New Zealand Trauma Registry
& National Trauma Network

Annual Report 2020/21

Te Hononga Whētuki ā-Motu
National Trauma Network

Contents

Our Tohu

We are delighted to present our new design for the first time. Designed by artist Jim Wiki (Te Aupōuri), this image of the pīwakawaka conveys the complexity of trauma work.

The pīwakawaka makes several important appearances in Māori mythology. Kupe saw the bird when he arrived in Aotearoa and it welcomed the new arrivals with a dance resembling the haka in that the pīwakawaka flutters from side to side brandishing its weapon. In another myth, Māui was on the hunt for fire from the fire maiden Mahuika and the pīwakawaka, a descendant of Mahuika, refused to tell him where she was hiding. In revenge, Maui squeezed the body of the bird, causing its tail to flare out and its eyes to pop and in this way giving the bird its distinctive appearance. The pīwakawaka is also known as the guide as you enter the realms of Tāne Mahuta, god of the forest.

The pīwakawaka in this design draws on these myths in symbolising the guide and guardian who stays with us during care and rehabilitation, as well as the many forms of trauma and the spectrum of life. It also represents the challenges a person faces in dealing with trauma and acknowledges the realm of death.

Details within the design build on these themes. The main kōwhaiwhai in the body depicts the strength a person needs in dealing with trauma while the kōwhaiwhai in each wing convey the support of whānau and services. The two koru at the base of the tail feathers symbolise the joining of whānau and services. The weaving pattern in the middle tail feathers depicts the strength in binding together. The haehae lines in the outer feathers portray the different pathways of trauma.

Te Hononga Whētuki ā-Motu
National Trauma Network

Foreword

This sixth annual report of the National Trauma Network (the 'Network') describes the burden of major trauma in New Zealand in 2020/21. This report contains the numbers, process metrics and key performance indicators from the New Zealand Trauma Registry as well as the activities of both the national and regional networks.

While there were no mass casualty events in 2020-21 as was the case in the two previous years, COVID-19 was ever-present. Despite the various lockdowns, trauma case numbers were the highest recorded in the registry. Inequity in both incidence and outcome remains a feature of trauma in New Zealand with socioeconomic deprivation, geography and ethnicity all playing a part in the uneven pattern. Case fatality rates remain low and risk-adjusted mortality rates are normative in all trauma hospitals. Serious traumatic brain injury continues to contribute substantially to both morbidity and mortality.

The ability to report on trauma is an essential part of the quality improvement process. The availability of the data is a testament to the hard work of the trauma nurse specialists and data collectors in each of our trauma hospitals as well as of the team at the Health Quality & Safely Commission (the Commission) who analyse and report it. This year we have had the benefit of using a new fit-for-purpose registry specifically created for the Network which reduces the work involved in data entry and has tools that allow each hospital and region to contemporaneously analyse its own data.

As trauma can affect anyone it is not surprising that understanding trauma is a core component of the activities of many government agencies. The Accident Compensation Corporation, Ministry of Health, district health boards and Waka Kotahi are all crucially involved in supporting the Network and assisting it in achieving its aims. The Commission works in partnership with the Network to deliver a range of quality improvement initiatives. Our thanks go to all those involved in caring for trauma patients and those involved in collecting and reporting the data that informs future strategies to improve outcomes.

Ian Civil

National Clinical Director

Siobhan Isles

National Programme Director

January 2021

Photo: Stuff Ltd

Executive Summary

This summary highlights the activities of the New Zealand Trauma Registry and the National Trauma Network.

New Zealand Trauma Registry report

The 2020/21 year was unusual in many respects. Major trauma case numbers were the highest recorded since the start of the population-based registry, although the proportion of major trauma cases in the most severely injured category (with an Injury Severity Score (ISS) above 45) has steadily decreased over the past four years. Falls amongst older people have increased substantially, particularly in the Central Region. Transport injury accounts for 50% of all mechanisms, and the number of people seriously injured on New Zealand roads has increased in Northern, Midland and South Island regions. Numbers of motorcycle, pedal cycle and pedestrian injuries have increased from previous years.

While the focus of the Network is on outcomes and processes of care for the seriously injured, the high burden of injury on Māori is persisting following similar trends to previous years. The age-standardised incidence rates for Māori were approximately 1.5 times the rates for non-Māori. Current work to understand how Māori and their whānau experience serious injury points to an opportunity to improve the process of care for Māori, and particularly those who live outside the main urban centres. This should be of interest to injury prevention work.

The case fatality rate has increased slightly from 7.4% to 8.0% but has fallen from the 11% recorded when the NZTR started in 2015/16. Most deaths (67%) were due to serious traumatic brain injury (sTBI), while we note that haemorrhage deaths have increased slightly to 12% (up from 10% the previous year).

Standardised mortality ratios require consideration of the risks of death associated with each type of injury. This year, the number of people with sTBI increased from 728 in 2019/20 to 866. It is possible the increase in SMR is a result of the mathematical model not fully accounting for the risk of death associated with head injuries. Nevertheless this increase in number of sTBI deaths and SMR signals that the process of care for sTBI has room for improvement.

Unwarranted variation in the process of care by rurality, ethnicity, and deprivation has been observed. Furthermore, the proportion of patients managed in a neuroscience centre has decreased to 72% (down from 74% last year), and patients waited an average of 10 hours from their time of injury to admission to a neuroscience centre, and is longer than previous years. These declining results are of concern and are the focus of ongoing work through the sTBI project.

This year we also started to explore the burden of chest injuries. The results indicate trauma patients with a serious chest injury make up nearly half of all major trauma and 81% of the most seriously injured patients. The majority of chest trauma (65%) was transport-related, and these patients tend to have a long hospital stay.

The results from 2020/21 indicate continued progress overall but highlight some serious areas of concern, particularly around the process of care for patients with sTBI. While the current quality improvement focus on sTBI is appropriate, it suggests there is much work still to be done. The prevalence of serious chest injuries and the associate morbidity strongly indicates the relevance of a quality improvement initiative for this group as well. The Network strives to see all New Zealanders receive equitable and high quality care and is amongst the best performers globally.

Report on the National Trauma Network

Comprising the Northern, Midland, Central and South Island regions

The Network continues to make good progress on its strategic priorities. Despite the disruption from Covid-19, the Network and its key partners have successfully implemented large quality improvement initiatives across the trauma system. The highlights are shown here.

Service excellence

Critical haemorrhage

- Aim is to eliminate avoidable deaths from haemorrhage
- Bundle of care published following extensive engagement
- Audit tool published to enable hospitals to audit their services
- Survey completed

Rehabilitation

- Work under way for 11 national collaborative teams focusing on traumatic brain injury, transitions of care and rehabilitation experience
- Data linkage with Accident Compensation Corporation and Australasian Rehabilitation Outcomes Centre data to understand long-term outcomes

Serious traumatic brain injury (sTBI)

- Data indicates mortality and other outcomes are not as good in New Zealand as other jurisdictions, and there is inequality for Māori
- Project began on patients with impaired consciousness and a significant anatomical injury and their transfer to the most appropriate hospital

Māori experience of trauma

- Project completed involving interviews with several major trauma patients and their whānau, and highlighting themes that support good recovery
- Project findings are being used to inform changes to hospital and rehabilitation processes

Patient-reported outcome measures

- Surveys of major trauma patients at 6, 12 and 24 months after injury using international tools such as the EQ5D and WHODAS
- The results will extend our current knowledge, which is limited to mortality, to provide a rich source of information on the long-term functional outcomes of patients
- Collection complete for 2020/21 cohort in the Northern, Central and South Island regions

Governance

- Group formed with senior executive representation from health and transport sectors, along with Māori and consumer representation
- New Chair appointed to the Data Governance Group, which is responsible for the use of National Trauma Registry data

Analytics and research

- Ad hoc reports on sTBI and rehabilitation
- Study of Road Trauma Evidence and Data (SORTED) recommenced with two years' data matched across seven health and transport data sets. The results provide a comprehensive and accurate view of all road trauma in New Zealand that goes beyond the traditional focus of motorised transport
- Research under way or completed on: coding accuracy, how disability-adjusted life years benefit from a formal trauma system, and the prevalence of psychoactive drugs in trauma patients presenting to an emergency department

Enablers

National Trauma Registry

- New registry software implemented, resulting in much faster data upload
- Abbreviated Injury Scale (AIS) coding audit undertaken and results published

Workforce

- Trauma Team Training delivered with 358 clinicians in 8 hospitals. This high-fidelity course simulates the first 30 minutes of emergency department presentation. The focus is on human factors to improve communication among teams that do not work together on a daily basis, but are expected to perform under pressure, as well as to enhance process and logistics
- 11 clinicians completed the Quality Improvement Facilitator Course

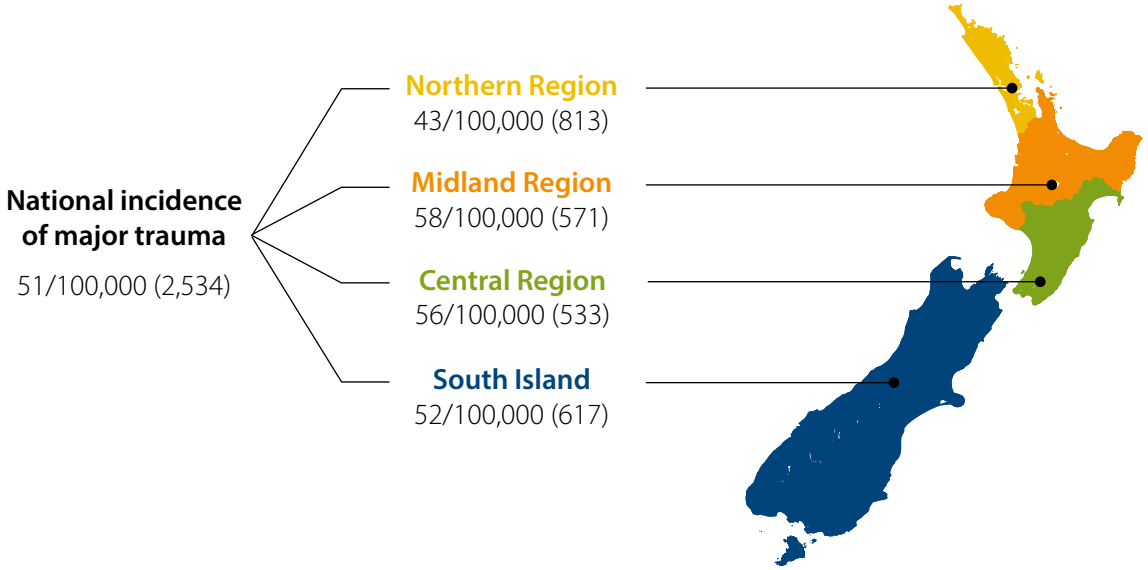
Part 1: New Zealand Trauma Registry (NZTR) report

The 2020/21 year was unusual in many respects. Major trauma case numbers were high, with a notable increase in falls among older people. As a result, the number of serious traumatic brain injuries this year was larger than any previous year on record. The case fatality rate was moderate, but risk-adjusted mortality was higher than in previous years.

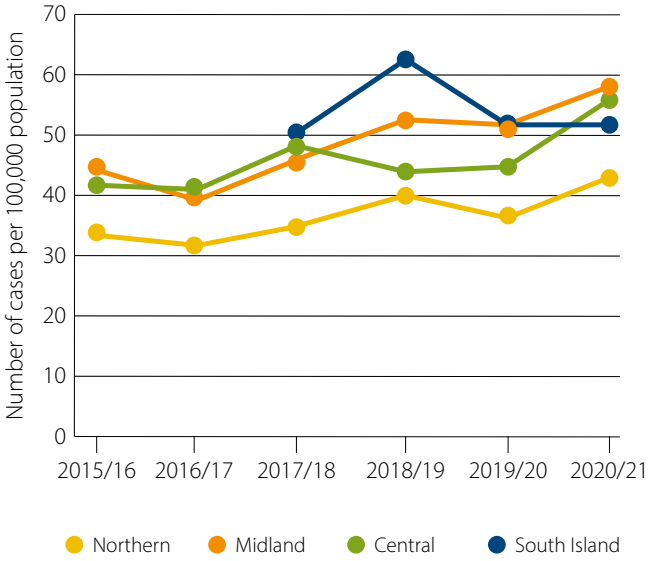
Incidence

This year saw the largest number of major trauma cases on record. In total, there were 2,534 major trauma cases, an increase of 16% from the previous year and an increase of 7% from the last pre-COVID year, 2018/19.

Incidence rates (caseload) of major trauma per 100,000 people by region, 2020/21



Incidence rates of major trauma per 100,000 people by region, 2015/16–2020/21



Patterns of injury

Over time, the proportion of major trauma cases from transport injuries has declined slightly, falling from 54% in both 2017/18 and 2018/19 to 52% in 2019/20 and 50% in 2020/21. This pattern is most evident in the South Island where transport injuries made up 47% of injuries in 2020/21, lower than the three previous years, when the average was 54%. Reduced domestic and international tourism due to travel restrictions from the COVID-19 pandemic may have lowered road traffic volumes in the South Island, given that the largest reduction is in car trauma (119 cases in 2020/21, a 29% decrease from the average of 168 cases in the three previous years).

The proportion of injuries from falls has increased. While falls made up 28% of major trauma cases on average from 2017/18 to 2019/20, they have increased to 32% of major trauma cases in 2020/21.

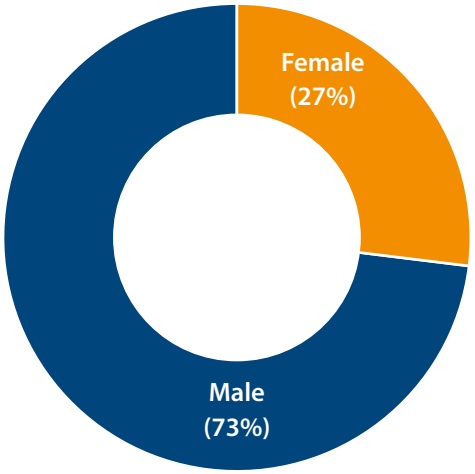
Number and percentage of major trauma cases by mechanism of injury and region, 2020/21

				Number and percentage of injuries					
	Falls	Struck by/ collision with object or person	Other	All Transport	Car	Motorcycle	Pedestrian	Pedal cycle	Quad bike/ other
Northern	268 (33%)	63 (8%)	83 (10%)	399 (49%)	166 (20%)	108 (13%)	43 (5%)	62 (8%)	20 (2%)
Midland	132 (23%)	35 (6%)	73 (13%)	331 (58%)	168 (29%)	84 (15%)	17 (3%)	45 (8%)	17 (3%)
Central	172 (32%)	55 (10%)	66 (12%)	240 (45%)	93 (17%)	73 (14%)	26 (5%)	39 (7%)	9 (2%)
South Island	231 (37%)	31 (5%)	64 (10%)	291 (47%)	119 (19%)	64 (10%)	25 (4%)	67 (11%)	16 (3%)
National	**803 (32%)**	**184 (7%)**	**286 (11%)**	**1,261 (50%)**	**546 (22%)**	**329 (13%)**	**111 (4%)**	**213 (8%)**	**62 (2%)**

Gender

Almost three-quarters (73%) of major trauma cases in 2020/21 were male. This is consistent with gender patterns over previous years. The male-to-female ratio is consistent across injury severity including the most serious traumas (as assessed by Injury Severity Score).

Percentage of major trauma by gender, 2020/21



Injury severity score (ISS)

In 2020/21, three-quarters of major trauma cases were in the least severe category (ISS less than 25), while 1.4% (36 cases) were in the most severe category (ISS 45 or higher). The proportion of most severe cases has reduced steadily over the four years for which we have complete national records in the NZTR, so that it is now half the proportion in 2017/18 (59 cases, 2.8% of caseload). Although it involves only a small proportion of the overall caseload, this reduction is statistically significant (P = 0.001).

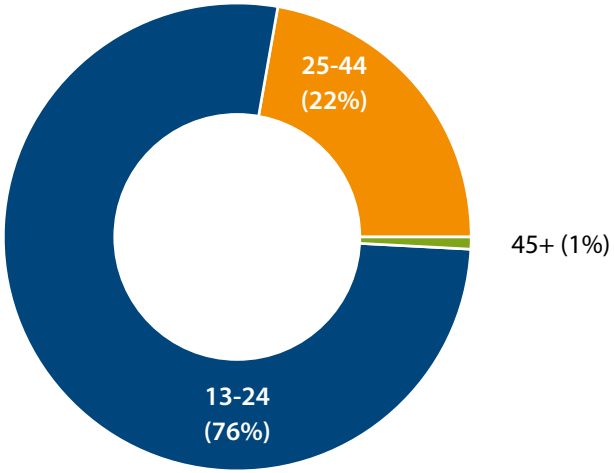
Dominant injury type

Consistent with previous years, 95% of major trauma cases were from blunt force. Another 4% were from penetrating injuries and 1% from burns.

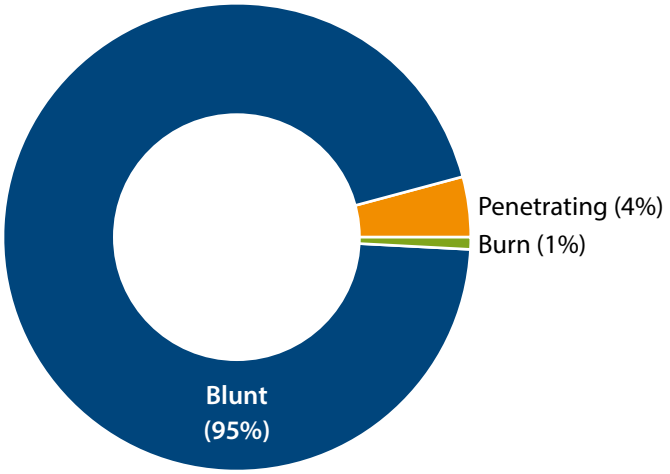
Injury intent

Also consistent with previous years, about 90% of injuries were unintentional. A slightly higher proportion of injuries were self-inflicted (2.6%) than in previous years (2.1% on average), but the difference is not statistically significant (P = 0.215).

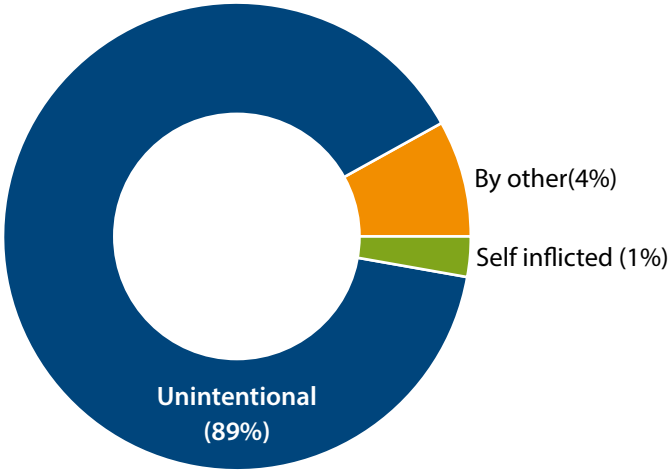
Percentage of injuries by their severity (Injury Severity Score), 2020/21



Percentage of injuries by type of injury, 2021



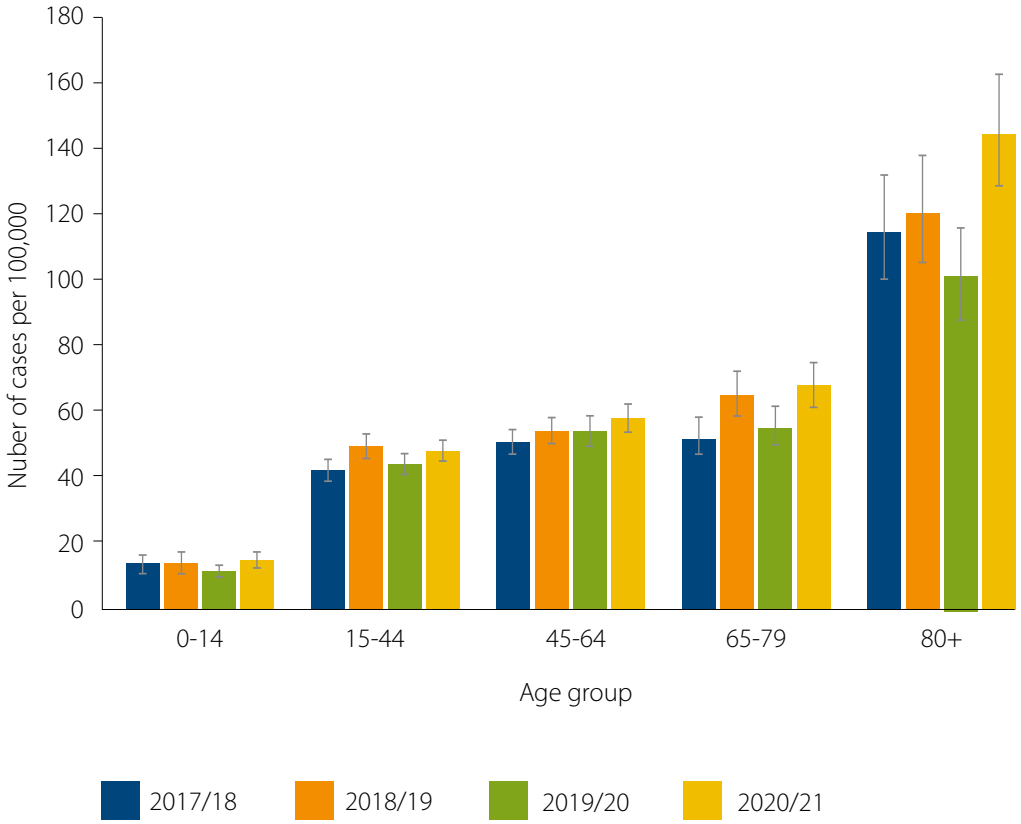
Percentage of injuries by intent, 2020/21



Age

Over the four years from 2017/18 to 2020/21, trauma case rates have increased modestly. The exception is 2019/20, when the response to the COVID-19 pandemic reduced the incidence of trauma, most clearly among those aged 65 years and older. While the total trauma case numbers have increased between the most recent pre-COVID year (2018/19) and 2020/21, most age groups show little change in rates, indicating most of the change is in line with population patterns.

Incidence rates of trauma per 100,000 people by age group, 2017/18–2020/21

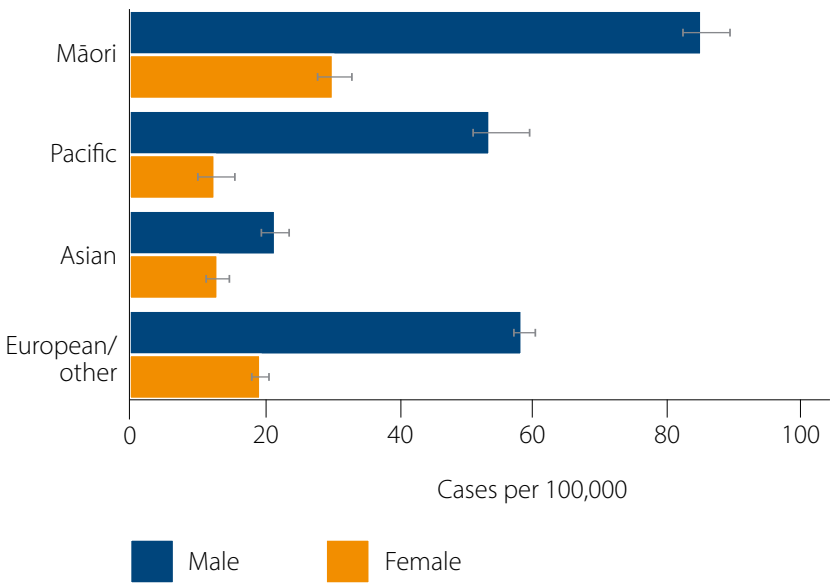


Ethnicity

Age-standardised incidence rates for Māori are approximately 1.5 times higher than the rates for non-Māori. While Pacific peoples and European/other ethnicities have similar trauma rates, Asian peoples have much lower rates of trauma.

Across all ethnic groups, the rate of trauma is substantially higher in males than in females. However, the male-to-female ratio varies by ethnicity, with the lowest variation in Asian peoples and the highest variation in Pacific peoples.

Age-standardised major trauma incidence rates per 100,000 people by ethnicity, 2017/18–2020/21



The low rates of trauma among Asian peoples, most notably Asian males when compared with males of other ethnicities, are findings that should be examined more closely. When we break down the rates by mechanism of injury, we can see the biggest difference occurs for transport; however, for all mechanisms of injury Asian males have reduced trauma rates compared with males of other ethnicities.

One reason for the difference may be that Asian peoples live mainly in urban areas, as urban populations have lower rates of some traumas (see 'Urban and rural trauma' below). However, rates of trauma do not vary between urban and rural populations for all mechanisms of injury. Further, even for mechanisms where urban and rural rates do vary, such as for transport, trauma rates for Asian peoples are lower than urban trauma rates, indicating that other factors help to explain the difference. Improving our understanding of the protective factors that reduce trauma in Asian peoples relative to the wider population may provide valuable information for public health initiatives.

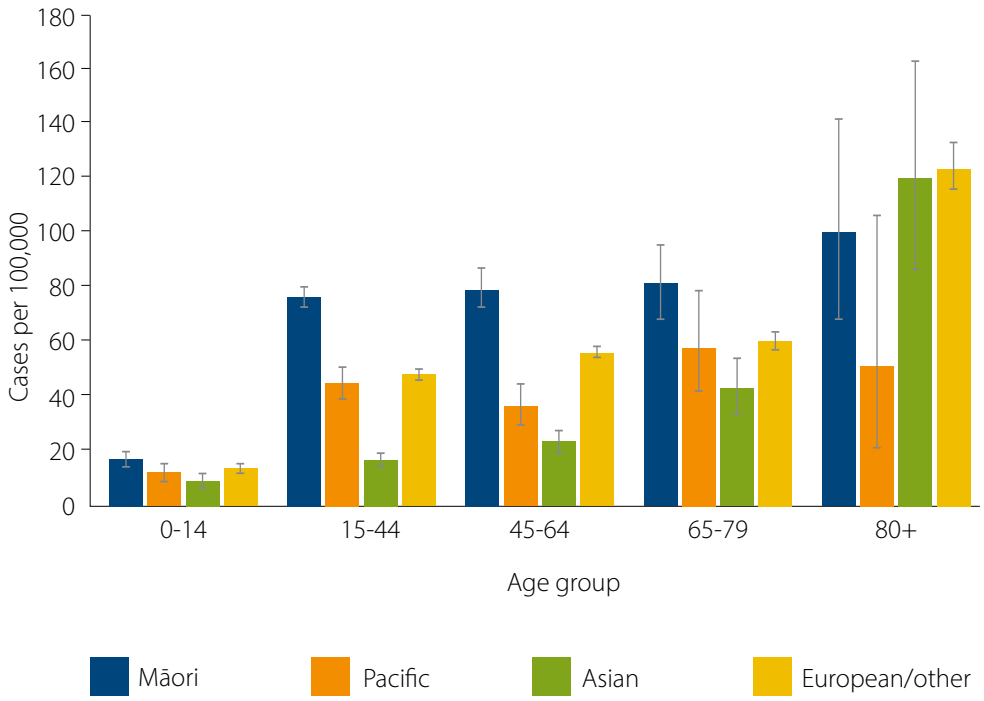
Age-standardised rates of major trauma per 100,000 people by gender, ethnicity and mechanism of injury, 2017/18–2020/21

		Mechanism of injury			
Gender	Ethnicity	Transport	Fall	Struck by/collision with person/object	Other
Male	Māori	47.1	15.0	10.1	12.8
	Pacific peoples	22.9	12.1	10.2	9.7
	Asian peoples	9.7	7.3	2.0	3.8
	European/other	35.1	12.9	4.7	5.9
Female	Māori	18.8	6.0	2.6	3.2
	Pacific peoples	6.9	3.3	1.5	1.6
	Asian peoples	8.6	3.3	0.5	1.2
	European/other	10.4	5.4	0.6	3.3

Trauma incidence rates per 100,000 people increase with age for Asian peoples and European/other ethnicities. However, for Māori and Pacific peoples, trauma rates are similar across the age groups from 15–44 years through to 80+ years. In fact, the point rate estimate for Pacific peoples is lower for those aged 80+ years than for those aged 65–79 years (although the confidence intervals are wide and overlap).

For two age groups (45–64 years and 80+ years), Pacific peoples have significantly lower rates of major trauma than European/other ethnicities. It would be valuable to investigate these differences, along with the low rates of trauma in Asian peoples aged under 65 years, as possible models for understanding risk and injury prevention.

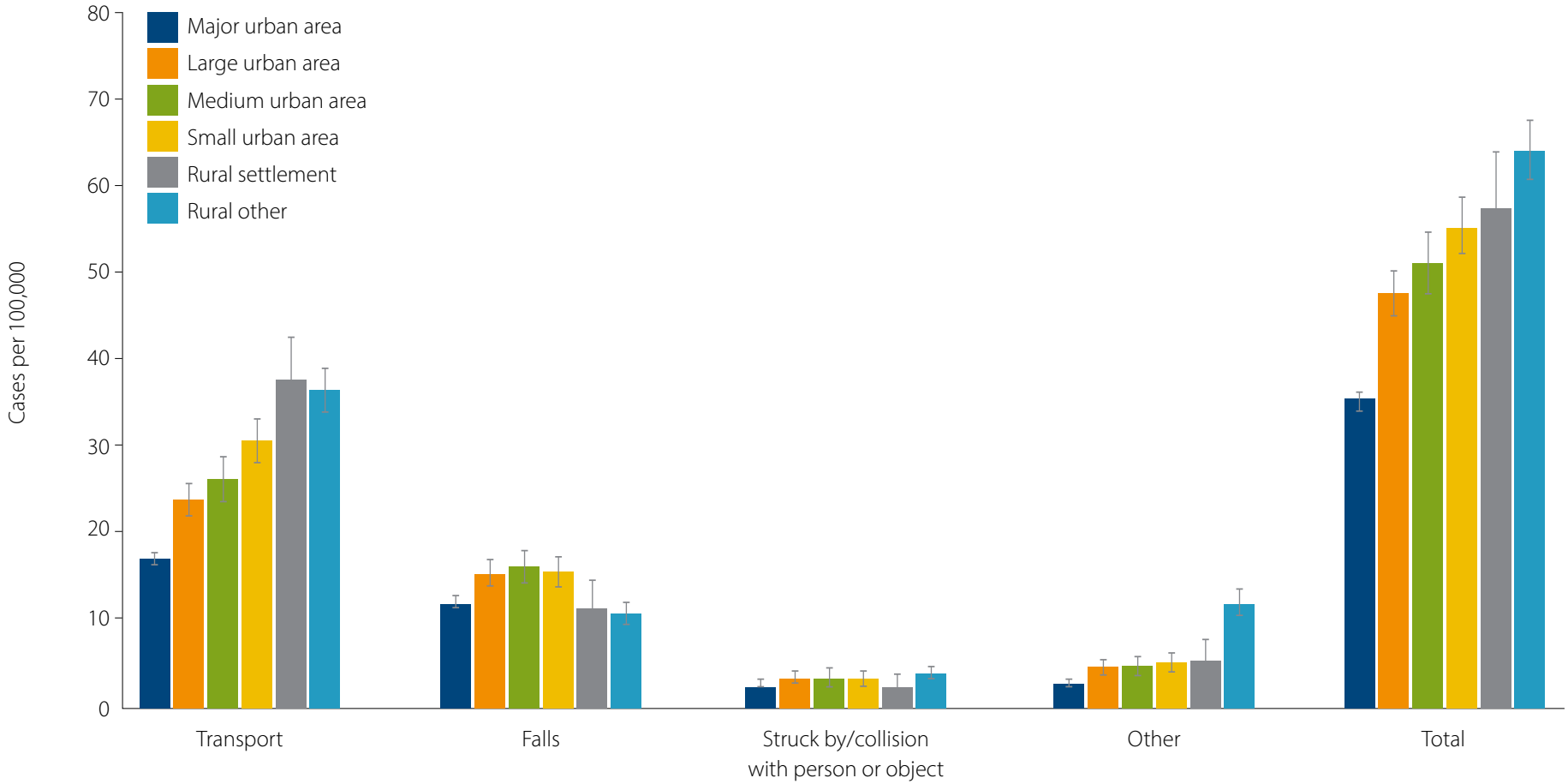
Annual major trauma incidence rate per 100,000 people by age group and ethnicity, 2017/18–2020/21



Urban and rural trauma

Incidence rates of major trauma per 100,000 people increase as population density reduces: the lowest rates are in major metropolitan areas and highest rates in rural areas. In 'other rural' areas, overall rates are 81% higher than in 'major urban' areas, with transport and 'other' mechanisms (which include animal injuries, many of which occur on farms) contributing the most to this difference.

Annual major trauma incidence rates per 100,000 people by mechanism of injury and urban–rural descriptor of domicile, 2017/18–2020/21



Inter-regional flow of trauma

Inter-regional flow for a given region is made up of:

- inflow – the number of trauma patients receiving definitive care in the region who normally live outside of the region, including overseas
- outflow – the number of trauma patients living in the region who receive definitive care in a different region

In 2019/20, the largest net inflow of trauma occurred in the South Island. In contrast, this year travel restrictions due to COVID-19 have been in place, so all regions have a more balanced inflow and outflow. While 87 overseas/unknown patients received care for major trauma in 2019/20, only 3 patients were in this category in 2020/21.

Inter-regional flow of trauma by region, 2020/21

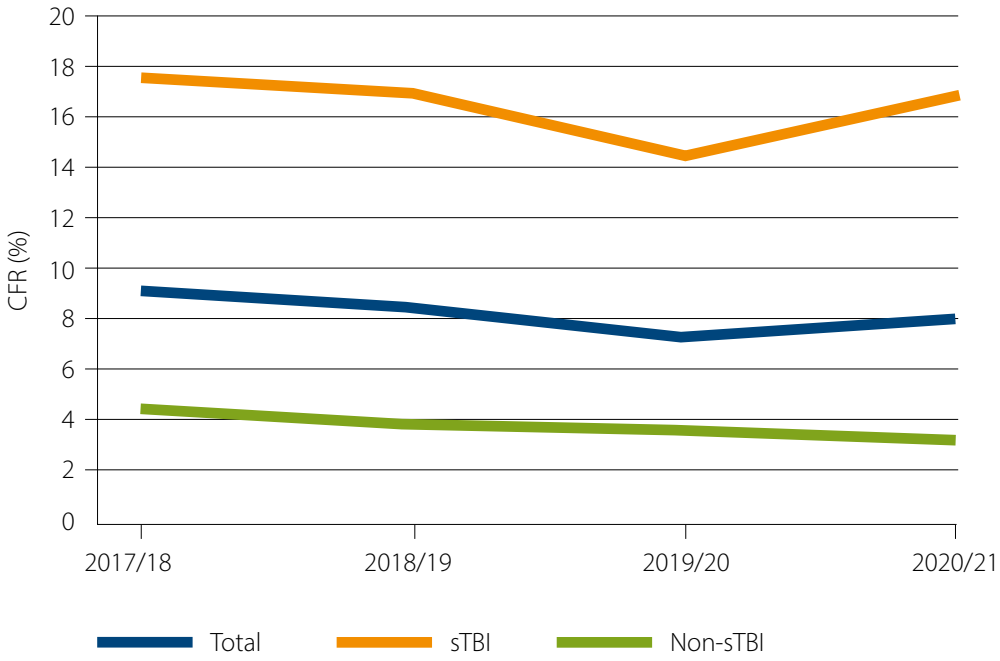
	Northern	Midland	Central	South Island	Unknown/ outside NZ
Inflow	90	82	54	56	–
Outflow	75	86	70	48	3
Net	15	-4	-16	8	-3

Photo: Stuff Ltd

Mortality

The case fatality rate for 2020/21 was 8.0%, which is up from the previous year, but lower than all other years in the NZTR. The case fatality rate is markedly higher for sTBI patients than for non-sTBI patients.

Case fatality rate by sTBI and non-STBI injury, 2017/18–2020/21



Simulation training mannequin

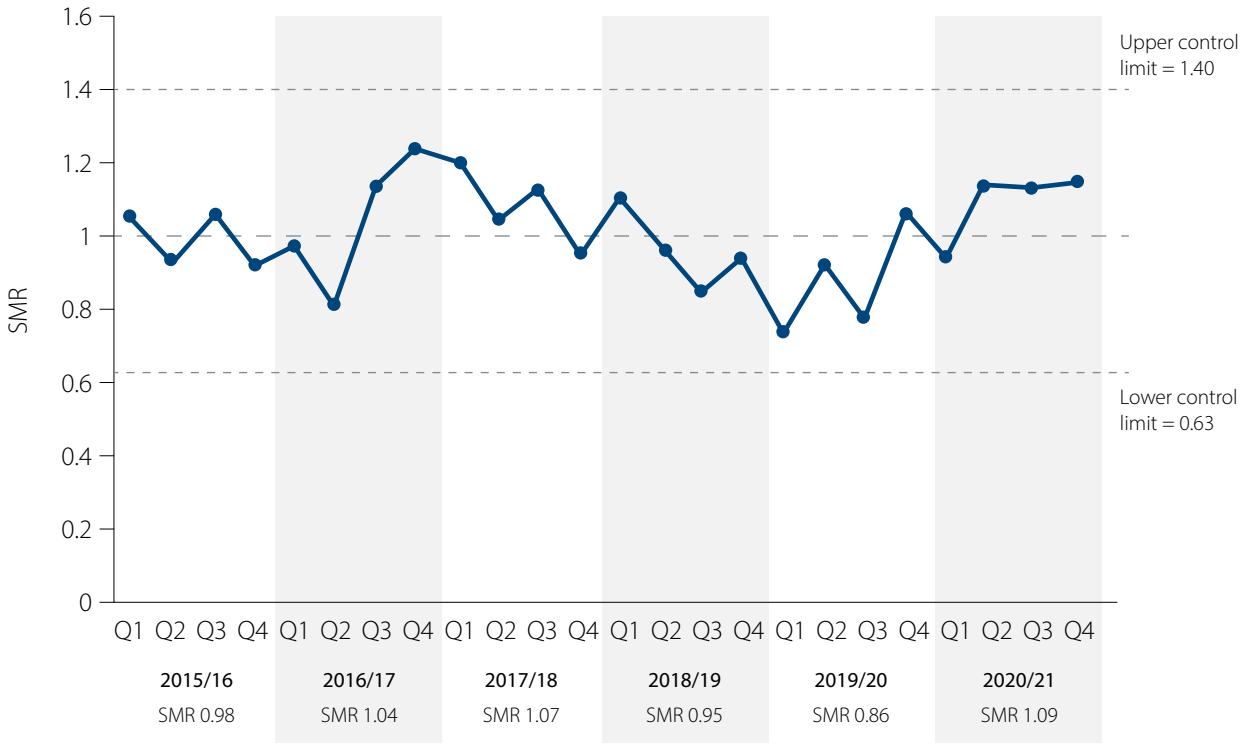
Risk-adjusted mortality

While the case fatality rate for 2020/21 was the second-lowest recorded in the NZTR, the standardised mortality ratio was higher in 2020/21 than in previous years. This appears to be normal variation, with no evidence of trend towards increased mortality through time. However, we will monitor these patterns closely in future years.

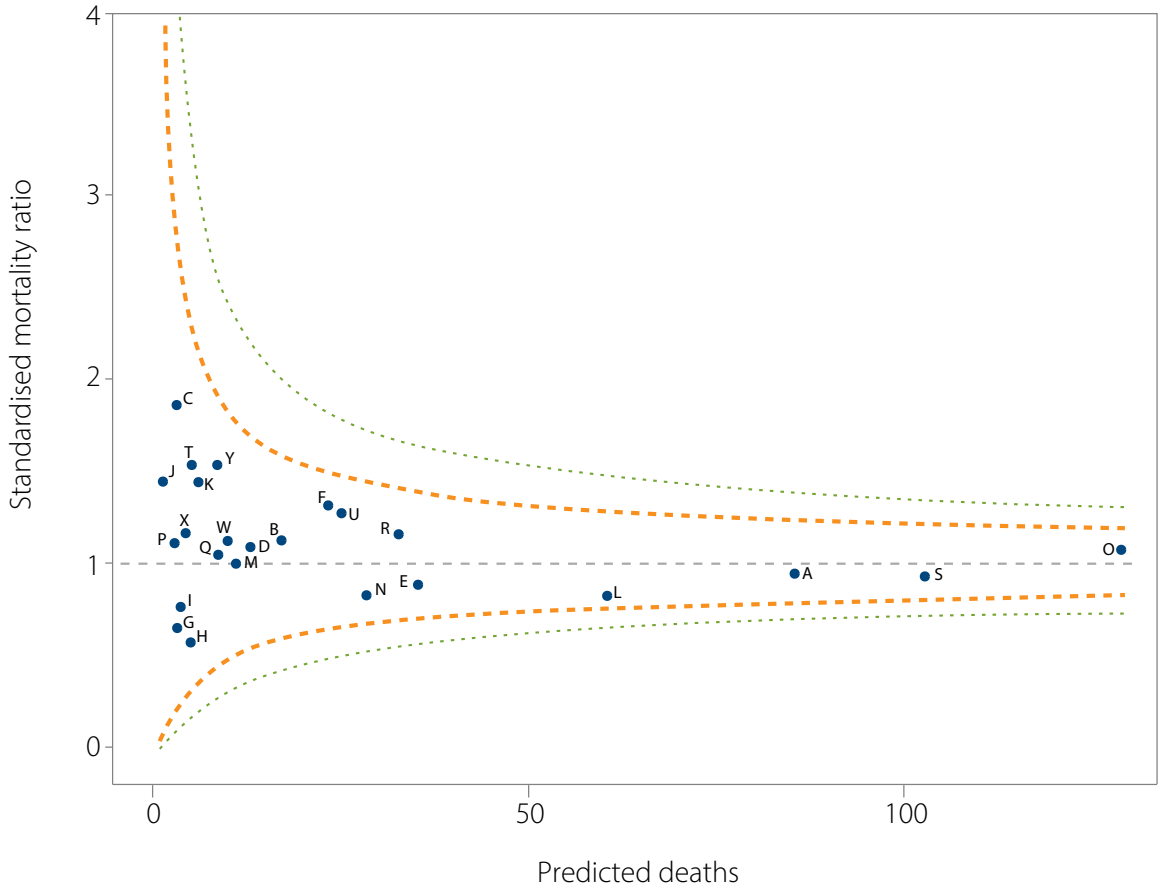
It is also worth noting that the proportion of deaths due to central nervous system injury has increased to 67% in 2020/21, and the number of sTBI cases was the highest recorded in the NZTR. Many central nervous system deaths are seen as unavoidable; it is possible that the physiological data and coded injury information available for risk adjustment may not capture the full risk of death.

The standardised mortality ratio by site shows no hospitals have significantly higher mortality rates than expected.

Standardised mortality ratio by quarter, 2015/16–2020/21



Standardised mortality ratio by predicted deaths for individual hospital sites, 2017/18–2020/21



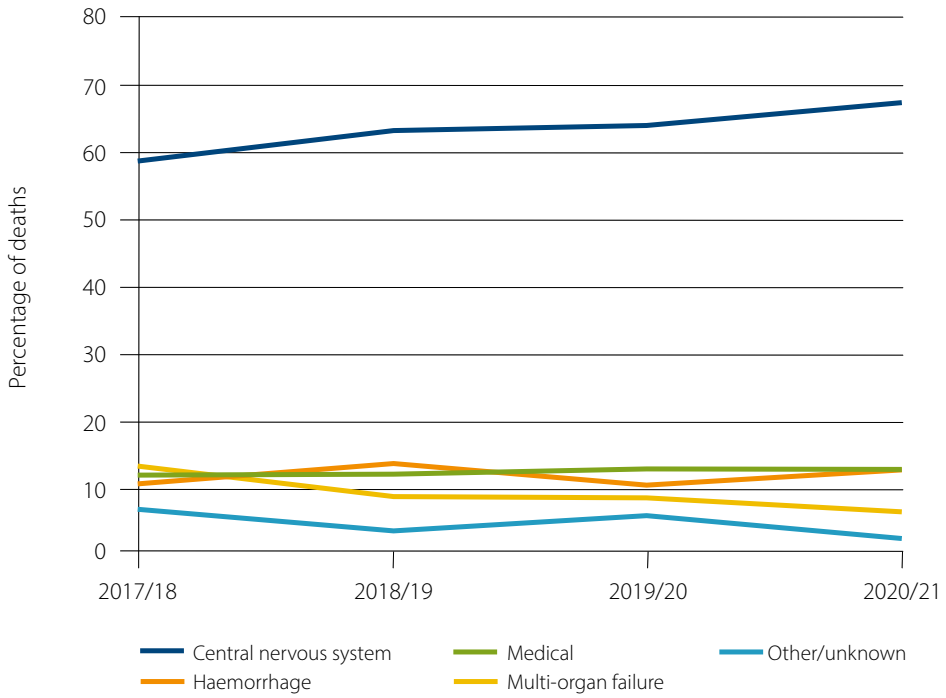
This funnel plot shows the standardised mortality ration for each major trauma hospital in NZ. Each hospital is represented by a letter with those having the highest number of death closely approximating the expected numbers whereas hospitals with fewer expected death have wider variation in the actual number of deaths. This finding is to be expected and consistent with the broadening 95% and 99% confidence parameters associated with a funnel plot.

Simulation training mannequin

Cause of death

Over the four years for which we have complete national data in the NZTR, the proportion of deaths due to central nervous system injuries has increased from 59% to 67%, while the proportion of deaths from multi-organ failure has fallen. Proportions of haemorrhage and medical deaths have remained about the same over these four years.

Percentage of deaths by cause of death, 2017/18–2020/21



Serious traumatic brain injury (sTBI)

Across the four years of complete data in the NZTR, the case fatality rate is more than three times higher for cases with isolated sTBIs (15.4%) than cases without sTBIs (3.9%) even though the cases are similar in terms of the average severity of the patient's anatomical injury and their age. Complex sTBIs (traumatic brain injury cases that include a non-head injury with severity of 3 or higher on the Abbreviated Injury Scale (AIS)) have a fatality rate of 19.3%, which is higher than the rate for isolated sTBIs (15.4%), although the reason for this difference may be that complex sTBIs have higher total injury severity (median ISS 29) than isolated sTBIs (median ISS 17).

In terms of mechanism of injury, isolated sTBIs differ from complex sTBIs (and non-STBI traumas) in that their main mechanism is falls rather than transport injuries.

Characteristics of complex and isolated sTBI and other major trauma, 2017/18–2020/21

sTBI group	Case fatality rate (%)	Median (mean) ISS	Median (mean) age in years	Mechanism of injury (%)		
				Falls	Transport	Other
Complex sTBI	19.3	29 (30.2)	41 (43.9)	23	66	11
Isolated sTBI	15.4	17 (20.1)	50 (49.1)	52	26	22
No sTBI	3.9	17 (18.8)	48 (47.1)	22	60	18

Patterns in the data on direct transport to neuroscience centres for patients with an sTBI highlight two points about equity of care.

First, Māori with an sTBI are overall less likely to be transported directly to a neuroscience centre by ambulance than non-Māori (47% vs 56% of cases, two-proportion test, $P = 0.0001$). The difference occurs among both those living in major urban areas (eg, central Christchurch, Wellington) and those living in rural areas (including rural settlements).

Second, across all ethnicities, residents of large urban areas (eg, Whangārei, Nelson) are less likely to be transported directly to a neuroscience centre by ambulance than residents of other areas (25% vs 60% of cases, two-proportion test, $P < 0.0001$). At least part of the explanation for this difference relates to how close patients live to a large secondary hospital. Patients who must be transferred to another hospital for definitive care could face delays in critical treatments.

Number of sTBI cases transported from scene by ambulance, and number and percentage directly transported to neuroscience centre, by ethnicity and urban/rural residence, 2017/18–2020/21

	Total sTBI ambulance transports		Direct to neuroscience centre (%)	
Urban/rural descriptor	Māori	Non-Māori	Māori	Non-Māori
Major urban area	199	985	79 (60%)	303 (69%)
Large urban area	123	309	90 (27%)	236 (24%)
Small and medium urban area	124	434	65 (48%)	220 (49%)
Rural	102	311	59 (43%)	141 (55%)
All areas	548	2,039	255 (47%)	1,139 (56%)

Among patients who are transferred within 24 hours to a neuroscience centre for definitive care, transfer times are typically faster for sTBI patients than for non-sTBI patients. The median time from first hospital to definitive care hospital for sTBI patients is 6 hours 34 minutes, compared with 7 hours 27 minutes for non-sTBI patients.

The New Zealand Deprivation Index 2013 (NZDep 2013) measures socioeconomic deprivation in New Zealand communities, classifying communities on a scale from 1 (least deprived) to 10 (most deprived). Patients with sTBIs from the least deprived communities are much more likely to be directly transported to a neuroscience centre than patients from the most deprived communities (74% for decile 1 vs 37% for decile 10).

Again, patients living in major urban centres are more likely to be directly transported to a neuroscience centre. However, there is no other consistent relationship between where patients live and the probability of being directly transported to a neuroscience centre. This means that living in a rural area does not explain the relationship between direct transport to a neuroscience centre and deprivation.

Rates of care at neuroscience facilities by level of socioeconomic deprivation (NZ Deprivation Index 2013), 2017/18–2020/21

Socioeconomic deprivation decile (NZDep 2013)	Transported directly to neuroscience centre	At neuroscience centre for definitive care
1	74%	85%
2	65%	81%
3	51%	72%
4	50%	68%
5	54%	70%
6	49%	70%
7	48%	74%
8	48%	73%
9	47%	73%
10	37%	74%

Note: 1 = least deprived; 10 = most deprived.

Serious chest trauma

Patients with serious chest trauma are major trauma cases who have injury in the AIS thorax body region with AIS severity of 3 or higher and injury to other body parts with AIS severity of 3 or higher. Serious chest trauma is divided into isolated chest trauma (no injuries to other body regions greater than AIS severity 2) and complex chest trauma (one or more injuries to other body regions of AIS severity 3 or greater).

Since 2017/18 there were an average of about 1,100 serious chest trauma cases a year. Of those cases, about 60% have been isolated chest trauma and 40% complex chest trauma.

Number and percentage of complex and isolated chest trauma cases, 2017/18–2020/21

Financial year	Complex Cases (%)	Isolated Cases (%)	Total
2017/18	414 (42%)	583 (58%)	**997**
2018/19	500 (42%)	695 (58%)	**1,195**
2019/20	416 (40%)	630 (60%)	**1,046**
2020/21	482 (40%)	732 (60%)	**1,214**

The cause of most serious chest trauma cases is blunt force (95%), while most of the remaining cases are due to penetrating injuries (4%). These patterns are similar to the overall proportions of major trauma. However, mechanisms of injury are noticeably different. Serious chest trauma is more common in transport injuries and less common in falls and strike/collision injuries compared with other traumas.

Number and percentage of serious chest trauma and other trauma by mechanism of injury, 2017/18–2020/21

Mechanism	Serious chest trauma Cases (%)	Other trauma Cases (%)
Transport	2,895 (65%)	1,899 (40%)
Fall	875 (20%)	1,792 (38%)
Struck by/collision with person or object	181 (4%)	466 (10%)
Other	501 (11%)	554 (12%)

Serious chest trauma is more strongly linked with severe overall injury, than is trauma that does not involve a serious chest injury. Of the 187 injuries in the last four years where the ISS is 45 or higher, 151 (81%) have been serious chest trauma cases.

Proportion of chest and non-chest trauma by ISS, 2017/18–2020/21

ISS	Serious chest trauma Cases (%)	Other trauma Cases (%)
13–24	3,318 (49%)	3,499 (51%)
25–44	983 (46%)	1,176 (54%)
45+	151 (81%)	36 (19%)

Among the most serious injury cases (based on ISS and excluding in-hospital deaths), serious chest trauma patients stay longer in acute hospital care than non-chest trauma patients. While length of stay is similar for all patients with ISS under 25, among patients with ISS of 25 and above the median length of stay for chest trauma patients is about 20% longer. In addition, among patients with ISS of 25 and above, median length of stay in an intensive care unit is 46 hours for chest trauma patients and 11 hours for non-chest trauma patients.

Length of stay in acute hospital care for non-fatal chest and other trauma by ISS, 2017/18–2020/21

ISS	Median length of stay (days)	
	Serious chest trauma	Other trauma
13–24	6.7	6.9
25–44	13.0	10.8
45+	27.2	22.5

Blood alcohol concentration

Among patients whose blood alcohol concentration was recorded when they arrived at a hospital, two-thirds have a zero blood alcohol reading. However, blood alcohol concentration varies with mechanism of injury. Alcohol concentrations are:

lowest in pedal cycle, struck by/collision with object, motorcycle and other mechanism injuries

highest in struck by/collision with person injuries, which includes most physical assaults.

In half of all struck by/collision with person injuries, the person injured had a blood alcohol concentration above the legal driving limit. Falls and penetrating injuries also have higher rates of non-zero blood alcohol concentrations.

Blood alcohol concentration in multiples of the legal driving limit when patients arrive at hospital within two hours of injury and have their blood alcohol concentration recorded, 2015/16–2020/21

Mechanism of injury	Zero blood alcohol	0-1 times driving limit	1-2 times driving limit	Over 2 times driving limit
Cutting/piercing/penetrating	61%	6%	5%	28%
High fall	60%	12%	2%	27%
Low fall	57%	8%	3%	31%
Struck by/collision with object	73%	10%	5%	13%
Struck by/collision with person	45%	5%	4%	46%
Other (non-transport)	75%	6%	2%	17%
Car/van/truck	64%	9%	4%	22%
Motorcycle	72%	12%	2%	13%
Pedal cycle	80%	11%	1%	8%
Pedestrian	68%	12%	2%	18%
Other vehicle	74%	11%	1%	14%
Total	**66%**	**10%**	**3%**	**21%**

Photo: Lifeflight

Part 2: National Trauma Network report

The National Trauma Network ('the Network') aims to reduce mortality, improve the level of disability for those that survive injury and create system efficiencies. The focus of our early work has been on pre-hospital and early hospital care, so the right patient goes to the right hospital at the right time. This year we are delighted to report progress on rehabilitation for major trauma patients.

Here are this year's highlights across the four key areas of work set out in the Network's Strategic Plan 2017–20221. Visit the Network's website www.majortrauma.nz for more details on these outcomes.

Governance

The National Trauma Network Governance Group was reformed to include cross sector representation from the health and transport sectors and Māori and consumer representation. The new governance arrangement is designed to provide a whole-of-system view of trauma and support the national programme of work. The Governance Group will also support directions under the new national health structure, which sees the amalgamation of the 20 DHBs into a single entity.

In 2021, Daniel Patrick was appointed Chair of the New Zealand Trauma Registry (NZTR) Data Governance Group. Daniel has a strong background in applied and health science research. He was Director of Ngā Pae o te Māramatanga, New Zealand's Māori Centre of Research Excellence and currently is Director of the New Zealand Biological Heritage Challenge. Over the past year the Data Governance Group has considered 23 submissions to use NZTR data.

Service excellence

Trauma team training

National roll-out to all emergency departments of the high-fidelity trauma team training simulation courses has progressed well, despite the impact of various lockdowns. Jointly funded by the DHBs and Waka Kotahi, the courses use real-life scenarios to identify practical steps for improving processes of care and communication between clinicians who do not typically work together but are expected to perform as a high-functioning team when treating critically injured patients.

To date, 358 clinical staff have been trained across 13 hospitals. We expect full national roll-out to be completed within the next two years.

Critical haemorrhage

The aim of the critical haemorrhage project is to eliminate avoidable deaths from haemorrhage on the reasoning that anyone with critical haemorrhage who presents to a hospital should survive.

Outcomes in this area have not been as good in New Zealand as in other jurisdictions so this quality improvement project began under the leadership of Dr Kerry Gunn, an anaesthetist who has led local initiatives to improve bleeding policies.

After extensive consultation, a bundle of care was published to provide guidance on identifying patients with critical haemorrhage and accelerating the treatment pathway. It also sets out a resuscitative strategy that covers:

- haemorrhage support and goals of treatment
- blood product delivery and administration
- antifibrinolytic use
- rapid investigations
- reversal of anticoagulant agents.

Disseminating the bundle across the country involved site visits and a comprehensive communication strategy. A recent survey of trauma-receiving hospitals demonstrated that 54% of survey respondents now have a formalised activation protocol for traumatic critical haemorrhage in place within their service, with a further two sites in the final stages of implementation. Other resources developed include a clinical audit tool for services to use to conduct structured reviews of critical bleeding cases, as well as guides for running simulation training exercises to meet best-practice guidelines outlined within the bundle. These resources are available on the Commission's website.

[1] *New Zealand Major Trauma Network. 2017. Strategic Plan 2017–2022. Wellington: New Zealand Major Trauma Network.*

Rehabilitation

Under the leadership of physiotherapist and clinical lead Kat Quick, the major trauma rehabilitation national collaborative was successfully launched in March 2020 with 11 project teams from across New Zealand. The collaborative provides quality improvement capability building for team members, as well as the opportunity to collaborate with each other to achieve their project aims.

The 11 project teams consist of a mixture of allied health professionals, nurses, doctors, quality improvers, service managers and consumers. Their projects address several issues identified during the scoping phase of the rehabilitation project, including the management of traumatic brain injury, the inpatient rehabilitation experience, discharge planning and transitions of care from hospital to community. With the principles of co-design operating successfully in these projects, teams actively work alongside consumers who have experienced major trauma and base many of their change ideas around their feedback. Additionally, teams have been committed to examining their local systems with a health equity lens to identify opportunities to close existing gaps in trauma rehabilitation health outcomes between Māori and non-Māori in New Zealand.

The teams look forward to sharing their project outcomes and service improvement work in 2022.

As part of the rehabilitation work programme, the Commission has analysed ACC rehabilitation contract data to advance understanding of rehabilitation service provision for the most seriously injured in New Zealand.

Early findings indicate that people in the major trauma population rarely participate in funded psychology, neuropsychology and pain services. Those few who do access this support do so a long time after their injury. Additionally, patterns differ for people over the age of 65 years, and across geographical locations. Māori tend to access services later than non-Māori and stay for a shorter time.

The results suggest that the impact of major trauma can become a chronic condition for many patients. New Zealand has the opportunity to implement a high-performance system of consistent and timely referral to key services. To do so, we need to do more work on systematic screening and education, and to explore what equity barriers to services that vulnerable groups face.

Māori experience of trauma

The Māori experience of trauma project, which involved kōrero with 21 Māori who had had major trauma and seven of their whānau, is near completion. Led by Sharon Pihema (Ngāti Porou), the project found the following themes were common to many of the participants in their descriptions of their rehabilitation experience.

- Including Kaupapa Māori values and practices in hospital was very important to them.
- Practices such as whanaungatanga (building relationships), manaakitanga (caring for others) and whānau ora (whānau-centred care and decision-making) made a positive contribution to their rehabilitation experience.
- The injury and rehabilitation process caused additional psychological stress that affected mental wellbeing of whānau. This stress strained relationships, created financial barriers and housing pressures, and prolonged their healing process.
- Whānau were integral to supporting effective rehabilitation, yet most were unable to access support and faced challenges when they did ask for help.
- Communication was inconsistent. Participants and whānau were frustrated with clinicians talking too fast or using technical language, which made it difficult to make informed decisions or support transition from hospital.

These findings signal the need for further work to develop specific actions that address these themes. This piece of work will be pivotal in improving the journey for the many Māori who are seriously injured.

Serious traumatic brain injury (sTBI)

The sTBI project started with the appointment of intensivist Dr David Knight to lead this large and complex work to improve the outcomes of sTBI. The project has two workstreams: acute care from the point of injury to definitive care; and rehabilitation, which includes the transition of care from acute care to community rehabilitation.

Training mannequin

Enablers

National Trauma Registry

The new NZTR is performing well as a single, web-based software platform for national data collection.

Initiatives are under way to establish consistent coding across the country, including through double-coding transferred patients and undertaking coding exercises. An audit of accuracy of injury coding in six large hospitals found differences in coding of patients who had injury to more than one body part, particularly where the injuries were to the head and chest regions. While at a macro level these differences resulted in very little variation overall, the results suggest the potential for improvement in coding at an individual patient level.

Patient-reported outcome measures (PROMs)

PROMs involve asking patients at 6, 12 and 24 months post-injury to understand their changes in functional performance (eg, eating and dressing) and to identify unwarranted variation in outcomes across New Zealand. The University of Otago has been contracted to administer the survey, in which it contacts a cohort of patients injured between 1 July 2019 and 30 June 2020. Participation rates are high with few opt-outs. Three regions – Northern, Central and South Island – are participating in this initiative.

Workforce

The capacity of the trauma nurse workforce is progressively improving. At the same time, the number of hospitals with significant shortages of these nurses has decreased.

Eleven clinicians successfully completed the Quality Improvement Facilitator course.

Analytics and research

The Study of Road Trauma Evidence and Data (SORTED) has started again, this time with nine agencies across police, transport, health and ACC involved. The Minister for Transport, the Hon Michael Wood, acknowledged the importance of this work to support the next stage of implementation of the Government's Road to Zero policy.

Research that the Network has been directly involved in includes:

- a serious traumatic brain injury report to support the quality improvement work
- rehabilitation outcomes to support the workstream
- audit of coding accuracy in the NZTR, which has been published in the Trauma journal
- prevalence of psychoactive drugs in trauma patients (under way)
- improvements to disability-adjusted life years in New Zealand after the introduction of a contemporary trauma system (under way).

Awards

The National Trauma Network's Annual Report for 2019/20 received the prize for Best Annual Report in the 2021 Plain English Awards.

Regional reports

Northern Region Trauma Network

The Northern Region Trauma Network (NRTN) supports the entire journey of the major trauma patient. Over the past year the NRTN has focused on the following three workstreams.

Improving major trauma rehabilitation

The NRTN has raised the profile of trauma rehabilitation and standardised approach to trauma rehabilitation services across the region. We wrote and endorsed the Regional Trauma Rehabilitation Core Standards paper. The local DHBs are socialising and implementing this document to introduce the first steps in standardising the provision of trauma rehabilitation. This work will continue to progress, which a regional trauma rehabilitation model of care – also in development – will complement.

Improving outcomes for patients with moderate brain injury

The NRTN has aimed to standardise and improve the treatment of patients with moderate brain injury. We now have an agreed regional communication and follow-up pathway for patients with moderate brain injury managed in centres without neurosurgery.

The region has also reviewed best practice of inpatient acute care for moderate head injury when no neurosurgery is required. The NRTN and the Northern Region's tertiary neurosurgery provider have both endorsed the review. The resulting guideline describes a clinical pathway that outlines a multidisciplinary approach to assessing and managing moderate traumatic brain injury. This pathway is currently rolling out in the Northern Region's DHBs.

Delivering and supporting trauma education

The NRTN has launched two successful educational pilots of an online Trauma Care After Resuscitation (TCAR) course. We planned and delivered the course through a virtual classroom, with local subject matter experts guiding the course. Over 30 nurses took part in the course. Among them were nurses from other regions who we shared this experience with.

With education always a major focus for the NRTN, we continue to draw on the ACC Incentive Fund to support education in many different avenues. Along with funding the TCAR pilots, in the last year the fund allowed nurses to attend the Emergency Management of Severe Burns course, the National Trauma Conference and National Trauma Nurses Training Day. The NRTN sponsored the Starship Trauma Education Evening for its fourth consecutive year. The event drew an audience of over 300, who attended either in person or virtually.

The NRTN has also revised and upgraded our website (www.northerntrauma.co.nz). Likewise the Adult Trauma Guidelines, available on the website, have undergone a complete review.

Midland Trauma System

This year the Midland Region became known as Te Manawa Taki (the heartbeat), representing our readiness to go forward and lead changes that work. Our regional trauma system is engaged in this change and will be known as Te Manawa Taki Trauma System.

With COVID-19 lockdowns to navigate and the cyber-attack on Waikato DHB that crippled most clinical systems including the Midland Trauma Registry, it has been a challenging year. Despite these challenges the clinical teams have continued to deliver high-quality trauma care and improve process and systems with the support of the hub service.

This year saw a strong focus on reviewing and improving the efficiency of trauma reception and introducing processes such as Code Red and T30 to our facilities. At the same time we delivered Trauma Team Training and revised our comprehensive trauma guidelines (www.midlandtrauma.nz/guidelines), which we are now disseminating widely for many uses in addition to Trauma Team Training.

Our Trauma Quality Improvement Programme this year included the development of a comprehensive quality assurance process that provided a platform using the registry to record and monitor trauma-related issues for loop closure within the region. We have also further developed the Trauma Reach Clinic along with a clinical safety net for vulnerable patients following discharge. Despite the interruptions during the year, the team delivered a successful trauma symposium, which drew over 150 people from around the region.

It has been a big year of collaboration for the Midland Trauma Research Centre (MTRC). The MTRC is using the information clinicians collected in DHBs to directly influence and support injury prevention activities. Work began with Ngā Toka Hauora Māori General Managers to address the significant inequities affecting Māori in the region and we look forward to contributing further to the partnership as plans develop. In another collaboration, the MTRC worked with the Transport Safety Strategy Steering Group, which on behalf of the Regional Transport Committee developed the Waikato Road to Zero Strategic Direction for 2020–2030 (www.waikatoregion.govt.nz/council/policy-and-plans/transport-policy/road-safety-strategy). With some of the worst road crash statistics in the country, our region needs collaborations like these, which integrate portfolios across public safety groups, as part of our efforts to improve road safety.

In the year ahead, a focus will be to resource our clinical teams and regional support system adequately to meet increasing demands, while adapting to the new health system. In addition, we will upgrade the regional registry as we continue collecting comprehensive trauma data from across the region for use in quality improvement and evidence-based change at community and regional levels.

We look forward to the year ahead and collaborating with our national and regional trauma colleagues to reduce the burden of trauma on patients and whānau in Aotearoa.

Central Region Trauma Network

The 2020/21 year has been busy for the Central Region Trauma Network. Although the intermittent COVID-19 restrictions have impacted trauma volumes at times, both clinical and organisational work continues apace.

A strategic network group was established comprising a broad representation of health professionals, clinical leaders, DHB executives and consumers. The group was tasked with developing a Vision and Strategic Plan for the region for 2021–2024, which would provide the network with both a high-level strategy and tangible targets to reduce the negative impact of trauma on our communities.

This year we have further developed a partnership with our regional shared-services provider, TAS, to develop a trauma data dashboard for the region. The dashboard allows trauma clinicians and leaders from each DHB to easily visualise their local trauma data and outcomes, and benchmark their hospital performance to others in the region. We are excited to see how this impressive tool will help to drive ongoing quality improvement across the region.

The network has continued to work towards standardising guidelines and protocols across the Central Region. This year, a significant piece of work was our collaboration with the Regional Radiology Network to standardise our approach to whole-body CT imaging in trauma. As a result of this work, we have adapted Capital & Coast DHB's evidence-based decision support tool for use in all DHBs in the region. The project also includes background information technology (IT) work to make ordering trauma CT scans easier for clinicians.

Following the Northern Region Trauma Network's example, we have implemented a case review system of trauma deaths that may have been preventable or potentially preventable. This system includes the review of pre-hospital trauma deaths in collaboration with the ambulance sector. A multidisciplinary review group has been established, including an external reviewer.

COVID-19 restrictions have continued to limit trauma education opportunities, although the national trauma symposium had excellent engagement. We have extended the reach of the monthly trauma education meetings held at Wellington Hospital by making them available virtually to the rest of the region.

A significant piece of work has been the implementation of critical haemorrhage pathways at hospitals around the region. In line with the National Trauma Network's quality improvement guidance, the specific pathways we developed target critically bleeding trauma patients so they can receive definitive haemorrhage control more quickly.

We acknowledge the work of our trauma clinicians and supporters across the region. In particular, we thank the network and strategic group members who continue to work hard to improve the quality of care and outcomes for our patients, their whānau and communities.

South Island Trauma Network

The South Island Alliance Major Trauma Workstream members continue to strive for a high-functioning trauma system that provides the care that all New Zealanders expect when they experience significant injury. A strength of the workstream is that it maintains knowledge and shares it as part of working towards common practices between districts.

The workstream has continued to push for resources to reduce some of the pressure on the trauma nurse coordinators and to record and use common regional data. From early 2022 the South Island Alliance will no longer support the trauma workstream and discussions are under way to reorganise trauma collaboration in the South Island. The task for the South Island Workstream now is to maintain its momentum, even if it no longer has the support of the Alliance, and prepare for the transition to the new health structure.

The following are some of the various projects and developments that took place across the region this year.

Southern DHB:

- has established a rib fracture bundle to provide consistent, better-quality care to adult patients with rib fractures
- has developed pelvic surgery guidelines to manage complex pelvic trauma
- held Care of the Trauma Patient' one-day nurse and allied health study days
- held trauma mortality and morbidity meetings to review all trauma deaths and conduct specific case reviews
- has expanded the Right Track programmes, leading to profound positive change in the lives of participants and supporters through encouraging better decision-making about driving. The delivery of the programme involves volunteers from the New Zealand Police, Department for Courts, New Zealand Fire Service, St John and DHBs. We hope the success of this programme will give encouragement to hold it in more locations across New Zealand.

Canterbury DHB:

- has progressed well in planning for an Admitting Trauma Service and expects to implement an admitting bed card by January 2022
- introduced dedicated trauma registrar hours, which has contributed to an increase in the number of tertiary surveys completed for trauma patients, as well as to faster discharge of patients who have not experienced major trauma
- has been developing the Code Crimson protocol, with plans to roll it out in December 2021
- began regular trauma mortality and morbidity meetings in August 2021 to address clinical and systems issues
- is continuing with multiple ongoing research projects and National Collaborative Rehabilitation Project work on traumatic brain injury assessments in Christchurch Hospital
- is undertaking ongoing COVID-19 response planning, including by running COVID-19 trauma simulations in the emergency department.

Across the South Island Region as a whole:

- some hospitals have undertaken Trauma Team Training
- St John Ambulance Service has contributed to the regional workstream. St John is currently working on aligning pre-hospital ultrasound with Code Crimson and building ambulance services for the future
- the role of intensive care paramedic is changing to a critical care paramedic (CCP). CCPs will have the delegated authority to independently perform many skills and to administer many medicines to patients with a wide range of clinical conditions.

Wayne's story

How whānau supported my recovery

I'm 55 years old and live in Paraparaumu. My whānau are from Wairoa in the Hawke's Bay. I've spent most of my life as a deep-sea fisherman, then truck and digger driving, forestry, dairy farming and in the volunteer fire brigade. In July 2020, I was in a single vehicle car crash in which I lost my arm. I was travelling to the Tararua Ranges when my tyre suddenly snapped off, the axel hit the road and my truck flipped over onto its side. As my window was open at the time, my arm got trapped between the truck and the road and my arm was taken off.

The people first on the scene were unable to cope with the horrific state I was in. Luckily the next person to arrive was a nurse and she was able to grab my first aid kit and attach a tourniquet to my arm, saving my life in the process. Because of my time in the fire brigade, I knew a lot of the first responders and seeing me critically injured like that was a traumatic experience for them.

I woke up three days later in Wellington Intensive Care Unit. My sisters were at my bedside and I remember asking them if my arm had been amputated. When they said yes, I started crying. I had a tangi for about two minutes and then I said to my sisters "Right, I'm never going to cry again". And I haven't. You've just got to get on with it.

Those first couple of weeks were really hard. When doctors came in, they'd use doctor lingo and I couldn't understand anything. My whānau (one of my sisters is a paramedic) and my occupational therapist were able to explain things to me.

The hospital staff were awesome. If there were any big decisions to be made, the doctors would wait for my whole whānau to come. I was rapt to meet a Māori doctor. He came and had some boil-up with me. He knew where I was from, where my farm was and who owned it. That just put me at ease straight away.

As soon as I was discharged from hospital, I was surrounded by help. Home help, physiotherapists, occupational therapists, the dietitian, the psychiatrist. Straight away, they were putting things in place for my recovery. I'm getting ready to receive my bionic arm shortly. That has been an amazing journey learning how they assess and build the prosthetics.

One of the hardest things to deal with is the phantom pain. It's absolutely mind-blowing how bad it gets. While I have my prosthetic arm on, it's fine. My brain can see that I've got something on the end of my limb. As soon as I take it off however, the pain hits with a vengeance.

Looking back at my whole experience there were so many positive aspects about the care I received. My whānau are amazing. I could not have got through all this without their support. They have been my rock throughout it all and I am forever grateful for their love and support. easier and pleasant. Tena koe Jeanette my Kaimanaaki from Te Hā Oranga for nurturing my wairua and just being there, tena koe."

Tena koutou katoa mo o koutou awhi me te aroha.
(Thank you all for your love and support)


HJC
STAR
Blackwells
ESCUE
Westpac
FIRE
RESCUE

Appendix A: RACS key performance indicators, 2020/21

Case fatality rate (ISS ≥ 13)

Northern	Midland	Central	South Island	National
9.7%	6.5%	8.3%	7.0%	8.0%

Pre-hospital transport time to hospital in hours (ISS ≥ 13)

Northern	Midland	Central	South Island	National
1.5	1.7	1.6	1.9	1.6

Discharge destination 2019/20 (ISS ≥ 13)

	Northern	Midland	Central	South Island	National
Home	60%	68%	62%	64%	63%
Rehabilitation	21%	15%	15%	24%	19%
Acute care facility	4%	0%	17%	2%	5%
Hospital for convalescence	8%	6%	1%	6%	5%
Left against medical advice	3%	2%	2%	1%	2%
Other/unknown	1%	6%	1%	0%	2%
Residential aged care service or nursing home (not usual residence)	3%	1%	1%	2%	2%
Special accommodation	1%	0%	1%	1%	1%

Median time in hours to CT for patients with impaired consciousness (GCS ≤ 13; ISS ≥ 13)

Northern	Midland	Central	South Island	National
0.7	0.8	1.1	0.8	0.9

Recording of blood alcohol concentration at first hospital

Northern	Midland	Central	South Island	National
74%	76%	62%	50%	66%

Time in hours in first hospital for patients transferred for definitive care (ISS ≥ 13)

Northern	Midland	Central	South Island	National
4.0	6.0	14.6	7.2	6.5

Time in hours in emergency department in first hospital (ISS ≥ 13)

Northern	Midland	Central	South Island	National
6.2	5.0	6.0	5.0	5.6

Appendix B: Methods

Data

The New Zealand Trauma Registry (NZTR) is hosted at Canterbury DHB and managed by Dendrite Clinical Systems. The Midland Trauma System host their own registry for injuries in their region. Extracts from both registries were combined to include all cases with an injury date between 1 July 2015 and 30 June 2021. Those injured between 1 July 2020 and 30 June 2021 were used in the analyses in this report for the current year. Many other analyses as specified cover the four years from 1 July 2017 to 30 June 2021 for which the major trauma collection is complete. Some analyses include data from the beginning of the registry at 1 July 2015, although the data is not nationally complete in this period before 1 July 2017.

For all years and in particular for the most recent year, it is possible that some cases will not be included. For example, a small number of patients may have not yet been discharged from their definitive care facility at the time of data extraction, or the record may not have been submitted to the registry at the time.

Population estimates for each DHB by ethnicity, age and sex are custom projections produced by Statistics New Zealand specifically for the Ministry of Health from the 2013 Census with projections updated in 2019. The projections are based on prioritised ethnicity and take into account DHB-specific rates of fertility, mortality, migration and inter-ethnic mobility.

Population-based rates

Population-based rates are produced by dividing a number of events by the estimated population size for the area of interest, presented on a per 100,000 usually resident people per annum basis. Unless otherwise specified, the numerator of all such rates is defined by the location of definitive care, not by patient domicile. The interpretation of such rates is the annual number of major trauma patients given definitive care per 100,000 residents and does not imply patients are from the resident population.

Age standardised rates

Age standardisation is performed using the directly standardised method employed in the R package dsrTest and using the Dobson method to calculate confidence intervals. Note, in the previous report the WHO standard population was used as the reference population. Here, we have used the estimated resident population in the 2013 census year for Māori as the reference population, in line with recommendations in the literature. This means that apparent rates are slightly lower overall, reflecting the age structure differences between the two reference populations.

Case fatality rate

The Royal Australasian College of Surgeons definition of the case fatality rate is the total number of deaths in the NZTR (ie, including ISS < 13) divided by the total number of major trauma cases in the NZTR (ISS ≥ 13). This is problematic because the inclusion of ISS < 13 deaths in the numerator without the inclusion of ISS < 13 cases in the denominator implies these are treated as 'never events'. However, the majority of such cases are medical deaths in patients aged 65 years and over, and as such other factors complicate their inclusion. We define the case fatality rate as the total number of major trauma deaths in the NZTR (ISS ≥ 13) divided by the total number of major trauma cases in the Registry NZTR (ISS ≥ 13). We discuss ISS < 13 deaths separately.

Standardised mortality ratio

The estimation of a standardised mortality ratio (SMR) requires a model to be built to take account of variation in mortality that is explained by factors external to the trauma system. There is a vast body of literature demonstrating that mortality varies with injury severity and type, patient age and other patient health factors such as presenting co-morbidities.

The SMR was modelled using a generalised additive model (GAM), predicting death at definitive care facility from:

- New Injury Severity Score
- first recorded pulse and systolic blood pressure
- base deficit/excess
- first recorded Glasgow Coma Score total
- age
- maximum head AIS score
- maximum vessels AIS score
- mechanism of injury
- time from injury to hospital
- mode of transport to hospital (ambulance/non-ambulance)
- injury type (blunt, penetrating, burn).

Missing data was handled through multiple imputation, with 20 imputed data sets. Models were compared using Akaike Information Criterion (AIC), and more complex models only retained if preferred by AIC. Other factors were considered, including patient ethnicity, sex and self-presentation to hospital, however they were not significant predictors of mortality and/or did not reduce model AIC.

The final GAM was used to predict probability of death for each case in the data set for ISS ≥ 13. The summed probabilities of death were used as an expected death count for contrast with observed deaths at each site.

Regional comparisons for the SMR exclude inter-regional transfers for definitive care.

Appendix C: Published research on injury in New Zealand

Allen MT, Thompson BC, Atkinson B, et al. 2021. Emergency department presentations in the Southern District of New Zealand during the 2020 COVID-19 pandemic lockdown. *Emergency Medicine Australasia* 33(3): 534–40. DOI: 10.1111/1742-6723.13749

Babl FE, Tavender E, Ballard DW, et al. 2021. Australian and New Zealand Guideline for Mild to Moderate Head Injuries in Children. *Emergency Medicine Australasia* 33(2): 214–31. DOI: 10.1111/1742-6723.13722

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