REPORT

Agency for Clinical Innovation

Summary of a linked data analysis of the NSW trauma system

Critical Care, Acute, Trauma and Emergency public health register

NSW GOVERNMENT

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Glossary

APDC	Admitted Patient Data Collection
CATE public health register	Critical Care, Acute, Trauma and Emergency public health register
ED	Emergency department
GSA HEMS	Greater Sydney Area Helicopter Emergency Medical Service
HEET	Health Economics and Evaluation Team
ITIM	Institute of Trauma and Injury Management
MTS	Major trauma service
NSWAS	NSW Ambulance Service
PTS	Paediatric trauma service
RTS	Regional trauma service

Executive summary

Severe injury remains one of the most important preventable causes of death and long term disability in the community. The NSW Trauma System was implemented almost 30 years ago to meet the needs of severely injured patients, and address the challenges of treating and transporting them to designated specialist trauma centres, often across vast distances.

The summary report describes a linked data analysis of NSW trauma system processes and outcomes. This represents a system-wide quantitative analysis of the NSW Trauma System, as a follow up to the *Trauma Patient Outcome Evaluation Qualitative Report* released in November 2016.

Findings were based on the Critical Care, Acute, Trauma and Emergency (CATE) public health register, which was established by the NSW Agency for Clinical Innovation (ACI). The CATE public health register links the NSW Ambulance Service (NSWAS), hospital, fact of death and the NSW major trauma minimum dataset (Collector) into one dataset. This is the first time data can provide comprehensive information about the patient journey from scene of injury to acute care hospital discharge.

This data analysis was led by the ACI Health Economics and Evaluation Team (HEET), in collaboration with the ACI Institute of Trauma and Injury Management (ITIM). The primary objectives were to:

- determine adult patient outcomes for Major Trauma Service (MTS) facilities and Regional Trauma Service (RTS) facilities after transport from the scene under ambulance protocol T1 (major trauma), stratified by metropolitan and rural scene of injury
- determine secondary transfer referral patterns and categorise them according to the adult and paediatric critical care tertiary referral network policy (PD2010_021, PD2010_030).

The following key findings are outlined in this report:

- Only 32% of transported patients who met the criteria for major trauma had the trauma protocol T1 recorded. This suggests a very high under-triage rate, especially in the over 60 year old age groups.
- On average, 90% of adult patients and 86% of paediatric patients transported under protocol T1 arrived at their destination within one hour.
- The majority (92%) of secondary trauma transfers were conducted as per the trauma/critical referral networks.
- The number and type of trauma related procedures conducted varied considerably between trauma centres.

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Introduction

Trauma care involves the interaction and coordination of multiple agencies, each with their own sources of clinical information. Therefore, to properly evaluate trauma systems of health care, these data silos must be combined and integrated. The CATE public health register links various sources of information into one comprehensive dataset that, for the first time, gives a picture of the patient journey from scene of injury to acute care hospital discharge.

The CATE major trauma cohort comprised all patients with any admission to NSW public hospitals who were linked to one or more records in the NSW Trauma Collector database (the Collector cohort) or who had any admission with one or more selected ICD10-AM principal or subsequent diagnosis codes indicative of major trauma Admitted Patient Data Collection (the APDC major trauma cohort). Analyses covered the period of calendar years 2012-2015.

Readers who require full details of the methods and results of this analysis should refer to the full report.

The data analysis provides information on:

- ambulance trauma protocols and transport outcomes
- secondary transfer referral patterns and policy compliance
- trauma related procedures.

Although there is a focus on trauma clinical outcomes, this report is designed to be interpreted in the context of an understanding of the principles and limitations of the data linkage process.

Ambulance trauma protocols and transport outcomes

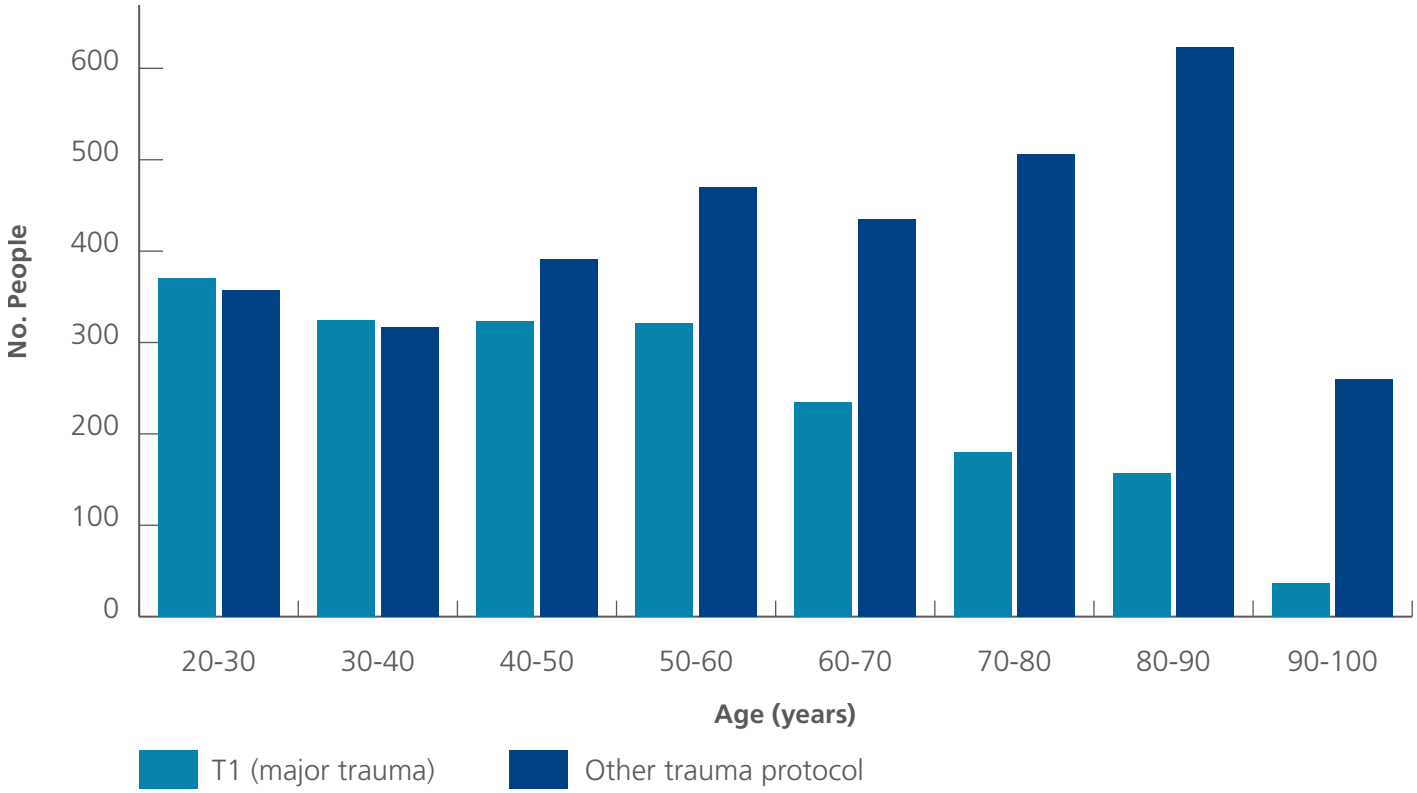
Trauma protocols

Results suggest that a large proportion of eligible transports (67.8%) were not assigned protocol T1. While under-recording of protocols in ambulance data overall may contribute to this observation, the apparent under-triage rate was still high when excluding transports where no trauma protocol was recorded. The significant proportion of patients older than age 60 in the apparent under-triage group was also notable.

Looking at patients transported under ambulance protocol T1, most patients (91%) were transported to a MTS or a RTS and only about 5% to a non-trauma-service local hospital. This contrasted with about 40% of patients transported to a non-trauma service local hospital under trauma protocols other than T1.

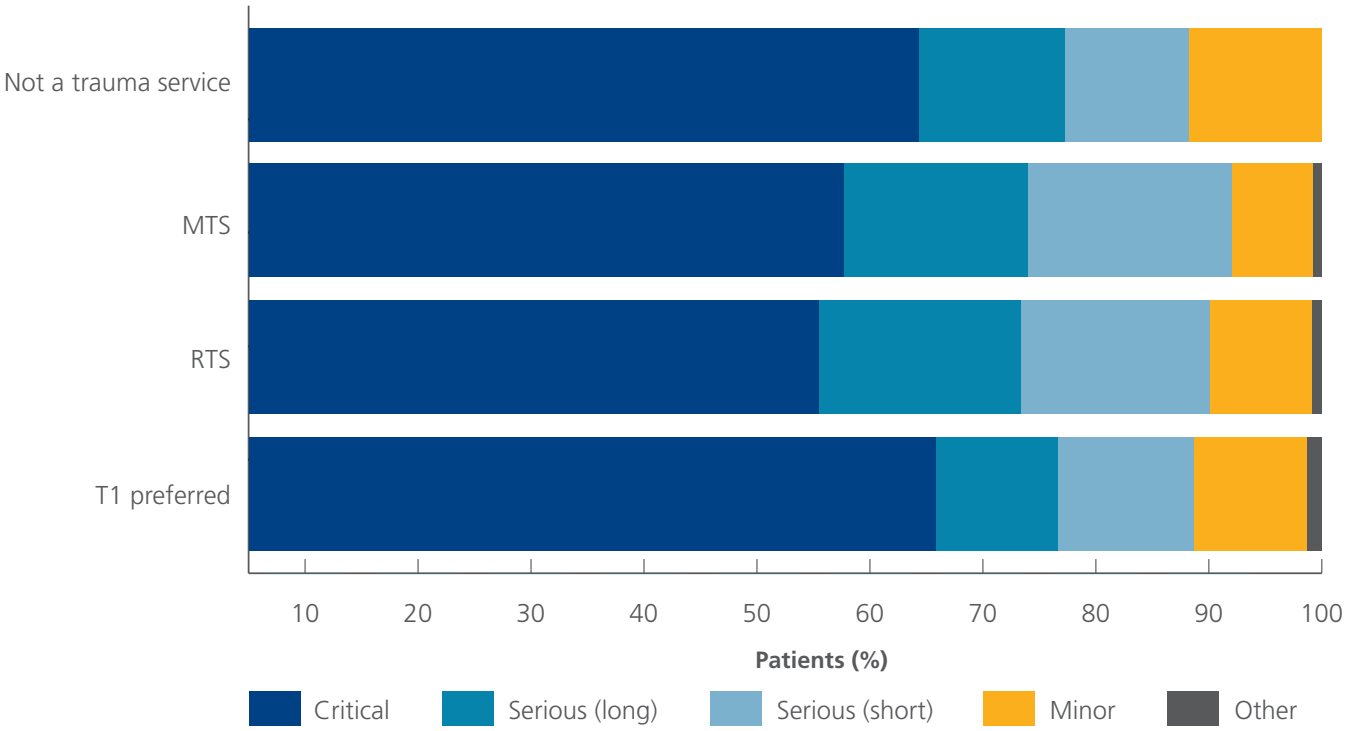
Analysis of outcome by remoteness of injury location for transport under protocol T1 found a greater proportion of critical outcomes for outer regional, remote or very remote locations. This could reflect a different case mix in these locations or a greater proportion of immediate transfers to higher level facilities after initial emergency department (ED) arrival.

Figure 1: All transports from scene for major trauma by age and ambulance trauma protocol, Collector data, NSW 2012-2015



Compared with patients transported under protocol T1, a greater proportion of patients transported under a non-trauma protocol or non-T1 trauma protocol were older than 60 years, with the imbalance increasing with increasing age beyond 60 years (see Figure 1).

Figure 2: Patient outcomes of adult transports from scene under protocol T1 by trauma service type, NSW 2012-2015



As shown in Figure 2, most patients were transported to a MTS (72.7%) or a RTS (18.3%). Looking at the breakdown of outcomes within each trauma service type, of the patients transported to non-trauma services and T1-preferred hospitals, a greater proportion of these had a critical-outcome (62.7% and 64.2% respectively).

Transport times and outcomes under protocol T1

Road transport times for adult patients under protocol T1 followed the expected pattern. Patients transported from an inner regional location travelled for longer if the destination was a MTS or a RTS rather than a local hospital, but the median travel time was under the target of one hour. Nonetheless, scene to ED travel times were quite variable, and almost half of the transports to MTS were greater than one hour. Travel times from more remote locations were longer again, regardless of destination. However, as many rural major trauma cases are transported from the scene by helicopter, the present results are not representative.

Adult transports

This section outlines the median time between departure from the scene to arrival in ED for adult patients who were transported under ambulance protocol T1 direct from scene, according to remoteness category of the pickup location and the facility type of the destination.

Transport times were shortest from major city locations (median 21 minutes) and longest in outer regional, remote or very remote locations (median 58 minutes).

Transports from a major city location were overwhelmingly to a MTS destination (93.7%). Transports from an inner regional location were shortest to a T1-preferred or non-trauma service hospital (median time 18 minutes for both), intermediate in duration to a RTS hospital (median time 35 minutes), and longest to a MTS hospital (median time 50 minutes). Transports from an outer regional, remote or very remote location were shortest to a non-trauma service hospital (median time 28 minutes), intermediate in duration to a T1-preferred or RTS hospital (median time 51 minutes and 1 hour 3 minutes, respectively) and longest to a MTS hospital (median time 2 hours 27 minutes).

Paediatric transports

This section outlines the median time between departure from the scene to arrival in ED for paediatric patients who were transported under ambulance protocol T1 direct from scene, according to remoteness category of the pickup location and the facility type of the destination.

Transport times were shortest from major city locations (median 23 minutes) and longest in outer regional, remote or very remote locations (median 54 minutes).

Transports from a major city location were mostly to a paediatric trauma service (PTS) (49.8%) or MTS destination (41.4%). Transports from an inner regional location were shortest to a T1-preferred or non-trauma service hospital (median time 22 minutes and 15 minutes, respectively), intermediate in duration to a RTS hospital (median time 25 minutes) and longest to a PTS or MTS hospital (median time 1 hour 9 minutes and 55 minutes, respectively). Transports from an outer regional, remote or very remote location were few and mostly to a RTS (63.9%), T1-preferred hospital (16.7%) or non-trauma service hospital (13.9%).

Greater Sydney Area Helicopter Emergency Medical Service (GSA HEMS)

Median transport times by GSA HEMS (helicopter) were somewhat longer than road ambulance transports. This information was based on scene to arrival in ED for adult patients by remoteness category of the pickup location and the facility type of the destination.

Remoteness could not be assigned for 28.1% of the transport pickup locations, and of the remainder, 51.3% were from a major city location, 38.5% were from an inner regional location, and 10.2% were from an outer regional, remote or very remote location.

Transport times were shortest from major city locations (median 37 minutes) and longest in outer regional, remote or very remote locations (median 52 minutes). Transports from a major city location were overwhelmingly to a MTS destination (94.5%). Transports from an inner regional location were slightly shorter to a RTS hospital (median time 42 minutes) than to a MTS hospital (median time 47 minutes). Transports from an outer regional, remote or very remote location were shortest to a RTS hospital (median time 45 minutes) than to a MTS hospital (median time 1 hour 2 minutes).

Secondary transfer referral patterns and policy compliance

Overall, 92.1% of transfers were within the trauma referral network.

Initial transfers of ambulance-transported major trauma cases with a critical outcome were mostly from a non-trauma service hospital to a trauma service hospital. The 20% or so of cases that did not follow this pattern may have involved transfers to the specialist burn unit at Concord Hospital or the specialist spinal unit at Prince of Wales Hospital.

The small proportion of adult patient transfers that were outside the networks may have related to major trauma with head, burn or spinal injury. In particular, outside network transfers to Royal North Shore were possibly to the burns unit and to Royal Prince Alfred Hospital to the neurosurgery unit. Similarly, the large proportion of out of network transfers of paediatric patients to the Children's Hospital at Westmead was possibly due to burns patients.

Figure 3: Initial transfer of patients with a major trauma diagnosis and critical outcome, by trauma service type of origin and destination, NSW 2012-2015

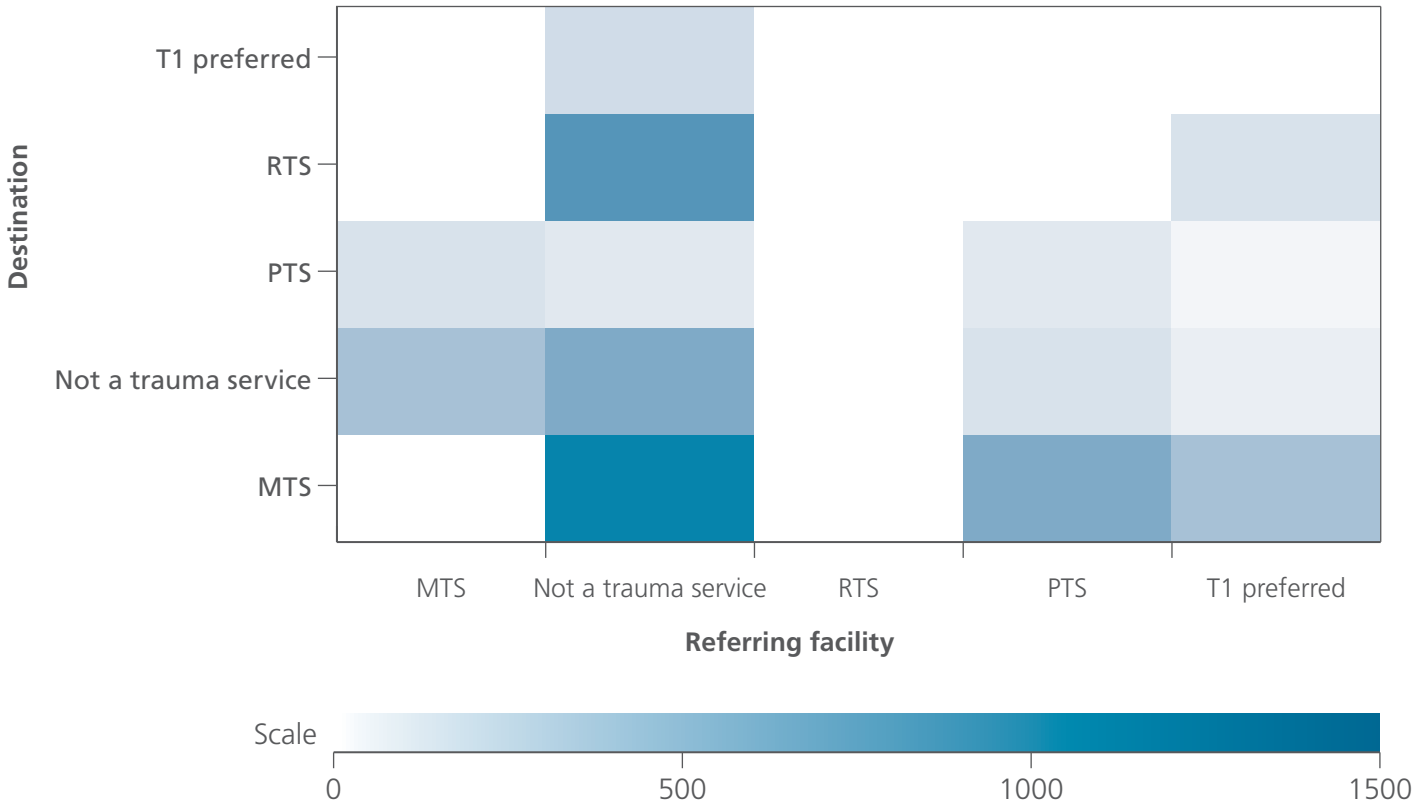


Figure 3 shows that the most frequent referring hospital type was a non-trauma service hospital (66.1%) and the most frequent destination hospital type was a MTS (49.2%). The destination was a MTS, RTS or PTS in 78.8% of cases. When the referring facility was a non-trauma service hospital or T1-preferred hospital, the destination was a MTS, RTS or PTS in 82.9% of cases.

Trauma related procedures

As expected, trauma related procedure rates were consistently higher in MTS than in RTS facilities. It was noted during the analysis that angio-embolisation is now as frequent as abdominal surgery.

In PTS facilities, the picture was mixed, with rates of some procedure types much lower than in MTS (e.g. abdominal procedures) and others not (e.g. intracranial procedures).

While a considerable number of trauma-related procedures were done in non-trauma service hospitals, the proportion varied by procedure type. Restricting the analysis to airway procedures and intracranial procedures, which appeared least likely to include non-trauma related cases, rates of procedures were about five and nine times higher (respectively) in MTS than in non-trauma service hospitals. Spinal procedures done at the spinal unit at Prince of Wales (a non-trauma service) may have contributed to the procedure count at non-trauma service hospitals.

Variation in procedure rates between individual MTS, RTS and PTS hospitals is in part reflected by specialisation. For example, the spinal cord injury service based at Royal North Shore and Royal Prince Alfred hospitals has a long established service in cardiothoracic surgery.

Figure 4: Rate (per 1000) of trauma-related procedures by trauma service type, CATE major trauma cases, NSW 2012-2015

Service Type	Facility	Abdominal	Airway	Angiography /embolisation	Cardiothoracic	Chest drain	Intracranial	Open orthopaedic	ORIF pelvis	Spinal
PTS	Children's at Westmead	14.5	9.4	6.8	18.8	40.1	79.4	15.4	4.3	6
	Sydney Children's	8.4	4.7	6.6	25.6	28.4	56.8	9.4	1.9	5.3
MTS	John Hunter	33.2	9.2	15.7	18.1	48.6	79.3	89.2	26.7	25.7
	Liverpool	39.1	16.7	14.4	32.6	78.6	59.8	58.4	8.2	4.7
	Royal North Shore	15.7	13.6	35	20.4	51.4	69	70.6	9.3	45
	Royal Prince Alfred	44.4	16.5	41.6	70.9	107.6	79.3	61.1	6.3	13
	St George	62.6	13.6	8.3	21.2	86.7	60.6	69.3	16	9.1
	St Vincents	13.3	15.1	21.9	55	90.7	77.9	49.7	9.3	6.5
	Westmead	39.9	21.9	23.7	32.7	73.1	57.7	90.2	19.5	11.9
RTS	Coffs Harbour	39.9	3.1	0.5	0.5	74.6	1.6	47.1	0.5	0
	Gosford	31.9	3.9	0.3	3.9	58.3	0	35.4	0.6	7.4
	Lismore	23.7	3.9	11.6	5.5	72.2	2.8	48.5	0.6	0
	Nepean	34	13.3	9.1	9.1	54.4	49.7	34.5	0	8
	Orange	41	8	8	3.7	72.2	0.6	53.8	1.8	4.3
	Port Macquarie	50	3.4	2.1	3.4	66.5	0	38.4	0	0
	Tamworth	22.3	2.3	0	1.2	62.7	0	47.5	0.6	0.6
	Tweed	22.4	7.6	0	15.2	52	0	26.5	1.3	2.7
	Wagga Wagga	32.8	6.1	4.6	0.5	61.4	0.5	54.2	0.5	7.7
	Wollongong	28.7	12.5	4.5	1.9	68.8	52.4	31.9	0	11.4

As shown in Figure 4, Royal Prince Alfred hospital had the highest rates of cardiothoracic procedures and chest drains, Royal North Shore had the highest rates of spinal procedures, and St George had the highest rates of abdominal procedures. Among the RTS hospitals, rates of airway and intracranial procedures were considerably higher at Nepean and Wollongong than other locations.

Limitations

The APDC major trauma cohort (as defined in the *NSW Trauma Services Plan (2009)* had a high false positive rate.

CATE has been designed with the assumption that cases would be found in the APDC as well as the specialist trauma (Collector), burns and spinal injury datasets. This design makes it less suitable for analysing the outcomes of patient cohorts with an index ambulance or ED event. To give a specific example, CATE is not suitable for measuring the degree of over-triage among patients transported under ambulance protocol T1. Expanding CATE to include these cohorts would require a suitable (major) trauma case definition for ambulance or ED. Similarly, trauma-related procedures in patients with relatively minor injuries may be of interest, but fall outside CATE and may be better analysed in a complete inpatient dataset.

The linkage rate between Collector and APDC within CATE was markedly lower than that between other datasets and APDC, introducing added uncertainty into the results. Low linkage rates for children were a key limitation and require investigation. Improvements may require probabilistic linkage using personal identifiers including name and address, in turn necessitating major changes to the data governance of Collector.

Next steps

There are a number of considerations for the ACI in determining next steps following the initial analysis of the CATE public health register. The ACI needs to consider future iterations of CATE, and this will ultimately be determined by the ACI's work priorities and the resource implications.

The following areas have been broadly discussed as areas of future focus:

- A more detailed analysis of the major trauma cohort, e.g. patient characteristics, mechanism of injury, remoteness of scene, transport time and method to shed more light on use of the T1 and other trauma protocols.
- Extension of the CATE dataset to look at other linked databases such as severe burn injury or spinal cord injury.
- Addressing data linkage and accuracy issues identified as part of the CATE analysis in collaboration with NSW Health agencies and the Centre for Health Record Linkage (CHeReL).

In the meantime, there are ongoing challenges in the trauma space. Ambulance triage tools need to identify more severely injured patients and bring them directly to trauma centres, particularly older patients. This work is already underway by NSW Ambulance. People injured in rural and regional NSW need to access specialist trauma centre care in a more timely manner.

This report identified many opportunities to improve the reliability and accuracy of the data, to allow more in-depth analyses and research studies. Although there is a focus on trauma clinical outcomes, this report is designed to be interpreted in the context of an understanding of the principles and limitations of the data linkage process.

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