




BMJ Open Understanding compensable and non-compensable patient profiles, pathways and physical outcomes for transport and work-related injuries in Queensland, Australia through data linkage

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ABSTRACT

Introduction In many jurisdictions, people experiencing an injury often pursue compensation to support their treatment and recovery expenses. Healthcare costs form a significant portion of payments made by compensation schemes. Compensation scheme regulators need accurate and comprehensive data on injury severity, treatment pathways and outcomes to enable scheme modelling, monitoring and forecasting. Regulators routinely rely on data provided by insurers which have limited healthcare information. Health data provide richer information and linking health data with compensation data enables the comparison of profiles, patterns, trends and outcomes of injured patients who claim and injured parties who are eligible but do not claim.

Methods and analysis This is a retrospective population-level epidemiological data linkage study of people who have sought ambulatory, emergency or hospital treatment and/or made a compensation claim in Queensland after suffering a transport or work-related injury, over the period 1 January 2011 to 31 December 2021. It will use person-linked data from nine statewide data sources: (1) Queensland Ambulance Service, (2) Emergency Department, (3) Queensland Hospital Admitted Patients, (4) Retrieval Services, (5) Hospital Costs, (6) Workers' Compensation, (7) Compulsory Third Party Compensation, (8) National Injury Insurance Scheme and (9) Queensland Deaths Registry. Descriptive, parametric and non-parametric statistical methods and geospatial analysis techniques will be used to answer the core research questions regarding the patient's health service use profile, costs, treatment pathways and outcomes within 2 years postincident as well as to examine the concordance and accuracy of information across health and compensation databases.

Ethics and dissemination Ethics approval was obtained from the Royal Brisbane and Women's Hospital Human Research Ethics Committee, and governance approval was obtained via the Public Health Act 2005, Queensland. The findings of this study will be used to inform key stakeholders across the clinical, research and compensation regulation area, and results will be

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This population-level epidemiological data linkage study will link nine separate health and compensation data sources for people sustaining a transport-related or work-related injury over an 11-year period.
- ⇒ Health service utilisation profiles and treatment pathways through the health and compensation systems will be constructed for specific injured cohorts using defined linkage logic parameters.
- ⇒ Terminology related to injury episodes, encounters and events will be clearly stated, with flowcharts used to simply describe data linkage processes and decision points.
- ⇒ Although ethics, governance, data provision and data management steps required for data linkage studies are lengthy, and, therefore, impact the rency of the data once findings are published, the methods during this study will remain relevant; furthermore, governance restrictions limited the breadth of follow-up data able to be released for non-physical conditions, which restricts our interpretation to the physical outcomes postinjury.

disseminated through peer-reviewed journals, conference presentations and reports/seminars with key stakeholders.

INTRODUCTION

In many jurisdictions, nationally and internationally, people experiencing an injury often pursue compensation under a variety of insurance schemes to support their treatment and recovery expenses. The effect that compensation has on health outcomes of injured people is unclear, with conflicting findings across injury schemes (eg, motor vehicle crashes, occupational injuries),

claimant populations (eg, whiplash, orthopaedic trauma) and outcomes (eg, mobility, mental health).¹⁻⁶

Apart from personal injury compensation covered under the Personal Injuries Proceedings Act 2002,⁷ such as those related to medical malpractice, and covered under other legislation, such as the Victims of Crime Assistance Act 2009,⁸ there are currently three main injury compensation schemes in Queensland, Australia, with different but overlapping inclusion criteria: the Workers' Compensation Scheme (introduced in 1916 and regulated by Office of Industrial Relations (OIR) Workers' Compensation Regulatory Service),⁹ Compulsory Third Party (CTP) motor accident insurance scheme (introduced in 1936 and regulated by the Motor Accident Insurance Commission (MAIC))¹⁰ and the National Injury Insurance Scheme Queensland (NIISQ) (introduced in July 2016).¹¹ More detail about how these schemes operate is provided in the Methods section.

To date, in Queensland, there have been no in-depth health data linkage studies to examine the profile, costs and outcome trajectories of claimants within the different compensation schemes operating in the State. While Queensland workers' compensation data have previously been included in cross-jurisdictional comparative studies examining injury profiles and outcome trajectories,^{12 13} these studies did not employ linkage to other health data sources. Comparative studies, which include Queensland motor accident insurance claimants, have previously been used to qualitatively assess the impact of compensation scheme design,¹⁴ given Queensland is an 'at fault' CTP scheme as distinct from several other jurisdictions in Australia; however, to the authors' knowledge, Queensland CTP claims data have not been released for comparative studies previously.

Previous studies in Victoria and New South Wales have examined healthcare utilisation and costs following compensable injuries in various cohorts.¹⁵⁻¹⁷ A study in Victoria assessed healthcare utilisation following transport-related injury, using compensation claims data, finding that over a third of cases required admission to hospital, and this cohort accessed a median of 19 health services per claimant in the 12 months postdischarge, with almost a quarter requiring further hospital care.¹⁵ Another Victorian study has examined the healthcare trajectories and costs of major trauma patients in both the Transport Accident Commission payments data and the Victorian State Trauma Registry over 3 years, comparing outcomes with the perspective of fault attribution, showing median healthcare costs per patient within 3 years postdischarge of almost \$57 500 AUD, with the most prevalent period for treatment in the first 12 weeks postinjury and those who attributed fault to another had 9% higher healthcare costs.¹⁶ Other work has compared outcomes following transport injury across different schemes and claimant types in Victoria and New South Wales, and key demographic and injury characteristic differences were identified between CTP claimants, workers compensation claimants and non-claimants, and

non-claimants returning to work more quickly than claimants.¹⁷ There has been some work linking time-loss claims for workers with low back pain, to General Practitioner service use across Western Australia, South Australia, Victoria and Queensland, with the mean number of GP services after a loss-time claim of 10 per claimant within 2 years of initial claim, which varied by jurisdiction, with Queensland having the lowest number of GP services and shortest duration of all jurisdictions.¹⁸ Another recent protocol for a study in New South Wales, Australia, will link workers' compensation claims data, health service use and pharmaceuticals data, hospital and emergency department data and social welfare data to examine the long-term impact of legislation reform on subsequent healthcare and welfare service use.¹⁹ Further abroad, a study in British Columbia, Canada, linked workers' compensation data, health services data and prescription data to investigate the effectiveness of gradual return-to-work for workers with work-related musculoskeletal disorders, which revealed differences in gradual return to work provision by injury severity, gender, age, wage, size of firm, duration and recency of claim.²⁰ While other studies have linked data to answer specific areas of need, there have been no comparable data linkage studies examining the concordance and quality of data across health and compensation databases, the methodological considerations when linking these data, nor the health service utilisation patterns for transport and work-related injury patients who do and do not receive compensation in Queensland, which enables scope for examining many areas of focus for not only the motor vehicle accident and workers' compensation sector but also the healthcare sector as well.

Healthcare costs form a significant portion of payments made by all compensation schemes and there is an increasing need for accurate and comprehensive data on injury severity, treatment and outcomes to enable scheme modelling, monitoring and forecasting. Currently, injury compensation scheme regulators, such as MAIC and OIR, mainly rely on claimant-level data provided by insurers, and these core data fields have limited health information on the patient claim management journey or patient clinical pathway, claimants' pre-existing medical conditions, patient injury types and severity, injury circumstances (including risk factors) and patient outcomes (including ongoing medical issues). In addition, workers' compensation scheme regulators also have access to results from national biennial return to work surveys.²¹ These surveys summarise outcomes for a sample of claimants such as return to work rates and challenges, physical and psychological health outcomes, experiences of the workplace and legal/insurance system, etc; however, these results are only for a sample of claimants across Australia and have relatively limited information about claimants' healthcare journeys, treatments and outcomes. NIISQ, in contrast, as the insurer (not the regulator) providing life-time treatment, care and support of people in their scheme has very detailed

information regarding the aspects of care which require NISSQ involvement. However, the accuracy and concordance of data provided to NISSQ compared with data captured within the health system have not yet been validated as this scheme is new to Queensland.

Furthermore, with regulatory agencies responsible for broader safety investments and initiatives, comprehensive insights into the circumstances, risk factors and injuries sustained are needed. For example, while Queensland workers' compensation trend data suggest that the rate of serious injury is decreasing over time, work-related injury hospitalisation trend data reveal a different story, showing an increase over recent years in Queensland.²² Data used by insurance schemes to inform injury prevention policy is largely based on compensation claims data, which provides a skewed picture because it includes only those who seek compensation. It has been found that young workers,²³ workers in retail, health, education, government and workers in rural and remote areas are underrepresented in compensation data when compared with incidence figures from workplace injury surveys.²⁴ In addition, compensation schemes have limited information about the specific injury cause, spatial and temporal distribution of injuries, treatment pathways and outcomes for patients, hence are limited in their ability to inform injury management and primary prevention initiatives.

Linking health data, drawn from ambulance and retrieval services, emergency departments and hospitalisation sources and deaths registries, with compensation data, drawn from motor vehicle accident compensation and worker' compensation schemes, enables the comparison of profiles, patterns, trends and outcomes of injured patients who claim, injured parties who are eligible but do not claim, and injured parties who fall outside the scope of compensation schemes but contribute to the injury burden.

Study objectives and aims

Broadly, this study aims to (1) evaluate the quality and value of linking Queensland compulsory third-party motor vehicle accident claims data, workers' compensation injury claims data and health data to address stakeholder information needs and (2) compare the health service use profiles, costs and treatment pathways and physical outcome trajectories of compensable and non-compensable transport and work-related injured patients using these linked data. The specific objectives are to:

- ▶ Examine the accuracy, concordance and completeness of data across each data source.
- ▶ Compare the health service use profile, costs, treatment pathways and physical outcomes of motor vehicle-related compensable and non-compensable patients over time.
- ▶ Compare the health service use profile, costs, treatment pathways and physical outcomes of injured work-related compensable and non-compensable patients over time.

METHODS AND ANALYSIS

Study design

This is a retrospective population-level epidemiological data linkage study of people who have sought ambulatory, emergency or hospital treatment and/or made a compensation claim in Queensland after suffering a transport-related or work-related physical injury (excluding other non-injury work-related diseases and excluding mental health only conditions for each cohort), over the 11-year period from 1 January 2011 to 31 December 2021.

Data sources

Transport-related or work-related injury records from nine statewide routinely collected data sources (figure 1) will be identified and linked with the Master Linkage File maintained by the Statistical Analysis and Data Linkage Unit (SALU)²⁵ within the Queensland Department of Health. These data sources are: (1) Queensland Ambulance Service (QAS) data collection, (2) Emergency Department Collection (EDC), (3) Queensland Hospital Admitted Patients Data Collection (QHAPDC), (4) Retrieval Services Queensland (RSQ) data collection, (5) National Hospital Cost Data Collection (NHCDC), (6) OIR Workers Compensation Regulator Database (OIR WCRD), (7) MAIC CTP Personal Injury Register (MAIC CTP PIR), (8) NISSQ database and (9) Queensland Deaths Registry (QDR).

Context

Queensland has an area of 1.7 million km² and a decentralised population of 5.24 million people,²⁶ with much of the population living along the eastern seaboard. Queensland's healthcare system incorporates 194 public healthcare facilities with varying degrees of clinical capability,²⁷ 302 ambulance response locations²⁸ and 13 aeromedical bases (personal communication, October 2022).

In regards to injury compensation schemes in Queensland, employers are required to have a Workers' Compensation accident insurance policy (or maintain a self-insurance policy if authorised to do so) to cover their workers for out-of-pocket medical expenses, lump sum payments for permanent impairment, past and future economic loss, pain and suffering costs, legal costs and death/funeral benefits. Workers' compensation covers work-related injury, disease and mental health conditions which arise while undertaking work, including during breaks or while travelling to and from work.²⁹ The CTP scheme is funded through a compulsory levy paid with each motor vehicle registration via a choice of private insurer. In Queensland, the CTP scheme is a 'fault'-based scheme where a person injured in a motor vehicle crash must first establish fault against another person, before seeking compensation through the compensation scheme.³⁰ In the instance where an 'at-fault' person is uninsured or unidentified, the Nominal Defendant manages the claim.³¹ The CTP scheme pays for out-of-pocket medical expenses, general damages and past and future economic losses. Where a work-related injury also

Queensland Ambulance Service (QAS) patient record system details: The QAS data collection¹⁷ compiles data from two systems for each patient: the Computer Aided Dispatch (CAD) data which is collected during the initial 000 (emergency) call (with this dataset using the Advanced Medical Priority Dispatch Software (MPDS) to prioritise calls and arrange ambulance resources appropriately), and the Ambulance Record Form, the electronic clinical case details which are recorded by paramedics on scene. Over the study time period, there were two Ambulance Record Forms in use (electronic Ambulance Record Form (eARF) and the Digital Ambulance Record Form (DARF)). The transition between these systems affected a small number of variables and these were integrated into a single data source along with the CAD data. CAD data include times and date variables to capture key points along the ambulance journey, location details, and priority details. The (e/D)ARF captures patient details, patient medical history, case history, initial and final assessments, vital signs, pre-hospital management, and ambulance destination decisions.

Emergency Department Collection (EDC) details: The EDC¹² is a statewide compilation of emergency presentations which occur in public (not private) hospitals throughout Queensland and contains administrative, demographic and basic clinical data to describe the presentation. EDC captures times and dates of presentation and discharge, arrival and discharge modes, funding sources, patient demographic details, ICD-10-AM principal and other diagnosis codes.

Queensland Hospital Admitted Patient Data Collection (QHAPDC) details: The QHAPDC¹⁸ is a statewide compilation of all hospital in-patient episodes of care which occur in both public and licensed private hospitals and private day surgeries throughout Queensland, and contains administrative, demographic and clinical data to describe each episode. QHAPDC captures times and dates of admission and discharge, care types, length of stay, transfer details, separation modes, funding sources, intensive care and continuous ventilatory support, patient demographic details, AR-DRG codes, ICD-10-AM diagnosis codes and Australian Classification of Healthcare Intervention (ACHI) procedure codes.

Retrieval Services Queensland database details: The Retrieval Services Queensland database, managed by the Aeromedical Retrieval and Disaster Management Branch of the Queensland Department of Health, contains details regarding the clinical coordination of all aeromedical retrieval and transport of patients around Queensland, including patient details, clinical observations, treatments received, aircraft details, journey timestamps (e.g. arrival, departure) and destinations.

National Hospital Cost Data Collection (NHCDC) details: The NHCDC¹⁹ contains the direct, overhead and total costs of treating each patient in public emergency departments and public hospitals, as well as specific details regarding the specialty cost centre.

Office of Industrial Relations Workers Compensation Regulator Database (OIR WCRD) details: The OIR WCRD²⁰ is a statewide compilation of workers compensation claims and contains administrative, demographic, cause, and basic diagnosis data to describe the claim. OIR WCRD captures dates of claims, time off work, claim payment amount, claimant demographic details, claimant occupation and industry, mechanism and agency of cause and injury diagnosis (coded using the Type of Occurrence Classification Scheme (TOOCS)²¹) and a severity indicator.

Motor Accident Insurance Commission Compulsory Third Party Personal Injury Register (MAIC CTP PIR) details: The MAIC CTP PIR²² is a statewide compilation of compulsory third party claims and contains administrative, demographic, cause, and basic diagnosis data to describe the claim. MAIC CTP PIR captures date of crash, a return to work indicator, claimant demographic details, details of the crash circumstances and location, injury diagnosis (coded using the Abbreviated Injury Scale (AIS)²³) and severity indicators.

National Injury Insurance Scheme Queensland (NIISQ) database: The NIISQ database includes details of catastrophically injured claimants and contains administrative, demographic, injury cause and detailed data about the type of injury sustained (ie. Brain injury, spinal cord injury, burn etc).

Death Registry details: The date of death and the cause of death for deaths registered in Queensland are contained within the Queensland Registry of Births Deaths and Marriages registry, and while date of death is available with little time delay, cause of death data is coded by the Australian Bureau of Statistics (ABS) and can be delayed several years due to processing delays.

Figure 1 Description of core data sources for linkage.

is eligible for compensation via the CTP scheme, Workers' Compensation is entitled to recover the costs of the claim from the CTP scheme insurer. The NIISQ is a more recently introduced no-fault scheme funded through the Queensland government insurer (through a compulsory levy paid with each motor vehicle registration) and covers all people, regardless of fault, catastrophically injured in

a motor vehicle crash in Queensland for medical treatment, rehabilitation and lifetime care. Catastrophically injured parties can claim through the NIISQ if they are at fault, and either NIISQ or CTP (or potentially both) scheme/s if they are not at fault.³⁰

Funding models for paying hospital treatment costs differ for each scheme. While a levy is currently paid

to the Queensland Department of Health to cover the public hospital treatment costs of CTP and NIISQ claimants, treatment at private hospitals is covered by a fee for service arrangement. Workers' Compensation moved to a fee for service patient-level arrangement in January 2016 for claimants at public hospitals, replacing a similar levy-based system. Recently, a standard table of costs for private hospital services was also introduced for Workers' Compensation claimants.³²

Terminology

This protocol uses the terminology described in Vallmuur and colleagues' paper,³³ a study which aimed to promote the use of consistent terminology in injury data linkage studies to describe episodes, encounters and events, which in summary states:

- ▶ Episodes are discrete units of health activity for a patient, including, for example, discrete ambulance records, emergency department records or hospital records, which can be numerous even for the one hospital stay (encounter) for a patient.
- ▶ Encounters are contiguous episodes of care within or between health services that are related temporally.
- ▶ Events are the group of health service encounters, which are related to the treatment of injuries sustained in one injury occurrence, regardless of the length of time since the injury.

In addition, the term 'records' will be used to describe sequencing, joining and merging records across the compensation and health datasets as a more generic alternative to 'episodes', given compensation data are usually referred to as 'claims'.

Case inclusion criteria

Inclusion scope

The cohort identification overview is depicted in figure 2 and the data sources are described in figure 1 and in summary, records meeting any of the criteria below and occurring between 1 January 2011 and 31 December 2021 are included in the study (see table 1 summary):

- ▶ Transport-related or work-related injury treated by the QAS.
- ▶ Transport-related or work-related injury-related presentation at a Queensland public emergency department.
- ▶ Transport-related or work-related injury-related separation from a Queensland public or private hospital.
- ▶ Aeromedical transport of a transport-related or work-related injured person to definitive care.
- ▶ Motor Accident Insurance CTP Claim for physical injury.
- ▶ OIR workers' compensation claim for physical injury.
- ▶ National Injury Insurance Scheme claim for physical injury.
- ▶ Transport-related or work-related death.

Exclusion scope

For index encounters, this study deliberately focuses on physical injury events and excludes cases of work-related or transport-related claims for diseases or conditions other than acute injury as that is not within the scope of this project. In regards to subsequent presentations postinjury event, it is a requirement for governance approval that episodes are restricted to those which could reasonably be viewed as having a high probability of being related to the

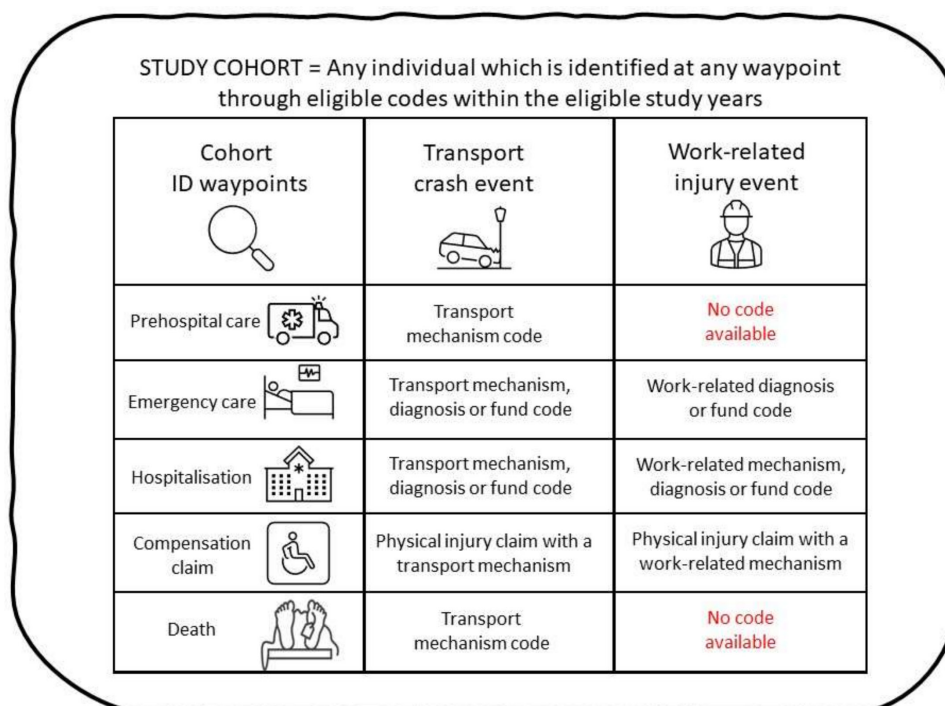


Figure 2 Schematic of cohort identification process.

Table 1 Summary of case inclusion criteria for any record identified in the 11-year period between 1 January 2011 and 31 December 2021

Data source	Inclusion criteria (<i>must meet at least one of the criteria below</i>)
Ambulance (MPDS; eARF, DARF)	Transport or work-related injury attendance
Emergency Department (EDC)	Transport or work-related injury ED presentation
Hospital Admission (QHAPDC)	Transport or work-related injury acute care admission
Aeromedical Transport	Transport or work-related injury aeromedical patient transport to definitive acute care.
CTP Claims (MAIC CTP PIR)	CTP claim present
Workers' Compensation claims (OIR WCRD)	Workers' Compensation claim for injury-related mechanism
Catastrophic injury claims (NIISQ)	NIISQ claim present
Deaths (QDR)	Transport or work-related injury cause of death

CTP, Compulsory Third Party; DARF, Digital Ambulance Record Form; eARF, Electronic Ambulance Record Form; EDC, Emergency Department Collection; MAIC, Motor Accident Insurance Commission; MPDS, Medical Priority Dispatch Software; NIISQ, National Injury Insurance Scheme Queensland; OIR WCRD, Office of Industrial Relation Workers Compensation Regulator Database; PIR, Personal Injury Register; QDR, Queensland Deaths Registry; QHAPDC, Queensland Hospital Admitted Patients Data Collection.

initial physical injury encounter. Provision of data about the patient that is broader than that may contravene the Public Health Act 2005, Queensland. Hence, episodes will be ineligible for selection (ie, excluded) if they do not have at least one diagnosis code, which indicates an injury, musculoskeletal condition or follow-up care factors (list provided in next section). Other conditions which may be of interest, such as mental and behavioural diagnoses post injury event, postsurgical infections, etc, will only be included in the episode selection, if they also have diagnosis codes, which refer to the injury, or refer to musculoskeletal conditions, or refer to follow-up care factors in at least one of the diagnosis codes in the string.

Identification of transport or work-related injury ambulance records

Selection of records from ambulance will occur in a two-step process as ambulance data do not record a flag to indicate an attendance is due to a work-related incident. The first step will use specific codes known to identify most transport-related cases. In the first step, the first extract of transport-related cases will be selected using any of the following criteria:

- ▶ *Medical Priority Dispatch Software Code 29*=Traffic/Transportation Accidents, or
- ▶ *Electronic Ambulance Record Form*: Case Nature=Bicycle collision; Motorcycle collision; Motor vehicle collision; Pedestrian collision.
- ▶ *Digital Ambulance Record Form (DARF)*: Cause of Injury=Car/Van, Motorcycle, Other vehicle, Pedal Cycle, Pedestrian, Truck/Bus.

In the second step, the researcher will provide the ambulance data provider via Queensland Health SALU, with the project ID for all cases which have been flagged as being work-related through the ED, QHAPDC or OIR WCRD and any additional transport cases which have been flagged in any of the other data sources and the

ambulance data provider will extract the content data for these cases and provide them to the researcher. The process for this is described in more detail in the following section on Data Linkage.

Identification of index episode of transport or work-related injury emergency department presentations and hospital admissions

To be eligible for inclusion in the emergency or hospitalisation cohort, a patient had to have at least one episode meeting the criteria for an index episode and have one or more codes indicating the episode was either transport related or work related:

- ▶ in EDC: an ICD-10-AM principal diagnosis code in the range S00-T75 or T79³⁴ AND
 - i. Payment class=Motor Vehicle Other, Motor Vehicle Other Ineligible, Motor Vehicle Qld, Motor Vehicle Qld Ineligible, Motor Vehicle Queensland, Motor Vehicle Queensland Ineligible, Workers Compensation Other, Workers Compensation Other Ineligible, Workers Compensation Queensland, Workers Compensation Queensland Ineligible OR
 - ii. Presenting complaint code (where available) = 9031 -Cycle-related, 9034-MBC/Quad-Driver, 9035-MBC/Quad-Passenger, 9036-MVC-Driver, 9037-MVC-Passenger, 9041-Crash-Other vehicle, 9042-Pedestrian OR
 - iii. Patient matches any of the transport or work-related cohort in any of the other data sources.
- ▶ in QHAPDC: an ICD-10-AM principal diagnosis code in the range S00-T75 or T79, and care type=Acute Care AND
 - i. Funding source=Motor vehicle third party personal claim, Workers compensation OR
 - ii. ICD-10-AM external cause code=V00xx-V89xx OR U730x OR

- iii. ICD-10-AM principal or other diagnosis code=Z041 or Z042
- iv. ICD Type 'PD' or 'OD' = ICD code Z041 Examination and observation following transport accident OR
- v. Patient matches any of the transport or work-related cohort in any of the other data sources.

Identification of subsequent episodes related to transport or work-related injury emergency department presentations and hospital admissions

To select subsequent episodes potentially related to the index transport or work-related injury event, patients who are flagged in any of the transport or work-related data sources who have a subsequent emergency department presentation or hospitalisation where the principal diagnosis for the episode is within the following International Classification of Diseases 10th revision, Australian Modification (ICD-10-AM) chapters will have these episodes of care included:

- ▶ CHAPTER 13: Diseases of the Musculoskeletal System and Connective Tissue (M00–M99).
- ▶ CHAPTER 19: Injury, Poisoning and Certain Other Consequences of External Causes (S00–T98).
- ▶ Selected codes from Chapter 21: Factors Influencing Health Status and Contact with Health Services:
 - Z02 Examination and encounter for administrative purposes.
 - Z04 Examination and observation for other reasons.
 - Z09 Follow-up examination after treatment for conditions other than malignant neoplasms.
 - Z42 Follow-up care involving plastic surgery
 - Z44 Fitting and adjustment of (external) prosthetic device.
 - Z45 Adjustment and management of drug delivery or implanted device.
 - Z46 Fitting and adjustment of other devices.
 - Z47 Other orthopaedic follow-up care.
 - Z48 Other surgical follow-up care.
 - Z50 Care involving use of rehabilitation procedures.
 - Z74 Problems related to care provider dependency.
 - Z75 Problems related to medical facilities and other healthcare.

Using these broad inclusion criteria will allow the research team to gain insight into how acute and sub-acute diagnosis codes are used across an injured patient's health and compensation journey.

Identification of transport or work-related injury aeromedical retrievals/transfers of injured people

All people with a transport or work-related injury mechanism recorded on the RSQ database who were transported

for definitive care (ie, either from the scene or from a referring hospital) by helicopter or fixed wing transport will be included in the cohort. Similar to the process undertaken with the Ambulance records, any RSQ record which links to any of the other cohort records in QAS, EDC, QHAPDC or death registry sources will also be included, with this second phase likely to extract most records as limited mechanism/activity-specific information is recorded in retrieval services data.

Identification of injury compensation claim records (motor vehicle, workers' compensation or NISQ)

All compulsory third-party insurance claimants, workers' compensation claimants and NISQ claimants who submitted a physical injury claim and were recorded on either the MAIC CTP PIR, OIR WCRD or NISQ data systems for an incident occurring between 1 January 2011 and 31 December 2021 will be included in the cohort. The injury-related workers' compensation claims will be selected using the Type of Occurrence Classification System codes which refers to injuries and musculoskeletal conditions. While acute injury events are the foci of this study, workers' compensation claims for musculoskeletal conditions are included for completeness as these more gradual onset conditions may have a preceding triggering acute injury event captured in the health data cohort within the 2 years prior to the musculoskeletal claim.

Identification of transport or work-related injury deaths

All injury-related death records where the underlying cause of death is coded to V01–V89 or Y85 or any death records that can be linked to one/more records extracted for the study cohorts described above, with a date of death occurring between 1 January 2011 and 31 December 2021, will be included in the cohort.

Data linkage

The Queensland Health SALU²⁵ will undertake the person-level data linkage in accordance with the Queensland Data Linkage Framework and this is depicted in figure 3. For cases meeting the inclusion criteria, personal information in the form of name, address and date of birth as well as a unique project identifier, will be provided by the data custodians to SALU only. All other details, such as clinical data, will remain with the data custodians and will not be accessible to SALU. This 'separation principle' protects the privacy of individuals, ensuring linkage units are not privy to the circumstances or details of the individuals' inclusion in the data set. The linkage of an individual's records within and across data collections is conducted using deterministic and probabilistic methods, and the available personal and demographic data in those collections will be used to match records. Record groups with uncertain matches in probabilistic linkage, between the cut-offs (upper 0.8 and lower 0.2 probability), were clerically reviewed. After completing the data linkage, SALU will assign a linkage ID to the personal information, and a project ID. This information will then be sent back to the

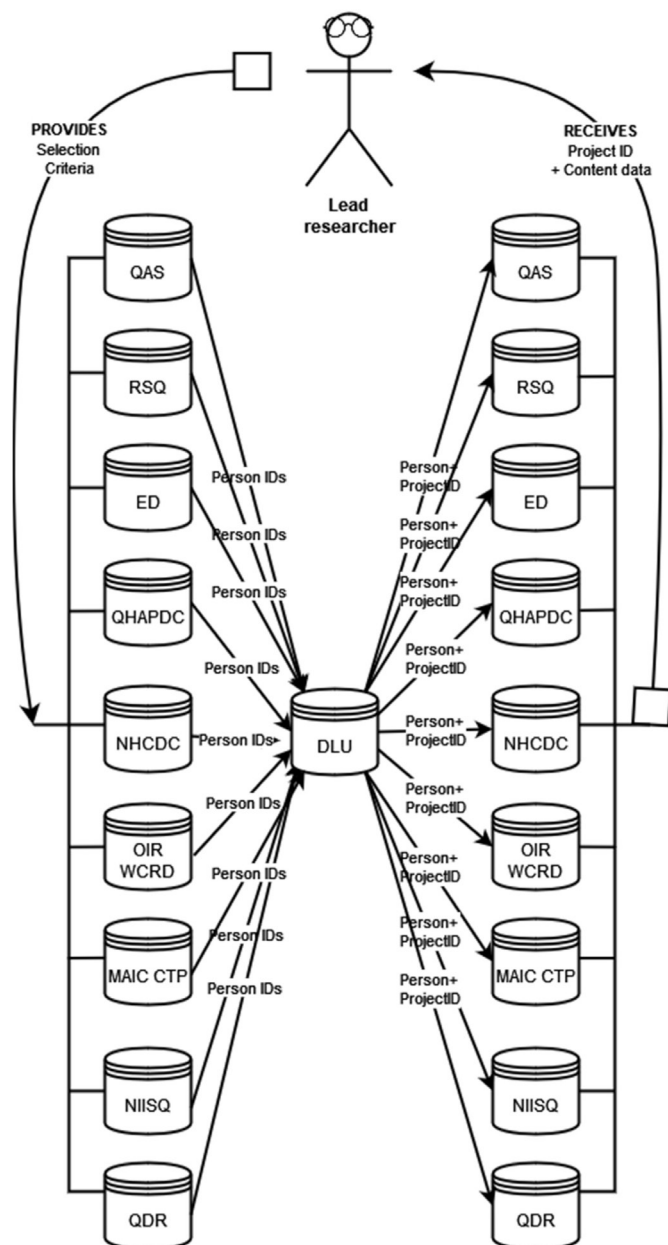


Figure 3 Schematic of data linkage process. CTP, Compulsory Third Party; ED, Emergency Department; MAIC, Motor Accident Insurance Commission; OIR WCRD, Office of Industrial Relation Workers Compensation Regulator Database; QAS, Queensland Ambulance Service; QDR, Queensland Deaths Registry; QHAPDC, Queensland Hospital Admitted Patients Data Collection; RSQ, Retrieval Services Queensland; DLU Data Linkage Unit.

data custodians to extract the relevant content/clinical data and to merge records with the linkage IDs. Linkage IDs and content/clinical data will then be provided to the research team with no identifying information attached.

To enable the second extract of eligible QAS records (see the Identification of transport or work-related injury ambulance records section), the linkage ID and the first date for each of the work-related injury records identified in MAIC CTP PIR, OIR WCRD, EDC or QHAPDC will first be provided by the researchers to the SALU. SALU

will then provide the relevant project identifiers to the QAS data service to enable extraction of the second batch of relevant QAS records for these patients. QAS will then provide the content data and project identifiers for these patients to the researcher to supplement the first data extract.

Data management

Removing duplicate records

As each of the datasets comes from routine administrative data collections, occasional duplication of records is expected to occur. Each data set will be reviewed, and a conservative approach used for detection and deletion of suspected duplicate records depending on the data source. For health data, records will only be considered duplicates if all data fields are identical as patients may present multiple times in the same day for treatment at the same facility and each row of data may provide unique information about the patients' journey. As healthcare episode data are grouped into encounter data, so that episodes occurring in close proximity to each other are considered part of the same encounter, duplicate rows will have minimal impact on the analysis and hence a conservative approach is employed to ensure valuable data are not removed unnecessarily. For compensation data, it is reasonable that duplicate records are identified only if custodians advise that the suspected duplicate case was superseded by other more complete record.

Record order sequencing within data sets

To construct and enable analysis of patient journeys over time, sequencing of records to best replicate the patients' actual movement through the health and compensation systems is an important first step in data management. As a general rule, sequencing is based on the starting date for records to reflect the initiation of each health/compensation system contact. If an end date for a record is available, it can also be used to sort records consecutively for cases where two records had the same start date but different end dates. Using the rules above, a file sequence variable will be added to records in each data set separately.

Joining and sequencing healthcare records with compensation and death records

To enable creation of a sequencing variable to reflect the order with which events unfold, MAIC CTP, OIR WCRD, NIISQ data, QAS, EDC, QHAPDC, RSQ data and QDR data will be merged into a single file, incorporating the primary keys from each data set, basic person data, start dates and times, end dates and times and injury information.

Sequencing of the merged records will be undertaken in two stages. The first stage will involve sorting the records by person ID, start date and source. Where an MAIC CTP or NIISQ record occurs on the same day as a health record, the compensation record is sequenced before the health record given MAIC CTP/NIISQ captures the crash date,

which precedes the healthcare encounter. In contrast, where an OIR WCRD record occurs on the same date as a health record, the OIR WCRD record is sequenced *after* the health record, given OIR WCRD records capture the date the workers' compensation claim was lodged (intimation date), which is always after the injury event and after initial health treatment is provided (if on the same day). As expected, death records will be sequenced last.

The second stage will involve resequencing the health records using both the date and time variables relating to the start and end of each record; time data only exists in the health datasets. Compensation and death records will retain the sequence number received during the first stage.

Grouping records into encounters

Using the merged data set, records will be grouped into encounters where there is less than 48 hours between the end date for a record and the start date of a subsequent record. This broad time-based logic is needed for grouping encounters across the different databases due to data quality variants in recording date fields and discrepancies in start/end date time fields caused by known differences in timestamping between EDC and QHAPDC data.³⁵ Administrative codes, such as referral source, transfer status, admission and separation modes, have previously been used by health agencies to sequence episodes of care,³⁶ however, given compensation records are included within an encounter in this study, only time-based logic will be used.

Flagging index records and encounters

The final data management step for the merged dataset will involve identifying and flagging the index record. As stated above, an MAIC CTP PIR or NIISQ record will always be flagged as the index record where one exists. For all other scenarios, the index record will be flagged using the index episode criteria for EDC (ie, ICD-10-AM principal diagnosis code S00-T75, T79) or QHAPDC (ICD-10-AM principal diagnosis code S00-T75, T79 and care type=Acute). Where an index record forms part of an encounter, all records within that encounter will be flagged as belonging to the index encounter. Encounters will then be sequenced using the same rules stated above for records.

Selecting transport-related and work-related cohorts

Tables 2 and 3 describe the data fields and codes which will be used to identify transport-related injuries and work-related injuries. The first record in the merged data set which is identified as transport-related or work-related injury will be flagged as the index encounter; all subsequent records (regardless of being flagged as transport-related or work-related injury) will be counted sequentially and included as subsequent records post the index encounter. Depending on the research questions being examined, certain subsequent records will be included or excluded, as appropriate. For example, if the

Table 2 Selection criteria for flagging index encounters for transport-related injuries

Data source	Data field	Code range	
QAS Data	MPDS Code 29	Traffic/transportation accidents	
		eARF: case nature	Bicycle collision
			Motorcycle collision
			Motor vehicle collision
	DARF: cause of injury	Paediatric collision	
		Car/Van	
		Motorcycle	
		Other vehicle	
		Pedal cycle	
		Pedestrian	
Truck/bus			
MAIC CTP PIR	N/A	All physical injury cases (excluding those for mental health only conditions)	
OIR WCRD	Mechanism	'Vehicle accident'	
EDC	Payment status	Motor vehicle other	
		Motor vehicle other ineligible	
		Motor vehicle Queensland	
		Motor vehicle Queensland ineligible	
		Presenting complaint	9031-cycle-related
			9034-MBC/quad-driver
	9035-MBC/quad-passenger		
	9036-MVC-driver		
	ICD-10-AM principal diagnosis	9037-MVC-passenger	
		9041-crash-other vehicle	
9042-pedestrian			
Z04.1 Examination and observation following transport accident			
QHAPDC	Funding source	Motor vehicle third party personal claim	
	ICD-10-AM external cause code	V00.xx-V89.xx	
	ICD-10-AM principal or other diagnosis	Z04.1 Examination and observation following transport accident	

CTP, Compulsory Third Party; DARF, Digital Ambulance Record Form; eARF, Electronic Ambulance Record Form; EDC, Emergency Department Collection; MAIC, Motor Accident Insurance Commission; MPDS, Medical Priority Dispatch Software; OIR WCRD, Office of Industrial Relation Workers Compensation Regulator Database; PIR, Personal Injury Register; QAS, Queensland Ambulance Service; QHAPDC, Queensland Hospital Admitted Patients Data Collection.

question asks about readmissions for treatment of injuries which are *related* to the index encounter, a more restrictive selection would be used. In comparison, a question relating to how many health service encounters a person has after an index injury event may include a broader selection of records. Details relating to the method of

Table 3 Selection criteria for flagging index encounters for work-related injuries

Data source	Data field	Code range
QAS data	Only QAS records linking to another identified work-related injury record are included, given there are no codes to identify work-related injuries in ambulance data	
OIR WCRD	Injury group description	Intracranial injuries
		Fractures
		Wounds, lacerations, amputations and internal organ damage
		Burn
		Injury to nerves and spinal cord
		Traumatic joint/ligament and muscle/tendon injury
		Other injuries
EDC	Payment status	Workers compensation other
		Workers compensation other ineligible
		Workers compensation Queensland
		Workers compensation Queensland ineligible
	ICD-10-AM principal diagnosis	Z04.2 examination and observation following work accident
QHAPDC	Funding Source	Worker's compensation
	ICD-10-AM external cause code	U73.0x
	ICD-10-AM principal or other diagnosis	Z04.2 examination and observation following work accident

EDC, Emergency Department Collection; OIR WCRD, Office of Industrial Relation Workers Compensation Regulator Database; QAS, Queensland Ambulance Service; QHAPDC, Queensland Hospital Admitted Patients Data Collection.

selecting subsequent encounters will be included within individual future manuscripts.

Analysis plan

Appropriate descriptive statistics (frequencies and percentages, means and SD and medians and IQR) will be used to first describe the injured cohort within each data source *separately*, based on data recorded in the index record; this includes details relating to demographics

(age, sex), injury/residential location, injury mechanism, injury diagnoses, compensation details (where relevant), treatment costs and outcomes (hospital admission, Intensive Care Unit admission, discharge destination, readmission postdischarge, postdischarge complications, claim/no claims, mortality). Reporting categories will be standardised for each variable prior to analysis, particularly those key variables that exist in each data source (eg, injury mechanism). Where a person's injury encounter includes records from more than one data source, concordance between the sources on the key variables will be undertaken using appropriate statistical methods (eg, Cohen's/Fleiss' Kappa/McNemar test, etc) and graphical representations, depending on the structure (ie, dichotomous, nominal, ordinal) of the variable being analysed. Linkage rates will also be calculated for 'expected linkages' across the sources (eg, where a QHAPDC record indicates a work-related compensable injury and there is/is not and OIR WCRD record present in the merged file). Health service use profiles will be described for specific cohort groups (eg, transport-related injury, work-related injury, compensation claimants, non-compensable injuries) and compared between cohorts (eg, transport-related injury with known health system contact with no compensation claim, compared with the same group with a compensation claim) using appropriate parametric and non-parametric statistical methods depending on the key variable's distribution. Cost profiles, using NHCDC costs for hospital admissions, appropriate average costs for QAS attendances and ED presentations and compensation costs will also be developed using the same strategy. Relevant visualisation techniques that have accepted use in healthcare settings (eg, Sankey diagrams)³⁷ will be used to demonstrate patient movement/trajectory through the health and compensation systems. In addition, relevant geospatial techniques, such as Bayesian spatial models,³⁸ will be used to explore inequalities in injury incidence, health service use profiles and patient trajectories by geographic location. Finally, regression models will be considered for examining predictive factors relating to patient outcomes and factors predictive of concordant information between data sources. The type of regression model will depend on the distribution of the dependent variable in each analysis.

PATIENT AND PUBLIC INVOLVEMENT

There was no patient involvement in the design of this data linkage study.

DISCUSSION

Linking health data with compensation data are vital to understand the concordance and consistency of data across sectors, to provide richer clinical pathway data to compensation schemes and richer contextual data to health sources, to examine profiles, patterns, trends and outcomes of injured patients and to compare those

who claim, and those who are eligible but do not claim. The cost of healthcare for injured compensable patients is substantial for all three insurance schemes showing an increasing need for accurate and comprehensive data on injury severity, treatment and outcomes to enable scheme modelling, monitoring and forecasting. To more fully use health data sources in compensation scheme modelling; however, it is important to understand the quality, concordance, completeness and value add of these data to existing compensation scheme data. The insurance scheme regulators currently have limited information about claimants' clinical pathways, pre-existing conditions, circumstances, severity and type of injuries sustained, and they have no visibility of the profiles of individuals who do not claim for injuries sustained in transport or work-related incidents.

The CTP hospital and emergency services levy is based on an estimate of the extent of road trauma which is covered by CTP insurance, but the actual proportions are unknown. The quality of recording of compensable status by emergency and hospital services is also unknown. Investigation of the proportion of road trauma covered by CTP insurance, and coding quality, will inform future decisions regarding levy estimates. Hospital data may provide a more detailed source of injury coding and severity estimation to complement compensation data, and its inclusion will improve understanding of claimant physical outcomes and aid in scheme premium calculation. It is unknown whether there are differences in patient initial hospital treatment, costs and outcomes depending on whether managed through CTP compensation, NISQ, Workers' Compensation or through no insurer. Similarly, effects on patient outcomes due to time from incident to hospital treatment and/or submitting a claim are unknown. Comparing the findings will inform scheme management approaches.

WorkSafe, NISQ and MAIC will benefit from an improved understanding of the 'real' burden of occupational and transport injury in the state. This will include the potential identification of injury trends apparent in health data sets that have not yet manifested in compensation data sets, thus facilitating business planning for impacts on future scheme performance. WorkSafe will obtain an earlier and clearer identification of workers at greatest risk for occupational injury, allowing the organisation to undertake more targeted occupational health and safety initiatives. MAIC and NISQ will benefit from earlier identification of levels of severity and costs of transport-related injuries to inform targeted investment in road safety initiatives.

The research will address this gap in the current understanding of compensable and non-compensated injuries in Queensland. More broadly, the study will enable the feasibility of and requirements for linkage of data relating to transport-related and work-related injuries to be determined.

Limitations

As this is a retrospective observational study, interpretations will be limited to associations rather than causations. Lengthy ethics, governance, data provision and data management steps required for data linkage studies are expected to impact the recency of the data once findings are published. Furthermore, strict data governance restrictions in Queensland limited follow-up data to only that which could reasonably be considered to pertain to direct physical injury follow-up care, which reduced the breadth of data regarding psychological impacts of injury, despite there being considerable evidence that psychological impacts of injury can be a significant factor in ongoing health service usage.¹⁵ Within this study, comorbid diagnoses of psychological impacts of injury can be examined provided there is also treatment for ongoing physical injuries, and the researchers aim to include these comorbid diagnoses in their analysis and continue working with governance bodies to promote the importance of follow-up care data provision for both physical and psychological injury to provide a more complete understanding of the ongoing burden of injury.

Additionally, the EDC data are limited to public emergency departments as private emergency department data are not included; this will limit some of the case capture of presentations to private emergency departments. This may impact more on work-related presentations, where anecdotal evidence suggests that compensable work-related injury cases are more likely to present to private hospital emergency departments. However, given this study will use linked compensation data for these cases along with linked hospitalisation records, it is likely that at least some of the records for these cases will be captured.

Administrative health data have limited details regarding specific circumstances contributing to an injury occurring and lacks rich information regarding patient quality of life and recovery after an injury event. However, these data sources do enable a population-level comparison of diagnoses, causes, interventions, health service use and costs as well as providing a more thorough understanding of the patient journey through the health and compensation systems after an injury event. Finally, while the data linkage process is well established with significant quality assurance procedures included to ensure linked data have a very high probability of accurate matches, there is always a potential for error and this needs to be acknowledged when providing interpretation of the study findings.²⁵

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REFERENCES

- Giummarra M, Ioannou L, Gibson S, *et al.* The relationship between compensation and recovery following A motor vehicle accident: A systematic review. 2013;51.
- Spearing NM, Connelly LB. Is compensation "bad for health"? A systematic meta-review. *Injury* 2011;42:15–24.
- Elbers NA, Hulst L, Cuijpers P, *et al.* Do compensation processes impair mental health? A meta-analysis. *Injury* 2013;44:S0020-1383(11)00571-7:674–83.:
- Prang K-H, Hassani-Mahmooei B, Collie A. Compensation research database: population-based injury data for surveillance, linkage and mining. *BMC Res Notes* 2016;9:456
- Murgatroyd DF, Harris IA, Tran Y, *et al.* The association between seeking financial compensation and injury recovery following motor vehicle related orthopaedic trauma. *BMC Musculoskelet Disord* 2016;17:282
- Murgatroyd DF, Casey PP, Cameron ID, *et al.* The effect of financial compensation on health outcomes following musculoskeletal injury: systematic review. *PLoS One* 2015;10:e0117597
- Queensland Government Insurance Fund. Medical indemnity. Available: <https://qgif.qld.gov.au/policy-information/medical-indemnity/> [Accessed 1 Nov 2022].
- Queensland Legislation. Victims of crime assistance act 2009. Queensland The State of Queensland; 2017. 190.
- WorkCover Queensland. A status review 1997-2011: worksafe; 54.
- Motor Accident Insurance Commission. CTP scheme overview. 2021. Available: <https://maic.qld.gov.au/scheme-knowledge-centre/ctp-scheme/> [Accessed 5 Apr 2022].
- National Injury Insurance Scheme Queensland. About the scheme. Available: <https://niis.qld.gov.au/about-the-scheme/> [Accessed 5 Apr 2022].
- Collie A, Lane TJ, Hassani-Mahmooei B, *et al.* Does time off work after injury vary by jurisdiction? A comparative study of eight Australian workers' compensation systems. *BMJ Open* 2016;6:e010910
- Lane TJ, Sheehan L, Gray S, *et al.* Regional differences in time off work after injury: a comparison of Australian states and territories within a single workers' compensation system. *J Occup Rehabil* 2022;32:252–9.
- Harrington R, Foster M, Fleming J. Experiences of pathways, outcomes and choice after severe traumatic brain injury under no-fault versus fault-based motor accident insurance. *Brain Inj* 2015;29:1561–71.
- Ruseckaite R, Gabbe B, Vogel AP, *et al.* Health care utilisation following hospitalisation for transport-related injury. *Injury* 2012;43:1600–5.
- Melita J G, Joanna F D, Alex C, *et al.* An evaluation of the association between fault attribution and healthcare costs and trajectories in the first three years after transport injury. *Injury* 2021;52:S0020-1383(21)00801-9:3309–19.:
- Giummarra MJ, Murgatroyd D, Tran Y, *et al.* Health and return to work in the first two years following road traffic injury: a comparison of outcomes between compensation claimants in victoria and new south wales, australia. *Injury* 2020;51:S0020-1383(20)30561-1:2199–208.:
- Collie A, Sheehan L, Di Donato M. Variation in general practice services provided to Australian workers with low back pain: a cross-jurisdictional comparative study. *J Occup Rehabil* 2022;32:203–14.
- Lane TJ, Berecki-Gisolf J, Iles R, *et al.* The impact of long-term workers' compensation benefit cessation on welfare and health service use: protocol for a longitudinal controlled data linkage study. *Int J Popul Data Sci* 2021;6:1419
- Maas ET, Koehoorn M, McLeod CB. Descriptive epidemiology of gradual return to work for workers with a work-acquired musculoskeletal disorder in British Columbia, Canada. *J Occup Environ Med* 2020;62:113–23.
- The Social Research Centre. 2021 national return to work survey report 2022. draft 3 ed: safe work australia; 2022. 71.
- Gillespie C. Safety in supply chains: evaluating sources of evidence [dissertation]. Queensland University of Technology; 2020.
- Lane T, Collie A, Hassani-Mahmooei B. Work-related injury and illness in australia 2004 to 2014. what is the incidence of work-related conditions and their impact on time lost from work by state and territory, age, gender and injury type? Melbourne (AU), 54.
- Safe Work Australia. Work-related injuries in australia, 2005–06. Health and community services industry: safe work australia; 2009. 11.
- Queensland Health. Queensland data linkage framework in statistical analysis and linkage unit. statistical services branch. Department of Health, Queensland Health; 2020. 27.
- Queensland Government Statistician's Office. Population estimates. state and territories. 2022. Available: <https://www.qgso.qld.gov.au/statistics/theme/population/population-estimates/state-territories> [Accessed 1 Nov 2022].
- Queensland Health. Hospital and health service facility profiles. 2022. Available: <https://www.health.qld.gov.au/services> [Accessed 1 Nov 2022].
- Department of Health. Annual report 2020-2021. Brisbane The State of Queensland (Queensland Health); 2021. 33.
- WorkSafe Queensland. Work-related injuries. 2022. Available: <https://www.worksafe.qld.gov.au/claims-and-insurance/work-related-injuries> [Accessed 1 Nov 2022].
- Motor Accident Insurance Commission. Who can claim. 2022. Available: <https://maic.qld.gov.au/for-injured-people/who-can-make-a-claim-2/> [Accessed 1 Nov 2022].
- Motor Accident Insurance Commission. Nominal defendant. 2021. Available: <https://maic.qld.gov.au/about/nominal-defendant/> [Accessed 2 Jun 2022].
- WorkSafe Queensland. Introduction of a private hospital services table of costs. 2021. Available: <https://www.worksafe.qld.gov.au/service-providers/working-with-workcover/introduction-of-a-private-hospital-services-table-of-costs> [Accessed 2 Jun 2022].
- Vallmuur K, McCreanor V, Cameron C, *et al.* Three es of linked injury data: episodes, encounters and events. *Inj Prev* 2021;27:479–89.
- AIHW: Pointer SC. Trends in hospitalised injury, australia 2007–08 to 2016–17. injury research and statistics series no.124. cat. no.INJCAT 204. Canberra AIHW; 2019. 166.
- Queensland Health. Comparison of EDIS and QHAPDC time stamps, 2012. Health statistics unit; 2013. 16.
- Hendrie D, Miller TR, *et al.* Incidence and costs of injury in western australia. Department of Health WA; 2016. 108.
- Lamer A, Laurent G, Pelayo S, *et al.* Exploring patient path through sankey diagram: a proof of concept. *Stud Health Technol Inform* 2020;270:218–22.
- MacNab YC. Bayesian spatial and ecological models for small-area accident and injury analysis. *Accid Anal Prev* 2004;36:1019–28.