Improving the coding and classification of ambulance data through the application of International Classification of Disease 10th revision

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Abstract

Objectives. This paper aims to examine whether an adaptation of the International Classification of Disease (ICD) coding system can be applied retrospectively to final paramedic assessment data in an ambulance dataset with a view to developing more fine-grained, clinically relevant case definitions than are available through point-of-call data.

Methods. Over 1.2 million case records were extracted from the Ambulance Victoria data warehouse. Data fields included dispatch code, cause (CN) and final primary assessment (FPA). Each FPA was converted to an ICD-10-AM code using word matching or best fit. ICD-10-AM codes were then converted into Major Diagnostic Categories (MDC). CN was aligned with the ICD-10-AM codes for external cause of morbidity and mortality.

Results. The most accurate results were obtained when ICD-10-AM codes were assigned using information from both FPA and CN. Comparison of cases coded as unconscious at point-of-call with the associated paramedic assessment highlighted the extra clinical detail obtained when paramedic assessment data are used.

Conclusions. Ambulance paramedic assessment data can be aligned with ICD-10-AM and MDC with relative ease, allowing retrospective coding of large datasets. Coding of ambulance data using ICD-10-AM allows for comparison of not only ambulance service users but also with other population groups.

What is known about the topic? There is no reliable and standard coding and categorising system for paramedic assessment data contained in ambulance service databases.

What does this paper add? This study demonstrates that ambulance paramedic assessment data can be aligned with ICD-10-AM and MDC with relative ease, allowing retrospective coding of large datasets. Representation of ambulance case types using ICD-10-AM-coded information obtained after paramedic assessment is more fine grained and clinically relevant than point-of-call data, which uses caller information before ambulance attendance.

What are the implications for practitioners? This paper describes a model of coding using an internationally recognised standard coding and categorising system to support analysis of paramedic assessment. Ambulance data coded

using ICD-10-AM allows for reliable reporting and comparison within the prehospital setting and across the healthcare industry.

Introduction

Ambulance services provide life-saving care for a range of medical or traumatic conditions as well as transport to hospital. Research into ambulance services using health record datasets informs the development of the best treatment and transport options. Use of a reliable and standard coding and categorising system is essential to support analysis of paramedic assessment data contained in these datasets. No such system exists to date.

We reviewed the literature on ambulance data related to temporal patterns in ambulance demand and identified studies that have coded ambulance datasets for the purposes of research.[1] The most common methods were either using a telephone triage-derived dispatch determinant (most commonly the Medical Priority Dispatch System (MPDS))[2–5] or 'a system devised by the authors'.[6–11]

Categorisation using MPDS occurs at the point-of-call receipt, before ambulance arrival. It is a structured electronic triage process allowing operators (typically laypeople) to prioritise ambulance cases, and is targeted at resource allocation and case prioritisation rather than clinical diagnosis. The system is based on information given by the caller (patient or bystander). Case information is often provided at a point of crisis, with the potential for inaccurate information, for example, cardiac arrest, the most time-critical condition, is correctly identified in only 76.7% of cases using this system.[12] MPDS sorts calls into 36 broad chief complaint categories based on responses to key questions. Each chief complaint can contain a wide variety of possible illnesses or injuries, each requiring different clinical management.[13] MPDS-coded data therefore do not provide clinically meaningful case classifications for research on ambulance demand. To support and facilitate clinically meaningful research, data derived from a more accurate and comprehensive understanding of ambulance deployment based on actual health conditions are needed. One way to collect such data is to develop systems that include the paramedic assessment of the patient.

Some previous research has used paramedic assessment to classify attendance. However, taken together, studies using what are described as 'a system devised by the authors' to categorise paramedic assessment fail to deliver a standard, validated, reliable method of classification. Each study method uses a different number of categories with different headings and there is very little detail about what cases were placed in each category.[6–11] These systems lack methodological rigour, which precludes reliable comparison across studies.

The ICD-10-AM is the Australian modification of the internationally recognised standard diagnostic classification tool for epidemiological, health management and clinical purposes, the International Classification of Disease, 10th revision (ICD-10). The ICD-10-AM is widely used for analysis of the general health of population groups in Australia, including monitoring of incidence and prevalence of diseases and other health problems.[15] Coding of ambulance data using ICD-10-AM would allow for comparison of not only ambulance service users but also other population groups. This data linkage would have broad potential use in the health and research communities.

ICD-10-AM-coded data can be sorted into one of 23 major diagnostic categories (MDC) and one pre-MDC.[16] MDC is a complimentary categorisation system to ICD-10-AM. Each MDC corresponds to a body system or aetiology, generally associated with a particular medical speciality.[16] This provides a standard, reproducible number of categories for analysis.

ICD-10-AM requires a diagnosis for accurate classification. When it comes to the classification for epidemiological analysis, ambulance patient care records are limited as they do not include a definitive 'diagnosis' because of lack of access to definitive testing such as laboratory testing and radiography. Instead only a 'final assessment' of the patient's clinical presentation is typically recorded. Although it may be possible to obtain ICD-10-AM coding for ambulance cases from linked hospital data, only 80% of patients assessed and treated by paramedics are transported to hospital. Therefore, relying on hospital coding for patients attended by ambulance services would result in an incomplete ambulance dataset.

Ambulance services need a tool for retrospective coding of paramedic assessment data so that analysis of their databases can be used to provide an evidence base to inform ambulance practice. Coding from data available at the point-of-call (e.g. MPDS) might not accurately reflect ambulance demand or have the level of accuracy required for analysis due to the limitations discussed above.[12,13] Better information might come from using data derived after paramedic assessment but no standardised system exists for coding and categorising this data for analysis. The ICD is internationally recognised, reliable and comprehensive. However, it relies on a definitive diagnosis not readily available in the prehospital setting. It is not known if it can be applied retrospectively to large datasets for research and quality-improvement purposes.

This paper aims to examine whether an adaptation of the ICD-10-AM system can be applied retrospectively to paramedic assessment data from an ambulance dataset, with a view to developing more fine-grained, clinically relevant case definitions than are available through MPDS-coded point-of-call data.

Methods

The study setting was Melbourne, Australia, which has an area of $10\,000\,\text{km}^2$ and a population of 4.16 million. The emergency medical service (EMS) for Melbourne is a two-tiered medical response system. There are >1000 ambulance paramedics authorised to practice some advanced life support as well as >400 mobile intensive care ambulance paramedics. Five steps

were involved in applying ICD-10-AM codes to data obtained from Ambulance Victoria, the EMS covering metropolitan Melbourne, Australia.

Extraction of the data from the data warehouse

All patients attended by EMS in Melbourne, Australia have patient care data collected and recorded in an electronic patient care record, known as VACIS®, that was developed to capture clinical information on cases attended by ambulances in Victoria. All cases of EMS attendance in metropolitan Melbourne, Australia were obtained from the Ambulance Victoria data warehouse for the period 1 January 2008 to 31 December 2011. VACIS® includes a variety of case-related information, and is designed as a database for monitoring and improving practice. For the purposes of this study the data extracted included the age and gender of the patient, MPDS dispatch code, final primary assessment (FPA), cause (CN) and whether the patient was transported to hospital. The dataset comprised 1 203 803 cases.

The variables FPA and CN were selected from the records as they represent the paramedic assessment of the patient. FPA is defined as the final assessment of the patient after a full history and examination, CN is defined as the cause of the injury or illness. In the VACIS® system FPA is multiple choice with 205 choice categories. CN is multiple choice with 282 choice categories.

Converting FPA to an ICD-10-AM code

The FPA was aligned with ICD-10-AM codes using the 'ICD-10' coding system. Coding involved finding an exact word match for the FPA category or the closest possible meaning. The coding was completed by the first author and checked by a hospital-based coding and case-mix manager and using the ICD-10-AM coding program 3M™ Codefinder™. The FPA and associated ICD-10-AM codes are listed in Table 1.

Four out of the 205 FPA choices could not be converted to standard ICD-10-AM codes. These were 'other', 'unknown', 'no problem identified' and 'asymptomatic'. The largest non-codable FPA was 'other'. Cases are listed as 'other' in VACIS® when paramedics cannot find an accurate final assessment. The condition is then described in a free-text section of the electronic case sheet but the FPA is listed as 'other'. This occurs with less-common diseases and conditions. Due to logistical constraints of working with a large dataset there was no searching of the free-text fields associated with the 'other' final assessment. The second FPA that could not be coded was 'unknown'. This is assigned when the ambulance crew attends the patient but is unsure what the problem is, such as when the patient states they are 'not quite right' or 'feel unwell' and wish to go to hospital.

Sometimes an ambulance is requested and attends a scene where no-one requires medical attention. Preliminary analysis showed that 4.17% of ambulance requests were not for a medical or traumatic condition but for some other cause such as standing by with police or fire at a potential incident or siege, false alarms, hoax calls or being called to road incidents where all the people at the scene decline ambulance assistance and assessment. These cases have a FPA code of 'no problem identified' or 'asymptomatic'. There was no corresponding ICD-10-AM code so four extra codes were added to classify these cases.

Grouping of ICD-10-AM codes into MDC

There are 23 MDC and one pre-MDC. These relate to single organ systems or aetiologies as well as an 'unassignable' category and a 'factors affecting health status' category.

ICD-10-AM codes were converted into MDC using the Australian Refined Diagnosis Related Groups Definitions manual.[16] There were cases where the ICD-10-AM could be coded into multiple MDC, one being a body system and the other being an infectious cause. In these cases, as the infective causative agent was not known, the body system MDC was chosen.

Cases where the FPA was recorded as 'other' or 'unknown problem' were placed in the 'unassignable' MDC.

The two added categories of 'no problem identified' and 'asymptomatic' represent cases where there was no medical problem, so a MDC classification could not be given. These were placed in their own category. This resulted in 25 categories (24 MDC standard categories and one of 'no problem identified').

Addition of CN to ICD-10-AM code

The ICD-10-AM codebook includes a chapter that contains codes relating to symptoms, signs or ill-defined conditions that do not indicate a classifiable diagnosis. The absence of specific diagnostic aids such as X-ray and biochemistry means that symptom-only FPA are common in our dataset. These include back pain, abdominal pain, dizziness, nausea, vomiting, rash, cramps and fever. Once converted, symptom-only ICD-10-AM codes are categorised into general body system MDC. However, some codes are too vague to be coded into general body system MDC and are coded into the specific MDC 'factors affecting health status'. These include pain, weakness, social problem and deceased. Minimising the number of cases assigned to symptom-only codes will lead to a more precise picture of ambulance demand.

We examined whether the addition of a cause classification to the FPA would alter the ICD-10-AM code from a symptom-only code to a more specific code. All symptom-only FPA were checked against the CN. Recoding was considered if there was a minimum of 1000 cases affected. The 1000-record threshold was chosen as, although this represented only 0.01% of the sample, it was considered a large enough sample of cases to warrant recoding.

The codes that were changed were:

- Post-loss of consciousness/unconscious and altered conscious state were recoded to intracranial injury if CN was traumatic.
- Post-loss of consciousness/unconscious, altered conscious state, psychiatric episode and nausea and vomiting were recoded to a mental and behavioural disorder due to alcohol/drugs if CN was overdose/exposure to alcohol or drugs.
- Short of breath was recoded to cardiac failure if CN was cardiac.

Coding of trauma cases to the external causes of injury codes

ICD-10-AM external cause of injury codes are a supplementary set of codes for classifying injury cause. Trauma cases can be coded using these external cause codes as well as the standard

Table 1.   Conversion of final paramedic assessment to ICD-10-AM and Major Diagnostic Category

Major Diagnostic Category key: 0 = unassignable; 1 = nervous system; 2 = eye diseases and disorders; 3 = ear, nose and throat; 4 = respiratory system; 5 = circulatory system; 6 = digestive system; 7 = hepatobiliary system and pancreas; 8 = musculoskeletal system and connective tissues; 9 = skin, subcutaneous tissue and breast; 10 = endocrine, nutritional and metabolic; 11 = kidney and urinary tract; 12 = male reproductive system; 13 = female reproductive system; 14 = pregnancy, childbirth and puerperium; 15 = newborns and other neonates; 16 = blood, blood from organs and immunology; 17 = neoplastic disorders; 18 = infectious and parasitic disorders; 19 = mental diseases and disorders; 20 = alcohol/drug use disorders; 21 = injury, poison and toxic effects of drugs; 22 = burns; 23 = factors influencing health status. PR, per rectum; PV, per vagina; STEMI, ST elevation myocardial infarction; NSTEMI, non-ST elevation myocardial infarction

Final paramedic assessment	ICD-10-AM	Major Diagnostic Category	ICD label
Diarrhoea	A09.9	6	Diarrhoea
Meningococcal septicaemia (possible)	A39.2	18	Meningcoccal septicaemia – suspected
Sepsis	A41.9	18	Sepsis
Sepsis: type: intra-abdominal	A41.9	18	Sepsis
Sepsis: type: other – specify	A41.9	18	Sepsis
Infection – other/not listed	B99	18	Infection
Infection – other/not listed: other	B99	18	Infection
Hypoglycaemia	E16	10	Hypoglycaemia
Dehydration	E86	10	Dehydration
Psychiatric episode	F29	19	Psychiatric episode
Depression	F32.9	19	Depression
Panic attack	F41.0	19	Panic attack
Anxiety	F41.9	19	Anxiety
Emotional distress	F43.9	19	Emotional distress
Seizure/s/convulsion/s: pseudoseizures	F44.5	19	Pseudoseizures
Eating disorder: type: anorexia nervosa	F50.0	19	Anorexia
Eating disorder: type: bulimia	F50.2	19	Bulimia
Eating disorder	F50.9	19	Eating disorder
Eating disorder: other – specify	F50.9	19	Eating disorder
Seizure/s/convulsion/s: partial – complex	G40.1	1	Seizures – partial
Seizure/s/convulsion/s: partial – simple	G40.1	1	Seizures – partial
Seizure/s/convulsion/s: generalised: time	G40.3	1	Seizures – generalised
Seizure/s/convulsion/s: generalised:other	G40.3	1	Seizures – generalised
Post ictal	G40.9	1	Post-ictal
Migraine/s	G43.9	1	Migraine
Transient ischaemic attack	G45.9	1	Transient ischaemic attack
Transient ischaemic attack: time of onset	G45.9	1	Transient ischaemic attack
Sleep disorder	G47.0	19	Sleep disorder
Diplopia	H53.2	2	Diplopia
Visual disturbance/loss	H54.9	2	Visual disturbance/loss
Hearing loss	H91.2	3	Hearing loss
Ear problem	H93.9	3	Ear problem
Hypertension	I10	5	Hypertension
Acute coronary syndrome: unstable angina	I20.0	5	Acute coronary syndrome: unstable angina
Angina	I20.1	5	Angina
Acute coronary syndrome	I20.9	5	Ischaemic pain, unspecified
Pain: location: chest – ischaemic	I20.9	5	Ischaemic pain, unspecified
Acute coronary syndrome: STEMI	I21.3	5	STEMI
Acute myocardial infarction: STEMI	I21.3	5	STEMI
Acute coronary syndrome: NSTEMI	I21.4	5	NSTEMI
Acute myocardial infarction: NSTEMI	I21.4	5	NSTEMI
Acute myocardial infarction	I21.9	5	Acute myocardial infarction
Acute myocardial infarction: time of onset	I21.9	5	Acute myocardial infarction
Pulmonary embolism	I26.9	4	Pulmonary embolism
Cardiac arrest	I46.9	5	Cardiac arrest
Cardiac arrest: not witnessed	I46.9	5	Cardiac arrest
Cardiac arrest: time of arrest	I46.9	5	Cardiac arrest
Cardiac arrest: unknown	I46.9	5	Cardiac arrest
Cardiac arrest: witnessed: other witness	I46.9	5	Cardiac arrest
Cardiac arrest: witnessed: witnessed by ambulance	I46.9	5	Cardiac arrest
Arrhythmia	I49.9	5	Arrhythmia
Acute pulmonary oedema	I50.1	5	Acute pulmonary oedema

(Continued next page)

Table 1. (*continued*)

Final paramedic assessment	ICD-10-AM	Major Diagnostic Category	ICD label
Cardiac failure	I50.9	5	Cardiac failure
Cardiac failure: acute	I50.9	5	Cardiac failure
Cardiac failure: chronic	I50.9	5	Cardiac failure
Subarachnoid haemorrhage	I60	1	Subarachnoid haemorrhage
Intracranial haemorrhage	I61.9	1	Intracranial haemorrhage
Stroke: onset ≤ 6 h	I64	1	Stroke
Stroke: onset >6 h	I64	1	Stroke
Stroke: specify onset: time of onset	I64	1	Stroke
Stroke: unknown time of onset	I64	1	Stroke
Aortic dissection	I71.0	5	Aortic dissection
Abdominal aortic aneurysm	I71.4	5	Abdominal aortic aneurysm
Deep vein thrombosis	I80.2	5	Deep vein thrombosis
Hypotension	I95.8	5	Hypotension
Throat infection	J02.9	3	Throat: infection/problem/sore
Throat problem: other – specify	J02.9	3	Throat: infection/problem/sore
Throat problem: sore throat	J02.9	3	Throat: infection/problem/sore
Croup	J05.0	3	Croup
Epiglottitis	J05.1	3	Epiglottitis
Flu-like illness	J11.1	3	Flu-like illness
Flu-like illness: comment	J11.1	3	Flu-like illness
Pneumonia	J18.9	4	Pneumonia
Respiratory tract infection	J20	4	Respiratory tract infection
Respiratory tract infection: influenza-like	J20	4	Respiratory tract infection
Respiratory tract infection: other – specify	J20	4	Respiratory tract infection
Bronchiolitis	J21.9	4	Bronchiolitis
Chest infection	J22	4	Chest infection
Bronchitis	J40	4	Bronchitis
Chronic obstructive pulmonary disease	J44.9	4	Chronic obstructive pulmonary disease
Asthma	J45.9	4	Asthma
Pneumothorax	J93.8	4	Pneumothorax
Respiratory failure	J96.0	4	Respiratory failure
Toothache	K08.88	3	Toothache
Gastrointestinal problem	K22.9	6	Gastrointestinal problem
Bowel obstruction	K56.6	6	Bowel obstruction
Constipation	K59.0	6	Constipation
PR bleeding	K62.5	6	PR bleed
Haematemesis	K92.0	6	Haematemesis
Malaena	K92.1	6	Malena
Cellulitis	L03.9	9	Cellulitis
Sunburn	L55.9	9	Sunburn
Joint effusion	M25.4	8	Joint swelling/effusion
Swollen joint	M25.4	8	Joint swelling/effusion
Pain: location: hip	M25.5	8	Hip pain
Pain: location: joint	M25.55	8	Joint pain
Pain: location: back	M54.9	8	Back pain
Pain: location: muscular/soft tissue	M79.1	8	Muscle/soft tissue pain
Renal failure	N19	11	Renal failure
Renal calculi/colic	N23	11	Renal colic
Urinary tract infection	N39.0	11	Urinary tract infection
PV bleeding	N93.9	13	PV bleed
Ectopic pregnancy	O00.9	14	Ectopic pregnancy
Childbirth: after arrival	O80	14	Childbirth
Childbirth: before arrival	O80	14	Childbirth
Childbirth: imminent	O80	14	Childbirth
Palpitations	R00.2	5	Palpitations
Palpitations: time of onset	R00.2	5	Palpitations
Epistaxis	R04.0	3	Epistaxis
Cough	R05	4	Cough
Short of breath	R06.0	4	Short of breath
Hyperventilation	R06.4	4	Hyperventilation

Table 1.   (*continued*)

Final paramedic assessment	ICD-10-AM	Major Diagnostic Category	ICD label
Pain: location: chest – pleuritic	R07.3	5	Chest pain: traumatic/pleuritic
Pain: location: chest – traumatic	R07.3	5	Chest pain: traumatic/pleuritic
Respiratory arrest	R09.2	4	Respiratory arrest
Respiratory arrest: time of arrest	R09.2	4	Respiratory arrest
Pain: location: abdominal	R10.4	6	Abdominal pain
Nausea	R11	6	Nausea and vomiting
Vomiting	R11	6	Nausea and vomiting
Abdominal distension	R14	6	Abdominal distension
Incontinence – faecal	R15	6	Incontinence – faecal
Rash	R21	9	Rash
Swollen limb	R22.4	9	Swollen limb
Cramps	R25.2	8	Cramps and spasms
Spasm/s	R25.2	8	Cramps and spasms
Mobility problem	R26.2	8	Mobility problem
Weakness: limb	R29.88	1	Weak limb
Dysuria	R30	11	Dysuria
Haematuria	R31	11	Haematuria
Incontinence – urinary	R32	11	Incontinence – urine
Urine retention	R33	11	Urine retention
Altered conscious state	R40.1	1	Altered conscious state
Post loss of consciousness	R40.2	1	Post loss of consciousness/unconscious
Unconscious	R40.2	1	Post loss of consciousness/unconscious
Unconscious: time of onset	R40.2	1	Post loss of consciousness/unconscious
Confusion	R41.0	1	Confusion
Dizzy	R42	3	Dizzy/vertigo
Vertigo	R42	3	Dizzy/vertigo
Febrile	R50.9	18	Fever
Headache	R51	1	Headache
Pain	R52.9	23	Pain
Pain: location: other – specify	R52.9	23	Pain
Pain: location: undiagnosed – severe	R52.9	23	Pain
Pain: time of onset	R52.9	23	Pain
Weakness: generalised	R53	23	Weakness
Weakness: other – specify	R53	23	Weakness
Collapse	R55	5	Collapse/faint
Faint	R55	5	Collapse/faint
Seizure/s/convulsion/s: febrile convulsions	R56.0	1	Febrile seizure
Seizure/s/convulsion/s: other – specify	R56.8	1	Seizures
Seizure/s/convulsion/s: time of onset	R56.8	1	Seizures
Suspected internal haemorrhage	R58	5	Internal haemorrhage – suspected
Hyperglycaemia	R73	10	Hyperglycaemia
Deceased	R99	23	Deceased
Deceased: date/time	R99	23	Deceased
Eye injury/problem	S05.9	2	Eye injury
Face injury/problem	S09.9	21	Face/head injury
Head injury: type: closed	S09.9	21	Face/head injury
Head injury: type: open	S09.9	21	Face/head injury
Flail chest	S22.5	21	Flail chest
Tension pneumothorax	S27.0	21	Tension pneumothorax
Spinal cord injury – suspected	T09.4	21	Spinal cord injury – suspected
Abrasion/graze	T14.01	21	Abrasion/graze
Blister(s)	T14.02	9	Blister
Bruising/haematoma	T14.05	21	Bruise/haematoma
Laceration	T14.1	21	Laceration/wound
Wound/puncture	T14.1	21	Laceration/wound
Fracture/s: type: closed	T14.2	21	Fracture
Fracture/s: type: open	T14.2	21	Fracture
Dislocation	T14.3	21	Dislocation/sprain/strain
Strain/sprain	T14.3	21	Dislocation/sprain/strain
Amputation	T14.7	21	Amputation/avulsion

Table 1.   (*continued*)

Final paramedic assessment	ICD-10-AM	Major Diagnostic Category	ICD label
Avulsion	T14.7	21	Amputation/avulsion
Soft tissue injury	T14.9	21	Soft tissue injury
Airway obstruction: complete	T17	21	Airway obstruction: partial or complete
Airway obstruction: partial	T17	21	Airway obstruction: partial or complete
Pulmonary aspiration	T17.8	4	Pulmonary aspiration
Burn/s	T30	22	Burns
Heat stress	T67.0	21	Heat stress/stroke
Heat stroke	T67.0	21	Heat stress/stroke
Hypothermia	T68	21	Hypothermia
Decompression illness	T70.3	21	Decompression illness
Decompression illness: acute	T70.3	21	Decompression illness
Decompression illness: chronic	T70.3	21	Decompression illness
Post immersion	T75.1	21	Post immersion
Post immersion: chlorinated water	T75.1	21	Post immersion
Post immersion: fresh water	T75.1	21	Post immersion
Post immersion: other – specify	T75.1	21	Post immersion
Post immersion: salt water	T75.1	21	Post immersion
Anaphylaxis	T78.2	21	Anaphylaxis
Allergic reaction	T78.4	21	Allergic reaction
Wound inflammation/infection	T79.3	18	Wound infection
Compartment syndrome	T79.6	21	Compartment syndrome
Surgical emphysema	T81.8	21	Surgical emphysema
Implantable defibrillator problem	T82.1	5	Pacemaker/internal defib problem
Pacemaker problem	T82.1	5	Pacemaker/internal defibrillator problem
Urinary catheter problem	T83.8	11	Urinary catheter problem
Feed tube problem	T85.5	6	Complication of gastrointestinal device
Social problem	Z63	23	Social problem
Asymptomatic			Asymptomatic
No problem identified			No problem identified
Other – specify		0	Other
Unknown problem		0	Unknown problem

ICD-10-AM codes based on FPA. CN was recoded into external cause of injury.

Categorisation of the dataset was performed using both external cause of injury and MDC. Trauma cases were categorised by the external cause code, medical cases were categorised by MDC.

Statistical analysis

All data were entered into a Stata datafile (Version 11.2; Stata Corporation, College Station, TX, USA). Variables were described in tabular form using frequencies, percentages and cumulative percentages.

Results

Table 2 shows the number and percentage of cases in each of the MDC. The highest number of cases was in the circulatory system MDC followed by injury, poisons and toxic effects of drugs. Symptom-only codes constituted 383 432 cases or 31.85% of the dataset, with most of these codes being categorised into a MDC aligned with a general body system. The symptom-only codes that were too vague to be coded into a general body system were categorised under the 'factors affecting health status' MDC and constituted 8.01% of the dataset. Unassignable codes (other, unknown problem)

constituted 9.24% of the dataset and no problem/asymptomatic codes made up 2.38%.

Table 2 also shows the number and percentage of cases in each MDC after recoding due to CN. The addition of CN did reduce the percentage of symptom-only coded cases by 2.25% and changed the distribution of cases among the MDC, especially in the MDC of injury and alcohol and drug use. However, the number of cases in the MDC of 'factors affecting health status' did not change.

Table 3 shows the data coded using different methods for medical cases versus trauma cases. Trauma cases were categorised by the external cause code, medical cases were categorised by MDC. The percentage of cases coded to symptom-only codes was 25.73% due to the recoding of symptoms such as pain to the cause of the injury. This also led to a reduction in the most vague symptom-only codes, those in the MDC of 'factors affecting health status', which went from 8.01 to 5.91% of the total dataset. The MDC 'unassignable' and 'no problem/ asymptomatic' also reduced in number because, even though the ICD-10-AM code was 'other' or 'no problem', the cause could be coded as an external cause of injury.

Although it might be tempting to just code trauma cases to an external cause of injury, it is important to code data into a primary ICD-10-AM code as well. This allows for the impact of the trauma to be analysed. This is demonstrated by an

Table 2. Ambulance caseload sorted into Major Diagnostic Categories (MDC)
ICD, International Classification of Disease

MDC	ICD-10-AM only MDC		ICD-10-AM and cause MDC		Difference
	Frequency	%	Frequency	%	
Circulatory system	187 789	15.60	190 412	15.82	2623
Injury, poison and toxic effects of drugs	162 167	13.47	168 242	13.98	6075
Nervous system	124 780	10.37	101 335	8.42	−23 445
Digestive system	108 127	8.98	106 126	8.82	−2001
Respiratory system	104 471	8.68	101 848	8.46	−2623
Factors influencing health status	96 465	8.01	96 465	8.01	0
Unassignable	89 476	7.43	89 476	7.43	0
Mental diseases and disorders	83 421	6.93	81 212	6.75	−2209
Musculoskeletal and connective tissue	63 335	5.26	63 335	5.26	0
No problem/asymptomatic	50 238	4.17	50 238	4.17	0
Ear, nose, mouth and throat	39 922	3.32	39 922	3.32	0
Infectious	29 050	2.41	29 050	2.41	0
Kidney and urinary tract	21 986	1.83	21 986	1.83	0
Endocrine, nutritional and metabolic	21 417	1.78	21 417	1.78	0
Female reproductive system	5506	0.46	5506	0.46	0
Pregnancy, childbirth	5254	0.44	5254	0.44	0
Skin, subcutaneous tissue and breast	4086	0.34	4086	0.34	0
Burns	3331	0.28	3331	0.28	0
Eye diseases and disorders	2894	0.24	2894	0.24	0
Alcohol/drug use	0	0	21 580	1.79	21 580
Total	1 203 803	100	1 203 803	100	

Table 3. Medical cases coded by Major Diagnostic Category (MDC), trauma cases coded by external cause of injury

MDC and external cause of injury	Frequency	%	Cumulative
Circulatory system	179 481	14.91	14.91
Fall	124 116	10.31	25.22
Digestive system	104 343	8.67	33.89
Respiratory system	100 611	8.36	42.25
Nervous system	97 239	8.08	50.32
Mental diseases and disorders	75 081	6.24	56.56
Factors influencing health status	71 128	5.91	62.47
Unassignable	67 720	5.63	68.09
Injury, poison and toxic effects of drugs	52 903	4.39	72.49
Overdose/exposure	40 756	3.39	75.87
Ear, nose, mouth and throat	37 835	3.14	79.02
Musculoskeletal and connective tissue	37 357	3.10	82.12
Motor vehicle collision	36 016	2.99	85.11
No problem/asymptomatic	29 826	2.48	87.59
Infectious	28 737	2.39	89.98
Kidney and urinary tract	21 922	1.82	91.80
Endocrine, nutritional and metabolic	21 079	1.75	93.55
Assault	20 404	1.69	95.24
Struck by object	6446	0.54	95.78
Motorbike collision	6011	0.50	96.28
Female reproductive system	5471	0.45	96.73
Pregnancy, childbirth	5252	0.44	97.17
Bicycle collision	5025	0.42	97.59
Sporting injury	4611	0.38	97.97
Pedestrian collision	4457	0.37	98.34
Skin, subcutaneous tissue and breast	3803	0.32	98.66
Eye diseases and disorders	2351	0.20	98.85
Stabbing	1920	0.16	99.01
Other external causes of injury	11 902	0.99	100
Total	1 203 803	100	

example in Table 4. This table shows that the two most common injuries after a bicycle collision are a fracture and graze/abrased skin.

Table 5 shows the calls prioritised to the MPDS version 11.3 category of 'unconscious' and subcategories 'unconscious–unconscious' and 'unconscious–not alert' with the associated final assessment by paramedics as an ICD-10-AM code. This table highlights the fine-grained, clinically relevant case definitions obtained by using paramedic assessment compared with data obtained from point-of-call. For example, the treatment and resources required for a patient suffering a hypoglycaemic episode are very different to those needed for a patient suffering a loss of consciousness due to an arrhythmia, stroke patients have different clinical needs to patients with a gastrointestinal problem, but these differences would be missed when examining point-of-call data alone.

Discussion

Ambulance services have a wealth of data that could be analysed to inform development of the best treatment and transport options as well as public health service provision. There is no standard method of coding and classifying paramedic assessment data in ambulance datasets. ICD-10 is the worldwide standard for coding of disease and injury for epidemiological analysis. The aim of this paper was to develop a standardised method to adapt the ICD-10-AM coding system so that it can be reliably applied to paramedic assessment data in large ambulance datasets. The method used in this study is a reproducible method for sorting ambulance data into manageable categories for analysis allowing comparisons with other ambulance services and health providers. It is useful for the coding of large datasets where the

Table 4. International Classification of Disease (ICD-10-AM) codes for the external cause of morbidity and mortality code of bicycle collision

ICD-10-AM codes for cases where cause is bicycle collision	Frequency	%
Fracture	808	16.39
Abrasion/graze	656	13.31
Pain	582	11.81
Laceration/wound	474	9.62
Face/head injury	371	7.53
Muscle/soft tissue pain	333	6.76
Soft tissue injury	333	6.76
Bruise/haematoma	208	4.22
Dislocation/sprain/strain	168	3.41
Post loss of consciousness/unconscious	142	2.88
Other	142	2.88
Altered conscious state	137	2.78
Back pain	121	2.45
Joint pain	73	1.48
Hip pain	64	1.30
Chest pain: traumatic/pleuritic	57	1.16
Spinal cord injury-suspected	50	1.01
Confusion	35	0.71
Headache	31	0.63
Abdominal pain	17	0.34
Amputation/avulsion	14	0.28
Unknown problem	11	0.22
Deceased	10	0.20
Anxiety	9	0.18
Other ICD-10-AM codes	83	1.66
Total	4929	100

Table 5. International Classification of Disease (ICD-10-AM) coding for the dispatch category of unconscious

ICD-10-AM coding	Category 31 (%) $n = 87\,790$ Unconscious	Subcategory 31D1 (%) $n = 13\,712$ Unconscious – unconscious	Subcategory 31D3 (%) $n = 27\,857$ Unconscious – not alert
Collapse/faint	26.23	12.95	25.75
Other	7.08	7.04	5.39
Dizzy/vertigo	4.85	0.79	2.79
Altered conscious state	4.15	10.25	6.26
Hypotension	3.75	1.93	4.18
Post loss of consciousness/ unconscious	3.55	7.04	3.48
Gastrointestinal problem	2.78	0.74	2.28
No problem identified	2.63	4.13	3.16
Unknown problem	2.29	2.55	2.37
Arrythmia	2.11	0.83	1.73
Stroke	2.05	4.84	2.64
Pain	1.86	0.99	1.43
Nausea and vomiting	1.79	0.63	1.67
Post ictal	1.54	3.39	2.28
Drug intoxication	1.53	5.85	1.63
Abdominal pain	1.44	0.64	1.25
Anxiety	1.40	0.89	1.05
Stimulant use	1.37	4.62	1.72
Hypoglycaemia	1.22	2.07	1.22
Cardiac arrest	0.67	2.72	0.42
Other ICD-10-AM codes	25.71	25.11	27.30
Total	100	100	100

logistical constraint of working with large numbers precludes the investigation of individual cases.

Some challenges were encountered when converting ambulance cases to ICD-10-AM. As the level of information became less specific, coding became more problematic in two ways. First, our dataset contained a substantial proportion of cases coded with symptom-only codes. The addition of ambulance 'cause' to certain ICD-10-AM symptom-only codes improved categorisation, especially those in the MDC of injury and alcohol and/or other drug use. Second, although most assessments could be converted into a diagnostic ICD-10-AM code, there were challenges when the data related to cases with an FPA of 'other' or 'unknown'. These could not be coded into ICD-10-AM codes and extra codes had to be added.

Presenting the data in different ways for medical and trauma cases further reduced the number of cases that were symptom-only codes and cases that could not be properly coded or categorised. Using a combination of ICD-10-AM codes for medical cases and external cause of injury codes for trauma cases vastly reduced the number of cases categorised in non-specific categories (i.e. 'factors affecting health status', 'unassignable' and 'no problem/asymptomatic').

This study also compared point-of-call data with paramedic assessment data in relation to the 'unconscious' dispatch category. Point-of-call data is one of the most commonly used information sources for assessment of ambulance demand and performance. Point-of-call data are reliant on the lay person caller rather than trained paramedics. Further, the coding system

(MPDS) used at the point-of-call is designed to target resource allocation and case prioritisation rather than provide any clinical diagnosis. Although point-of-call information is an easily attainable source of data, our study shows that final assessments by paramedics can be used to generate more fine-grained, clinically relevant case definitions that are relevant to resource allocation and service planning. Using paramedic assessment data that are coded and categorised using an internationally recognised standard method means that research using these data will not only inform practice at Ambulance Victoria but can also underpin comparisons with other ambulance services and population groups.

Study limitations

This study had some limitations. The translation of ambulance data into ICD-10-AM data was imperfect. There was no record review to determine the accuracy of the FPA or cause as recorded by paramedics; however, the size of the dataset would obscure single case errors, so this is not likely to have had a major impact on the results. A percentage of cases can't be coded as they lack FPA or are coded as 'other' or 'unknown'. This is a limitation of the dataset, and further work is required to determine an easy method for exploring and sorting information contained within free-text fields in the current VACIS® system, particularly the main free-text field 'case description'. The proportion of cases coded as 'other' or 'unknown' should be monitored as they represent a lost data opportunity and may impact on demand-management analyses.

Conclusion

Ambulance paramedic assessment data can be aligned with ICD-10-AM and MDC categories with relative ease, allowing retrospective coding of large datasets. Coding of ambulance data using ICD-10-AM allows for comparison of not only ambulance service users but also other population groups. Representation of ambulance case types using ICD-10-AM-coded information obtained after paramedic assessment has more fine-grained, clinically relevant case definitions than point-of-call data using MPDS coding, which is based on caller information before ambulance attendance. Areas of further research include whether this adaptation of the ICD-10-AM coding system can be applied to data from other ambulance services, which would ensure the ease of applicability and reliability of the method and a determination of the accuracy of paramedic final assessment in relation to a more definite diagnosis.

Competing interests

KC, AM and KS were all employees of Ambulance Victoria at the time of manuscript preparation and submission. Ambulance Victoria had no direct input into the design, analysis and conduct of the project.

Acknowledgements

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