New Zealand Major Trauma Registry & National Clinical Network

Annual Report 2015-2016




Major Trauma
National Clinical Network

Contents

Foreword

It is with great pleasure that we produce this first annual report from the Major Trauma National Clinical Network. The Network has been in existence for four years but this is the first year that data from the newly formed New Zealand Major Trauma Registry has been available. While still in its development phase this registry allows some insight into the incidence, severity and outcomes from major trauma on a regional basis. This report also details the other activities of the Network over the past year, the relevance of which is able to be reflected in the registry data.

Acknowledgement is given to all those who have worked hard over the past year either delivering care to trauma patients at their hospitals or more specifically involved in the Network and the activities of the Major Trauma Registry. The support of the sponsors, Accident Compensation Corporation and the Ministry of Health, has been vital for this activity to proceed and with their ongoing support improved outcomes for major trauma patients and reduced costs in the health and rehabilitation sectors could be anticipated.

Ian Civil

National Clinical Lead
Major Trauma National Clinical Network

7 December 2016

Executive Summary

The summary findings for 2015-16 show that we are achieving outcomes for major trauma patients within a range demonstrated by various international jurisdictions, but with room to improve to be amongst the best performers. We are however cognisant that the data we have used in this report is largely from the more mature trauma systems in the North Island which presumably have better outcomes than the less mature regions. The Central Region and to some extent the South Island have made good progress to establish the foundations to achieve contemporary trauma care. A key challenge is securing the sustainability of the trauma system to build on the gains made over the 2015-16 year.

The Major Trauma National Clinical Network was established in 2012 to address concerns about the possible high mortality rate and variation of care for trauma patients in New Zealand. The goal of the network is to establish a contemporary trauma system across all of New Zealand by building on areas of excellence in the upper North Island, and supporting the new systems in the Central Region and South Island. We would like to see the benefits seen elsewhere such as reductions in mortality, improvements in the long-term disability outcomes and cost savings also realised in New Zealand.

This report outlines the 2015-16 progress and initial findings from the Major Trauma Registry (NZ-MTR). For the first time we are able to report the incidence of major trauma and high-level outcomes and to compare ourselves with others internationally. We can now identify the areas of concern and the findings in this and future reports will help us drive quality improvement initiatives over the next 5-10 years.

The NZ-MTR has over 1,300 patients entered from most of the North Island DHBs. The South Island has been excluded from this analysis due to insufficient data although we expect this to resolve in the next year.

At an aggregate level:

Incidence rate is 40.8/100,000	This is within the expected range. There is some variability between DHBs which may result from differences in the underlying injury patterns in the various regions. There may be an element of underreporting in Northern and Central regions.
Three age group peaks	20-24 year old age group as a result of motor vehicle crashes (occupants) and assault 50-60 year old age group due to falls, motorcycle crashes and motor vehicle crashes (occupants) 75 year old and older age group due to falls and motor vehicle crashes (occupants)
Māori	The incidence for Māori is 69/100,000/yr compared to 39/100,000/yr for non-Māori. Further work is signalled to better understand this vulnerable population to target prevention.
Case Fatality Rate	9% nationally and consistent across the three regions. This is comparable to other jurisdictions but not as good as the best performers internationally who have rates around 6%.
Road Traffic Crash	Road traffic crashes account for 52% of all major trauma, with motor vehicle occupants the most commonly injured group.

These findings are within the expected range and validate the quality of the data in the NZ-MTR. An unexpected finding is the high proportion of patients who are very seriously injured (ISS> 40) in one region which will require further analysis.

The regional breakdown of this data shows us some interesting information. Of note:

- Northern Region has lower than average incidence rate, but a higher proportion of Maori and pedestrians compared to the average. This is consistent with what might be expected from population ethnicity data and the relative low vehicle speeds and high numbers of pedestrians
- Midland Region has a higher than average major trauma incidence (but data collection is more established in this region), and a higher proportion of road traffic crashes. The high-speed roads through the region will likely be a contributing factor
- Central Region has a higher proportion of major trauma patients in the older age groups, with a corresponding high rate of falls

The process indicators which look at how well our trauma system is working showed:

- 87% of all patients arrive in hospital within 2 hours of first observations at the scene of injury (55% within the first "golden hour")
- Glasgow Coma Scale is a poor predictor of traumatic brain injury in the pre-hospital setting
- Around 21% of patients were transferred at least once in the first 72 hours after injury before they reached a definitive care hospital. This will serve as the baseline once we implement the pre-hospital destination policy in early 2017
- The more mature trauma systems in Midland and Northern showed the majority of patients had:
    - A CT scan within two hours from arrival in first hospital
    - Alcohol levels measured. Where results were available there was a strong correlation with assault as the cause of injury

These process indicators suggest more work is needed on improving the process of in-hospital care in the regions with new trauma systems.

Over the next few years as we get more data into the NZ-MTR and collaborate with other countries, and in particular Australia with whom we have closely aligned our dataset, we expect to be able to provide more statistically significant data.

The 2015-16 data from the NZ-MTR provides a baseline from which we can measure the impact of activities we are working on to achieve contemporary trauma systems. These activities include:

- Pre-hospital destination policy which involves a nationally consistent approach for ambulance personnel to triage major trauma patients, and identifies the definitive hospital for these patients. The intent is to take patients to the right hospital first time. This has been shown to improve patient outcomes and is expected to be financially favourable to both the DHB of service and the DHB of domicile. These policies are planned for implementation in early 2017.
- New regional clinical networks started in the Central and South Island Regions with an initial focus on data collection and establishing a foundation of work to build on.
- Policy settings to support the collection of data. The Ministry of Health included data collection as a mandatory requirement in the 2015/16 Annual Planning Guidance for DHBs, and Accident Compensation Corporation allocated $80K per annum for entries to the NZ-MTR on a pro rata basis. Both policies have been instrumental in encouraging data collection.

The support of our sponsors – Accident Compensation Corporation and the Ministry of Health – has been critical in providing assistance to the national trauma work programme.

The programme of work we are commencing will take 5-10 years to reach its full benefit. However, the results we are able to show in this first year are enormously encouraging and helpful to the large number of committed clinicians and other stakeholders who have dedicated their time, some of it personal time, to achieve our common goal of a contemporary trauma system in New Zealand.


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Introduction

The Major Trauma National Clinical Network ("the Network") is charged with ensuring the NZ trauma system delivers optimal trauma care and provides those who do not die immediately from their injury the greatest chance of uncomplicated survival. Our goal is to establish a contemporary trauma system in New Zealand which brings us up to international best practice and delivers the benefits to trauma patients, the population, and cost effectiveness across the health system.

This paper reports on the Network's activities for 2015-16 and comprises two parts. The first part sets out the findings from data entered into the NZ Major Trauma Registry (NZ-MTR) and the second part describes the progress of the Networks priority areas.

This is our first year that the requirement to establish regional trauma networks and start data collection has been in place. Being cognisant of our early stage of development this is a relatively modest report. The analysis is high-level with a view that next year and beyond we will be able to undertake more detailed analysis and measure against key performance indicators. Notwithstanding these limitations, for the first time we have an emerging view of trauma outcomes in New Zealand.

New Zealand – Major Trauma Registry

The incidence of major trauma, and therefore the demand on the health system and healthcare providers, has not been determined previously in NZ. Existing healthcare databases use diagnostic categories that do not align with the Injury Severity Score and thus do not allow the calculation of an overall mortality risk, nor international comparability. The development of the NZ-MTR has allowed this to happen for the first time in NZ on a national basis.

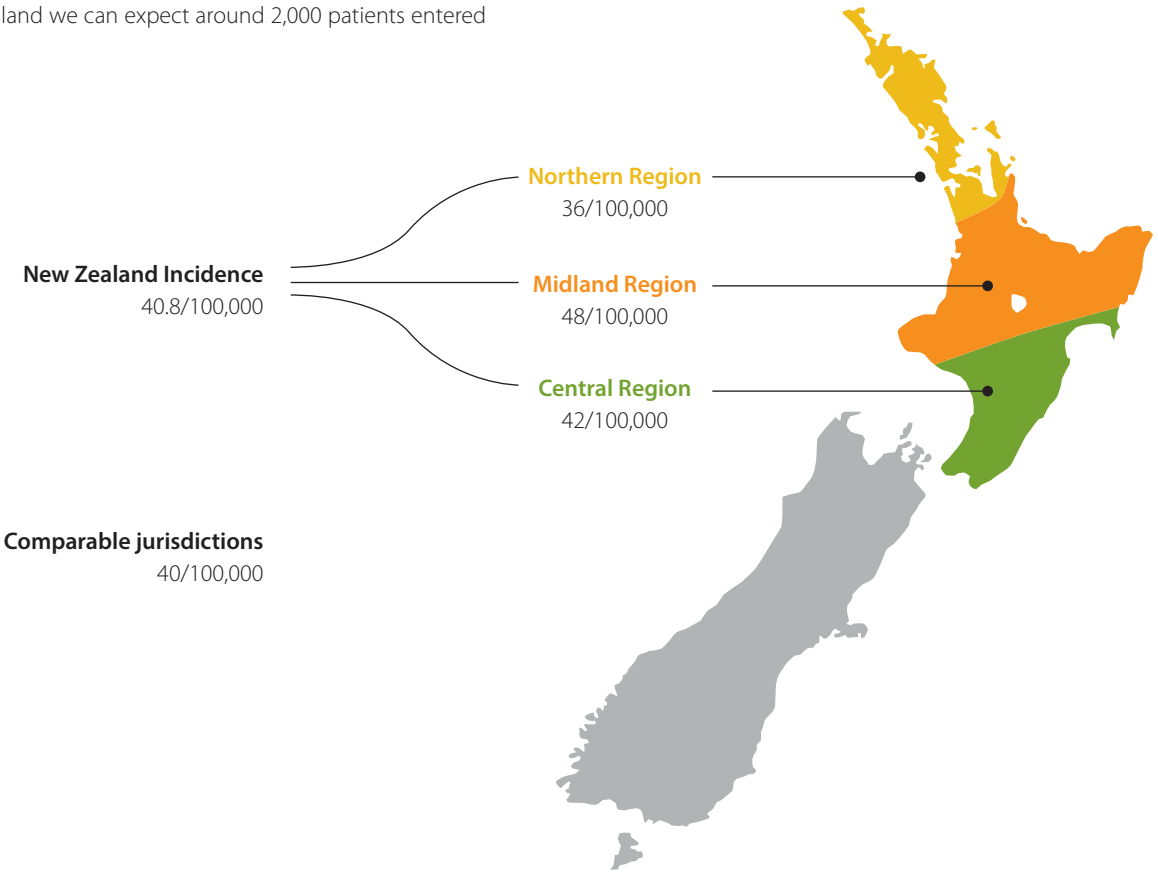
The NZ-MTR began on 1 July 2015 as a single web-based system hosted by Waikato DHB. Over the year most of the North Island DHBs have collected and input data on major trauma patients admitted to their hospital. Collection in the South Island has been patchy and thus excluded from this analysis.

There are 1301 entries in the NZ-MTR. When full collection starts in the South Island we can expect around 2,000 patients entered each year.

Incidence

There is no "normal" rate of major trauma but countries similar to NZ such as Canada, UK and Australia, where the incidence of major trauma and the outcomes have been measured show incidences of around 40 cases/100,000 population[1,2,3,4]. One of the first findings from the NZ-MTR therefore relates to the incidence of major trauma in NZ.

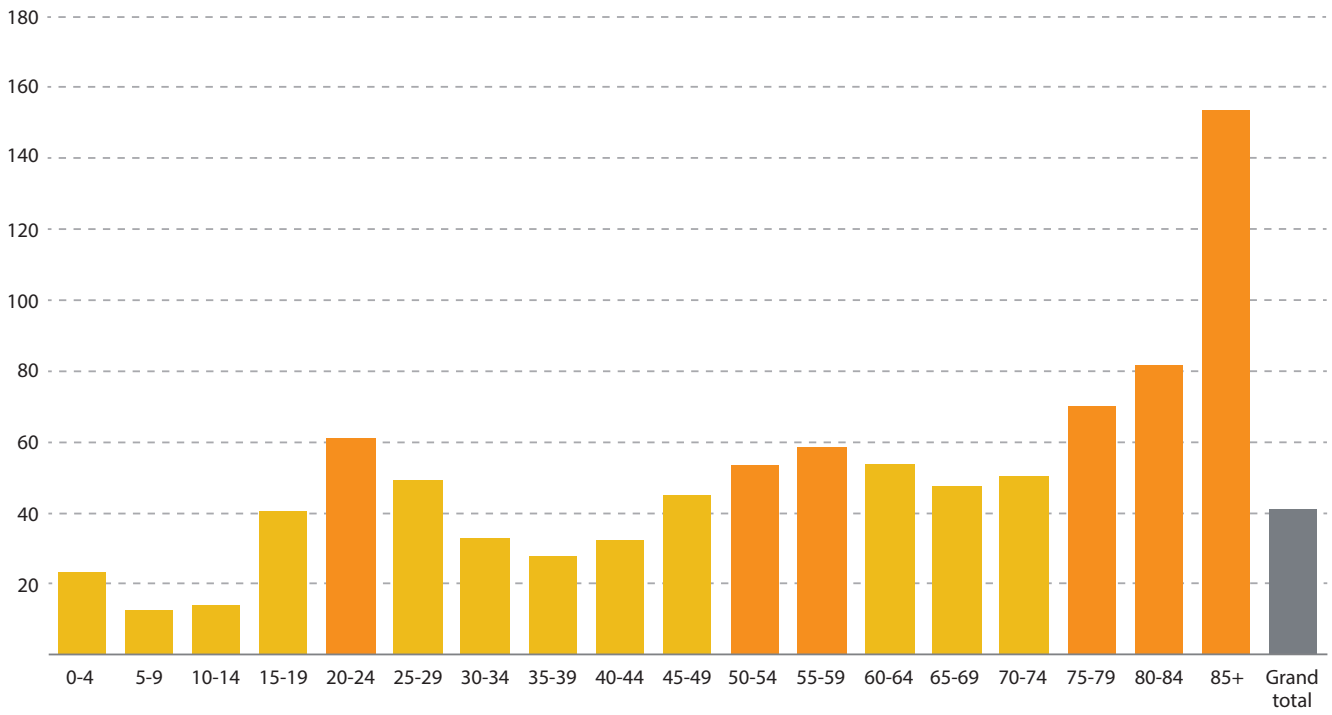
While the national aggregate is in line with the expected incidence, there is variability between regions. There is an element of underreporting particularly in the Central Region with a delay in some DHBs starting collection. Overall the reported North Island incidence is 40.8/100,000/year and with the known underreporting in the first year this indicates that while the NZ incidence may be slightly higher it is within range of comparable jurisdictions.



Demographics

Major trauma is traditionally a disease of the young and indeed in most regions of the world it is the leading cause of death in those under 44 years of age.

Incident by age band per 100,000



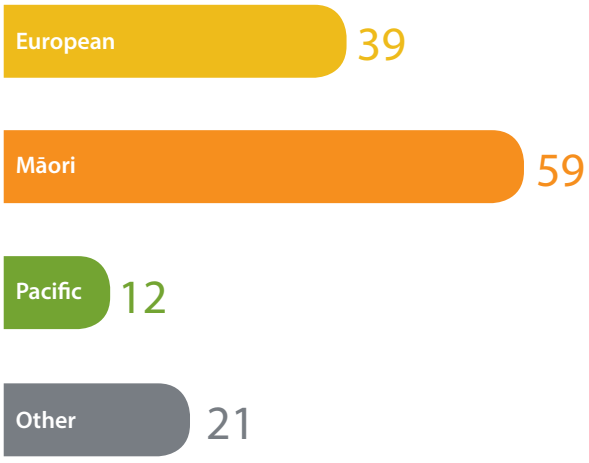
Approximately 10% of major trauma occurs in the paediatric age group (0-15 years) and 20% in those aged over 65 years.

Trauma impacts all age groups but with three peaks observed in:

- **20-24 age group** with the most common causes being motor vehicles (occupant) and assault
- **50-60 age group** with the most common causes being falls, motorcycles and motor vehicles (occupant)
- **75 and over age group** due to falls and motor vehicles (occupant).

Event rate by ethnic group per 100,000 of the population

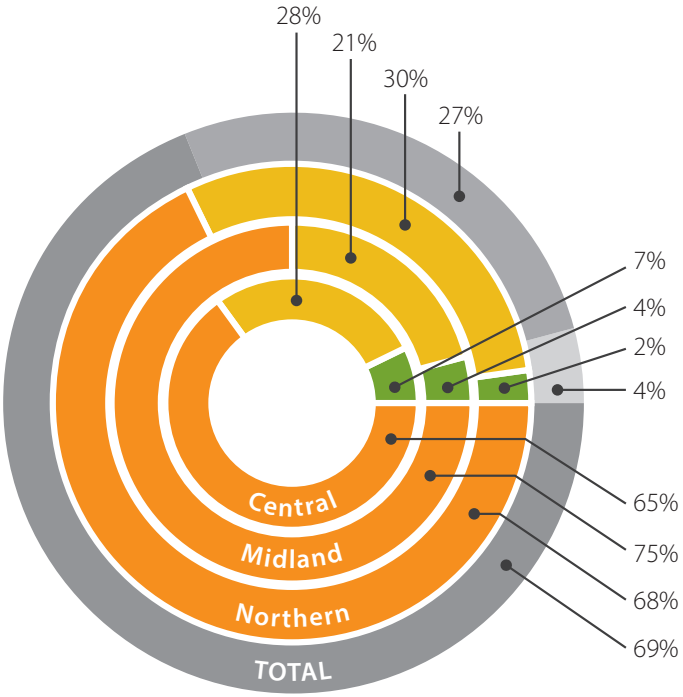
The ethnic makeup of New Zealand is very different in the different regions and this would be expected to be reflected in the incidence of major trauma as well. Indeed, areas where there is a high Māori population such as Tairawhiti, Northland and Whanganui there are higher percentages of Māori suffering major trauma than in other DHBs. When the rates of major trauma are denominated by the ethnic population numbers an even more striking pattern emerges with the incidence of trauma amongst Māori being 69/100,000 compared with 31/100,000 for non-Māori. Further work is signalled to explore this finding.

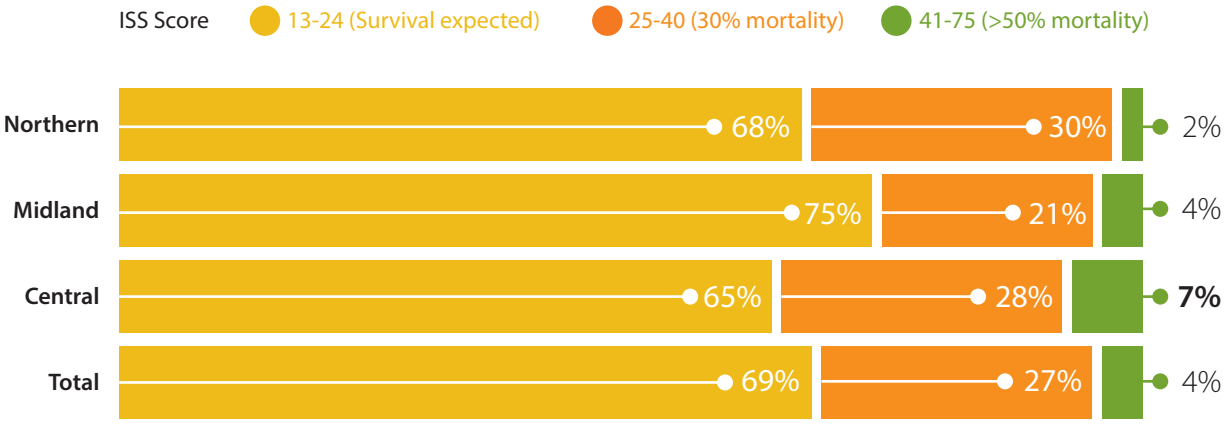


Injury Severity Score

Injury Severity Score (ISS) is a numerical way of grading severity of injury that occurs in different body areas. Each injury is given a grade as described in the Abbreviated Injury Scale (AIS) between 1 to 5, with 1 being minor, 2 moderate and 3 or more being serious, severe or critical. The ISS sums the scores (when squared) for the three most severely injured body regions. A score of 13 or more implies either a serious injury in one body region, and/or lesser severity injuries in two or more body parts. The ISS can be directly correlated with a threat to life and to a lesser degree to complications, length of stay, and outcome. In line with the Network's focus on the most severely injured patients, the NZ-MTR collects data on patients described as meeting the criteria of ISS[5] of 13 or more.

Major trauma as defined by ISS can be stratified into any number of specific groups. In this report three groupings have been used. One would expect the proportions of these three groups to be similar in every DHB and approximate the overall percentages which are 74%, 22% and 4%.





The relatively high proportion of patients in the highest ISS category in the Central Region is of concern and needs further investigation to better understand the contributing factors.


Blackwells
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Case Fatality Rate

Case fatality rate has previously been unknown in NZ but is expected to fall within the 6-23% range reported by the various similar jurisdictions currently and historically in the UK, US, Canada and Australia[1,4,6,7].

The overall mortality reported here is 9% with little variation between the regions and well within the international range, although there is room for improvement to achieve the 6% rate of the best performers.

Cause of injury

Cause of injury is highly variable between the regions. Of note is the variability in falls from 19% (Midland) to 35% (Central). The combined causes of road traffic crashes (RTC) account for 52% of all cases although again within this category there are significant variances between regions, such as:

- Pedestrians in the metro Auckland area who account for 12% of all injuries, compared to 3-5% in the other two regions
- Motor vehicle occupants in Midland comprise 32% of all patients, compared to 18-22% in the other two regions

These findings are not surprising given the density of pedestrian areas in metro Auckland and the high speed roads in Midland.

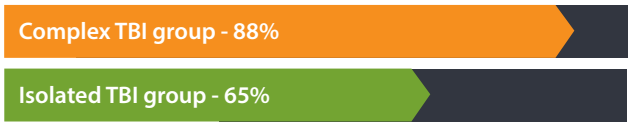
	Northern	Midland	Central	National
Fall	**29%**	**19%**	**35%**	**28%**
Assault	**7%**	**7%**	**11%**	**8%**
All RTC	**50%**	**61%**	**46%**	**52%**
Car occupant	22%	32%	18%	24%
Motorcycle rider	9%	13%	11%	11%
Pedestrian	10%	3%	5%	6%
Pedal cyclist	6%	7%	6%	6%
Other vehicles	1%	2%	4%	2%
Quad bike *(non-traffic)*	1%	3%	1%	2%
Quad bike *(traffic)*	1%	1%	1%	1%
Other	**14%**	**13%**	**8%**	**12%**

Traumatic Brain Injuries (TBI)

TBI patients were identified if they had an Abbreviated Injury Score of three or more. This implies a moderate severity injury in the head region and one which would be expected to be associated with a short term risk of death and a longer term expectation of a need for rehabilitation.

We decided to focus on traumatic brain injuries as they comprised 40% of all cases (n=517) and 34% (n=38) of all deaths. The TBI patients were split into two groups; those with isolated injury (n=88) and those with other injuries which had an AIS score >2 (n=429).

TBI patients – CT within 2 hours



The analysis showed:

- Glasgow Coma Scale at the scene was a poor predictor of serious TBI with only 12- 15% of patients with either isolated or complex TBI assessed as having a GCS < 9 at scene
- Almost all patients (88%) of the complex TBI group had a CT within two hours of arrival at the first hospital, compared to only 65% of the isolated TBI group. A short time to CT is a critical process marker for the TBI cohort and an issue to work on is decreasing the time to CT for all TBI patients

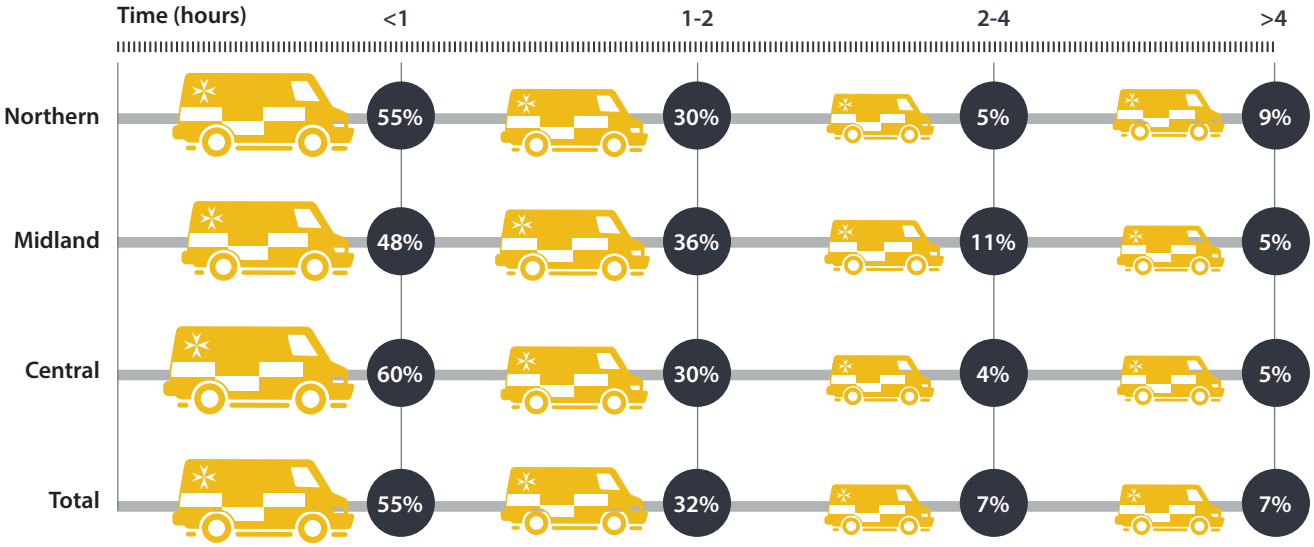
Under the new pre-hospital triage policy ambulance personnel will be using motor score only to initially assess whether there has been brain injury involvement. Further work is required in all hospitals to improve the arrival to CT time for all patients and particularly the TBI group.

Process markers

Pre-hospital – Time from scene to first hospital

From the time R Adams Cowley[8] first coined the term "The Golden Hour", time has been recognised as an important variable in patient survival. Numerous studies have shown that the sooner patients get to the hospital that can provide definitive care the better the chance of survival. The Australian Trauma Registry has shown that to be just under 2 hours in most States and given our smaller but less centralised geography whether that figure was also relevant for NZ was unknown.

Our results showed 55% of patients were transferred from scene to first hospital within an hour, and a total of 87% within two hours. There were some differences between the regions, showing:



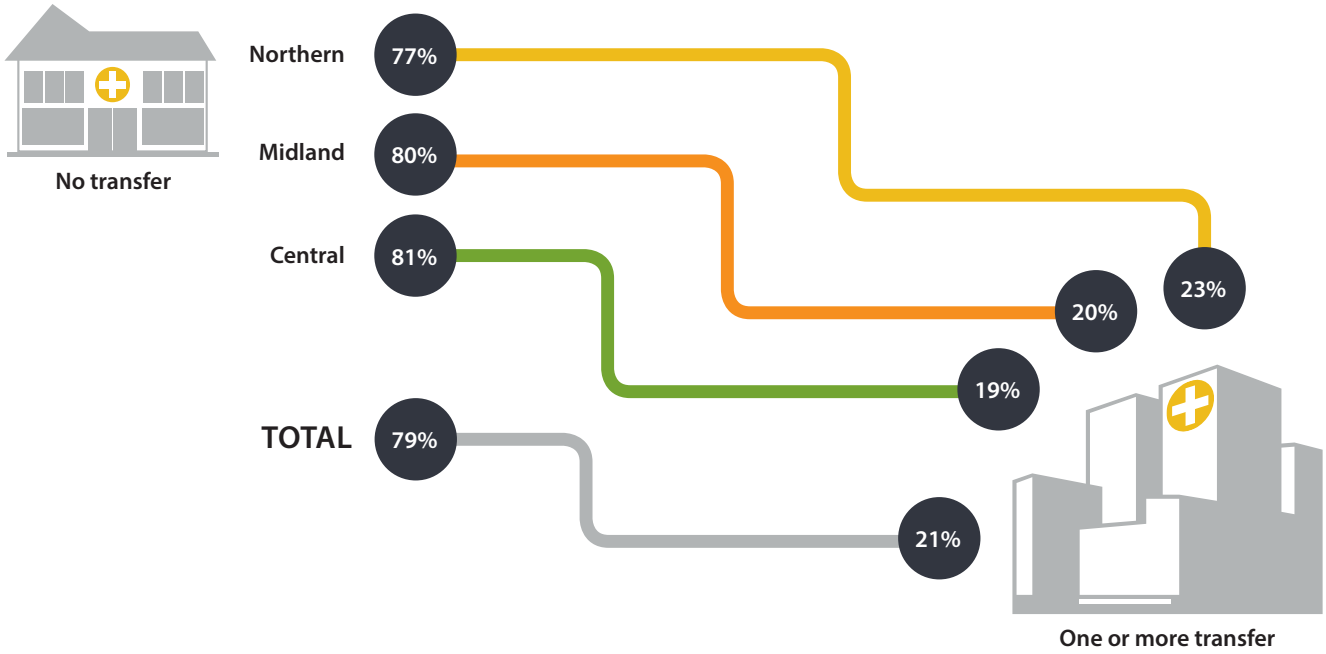
The longer transfer times are not necessarily negative, and may be attributed to a number of reasons including:

- Introduction policy for Acute Spinal Cord Impairment policy for direct transfer of these patients to Middlemore Hospital
- Longer transfer time to first hospital, if the patient is seriously injured and requires transfer to a tertiary hospital for definitive care
- Geographical isolation

While these results are contextual, in subsequent years we will be monitoring this indicator to assess the impact of the pre-hospital destination policy which is envisaged to increase scene to first hospital time, but decrease the time from scene to definitive hospital. The benefits of a longer initial transfer are believed to outweigh the potential drawbacks associated with delayed care in a definitive care hospital.

Pre-hospital: Number of hospitals patient went to before receiving definitive care

One of the goals of an effective trauma system is to get the patient to the hospital that can provide them definitive care directly. Any patient who has to be transferred from one hospital to another (or from two hospitals to a third) represents an opportunity for destination policy to be refined so that patients get to a hospital which could care definitively for their injuries directly. In each of the regions between 19 -23% of patients were transferred for definitive care within 72 hours and these patients would likely represent a group who could have had their care trajectory improved.



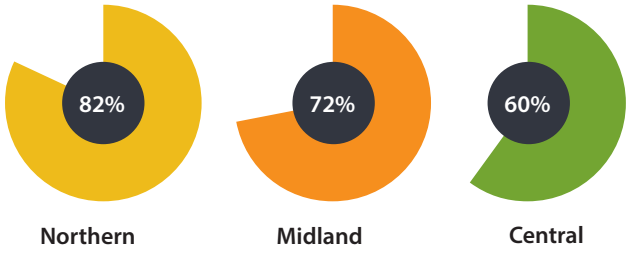
Hospital – time to CT

Once a patient arrives in hospital, one of the important process of care markers is time to first CT as evidence of effective in-hospital systems. Most major trauma patients need a CT of at least one body region and thus this indicator is an important marker of the process of care of trauma patients.

The time to CT is different in the three regions with all needing to improve to get closer to 100%.

This suggests that the guidelines and systems of care are probably different between the regions leading to more prompt radiological evaluation of major trauma patients injuries in some hospitals compared to others.

Time to CT <2 hours



Blood alcohol

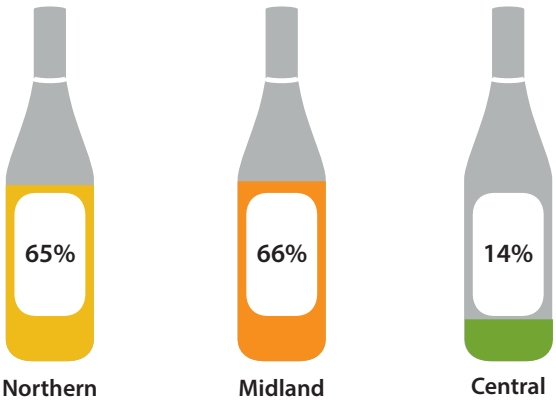
Alcohol is an important association with major trauma. While there are legal limits applied to driving and blood alcohol levels, many other forms of trauma such as falls and assaults are also associated with alcohol intoxication. Before being able to suggest interventions that might be relevant in the different forms of trauma it is important to know the blood alcohol levels of injured patients. Various aspects of clinical care can be affected by elevated blood alcohol so having blood alcohol levels recorded on major trauma patients is evidence of an effective process of care and one of the recognised KPIs.

In Midland and Northern Regions two-thirds of major trauma patients had a blood alcohol level recorded, whereas in the Central Region only 14% had a blood alcohol level recorded.

Not surprisingly there is a strong correlation between blood alcohol above the legal limit and assault, and a marginal correlation with being injured while in a car.

A good case can be made for measuring and recording blood alcohol to inform injury prevention initiatives.

% Blood alcohol level recorded



National Clinical Network Activities

About the Network

The Network is focussed on those patients with major trauma where there is the greatest potential for mortality and complications.

The Network was established in 2012 to achieve a contemporary trauma system in New Zealand. Sponsored by Accident Compensation Corporation as its primary sponsor with the Ministry of Health, progress has been made across the Network's priority areas.

Establishing the NZ-Major Trauma Registry – carrots and sticks

Over the past year we have achieved a single web-based trauma Registry hosted by Waikato DHB with financial contribution from DHBs. All DHBs have signed up to this agreement.

Data collection on major trauma patients has been supported by two key initiatives:

a. Ministry of Health requirements for all DHBs to collect data since 1 July 2015. This requirement has been the single most effective tool to encourage DHBs to invest in data collection resource

b. Accident Compensation Corporation's provision of an incentive to DHBs to submit data to the NZ-MTR. This year, and for the next two years, there is commitment to pay $80K pro rata based on number of entries to the NZ-MTR. The Network agreed to use this for nurse and allied health education to advance trauma capability in each region

Over the course of the year data collectors were trained in AIS coding and using the NZ-MTR. By the end of the year data collection was consistently underway in 17 of 22 hospitals, and included all major trauma hub hospitals except Dunedin. Four hospitals had firm plans in place to implement data collection imminently.

Foundation work developed to support the NZ-MTR includes:

- The National Minimum Dataset for trauma with 55 out of 67 fields consistent with the Australian Trauma Registry dataset
- A Privacy Framework endorsed by the Office of the Privacy Commission
- A Data Governance Framework established with an independent Chair and Terms of Reference to manage the use of data in the NZ-MTR

Pre-Hospital Destination Policy

We started development of a nationally consistent pre-hospital destination policy in collaboration with the ambulance sector. This initiative is driven by strong international evidence which demonstrates improved health outcomes when major trauma patients are taken direct to a hospital which can provide definitive care from the scene. The following deliverables have been developed:

- A new triage criteria for ambulance personnel to identify patients with major trauma
- Designation of major trauma hospitals which have appropriate capacity and capability
- Regional policies which guide ambulance officers in each region on the designated hospitals

Work has also started on developing staging guidelines as a new concept in New Zealand.

Subsequent work will seek full endorsement from key stakeholders and the Ministers for ACC and Health prior to implementation in early 2017.

Roadshows, education and training

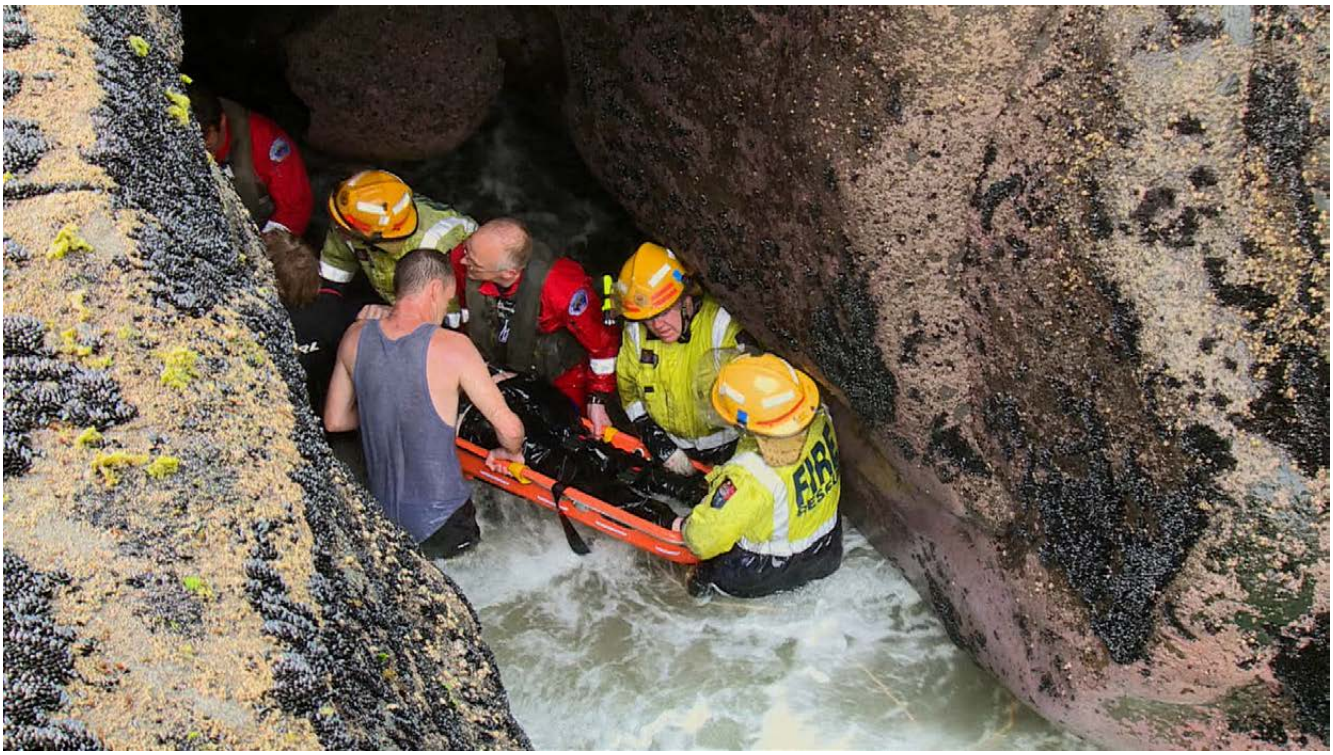
A series of roadshows presenting 'what's new' in trauma was presented in almost all hospitals around the country. The presentation covered both the subtle and radical changes in clinical care and research into trauma systems and what has worked or not.

A plethora of trauma symposiums and education has erupted across the country generating a good level of interest and enthusiasm.

Other developments

The website has been redeveloped (www.majortrauma.nz) and has started to become an effective repository of information and training.

While the Network has been largely focussed on foundation work and data collection, interaction with other agencies has been limited. There are many agencies which are concerned with aspects of our work such as New Zealand Transport Agency, the Australian National Trauma Research Institute, and the Royal Australasian College of Surgeons, and we see elaboration of our relationships as a key feature of work over the next year.



Key priorities for 2016-17

National consistency

Continue to support the Central and South Island regions as they build their trauma systems to provide a consistent and equitable level of service across the country. We aim to achieve a similar level of care regardless of where the incident occurred.

NZ-MTR

Embed the NZ-MTR with data collection in the South Island DHBs and explore opportunities to streamline the collection process.

Research & collaboration

Particularly with the Australian Trauma Registry and partners in the Australian states, and seek opportunities for collaboration with NZ universities and stakeholders.

Funding sustainability

Secure medium – long term funding in line with the strategic plan for the national programme of work.

Conclusions

Over the past year the Network has made considerable progress in its goal to achieve a contemporary trauma system in New Zealand. The Sponsors support to mandate and incentivise data collection has been critical to getting traction to the data collection process and will help us understand what needs to change in how well we care for patients and how well the trauma system functions.

For the first time we have some visibility of outcomes for major trauma patients in NZ and the results are encouraging. Our 40.8/100,000 incidence is about what we would expect and the 9% Case Fatality Rate is within a reasonable (though not great) level. We are building a picture of the regional differences in the cause of trauma injuries which will enable us to build on to inform prevention activities.

The pre hospital destination policy is expected to improve the journey for the cohort of patients who are transferred multiple times before they receive definitive care, and the capability and capacity of the trauma community is growing across the country.

There is of course much more to be done before we reap the full benefits of a contemporary trauma system, and this may take 5-10 years[9]. The significant rate of progress over this year has been a key milestone in this journey.

Appendix A: Regional trauma network updates

The four regional trauma networks are the foundation of the formal trauma system. While the Northern and Midland networks have been established for some years, the new networks in Central and the South Island regions established quickly and worked hard to progress key regional and national initiatives.

A summary of the regional networks progress in the past year is outlined below, in geographical order of north to south.

Northern Region Trauma Network

Formed in 2013 the Northern Region Trauma Network has focussed on implementing an effective regional trauma system through three key initiatives:

- Inter-hospital transfer guidelines to indicate which hospital patients with specific injuries can be taken to for definitive care. This is pertinent in this region because of the split of some tertiary services between Auckland and Counties Manukau DHBs
- Single point of contact at Auckland City Hospital has been a low-cost, high-impact initiative to streamline the transfer of patients within the region
- Clinical audit of cases where there have been regional or systemic issues

The Injury 2016 conference and the Kids Trauma Conference, both supported by Auckland DHB, were held with national and international guest speakers. From the ACC incentive funding 18 nurses and allied health staff were sponsored to attend. Other DHBs and the region have developed training and education programs to advance trauma capability.

Midland Trauma System

The Midland Trauma System was established in 2010 and has developed the Midland Trauma Registry (which also hosts the NZ-MTR). Progress over the past year has focussed on strengthening trauma data collection and analysis through:

- Modification to enable other DHBs to access the registry with easy access to the NMDS
- Approval for a business case for an additional server to provide the platform for improved reporting and analysis
- Data entry decentralised to achieve entry at point of contact
- Business Intelligence tool developed to enable analysis of trauma data

The regional trauma symposium was held in May with national and international guest speakers. In collaboration with the University of Waikato a research post has been appointed to advance trauma research.

Central Region Trauma Network

Established in May 2015 the Central Region Network has progressed through the network foundation activities to identify its regional priorities. With cross-sector representation the network has focussed on education and training on AIS and use of the Registry, and education on broader trauma topics through the regional and CCDHB trauma symposium held in Wellington.

Resource for data collection is in place in all DHBs.

South Island Trauma Workstream

The South Island Workstream was established in 2015 with a focus on identifying the resource requirements to collect data and coordinate care across the region. This has had some limited success with Timaru Hospital in South Canterbury the only place to implement resource initially. The subsequent appointment of a coordinator at Christchurch Hospital in early 2016 was a major step and important given the Hospital's role as the main referral centre for the region and the largest trauma centre in the country. Data collection in Southern, West Coast and Nelson Marlborough has been patchy or non-existent.

Despite these challenges, the region has built on strong leadership and a good level of interest amongst its members.

Glossary

ACC	Accident Compensation Corporation
AIS	Abbreviated Injury Score
DHB	District Health Board
ISS	Injury Severity Score
MoH	Ministry of Health
MTNCN	Major Trauma National Clinical Network
NZ-MTR	New Zealand Major Trauma Registry
RTC	Road Traffic Crash

References

1. Cameron P, Gabbe B, Cooper D, et al. *A state-wide system of trauma care in Victoria: effect on patient survival.* Med J Aust. 2008;189:546–550
2. Gabbe B, Simpson P, Sutherland AM et al. *Improved Functional Outcomes for Major Trauma Patients in a Regionalized, Inclusive Trauma System.* Annals of Surgery 2012; 255:1009-1015
3. Roberts DJ, Ouellet J, McBeth PB et al. *The "weekend warrior": Fact or fiction for major trauma?* Can J Surg. 2014;7: E62–E68
4. Gabbe B, Lyons AB, Fitzgerald MC et al. *Reduced Population Burden of Road Transport–related Major Trauma After Introduction of an Inclusive Trauma System.* Annals of Surgery 2015; 261:565-572
5. Baker SP, O'Neill B, Haddon W Jr, Long WB. *The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care.* J Trauma. 1974;14:187-96
6. MacKenzie E, Rivara F, Jurkovich G, et al. *A national evaluation of the effect of trauma-center care on mortality.* New Engl J Med. 2006;354:366–378
7. Davidson GH, Hamlat CA, Rivara FP et al. *Long-term survival of adult trauma patients.* JAMA 2011;305(10):1001-7
8. Cowley RA. *A total emergency medical system for the state of Maryland.* Md State Med J 1975;45:37-45
9. Nathens AB, Jurkovich GJ, Maier RV, et al. *Relationship between trauma center volume and outcomes.* JAMA. 2001; 285: 1164–1171

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