) Injury Information Manager (IIM), and each lead agency for the NZIPS Priority Areas, namely: ACC, Ministry of Justice (MoJ), Ministry of Social Development (MSD), Department of Labour (DoL), Ministry of Health (MoH), and Ministry of Transport (MoT).

There were two meetings of stakeholders. At the first meeting, preliminary results of the analyses investigating alternative definition A, along with case scenarios, were presented. Each case scenario presented an injured individual’s principal and associated diagnoses, along with E-code descriptions. Stakeholders were asked if they thought the case should be captured (or not) as an injury case, or if they would consider the case to fall within their Priority Area. The purpose of this was to start to develop a set of rules that were consistent with the choices that the stakeholders made.

At the second meeting, the results of the analyses investigating alternative definition B, along with case scenarios, were presented. The project team also presented the findings of the further analyses arising from stakeholder meeting 1, for discussion. At the second meeting, we sought agreement on which case definition to use for the NZIPS serious non-fatal indicators for future chartbooks.

Given that this was an exploratory project, consideration of the initial results, as well as discussions with stakeholders, resulted in the identification and execution of some further empirical investigation. The methods and results relating to any further work, proposed by stakeholders, are reported in the Results section.

### Consultation with key informants

Following the first stakeholder meeting, we consulted with key informants included on the International Collaborative Effort (ICE) on Injury Statistics list-serve. The ICE on Injury Statistics is one of several international activities sponsored by the Centers for Disease Control and Prevention's National Center for Health Statistics in the USA. The goal of the ICE on Injury Statistics is to provide a forum for international exchange and collaboration among injury researchers who develop and promote international standards in injury data collection and analysis. A secondary goal is to produce products of the highest quality to facilitate the comparability and improved quality of injury data.

The following message was sent in January 2010 to the ICE list-serve:

*“We (Colin Cryer, John Langley, Pauline Gulliver et al., University of Otago, New Zealand) are currently engaged in a project examining the case definition of serious non-fatal injury. Our “hypothesis” is that we are missing a material number of injury cases using our current definition, based on hospital inpatient data.*

*Current definition: Principal diagnosis (PDx) in the range S00-T78, ICISS≤0.941*

*Alternative defn: Any diagnosis in the range S00-T78, ICISS≤0.941.*

*The alternative definition will pick up people, for example, who self-harm, are seriously injured, but who are discharged from hospital with a PDx of a mental health condition. Applying this definition to the NZ Priority Areas and to all cause injury gives the following % additional cases:*

*Assault 2%*

*Self-Harm 17%*

*Work-related (non-MVTC) 2%*

*Falls 8%*

*MVTC 1%*

*All cause 7%*

*Are you using a case definition of serious injury similar to this, eg. the injury definition just based on the presence of an external cause code?*

*Do you have any arguments against the use of this expanded definition of serious injury?*

*We would be extremely pleased to hear your views.”*

### 3 Results

#### 3.1 Original NZIPS case definition

##### Statistical analysis

69,993 first admission discharge events were identified as injuries using the current NZIPS case definition. The distribution of these events across Priority Areas is shown in Table 1.

#### 3.2 Case definition A

Alternative definition A was: at least one injury diagnosis (not necessarily the PDx) present in the range S00-T78; a first E-code in the range V01-Y36; and ICISS $\leq$ 0.941.

##### Statistical analysis

Table 1 shows the number of events identified using the current definition together with additional cases identified using the new definition A. Note, this only uses the first listed external cause of injury code to classify NZIPS Priority Area (except for Drowning, classified using principal diagnosis, and Work-related, identified using ACC data).

There were 4,704 additional cases identified when using new case definition A, an increase of 7%. The results indicate that an alternative case definition of serious non-fatal injury could affect the magnitude of the NZIPS serious non-fatal injury indicators, particularly for Self-harm, where the new definition identified 17% more cases. For Falls there was also a material number of additional cases identified (8%).

**Table 1**

**Serious non-fatal events identified as injury using the current NZIPS case definition and the new case definition A – 2001 to 2008.**

NZIPS Priority Areas	Current NZIPS	Additional using definition A	Additional %	Total
Assault	6,379	133	2	6,512
Self-harm	1,594	277	17	1,871
Drowning	86	0	0	86
Falls	34,827	2,646	8	37,473
MVTC	13,335	191	1	13,526
Work-related	3,445	84	2	3,529
<b>All injury(1)</b>	<b>69,993</b>	<b>4,704</b>	<b>7</b>	<b>74,697</b>

(1) Some discharge events do not belong to any Priority Area, and others belong to multiple Priority Areas. As a result, the columns in the table do not add to the 'All injury' total.

Source: MoH NMDS 2001 to 2008.

## Exploratory analysis

Table 2 shows the principal diagnosis for the 4,704 additional cases identified using the new definition A. PDx is summarized by ICD-10 chapter for all additional cases and for each of the Priority Areas separately.

**Table 2**  
**The principal diagnosis of additional cases identified using new case definition A, by Priority Area, 2001-2008 – Percentages.**

ICD-10 diagnosis chapters	All Injury (1)	Assault	Self-harm	Falls	MVTC	Drowning	Work-related
Infections	1	2	0	1	1	0	0
Neoplasms	2	2	0	3	0	0	1
Blood / immune	1	2	0	1	0	0	0
Endocrine / metabolic	4	2	1	3	2	0	5
Mental & behavioural	14	25	88	7	5	0	10
Nervous system	5	4	2	6	4	0	8
Eye & adnexa	0	4	0	0	1	0	0
Ear & mastoid process	0	0	0	0	0	0	0
Circulatory	17	5	2	20	17	0	11
Respiratory	8	7	1	8	5	0	5
Digestive	4	4	1	4	1	0	2
Skin	6	4	2	2	4	0	25
Musculoskeletal	4	2	0	4	8	0	5
Genitourinary	3	2	0	3	2	0	0
Pregnancy / childbirth	1	17	0	0	2	0	0
Perinatal	0	1	0	0	0	0	0
Congenital malf.	0	1	0	0	0	0	0
Abnormal findings	12	14	1	14	13	0	12
Injury	1	2	0	1	6	0	6
Health status / service factors	17	6	1	22	30	0	11
<b>Total (%)</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>0</b>	<b>100</b>
<b>Total (n)</b>	<b>4,704</b>	<b>133</b>	<b>277</b>	<b>2,646</b>	<b>191</b>	<b>0</b>	<b>84</b>

(1) Some discharge events do not belong to any Priority Area, and others belong to multiple Priority Areas. As a result, the rows in the table do not sum to the 'All injury' total.

Source: MoH NMDS 2001 to 2008.

Key features of the PDx of the additional cases shown in this table were as follows:

**Assault:** There were relatively few additional Assault cases. The highest proportions of the cases were Mental and behavioural disorders, Conditions during pregnancy and childbirth, and Abnormal findings signs and symptoms.

**Self-harm:** Almost all additional Self-harm cases were Mental and behavioural disorders.

**Falls:** The PDx's were distributed across a wide range of diagnoses; the biggest groups were diseases of the Circulatory system, Abnormal findings signs and symptoms, and Factors influencing health status.

**MVTC:** There were relatively few additional cases of MVTCs. The highest proportions of the cases were diseases of the Circulatory system, Abnormal findings signs and symptoms, and Factors influencing health status.

**Work-related:** There were relatively few additional Work-related cases. The highest proportion of the additional cases were diagnoses involving Skin and subcutaneous tissue. Other, but less prevalent, categories were Abnormal findings signs and symptoms, Circulatory problems, Factors affecting health status, and Mental and behavioural disorders.

Note: There were a small number of cases with PDx code in the Injury and poisoning chapter. The PDx of these cases were out of the range considered for a case using the current NZIPS indicators definition (ie. outside the ICD-10 code range S00-T78). These cases related to complications of trauma, complications of surgical and medical care, and sequelae of injuries.

### Case Scenarios

Case scenarios were generated and were included in the pre-meeting report for the first stakeholder meeting. These were used to provoke discussion at the stakeholder meeting.

Example case scenario:

The case was a 0-4 year old. PDx of “Cervicalgia” (disorder of the musculo-skeletal system). The circumstances were described as a fall from or out of a building. Additional diagnoses included fracture of the vault of the skull and fracture of the base of the skull.

### 3.3 Consultation with key informants

We had responses to our request for views from the ICE members from the following:

- Dr J Lee Annest, National Center for Injury Prevention and Control, CDC, Atlanta, Georgia, USA;
- Professor James Harrison, National Injury Surveillance Unit, Flinders University, Australia;
- Dr Jens Lauritsen, Institute of Public Health, University of Southern Denmark;
- Dr Ted Miller, Pacific Institute for Research and Evaluation, Maryland, USA;
- Dr Yvonne Robataille, National Institute of Public Health of Quebec, Canada;
- Dr Margaret Warner, National Center for Health Statistics, CDC, Hyattsville, Maryland, USA.

The key points from the interchange with these ICE members were: general support for the approach to define “serious non-fatal injury” using both principal and additional diagnoses (provided  $ICISS \leq 0.941$ ); and restrict the number of additional diagnoses used from a hospital record if the average number of diagnoses captured over time has increased. Given there has been only a small increase (a median of 3.2 additional diagnoses in 2001 to 3.5 additional diagnoses in 2007), the relevance of the last point was reduced.

### 3.4 Case definition B

The proposed alternative case definition B was: any E-code in the range V01-Y36; PDx in the range S00-T78; and  $ICISS \leq 0.941$ . That is, all relevant E-codes were used to classify a case to an NZIPS Priority Area, leading to the possibility of discharge records being counted in more than one NZIPS Priority Area.

### Statistical analysis

Table 3 shows the number of discharge events identified in each NZIPS Priority Area by the new case definition B, in comparison with the numbers identified by the current NZIPS definition.

**Table 3**  
**Serious non-fatal events identified as injury using the current NZIPS case definition and the new case definition B – 2001 to 2008.**

NZIPS Priority Areas	Current NZIPS	Additional using definition B	Additional %	Total
Assault	6,379	129	2	6,508
Self-harm	1,594	70	4	1,664
Drowning	86	27	31	113
Falls	34,827	480	1	35,307
MVTC	13,335	111	1	13,446
Work-related	3,445	4	0	3,449
<b>All injury (1)</b>	<b>69,993</b>	<b>145</b>	<b>0</b>	<b>70,138</b>

(1) Some discharge events do not belong to any Priority Area, and others belong to multiple Priority Areas. As a result, the columns in the table do not sum to the 'All injury' total.

Source: MoH NMDS 2001 to 2008.

Note that, even though Drowning and Work-related injury are defined using diagnosis codes and ACC data respectively, additional cases have been identified as a result of relaxing the case definition of injury to include any E-code (first or subsequent) in the range V01-Y36.

Of the 70,138 discharge records that were identified as injuries using this definition, 1,820 (2.6%) were assigned to multiple Priority Areas. Amongst the Priority Areas defined by E-code (namely Assault, Self-harm, Falls and MVTC), during 2001 to 2008, 291 were assigned to two Priority Areas and one discharge record to three. This is an additional 1% of counts across those Priority Areas.

Relaxing the requirement, within the case definition, for the Priority Area to be defined using solely the first E-code, only resulted in an additional 480 falls cases (1% increase), 129 assaults (2% increase), 111 MVTCs (1% increase) and 70 self-harm cases (4% increase).

### Exploratory analysis

Amongst the records assigned to two Priority Areas (defined by E-code), the combinations of Priority Areas are presented in Table 4.

**Table 4**  
**Combinations of Priority Areas for cases, using alternative definition B – 2001 to 2008.**

NZIPS Priority Areas(1)	Assault	Self-harm	Falls	MVTC
Assault	-	9	49	9
Self-harm	20	-	34	5
Falls	27	10	-	12
MVTC	27	12	74	-
None	3	3	0	0

(1) Rows present Priority Area defined by the first E-code. Columns present the additional Priority Area identified if using alternative definition B. This is restricted to Priority Areas Assault, Self-harm, Falls and MVTC, since Drowning is defined by diagnosis code, and Work-related from ACC data.

Source: MoH NMDS 2001 to 2008.

One person would be counted in 3 Priority Areas, excluding Drowning and Work-related, using alternative definition B; namely, Assault, Self-harm, and Falls.

## Case Scenarios

A sample of case scenarios were generated for each non-zero cell of Table 4 and were included in the pre-meeting report for the second stakeholder meeting. These were used to provoke discussion at the stakeholder meeting.

Example case scenario:

The PDx for this case was a fracture of the vault of the skull. Multiple additional open wounds and abrasions were also listed. The first external cause code was 'assault by bodily force by unknown person'. There were an additional four external cause codes relating to the detail of the assault (providing information on the method of the assault). There was also a self harm external cause code listed (intentional self poisoning) and a related diagnosis of 'toxic effect of unspecified substance', which occurred on the same day as the assault.

## 3.5 Understanding the capture and prioritisation of the external cause of injury codes

We investigated whether there were ICD-10 coding rules or national conventions concerning how additional external cause codes were recorded. For example, were there rules that determined which external cause code was listed first? It was also important to determine, if a hierarchy existed, whether this was consistently implemented throughout the country.

In order to develop an understanding of the coding rules and conventions for external cause of injury coding, we interviewed four clinical coders from around the country. Two of these represented hospitals in two metropolitan areas, one was responsible for coding in rural areas (where there may not be access to electronic coding facilities), and one MoH coder who was responsible for clinical coders throughout the country.

The following is a summary of discussions with the coders.

### Prioritisation of external cause coding

According to the coders interviewed, the first listed external cause code should be the cause of the injury that was the principal reason for the person's stay in hospital. There must be at least 1 external cause and 2 related codes recorded for each injury event. The external cause code gives the reason that the injury occurred, and the 2 related codes give the location where the injury event took place, and the activity being undertaken at the time of the injury event (i.e. was the person injured at home, were they involved with sports)<sup>4</sup>. For the purposes of this report, the latter two related codes are referred to as 'Location' and 'Activity' codes and were not considered as **external cause** codes.

Although not encouraged by the team at the Information Directorate of the Ministry of Health, more than one external cause code may be used to provide more complete detail about the injury event. The MoH coder expected that the code that best described the event that resulted in the injury would be recorded first.

### Consistency of application of the convention

Hospital coders sometimes assigned more than one external cause code to provide a more complete picture of the event leading up to the injury.

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<sup>4</sup>Separate fields are created for the location and activity codes by IPRU data managers. This prevents these codes being counted as external cause codes and allows for ease of analysis.



The Australian Modification of the ICD-10 (ICD-10-AM) coding scheme changes regularly to allow more specific injury events to be coded (i.e. “fall from a trampoline”). New Zealand has recently moved from the 3<sup>rd</sup> to the 6<sup>th</sup> version of ICD-10-AM. Although this does not affect the ‘big picture’ when injuries are grouped according to NZIPS Priority Areas, it may reduce the requirement to record more than one external cause code as the addition of new codes may provide a more accurate picture of how the injury occurred.

It was reported that there were no national routine audits of external cause data – aimed at ensuring consistency regarding what was recorded. Individual DHBs were (and still are) responsible for organizing their own audits. These occur at different intervals, depending on the resources available. For example, one DHB conducted annual audits, while another had not had an audit for over two years.

External cause codes do not contribute to cost weights<sup>5</sup> and so this would not impact on external cause coding practices.

### **Rural hospitals**

There were a number of rural hospitals in NZ that sent a hard-copy of the discharge summary to the Information Directorate at the MoH for coding purposes. These hospitals, generally, did not have access to computer programs that allowed electronic recording of the patient records. The data submitted from these hospitals were included in the NMDS.

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<sup>5</sup> Cost weights are used both to measure volume and to calculate prices for specified inpatient purchase units defined in the Data Dictionary of the National Service Framework. Such weights are intended to reflect the relative resource consumption between diagnosis-related groups (DRGs). (Ministry of Health, National Service Framework Project Report of the Cost Weights Project Group, 23 March 2001)

## 3.6 Stakeholder meetings

### Meeting 1

Present at the first stakeholder meeting were: Pauline Gulliver (IPRU), Ingrid Jaegers (IIM), Sarah Johnson (IIM), Lorna Bunt (ACC), Craig Wright (MoH), Nick Matsas (DoL), Anne Hawker (MSD), Harry Kent (MoJ), and Wayne Jones (MoT).

The first 25 minutes of the three hour meeting included introductions and a presentation which briefly covered the report circulated prior to the meeting. The remaining time involved discussion of the case scenarios presented. There was a high level of engagement.

There was active discussion of seven case scenarios. The general consensus was that, for selected cases, it was difficult to determine if the diagnoses listed all referred to the same event. For example, one case scenario discussed was that of an older person who had been assigned a PDx of "Rheumatic fever with cardiac involvement" at discharge from hospital. Additional diagnoses included concussion and traumatic subarachnoid haemorrhage, and an external cause code of unspecified fall. These appear to consist of an underlying chronic condition (rheumatic fever) alongside a recent traumatic event. Rheumatic fever was judged by the hospital to be the PDx – ie. the diagnosis established after study at discharge to be chiefly responsible for occasioning the patient's episode of care in hospital.

It was also identified that, for some records, Z-codes (supplementary conditions influencing health status) had been used as the PDx. Z-codes can be used as PDx, but they mark particular types of episodes of care. For example, if a patient is admitted to hospital for the purposes of rehabilitation from a prior injury, the PDx should be Z50. (National Centre for Classification in Health, 2000) This code is then followed by the diagnosis and E-code of the original injury event – that resulted in the need for rehabilitation.

As a result of the stakeholder discussions, the following additional areas of investigation were identified:

1. Look at the proximity of the date of injury to the date of admission.
2. Investigate the impact of dropping Z-codes as a principal diagnosis.
3. Investigate the number of injury dates listed for each hospital admission.
4. Test the assumption that the principal diagnosis, when it is not an injury, is related to the injury diagnoses listed.

## Further work - Methods

### ***Proximity of date of injury to date of admission***

For those ‘additional’ cases, under definitions A and B combined, with only one injury listed, the number of days between the date of injury and the date of admission were calculated and tabulated.

### ***Identifying ‘additional’ cases with a ‘Z’ code principal diagnosis***

The “additional cases”, when applying alternative definition A, with a PDx=Z-code were separated from other ‘additional’ diagnoses and tabulated.

### ***The number of injury dates listed for each hospital admission***

There was some debate during the first stakeholder meeting about whether the information contained within a hospital discharge event related to only one, or more than one, injury event. In order to understand the impact of multiple injury events when trying to interpret a case scenario, it was recommended that we investigate the number of injury dates recorded<sup>6</sup> per hospital discharge record. For first admissions only (i.e. readmissions for the same injury were excluded), the number of injury dates per hospital admission were calculated and tabulated.

### ***Testing the assumption that the principal diagnosis (if it is not injury) is related to the injury diagnosis.***

The research group discussed the possibility of testing the assumption that the non-injury PDx is related to the injury diagnoses listed. In order to test this assumption, it would be necessary to conduct a detailed review of a random selection of case notes. Without the resources to conduct such a detailed investigation, this action could not be pursued.

However, the coding guidelines for ICD-10 state:

*“In addition to the main condition, the record should, whenever possible, also list separately other conditions or problems dealt with during the episode of health care. Other conditions are defined as **those conditions that co-exist or develop during the episode of health care and affect the management of the patient.** Conditions related to an earlier episode that have no bearing on the current episode should not be recorded”.*

Consequently, it is possible that an injury diagnosis may not relate to the principal diagnosis, but may have an impact on patient management and be recorded on the patient record. For example, in the case of a patient admitted with a diagnosis related to a circulatory problem who had a historical injury of a fractured neck of the femur (FNOF), it is possible that the FNOF would be listed because this may reduce mobility, heightening the risk of a blood clot. However, in this case we would not be interested in the serious non-fatal injury (FNOF), as it is likely that it would have been previously recorded when the original injury occurred. Data linkage is used to remove readmissions, and so, if the FNOF case had been previously admitted, it would be screened out as a readmission.

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<sup>6</sup> For each hospital discharge event, cases have a list of diagnosis, procedural and external cause codes. Each external cause code is listed after the diagnosis to which it relates, and must have an associated date of injury field. For the purposes of this analysis, we assumed that where there was more than one date of injury, this related to a separate injury event. It is possible, however, that additional injury dates were due to typographical errors.

## Results of further work

### ***Proximity of date of injury to date of admission***

Table 5 shows the proximity of the injury date to the date of admission, as recorded in the NMDS, for 'additional' cases only - under definitions A and B combined, with only one injury-event listed. This analysis has been conducted for first admissions only. Just over 50% of 'additional' serious non-fatal injury events were admitted on the day of the injury. A further 5% were injured the day before they were admitted to hospital. There were 21% of 'additional' serious non-fatal injury events that occurred after hospital admission, and 9% over 2 weeks before admission.

**Table 5**

**Proximity of injury date to date of admission ('additional' cases only) – 2001 to 2008.**

Injury date	Frequency	%
After admission	1,101	21
On day of admission	2,724	52
1 day before admission	278	5
2	125	2
3	92	2
4	76	1
5-9	209	4
10-14 days before admission	139	3
>2 weeks before admission	481	9
Missing	22	0
Total	5,247	100

Source: MoH NMDS 2001 to 2008

**Identifying ‘additional’ cases where the principal diagnosis is a Z-code**

Where the recorded PDx is a Z-code, if we ignore the recorded PDx and take the next diagnosis as the principal diagnosis, then in such instances the additional number of cases identified using the original definition is shown in Table 6. It is apparent from Table 6 that the Z-codes impact more on some Priority Areas than others. For example, between 2001 and 2008, 73% (584/802) of the records with PDx=Z-code are Falls, and 7% (57/802) are MVTCs. 22% (584/2646) of the “additional cases” using alternative definition A, in the ‘Falls’ Priority Area, had a Z-code as the principal diagnosis, and 30% (57/191) of the “additional cases” in the MVTC Priority Area had a Z-code as the PDx.

**Table 6: Serious non-fatal events identified as injury using the current NZIPS case definition and the new case definition A – 2001 to 2008.**

NZIPS Priority Areas	Current NZIPS	Additional cases that had a PDx Z-code	Remaining additional cases using definition A	Total additional	
				n	% Z-codes
Assault	6,379	8	125	133	6
Self-harm	1,594	4	273	277	1
Drowning	86	0	0	0	0
Falls	34,827	584	2,062	2,646	22
MVTC	13,335	57	134	191	30
Work-related	3,445	9	75	84	11
<b>All injury</b>	<b>69,993</b>	<b>802</b>	<b>3,902</b>	<b>4,704</b>	<b>17</b>

(1) Some discharge events do not belong to any Priority Area, and others belong to multiple Priority Areas. As a result, the columns in the table do not add to the ‘All injury’ total.

Source: MoH NMDS 2001 to 2008

**The number of injury dates per hospital discharge.**

Table 7 shows that the majority of serious non-fatal injury events that required hospitalisation, using the alternative case definition A and B combined, had only one injury date. There was a larger proportion of “additional cases” that had more than one injury date listed – see last line of Table 7.

**Table 7  
Number of injury dates per serious non-fatal injury hospital event – 2001 to 2008.**

No. of injury dates	Case definition A and B combined (all)	Case definition A and B combined (additional)
0	180	18
1	70,450	4,549
2	4,235	577
3	322	77
4	40	17
5	10	7
6	2	2
7	1	0
<b>Total</b>	<b>75,240</b>	<b>5,247</b>
<b>% with multiple</b>	<b>6</b>	<b>13</b>

Source: MoH NMDS 2001 to 2008

## Meeting 2

Present at the second stakeholder meeting were: Colin Cryer (IPRU), Pauline Gulliver (IPRU), Conal Smith (IIM – part of the meeting only), Sarah Johnson (IIM), Barbara Lash (IIM), John Wren (NZIPS/ACC), Lorna Bunt (ACC), Nick Matsas (DoL), and Anne Hawker (MSD).

The pre-meeting notes provided the following for discussion:

- The methods and results used to investigate the questions identified in the first stakeholder meeting (see above);
- The methods and results relating to our investigation of the additional cases identified under alternative case definition B;
- A sample of case descriptions relating to the additional cases identified under alternative case definition B;
- Methods and results relating to our investigation of the rules and conventions used when external cause coding (see section 3.5 above);
- Questions for discussion.

Those questions were as follows:

- “With almost 12% of ‘additional’ serious non-fatal injury events having more than one injury date recorded, should we be trying to identify the first listed diagnosis for the additional injury events associated with these injury dates? This question assumes that more than one injury date means that there is more than one injury event.
- Given the lack of encouragement for coding more than one external cause code to describe the injury event, should we retain our limit of using only the first listed external cause code for each injury?”

Also, as a starting point for discussion, the following alternative operational definition for serious non-fatal injury was provided in the pre-meeting report:

- “At least one injury diagnosis present in the range S00-T78
- A first listed external cause code in the range V01-Y36
- $ICISS \leq 0.941$
- Injury event date no more than 2 days before admission (but with no restriction if the principal diagnosis is an injury in the range S00-T78).”

As a result of the stakeholder discussions at this second meeting, the following definition was agreed by the stakeholder group:

- A person-event is identified as an E-code in the range V01-Y36 following one or more injury diagnoses (eg. DDDE, where D designates a diagnosis code, and E designates an E-code). Multiple E-codes will be ignored if the second or subsequent E-code directly follows an E-code (eg. DDDEE). More than one person-event can be identified on the same record by diagnosis-E-code sequences (eg. two person-events if DDEDDDE).
- Identify a person-event as a serious non-fatal injury if the PDx **or** ADx is in the range S00-T75, T78.8, T79 (based on STIPDA recommendations – see page 10) (Injury Surveillance Workgroup, 2003), and  $ICISS \leq 0.941$  - where ICISS is calculated for each person-event. (For example, if  $D_1D_2D_3E_1D_4D_5E_2$ ,  $ICISS[1]$  is calculated from  $D_1D_2D_3$ , and  $ICISS[2]$  from  $D_4D_5$ ). Additionally, the Priority Area is identified by the first occurrence of an E-code for a given person-event. It was agreed to place no restriction on the number of injury diagnoses considered on each record.

It was agreed that there was a need for further investigations, relating to this agreed definition, namely:

- Investigate those injuries that occurred at least 2 weeks before admission.
- Can we identify additional diagnoses that are injuries that have been previously admitted, and that only appear as additional diagnoses because they affect the treatment relating to the primary diagnosis? What is the size of this problem? Do they appear on the record without an E-code?
- Check to see if any first admission records include the same diagnosis repeated more than once.

Finally, the following recommendations were made by the meeting:

*Counting person-events in more than one NZIPS Priority Area:* For a given person-event, only one Priority Area can be assigned, in all cases except for work-related events. It was recommended that this be highlighted in the chartbooks, including the size of the “double counting” by Priority Area.

*Implementation:* For any recommended change in the case definition, there should be parallel implementation – ie. for a few years, chart trends should be shown with both the original case definition and the new case definition.

#### **Further work - Methods**

##### ***Investigate those injuries that occurred at least 2 weeks before admission***

The concern was that, for serious injury cases, where “serious” is defined with a goal of identifying injuries that one would expect to be admitted, it seems unusual for the admission of such injuries to be delayed by 2 weeks or more.

We selected records with an admission date 2 weeks or more after the injury date. From a visual inspection of these NMDS records, it became obvious that a number of these were rehabilitation admissions or late effects resulting from a previous injury or hospital procedure. The question we investigated was reformulated to:

*Amongst the injuries that occurred at least 2 weeks before admission, have we counted the original serious non-fatal events before?*

For records with the admission date more than 2 weeks after the injury date, we searched the morbidity datasets (2001-2008) to see if we could identify a hospital discharge event with the same NHI and injury date. We looked for exactly the same date (i.e. without deviations – note: deviations are allowed under probabilistic linkage).

The ‘eventids’ of cases fulfilling these criteria were retained. We then endeavored to match these eventids to the morbidity dataset that was used in the creation of the Chartbooks. Those eventids that matched represented cases that had already been counted as part of the Chartbooks (i.e. they are **not** 'additional' cases).

##### ***Can we identify additional diagnoses that are injuries that have been previously admitted, and that only appear as additional diagnoses because they affect the treatment relating to the primary diagnosis?***

We reviewed a sample of 100 records for which there was multiple external cause coding. We assessed whether the clinical data on the record was sufficient to permit the identification of historical injuries, only included on the record because they affect the treatment relating to the PDx.

***Check to see if any first admission records include the same diagnosis repeated more than once.***

We reviewed the same sample of 100 records for which there was multiple external cause coding, and estimated the proportion of records that had the same diagnosis code recorded multiple times.

#### **Further work - Results**

***Investigate those injuries that occurred at least 2 weeks before admission***

Of the records that had an injury date over 2 weeks before the admission date, 29% were identified in the Chartbook dataset. It can be inferred that these include cases that were sequelae or complications of a previous injury, and had already been counted using hospital discharges at a time closer to the injury event.

***Can we identify additional diagnoses that are injuries that have been previously admitted, and that only appear as additional diagnoses because they affect the treatment relating to the primary diagnosis?***

Out of the 100 records inspected, there were 3 where we could unequivocally identify that the injuries, associated with the second person-event on the record, were historical injuries. There were uncertainties for several other records due to the limited information captured on the NMDS record.

As an incidental finding, it was clear from the examination of the 100 records that the validity of using sequences of diagnosis and E-codes to identify person-events should be investigated in further research since, in approximately a third of the sequences examined, there were uncertainties regarding the number and / or nature of the second or subsequent person-events shown on the discharge record.

***Check to see if any first admission records include the same diagnosis repeated more than once.***

From our sample, there was no evidence that the same diagnosis code was used multiple times on any record.



## 4 Discussion

### Principal findings

Relaxing the requirement, within the case definition, for the PDx to be an injury – provided the external cause code was in the range V01-Y36 and  $ICISS \leq 0.941$ , alternative definition A resulted in 7% (n=4,704) more serious non-fatal injury cases in the period 2001 to 2008. This was mainly due to the increased number of Falls cases ascertained (8%; n=2,646), as well as additional Self-harm cases (17%; n=277). Seventeen percent (n=802) of these 4,704 additional cases had Z-codes coded as the principal diagnosis. This was mainly for the Falls and for the MVTC Priority Areas.

From those members of the International Collaborative Effort on Injury Statistics who responded to a request for input regarding a possible change to alternative case definition A (ie. relaxing the requirement for the PDx to be an injury, provided at least one additional diagnosis is an injury, and  $ICISS \leq 0.941$ ), there was general support for this change.

Relaxing the requirement, within the case definition, for the Priority Area to be defined solely using the first E-code (alternative definition B) resulted in 480 additional Falls cases (1% increase), 129 additional Assaults (2% increase), 111 additional MVTCs (1% increase) and 70 additional Self-harm cases (4% increase). However, use of multiple E-codes for a given person-injury event is discouraged by the MoH. Some District Health Boards comply with this, others do not - thus, there is inconsistency across the country.

For the additional cases that we found, 52% were admitted on the day of the injury, 7% in the 2 days after the injury, 10% 3-14 days after the injury, and 21% after admission. Nine percent were admitted over 2 weeks after the injury event.

Having excluded readmissions, 6% of cases –under alternative definitions A and B combined - had more than one injury date listed on the record.

At the final stakeholder meeting the following was agreed.

- That a person-event can be identified as an E-code following one or more diagnoses (eg. DDDE). Multiple E-codes will be ignored if the second or subsequent E-code directly follows an E-code (eg. DDDEE). Multiple person-events can be identified on the same record by diagnosis-E-code sequences (eg. two person-events if DDDEDDE).
- They further agreed to identifying a person-event as a serious non-fatal injury if the principal **or** any additional diagnosis is in the range S00-T75, T78.8, T79 and  $ICISS \leq 0.941$  - where  $ICISS$  is calculated for each person-event. (For example, if  $D_1D_2D_3E_1D_4D_5E_2$ ,  $ICISS[1]$  is calculated from  $D_1D_2D_3$ , and  $ICISS[2]$  from  $D_4D_5$ ). Additionally, the Priority Area should be identified by the first listed E-code for a given person-event.

On further investigation, it was clear from the examination of the 100 records that the validity of using sequences of diagnosis and E-codes to identify person-events should be investigated in further research since, in approximately a third of the sequences examined, there were uncertainties regarding the number and / or nature of the person-events shown on the discharge record.

### What the results mean

The current case definition fails to count a material number of serious non-fatal injury cases that are of interest to the injury prevention community. There is a need, therefore, to use an alternative case definition.

Both the stakeholders and the international injury statistics community consulted agreed to the relaxation of the need for the principal diagnosis to be an injury code, provided that at least one ADx is an injury code within the stated range, the first external cause code is in the range V01-Y36, and ICISS $\leq$ 0.941. This relaxation alone would result in a 7% increase in the number of serious non-fatal injury cases ascertained overall, with a 17% increase in the number of Self-harm serious injury cases, and 8% increase in the number of Falls cases.

The results show that, in some instances, there are multiple injury events captured on the inpatient record. In some instances, these additional events occurred in hospital. For example, an older person had a MVTC and sustained serious head injuries. Whilst treated in hospital, they fell whilst moving around the ward and sustained a hip fracture. Cases having an injury date after the date of admission include injury events occurring in hospital.

The MoH discourage the use of multiple E-codes for a given person-event. The inconsistent use of multiple E-codes across the country suggests that the current policy of just taking the first E-code to classify Priority Area is sensible.

The E-code is coded immediately after the diagnosis codes to which it relates. It may be possible to use the sequence of diagnosis and E-codes on a record to identify multiple events. For example, the sequence of diagnosis and E-codes on the record DDDEE represents one person-event with multiple E-codes (where 'D' represents a diagnosis code and 'E' an E-code). For example:

- D1=Focal cerebral haematoma.
- D2=Loss of consciousness of unspecified duration.
- D3=Open wound of the scalp.
- E1=Assault by blunt object.
- E2=Fall on the same level.

Whereas, DDEDE potentially represents two person-events (DDE & DE), each with one E-code. For example:

- D1=Laceration of liver.
- D2=Laceration of kidney.
- E1=Car occupant injured in collision with another vehicle.
- D3=Contusion of eyelid and periocular area.
- E2=Assault by bodily force, partner.

Stakeholders agreed that multiple person-events should be counted in this way, if it is feasible to do so. The validity of this definition should be investigated, along with the feasibility of applying this definition operationally. If the number of unique injury dates per record can be used to estimate the number of person-events, the results indicate that this would result in an estimated 6% more cases being identified.

## Strengths and weaknesses of the study

### Strengths

One strength of this work is the systematic nature of the investigation. A further strength lies in the mixed methods used: statistical analysis, examination of cases scenarios, and the involvement of stakeholders and the international injury statistics community in considering alternative case definitions. The stakeholders were crucial to the project in agreeing a case definition that could be the basis for the modification of the specifications of the NZIPS indicators. Without agreement amongst stakeholders, future changes to the case definition would be much more difficult.

## Weaknesses

Any case definition will result in some cases being counted when they should not. Take the hypothetical example of a person with an NMDS principal diagnosis of non-injury, and the additional diagnosis of an injury with an accompanying E-code. If the injury is an old one, recorded because its presence affects treatment of the principal problem, and if this old injury had been counted before, then it could result in multiple counting of the same person-injury event. However, the use of an algorithm to remove readmissions for a given injury (which is current practice) should minimize this problem.

## Recommendations

- 1 Changed case definition: It is recommended that the change to alternative definition 'A' be adopted by NZIPS, and the NZIPS indicator specifications be changed as soon as possible.
- 2 Person-events: The decision relating to the counting of person-events, as stated in 'What the results mean' above, should be investigated for its validity, as well as the feasibility of its implementation.
- 3 Adoption: If found to be valid and feasible, it should be adopted by NZIPS.
- 4 Counting person-events in more than one NZIPS Priority Area: Under the current NZIPS case definition of serious non-fatal injury, only one Priority Area is assigned in all cases except for work-related events. For example, a fall at work is currently counted both in Priority Areas 'Falls' and 'Work-related injury'. It is recommended that this should be highlighted in future Chartbooks, including the size of the "double counting" across Priority Areas.
- 5 Implementation: If the recommended change to the NZIPS case definition is made, there should be parallel implementation – eg. for 5 years, chart trends within the NZIPS Chartbooks should be shown with both the original case definition and the new case definition (or the new case definition in the body of the report with the original case definition as a hyper-linked appendix).

## 5. Conclusions

The current NZIPS case definition misses a material number of serious non-fatal injury cases that are of interest to the stakeholder community. Therefore, there is a need to use an alternative case definition. There is evidence to support the adoption of alternative definition A<sup>7</sup>, but not alternative definition B<sup>8</sup>.

Additionally, the attendees at the second stakeholder meeting agreed a case definition that potentially counted more than one person-event from the same record. Before adoption, further work is required to investigate the validity and feasibility of counting person-events in the manner proposed by the stakeholder group.

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<sup>7</sup> Alternative definition A: at least one injury diagnosis present in the range S00-T78; a first external cause code in the range V01-Y36; and ICISS $\leq$ 0.941.

<sup>8</sup> Alternative definition B: The current NZIPS serious injury case definition requires cases to be classified to the NZIPS Priority Area on the basis of the first E-code on the NMDS record for the injured person. The question was: can any E-code on the record be used to allocate a case to one or more Priority Areas? The proposed alternative case definition B was: any external cause code in the range V01-Y36; principal diagnosis in the range S00-T78; and ICISS $\leq$ 0.941.

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